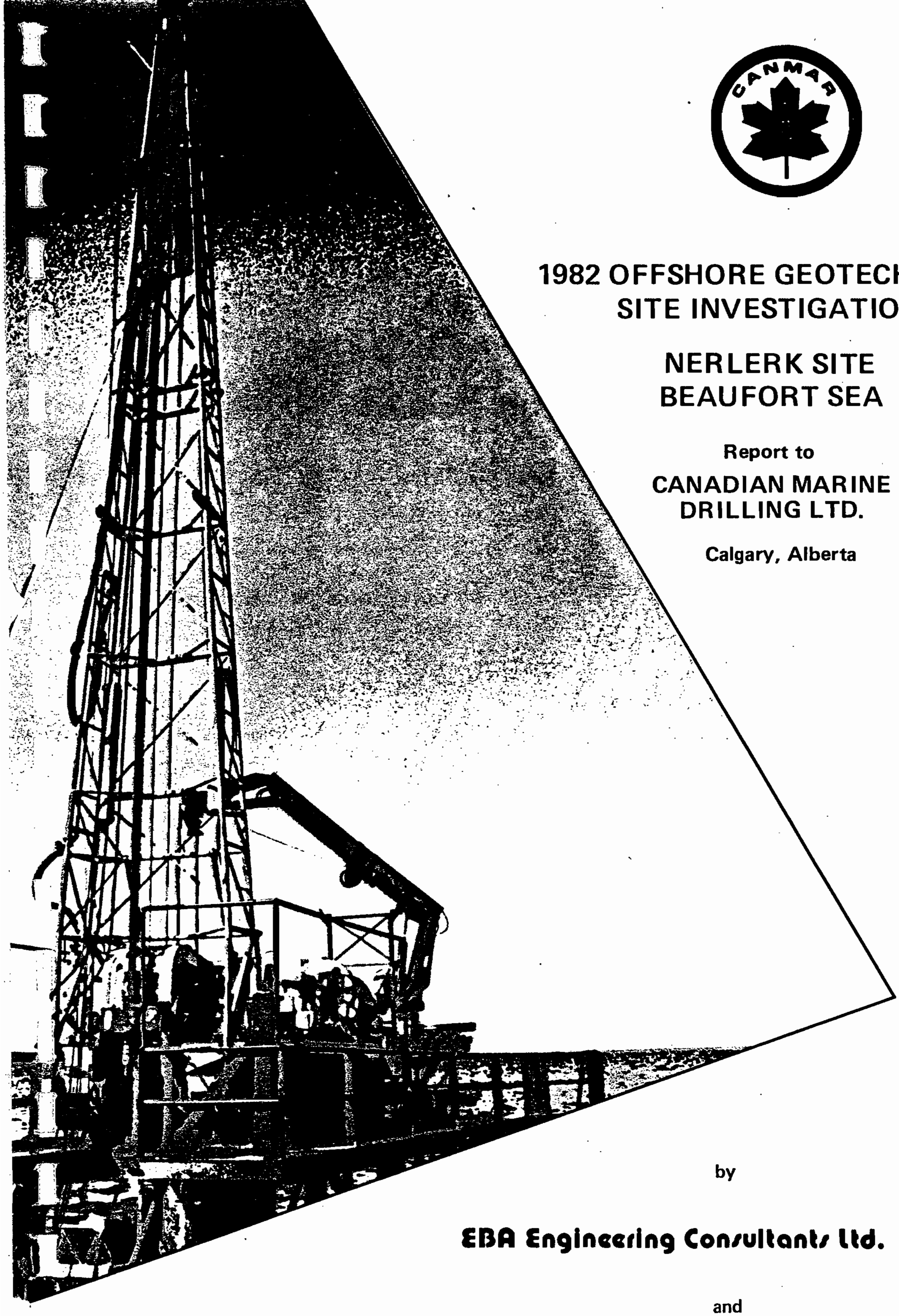

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION

NERLERK SITE
BEAUFORT SEA

Report to

CANADIAN MARINE
DRILLING LTD.

Calgary, Alberta

by

EBA Engineering Consultants Ltd.

and

McClelland engineers, inc.

EBA Engineering Consultants Ltd.

EARTH-SCIENCES ENGINEERING

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1983 02 03

Canadian Marine Drilling Ltd.
Roslyn Building
5th Floor, 400 - 5 Avenue, S.W.
CALGARY, Alberta
T2P 3G3

Our File: 101-3605

Attention: Mr. K.J. Hewitt, P.Eng.
Senior Geotechnical Engineer
Beaufort Sea Construction

Dear Sirs:

Re: Final Report - "1982 Offshore Geotechical Site Investigation
Nerlerk Site, Beaufort Sea"

We are pleased to submit 10 copies of the subject report, which are attached herewith. This constitutes our final transmittal for this site investigation project. The project team of EBA Engineering Consultants Ltd. and McClelland Engineers, Inc. has appreciated the opportunity to work on this interesting project, and we hope that our contribution has been of value to Canmar.

We would also like to thank you and your colleagues for the assistance and cooperation that was extended during the planning, execution, and reporting stages of this project. Should you have any questions or comments that arise regarding our final report, please do not hesitate to contact us.

Yours very truly,

EBA Engineering Consultants Ltd.

W.D. Roggensack, Ph.D., P.Eng.
Associate Consultant

WDR/dmt

Encl.

cc Mr. C. Ehlers, P.E. - MEI

14535-118 AVENUE, EDMONTON, ALBERTA T5L 2M7 TELEPHONE (403)451-2121

THE ASSOCIATION OF
PROFESSIONAL ENGINEERS
OF ALBERTA
PERMIT NUMBER
P 245
E B A ENGINEERING
CONSULTANTS LTD.

1982 OFFSHORE GEOTECHNICAL
SITE INVESTIGATION
NERLERK SITE
BEAUFORT SEA

Report to

CANADIAN MARINE DRILLING LTD.
CALGARY, ALBERTA

by

EBA ENGINEERING CONSULTANTS LTD.
EDMONTON, ALBERTA

and

McCLELLAND ENGINEERS INC.
HOUSTON, TEXAS

JANUARY 1983

EXECUTIVE SUMMARY

A geotechnical investigation of seabed soil conditions was performed for Canadian Marine Drilling Ltd. at the Nerlerk site in the Beaufort Sea. The objectives of this investigation were to provide ground-truth data for a previous seismic survey program, to verify and evaluate granular borrow prospects, and to determine soil and foundation conditions prior to island construction and drilling of an exploratory well.

Drilling was carried out at forty four locations for a total of 587 metres of borehole. Water depths across the site range from 42 to 48 metres. An integrated drilling plan incorporated three different borehole depths, and both the Failing 1500 rotary drill and the Rokleng air hammer (vibrocorer) were used to advance the boreholes. Twenty two short boreholes penetrated less than 6 metres into the seabed, twenty one boreholes of intermediate length were advanced to an average of 30 metres seabed penetration, and a single borehole was advanced to 122 metres seabed penetration. This report describes the methodology involved in obtaining soil samples and performing laboratory tests, and includes a complete presentation of the test results.

Field and laboratory tests were performed on most of the soil samples recovered. Field tests included determination of moisture content, core temperature, shear strength, bulk density, frozen moisture content. Representaive cores were photographed. The laboratory program conducted in EBA's Edmonton laboratory consisted of additional classification, index, shear strength and consolidation tests. Subconsultants reported separately on the time domain reflectometry data, porewater chemistry analyses, and light hydrocarbon gas analyses.

Although anomalies exist, soil conditions generally consist of a one metre thick surficial layer comprising very soft to soft CLAY and CLAYEY SAND which grades into a 52 metre thickness of fine-grained SAND. The first 13 metres of this SAND (to -60 m Elevation) was described as unfrozen with frequent thin laminations or thin interbeds of CLAY, SILT, ORGANICS and coal detritus. The remainder of this SAND unit was observed to have infrequent thin laminations. The last 18 metres of SAND was frozen, well-bonded with no excess ice (Nbn). This frozen SAND grades into a 57 metre thickness of very stiff CLAY and SILT at -95 m Elevation. Only the last 20 metres of the CLAY and SILT (below about -132 m Elevation) was described as frozen, poorly-bonded (Nf) with a single 2 mm thick ice lens (Vs) observed. The frozen CLAY and SILT grades into frozen fine-grained SAND with thin laminations of SILT and ORGANICS near the -152 m Elevation. The boring penetrated only 15 metres of this deepest SAND, which was described as well-bonded with no excess ice (Nbn).

The two main factors to be considered in evaluating foundation conditions for island design are the soft soil layer at the seabed and the clay interbeds in the sand encountered within 15 metres of seabed. Development of the Nerlerk sands for use as borrow in island construction presents concerns because the fines content is greater than 5 percent to at least the -60 m Elevation, thus detrimentally affecting the texture of dredgeable borrow. Although none of the frozen soils encountered exhibited high ice contents, the sands may require thermal consideration during drilling to control erosion.

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1.0 INTRODUCTION

1.1 Outline of Site Investigation

A preliminary geotechnical site investigation of seabed soil conditions was performed for Canadian Marine Drilling Ltd. (Canmar) at the Nerlerk Site in the Beaufort Sea. The objectives of this investigation were to provide ground-truth data for the seismic survey program, to verify and evaluate granular borrow prospects, and to determine soil conditions prior to island construction and drilling an exploratory well.

The fieldwork was carried out intermittently between July 4 and September 20, 1982 (26 elapsed days). Drilling was carried out at forty four locations for a total of 587 metres of borehole. The water depths across the site range from 41.8 to 47.5 metres. All the borehole coordinates were selected by Canmar field representatives. The general location of the Nerlerk site in the Beaufort sea is shown on Figure 1, and the detailed site map in Figure 2 shows all the borehole locations. The borehole coordinates are tabulated in Appendix A.

The field program utilized an integrated drilling plan that incorporated three different borehole depths:

1. Twenty two short boreholes were advanced less than 6 metres into the seabed. Sixteen of these were drilled with the Rokleng air hammer which was capable of a 5 metre maximum seabed penetration. The remaining six boreholes were drilled with the Failing 1500 rotary drill rig. The main purpose of these short boreholes was to verify the thickness and distribution of the surficial clay layer. This data was used

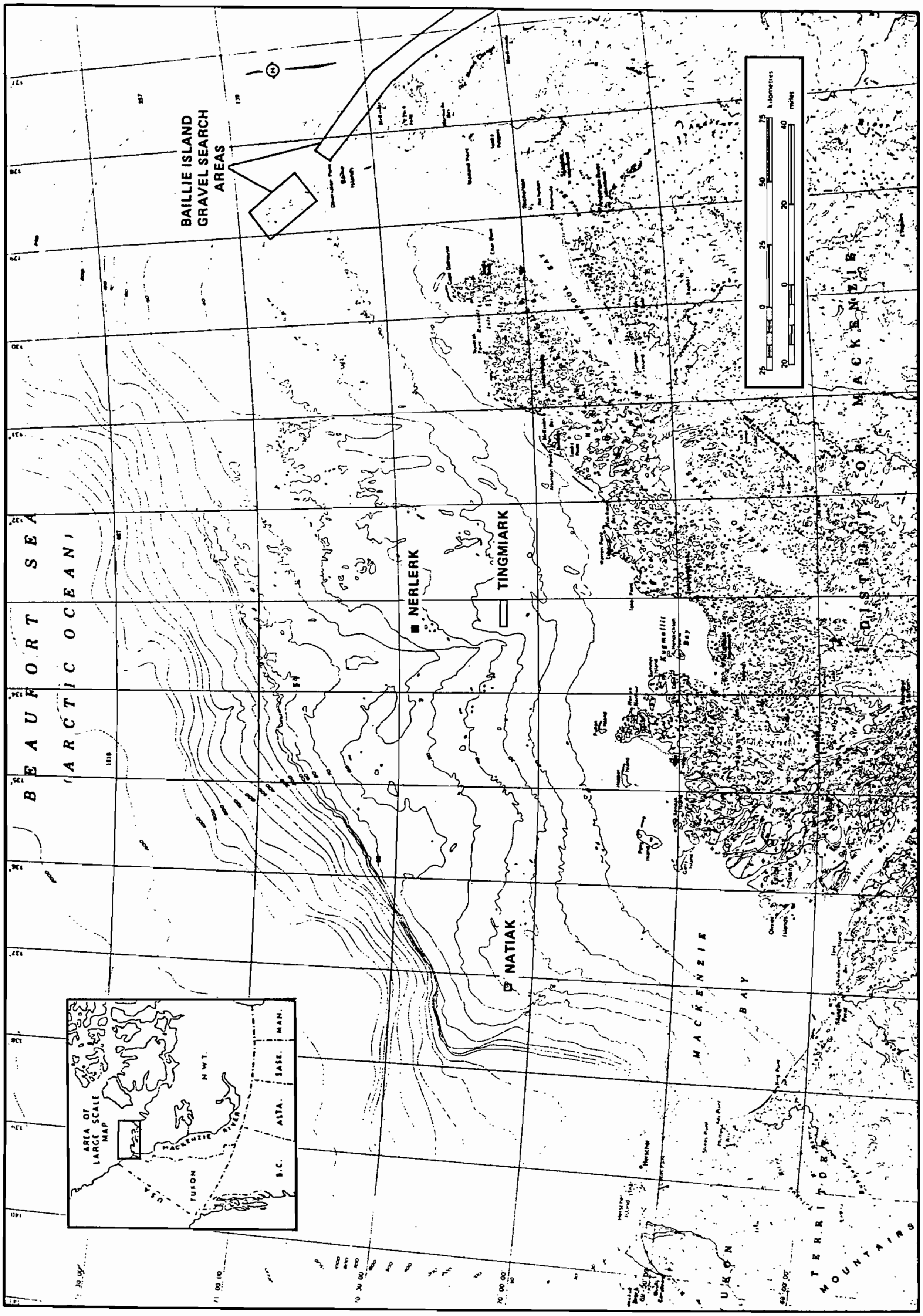

FIGURE 1 — GENERAL LOCATION MAP

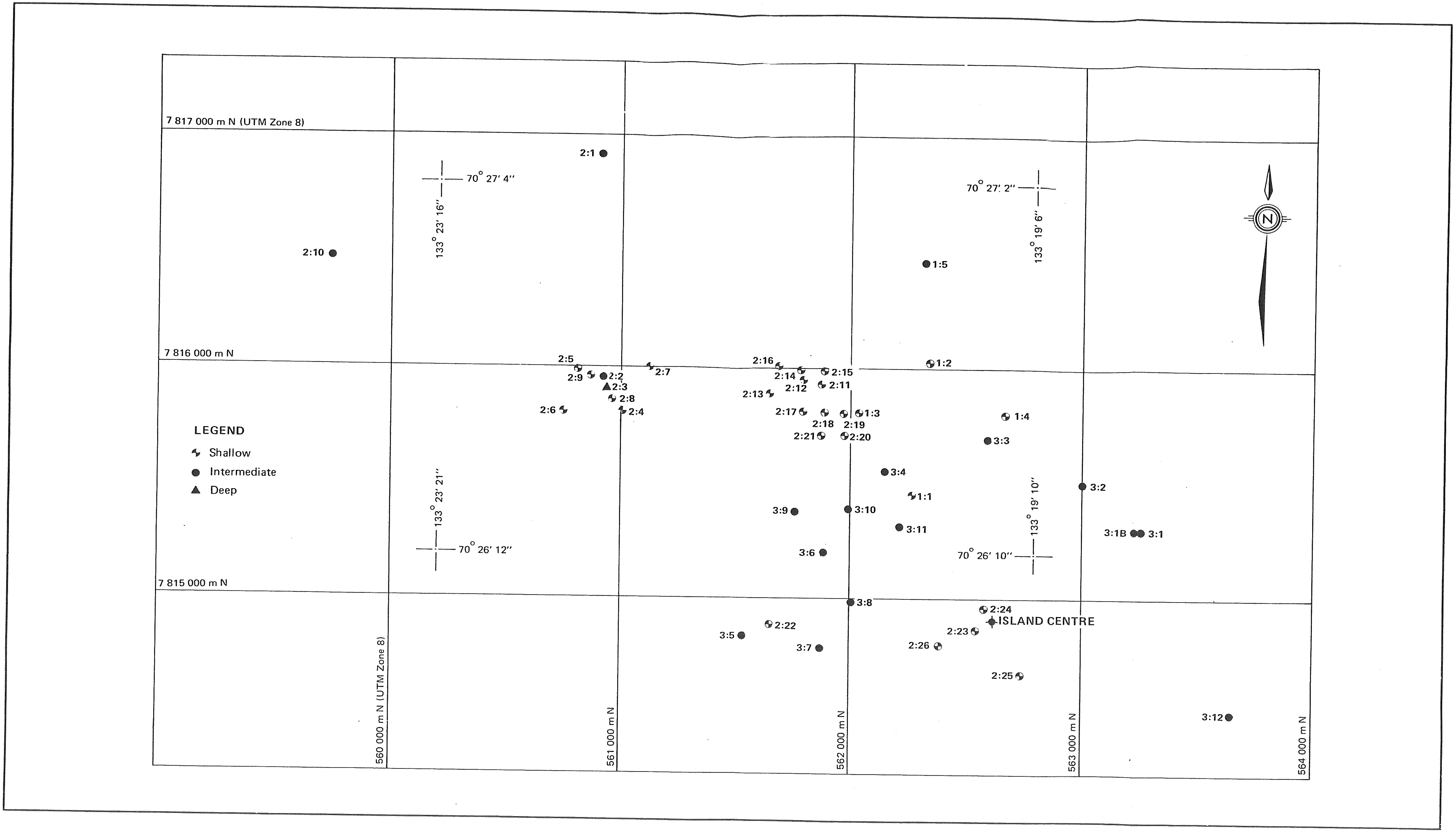

FIGURE 2 DETAILED BOREHOLE LOCATION MAP FOR NERLERK SITE

to assist in the field interpretation of high resolution shallow seismic records.

2. Twenty one boreholes of intermediate length were advanced 12 to 32 metres into the seabed. All these boreholes were drilled with the Failling 1500, and the first seventeen were drilled to an average of 30 metres seabed penetration. The purpose of these intermediate length boreholes was to penetrate and sample potential sand borrow to a depth exceeding the dredging limit of the Aquarius. The last four of the intermediate length boreholes were stopped at about 15 metres seabed penetration because the seismic data and results from the previous seventeen boreholes had indicated insignificant variations in sand lithostratigraphy below this depth.

3. A single borehole was advanced to 122 metres seabed penetration. The primary purpose of this borehole was to provide ground-truth for the deeper multichannel seismic survey that is used to evaluate geological hazards. Also, sufficient numbers of quality samples were recovered from this deep borehole to permit a preliminary evaluation of the foundation conditions.

Geotechnical work completed at this site is shown relative to other 1982 field activities in an operational calendar included as Figure 3.

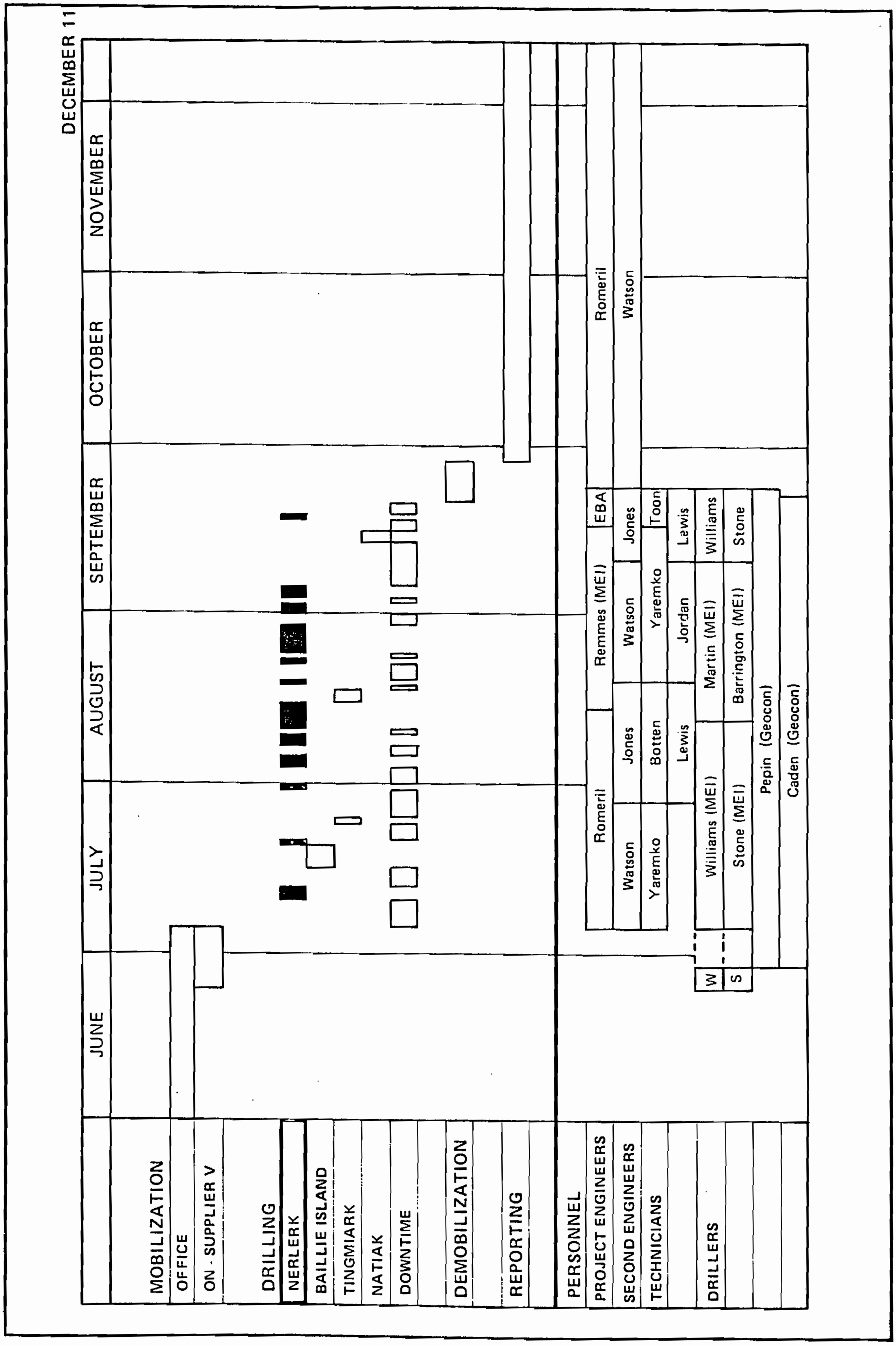

FIGURE 3 OPERATIONAL CALENDER

1.2 Execution of the Investigation

Several companies were actively involved in the fieldwork. The companies and their respective responsibilities were as follows:

- Joint Venture, EBA Engineering Consultants Ltd. (EBA), Edmonton, Alberta and McClelland Engineers Inc. (MEI), Houston, Texas.

  Either EBA or MEI provided a site engineer who supervised the field operations under the direction of Canmar's representative. EBA also provided three junior engineers/technicians who were responsible for the logging, handling, and subsequent laboratory testing of samples recovered. MEI provided two drillers who were responsible for all rotary drilling and sampling operations. EBA produced this report.

- Geocon Offshore Ltd., Toronto, Ontario

  Provided two drillers to act as helpers in the rotary drilling operation, and to operate the vibrocoring equipment.

- Offshore Navigation (Canada) Limited/Dome Survey

  Provided two surveyors and "ARGO" positioning equipment for directing the vessel to designated borehole locations.

- Canadian Marine Drilling Ltd. (Canmar), of Calgary, Alberta

  Provided all marine plant and services, as well as, one crew member per shift to assist in the drilling operations.

1.3 Authorization for Investigation

The site investigation was carried out with the various participants listed above and was supervised by Canmar representatives Mr. K. Hewitt, P.Eng., Mr. G. Johnson and Mr. M. Bradshaw. The work was performed as part of Canmar AFE No. 097-2052 under PR No. 0168490.

2.0 FIELD INVESTIGATION

2.1 Drilling and Sampling

The fieldwork was executed from the Canmar Supplier V, a 40 metre long shallow-draught vessel specially equipped for geotechnical investigations. The vessel was positioned at designated borehole locations by means of a microwave range-range system (ARGO); the positioning system is thought to provide coordinate accuracy to within ±5 metres.

Most of the boreholes were drilled by a Failing 1500 rotary rig mounted near the stern of the vessel, and working through a moonpool situated approximately amidship. The drill rig was mounted on a platform standing 3.2 metres above the deck. Borings were advanced using an open-centre drag bit with tungsten carbide inserts, which cuts a hole of 228 mm nominal diameter. The drill string comprised "NC50" drill pipe of 114 mm -ID and 156 mm -OD at the tool joints. Seawater was mixed with 'Zeogel' attapulgite mud and "Baroid" barite weight components in varying ratios (dependent upon the formations encountered) for use as circulating fluid. Occasionally, caustic soda was added to accelerate the gelling process of the attapulgite mud. The mud mixture was kept as cool as possible by drawing water from below the warmer surface waters. Mud temperatures were generally about +4°C or cooler. As conductor casing was not employed during any of the borings, drilling mud was discharged on the seabed.

With the rotary drill, sampling intervals were the same for each borehole, regardless of the depth of final penetration. Tube samples were collected semicontinuously at 1 metre intervals for the first 15 metres, and at 3 metre intervals thereafter, using either 57 mm -ID or 76 mm -ID stainless steel tubes. In both thick-walled and thin-walled configurations. The tubes were either pushed with the drill string or driven with a wireline hammer. The type of sampler or sampling method used at any particular depth in a borehole was specified on the basis of the soil conditions and objectives. The percussion sampler and 57 mm -ID thin-walled tube combination was routinely used to start all the boreholes in this investigation. If an undisturbed sample was required from the surficial clay or from any clay layer encountered at depth, the push sampler was utilized with a 76 mm -ID thin-walled sample tube. Pushing the large diameter thin-walled tubes yields samples with only minimal sample disturbance. In previous field programs only the percussion sampler was utilized.

The push sampler was a mechanical latch-in wireline retractable system operated through the bore of the drill pipe. The push sampler comprises a sampling tube adapter to connect the tube to the latch-in assembly and the latch-in assembly equipped with mechanical pawls that are engaged at the bit face by a weight with an overshot on top. In this operation, the drill pipe was raised off the bottom of the borehole and the sampler falls under its own weight to the bit, where the weight mechanically latches the sampler into the bit. The sample tube extends through the open-faced drag bit. The entire drill string was then lowered to fill the sample tube, after which the assembly and sample was retracted and retrieved to surface with an overshot on a wireline.

The percussion sampler was also operated on a wireline through the bore of the drill pipe and was driven with a 79.4 kg sliding weight. Normally, the weight was dropped between 20 and 30 times through approximately 1.5 m to achieve the desired 0.6 m penetration of the sampler. As neither the free fall of the weight nor the penetration of the sampler can be measured during normal sampling practice, the penetration resistance of the soil cannot be reliably estimated from blow count/penetration records.

To investigate the surficial deposits, short borehole cores were extracted as often as possible using a vibrocoring unit. Vibrocoring was effected using the free-standing, remote Rokleng air hammer unit lowered to the sea-floor from a crane mounted at the stern of the vessel. The unit comprises an air hammer supported in a guide frame and mounted at the top of a 5 metre long steel coring tube. The coring tube is fitted with a steel basket-type core catcher and a 65 mm -ID PVC liner. The air hammer and coring tube assembly are connected directly to the crane winch, and are free to move down within the guide frame as penetration occurs. An umbilical tube connects the air hammer to an air compressor situated on the vessel. The air hammer was typically operated for 30 to 60 minutes before retrieving the vibrocore. During withdrawal, the crane first lifts the core tube out of the seabed, then returns the entire vibrocore unit to the vessel. Depth of penetration was measured with a slide mounted on the guide frame that is displaced downward by the air hammer as the coring tube advances into the seabed. A schematic of the vibrocorer is presented in Figure 4.

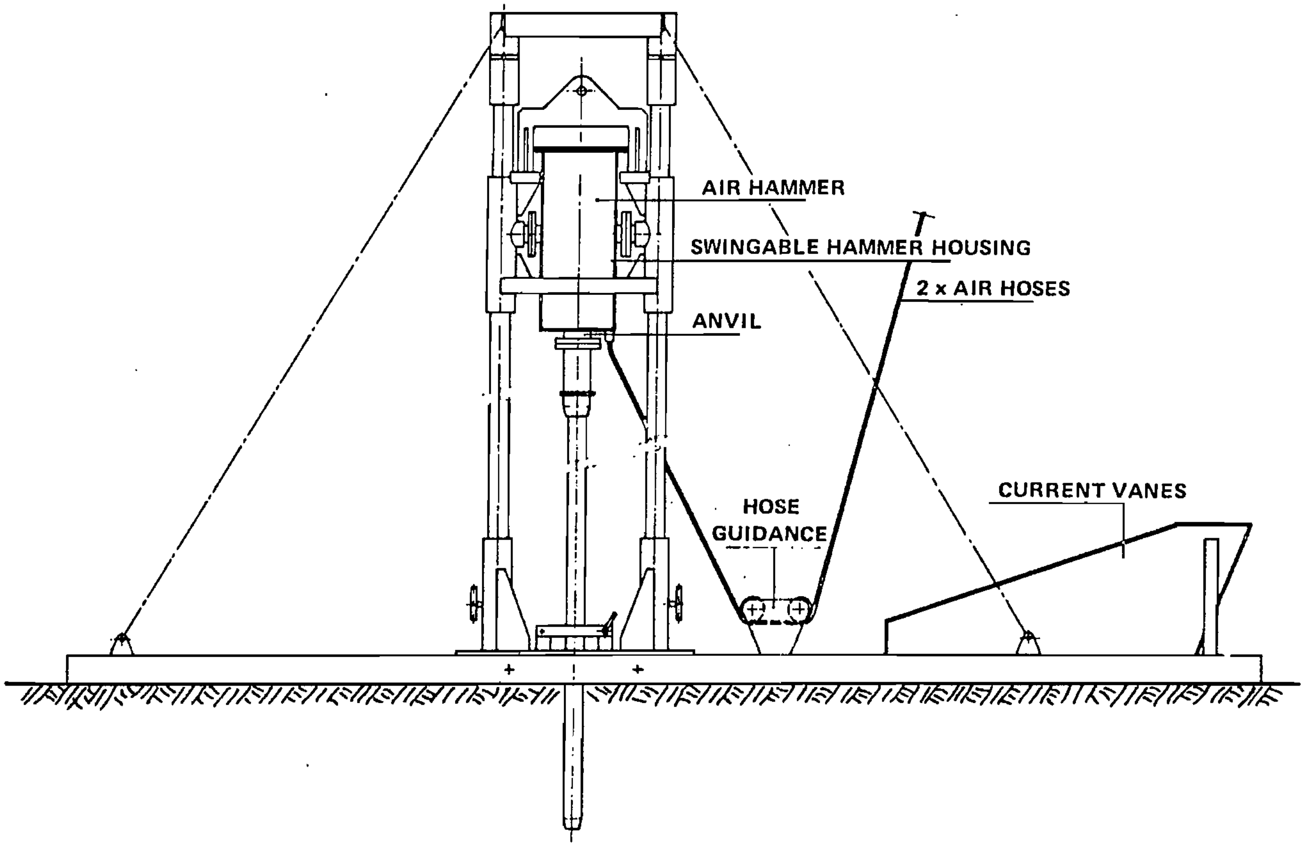

FIGURE 4 SCHEMATIC OF 'ROKLENG' AIR HAMMER UNIT

2.2 Sample Handling and Ship-Board Testing

Immediately upon recovery of the sampling tube from the borehole, the temperature of soil contained therein was determined using a thermistor probe accurate to ±0.1°C. The probe was inserted about 50 mm into the end of the sample. Depending upon the nature of the soil observed in the end of the sampling tube, a sequence of standard procedures was carried out in the ship-board laboratory to determine pertinent soil properties.

Rotary drilling provides tube samples of unfrozen cohesive soil that are relatively undisturbed. Unfrozen cohesive soils were generally subjected to a simple "Pilcon" hand vane used to estimate the undrained shear strength of soil. Time domain reflectometry (TDR) analysis was also carried out before extrusion of most samples with a temperature below 0°C indicating a potential for frozen moisture. TDR analysis provides an approximate measure of the frozen moisture content of the sample. The sample was then either fully extruded or retained in the sampling tube and sealed with wax. In the latter case, a portion of the sample was extruded for logging and testing prior to sealing the tube. Only one of the undisturbed samples taken at the Nerlerk site was retained in the tube. All unfrozen cohesive samples were split, logged and photographed immediately after extrusion. The high quality unsplit samples were wrapped in cellophane and placed in cylindrical cardboard containers. Sand was placed in the annulus between the soil sample and the container, and then the container was sealed with wax. Subsamples split from the main sample during this phase were subjected to moisture content and fall-cone shear strength determinations. All remaining materials were sealed in labelled polyethylene bags, pending further analysis. Undrained shear strengths measured by the fall-cone and 'Pilcon' vane are presented on the borehole logs in Appendix A, and on a summary shear strength profile in Appendix B. These data are also tabulated on the laboratory testing summary sheets in Appendix C.

Because tube samples of unfrozen noncohesive soil likely experienced moderate mechanical disturbance, there was no reason to preserve core, so all samples were fully extruded and logged immediately upon recovery. Whenever possible, subsamples were selected from the midpoint of the representative sample length for moisture content and particle size distribution analyses to avoid zones that may have been contaminated by drilling mud. The remaining material was sealed in labelled polyethylene bags, pending further testing.

TDR analysis was performed on all well-bonded frozen soils prior to extrusion. Irrespective of texture, the soil was generally extruded fully, and a portion was immediately removed, wrapped and placed in the freezer. The remaining sample was split, logged and photographed as quickly as possible to minimize thaw, then further subsamples were taken for moisture content and bulk density determinations. If sufficient cohesive sample was available, the remaining core was allowed to thaw, and was prepared for storage as described above for unfrozen cohesive soils. A small core segment was routinely allowed to thaw so that consistency could be compared before and after thaw. This allowed an indirect assessment of the effect of nonvisible ice bonding.

The vibrocore unit provided a continuous sample from the seabed to a maximum penetration of 5 m. Upon removing the PVC liner from the steel coring tube, the liner was cut into 1 m sections starting at seabed and proceeding to the bottom end of the core. Each section was then split longitudinally to expose the 65 mm -OD sample. In all cases, the sample was mechanically disturbed, but remained straigraphically intact. Most of the core was photographed, then representative portions were selected for classification testing. The remaining samples were sealed in labelled plastic bags, pending further analysis.

In addition to the procedures detailed above, smaller subsamples were taken from selected intervals to facilitate analysis of porewater chemistry and dissolved gases.

Undisturbed frozen samples were transported between the ship and EBA's Edmonton laboratory in freezers modified to maintain samples at or near in situ temperatures. Whenever possible, the freezers were kept operational when stored in a warm area during transportation. The max-min thermometers which accompanied the samples during transportation showed that samples stored in the freezer had been exposed to a maximum temperature range of 0°C to -8°C. The single undisturbed unfrozen sample that remained sealed in a sampling tube was hand-carried between the ship and EBA's Edmonton laboratory. These samples were exposed to ambient temperatures estimated to be between 0°C and 20°C. Mechanically disturbed samples were stored in pails and shipped in large wooden crates; these samples were not protected from extremes of temperature.

2.3 Time Domain Reflectometry

Time domain reflectometry (TDR) is an experimental field technique that has been adapted to determine the volumetric unfrozen water content of permafrost soils. The dielectric constant is determined by measuring the velocity of propagation of electromagnetic waves transmitted between parallel transmission lines embedded in soil, using time domain reflectometry. The dielectric constants of soil and ice are similar, but differ significantly from the dielectric constant of water; therefore, variations in unfrozen water content directly affect the measured travel times (i.e. apparent dielectric constant). Patterson and Smith (1981) successfully applied the TDR technique to measurement of unfrozen water content in partially-frozen nonsaline soils.

The field equipment package used in this investigation was modelled after the experimental equipment utilized by Dr. M.W. Smith in his research studies at Carleton University. The TDR unit is a commercially available cable tester (e.g. a Tektronix 1502). The tester consists of a pulse generator which produces a fast rise time step voltage, a sampler which transforms a high frequency signal into a lower frequency output, and an oscilloscope or recording device. TDR measurements are made by launching the step signal into the soil and measuring the travel time. More detailed descriptions of the working principles of the TDR technique can be found in Topp et al. (1980) and Smith and Patterson (1980).

A trace typical of those obtained from ice-bonded soil sampled during this investigation is shown in Figure 5. The dielectric properties of the material are characterized by the shape of the trace between points A and B. The horizontal distance between these two points represents the travel time of the signal through the soil. This travel time is converted to a volumetric unfrozen moisture content from an empirical chart presented by Topp et al. (1980). These volumetric values are then converted to the more usual gravimetric values, using the dry density of the soil which is determined separately. The frozen moisture contents estimated from TDR results are plotted in profile in Appendix B, and are tabulated on the laboratory testing summary sheets in Appendix C.

As TDR remains an experimental procedure, especially in soils exhibiting saline porewater, the results presented in this report are intended to

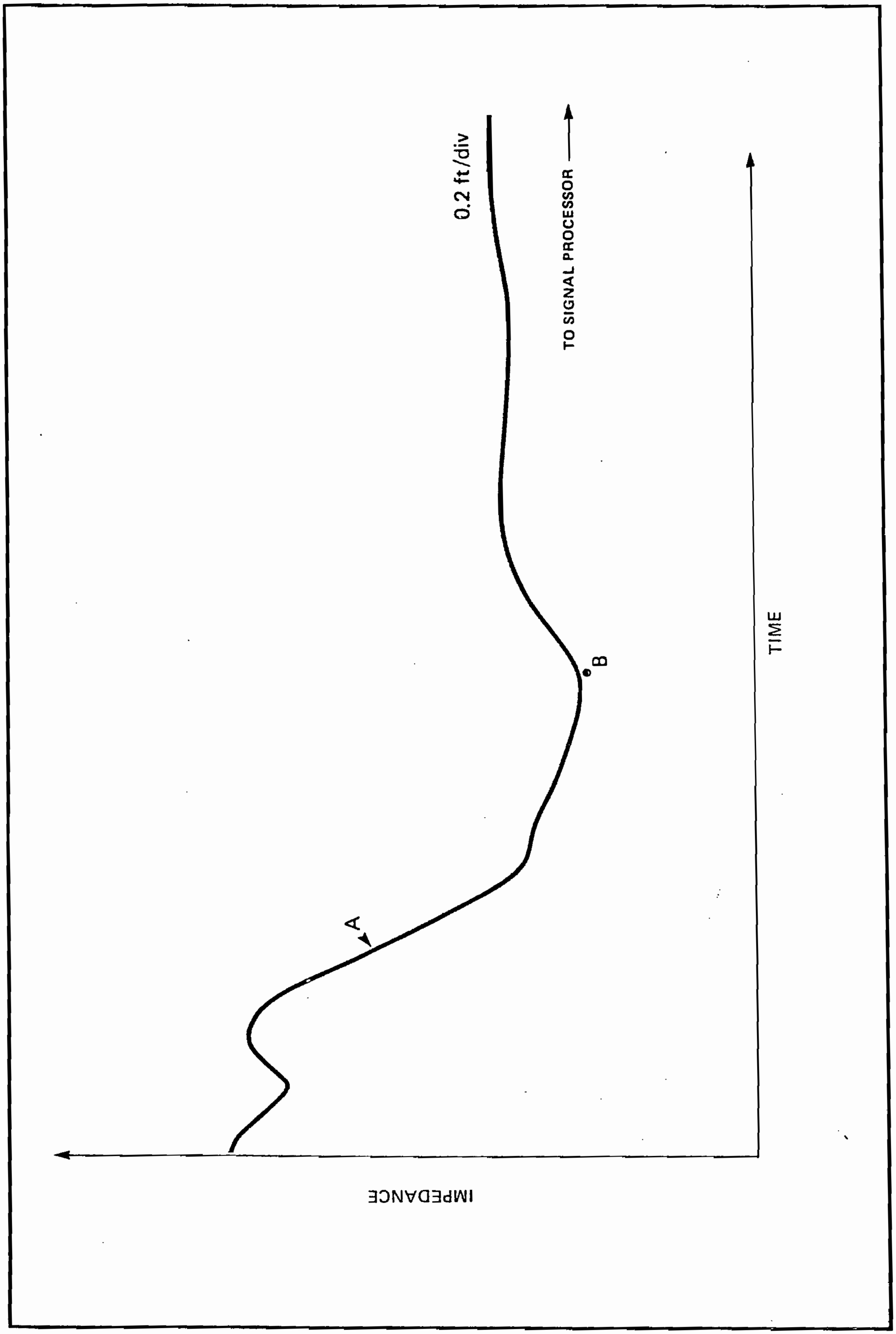

FIGURE 5 TYPICAL TDR TRACE

provide only an indication of the degree of ice bonding of the sample. TDR was adopted as a field procedure to augment the description and classification of ground ice contained in poorly-bonded, saline permafrost soils. Due to the experimental nature of the TDR equipment and procedures, the field data is externally reviewed. As part of this review process, a general progress report, and evaluation of the TDR technique and test results was commissioned and is included in Appendix F.

3.0 LABORATORY TESTING OF SAMPLES

3.1 Particle Size Distribution

3.1.1 Sieving Method

This test was performed on 241 samples in accordance with ASTM standard designation D 422-63 (Reapproved 1972). Where necessary, the samples were divided by riffle-box to produce samples of standard mass. All samples were prepared in accordance with ASTM designation D2217-66 (Reapproved 1972) if hydrometer method tests were not required. Particle size distribution curves obtained by sieving are presented in Appendix C.

3.1.2 Hydrometer Method

This test was performed on 33 samples in accordance with ASTM standard designation D-422-63 (Reapproved 1972). The samples were pretreated with hydrogen peroxide to remove organic matter. Particle size distributions obtained from hydrometer analyses are presented in Appendix C.

3.2 Atterberg Limits

Atterberg limits were determined for 49 samples, and results are presented in Appendix C.

3.2.1 Liquid Limit

Liquid limits were determined in accordance with ASTM standard designation D-423-66 (Reapproved 1972), using a three-point method.

3.2.2 Plastic Limit

The plastic limit test was performed in accordance with ASTM standard designation D-424-59 (Reapproved 1971). Composite profiles of plasticity index and liquidity index are presented in Appendix B.

3.3 Natural Bulk Density and Dry Density

Densities were calculated for the triaxial and oedometer specimens by obtaining the weight of a known volume of soil and the associated moisture content. The results of these determinations are tabulated in the summary of laboratory test results in Appendix C, and also with the shear strength and consolidation test results in Appendices D and E, respectively.

3.4 Specific Gravity of Mineral Grains

The specific gravity of soil solids was determined for 5 samples in accordance with ASTM standard designation D854-58 (Reapproved 1972). The results are presented in Appendix C and have been used in calculations associated with other test results.

3.5 Strength Testing

3.5.1 Triaxial Shear Testing

Unconsolidated-undrained triaxial testing of 8 undisturbed unfrozen samples with diameters between 30 mm and 50 mm were conducted according to procedures described in Appendix H. A pore pressure response test was performed on 10 triaxial specimens to obtain an indication of the degree of saturation prior to shearing. The last three samples were maintained in a frozen condition from the field but were thawed prior to testing. Results from these triaxial tests are presented in Appendix D.

3.6 Compressibility Testing

Seven samples were subjected to standard oedometer/consolidation tests, following procedures outlined in Appendix H. Individual test results are presented in Appendix E.

3.7 Porewater and Gas Analyses

3.7.1 Porewater Salinity/Chemistry Tests

Eight samples were analyzed for porewater salinity. These samples were wrapped in several layers of plastic and duct tape immediately after extrusion in the field, and were then frozen. Five samples were shipped in the frozen state to Dr. J.F. Barker, University of Waterloo, for complete porewater chemistry analysis. The remaining three samples were analyzed in EBA's laboratory utilizing the titration procedure for determining porewater salinity that is outlined in Appendix H. Porewater salinity data is presented in profile in Appendix B, and also appears in tabular form in Appendix F.

3.7.2 Dissolved Gas Analysis

Samples for gas analysis were sealed in 500 ml cans in the field with approximately 400 ml of deaired brine, and were shipped to the University of Waterloo. Five samples were analyzed, and test results are presented in Appendix F.

3.8 Organic Content

Eight samples were subjected to organic content determinations, utilizing the ignition procedure described in Appendix H. Results from these tests are presented in the tabular summary of laboratory results in Appendix C.

4.0 SITE STRATIGRAPHY

4.1 General Geological History

The sediments encountered in this geotechnical exploration were probably deposited during the Illinoisan and Wisconsin stage of the Quaternary Period.

The oldest units penetrated comprise a glaciofluvial deltaic sequence that occupies a structural depression developed by late Cretaceous block faulting. This sequence consists of prodeltaic and marine clay-silt-sand rhythmic units, and is probably of Illinoisan age. The overall distribution and nature of the overlying sediments has been influenced by two major sea level fluctuations in the Wisconsin stage. These events depressed sea level to between 60 and 100 metres below present level and exposed the shelf to a periglacial climate and consequent permafrost aggradation. This exposure of the shelf resulted in some subaerial erosion and aeolian deposition. The thick layer of uniform fine-grained sand deposited during late Wisconsin appears to be fluviodeltaic in origin and lies uncomformably on the eroded older deltaic sequence. While the sea levels were depressed, a significant distributary of the prehistoric Mackenzie River cut a deep channel (Kugmallit Trough) through the fine-grained sands, establishing a route for drainage and imposing deposition control that remains active to the present day.

As the sea level rose during the late Wisconsin marine transgression, submergence by relatively warm, shallow water thawed parts of the frozen land surface. Reworking of surface material also took place during the transgression, redepositing material in sequences that reflect the uneven advance of the sea over the land surface. A sustained influx of fine-grained sediment from the Mackenzie River concurrently filled local drainage channels that had developed during periods of depressed sea level and blanketed regions of low current activity.

4.2 Lithostratigraphy

The Nerlerk site lies on the edge of a thick deltaic sand wedge covering the continental shelf to the east of the Kugmallit Trough. This extensive sand plain lying off the Tuktoyaktuk peninsula is designated here as the Tuktoyaktuk Plain. The site is situated proximal to the mouth of an old, shallower distributary of the Mackenzie River. During the late Wisconsin marine transgression and again in relatively modern times, this distributary was probably an active depositional environment. Deposition and erosion associated with current activity probably caused extensive reworking of sediments. Current activity appears to have precluded any significant accumulation of finer-grained Holocene sediments.

The lithostratigraphy of the Nerlerk Site as revealed by the soil samples recovered to 122 metres seabed penetration can be characterized as follows:

LITHOSTRATIGRAPHIC UNIT		THICKNESS (m)	SEABED PENETRATION AT TOP OF UNIT (m)	ELEVATION AT TOP OF UNIT (m)
UNIT I	Surficial layer of very soft to soft CLAYS and SANDS, not frozen [Holocene Sediments]	0.2 to 2		-44 to -47
UNIT II	Fine-grained SANDS with frequent thin laminations and/or thin interbeds of CLAY, SILT, coal detritus and ORGANICS, not frozen [Transgressive Sequence]	7 to 13(1,2)	0.2 to 2	-45 to -49
UNIT III	Fine-grained SAND with infrequent thin laminations of CLAY, SILT and ORGANICS, frozen at depth [Deltaic Sand Sequence]	36 to 39	11 to 16	-58 to -61
UNIT IV	Sequence of CLAY and SILT, rhythmites becoming laminated SILTY CLAY, frozen at depth [Prodelta Sequence]	57	50	-95
UNIT V	Fine-grained SAND with laminations of SILT and coal detritus, frozen. [Deltaic Sand Sequence]	15	107	-152

NOTE: 1) Unit (II) 26 to 31 metres thick in Boreholes 3:1B, 3:2, 3:3 and 3:4
2) Unit (II) absent in Boreholes 2:10 and 3:12

The surficial unit (I) sediments vary widely across the site in both texture and thickness. Textural variations encountered in unit (I) are presented here in descending order of importance. The CLAY unit (I) can be silty, sandy or both, and can exhibit low to high plasticity. The clay was described as soft to very soft with disseminated organics or very thin organic laminations. The SAND unit (I) can be silty, clayey or both, and generally becomes sandier with depth. The SAND unit (I) was observed at only two locations (Boreholes 2:1 and 2:10). Both the SAND and CLAY unit (I) were encountered with clean, fine-grained sand laminations or interbeds. The best examples of this were observed in Boreholes 3:5 and 3:6. The surficial unit (I) generally becomes coarser-grained and grades into the underlying sand unit.

The SAND unit (II) was observed on all boreholes with the only exceptions being in Boreholes 2:10 and 3:12. These sands are fine-grained with frequent thin laminations and/or thin interbeds of clay, silt, coal detritus and organics, and they rest unconformably on the underlying sand unit (III). The character of this unit was observed to change significantly across the site. The shallow seismic may provide background that would enhance interpretation of the observed variations. In Boreholes 1:5, 2:1, 2:2, 2:3 and 3:8, unit (II) was observed to have frequent laminations of clay, silty, coal detritus and organics. In the remaining boreholes, (3:1b, 3:2, 3:3, 3:4, 3:5, 3:6, 3:7, 3:9 and 3:10), unit (II) was observed to have at least one significant clay or silt interbed and frequent thin laminations of coal detritus and organics. Boreholes 3:1b, 3:2, 3:3 and 3:4 are atypical, in that a larger thickness of unit (II) sand was encountered. These boreholes indicate that unit (II) can be 26 to 31 metres thick. Boreholes 2:10 and 3:12 present anomalous lithostratigraphy because the sand underlying unit (I) is more like the sand in unit (III) than unit (II). Unit (II) may be absent at these locations.

The SAND unit (III) was encountered in Boreholes 1:5, 2:1, 2:2, 2:10, 3:5, 3:6, 3:7 and 3:8, and was fully penetrated only in Borehole 2:3, where a thickness of 39 metres was attained. These sands are fine-grained, uniform, and exhibit only minor variations in texture. The nearly total absence of both laminations and textural variations distinguishes the unit (III) SAND from the unit (II) SAND. In Boreholes 2:3 and 3:5, the SAND unit (III) below about 31 metres seabed penetration (-76 m Elevation) was frozen, well-bonded, and contained no visible ice (Nbn). Unit (III) was observed to be frozen to the contact with the underlying unit (IV) at about 50 metres seabed penetration (-95 m Elevation). Unit (III)'s basal contact is gradational into the underlying silts and clays of unit (IV). The degree of ice bonding decreases gradually to poorly-bonded with no visible ice (Nf), mainly reflecting increasing the fines contents with depth.

Unit (IV) was observed only in Borehole 2:3 where a thickness of 57 metres was attained, comprised mainly of CLAY and SILT. The top 20 metres of the unit (IV) are SILT and CLAY interbedded with occasional thin laminations of sand and organics. The CLAY interbeds often appear as convoluted structures that may represent submarine slumping. The middle 23 metres of unit (IV) are described as CLAY (CL) and SILT with thin laminations of organics. A slickensided surface oriented at 45° to the horizontal was observed at 87 metres seabed penetration (-132 m Elevation). A 2 mm thick ice lens was noted oriented parallel to the slickenside in the same sample. From this first occurrence of visible ice to the base of unit (IV), soil was logged as being frozen, poorly-bonded with no visible ice (Nf). Laminations or bedding planes oriented at 5° to 10° to the horizontal were observed in unit (IV) from 70 metres seabed penetration (-115 m Elevation) to the base of unit (IV) at 102 metres seabed penetration (-147 m Elevation). The bottom 14 metres of unit (IV) comprises 9 metres of CLAY (CH) and SILT underlain by a 5 metre thick transitional zone. The CLAY unit (IV) was described as being frozen (Nf), of high plasticity, with a trace of shell fragments, and a strong organic odor. The transitional zone covers the major textural from CLAY unit (IV) through silt and silty sand to SAND unit (V). Once again, the degree of ice bonding relects textural changes: as dian grain size increases the soil becomes well-bonded with no visible (Nbn).

D unit (V) was observed only in Borehole 2:3, where the unit was ted for 15 metres before the borehole was terminated. The sand was bed as being fine-grained with a trace of silt and coal detritus in minations. At the termination of Borehole 2:3, the unit (V) was ith a 3 mm thick lamination of coal detritus oriented at 10° to the ntal. This unit was frozen and well-bonded with no excess ice d in any of the samples recovered (Nbn).

.0 SOIL PROPERTIES

1 General

llowing section presents a summary of the soil properties derived from nical investigations at the Nerlerk site. Engineering properties are d in Appendix C, and detailed test results are given in Appendices , F, and F. Several important parameters have been plotted with depth presented as diagnostic profiles in Appendix B.

line push sampler with 76 mm -ID sample tubes was utilized to high quality undisturbed samples of the clays and silts encountered Nerlerk boreholes. In previous field programs, a percussion sampler 57 mm -ID thin-walled tubes was utilized as the primary sampling d. Both the smaller sample diameter and the percussion sampling method ute to the mechanical disturbance of the sample.

Mechanical disturbance can significantly alter the stress-strain behavior observed in triaxial tests on overconsolidated soils from the Nerlerk site. The stress-strain behavior of the triaxial tests discussed in the following section attest to the minimal sample disturbance achieved by utilizing the wireline push sampler with 76 mm -ID tubes.

5.2 Geotechnical

The thin surficial CLAY or clayey SAND unit (I) is soft to very soft in consistency. Results from grading analyses vary considerably, but all samples from unit (I) comprise a mixture of clay, silt and sand such that the samples exhibit plasticity. The fine fraction classifies as CH, CL, or SC on the basis of Atterberg limits, with the data plotting parallel to and near the "A" line, as shown in Figure 6. These results probably reflect the gradation between the soft surficial layer, through a mixed zone of variable texture, into the underlying fine-grained sand.

The SAND unit (II) was seen to be predominantly fine-grained with frequent silt and clay interbeds or laminations that are responsible for the broad grain size distribution envelope shown in Figure 7. Generally, the SAND unit (II) has a fines content less than 20% and a D_{50} in the range of 180 to 320 microns. Silt and clay layers produce localized fines contents of up to 80% and D_{50}'s as low as 50 microns. The occurrence of the silt and clay layers within unit (II) is variable across the site from a series of 25 mm thick laminations observed in Boreholes 1:5, 2:1 and 2:2 to a 1000 mm thick clay or silt interbed in Boreholes 3:1b, 3:2, 3:3, 3:4, 3:5, 3:6, 3:7, 3:8, 3:9, 3:10, and 3:11. Unit (II) appeared to be absent in Boreholes 2:10 and 3:12.

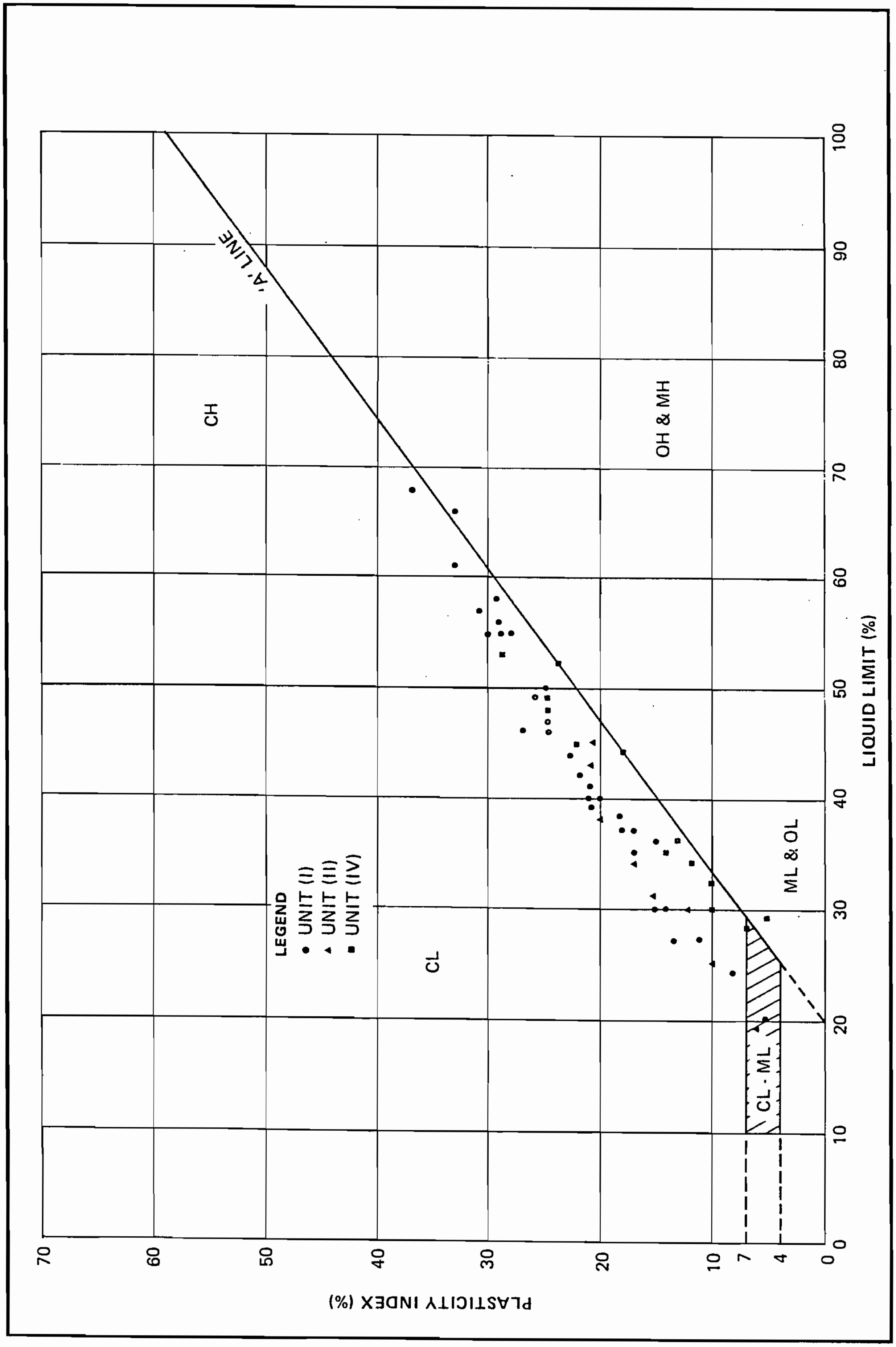

FIGURE 6 PLASTICITY CHART

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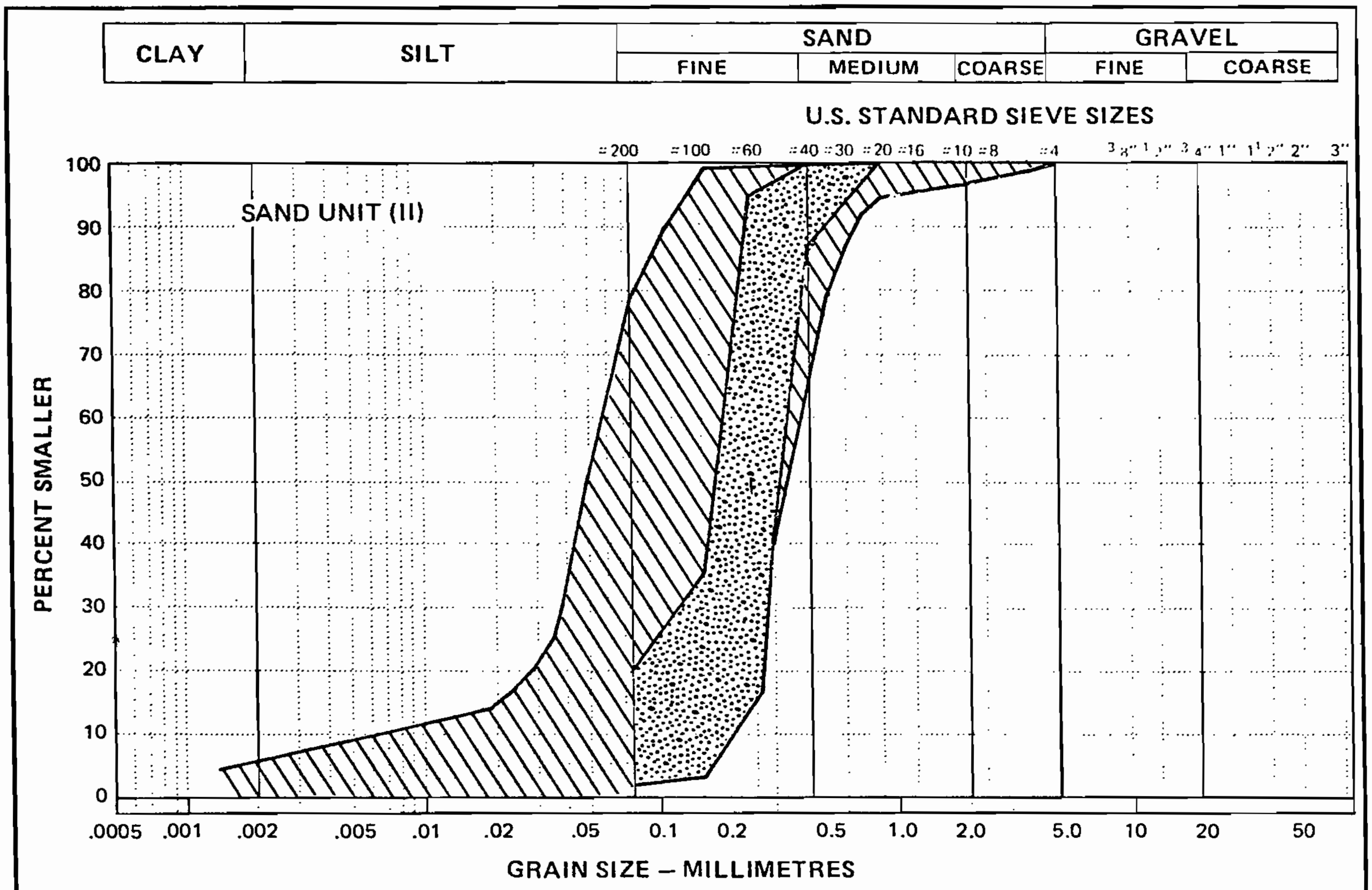
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
▒	MOST COMMON GRADING FOR 176 SAMPLES TESTED		D_{50} = 180 to 320 microns				mean	D_{50}	≈ 231 μ
▨	OUTER LIMIT OF ENVELOPE FOR SAMPLES TESTED		D_{50} = 50 to 320 microns						

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FIGURE 7 GRADING ENVELOPE, SAND UNIT (II)

From all borehole locations where interbeds are specified, the unit (II) interbeds were described as either SILT and clay or CLAY and silt and classified as ML or CL respectively on the basis of plasticity properties. Data for the cohesive interbeds in unit (II) are plotted on the plasticity chart in Figure 6. The clays display liquid limits of between 19 and 45%, and plastic limits of between 13 and 23%. Natural moisture contents vary between 18 and 31%. A single sample of the unit (II) clay interbed was recovered from Boreholes 3:3 and 3:11. The bulk density of these two samples, measured prior to triaxial testing, were 1.92 and 1.97 t/m^3. Two unconsolidated-undrained triaxial tests provided shear strengths at 116 and 101 kPa for the interbeds. Pore pressure response evaluated prior to unconsolidated-undrained triaxial tests indicated a high degree of saturation. Shear planes formed at 50 to 55° to the horizontal in the test specimens. The stress-strain curves were typical of an overconsolidated soil with a well-defined peak failure stress developing at axial strains of 12 and 8%. No consolidation information is available for the clay interbeds.

The SAND unit (III) is a uniformly fine-grained and thickly bedded, with a very narrow grading envelope as presented in Figure 8. The fines content is generally less than 10% and the D_{50} ranges from 180 to 310 microns. Minimal textural variation is encountered in this unit. The SAND unit (III) grades into the SILT and CLAY unit (IV), which is then underlain by SAND unit (V). Soil units (IV) and (V) were encountered only in Borehole 2:3, so the lateral extent of these units was not revealed by this investigation.

The CLAY and SILT unit (IV) consists of alternating layers of unfrozen silt (ML) and clay (CL) in what has been called a rhythmite sequence, which grades gradually into an unfrozen CLAY (CL) and SILT of low plasticity which becomes ice-bonded just above the gradational contact with the underlying

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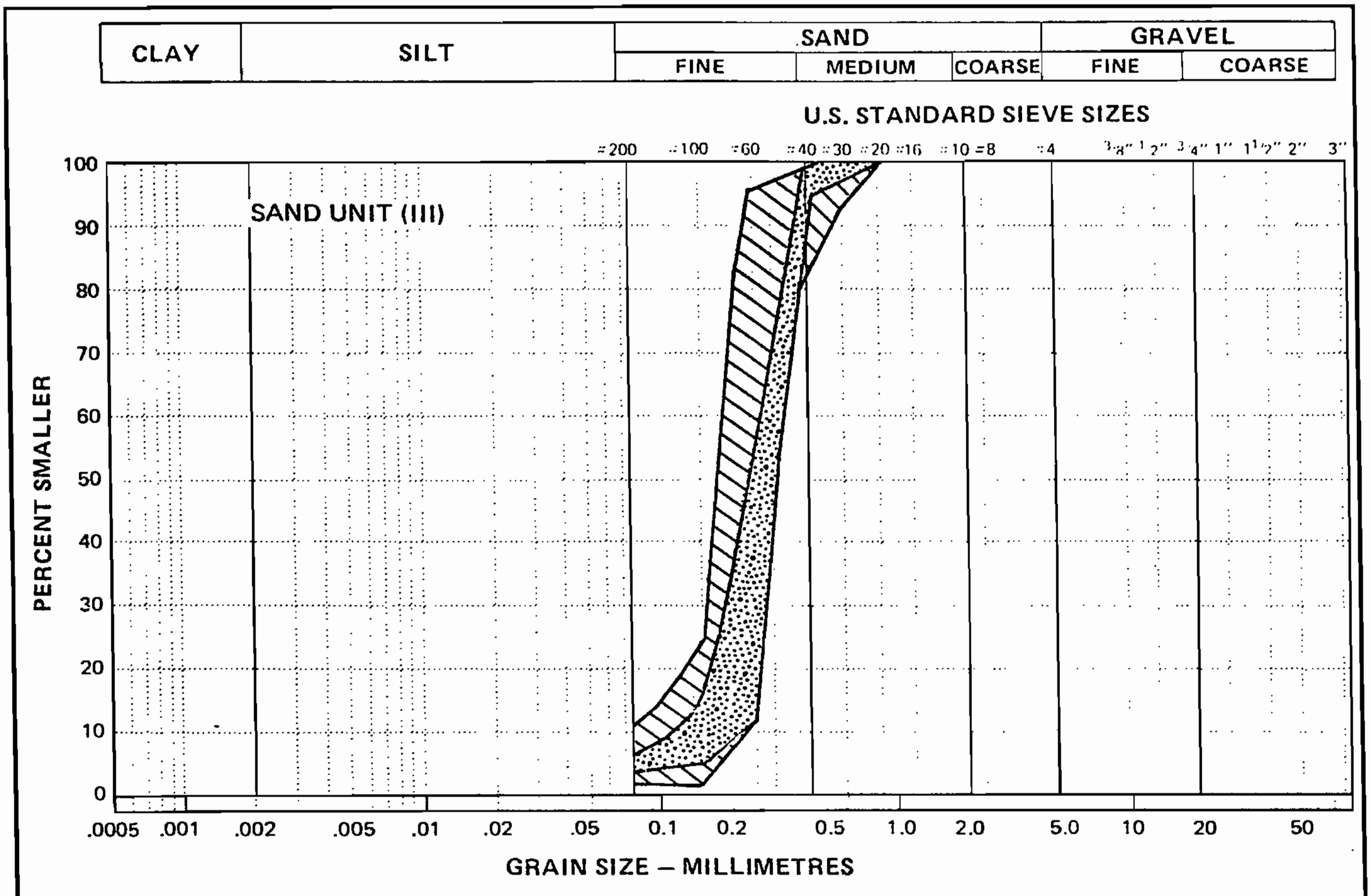

SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
░	MOST COMMON GRADING FOR 53 SAMPLES TESTED		D_{50} = 230to310 microns						
▨	OUTER LIMIT OF ENVELOPE FOR SAMPLES TESTED		D_{50} = 181 to 310 microns						

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FIGURE 8 GRADING ENVELOPE, SAND UNIT (III) high plasticity CLAY (CH) and SILT. In unit (IV), the plasticity varies significantly with depth in response to textural changes, with the Atterberg limits again plotting near to the 'A' line, as shown in Figure 6. Natural moisture contents in the CLAY and SILT unit (IV) range from 29 to 37%. Saturated unfrozen bulk densities range from 1.83 to 2.01 t/m^3.

Both unconsolidated-undrained triaxial shear strength and consolidation test were performed on samples recovered from unit (IV). Pore pressure response tests conducted on the first nine unconsolidated-undrained triaxial tests indicated a high degree of saturation. No pore pressure response tests were conducted on the last seven triaxial shear tests. Fifteen of 16 unconsolidated-undrained triaxial shear strengths measured on thawed samples range from 108 to 251 kPa, typically with 5 to 13% axial strain at peak failure stress. Shear planes generally formed at 50° to 65° to the horizontal.

Visible ice (Vx trace) and undrained thaw strains of 1 to 2% were noted prior to shear of the triaxial specimens. This suggests that some porewater redistribution may have occurred due to ice formation during either storage or transport, because the field observations indicated little or no visible ice upon recovery from the seabed. When these two specimens were tested, the shear strength values of 55 and 251 kPa were measured and the 55 kPa value is clearly outside the range of values indicated above. This single test also exhibited a bulge-type failure. On this basis, this single shear strength is probably not representative of in situ conditions and should be disregarded.

Results for seven consolidation test results indicate that unit (IV) is slightly overconsolidated to normally consolidated with, compression indices ranging from 0.17 to 0.35. Both the overconsolidation ratio and the compression index values have been plotted against depth, and are presented with the other diagnostic profiles in Appendix B.

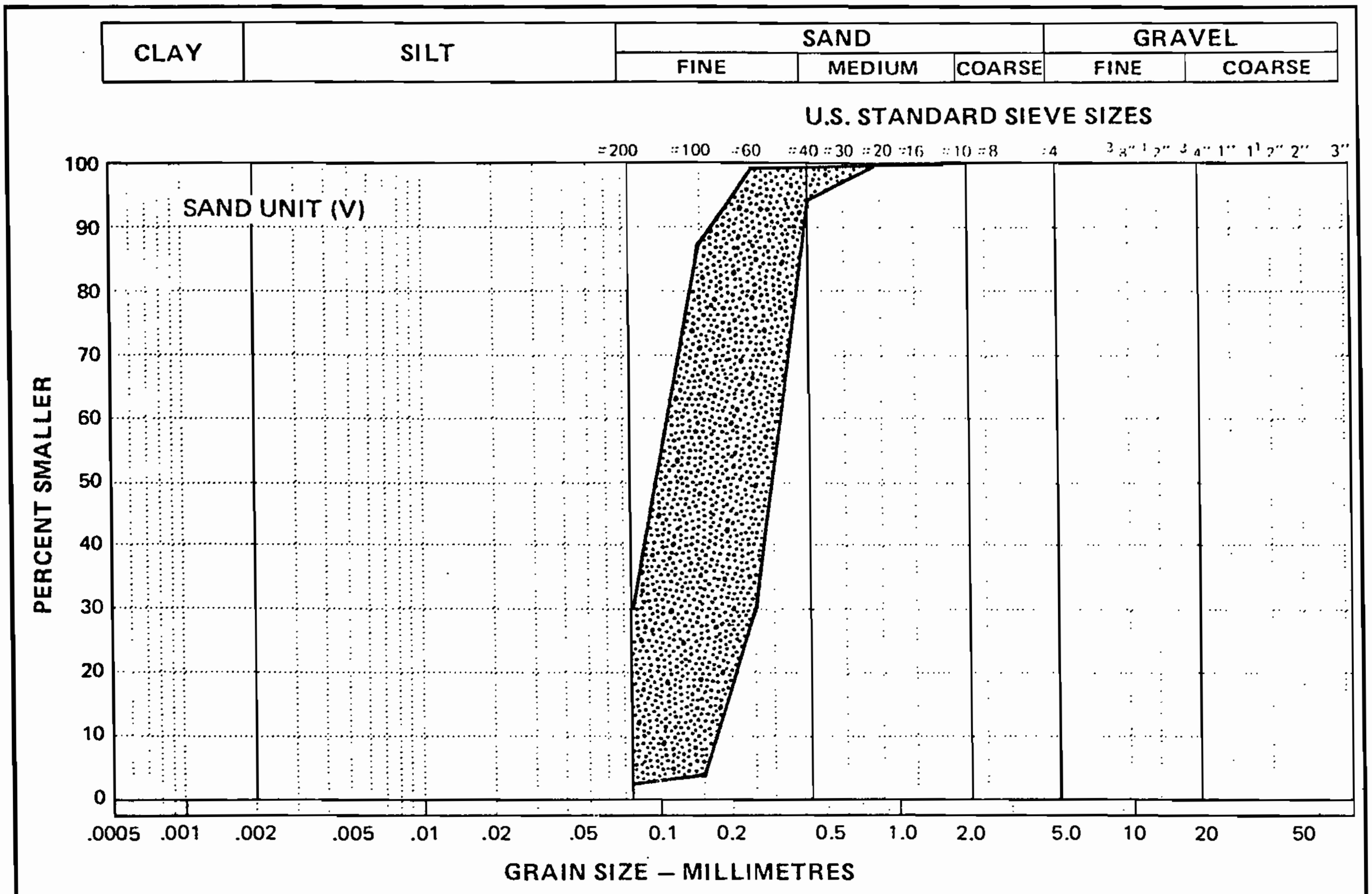
The SAND unit (V) is fine-grained with a fines content ranging from 2 to 30% and a D_{50} from 100 to 300 microns. The unit (V) SAND is similar to the unit (III) SAND, but once again, silt and clay interbeds result in a broad grading envelope as shown in Figure 9.

5.3 Permafrost and Ground Ice

Permafrost is defined as any earth material that has been at or below 0°C for a prolonged period of time without any regard to phase composition of moisture present in the pore spaces. The typical marine sediments from the Beaufort Sea have porewater salinities between 30 and 40 ppt, resulting in a freezing point depression of close to 1.5C°. As a result, soil can exist at temperatures well below 0°C, but exhibit no significant ice bonding or segregated ice. For the purposes of this field program, soil has been designated "frozen" only if either visible ice and/or ice bonding were encountered, or if a significant frozen moisture content was indicated by TDR analysis. "Frozen" soil has therefore been distinguished from permafrost in this report, as the presence of permafrost conditions is not necessarily of engineering significance.

Ice-bonded soil was observed only in Borehole 2:3, and it was first encountered approximately 32 metres below seabed (-77 m Elevation). Below 32 metres seabed penetration, a 16 metre thickness of SAND unit (III) was observed to be well-bonded with no visible ice crystals (Nbn). The degree of ice-bonding decreased to poorly-bonded with no visible ice (Nf) in the transition zone near the base of unit (III), at about 48 metres seabed penetration (-93 m Elevation). The poorly-bonded zone was inferred to be 4

PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
▨	MOST COMMON GRADING FOR SEVEN SAMPLES TESTED		D_{50} = 100 to 300 microns						

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FIGURE 9 GRADING ENVELOPE, SAND UNIT (V) metres thick, and below 52 metres seabed penetration (-97 m Elevation), no further evidence of ice-bonding was observed in the unit (IV) CLAY and SILT.

Visible ice was first encountered in unit (IV) at about 87 metres seabed penetration (-132 m Elevation). A 2 mm thick ice lens was observed to be oriented at 45° to the horizontal and parallel to a slickensided surface (Vs trace). Apart from this single occurrence of visible ice, the clay was described as "frozen", but poorly-bonded with no visible ice (Nf). This zone of poorly-bonded soil was inferred to be about 15 metres thick. Near the base of CLAY and SILT unit (IV), at about 102 metres seabed penetration (-147 m Elevation), the soil gradually becomes coarser-grained, and the degree of ice-bonding increases to well-bonded with no visible ice (Nbn). The underlying SAND unit (V) was well-bonded (Nbn) to the borehole termination depth of 122 metres seabed penetration.

Sample temperatures were not measured in this borehole as measuring equipment was in transit. However, the physical and visual condition of samples recovered were used to designate the soil as being "frozen", and are considered to provide be a reliable indication of in situ conditions.

5.4 Sediment Gases

Methane with trace amounts of ethane and ethylene were the hydrocarbon gases detected in samples collected from Borehole 2:3. Methane concentrations, comprising by far the largest portion of the total light hydrocarbon gas content, were between 29 and 4800 ppm at 1 atmosphere and 20°C. There appears to be sufficient methane present in the clays to generate a vapour phase, which could then affect the undrained shear strengths of these soils.

Detailed results from the gas analyses are presented in a subconsultants report in Appendix F.

5.5 Porewater Salinity

Porewater salinities were calculated from chlorinity concentration determined on samples of extruded porewater. According to Dr. J.F. Barker's chlorinity results, the porewater salinities range from 17 ppt to 46 ppt. Chlorinity results obtained by EBA agree with Barker's data with porewater salinities typically falling between 17 ppt and 35 ppt. These salinities are generally near that of Arctic sea water, which has a salinity of about 33 ppt.

Dr. J.F. Barker also calculated salinity from electrical conductivity of porewater using experimental salinity-conductivity data for artificial seawater mixtures. Salinity values calculated from chlorinity data are considerably greater than those calculated from conductivity data. Chloride concentrations are less likely to be modified by chemical reaction following sedimentation than are concentrations of ions which contribute to conductivity. Thus, the salinity values calculated from chlorinity data are considered more appropriate. Dr. J.F. Barker's results are presented in Appendix F, and all the porewater salinity results obtained are plotted with depth as a diagnostic profile in Appendix B.

6.0 GEOTECHNICAL CONSIDERATIONS

6.1 Soft Seabed Soils

The surficial layer of soft soil is generally less than one metre thick, but in some areas, thicknesses of more than two metres were observed. The shear strength of this clay layer is uniformly low, and will require special consideration in designing and assessing the stability of a structure founded on the seafloor. Two possible approaches for dealing with this soft soil layer are either removal or displacement. At the time of writing, the displacement approach has been adopted by Canmar. Therefore, the geotechnical concerns that should be investigated are the impact and extent of clay contamination of the basal fill, lateral variability of thickness and shear strength of both the soft seabed soil layer and clay-contaminated basal fill, and strength gains that may develop as consolidation proceeds prior to commencement of the 1983 construction season.

6.2 Silt and Clay Interbeds

In its undisturbed state, the stratigraphic succession encountered in boreholes of intermediate depth (e.g. 30 metres) presents generally good foundation conditions. However, the SILT and CLAY interbeds in SAND unit (II) are sufficiently close to the seabed that they should be considered in more detail. The lateral continuity, thickness and shear strength variations could be important to the stability of a bottom-founded gravity structure. Since the surrounding SANDS are unfrozen and relatively clean, shear strength is expected to increase as a result of consolidation during and after construction. Consolidated-undrained triaxial tests would provide a means of estimating appropriate shear strengths.

6.3 Ice-Bonded Soils

Borehole 2:3 revealed frozen SAND in units (III) and (V), and "frozen" CLAY and SILT in unit (IV). The frozen SANDS showed no evidence of excess ice, suggesting that in situ thawing would result in minimal thaw settlement. Only driven samples of the frozen SAND were recovered, so coring would be required to obtain a more detailed evaluation of in situ conditions. The

CLAY and SILT unit (IV) is lightly overconsolidated, low to moderately compressible and stiff to very stiff. CLAY and SILT unit (IV) is 57 metres thick and only the last 20 metres were logged as ice-bonded. In that 20 metre thickness, only one ice lens 2 mm thick was observed, so this interval also comprises a reasonably competent foundation soil. The unfrozen CLAY ad SILT of unit (IV) is capped above and below by frozen well-bonded SAND, Consolidation settlements in this unit should be small since drainage must occur horizontally along unfrozen silt layers.

6.4 Borrow Materials

When used as a suction dredge, the Aquarius presently has an operational depth limitation of -70 m Elevation. Therefore, unit (I) CLAY, unit (II) SAND, and unit (III) SAND are all encountered within the zone of borrow development. Assuming a coring a cone rising from -70 m Elevation, the relative volume contribution from each soil unit would be: 12% from a one metre thickness of unit (I); 82% from 14 metre thickness of unit (II); and 6% from a 10 metre thickness of unit (III). Further, utilizing the most common grading curve for each unit and volume contributions weighted according to the percentages noted above produces a range of textures that is compared to the Uviluk fill specification in Figure 10. The broad variation of D_{50} and fines content that could be obtained from borrow developed to -70 m Elevation is apparent. Figure 10 suggests that it may be difficult to meet the Uviluk specification using sand borrow at Nerlerk if appreciable amounts of fines are not washed out during the dredging process. Careful borrow delineation, controlled development, and detailed post-construction assessment of materials placed in the Nerlerk berm are therefore essential. Recognizing that the Uviluk specification will be difficult to meet using local borrow, laboratory tests could be initiated to assess shear strength and volume change behavior for Nerlerk sands. Data obtained from these tests could be used to justify some relaxation of textural specifications to a D_{50} and fines content that can be met by material placed in the Nerlerk fill during 1982.

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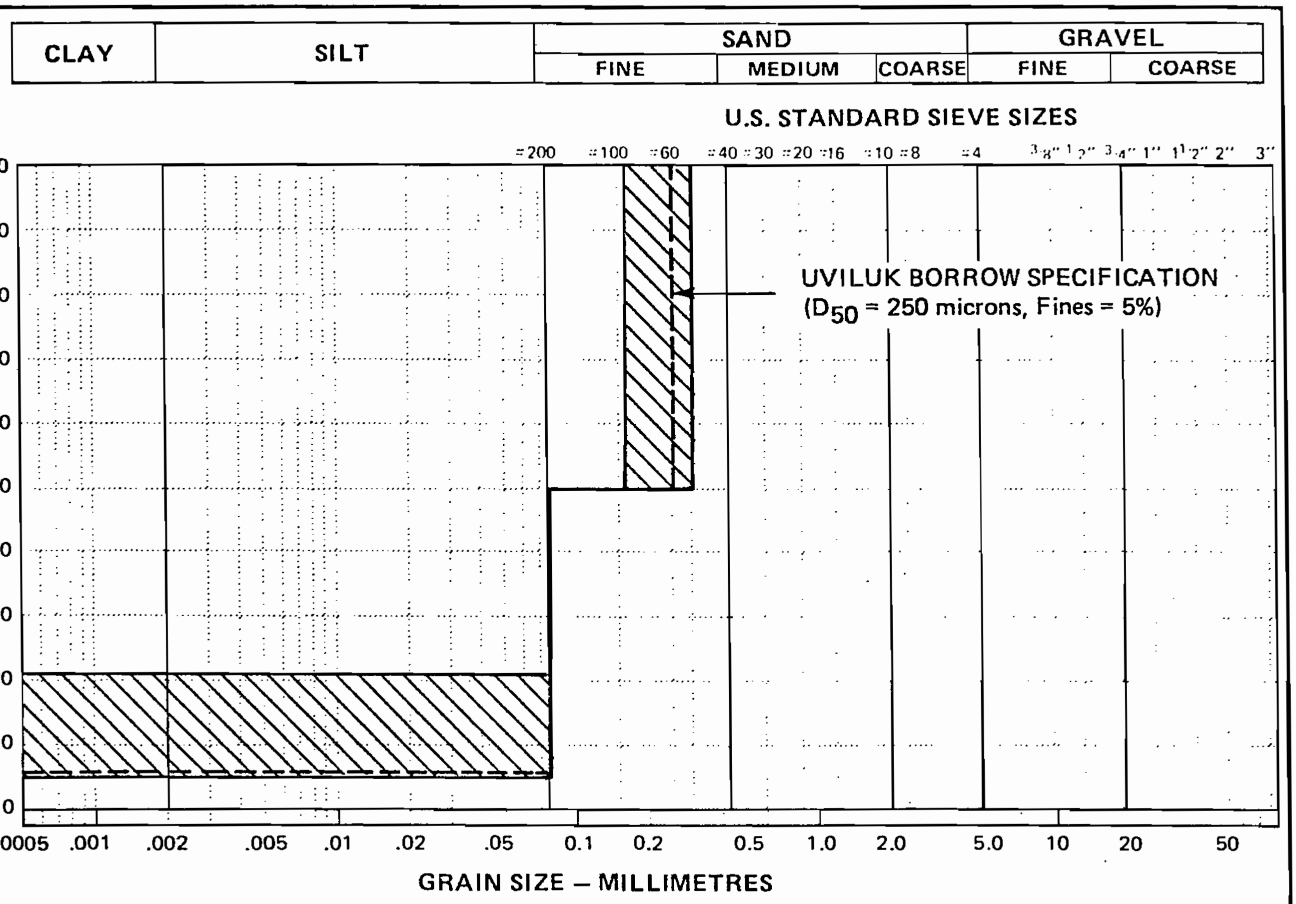

SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
▨	Volume weighted range of most common gradings for units (I), (II) and (III).								

Assuming 120 degrees apex symetrical cone developed to 70 metres elevation with:
UNIT (I) being 1 metre thick (12% by volume)
UNIT (II) being 14 metres thick (82% by volume)
UNIT (III) being 10 metres thick (6% by volume)

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FIGURE 10 COMPOSITE POTENTIAL BORROW COMPARED TO UVILUK BORROW SPECIFICATION

7.0 CLOSURE

The geotechnical information contained in this report was obtained from the seabed soil samples that were collected during the 1982 Offshore Geotechnical Program carried out for Canadian Marine Drilling Ltd.

EBA Engineering Consultants Ltd. has appreciated the opportunity to work on this project and would like to acknowledge the cooperation and guidance provided by all of the companies involved in this program.

Respectfully submitted,

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TABLE A3 NERLERK SITES INVESTIGATED

BOREHOLE NO.	UTM COORDINATES (m)	GEOGRAPHIC COORDINATES	WATER DEPTH (m)	PENETRATION (m)	DATE ADVANCED
B-NER 1:1	7,815,456N 562,286E	70°26'19"N 133°19'59"W	43.6	3.6	82-07-12
B-NER 1:2	7,816,034N 562,342E	70°26'37"N 133°19'52"W	43.6	3.2	82-07-13
B-NER 1:3	7,815,811N 562,043E	70°26'30"N 133°20'22"W	46.6	0.8	82-07-13
B-NER 1:4	7,815,805N 562,672E	70°26'30"N 133°19'21"W	44.2	0.0	82-07-13
V-NER 2:4	7,815,807N 561,013E	70°26'31"N 133°22'1"W	46.3	5.9	82-08-08
V-NER 2:5	7,815,985N 560,802E	70°26'37"N 133°22'21"W	47.5	4.1	82-08-08
V-NER 2:6	7,815,805N 560,749E	70°26'31"N 133°22'26"W	46.6	4.2	82-08-08
V-NER 2:7	7,816,004N 561,121E	70°26'37"N 133°21'50"W	45.4	4.0	82-08-08
V-NER 2:8	7,815,866N 560,947E	70°26'33"N 133°22'7"W	44.8	5.9	82-08-08

* Supplier No. 5 abandoned location due to ice floes

TABLE A3 NERLERK SITES INVESTIGATED (continued)

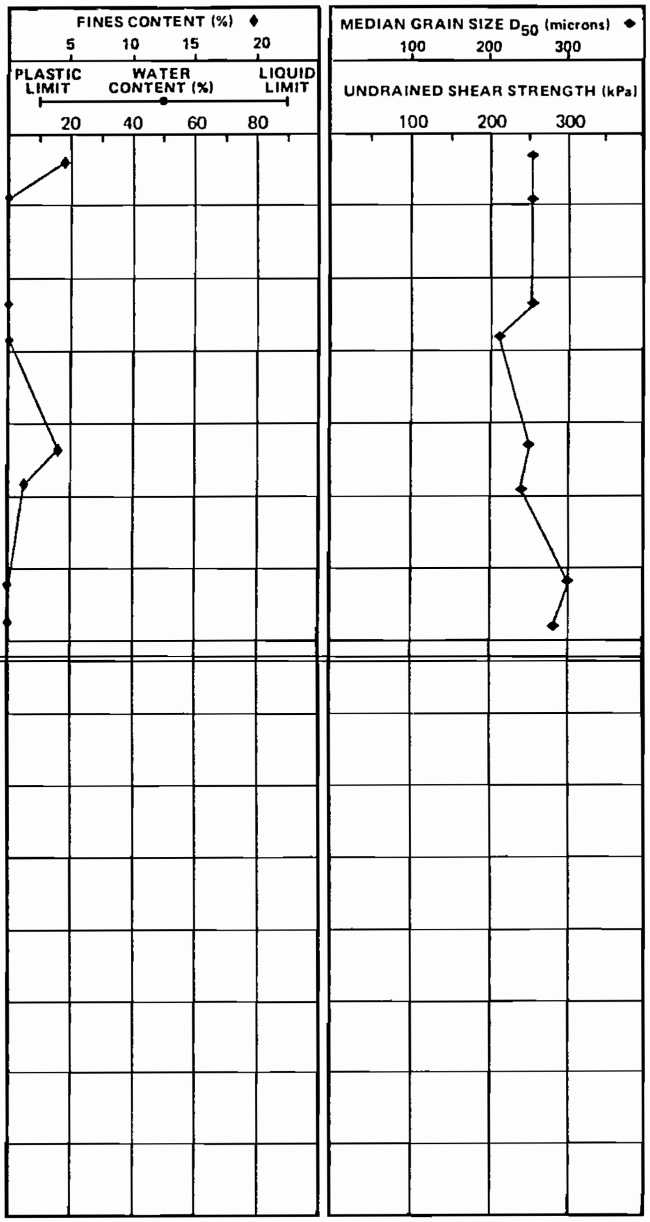
BOREHOLE NO.	UTM COORDINATES (m)	GEOGRAPHIC COORDINATES	WATER DEPTH (m)	PENETRATION (m)	DATE ADVANCED
V-NER 2:9	7,815,867N 560,870E	70°26'33"N 133°22'14"W	45.1	5.8	82-08-08
V-NER 2:11	7,815,933N 561,875E	70°26'34"N 133°20'37"W	42.6	4.6	82-08-11
V-NER 2:12	7,815,947N 561,789E	70°26'35"N 133°20'46"W	43.6	5.1	82-08-12
V-NER 2:13	7,815,890N 561,654E	70°26'33"N 133°20'58"W	45.1	3.0	82-08-13
V-NER 2:14	7,815,999N 561,790E	70°26'37"N 133°20'46"W	45.1	5.0	82-08-14
V-NER 2:15	7,815,999N 561,886E	70°26'37"N 133°20'36"W	44.2	1.2	82-08-14
V-NER 2:16	7,816,005N 561,696E	70°26'37"N 133°20'54"W	44.2	3.2	82-08-15
V-NER 2:17	7,815,820N 561,798E	70°26'31"N 133°20'45"W	44.2	4.2	81-08-15
V-NER 2:18	7,815,812N 561,886E	70°26'31"N 133°20'37"W	44.8	4.2	82-08-15

TABLE A3 NERLERK SITES INVESTIGATED

BOREHOLE NO.	UTM COORDINATES (m)	GEOGRAPHIC COORDINATES	WATER DEPTH (m)	PENETRATION (m)	DATE ADVANCED
V-NER 2:19	7,815,808N 561,973E	70°26'30"N 133°20'28"W	46.0	4.6	81-08-15
V-NER 2:20	7,815,707N 561,978E	70°26'27"N 133°20'28"W	45.1	4.6	82-08-15
V-NER 2:21	7,815,712N 561,875E	70°26'28"N 133°20'38"W	44.2	3.6	82-08-15
V-NER 2:22	7,814,875N 561,668E	70°26'00"N 133°21'00"W	42.4	3.7	82-08-19
V-NER 2:23	7,814,877N 562,562E	70°25'60"N 133°19'34"W	44.2	4.4	81-08-19
V-NER 2:25	7,814,691N 562,747E	70°25'54"N 133°19'17"W	43.3	2.7	82-08-25
V-NER 2:26	7,814,802N 562,400E	70°25'57"N 133°19'50"W	42.7	3.5	82-08-25

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 456 m. N. 562 286 m. E. WATER DEPTH: 43.6 m

DEPTH BELOW SEABED (metres)	SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
0	▨	1A	SAND (SP) - traces of SILT and shell fragments, fine-grained, uniform, grey brown	NOT FROZEN
	▨	1B	- becoming yellowish brown below 0.3 m	
	▨	1C		
1	▨	2A	- one 5 mm diameter pebble	
	▨	2B		
2	▨	2C		
	▨	3A		
	▨	3B		
3	▨	3C		
	▨	4A		
	▨	4B		
			END OF BOREHOLE 3.6 m(-47.2 m El.)	
4			*Note: Maximum penetration after 60 minutes*	
5				
6				
7				



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/07/12
BOREHOLE DEPTH: 3.6 m(-47.2 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: DDY/PMR

LEGEND

SOIL SYMBOLS

▨	▥	▧
SAND	SILT	CLAY

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
✱ Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

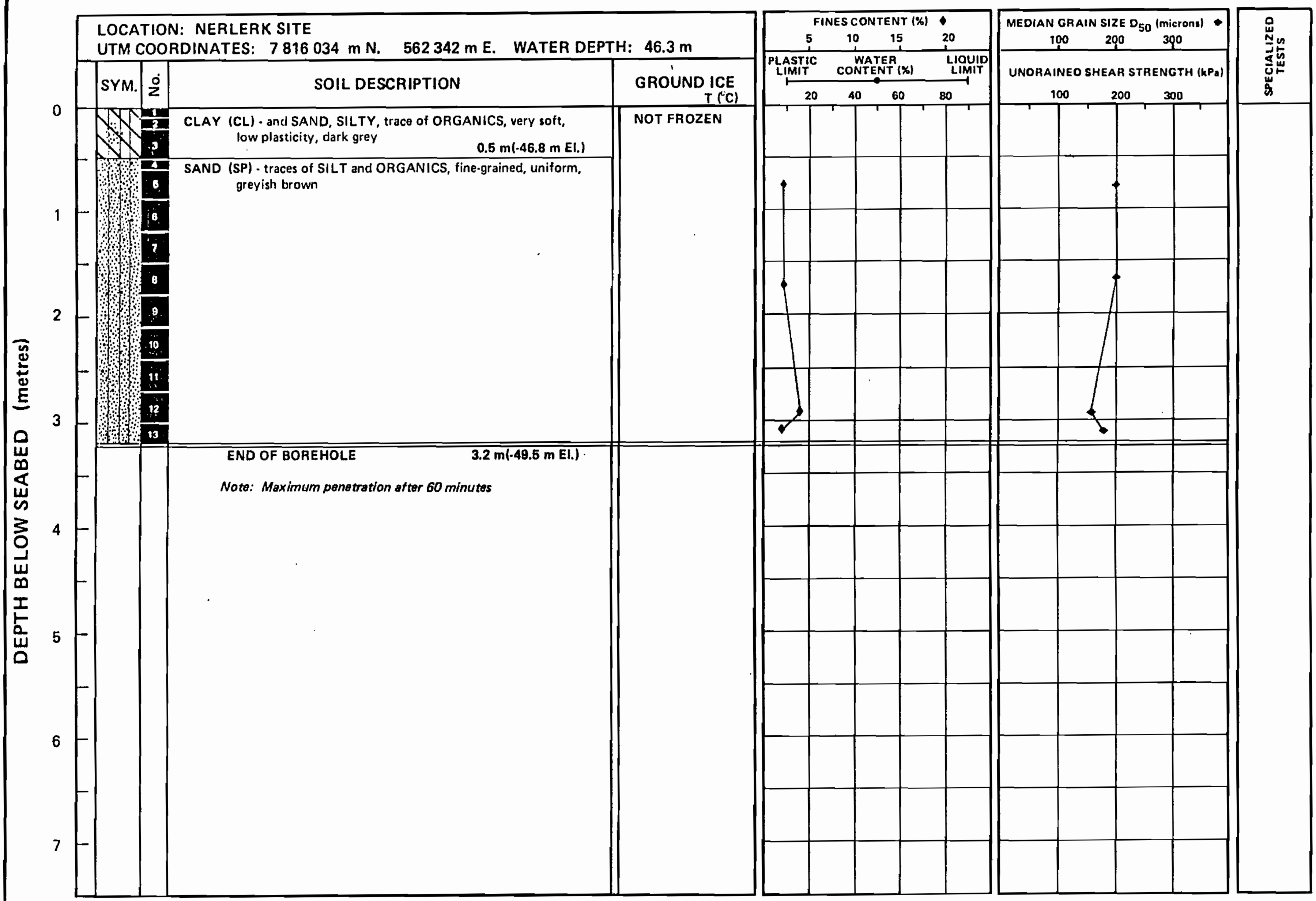
C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TO - TDR	G - Gas Analysis
Ca - Calorimetry	

BOREHOLE NUMBER
B-NER 1:1

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 816 034 m N. 562 342 m E. WATER DEPTH: 46.3 m



CLAY (CL) - and SAND, SILTY, trace of ORGANICS, very soft, low plasticity, dark grey
0.5 m(-46.8 m El.)

SAND (SP) - traces of SILT and ORGANICS, fine-grained, uniform, greyish brown

END OF BOREHOLE 3.2 m(-49.5 m El.)

Note: Maximum penetration after 60 minutes

NOT FROZEN

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/07/13
BOREHOLE DEPTH: 3.2 m(-49.5 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: MDW/PMR

LEGEND

SOIL SYMBOLS

▨ SAND	▥ SILT	▧ CLAY

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
◆ Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TD - TDR	G - Gas Analysis
Ca - Calorimetry	

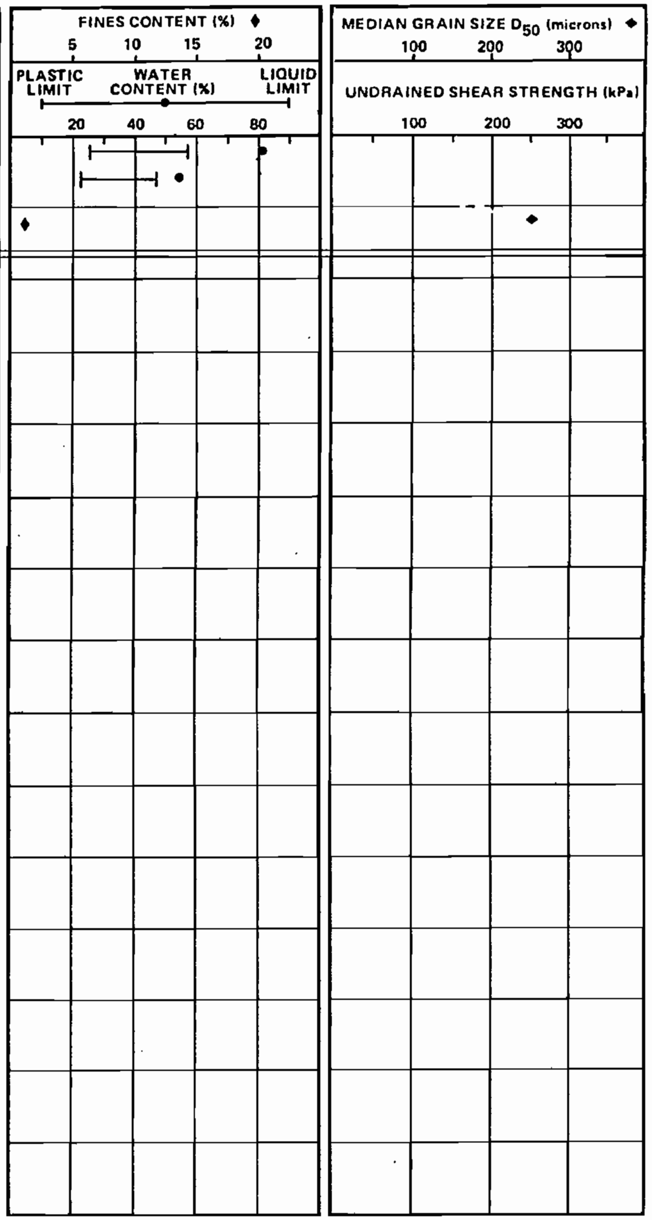
BOREHOLE NUMBER
B-NER 1:2

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 811 m. N. 562 043 m. N.. WATER DEPTH: 46.6 m

DEPTH BELOW SEABED (metres)	SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
0		1	CLAY (CH) - SILTY and SANDY, trace of ORGANICS, flocculated at the mudline, very soft, high plasticity, dark grey 0.2 m(-46.8 m El.)	NOT FROZEN
		2		
		3	CLAY (CL) - and SAND, trace of ORGANICS, very soft, high plasticity, dark grey 0.5 m(-47.1 m El.)	
1			SAND (SP) - traces of SILT and ORGANICS, fine-grained, uniform, grey brown	
			END OF BOREHOLE 0.8 m(-47.4 m El.)	
			Note: Maximum penetration after 60 minutes	
2				
3				
4				
5				
6				
7				



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/07/13
BOREHOLE DEPTH: 0.8 m(-47.4 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: MDW/PMR

LEGEND

SOIL SYMBOLS

▨	▥	▧
SANO	SILT	CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
♦ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

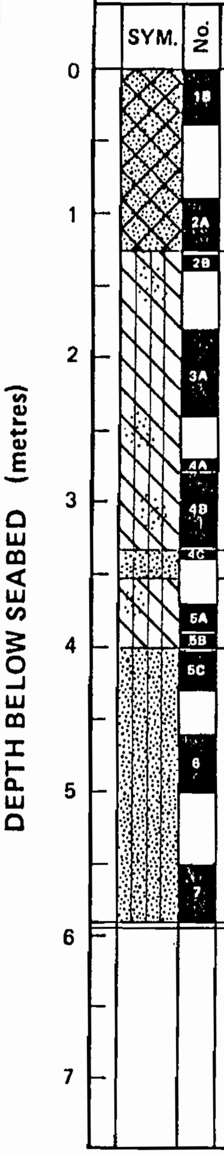
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 1:3

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 807 m. N. 561 013 m. E. WATER DEPTH: 46.3 m



SOIL DESCRIPTION

SAND (SP) - medium to fine-grained, uniform, brown
MADE GROUND

*original seabed 1.3 m(-47.6 m El.)

CLAY (CH) - SILTY, some SAND, trace ORGANICS, very soft, high plasticity, dark blackish grey

- (CL), SILTY and SANDY
- ORGANIC pockets below 2.8 m

- fine-grained SAND layer at 3.3 m 3.4 m(-49.7 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform brown 3.5 m(-49.8 m El.)

CLAY (CH) - SILTY, some SAND, very soft, high plasticity, grey 4.0 m(-50.3 m El.)

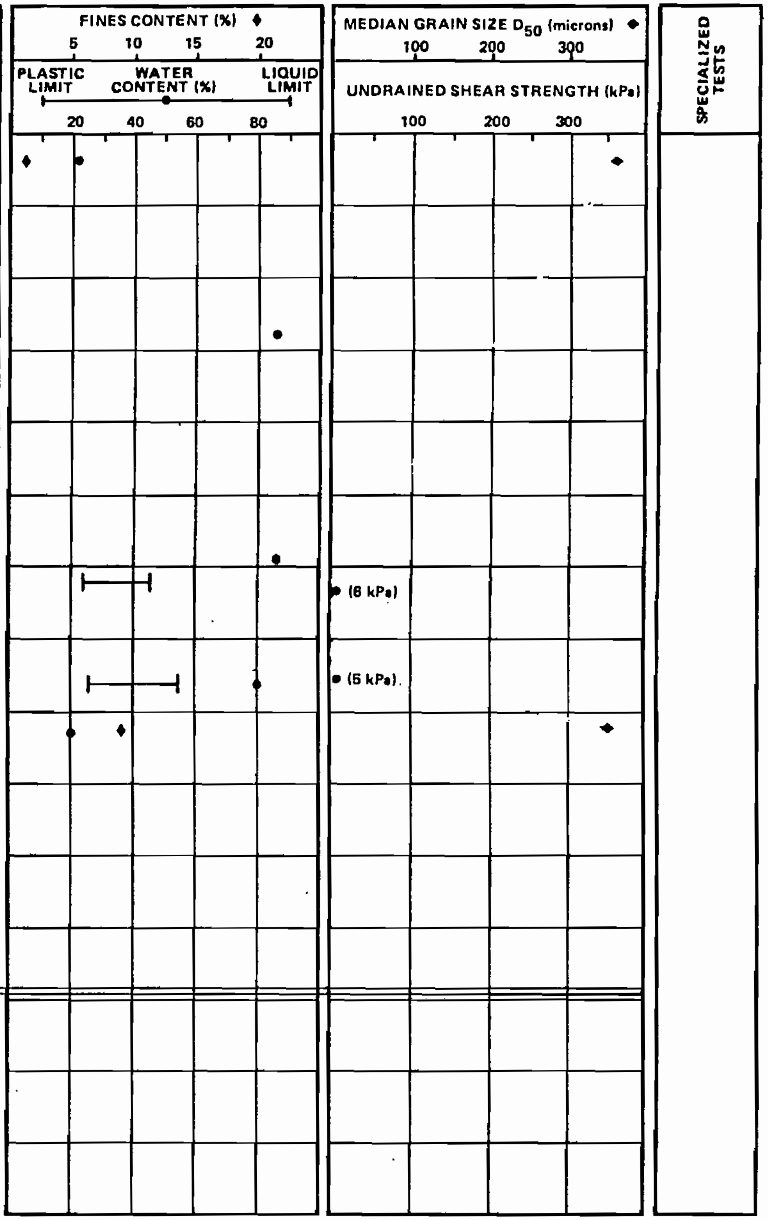
SAND (SP - SM) - traces of SILT and shell fragments, fine-grained, uniform, grey brown

END OF BOREHOLE 5.9 m(-52.2 m El.)

Note: Borehole was terminated after seabed clay thickness was verified.

GROUND ICE
T (°C)

NOT FROZEN



JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/09
BOREHOLE DEPTH: 5.9 m(-52.2 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: PMR/CHL

LEGEND

SOIL SYMBOLS
▒ SAND
▥ SILT
▨ CLAY

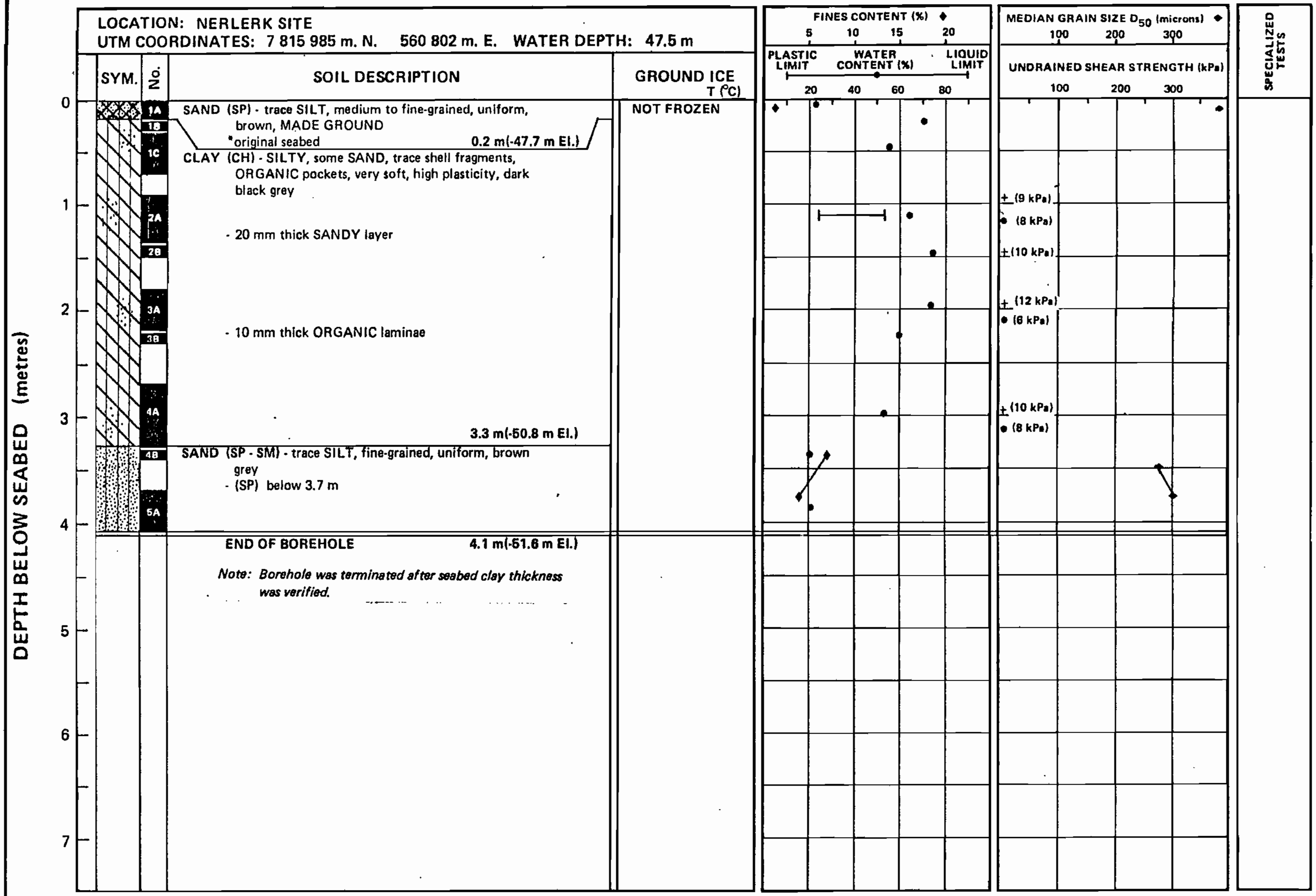
SHEAR STRENGTH
+ Torvane
× Min. Vane
♦ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:4
PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 985 m. N. 560 802 m. E. WATER DEPTH: 47.5 m



SOIL DESCRIPTION

SAND (SP) - trace SILT, medium to fine-grained, uniform, brown, MADE GROUND

*original seabed 0.2 m(-47.7 m El.)

CLAY (CH) - SILTY, some SAND, trace shell fragments, ORGANIC pockets, very soft, high plasticity, dark black grey

- 20 mm thick SANDY layer

- 10 mm thick ORGANIC laminae

3.3 m(-50.8 m El.)

SAND (SP - SM) - trace SILT, fine-grained, uniform, brown grey

- (SP) below 3.7 m

END OF BOREHOLE 4.1 m(-51.6 m El.)

Note: Borehole was terminated after seabed clay thickness was verified.

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/08
BOREHOLE DEPTH: 4.1 m(-51.6 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: PMR/CHL

LEGEND

SOIL SYMBOLS

▨	▥	▧
SAND	SILT	CLAY

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
● Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TD - TDR	G - Gas Analysis
Ca - Calorimetry	

BOREHOLE NUMBER
V-NER 2:5

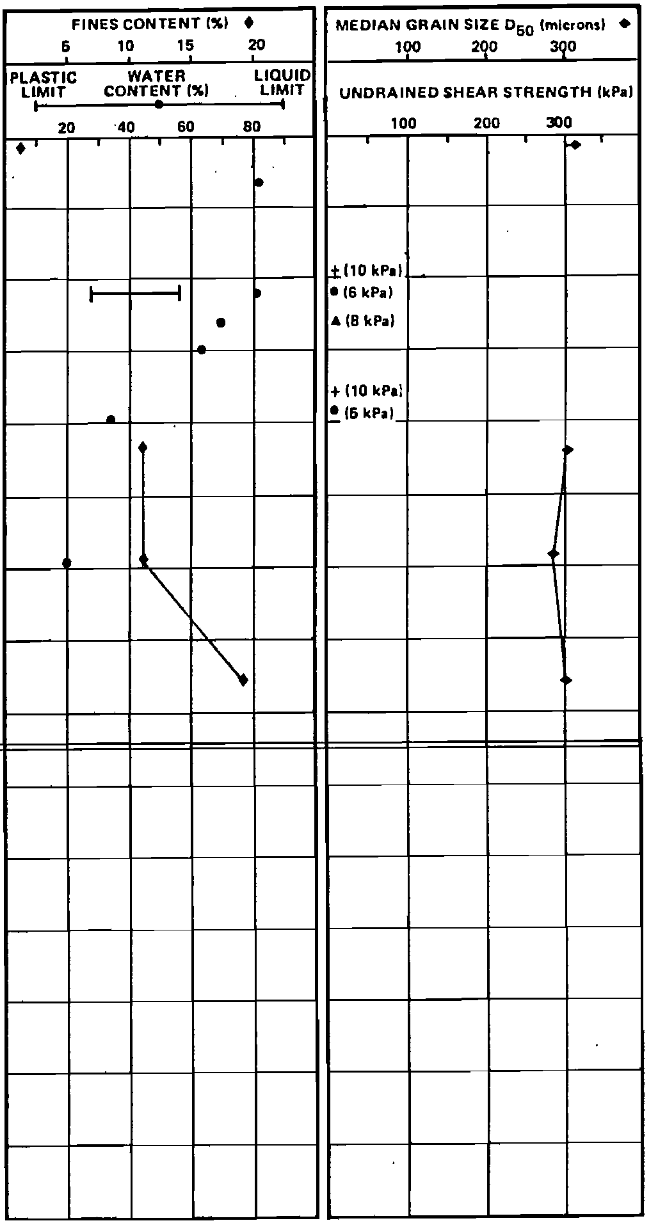
PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 805 m. N. 560 749 m. E. WATER DEPTH: 46.6 m

DEPTH BELOW SEABED (metres)

SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
	1A 1B	SAND (SP) - trace SILT, fine-grained, uniform, brown MADE GROUND *original seabed 0.1 m(-46.7 m El.)	NOT FROZEN
	2A 2B 2C 3A	CLAY (CH) - and SILT, trace SAND, ORGANIC pockets and shell fragments, very soft, high plasticity, dark grey - mottled brown - 2 mm thick SAND layer 2.1 m(-48.7 m El.)	
	3B 4A 5A	SAND (SP - SM) - traces of SILT, CLAY and shell fragments, fine-grained, uniform, brown - 4 mm thick SILT layer - (SM), 10 mm thick SILT layers at 3.7 m and 4.1 m	
		END OF BOREHOLE 4.2 m(-50.8 m El.) *Note: Borehole was terminated after seabed clay thickness was verified.*	



SPECIALIZED TESTS

BULK DENSITY = 1.5 Mgm-3

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JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/08
BOREHOLE DEPTH: 4.2 m(-50.8 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: KWJ/RB

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
◆ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

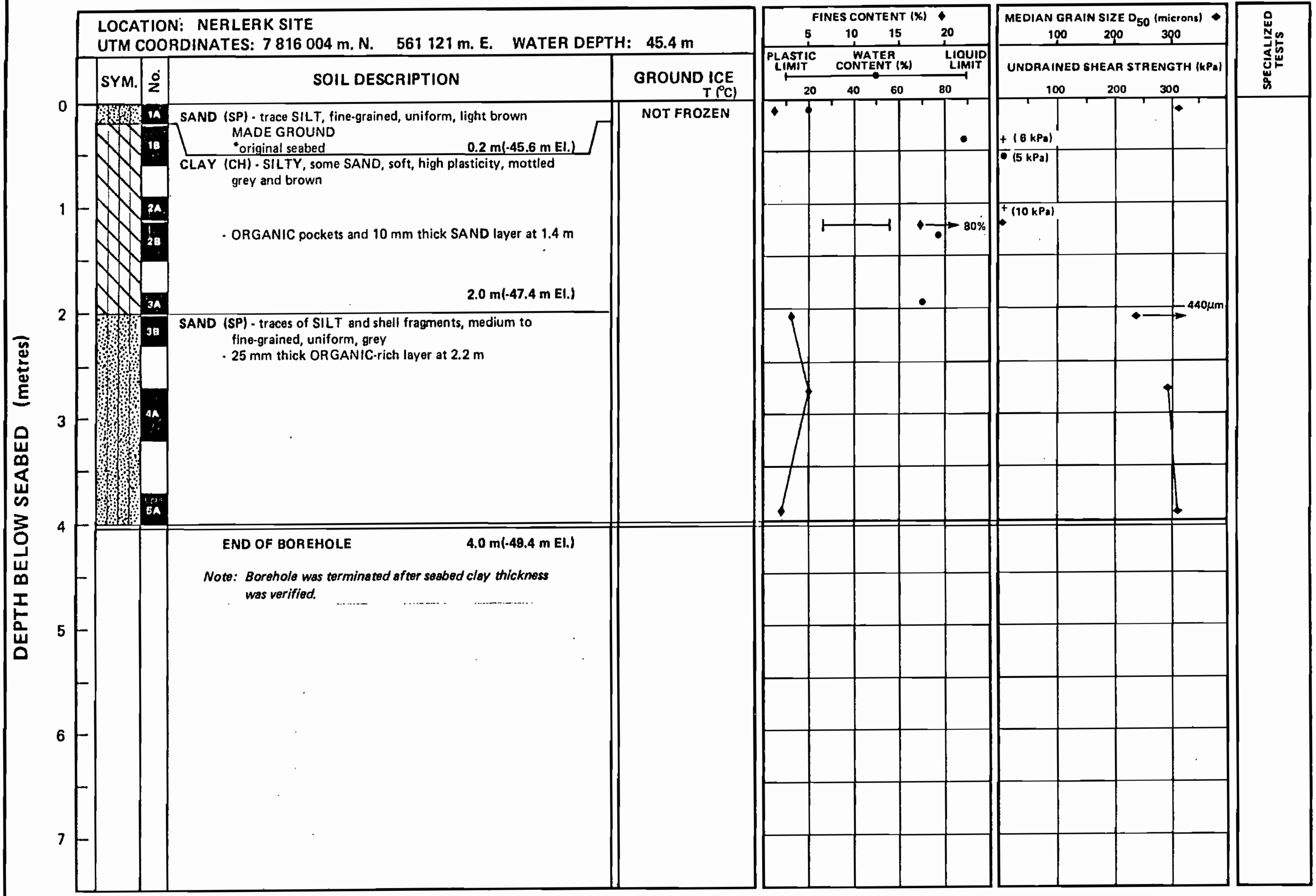
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:6

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 816 004 m. N. 561 121 m. E. WATER DEPTH: 45.4 m



SAND (SP) - trace SILT, fine-grained, uniform, light brown
MADE GROUND
*original seabed 0.2 m(-45.6 m El.)

CLAY (CH) - SILTY, some SAND, soft, high plasticity, mottled grey and brown
- ORGANIC pockets and 10 mm thick SAND layer at 1.4 m

2.0 m(-47.4 m El.)

SAND (SP) - traces of SILT and shell fragments, medium to fine-grained, uniform, grey
- 25 mm thick ORGANIC-rich layer at 2.2 m

END OF BOREHOLE 4.0 m(-49.4 m El.)

Note: Borehole was terminated after seabed clay thickness was verified.

JOB No.: 101 3605
DRILLING COMPLETED: 82/08/08
BOREHOLE DEPTH: 4.0 m(-49.4 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: KWJ/RB

LEGEND

SOIL SYMBOLS

▩	▥	▧
SAND	SILT	CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- ◆ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

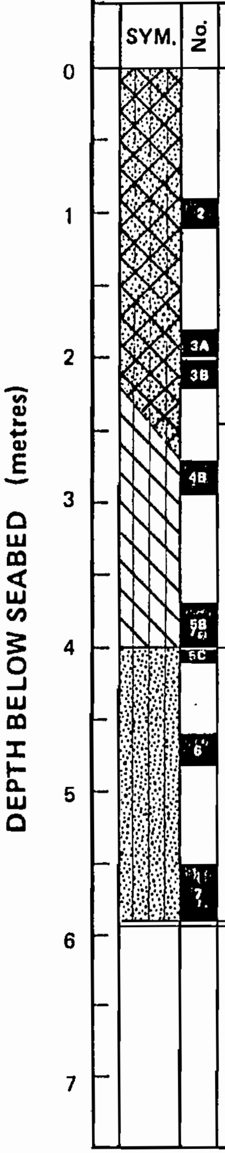
TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:7

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 866 m N. 560 947 m E. WATER DEPTH: 44.8 m



SOIL DESCRIPTION

SAND (SP) - trace SILT, medium to fine-grained, some coarse-grained SAND, poorly graded, brown,
MADE GROUND
(No recovery at sample interval No. 1)

- 20 mm diameter pebble and shell fragments

2.5 m(-47.3 m El.)

CLAY (CH) - and SILT, trace of SAND, ORGANIC pockets, very soft, high plasticity, mottled grey and brown

4.0 m(-48.8 m El.)

SAND (SP) - trace to some SILT, trace shell fragments, medium to fine-grained, some coarse-grained SAND, uniform, grey brown

- SILT pockets in Sample No. 6

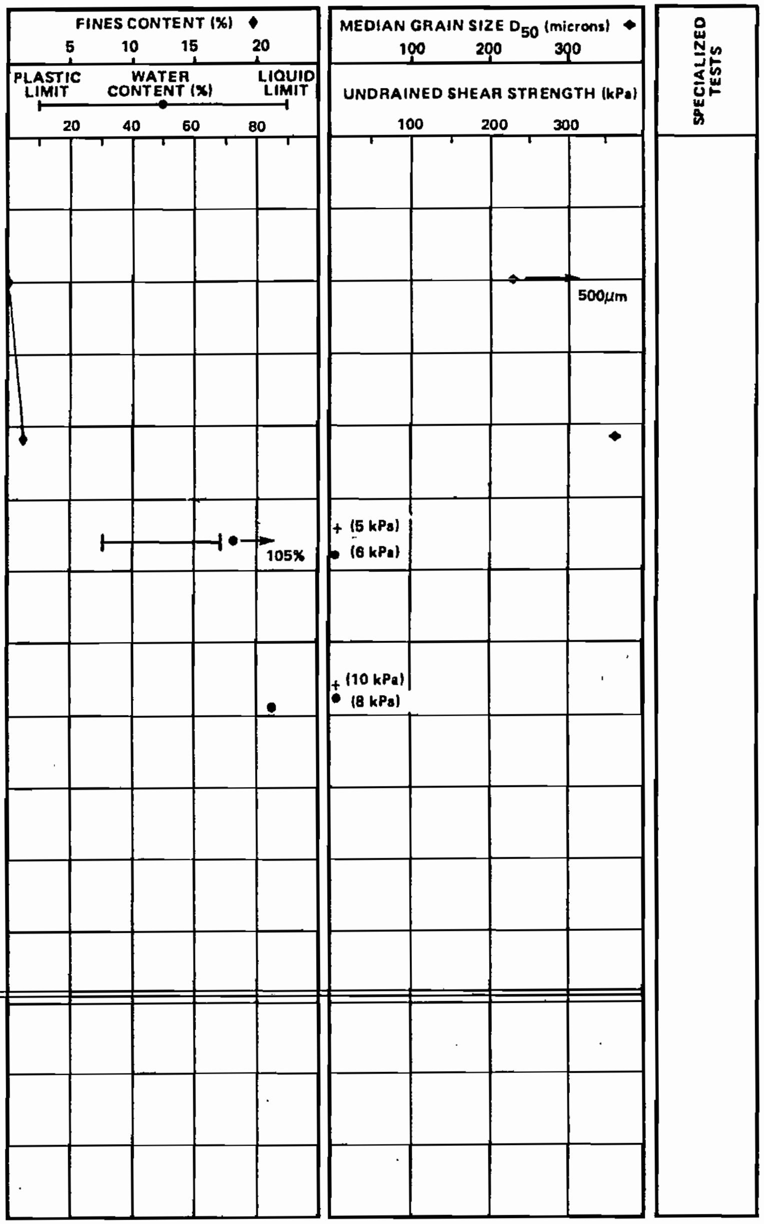
- 5 mm thick SILT layer with one 20 mm diameter pebble

END OF BOREHOLE : 5.9 m(-50.7 m El.)

Note: Borehole was terminated after seabed clay thickness was verified.

GROUND ICE
T (°C)

NOT FROZEN



JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/08
BOREHOLE DEPTH: 5.9 m(-50.7 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: PMR/CHL

LEGEND

SOIL SYMBOLS
▩ SAND
▥ SILT
▨ CLAY

SHEAR STRENGTH
+ Torvane
● Fall Cone
× Min. Vane
▲ UU Triaxial
• Pilcon Vane
■ CU Triaxial
○ Halibut Vane

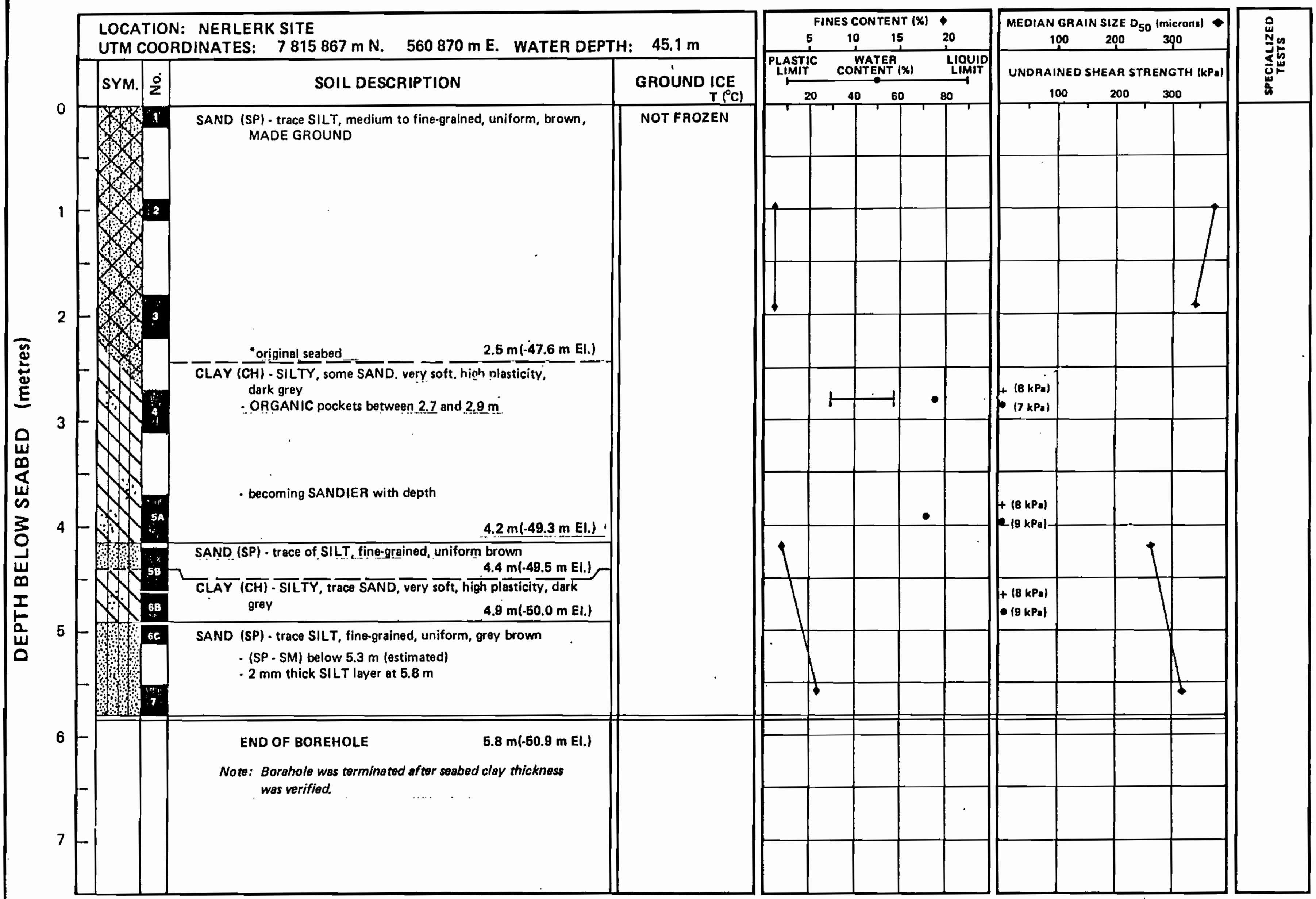
TEST IDENTIFICATION
C - Consolidation
T - Triaxial Shear
DS - Direct Shear
S - P.W. Salinity
TD - TDR
G - Gas Analysis
Ca - Calorimetry

BOREHOLE NUMBER
V-NER 2:8

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 867 m N. 560 870 m E. WATER DEPTH: 45.1 m



SOIL DESCRIPTION

SAND (SP) - trace SILT, medium to fine-grained, uniform, brown,
MADE GROUND

*original seabed 2.5 m(-47.6 m El.)

CLAY (CH) - SILTY, some SAND, very soft, high plasticity,
dark grey
- ORGANIC pockets between 2.7 and 2.9 m

- becoming SANDIER with depth

4.2 m(-49.3 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform brown

4.4 m(-49.5 m El.)

CLAY (CH) - SILTY, trace SAND, very soft, high plasticity, dark
grey

4.9 m(-50.0 m El.)

SAND (SP) - trace SILT, fine-grained, uniform, grey brown
- (SP - SM) below 5.3 m (estimated)
- 2 mm thick SILT layer at 5.8 m

END OF BOREHOLE 5.8 m(-50.9 m El.)

Note: Borehole was terminated after seabed clay thickness was verified.

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/08
BOREHOLE DEPTH: 5.8 m(-50.9 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: PMR/CHL

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
+ Torvane
● Fall Cone
× Min. Vane
▲ UU Triaxial
● Pilcon Vane
■ CU Triaxial
○ Halibut Vane

TEST IDENTIFICATION
C - Consolidation
T - Triaxial Shear
DS - Direct Shear
S - P.W. Salinity
TD - TDR
G - Gas Analysis
Ca - Calorimetry

BOREHOLE NUMBER V-NER 2.9

PAGE 1 OF 1

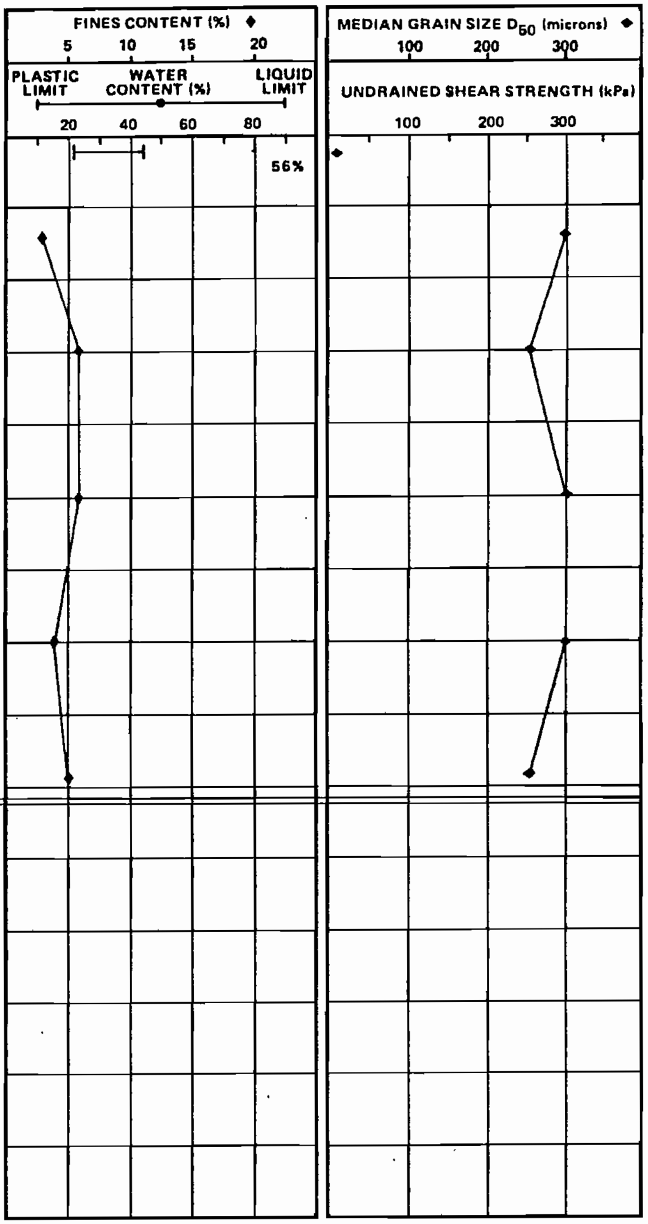
BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 933 m N. 561 875 m E. WATER DEPTH: 42.6 m

DEPTH BELOW SEABED (metres)

SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
▨	1	CLAY (CL) - and SAND, some SILT, ORGANIC pockets, very soft, high plasticity, dark grey black 0.3 m(-42.9 m El.)	NOT FROZEN
▒	2	SAND (SP) - trace SILT, fine-grained, uniform, grey brown - some ORGANICS at 0.6 and 0.8 m	
▒	3	- 10 mm thick ORGANIC layer - occassional SILT pockets, trace shell fragments, ORGANIC laminations at 2.1, 2.4, and 2.7 m	
▒	4	- (SP) below 3 m	
▒	5		
▒	6	- (SP - SM) below 4 m	
		END OF BOREHOLE 4.6 m(-47.2 m El.)	

Note: Borehole was terminated after seabed clay thickness was verified.



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/11
BOREHOLE DEPTH: 4.6 m(-47.2 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: PMR/CHL

LEGEND

SOIL SYMBOLS
▒ SAND
▥ SILT
▨ CLAY

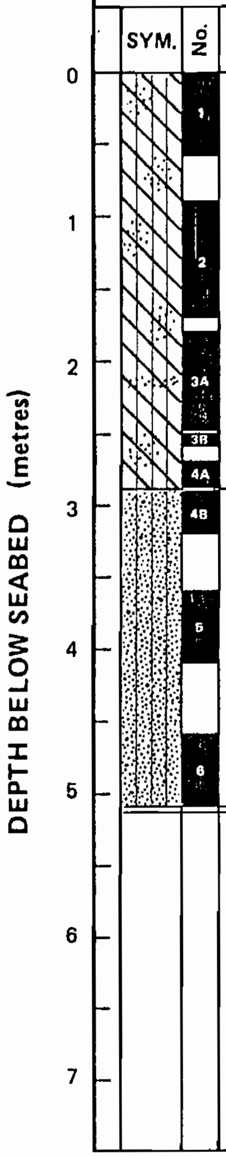
SHEAR STRENGTH
+ Torvane
× Min. Vane
* Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G Gas Analysis

BOREHOLE NUMBER
V-NER 2:11
PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 947 m N. 561 789 m E. **WATER DEPTH:** 43.6 m



SOIL DESCRIPTION

CLAY (CH) - SILTY, some SAND, trace ORGANICS, very soft, high plasticity, dark grey

- (CL) and SAND, some SILT below 1.25 m (estimated)

- trace shell fragments

- 10 cm thick SILT-SAND layer

2.9 m(-46.5 m El.)

SAND (SP - SM) - trace to some SILT, trace shell fragments, fine-grained, uniform, grey brown

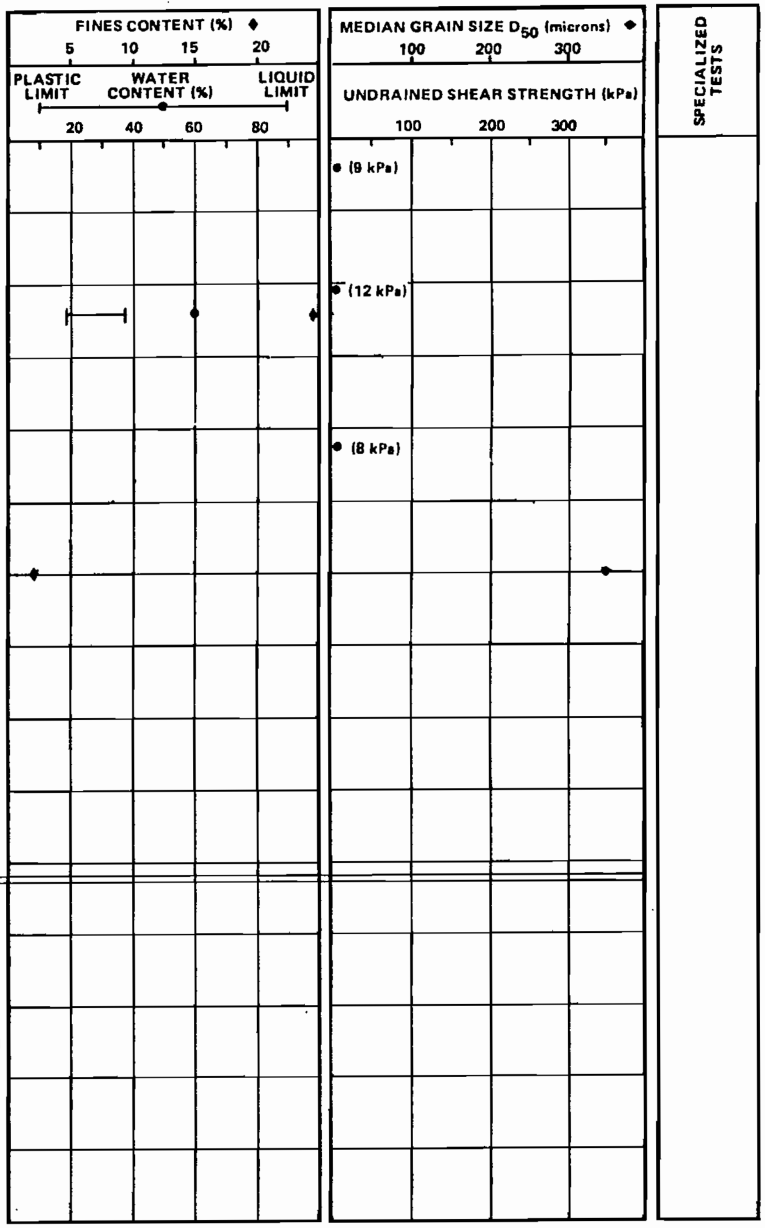
- ORGANIC layer at 3.1 m

END OF BOREHOLE 5.1 m(-48.7 m El.)

Note: Borehole was terminated after seabed clay thickness was verified.

GROUND ICE
T (°C)

NOT FROZEN



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JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/12
BOREHOLE DEPTH: 5.1 m(-48.7 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: CHL/BR

LEGEND

SOIL SYMBOLS

SAND	SILT	CLAY
▨	▥	▧

SHEAR STRENGTH

- + Torvane
- × Min. Vane
- ♦ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

TEST IDENTIFICATION

- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

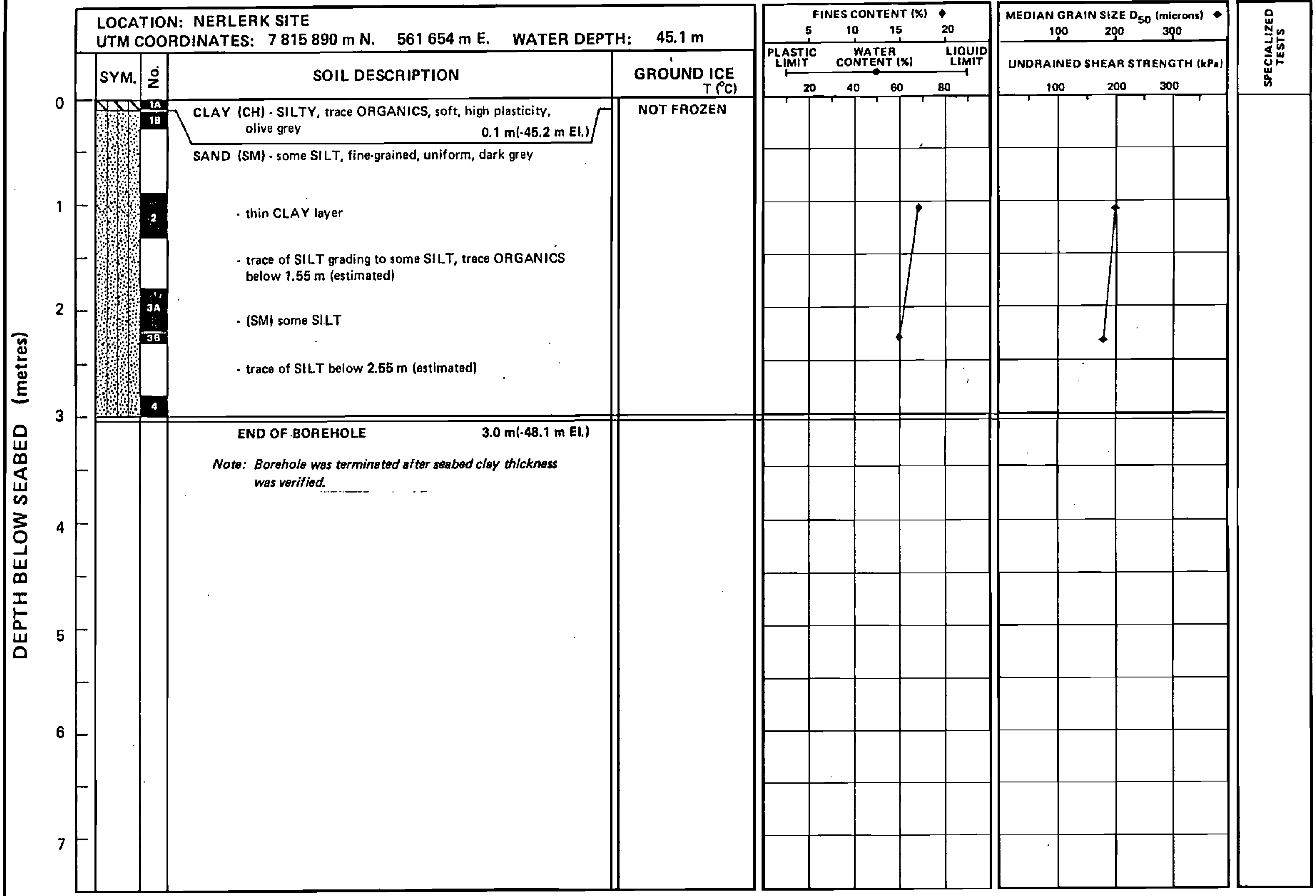
BOREHOLE NUMBER
V-NER 2:12

PAGE1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 890 m N. 561 654 m E. WATER DEPTH: 45.1 m

SOIL DESCRIPTION	GROUND ICE T (°C)
CLAY (CH) - SILTY, trace ORGANICS, soft, high plasticity, olive grey 0.1 m(-45.2 m El.)	NOT FROZEN
SAND (SM) - some SILT, fine-grained, uniform, dark grey	
- thin CLAY layer	
- trace of SILT grading to some SILT, trace ORGANICS below 1.55 m (estimated)	
- (SM) some SILT	
- trace of SILT below 2.55 m (estimated)	
END OF BOREHOLE 3.0 m(-48.1 m El.)	
Note: Borehole was terminated after seabed clay thickness was verified.	



JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/13
BOREHOLE DEPTH: 3.0 m(-48.1 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: CHL/BR

LEGEND

SOIL SYMBOLS
▨ SAND ▥ SILT ▧ CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
• Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

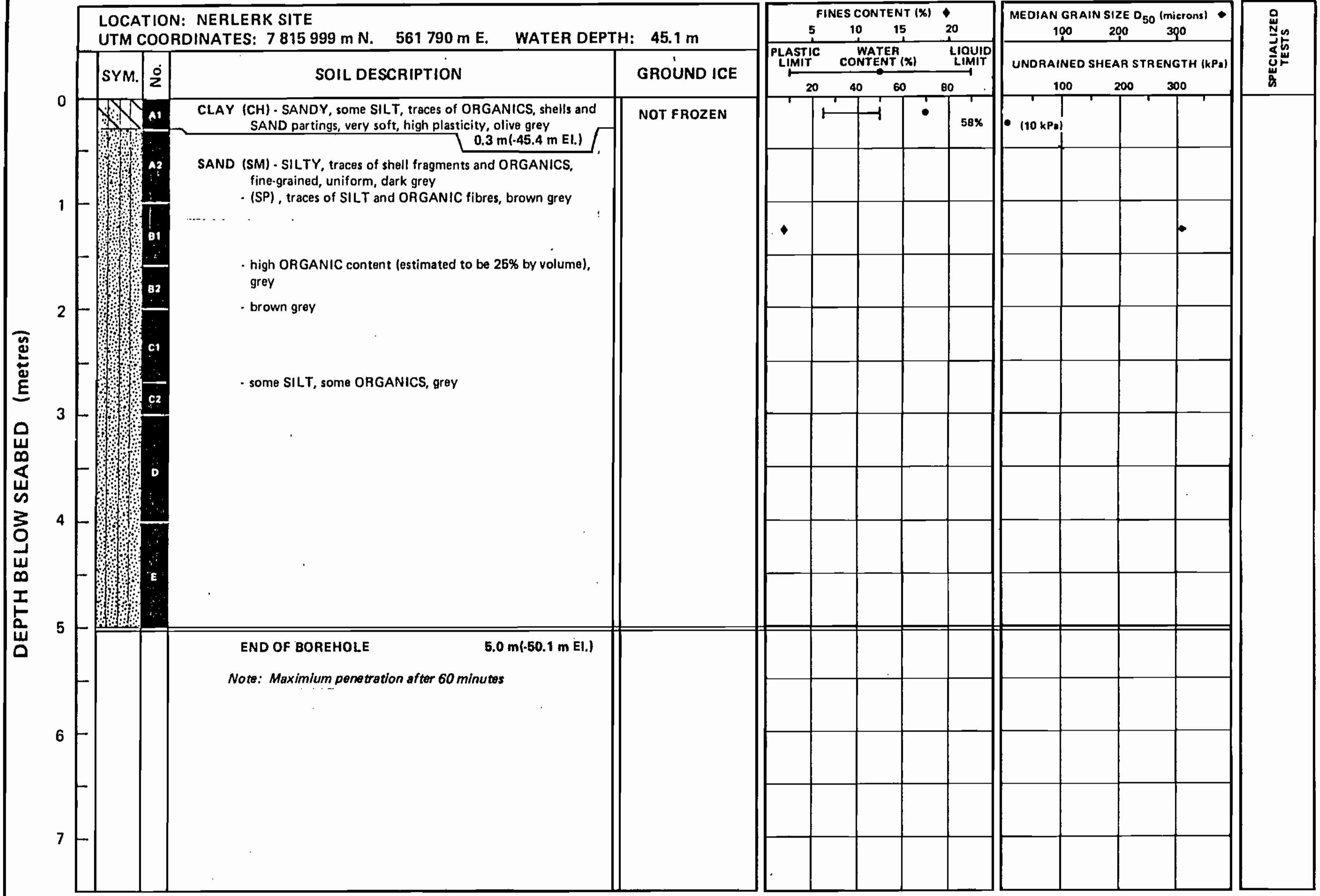
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:13

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 999 m N. 561 790 m E. WATER DEPTH: 45.1 m



CLAY (CH) - SANDY, some SILT, traces of ORGANICS, shells and SAND partings, very soft, high plasticity, olive grey
0.3 m(-45.4 m El.)

SAND (SM) - SILTY, traces of shell fragments and ORGANICS, fine-grained, uniform, dark grey
- (SP), traces of SILT and ORGANIC fibres, brown grey
- high ORGANIC content (estimated to be 25% by volume), grey
- brown grey
- some SILT, some ORGANICS, grey

END OF BOREHOLE 5.0 m(-50.1 m El.)

Note: Maximum penetration after 60 minutes

NOT FROZEN

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/14
BOREHOLE DEPTH: 5.0 m(-50.1 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: BR/CL

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- ◆ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

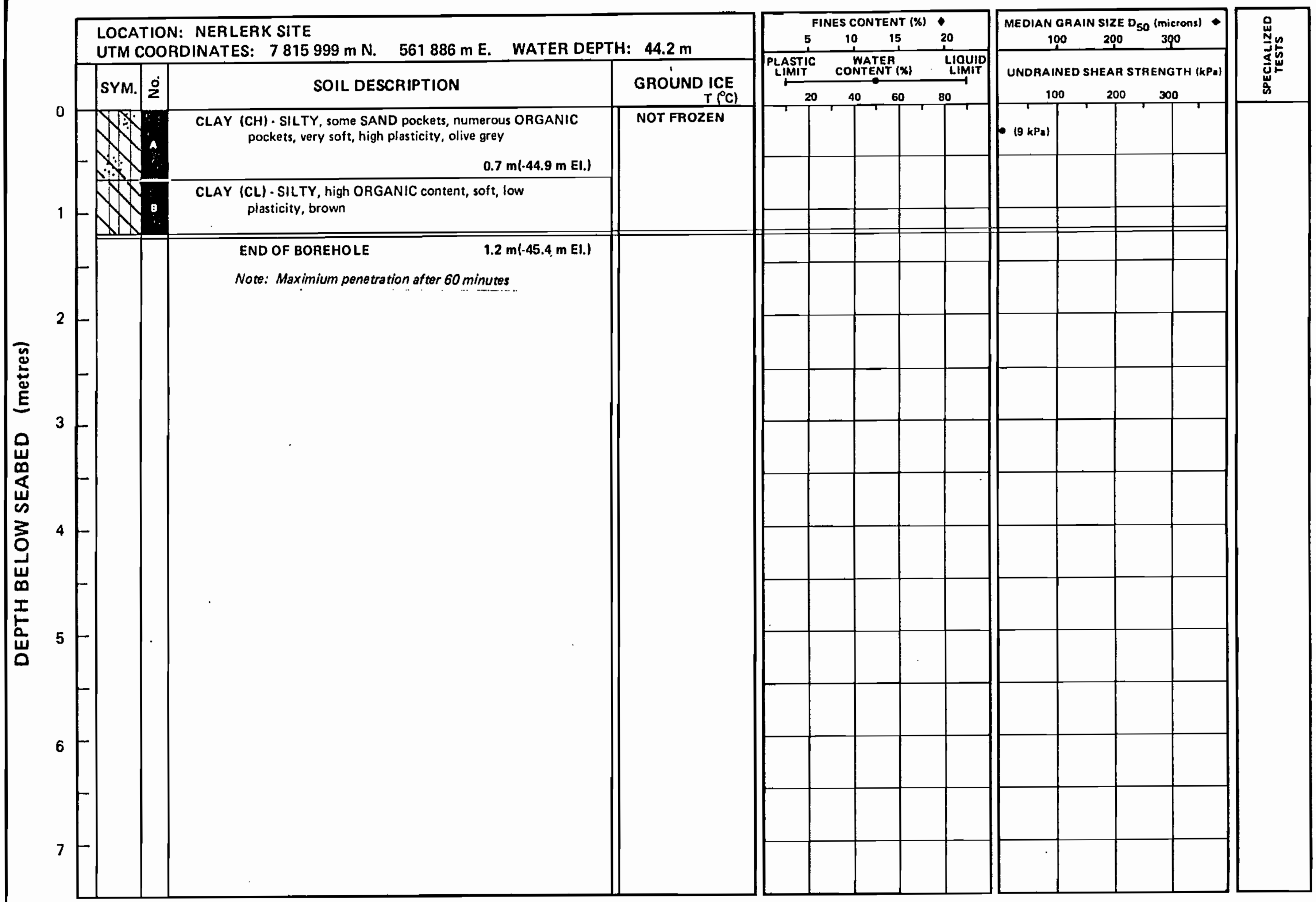
TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:14

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 999 m N. 561 886 m E. WATER DEPTH: 44.2 m



SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
▨	A	CLAY (CH) - SILTY, some SAND pockets, numerous ORGANIC pockets, very soft, high plasticity, olive grey 0.7 m(-44.9 m El.)	NOT FROZEN
▨	B	CLAY (CL) - SILTY, high ORGANIC content, soft, low plasticity, brown	
		END OF BOREHOLE 1.2 m(-45.4 m El.) *Note: Maximium penetration after 60 minutes*	

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/14
BOREHOLE DEPTH: 1.2 m(-45.4 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: BR/CL

LEGEND

SOIL SYMBOLS
▒ SAND
▥ SILT
▨ CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
◆ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

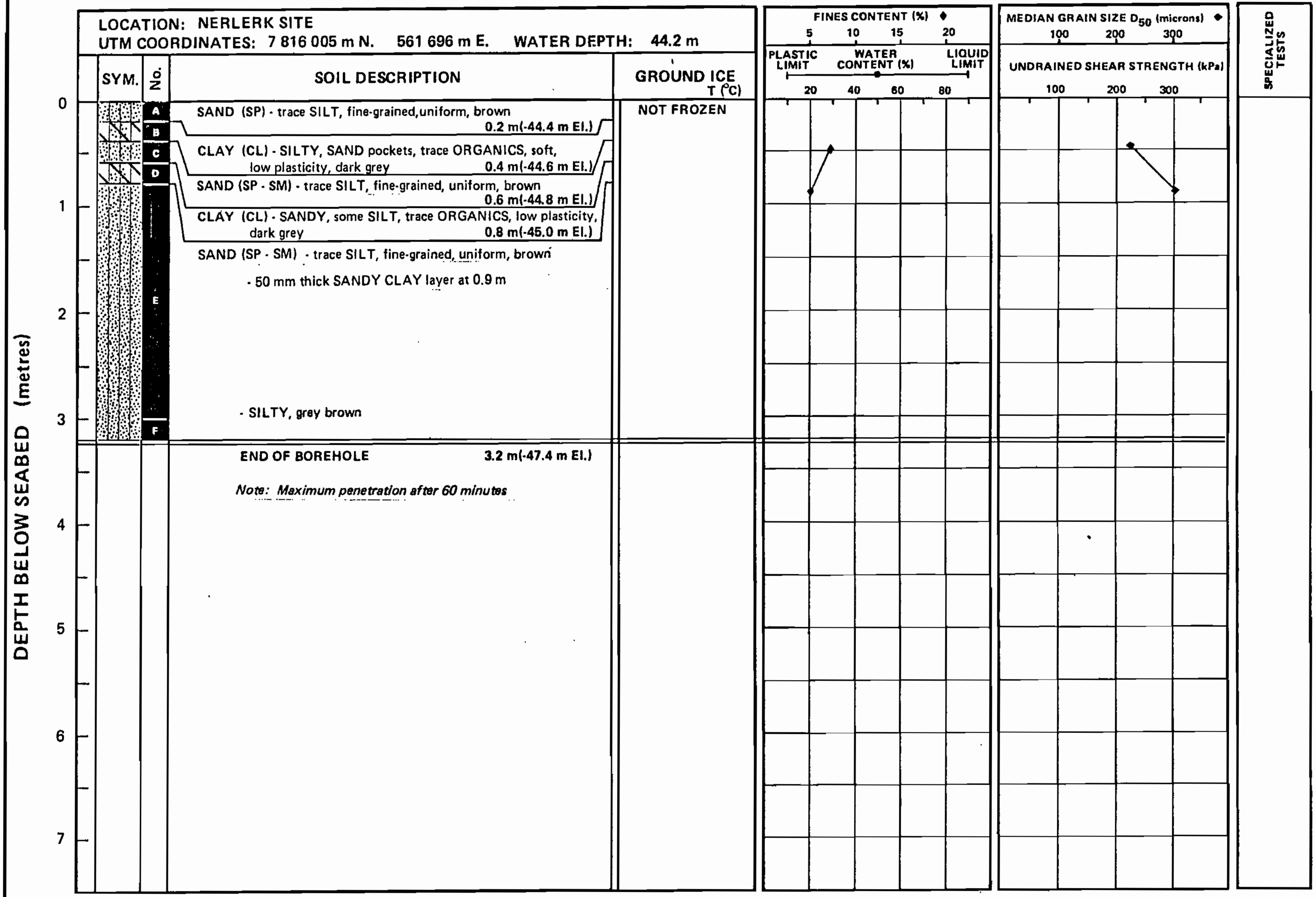
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:15

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 816 005 m N. 561 696 m E. WATER DEPTH: 44.2 m



SAND (SP) - trace SILT, fine-grained,uniform, brown 0.2 m(-44.4 m El.)

CLAY (CL) - SILTY, SAND pockets, trace ORGANICS, soft, low plasticity, dark grey 0.4 m(-44.6 m El.)

SAND (SP - SM) - trace SILT, fine-grained, uniform, brown 0.6 m(-44.8 m El.)

CLAY (CL) - SANDY, some SILT, trace ORGANICS, low plasticity, dark grey 0.8 m(-45.0 m El.)

SAND (SP - SM) - trace SILT, fine-grained, uniform, brown

- 50 mm thick SANDY CLAY layer at 0.9 m

- SILTY, grey brown

END OF BOREHOLE 3.2 m(-47.4 m El.)

Note: Maximum penetration after 60 minutes

NOT FROZEN

eba

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/15
BOREHOLE DEPTH: 3.2 m(-47.4 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: BR/CL

LEGEND

SOIL SYMBOLS

▒	▥	▨
SAND	SILT	CLAY

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
♦ Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TD - TDR	G - Gas Analysis
Ca - Calorimetry	

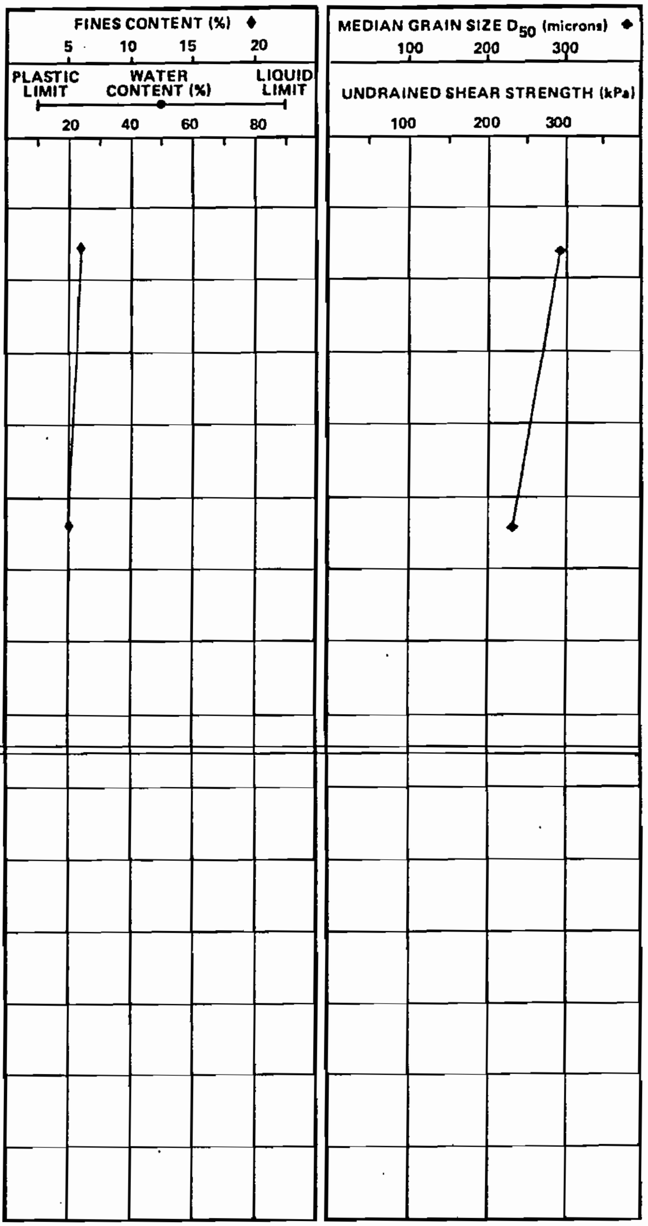
BOREHOLE NUMBER
V-NER 2:16

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 820 m N. 561 798 m E. WATER DEPTH: 44.2 m

DEPTH BELOW SEABED (metres)	SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
0	CLAY	1A	CLAY (CH) - some SILT, some SAND, very soft, high plasticity, grey brown 0.2 m(-44.4 m El.)	NOT FROZEN
	SAND	2A	SAND (SP - SM) - trace SILT, fine-grained, uniform, brown	
1			- some SILT to 2.2 m	
		3A		
2			- SILT lenses to 2.2 m - ORGANIC pockets to 3.2 m	
		4A		
3				
		5A		
4			END OF BOREHOLE 4.2 m(-48.4 m El.) *Note: Maximium penetration after 60 minutes*	
5				
6				
7				



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/15
BOREHOLE DEPTH: 4.2 m(-48.4 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: KWJ/RB

LEGEND

SOIL SYMBOLS
- ▨ SAND
- ▥ SILT
- ▧ CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- ♦ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

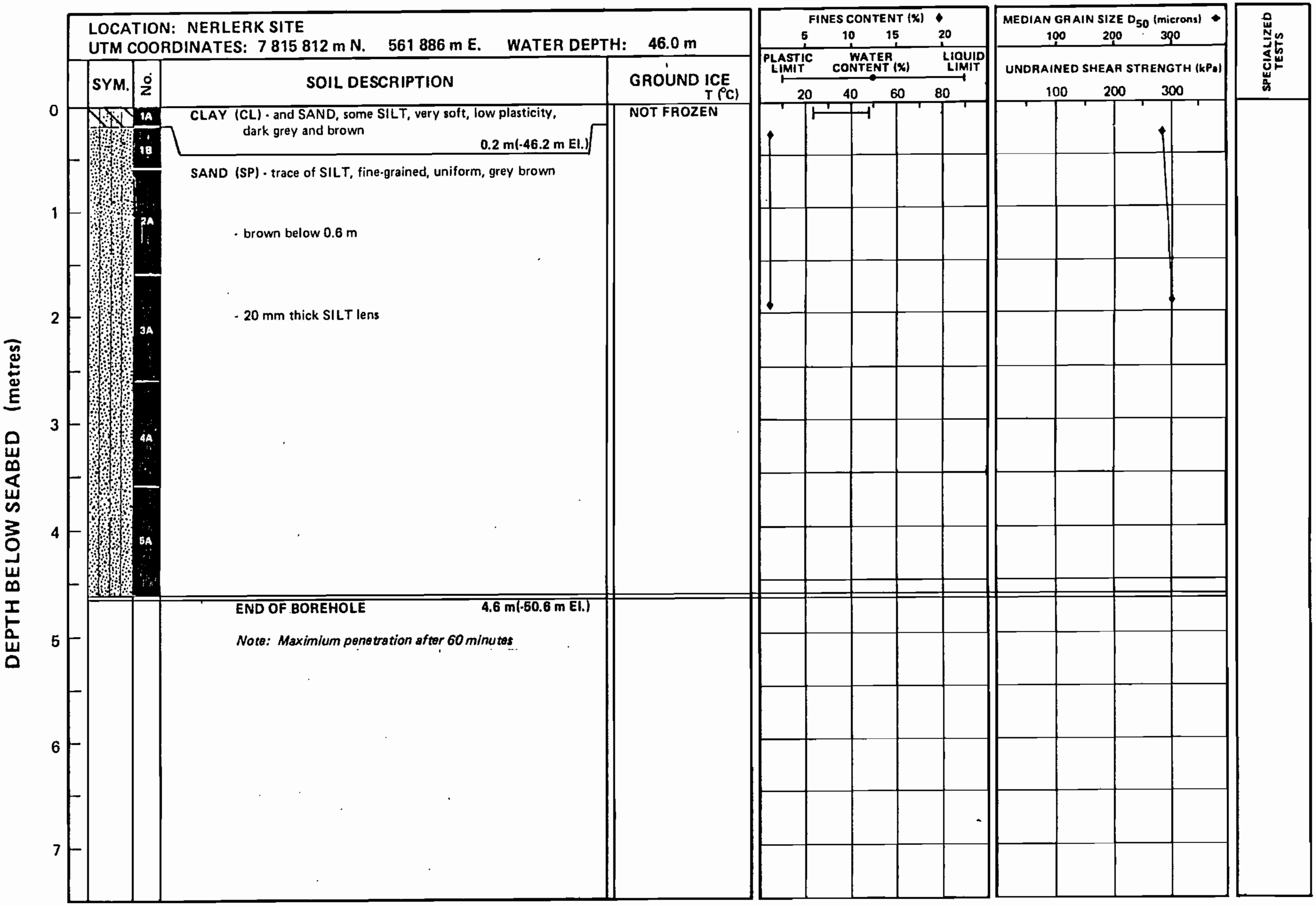
TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:17

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 812 m N. 561 886 m E. WATER DEPTH: 46.0 m



SOIL DESCRIPTION	GROUND ICE T (°C)
CLAY (CL) - and SAND, some SILT, very soft, low plasticity, dark grey and brown 0.2 m(-46.2 m El.)	NOT FROZEN
SAND (SP) - trace of SILT, fine-grained, uniform, grey brown - brown below 0.6 m - 20 mm thick SILT lens	
END OF BOREHOLE 4.6 m(-50.6 m El.) *Note: Maximum penetration after 60 minutes*	

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/15
BOREHOLE DEPTH: 4.6 m(-50.6 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: KWJ/RB

LEGEND

SOIL SYMBOLS
- ▨ SAND
- ▥ SILT
- ▧ CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- ♦ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:18

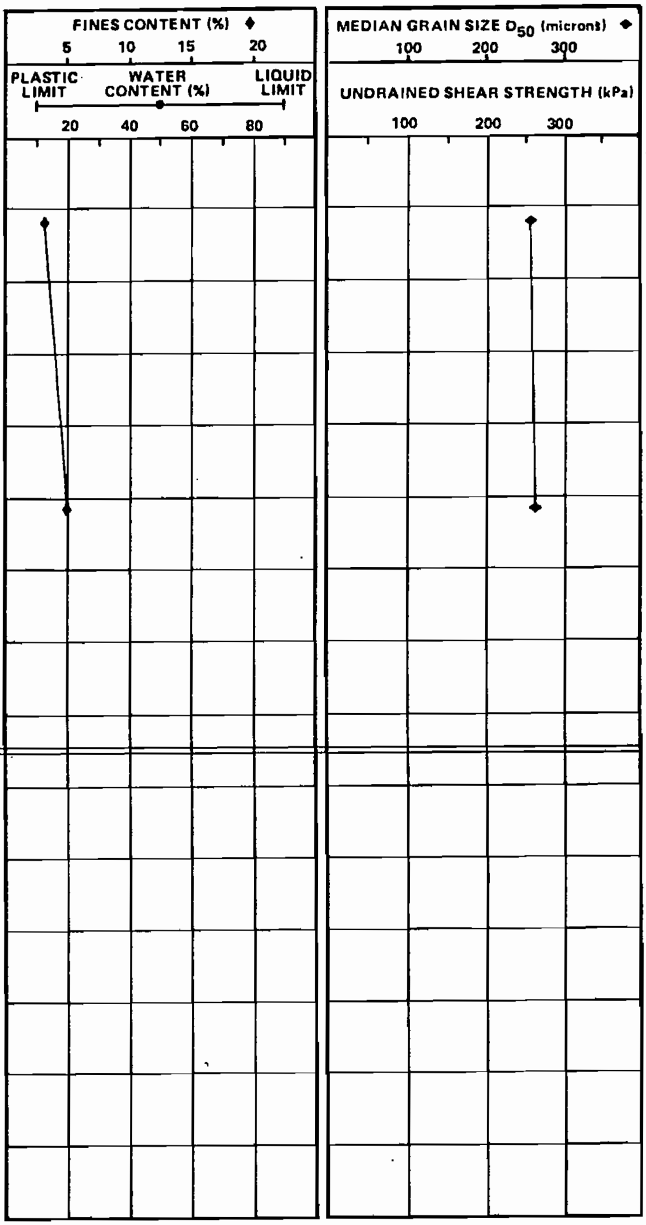
PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 808 m N. 561 973 m E. **WATER DEPTH:** 44.8 m

DEPTH BELOW SEABED (metres)

SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
CLAY	1A	CLAY (CL) - and SAND, some SILT, very soft, low plasticity, dark grey and brown 0.2 m(-45.0 m El.)	NOT FROZEN
SAND	2A, 3A, 4A, 5A	SAND (SP) - traces of SILT and ORGANICS, fine-grained, uniform, grey - (SP - SM) below 2.2 m	
		END OF BOREHOLE 4.2 m(-49.0 m El.) *Note: Maximium penetration after 60 minutes*	



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/15
BOREHOLE DEPTH: 4.2 m(-49.0 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: KWJ/RB

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
+ Torvane
● Fall Cone
× Min. Vane
▲ UU Triaxial
♦ Pilcon Vane
■ CU Triaxial
○ Halibut Vane

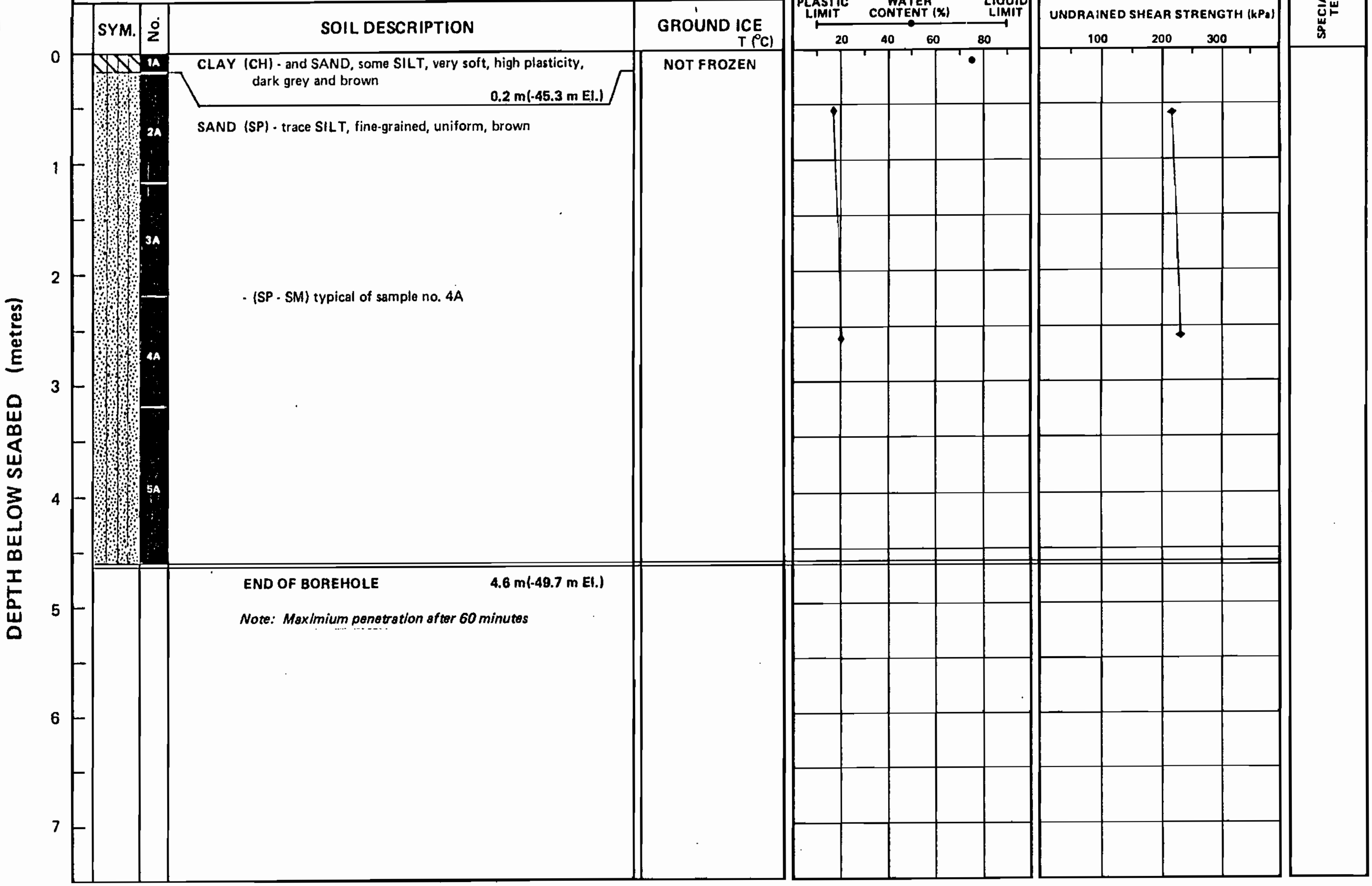
TEST IDENTIFICATION
C - Consolidation
T - Triaxial Shear
DS - Direct Shear
S - P.W. Salinity
TD - TDR
G - Gas Analysis
Ca - Calorimetry

BOREHOLE NUMBER
V-NER 2:19

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 707 m N. 561 978 m E. WATER DEPTH: 45.1 m



CLAY (CH) - and SAND, some SILT, very soft, high plasticity, dark grey and brown
0.2 m(-45.3 m El.)

SAND (SP) - trace SILT, fine-grained, uniform, brown

- (SP - SM) typical of sample no. 4A

END OF BOREHOLE 4.6 m(-49.7 m El.)

Note: Maximium penetration after 60 minutes

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/15
BOREHOLE DEPTH: 4.6 m(-49.7 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: KWJ/RB

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
♦ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

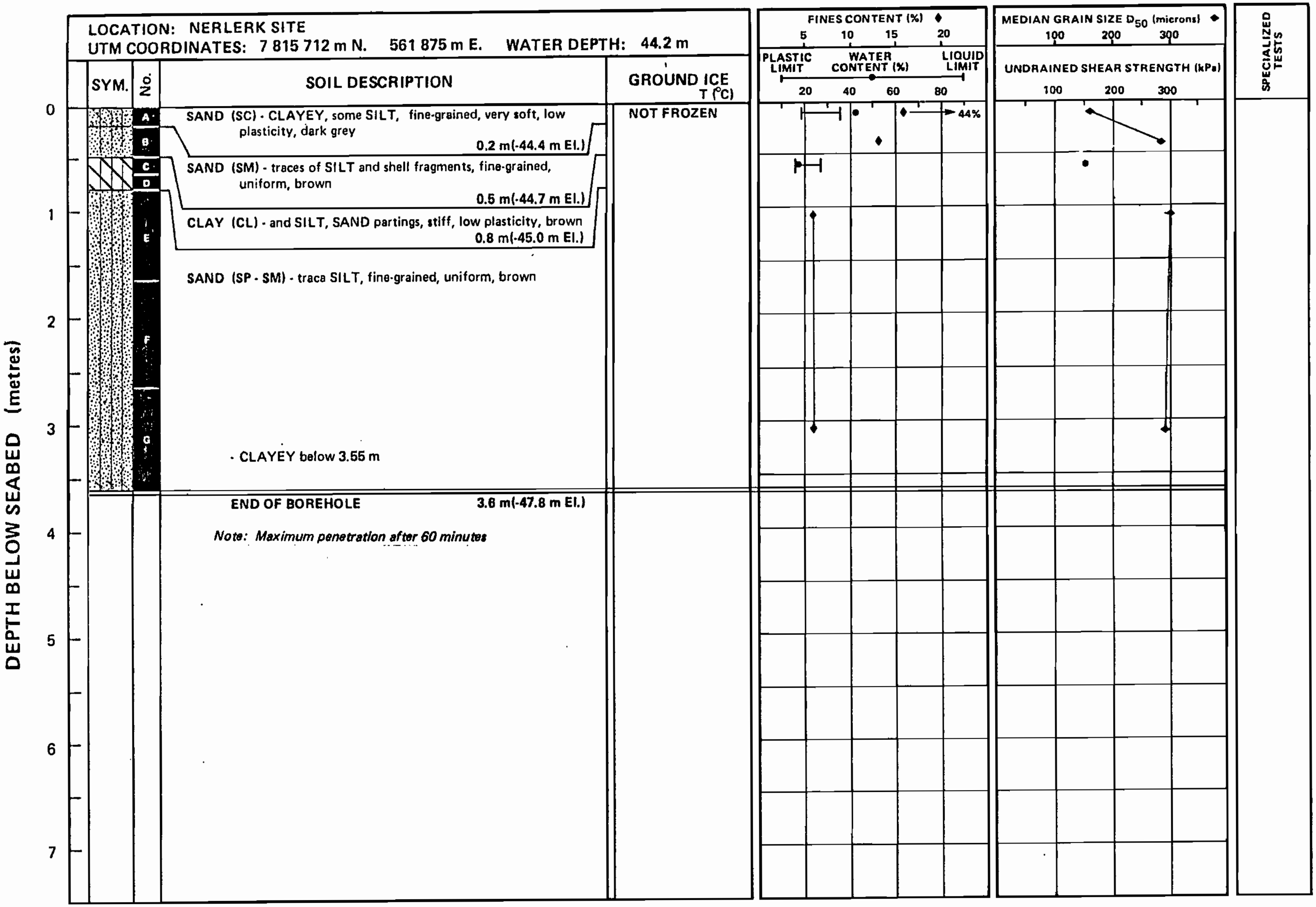
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:20

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 712 m N. 561 875 m E. WATER DEPTH: 44.2 m



SOIL DESCRIPTION

SAND (SC) - CLAYEY, some SILT, fine-grained, very soft, low plasticity, dark grey

0.2 m(-44.4 m El.)

SAND (SM) - traces of SILT and shell fragments, fine-grained, uniform, brown

0.5 m(-44.7 m El.)

CLAY (CL) - and SILT, SAND partings, stiff, low plasticity, brown

0.8 m(-45.0 m El.)

SAND (SP - SM) - trace SILT, fine-grained, uniform, brown

- CLAYEY below 3.55 m

END OF BOREHOLE 3.6 m(-47.8 m El.)

Note: Maximum penetration after 60 minutes

GROUND ICE T (°C)

NOT FROZEN

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/15
BOREHOLE DEPTH: 3.6 m(-47.8 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: BR/CL

LEGEND

SOIL SYMBOLS

▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH

- + Torvane
- × Min. Vane
- • Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

TEST IDENTIFICATION

- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

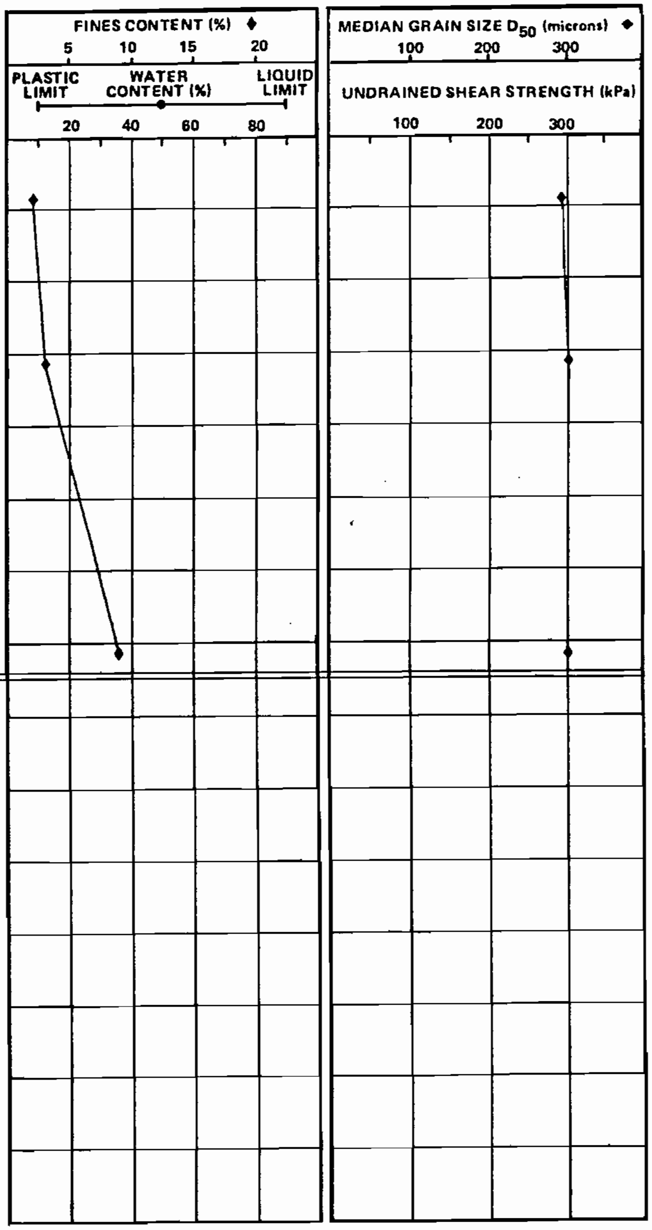
BOREHOLE NUMBER
V-NER 2:21

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 875 m N. 561 668 m E. WATER DEPTH: 42.4 m

DEPTH BELOW SEABED (metres)	SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
0	▨	1	CLAY (CL) - SILTY, SANDY, soft, low plasticity, dark grey 0.2 m(-42.6 m El.)	NOT FROZEN
	▩	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	SAND (SP) - trace SILT, fine-grained, uniform, brown NOTE: *Without moving anchors or winching in any direction, 3 attempts were made to core. There was no recovery in 1st attempt; 200 mm of clay recovered in 2nd attempt and continuous sand with no clay on 3rd attempt. The 200 mm of seabed clay has been included above.* - dark grey SAND lenses below 1.7 m - shell fragments below 2.7 m - (SP - SM) below 3.3m	
3.7			END OF BOREHOLE 3.7 m(-46.1 m El.) *Note: Maximium penetration after 60 minutes*	



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/19
BOREHOLE DEPTH: 3.7 m(-46.1 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: MDW/DJ

LEGEND

SOIL SYMBOLS	SHEAR STRENGTH	TEST IDENTIFICATION
▩ SANO ▥ SILT ▨ CLAY	+ Torvane × Min. Vane ◆ Pilcon Vane ○ Halibut Vane ● Fall Cone ▲ UU Triaxial ■ CU Triaxial	C - Consolidation DS - Direct Shear TD - TDR Ca - Calorimetry T - Triaxial Shear S - P.W. Salinity G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:22

PAGE 1 OF 1

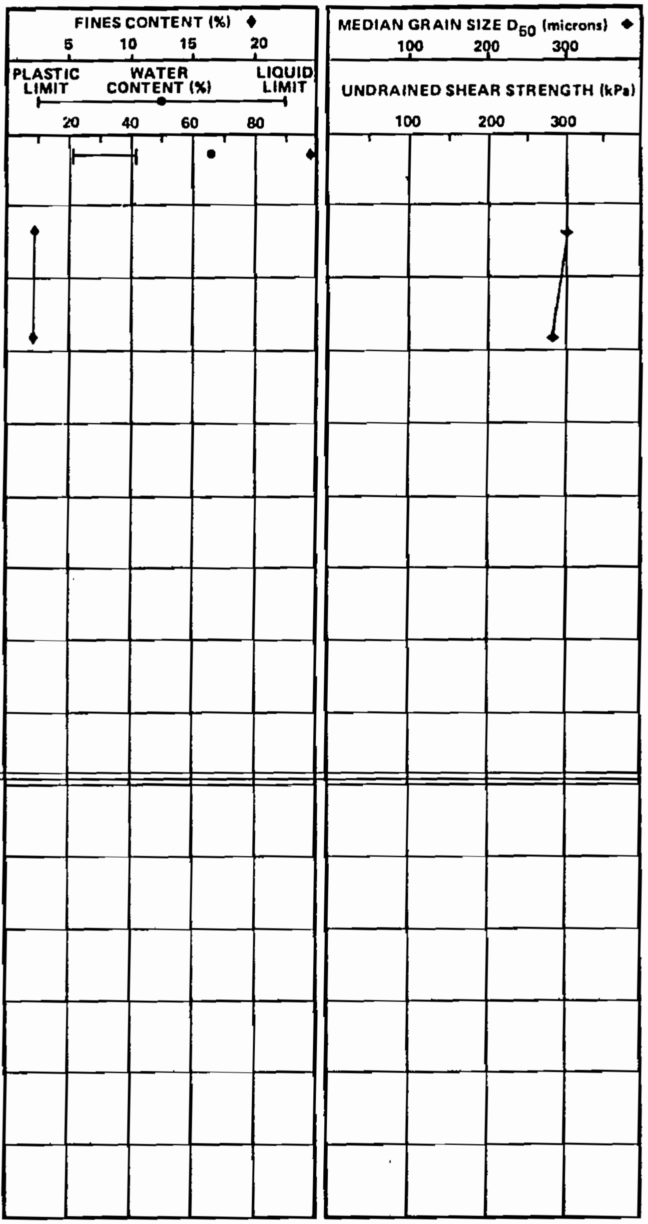
BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE

UTM COORDINATES: 7 814 877 m N. 562 562 m E. WATER DEPTH: 44.2 m

DEPTH BELOW SEABED (metres)

SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
	1	CLAY (CL) - and SAND, some SILT, very soft, low plasticity, dark grey 0.3 m(-44.5 m El.)	NOT FROZEN
	2, 3, 4, 5	SAND (SP) - trace SILT, fine-grained, uniform, grey brown	
	6, 7, 8	- trace shell fragments	
		END OF BOREHOLE 4.4 m(-48.6 m El.)	
		Note: Maximium penetration after 60 minutes	



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/19
BOREHOLE DEPTH: 4.4 m(-48.6 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: MDW/DJ

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
♦ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

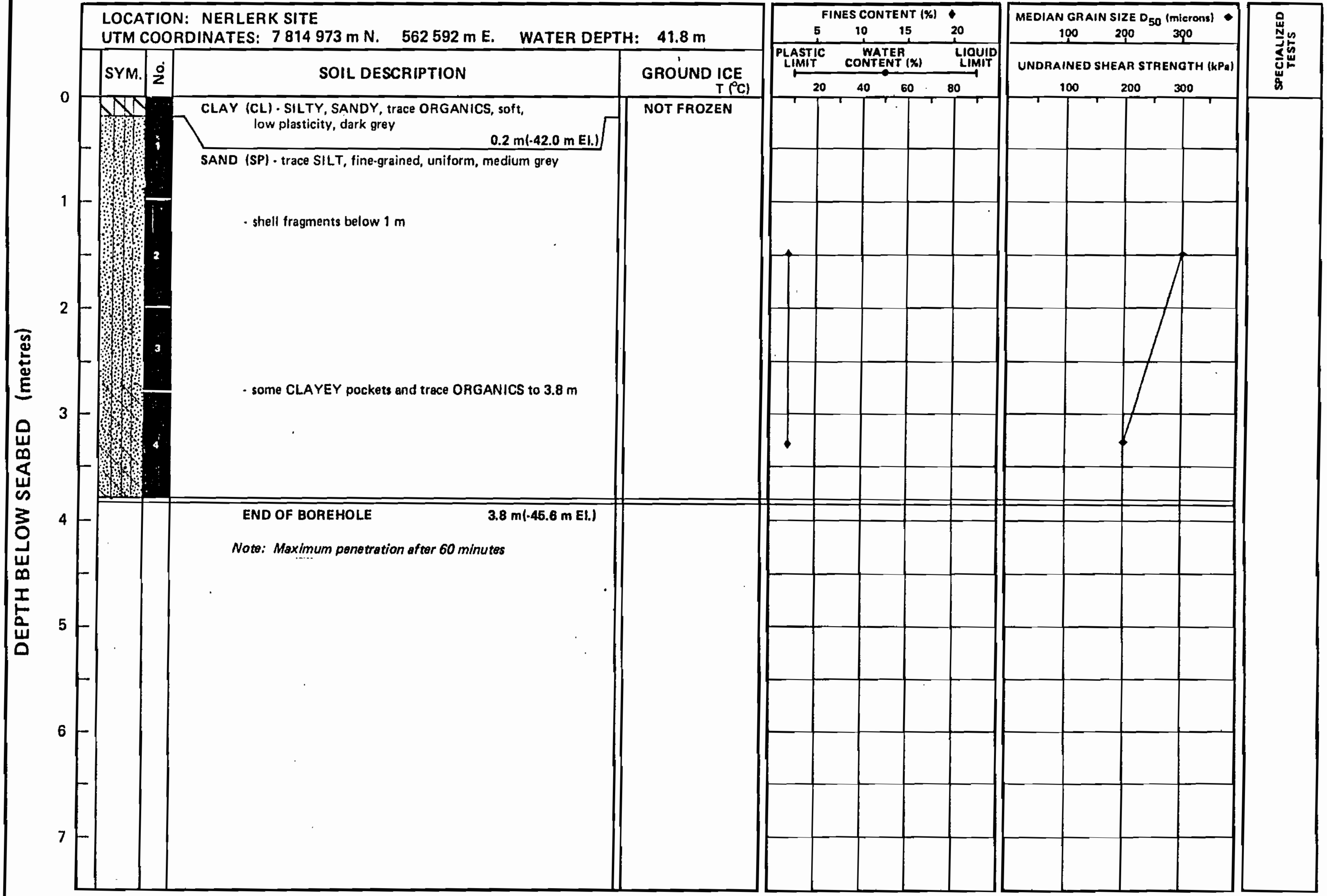
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:23

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 973 m N. 562 592 m E. **WATER DEPTH:** 41.8 m



CLAY (CL) - SILTY, SANDY, trace ORGANICS, soft, low plasticity, dark grey

0.2 m(-42.0 m El.)

SAND (SP) - trace SILT, fine-grained, uniform, medium grey

- shell fragments below 1 m

- some CLAYEY pockets and trace ORGANICS to 3.8 m

END OF BOREHOLE 3.8 m(-45.6 m El.)

Note: Maximum penetration after 60 minutes

NOT FROZEN

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/19
BOREHOLE DEPTH: 3.8 m(-45.6 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: DY/BR

LEGEND

SOIL SYMBOLS		
▨	▥	▧
SAND	SILT	CLAY

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
◆ Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

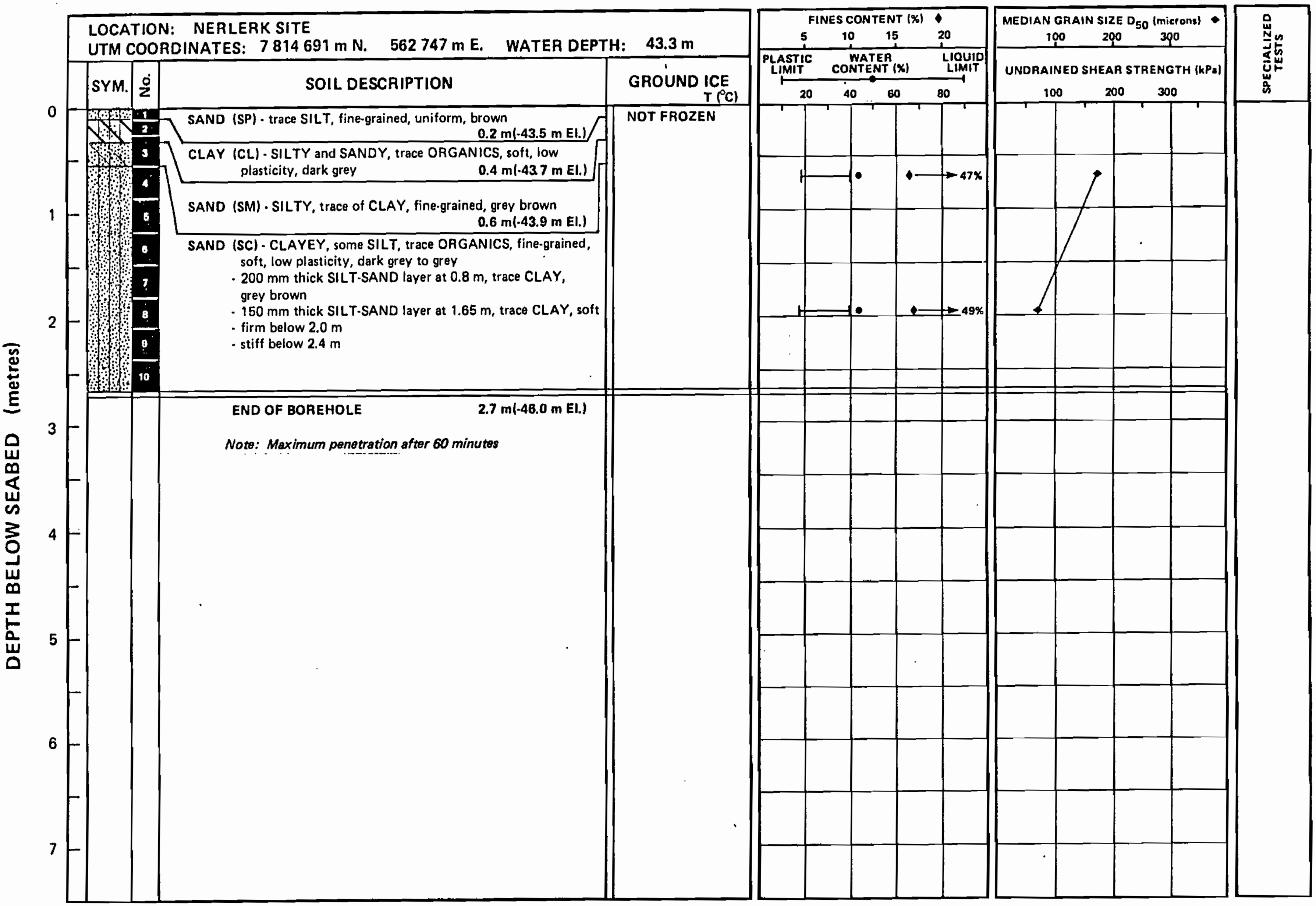
C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TD - TDR	G - Gas Analysis
Ca - Calorimetry	

BOREHOLE NUMBER
V-NER 2:24

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 691 m N. 562 747 m E. WATER DEPTH: 43.3 m



SOIL DESCRIPTION	GROUND ICE T (°C)
SAND (SP) - trace SILT, fine-grained, uniform, brown 0.2 m(-43.5 m El.)	NOT FROZEN
CLAY (CL) - SILTY and SANDY, trace ORGANICS, soft, low plasticity, dark grey 0.4 m(-43.7 m El.)	
SAND (SM) - SILTY, trace of CLAY, fine-grained, grey brown 0.6 m(-43.9 m El.)	
SAND (SC) - CLAYEY, some SILT, trace ORGANICS, fine-grained, soft, low plasticity, dark grey to grey - 200 mm thick SILT-SAND layer at 0.8 m, trace CLAY, grey brown - 150 mm thick SILT-SAND layer at 1.65 m, trace CLAY, soft - firm below 2.0 m - stiff below 2.4 m	
END OF BOREHOLE 2.7 m(-46.0 m El.) *Note: Maximum penetration after 60 minutes*	

JOB No.: 101-3605
DRILLING COMPLETED: 82/08/25
BOREHOLE DEPTH: 2.7 m(-46.0 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: MDW/DJ

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- • Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:25

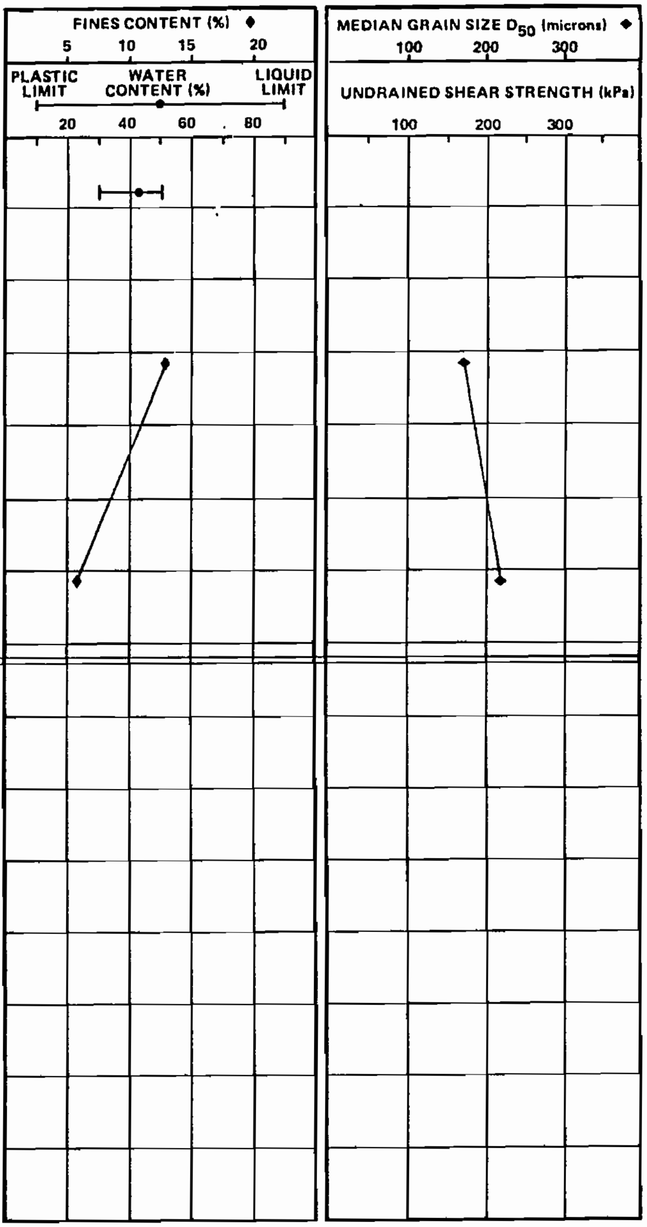
PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 802 m N. 562 400 m E. **WATER DEPTH:** 42.7 m

DEPTH BELOW SEABED (metres)

SYM.	No.	SOIL DESCRIPTION	GROUND ICE T (°C)
SAND	1	SAND (SM) - SILTY, some ORGANICS, fine-grained, light grey 0.3 m(-43.0 m El.)	NOT FROZEN
CLAY	2	CLAY (CH) - and SILT, SANDY, trace ORGANICS, stiff, high plasticity, dark grey 0.5 m(-43.2 m El.)	
SAND	3, 4, 5, 6	SAND (SM) - some SILT to SILTY, fine-grained, uniform, dark grey - 100 mm thick ORGANIC-rich layer - (SP - SM) trace of SILT below 2.9 m, medium grey - SANDY CLAY pockets at 3.5 m	
		END OF BOREHOLE 3.6 m(-46.3 m El.) *Note: Maximum penetration after 60 minutes*	



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/25
BOREHOLE DEPTH: 3.6 m(-46.3 m El.)
DRILLING RIG: Vibrocore
LOG COMPILED BY: DY/BR

LEGEND

SOIL SYMBOLS
- ▨ SAND
- ▥ SILT
- ▧ CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- ◆ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
V-NER 2:26

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER1:1																							
1A	B	0.0-1.0	SP										95	0	250								
1B	B	0.0-1.0	SP										100	0	250								
1C	B	0.0-1.0																					
2A	B	1.0-2.0	SP										100	0	250								
2B	B	1.0-2.0	SP										100	0	210								
2C	B	1.0-2.0																					
3A	B	2.0-3.0	SP										96	0	250								
3B	B	2.0-3.0	SP										99	0	240								
3C	B	2.0-3.0																					
4A	B	3.0-3.6	SP										100	0	300								
4B	B	3.0-3.6	SP										100	0	280								
B-NER1:2																							
1	B	0.0-0.1	CL			55			46	21	34	26	40	0	5								
2	B	0.1-0.2																					
3	B	0.2-0.5																					
4	B	0.5-0.6																					
5	B	0.6-0.9	SP										98	0	200								
6	B	0.9-1.2																					
7	B	1.2-1.5																					

LEGEND AND NOTES

B - Bag Sample
G - Gas Sample
L - Liner Sample
P - Piston Sample
NR - No Recovery
NS - No Sample Remaining

PF - Permafrost Sample
PW - Porewater Sample
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W - Waxed Sample
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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER1:2 (continued)																							
8	B	1.5-1.8	SP										98	0	200								
9	B	1.8-2.1																					
10	B	2.1-2.4																					
11	B	2.4-2.7																					
12	B	2.7-3.0	SP										96	0	160								
13	B	3.0-3.3	SP										98	0	180								
B-NER1:3																							
1	B	0.0-0.2	CH			81			57	26	47	24	29		2								
2	B	0.2-0.5	CL			55			47	22	34	21	45		7								
3A	B	0.5-0.8																					
3B	B	0.5-0.8	SP										99	0	250								

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Project Number: 101-3605

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Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:4																							
1B	B	*0.0-0.4				22							99	0	360								
2A	B	*09.-1.3																					
2B	B	*1.3-1.4				86																	
4A	B	*2.7-2.8																					
4B	B	*2.8-3.4	CL			86			45	24	39	29	32	0	4	FC	6		v. soft				
4C	B	*3.4-3.4																					
5A	B	*3.7-3.9	CH			79			55	26	49	34	17	0	2	FC	5		v. soft				
5B	B	*3.9-4.0																					
5C	B	*4.0-4.3	SP-SM			20							91	0	350								
6	B	*4.6-5.0																					
7	B	*5.5-5.9																					
V-NER2:5																							
1A	B	*0.0-0.2	SP			23							99	0	380								
1B	B	*0.2-0.3				70																	
1C	T	*0.0-0.7	SC			55																	
2A	B	*0.9-1.4	CH			64			53	24	52	32	16	0	2	TV	9		v. soft				
																FC	8		v. soft				
2B	NS	*1.4-1.5				75										TV	10		v. soft				

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Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:5																							
3A	B	*1.8-2.2				73										TV	12		v. soft				
																FC	6		v. soft				
3B	W	*2.2-2.3				60																	
4A	B	*2.7-3.3				53										TV	10		v. soft				
																FC	8		v. soft				
4B	B	*3.3-3.4	SP-SM			21							93	0	270								
5A	B	*3.7-4.0	SP			21							96	0	300								
V-NER2:6																							
1A		*0.0-0.1	SP										99	0	310								
1B	B	*0.1-0.4				81																	
2A	B	*0.9-1.2	CH			80			56	27	55	39	6	0	1.7	TV	10		v. soft				
																FC	6		v. soft				
2B	W	*1.2-1.4				69		1.49								UU	8	6	v. soft				
2C	B	*1.4-1.6				63																	
3A	B	*1.8-2.1				33										TV	10		V. soft				
																FC	5		v. soft				
3B		*2.1-2.2	SP-SM										89	0	300								
4A	B	*2.7-3.2	SP-SM			20							89	0	280								
5A	B	*3.7-4.2	SM			19							81	0	300								

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:7																							
1A	B	*0.0-0.2	SP			20							99	0	310								
1B	B	*0.2-0.6				89										TV	6		v. soft				
2A	NS	*0.9-1.1														FC	5		v. soft				
2B	B	*1.1-1.5	CH			77			55	26	48	32	20	0	2	TV	10		v. soft				
3A	B	*1.8-2.0				70																	
3B	B	*2.0-2.3	SP										97	0	440								
4A	B	*2.7-3.2	SP										95	0	290								
5A	B	*3.7-4.0	SP										98	0	310								
V-NER2:8																							
2	B	*0.9-1.1	SP										100	0	500								
3A	B	*1.8-2.0																					
3B	B	*2.0-2.2	SP										99	0	360								
4B	B	*2.7-2.9	CH			105			68	31	57	41	2	0	1.6	FC	4		v. soft				
																TV	5		v. soft				
5A	B	SLOUGH	SP										99	0	600								
5B	B	*3.7-4.0				85										TV	10		v. soft				
																FC	8		v. soft				
5C	B	*4.0-4.1																					
6	B	*4.6-4.8				20																	

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:8 (continued)																							
7	B	*5.5-5.9																					
V-NER2:9																							
1	B	*0.0-0.2																					
2	B	*0.9-1.1	SP										99	0	375								
3	B	*1.8-2.2	SP										99	0	340								
4	B	*2.7-3.1	CH			76			58	29	51	34	15	0	2	TV	8		v. soft				
																FC	7		v. soft				
5A	B	*3.7-4.2				72										TV	8		v. soft				
																FC	9		v. soft				
5B	B	*4.2-4.2	SP										98	0	260								
6A	NS	*4.6-4.7														TV	8		v. soft				
																FC	9		v. soft				
6B	B	*4.7-5.0																					
6C	B	*5.0-5.2																					
7	B	*5.5-5.8	SP-SM										94	0	320								

LEGEND AND NOTES

B	Bag Sample	PF	Permafrost Sample	MV	Minivane	UU	Unconsolidated Undrained Triaxial	O	Organic Content
G	Gas Sample	PW	Porewater Sample	FC	Fall Cone	UUp	UU Triaxial with Pore Pressure Measurements	S	Salinity
L	Liner Sample	T	Sample Stored in Tube	TV	Torvane	CU	Consolidated Undrained Triaxial	TS	Thaw Strain
P	Piston Sample	W	Waxed Sample	PV	Pilcon Vane	CUp	CU Triaxial with Pore Pressure Measurements	SG	Specific Gravity
NR	No Recovery	RC	Radiocarbon Sample	RV	Remote Vane	CD	Consolidated Drained Triaxial		
NS	No Sample Remaining								

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:11																							
1	B	*0.0-0.3	CL			40			44	21	35	21	44	0	8								
2	B	*0.3-1.0	SP										97	0	300								
3	B	*1.0-2.0	SP-SM										94	0	250								
4	B	*2.0-3.0	SP-SM										94	0	300								
5	B	*3.0-4.0	SP										96	0	300								
6	B	*4.0-4.6	SP-SM										95	0	255								
V-NER2:12																							
1	B	*0.0-0.6														FC	9		v. soft				
2	B	*0.9-1.7	CL			60			37	19	32	19	49	0	13	FC	12		v. soft				
3A	B	*1.8-2.5														FC	8		v. soft				
3B	B	*2.5-2.6																					
4A	B	*2.7-2.9																					
4B	B	*2.9-3.2	SP										98	0	350								
5	B	*3.6-4.1																					

LEGEND AND NOTES

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:12 (continued)																							
6	B	*4.6-5.0																					
V-NER2:13																							
1A	B	*0.0-0.1																					
1B	B	*0.1-0.3																					
2	B	*0.9-1.3	SM										83	0	200								
3A	B	*1.8-2.2																					
3B	B	2.2-2.3	SM										85	0	180								
4	B	*2.8-3.0																					
V-NER2:14																							
A1	B	*0.0-0.3	CH			70			50	25	35	23	42	0	5	FC	10		v. soft				
A2	B	*0.3-1.0																					
B1	B	*1.0-1.6	SP										98	0	310								
B2		*1.6-2.0																					
C1	B	*2.0-2.7																					
C2	B	2.7-3.0																					
D1	B	*3.0-4.0																					
E1	B	*4.0-5.0																					

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SUMMARY OF TEST RESULTS

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Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:15																							
A	B	*0.0-0.7														FC	9		v. soft				
B	B	*0.0-1.2																					
V-NER2:16																							
A	B	*0.0-0.2																					
B	B	*0.2-0.4																					
C	B	*0.4-0.6											93	0	220								
D	B	*0.6-0.8																					
E	B	*0.8-3.0	SP-SM										95	0	300								
F	B	*3.0-3.2																					
V-NER2:17																							
1A	B	*0.0-0.2																					
2A	B	*0.2-1.2	SP-SM										94	0	290								
3A	B	*1.2-2.2																					
4A	B	*2.2-3.2	SP-SM										95	0	230								
5A	B	*3.2-4.2																					

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm-3)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:18																							
1A	B	*0.0-0.2	CL			55			49	23	37	21	42		6								
1B	B	*0.2-0.6	SP										99	0	280								
2A	B	*0.6-1.6																					
3A	B	*1.6-2.6																					
4A	B	*2.6-3.6	SP										99	0	300								
5A	B	*3.6-4.6																					
V-NER2:19																							
1A	B	*0.0-0.2																					
2A	B	*0.2-1.2	SP										97	0	250								
3A	B	*1.2-2.2																					
4A	B	*2.2-3.2	SP										95	0	260								
5A	B	*3.2-4.2																					
V-NER2:20																							
1A	B	*0.0-0.2				75																	
2A	B	*0.2-1.2	SP										96	0	210								
3A	B	1.2-2.2																					
4A	B	2.2-3.2	SP-SM										95	0	230								
5A	B	3.2-4.6																					

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NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	ATTERBERG LIMITS Liquid Limit (%)	Plastic Limit (%)	GRAIN SIZE DISTRIBUTION Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	SHEAR STRENGTH Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	CONSOLIDATION CHARACTERISTICS P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:21																							
A	B	*0.0-0.2	SC			42			35	18	26	18	56	0	160								
B	B	*0.2-0.5	SM								4	9	87	0	280								
C	B	*0.5-0.6	CL			17			27	16	25	49	26	0	8	FC	147		stiff				
D	B	*0.6-1.6	SP-SM										94	0	300								
E	B	*1.6-2.6																					
F	B	*2.6-3.6	SP-SM										94	0	300								
V-NER2:22																							
1	3	*0.0-0.3	SP										98	0	290								
2	B	*0.3-0.6																					
3	B	*0.6-0.9																					
4	B	*0.9-1.2																					
5	B	*1.2-1.5																					
6	B	*1.5-1.8	SP										97	0	300								
7	B	*1.8-2.1																					
8	B	*2.1-2.4																					
9	B	*2.4-2.7																					
10	B	*2.7-3.0																					
11	B	*3.0-3.3																					
12	B	*3.3-3.7	SP-SM										91	0	300								

LEGEND AND NOTES

B - Bag Sample
G - Gas Sample
L - Liner Sample
P - Piston Sample
NR - No Recovery
NS - No Sample Remaining

PF - Permafrost Sample
PW - Porewater Sample
T - Sample Stored in Tube
W - Waxed Sample
RC - Radiocarbon Sample

MV - Minivane
FC - Fall Cone
TV - Torvane
PV - Pilcon Vane
RV - Remote Vane

UU - Unconsolidated Undrained Triaxial
UUp - UU Triaxial with Pore Pressure Measurements
CU - Consolidated Undrained Triaxial
CUp - CU Triaxial with Pore Pressure Measurements
CD - Consolidated Drained Triaxial

O - Organic Content
S - Salinity
TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
V-NER2:23																							
1	B	*0.0-0.3	CL			65.			41	20	34	18	48	0	8								
2	B	*0.3-0.6	SP										98	0	300								
3	B	*0.6-0.9																					
4	B	*0.9-1.2																					
5	B	*1.2-1.5	SP										98	0	280								
6	B	*1.5-2.5																					
7	B	*2.5-3.5																					
8	B	*3.5-4.4																					
V-NER2:24																							
1	B	*0.0-1.0																					
2	B	*1.0-2.0	SP										98	0	300								
3	B	*2.0-2.8																					
4	B	*2.8-3.8	SP										98	0	200								
V-NER2:25																							
1	B	*0.0-0.2																					
2	B	*0.2-0.3																					
3	B	*0.3-0.6																					
4	B	*0.6-0.9	SC			44			40	19	30	17	53	0	170								

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
V-NER2:25		(continued)																					
5	B	*0.9-1.2																					
6	B	*1.2-1.5																					
7	B	*1.5-1.8																					
8	B	*1.8-2.1	SC			44			40	19	33	16	51	0	70								
9	B	*2.1-2.4																					
10	B	*2.4-2.7																					
V-NER2:26																							
1	B	*0:0-0.3																					
2	B	*0.3-0.5	CH			43			50	30	20	49	31	0	33								
3	B	*0.5-1.5																					
4	B	*1.5-2.5	SM										87	0	170								
5	B	*2.5-2.9																					
6	B	*2.9-3.6	SP-SM										94	0	220								

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605
Reviewed By: ______________ P.Eng.
Page 13 of 13

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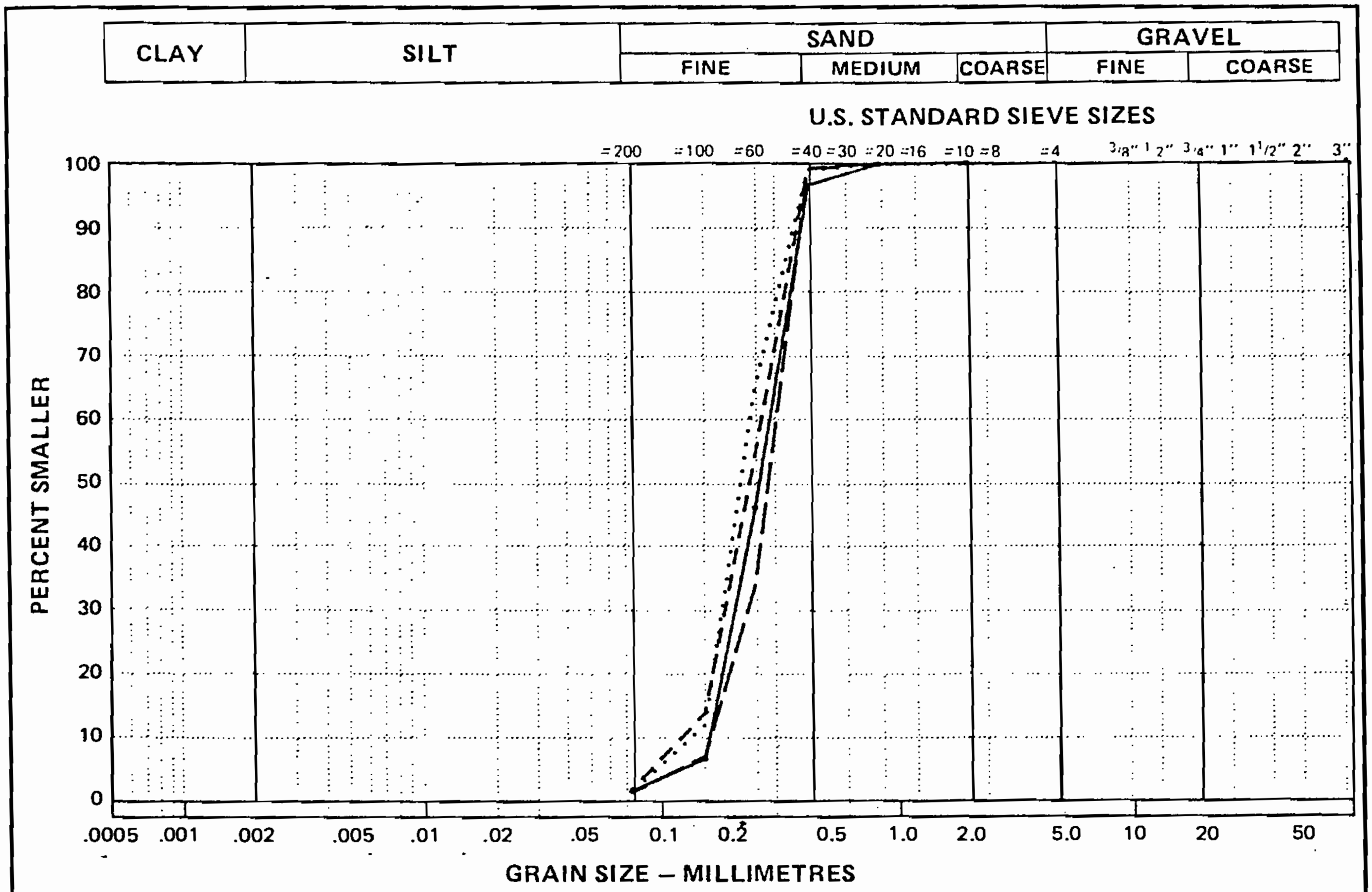
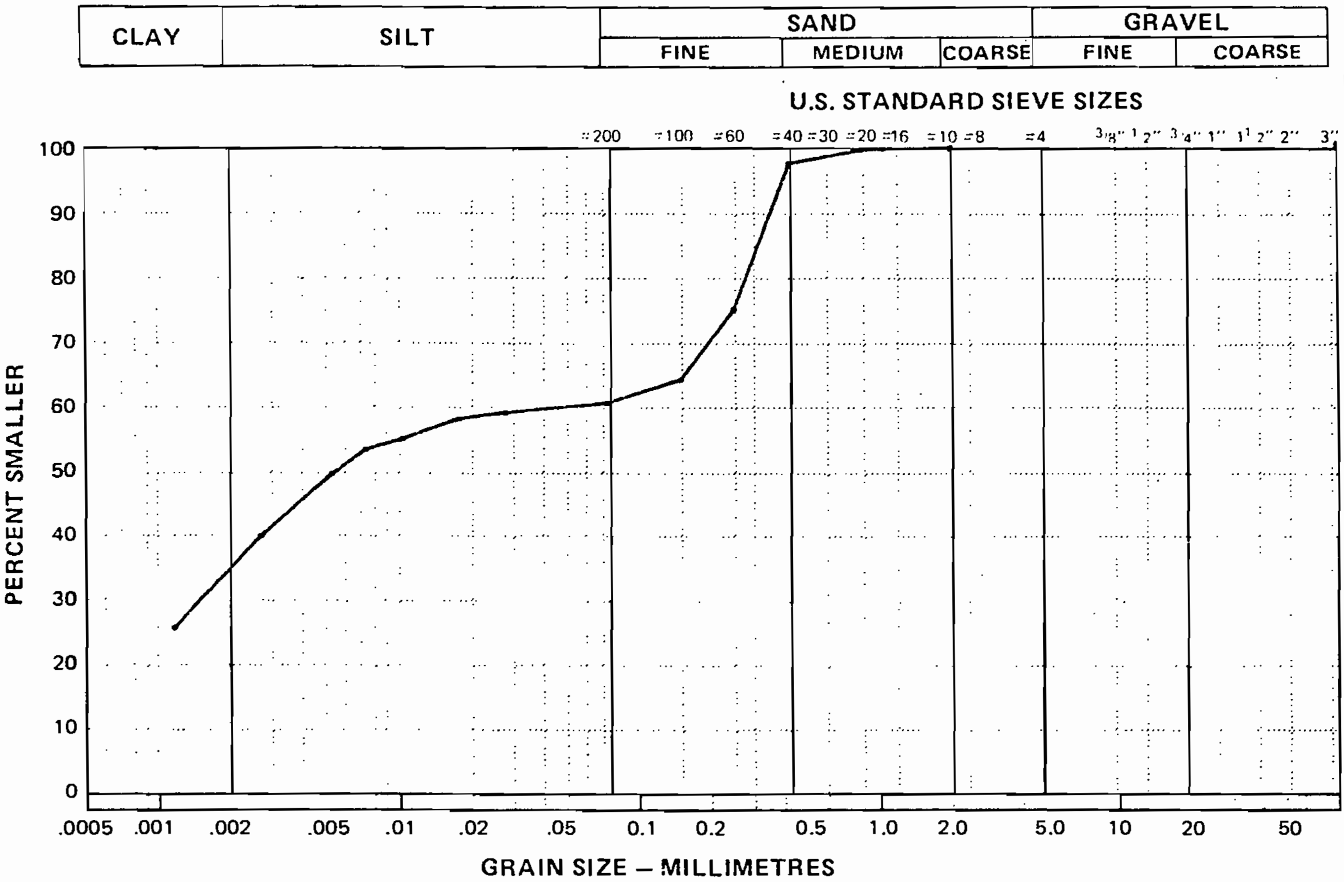
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER1: 1	0.00 - 1.00	-	.4	99.6	0.0	1.8	.9	SP
·····	B: NER1: 1	1.00 - 2.00	-	.2	99.8	0.0	1.7	1.0	SP
– – –	B: NER1: 1	2.00 - 3.00	-	.6	99.4	0.0	2.1	1.0	SP
—— ——	B: NER1: 1	3.00 - 3.60	-	.1	99.9	0.0	1.9	1.1	SP

JOB NO. 101 -3605 DATE 82-10-15

PARTICLE - SIZE ANALYSIS OF SOILS



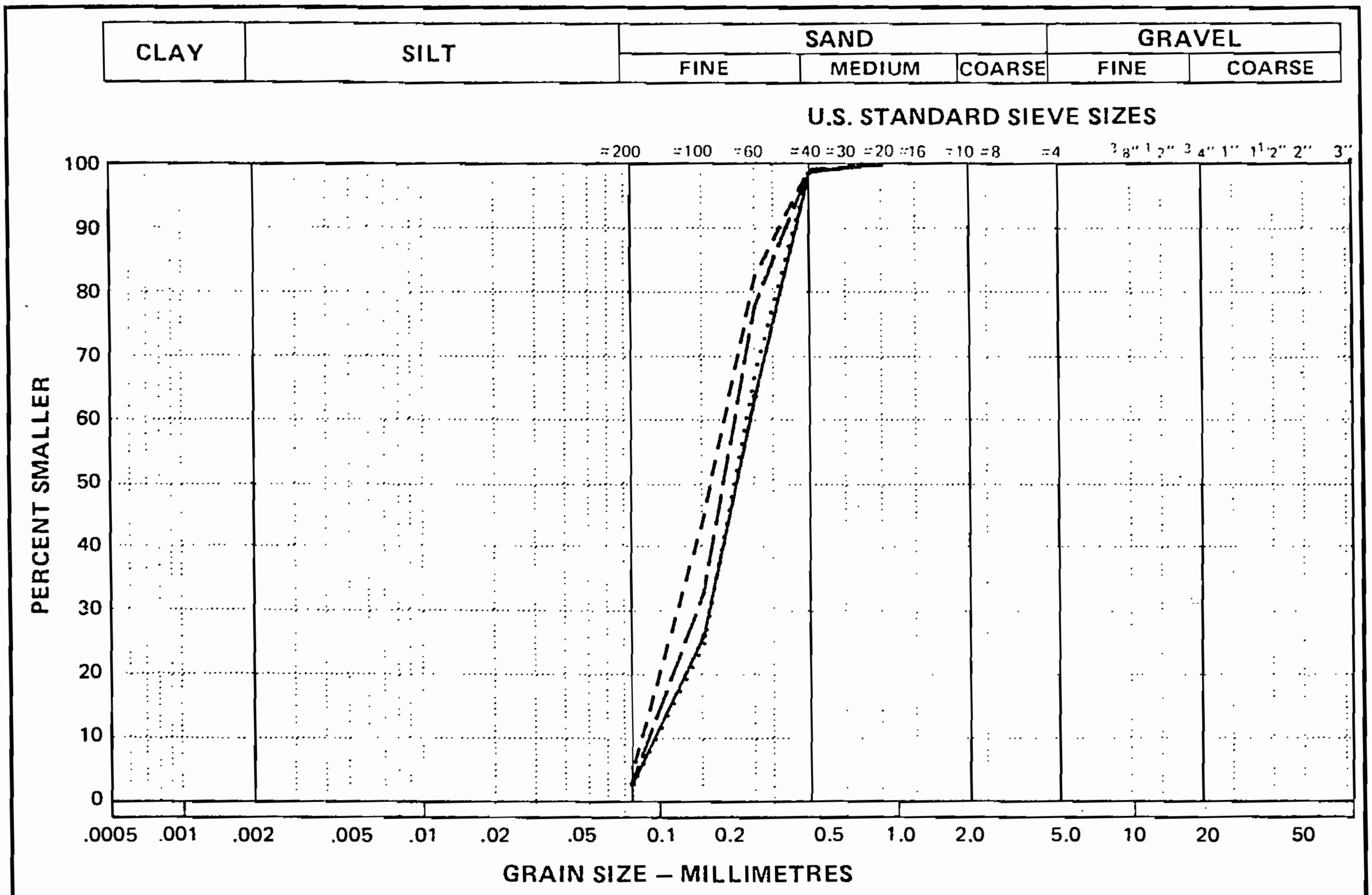
SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	B:NER1:2	0.00 - .10	34.4	25.8	39.8	0.0	-	-	

JOB NO. 101 -3605

DATE 82-11-16

2094a

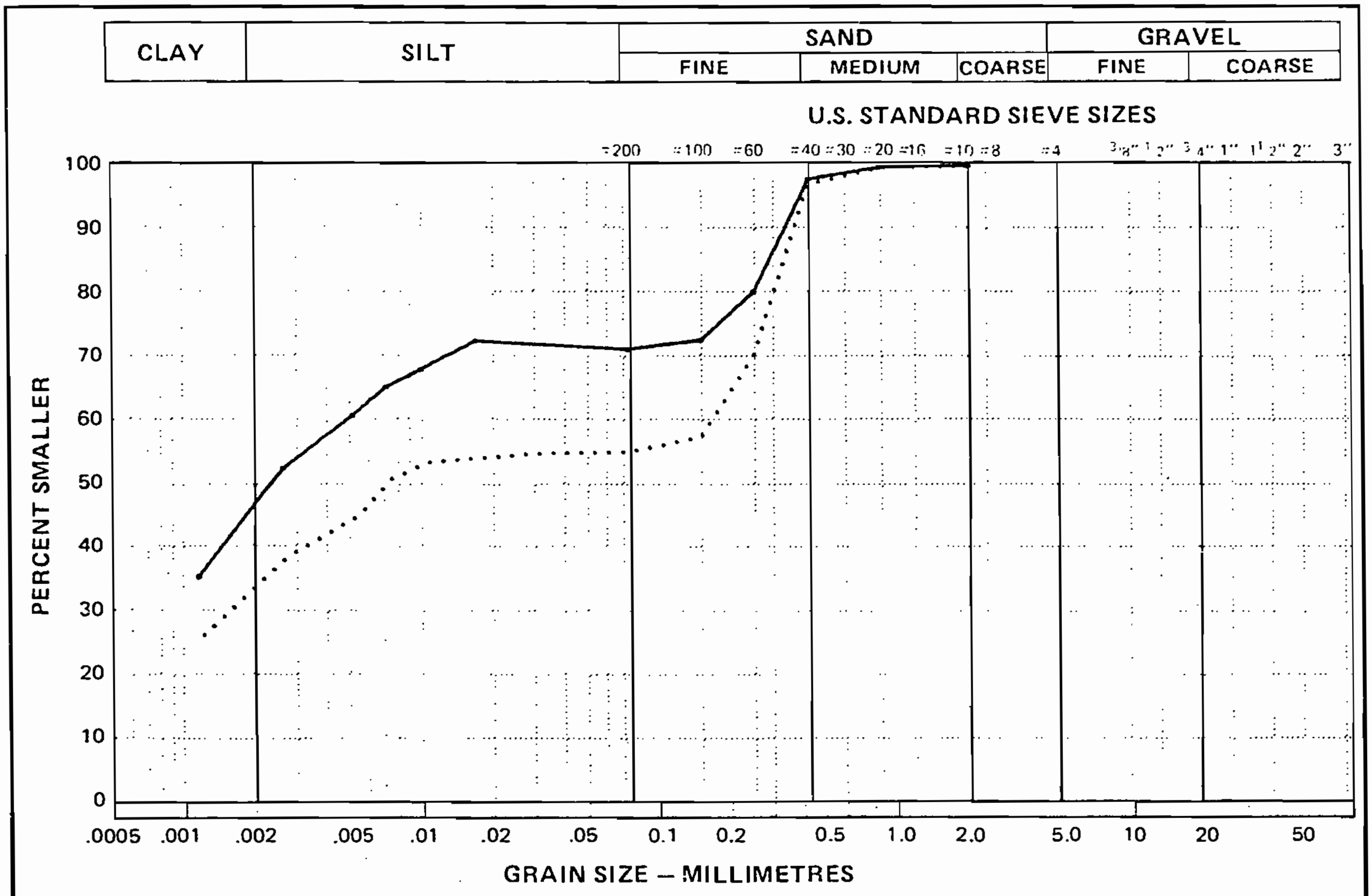
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER1: 2	.60 - .90	-	1.9	98.1	0.0	2.5	1.1	SP
.....	B: NER1: 2	1.50 - 1.80	-	1.6	98.4	0.0	2.4	1.2	SP
– – –	B: NER1: 2	2.70 - 2.70	-	3.8	96.2	0.0	2.3	.9	SP
—— ——	B: NER1: 2	3.30 - 3.30	-	2.3	97.7	0.0	2.3	1.1	SP

JOB NO. 101 -3605 **DATE** 82-10-15

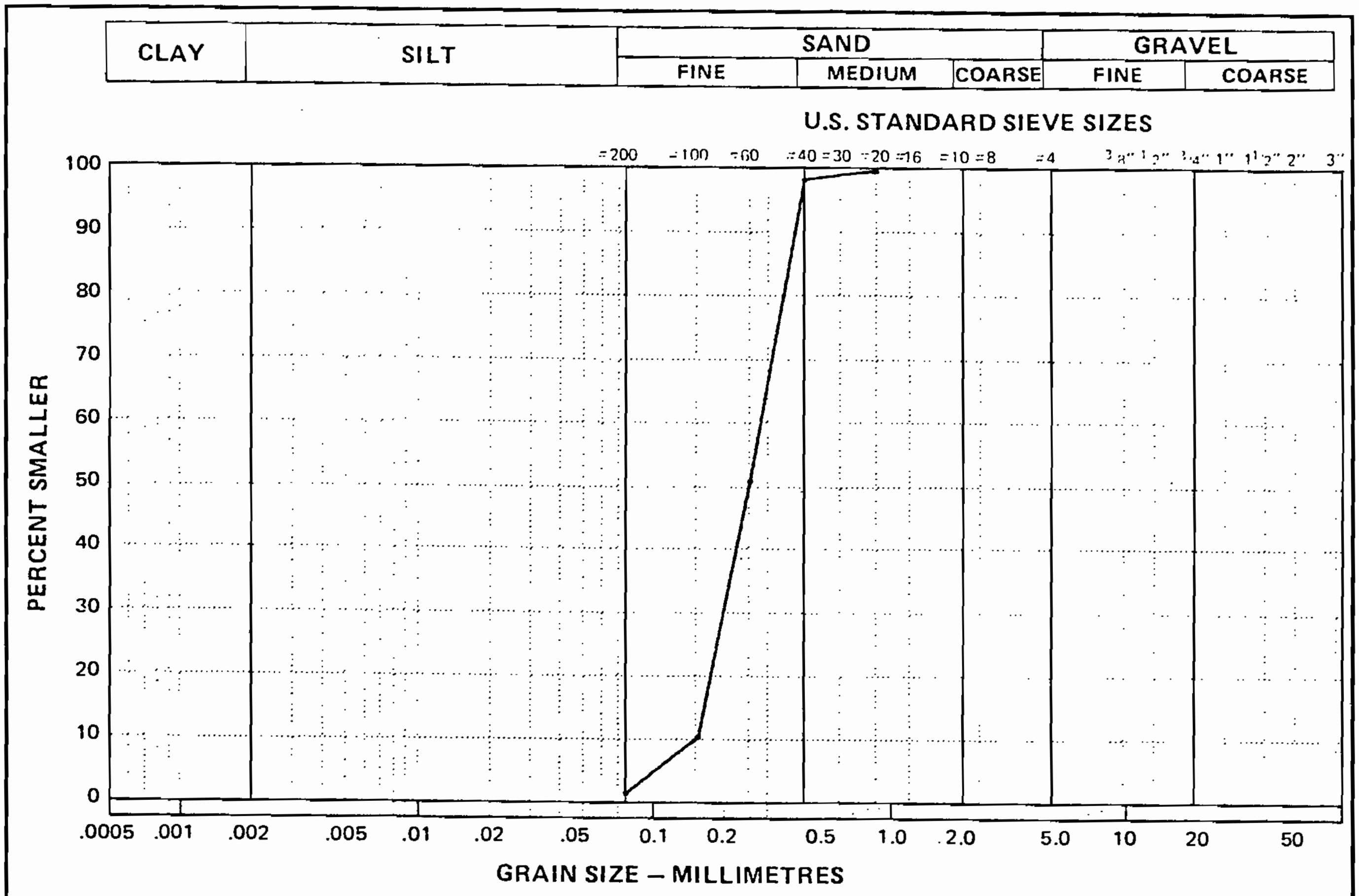
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	DESCRIPTION SILT (%)	DESCRIPTION SAND (%)	DESCRIPTION GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER1: 3	0.00 - .50	47.1	24.3	28.6	0.0	-	-	
. . . . .	B: NER1: 3	.50 - 1.50	33.9	21.0	45.1	0.0	-	-	

JOB NO. 101 -3605 DATE 82-11-15

PARTICLE - SIZE ANALYSIS OF SOILS

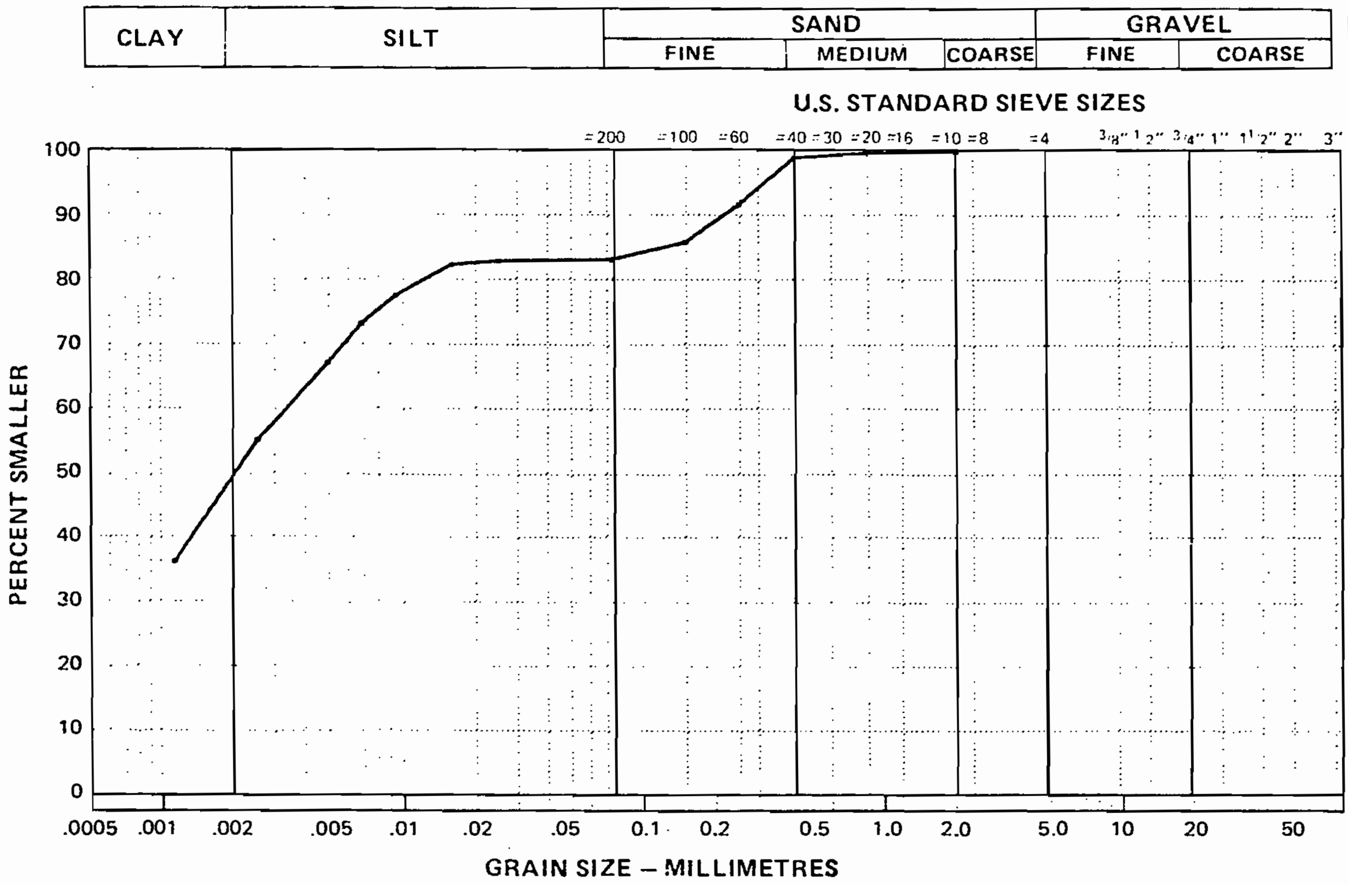


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
—	B: NER1: 3	.45 - .75	-	.7	99.3	0.0	1.8	.9	SP

JOB NO. 101 -3605

DATE 82-10-15

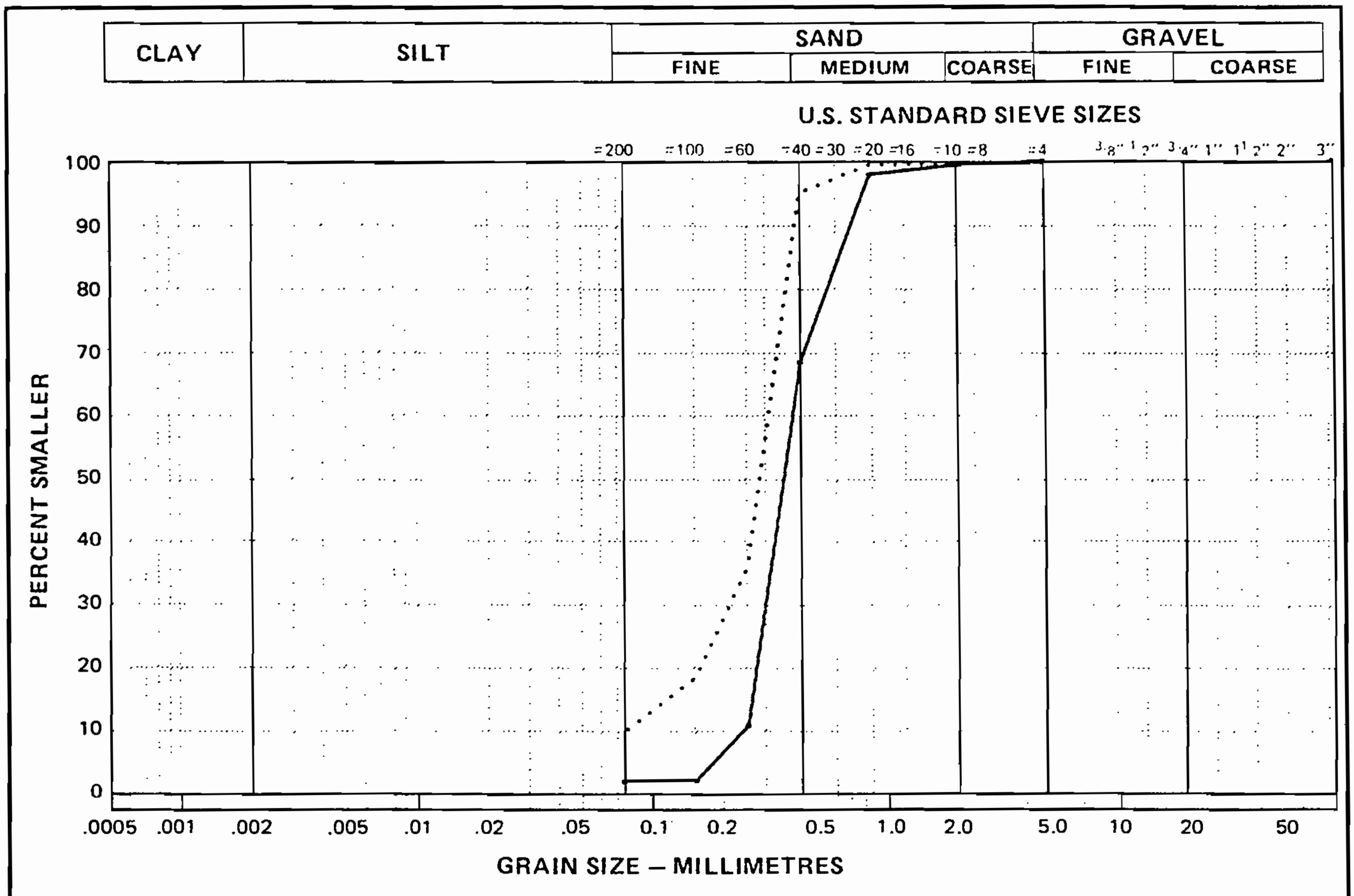
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V: NER2: 4	3.70 - 3.90	49.2	34.1	16.7	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-16

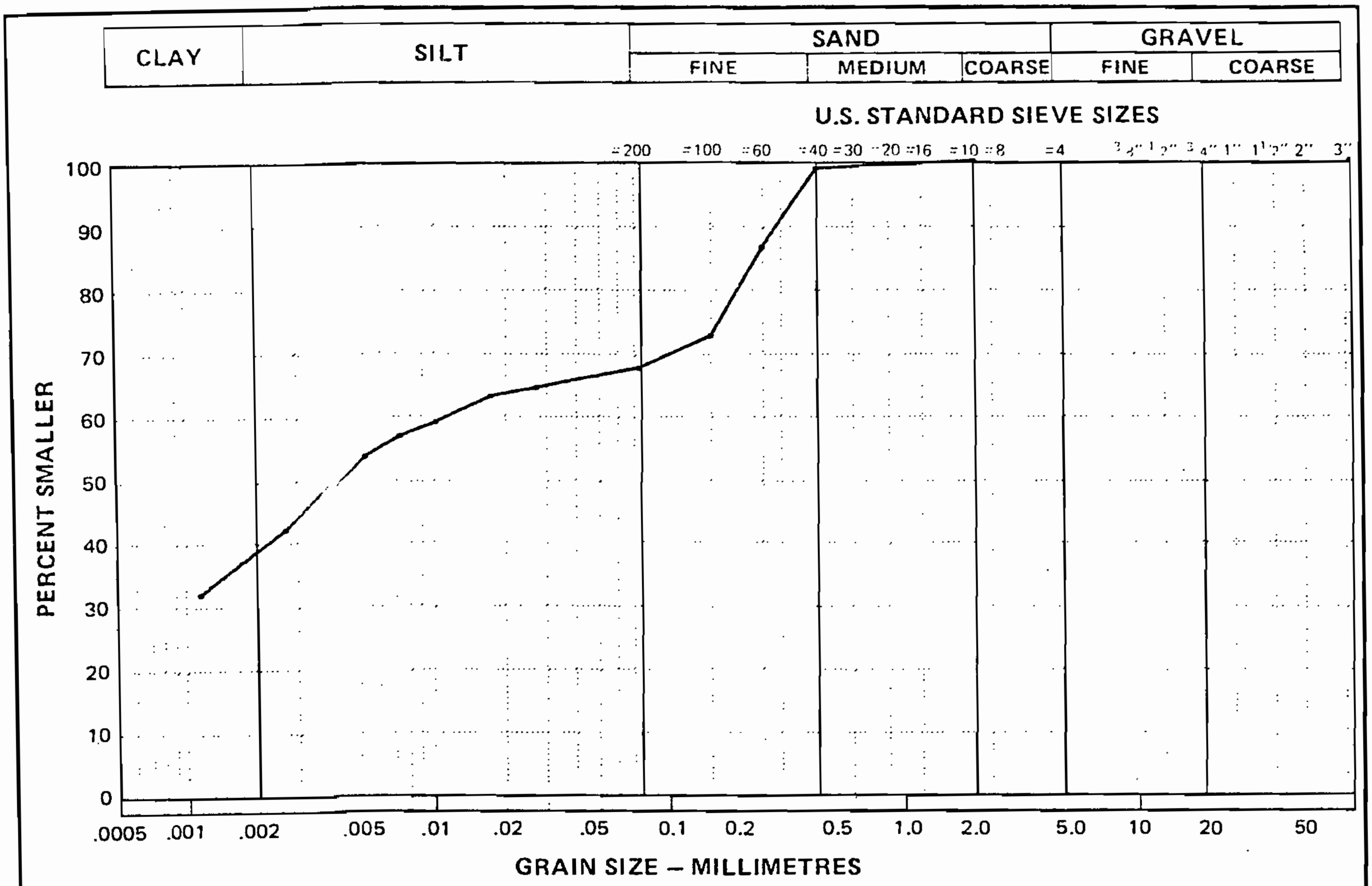
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 4	0.00 - 0.00	-	.9	99.1	0.0	1.6	.9	SP
·····	V: NER: 2: 4	4.20 - 4.20	-	8.9	91.1	0.0	3.9	1.8	SP-SM

JOB NO. 101 -3605 **DATE** 82-08-06

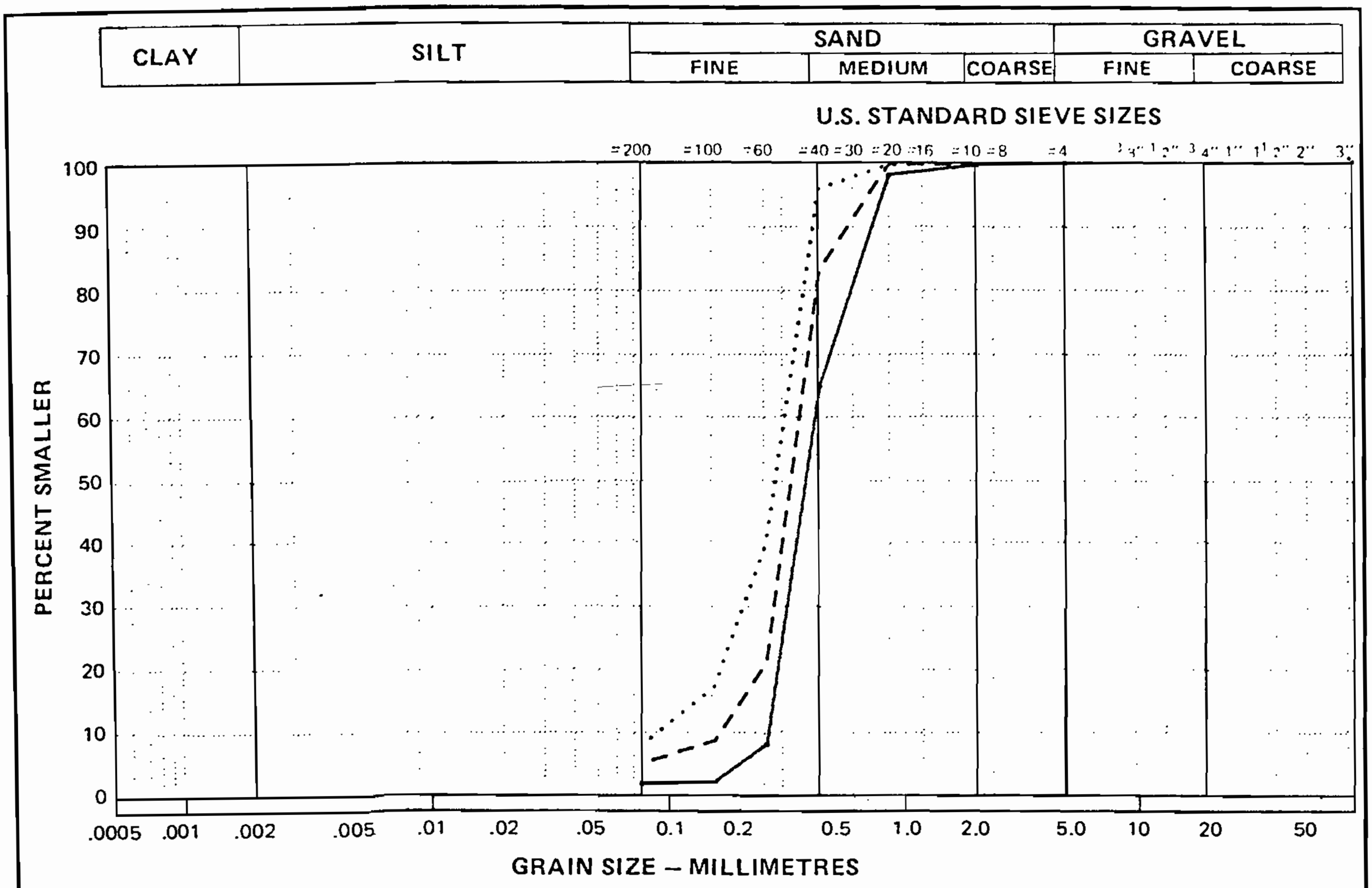
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V: NER2: 4	2.80 - 3.40	38.6	28.7	32.7	0.0	-	-	

JOB NO. 101 -3605 DATE 82-09-21

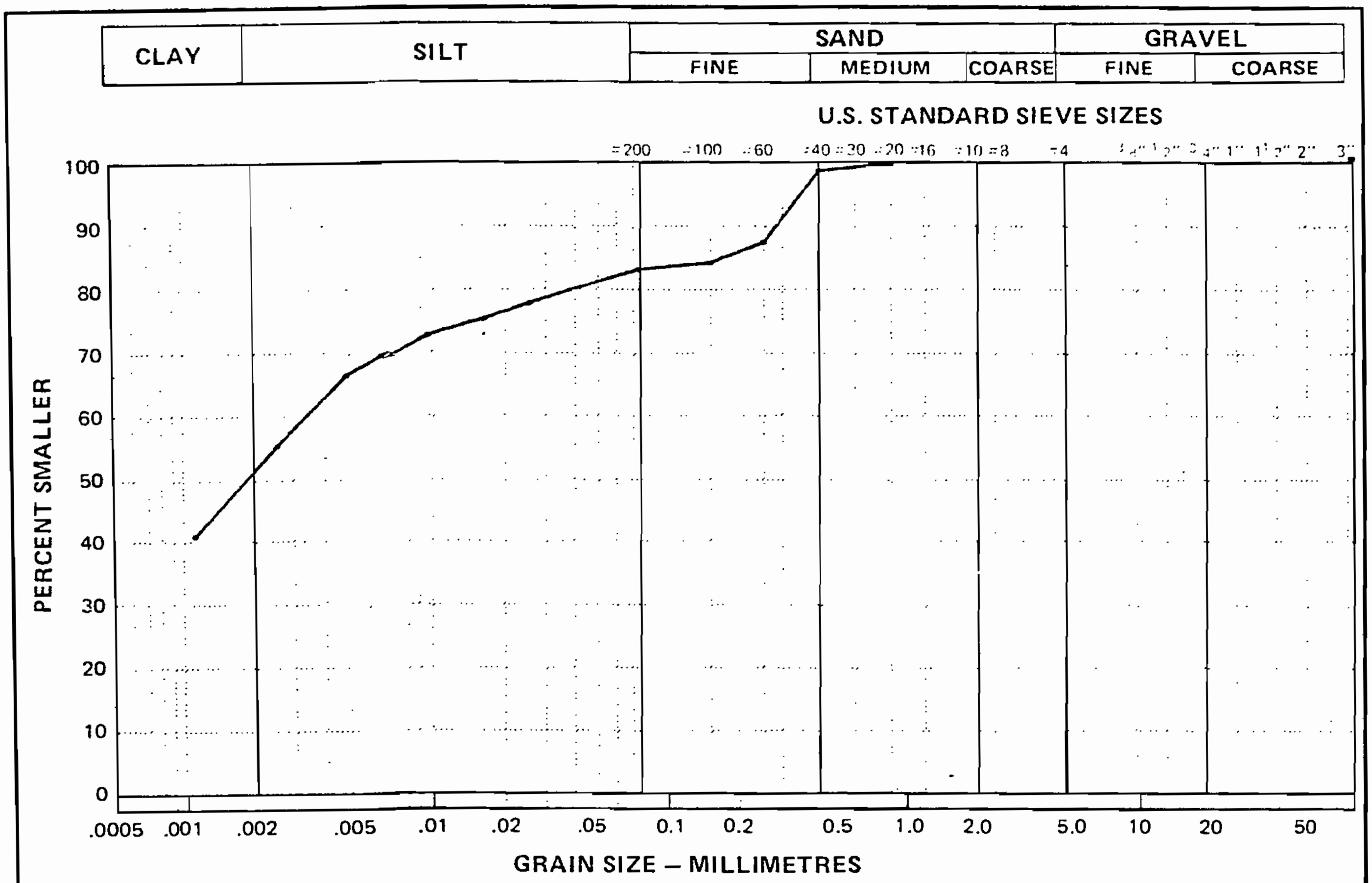
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 5	0.00 - .22	-	.8	99.2	0.0	1.6	.9	SP
·····	V: NER: 2: 5	3.40 - 3.40	-	7.1	92.9	0.0	3.3	1.5	SP-SM
– – –	V: NER: 2: 5	3.80 - 3.90	-	4.1	95.9	0.0	2.1	1.3	SP

JOB NO. 101 -3605 DATE 82-08-06

PARTICLE - SIZE ANALYSIS OF SOILS

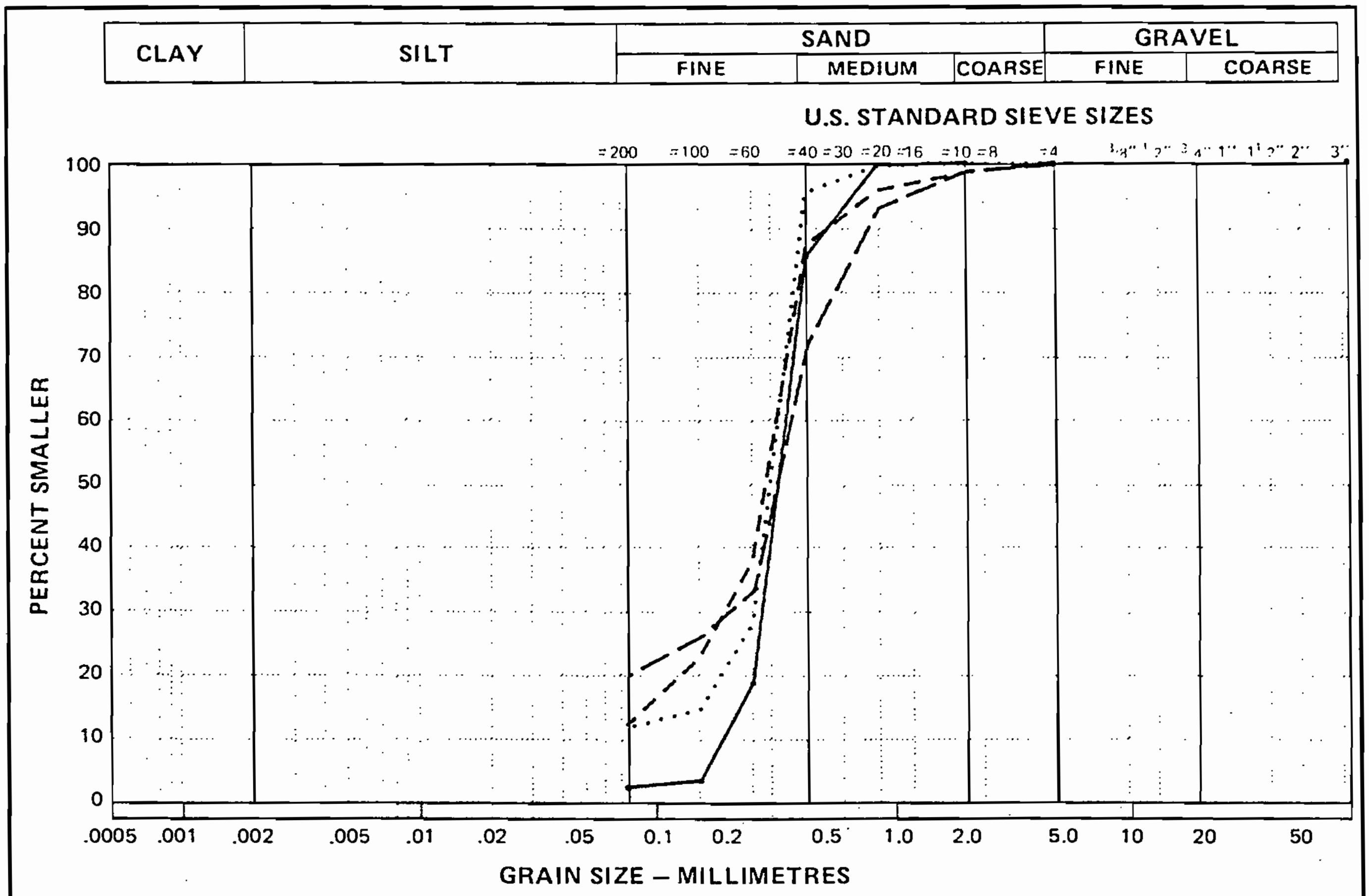


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V: NER2: 5	.91 - 1.37	51.6	31.8	16.6	0.0	-	-	

JOB NO. 101 -3605

DATE 82-09-21

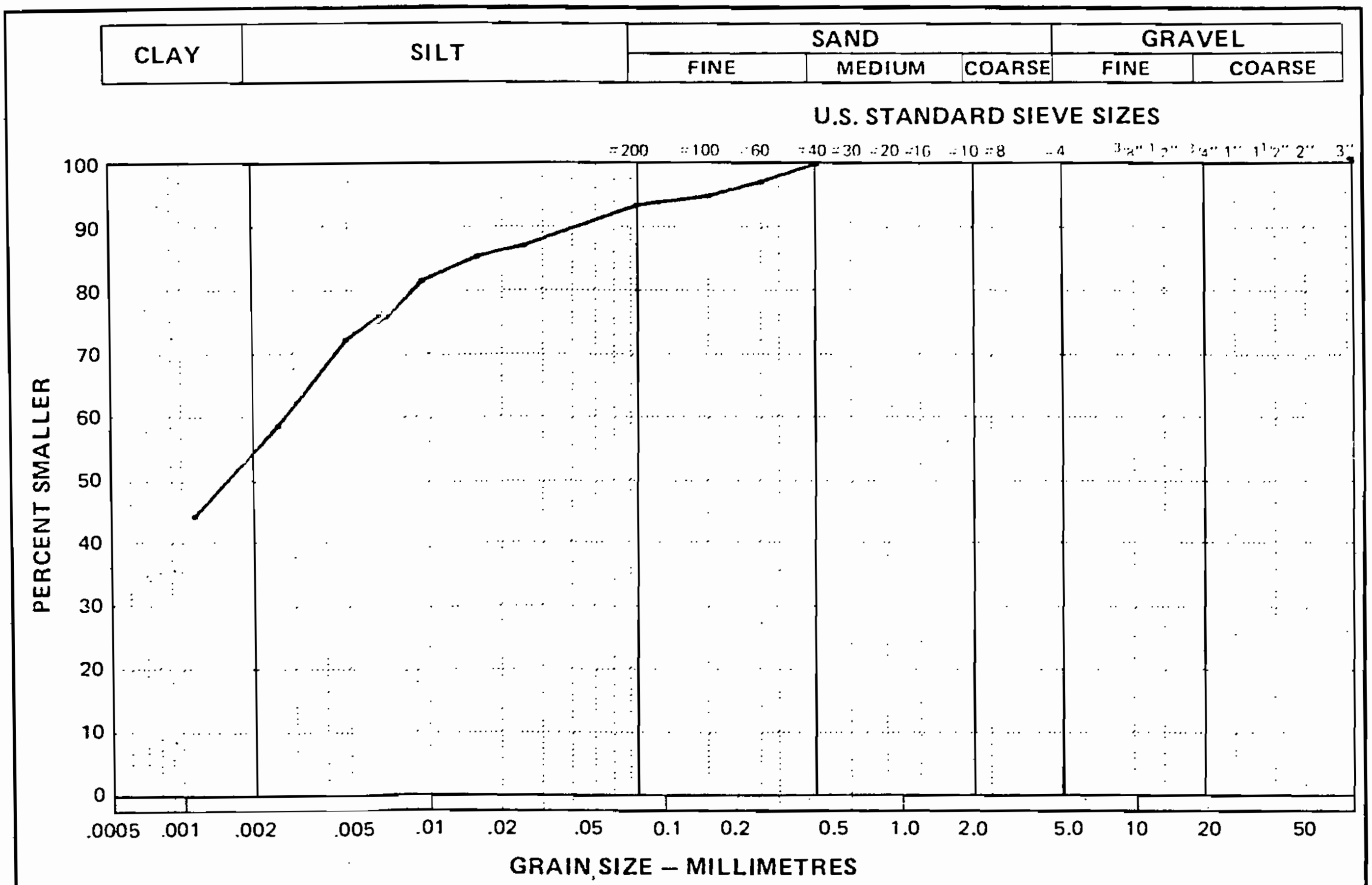
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 6	0.00 - .10	-	1.2	98.8	0.0	1.8	1.1	SP
.....	V: NER: 2: 6	2.10 - 2.20	-	10.7	89.3	0.0	-	-	
— — —	V: NER: 2: 6	2.70 - 3.20	-	11.2	88.8	0.0	-	-	
—— ——	V: NER: 2: 6	3.70 - 4.20	-	19.4	80.6	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-08-06

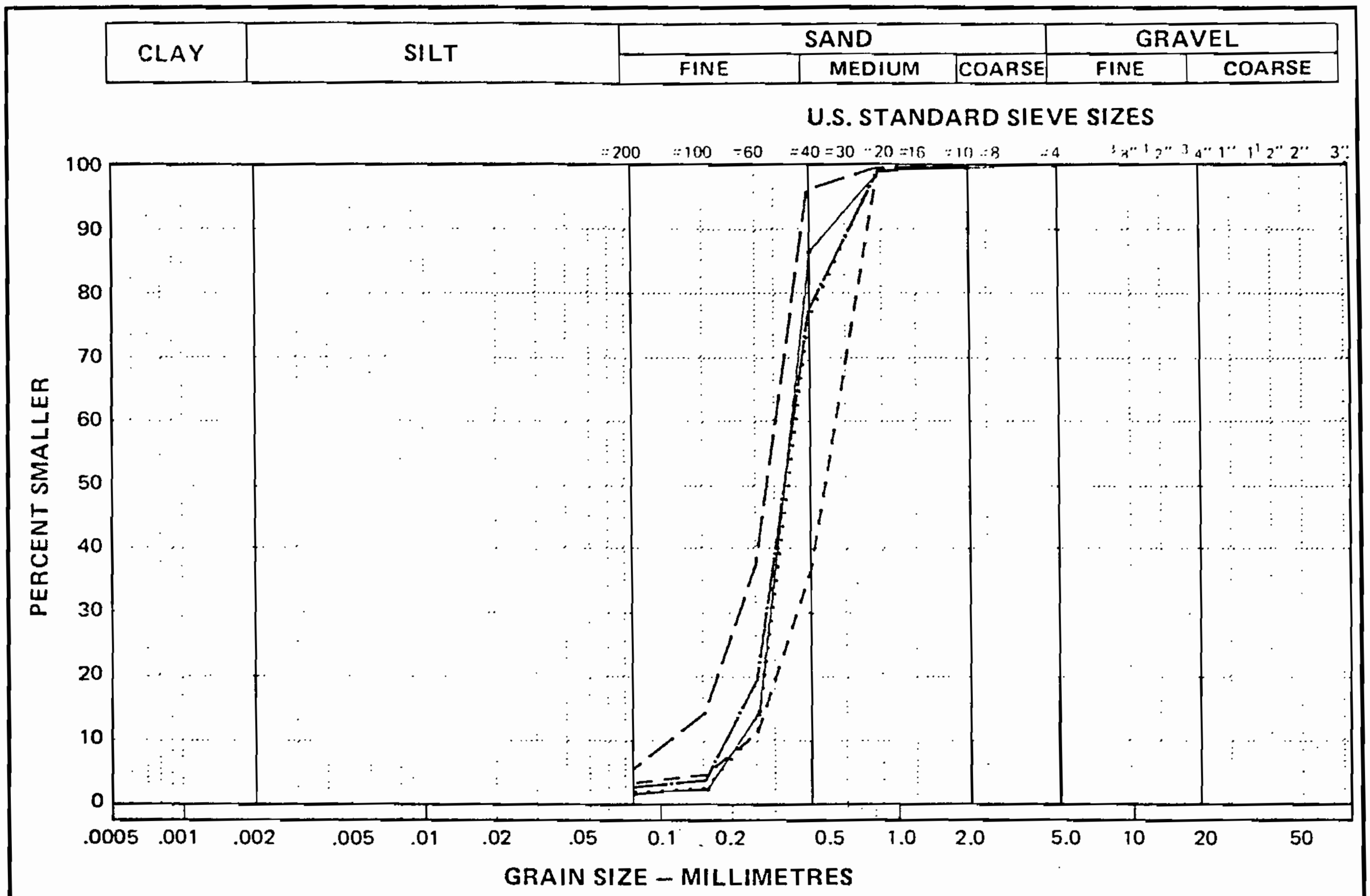
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
______	V: NER2: 6	.91 - 1.25	54.9	38.8	6.3	0.0	-	-	

JOB NO. 101 -3605 DATE 82-09-21

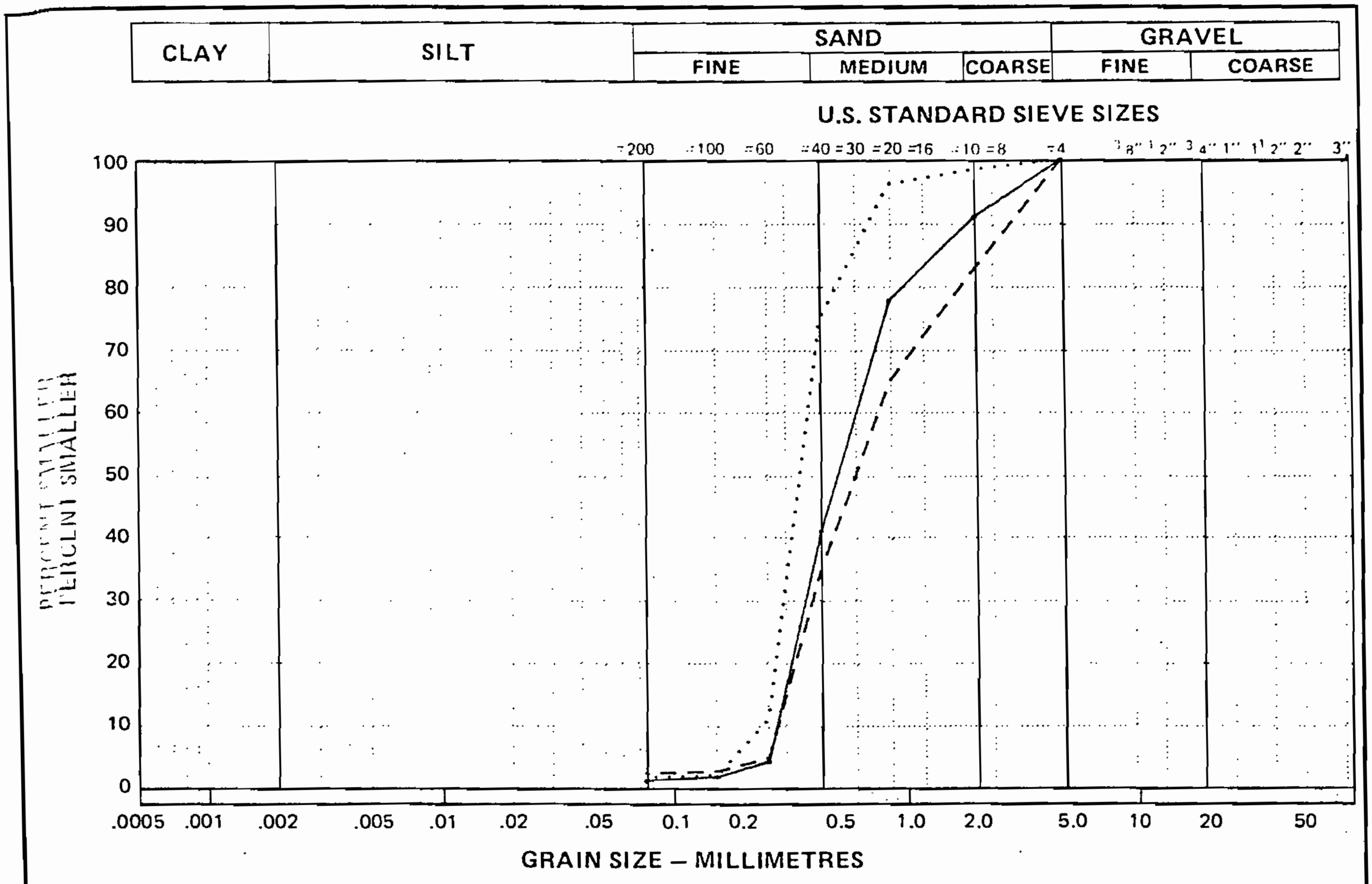
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	V: NER: 2: 7	0.00 - .20	-	1.0	99.0	0.0	1.7	1.1	SP
· · · · ·	V: NER: 2: 7	.91 - 1.08	-	1.3	98.7	0.0	1.6	1.0	SP
— — —	V: NER: 2: 7	2.00 - 2.30	-	2.7	97.3	0.0	2.3	1.0	SP
—— ——	V: NER: 2: 7	2.74 - 3.20	-	4.9	95.1	0.0	2.7	1.3	SP
——·——	V: NER: 2: 7	3.66 - 4.00	-	2.0	98.0	0.0	1.9	1.1	SP

JOB NO. 101 -3605 **DATE** 82-08-08

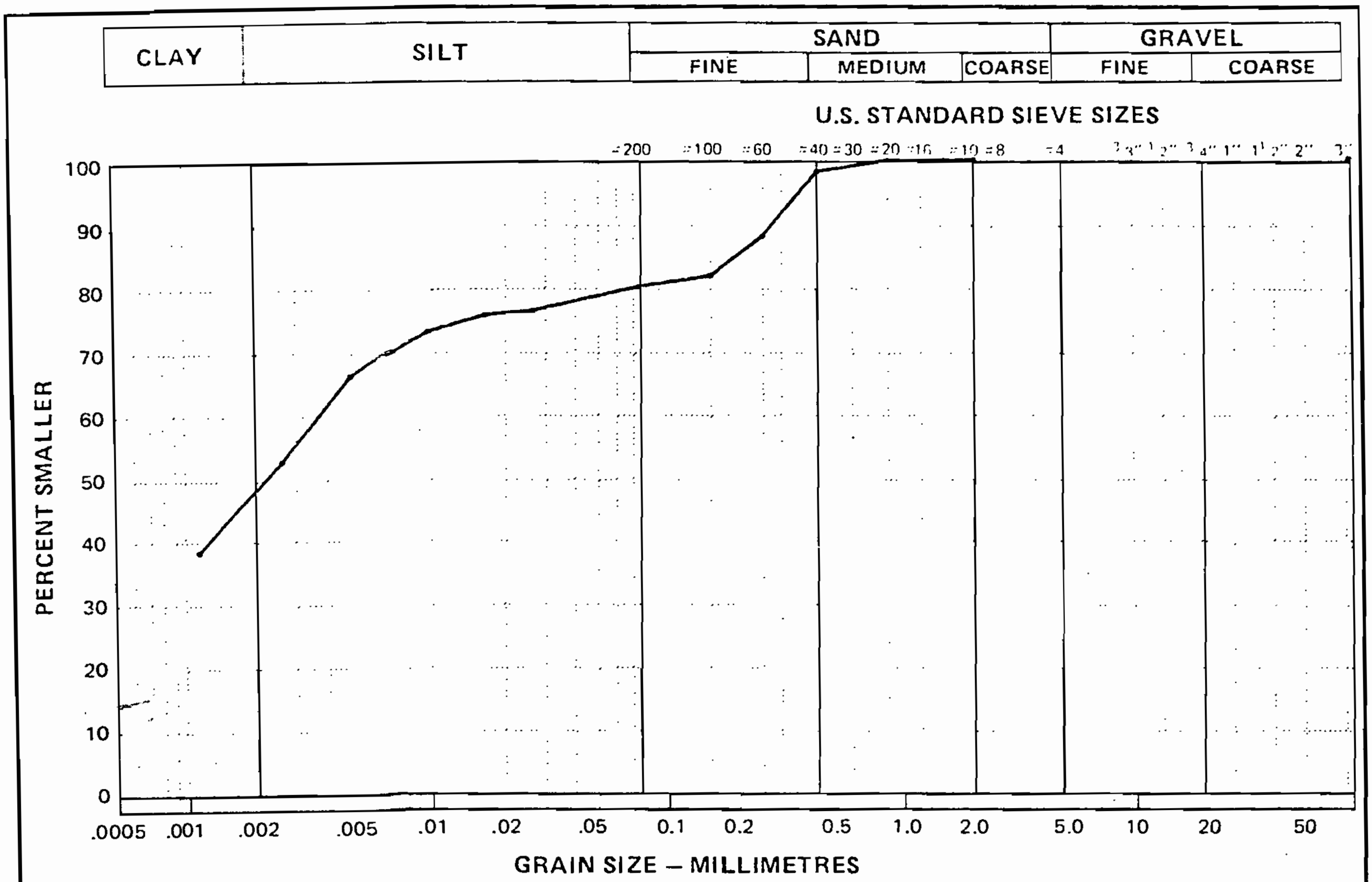
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 8	.90 - 1.10	-	0.0	100.	0.0	2.2	.8	SP
· · · · ·	V: NER: 2: 8	2.00 - 2.20	-	.5	99.5	0.0	1.5	.9	SP
— — —	V: NER: 2: 8	3.66 - 4.08	-	1.2	98.8	0.0	2.8	.7	SP

JOB NO. 101 -3605 **DATE** 82-08-08

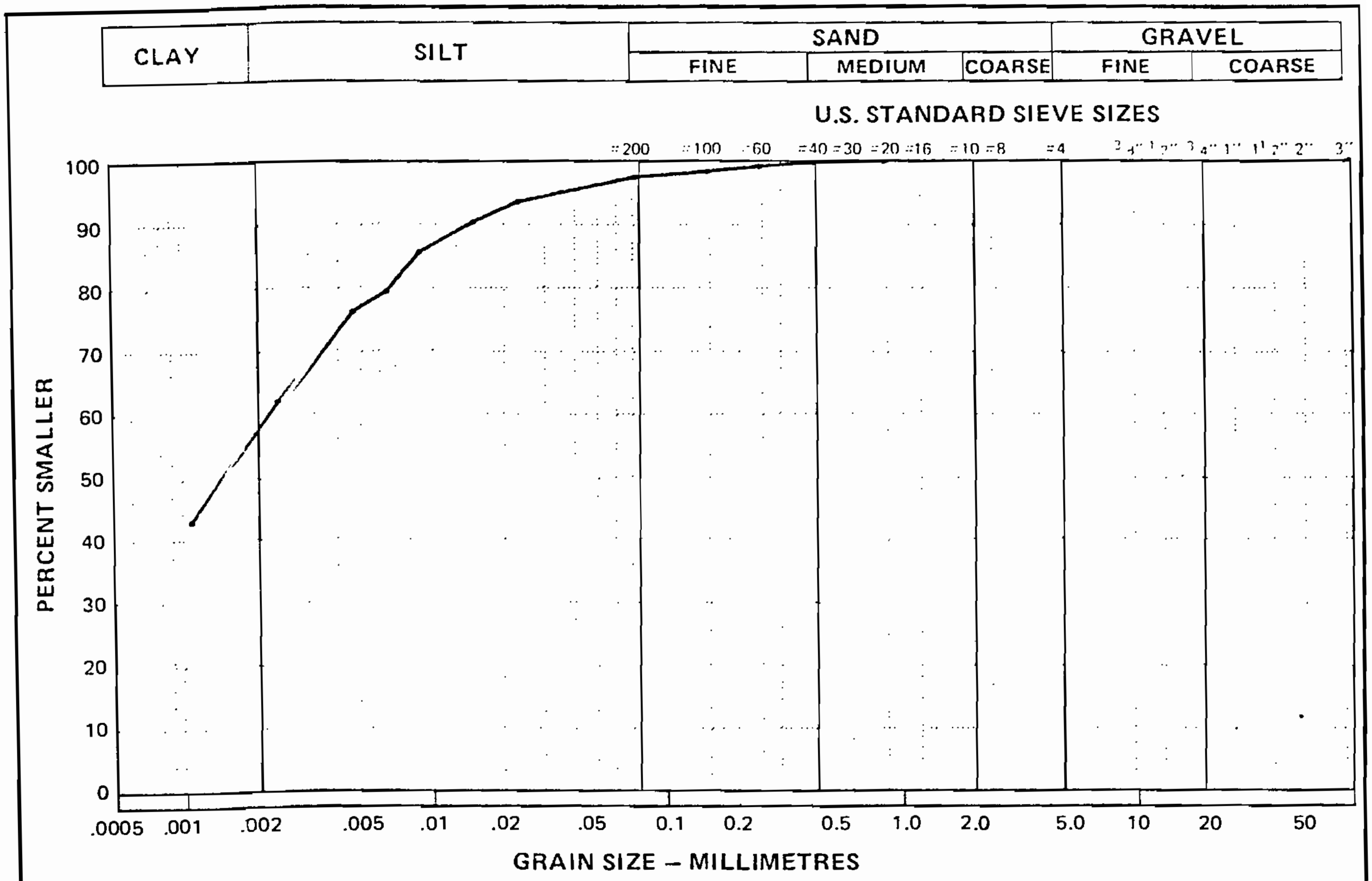
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V: NER2: 7	1.08 - 1.46	48.0	32.1	19.9	0.0	-	-	

JOB NO. 101 -3605 DATE 82-09-22

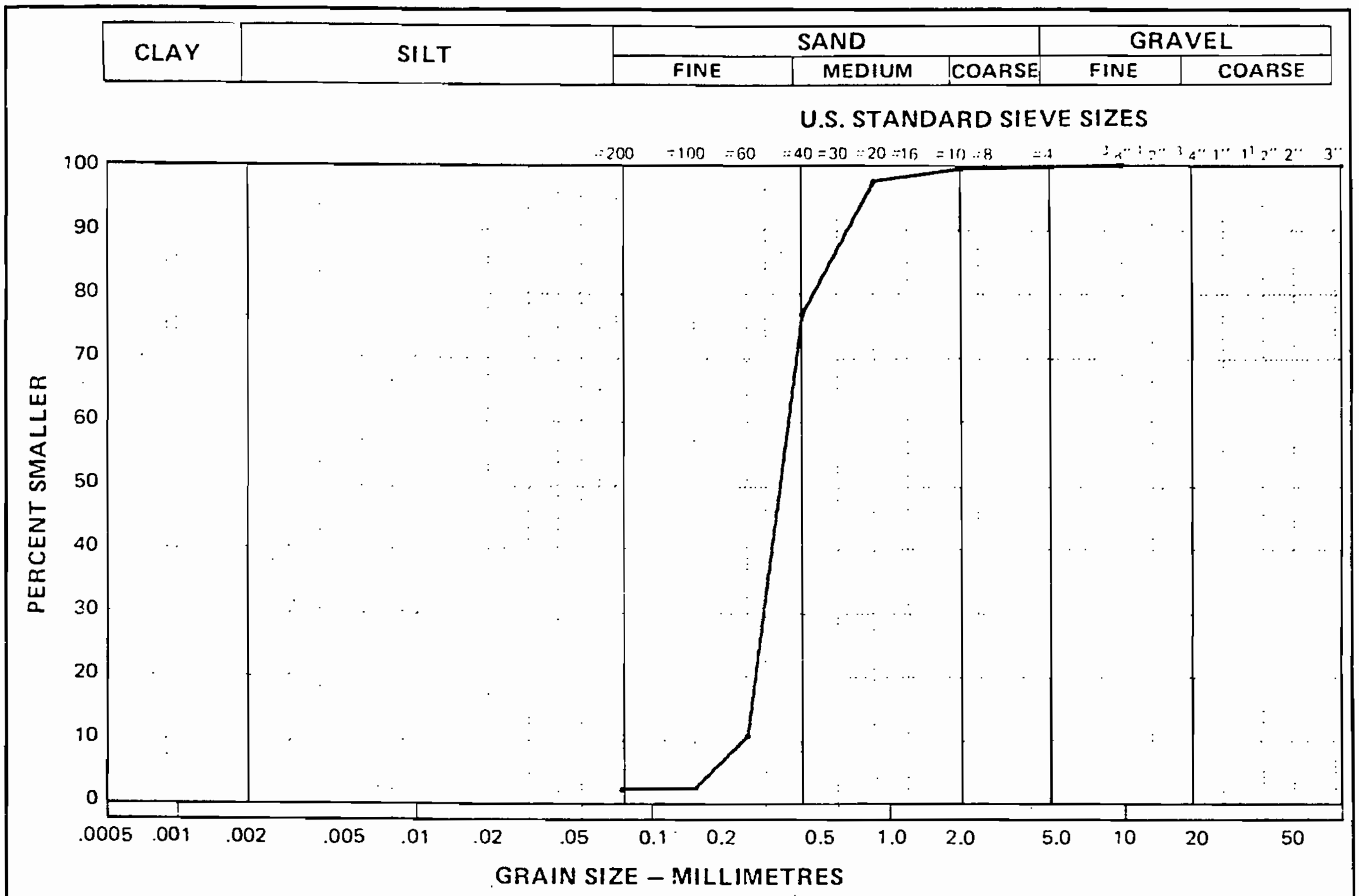
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	 SILT (%)	 SAND (%)	 GRAVEL (%)	Cu	Cc	U.S.C.
———	V:NER2:8	3.20 - 3.40	57.2	40.5	2.3	0.0	-	-	

JOB NO. 101 -3605 DATE 82-09-21

PARTICLE - SIZE ANALYSIS OF SOILS

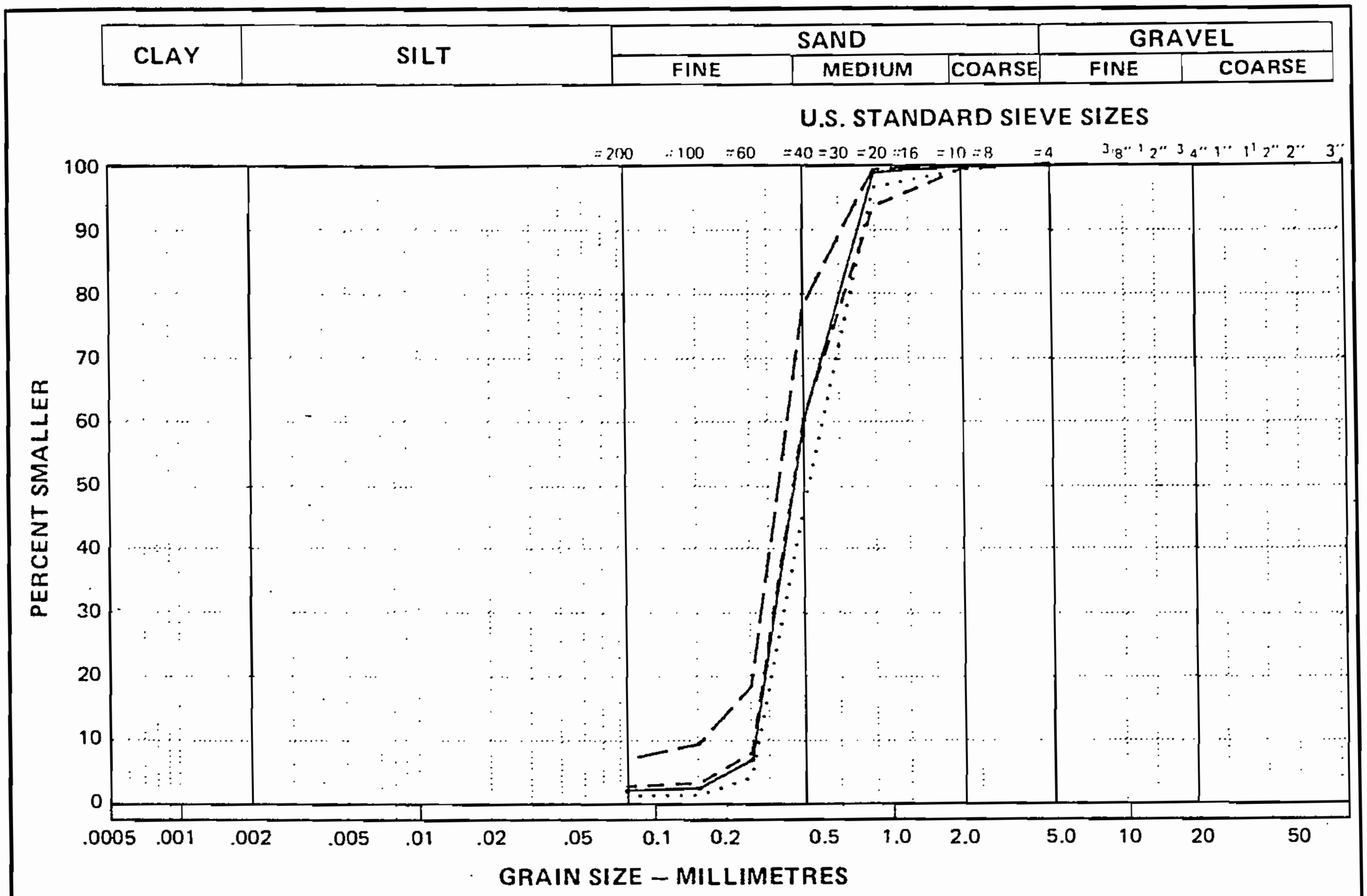


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	V: NER2: 9	1.80 - 2.20	-	.8	99.1	.1	1.5	.9	SP

JOB NO. 101 -3605

DATE 82-11-18

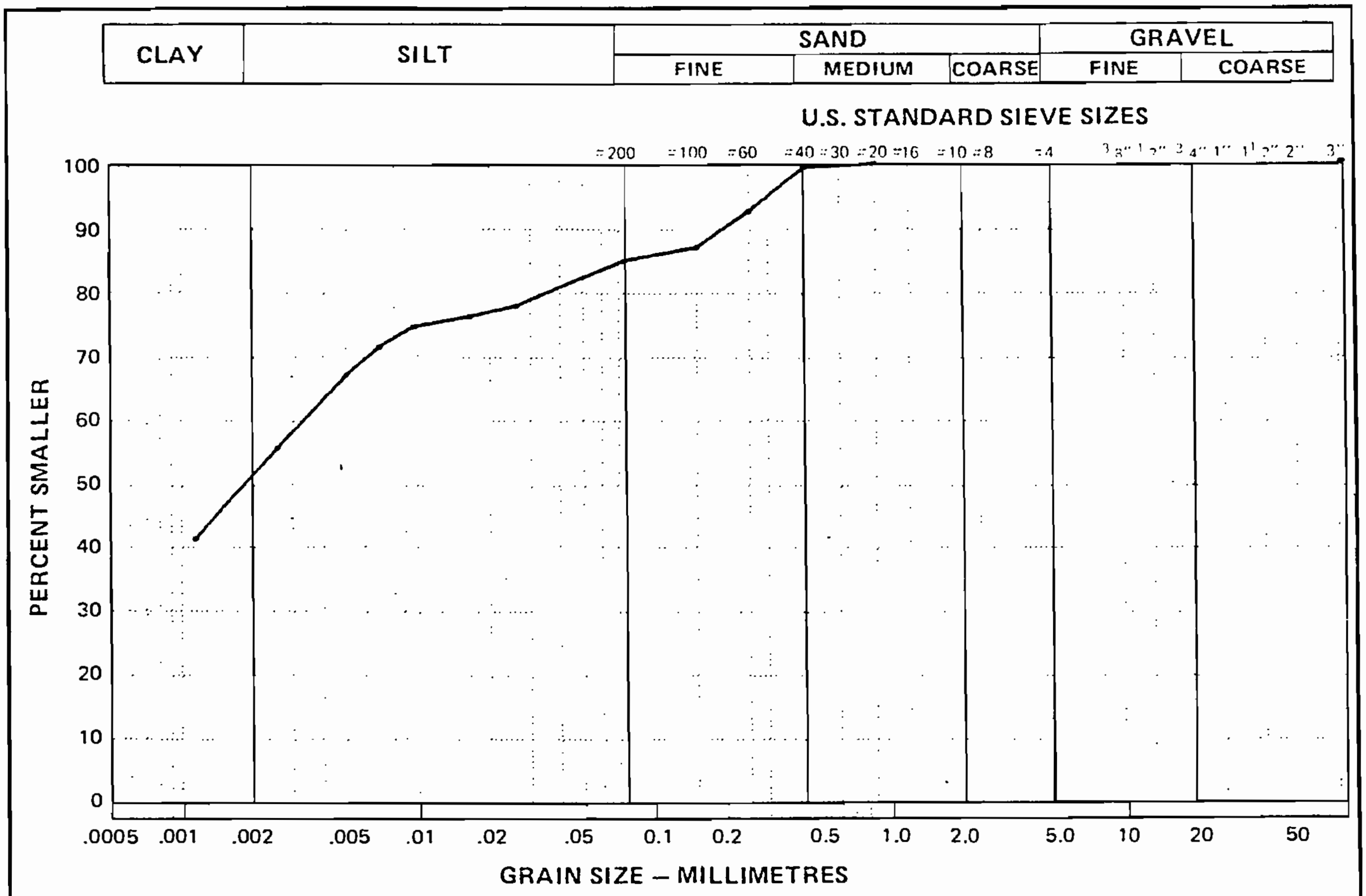
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	V: NER: 2: 9	.90 - 1.10	-	1.1	98.9	0.0	1.6	.9	SP
· · · · ·	V: NER: 2: 9	2.74 - 3.10	-	0.0	100.	0.0	1.9	.9	SP
— — —	V: NER: 2: 9	4.16 - 4.20	-	1.5	98.5	0.0	1.7	.9	SP
—— ——	V: NER: 2: 9	5.49 - 5.75	-	5.8	94.2	0.0	2.2	1.3	SP-SM

JOB NO. 101 -3605 **DATE** 82-08-08

PARTICLE - SIZE ANALYSIS OF SOILS

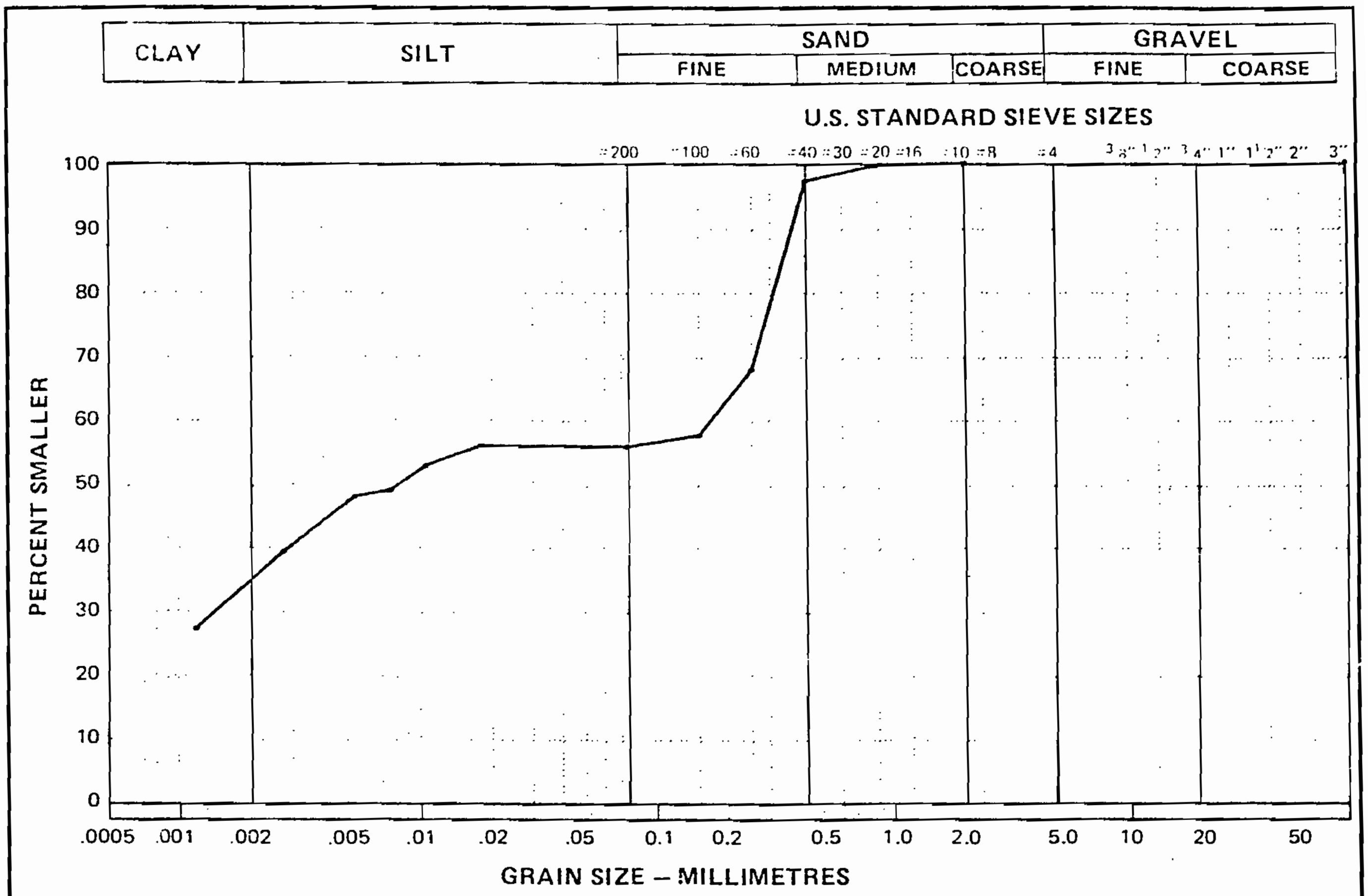


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V: NER2: 9	3.10 - 3.39	51.4	33.6	15.0	0.0	-	-	

JOB NO. 101 -3605

DATE 82-09-22

PARTICLE - SIZE ANALYSIS OF SOILS

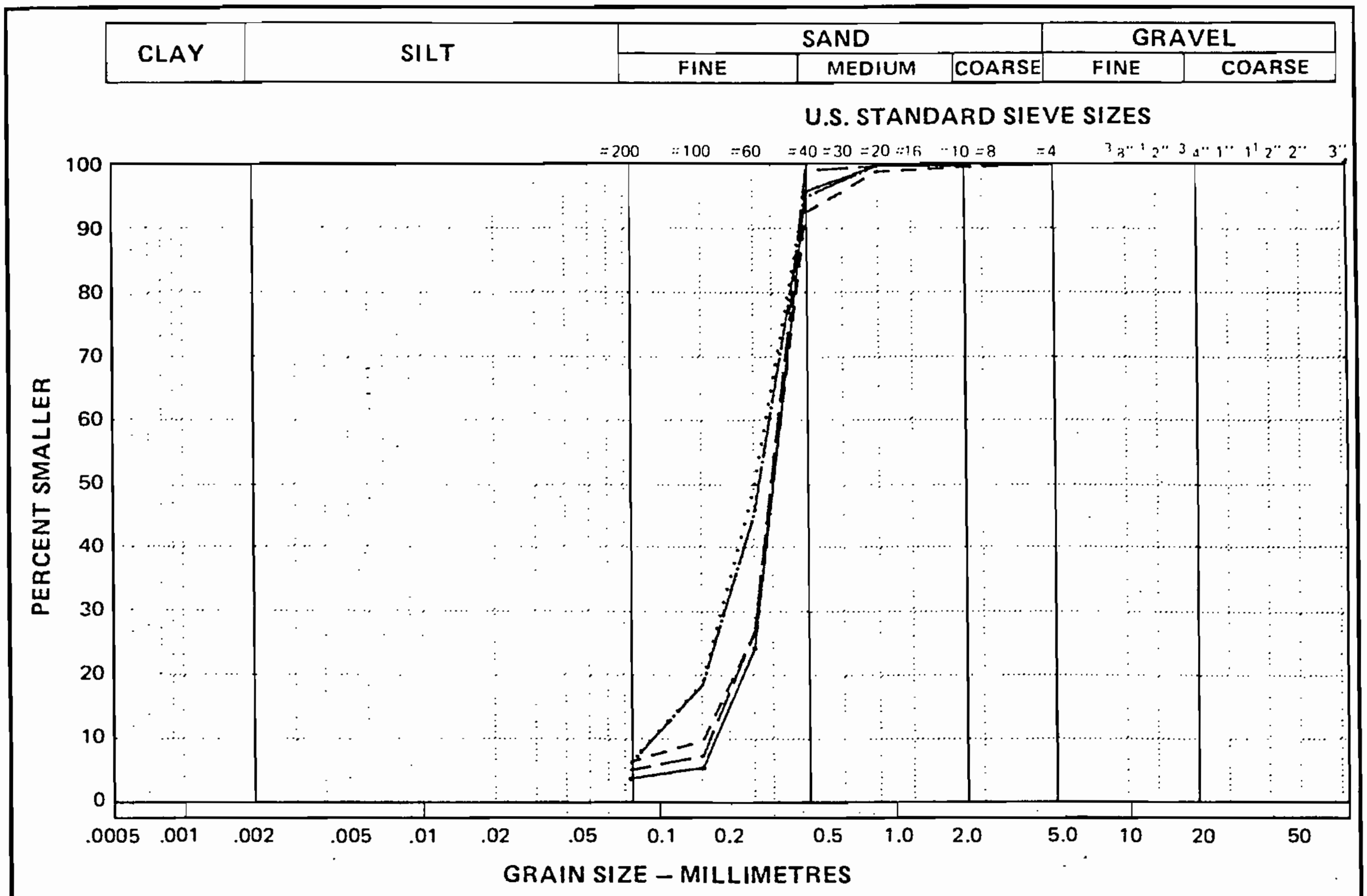


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V:NER2:11	0.00 - .30	34.7	20.7	44.6	0.0	-	-	

JOB NO. 101 -3605

DATE 82-11-16

PARTICLE - SIZE ANALYSIS OF SOILS



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<tr><th rowspan="2">SYMBOL</th><th rowspan="2">BOREHOLE NUMBER</th><th rowspan="2">DEPTH (m)</th><th colspan="4">DESCRIPTION</th><th rowspan="2">Cu</th><th rowspan="2">Cc</th><th rowspan="2">U.S.C.</th></tr>
<tr><th>CLAY (%)</th><th>SILT (%)</th><th>SAND (%)</th><th>GRAVEL (%)</th></tr>
<tr><td>———</td><td>V:NER:2:11</td><td>.30 - 1.00</td><td>—</td><td>2.8</td><td>97.2</td><td>0.0</td><td>1.9</td><td>1.2</td><td>SP</td></tr>
<tr><td>.....</td><td>V:NER:2:11</td><td>1.00 - 2.00</td><td>-</td><td>5.6</td><td>94.4</td><td>0.0</td><td>3.0</td><td>1.2</td><td>SP-SM</td></tr>
<tr><td>— — —</td><td>V:NER:2:11</td><td>2.00 - 3.00</td><td>-</td><td>5.5</td><td>94.5</td><td>0.0</td><td>2.1</td><td>1.3</td><td>SP-SM</td></tr>
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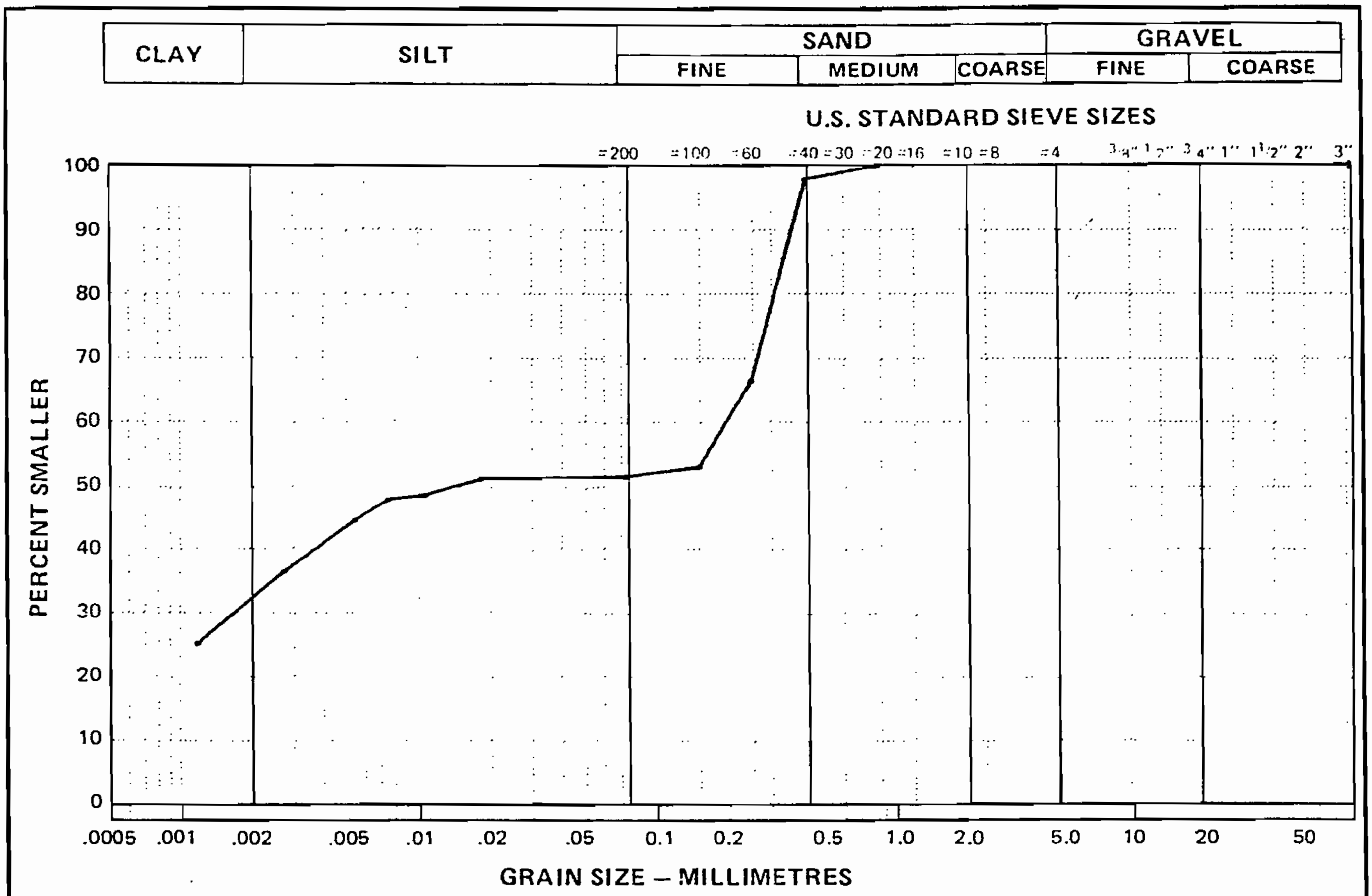
JOB NO. 101 -3605 **DATE** 82-08-08

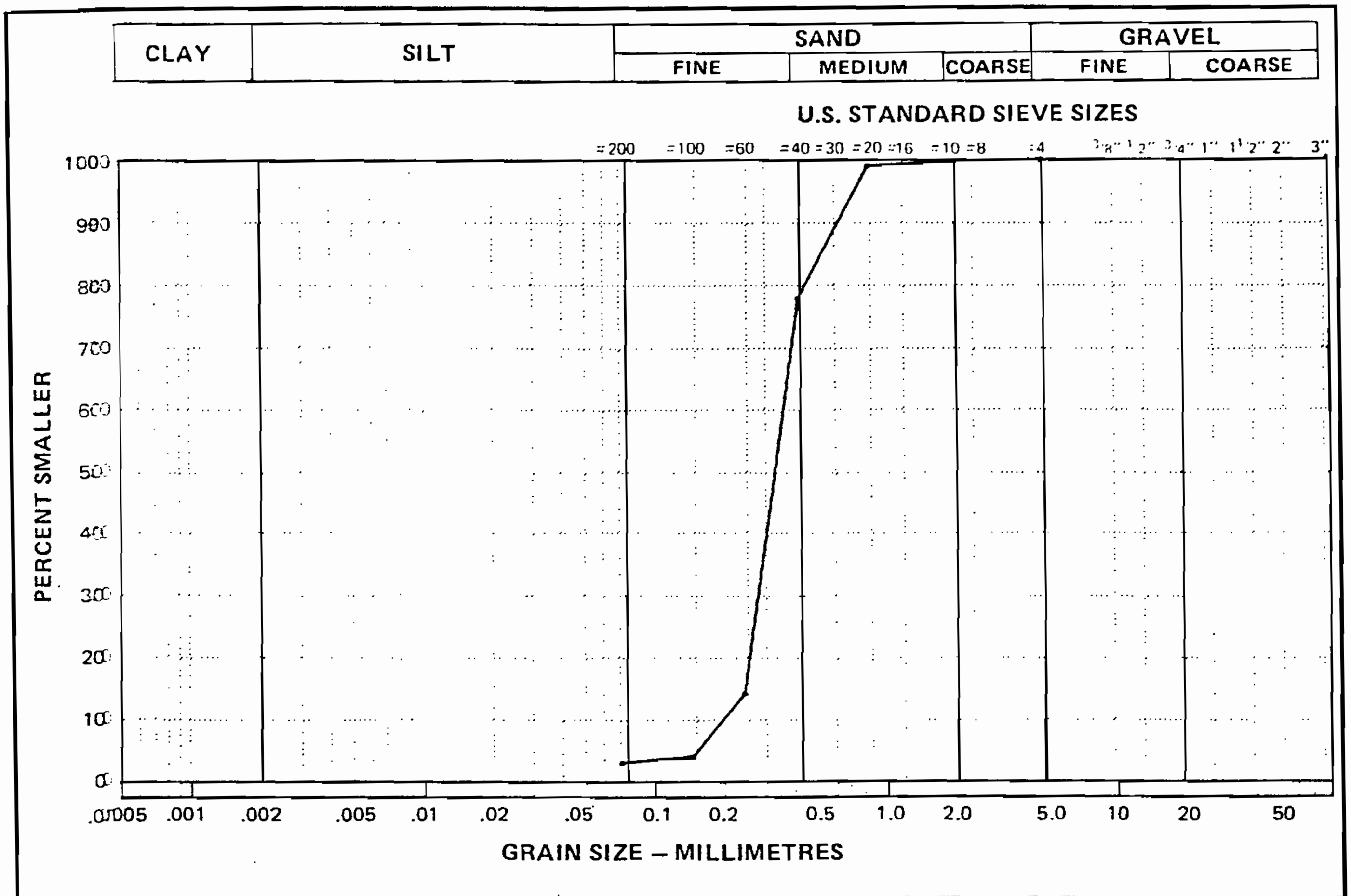
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V:NER2:12	.90 - 1.70	32.0	18.9	49.1	0.0	-	--	

JOB NO. 101 -3605 DATE 82-11-17

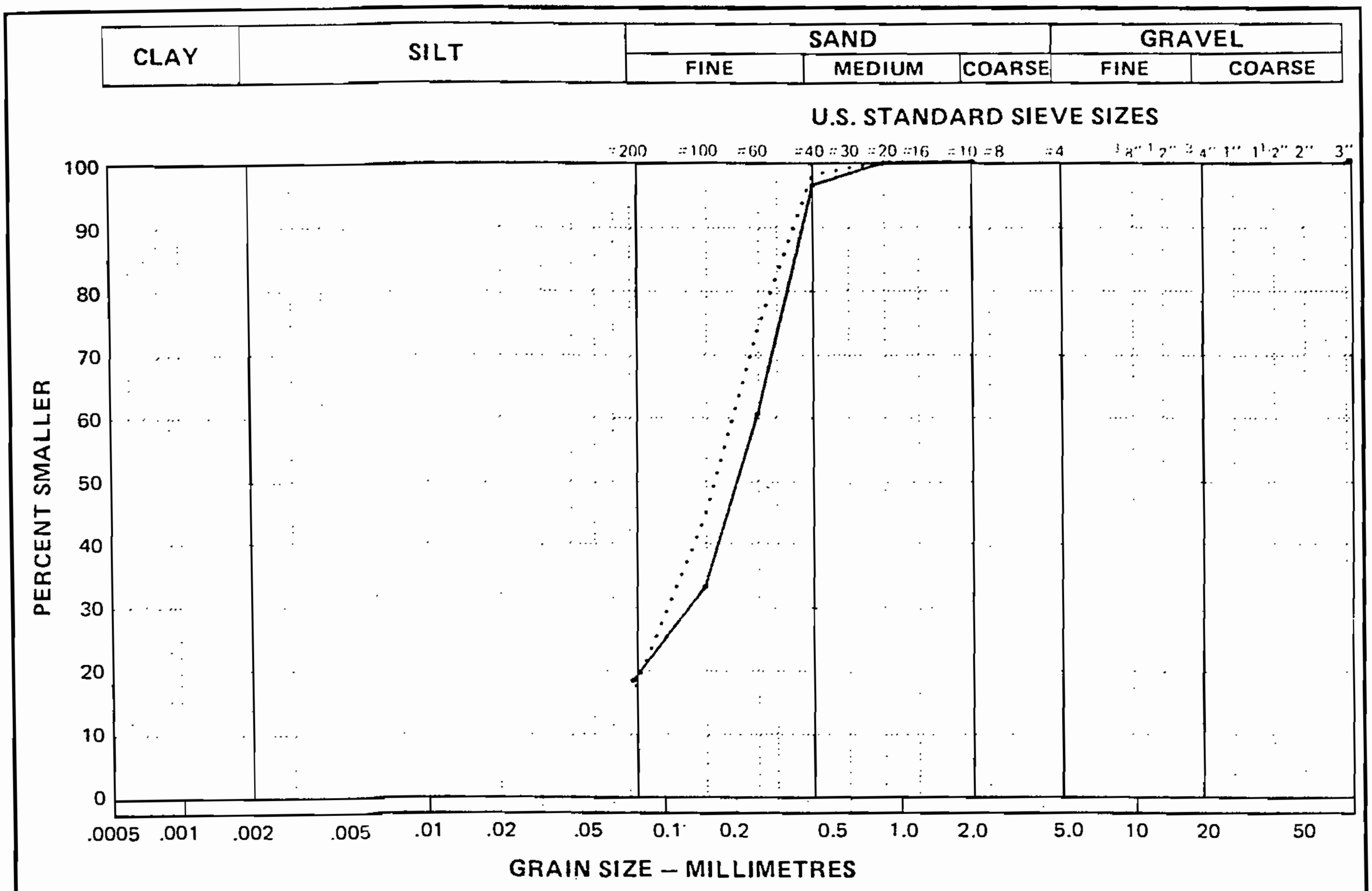
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
________	V:NER:2:12	2.90 - 3.15	-	1.5	98.5	0.0	1.7	1.0	SP

JOB NO. 101 -3605 **DATE** 82-08-14

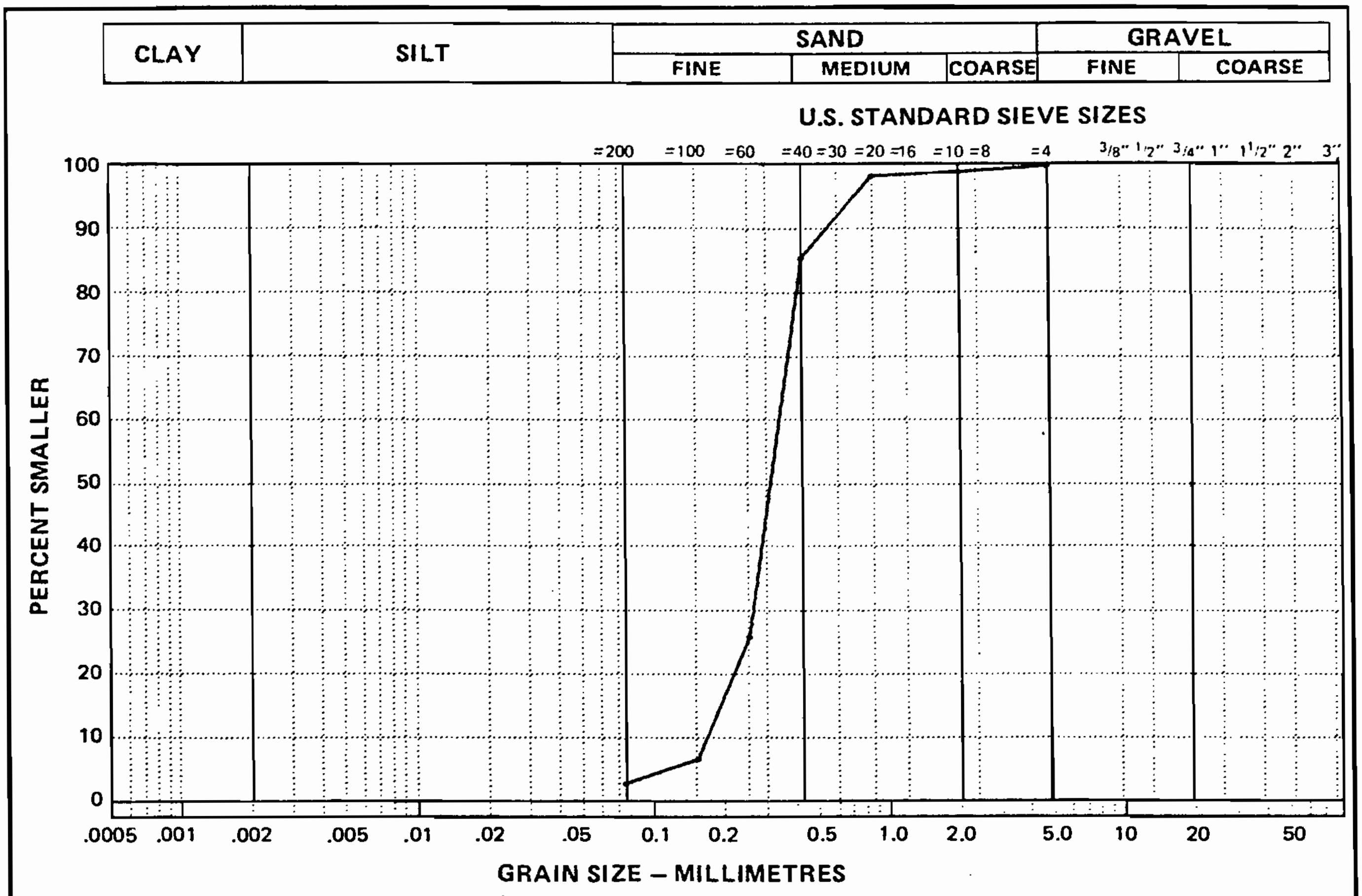
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
——	V: NER: 2: 13	.91 - 1.31	-	16.9	83.1	0.0	-	-	
·····	V: NER: 2: 13	2.15 - 2.30	-	15.0	85.0	0.0	-	-	

JOB NO. 101 -3605 DATE 82-08-14

PARTICLE - SIZE ANALYSIS OF SOILS

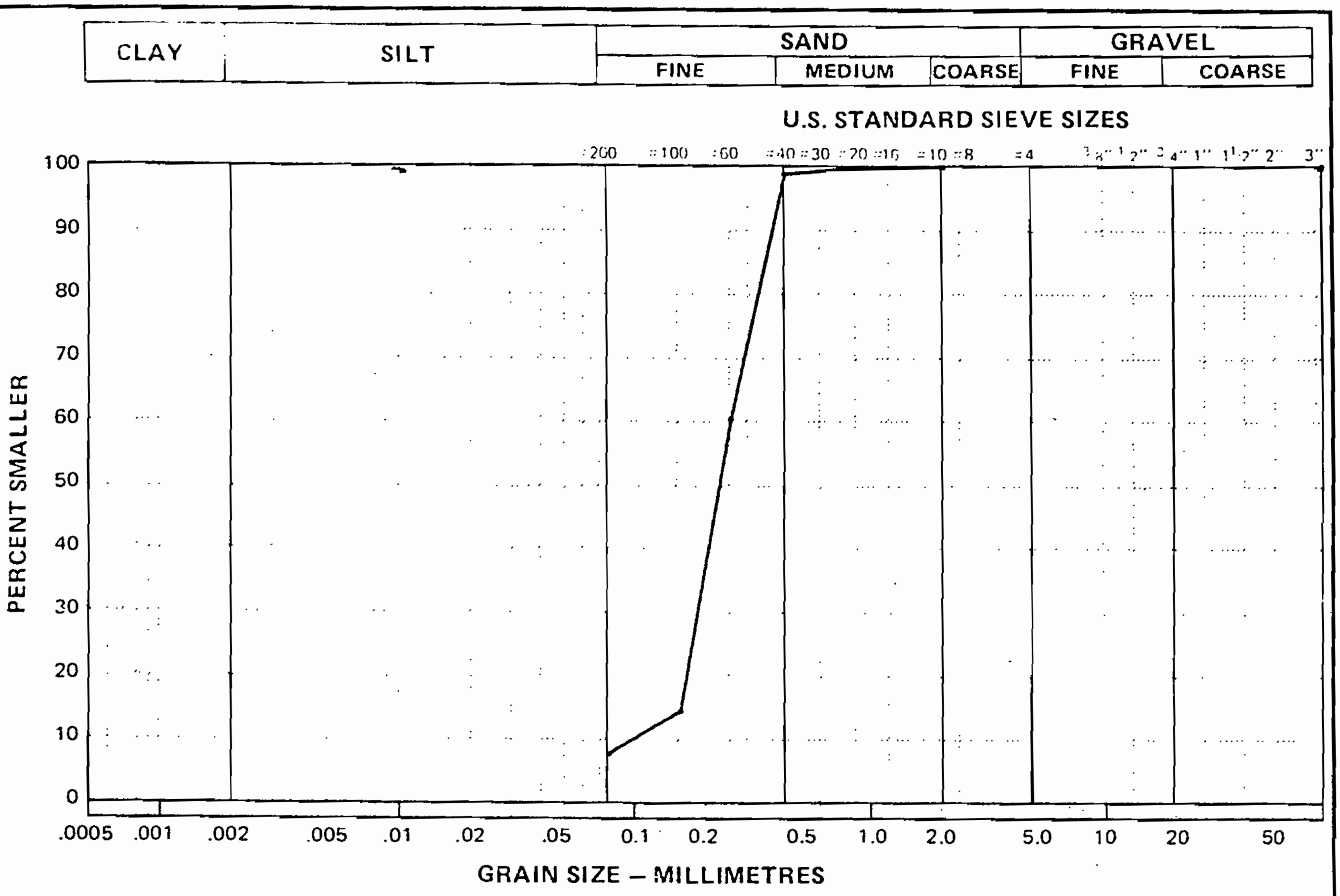


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
—	V: NER: 2: 14	1.00 - 1.60	-	2.1	97.9	0.0	2.0	1.2	SP

JOB NO. 101 -3605

DATE 82-08-17

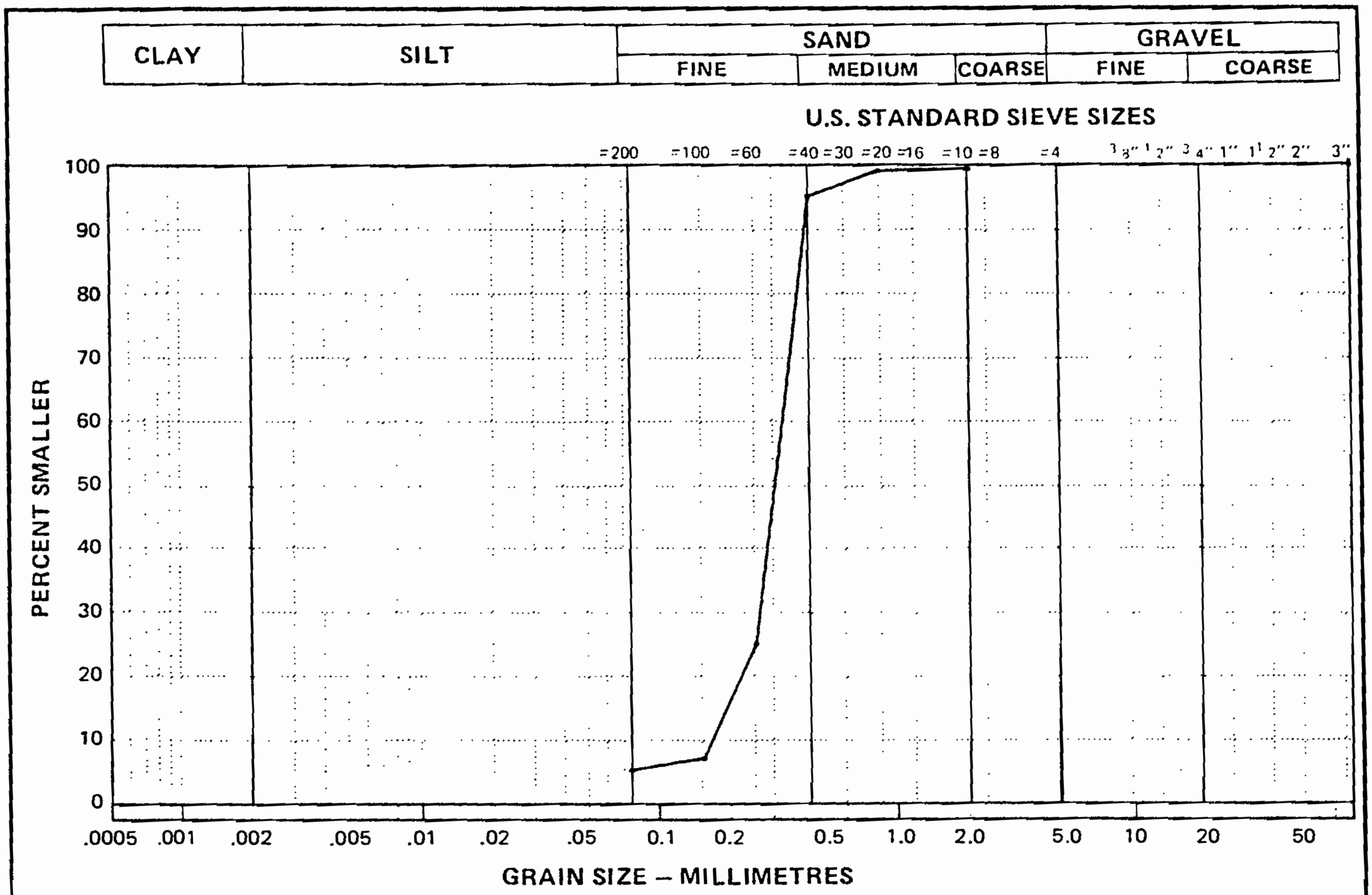
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER2: 16	.40 - .60.	-	6.9	93.1	0.0.	2.4	1.3	SP-SM

JOB NO. 101 -3605 DATE 82-11-18

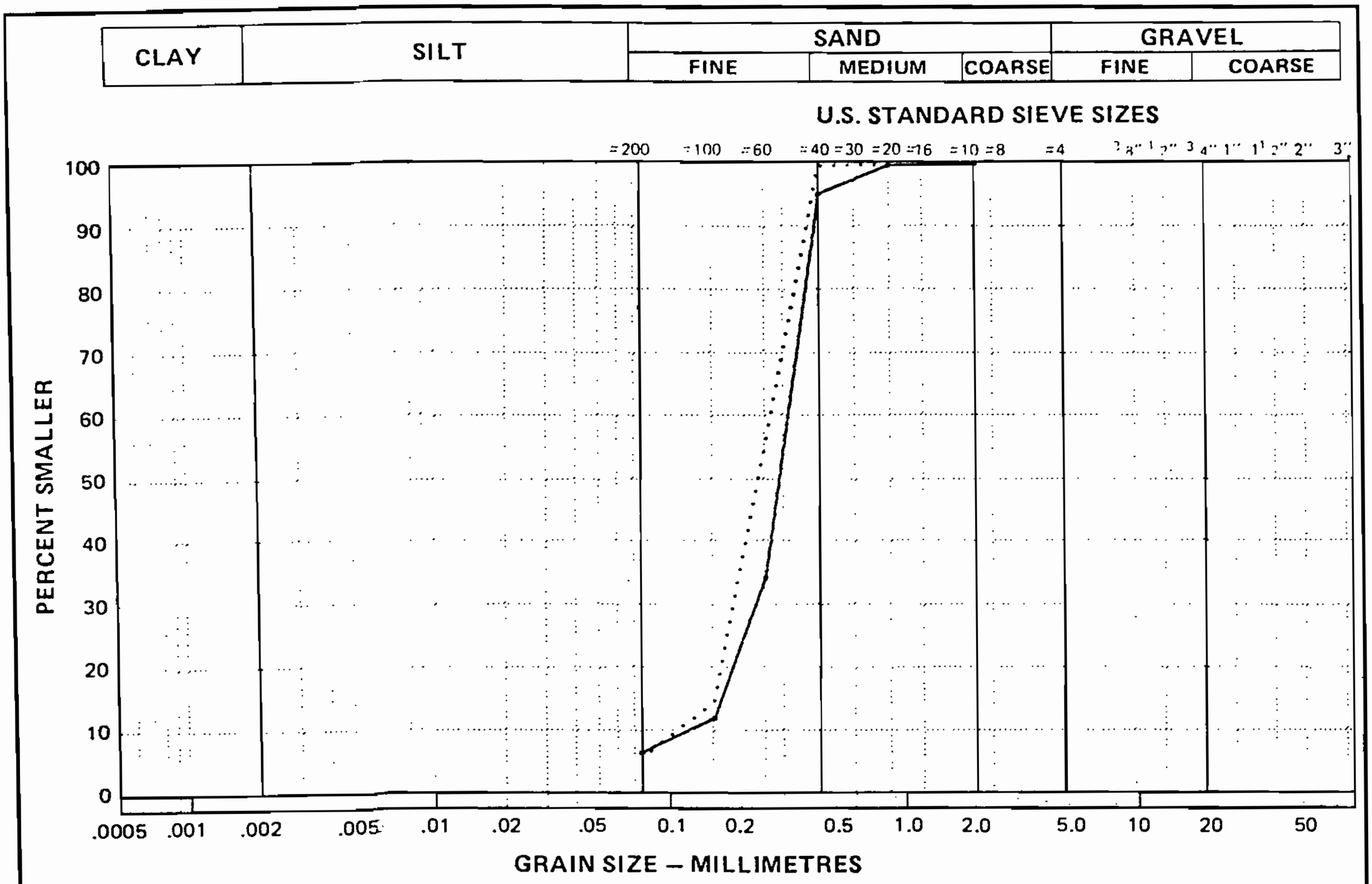
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V: NER: 2: 16	.80 - 3.00	-	4.8	95.2	0.0	2.0	1.3	SP

JOB NO. 101 -3605 **DATE** 82-08-17

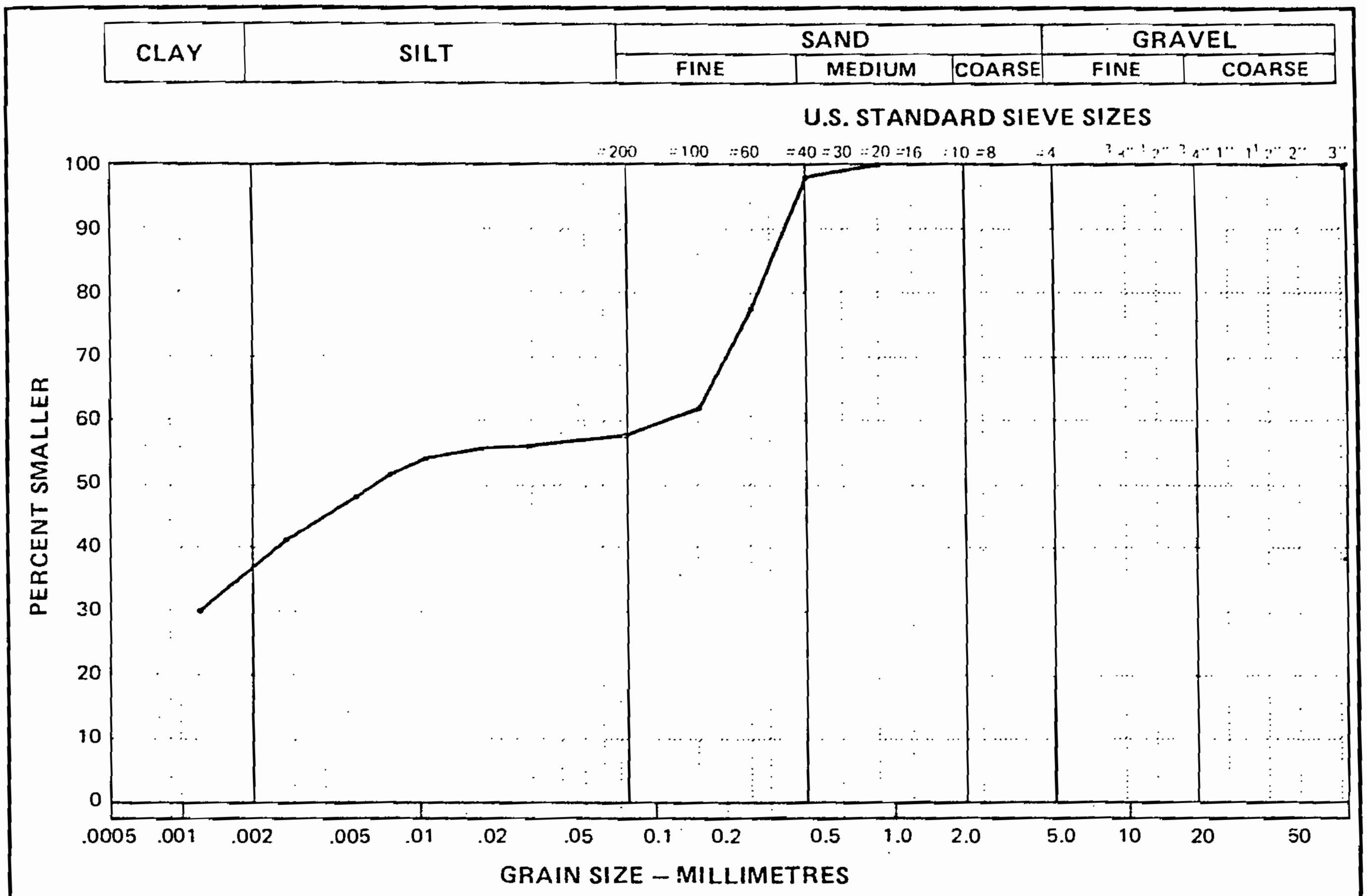
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	V: NER: 2: 17	.22 - 1.22	-	5.6	94.4	0.0	2.4	1.3	SP-SM
. . . . .	V: NER: 2: 17	2.22 - 3.22	-	4.7	95.3	0.0	2.4	1.1	SP

JOB NO. 101 -3605 **DATE** 82-08-17

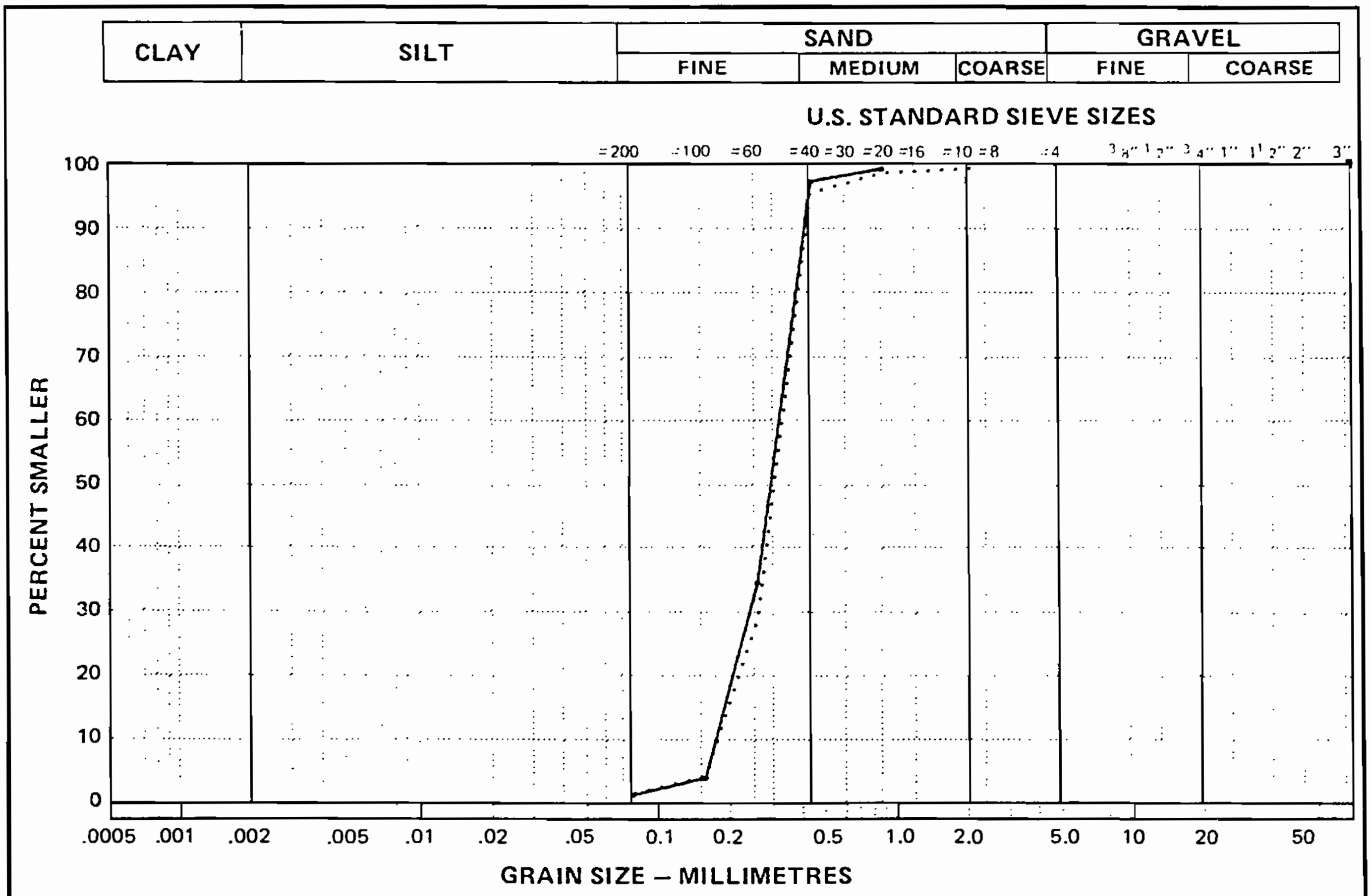
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
______	V: NER2: 18	0.00 - .20	36.6	20.6	42.8	0.0	-		

JOB NO. 101 -3605 **DATE** 82-11-17

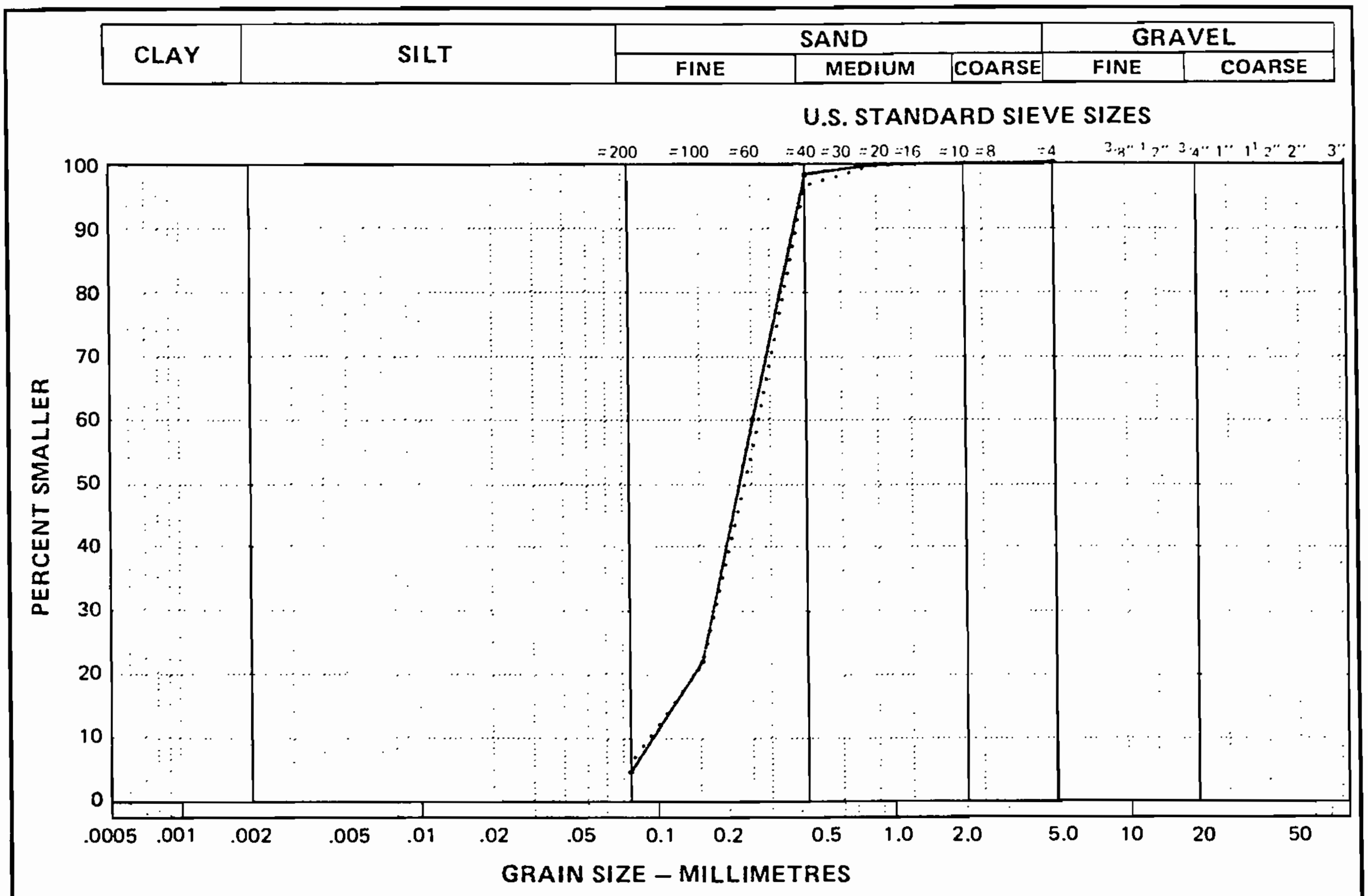
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
—	V: NER: 2: 18	.20 - .57	-	.9	99.1	0.0	1.9	1.0	SP
·····	V: NER: 2: 18	2.57 - 3.57	-	1.1	98.9	0.0	1.9	1.2	SP

JOB NO. 101 -3605 **DATE** 82-08-18

PARTICLE - SIZE ANALYSIS OF SOILS

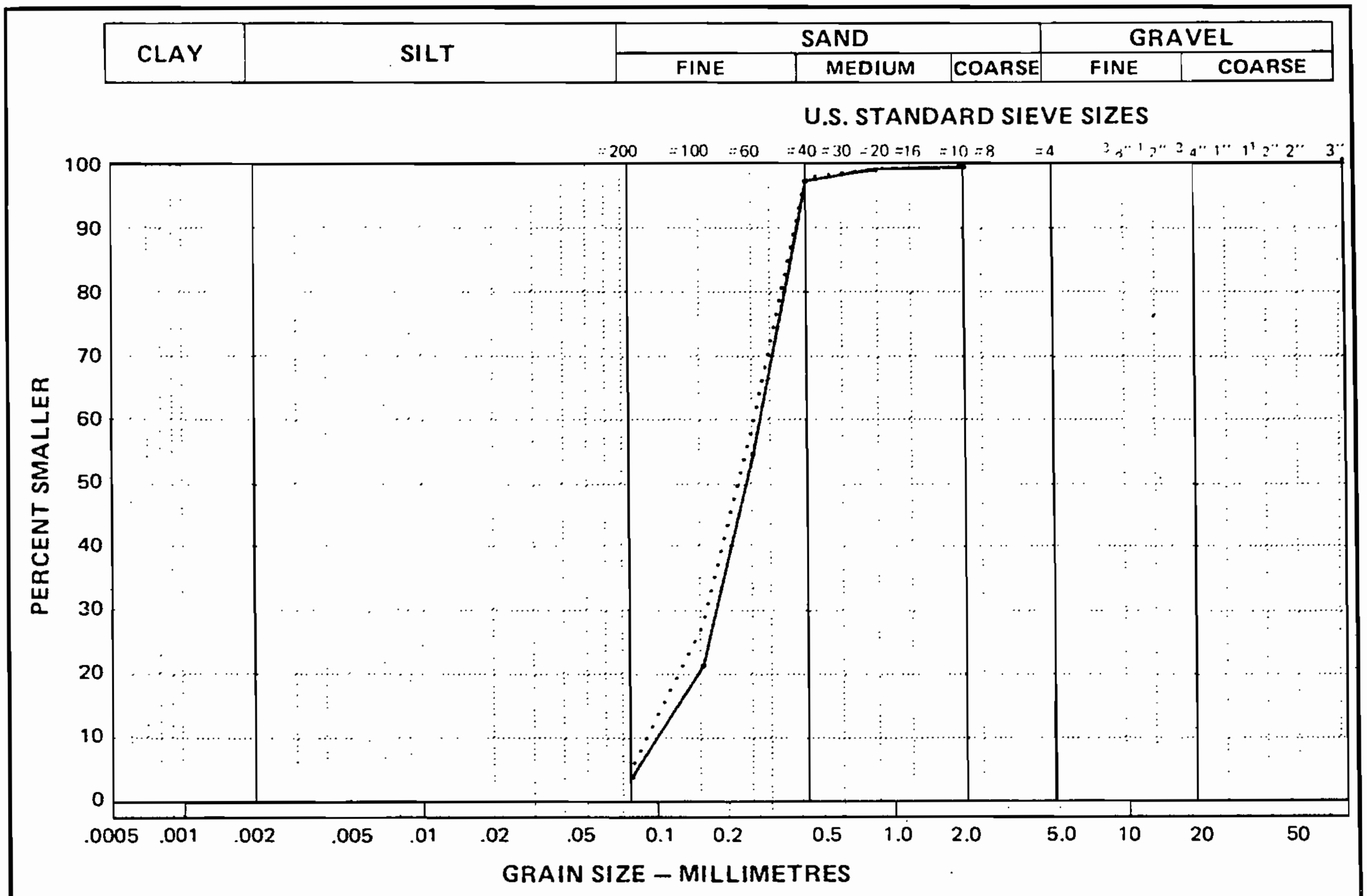


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 19	.20 - 1.20	-	3.5	96.5	0.0	2.6	1.2	SP
·····	V: NER: 2: 19	2.20 - 3.20	-	4.9	95.1	0.0	2.9	1.2	SP

JOB NO. 101 -3605

DATE 82-08-07

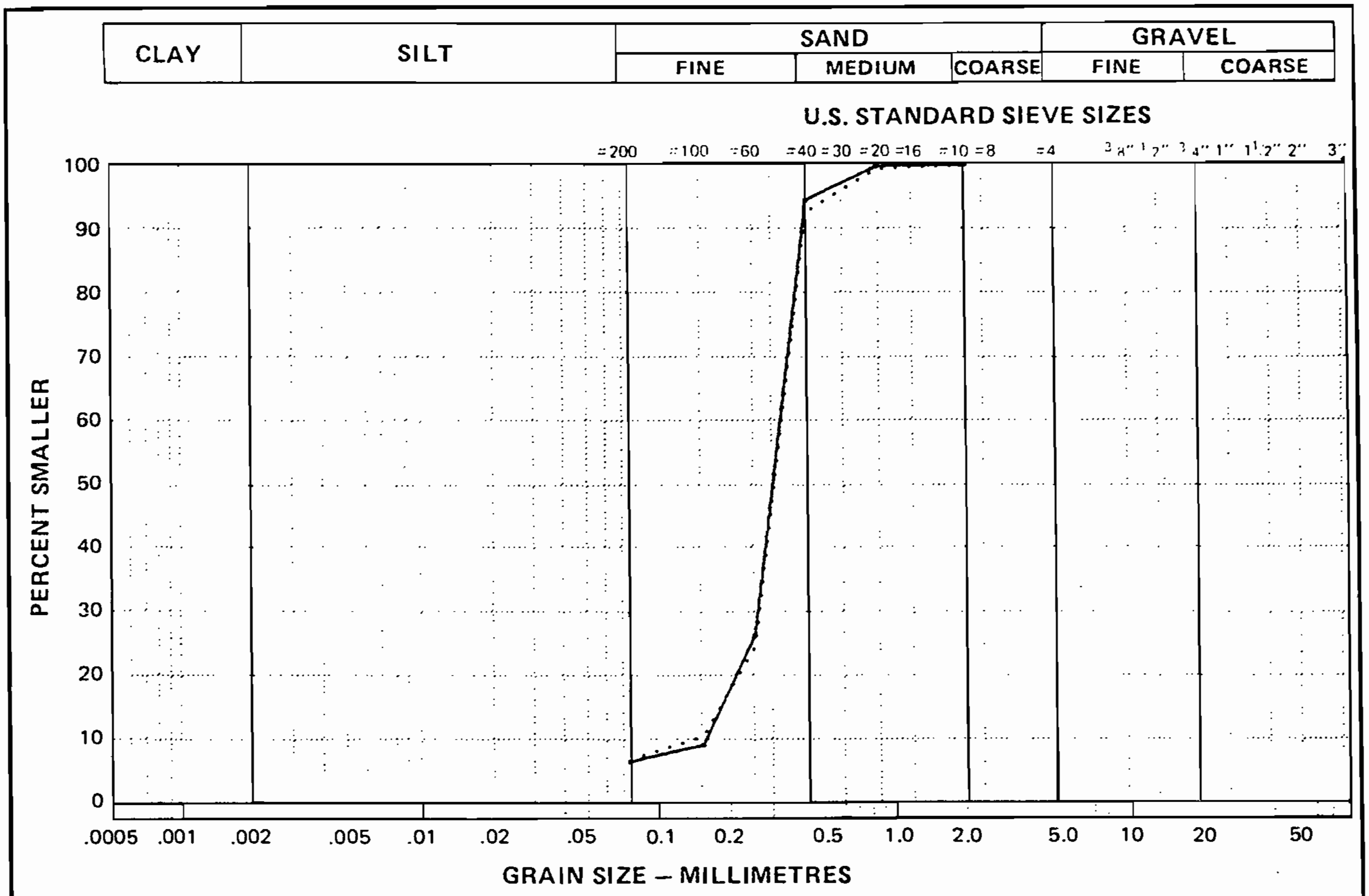
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 20	.15 - 1.50	-	3.5	96.5	0.0	2.8	1.2	SP
· · · · ·	V: NER: 2: 20	2.15 - 3.05	-	5.0	95.0	0.0	2.9	1.1	SP-SM

JOB NO. 101 -3605 **DATE** 82-08-17

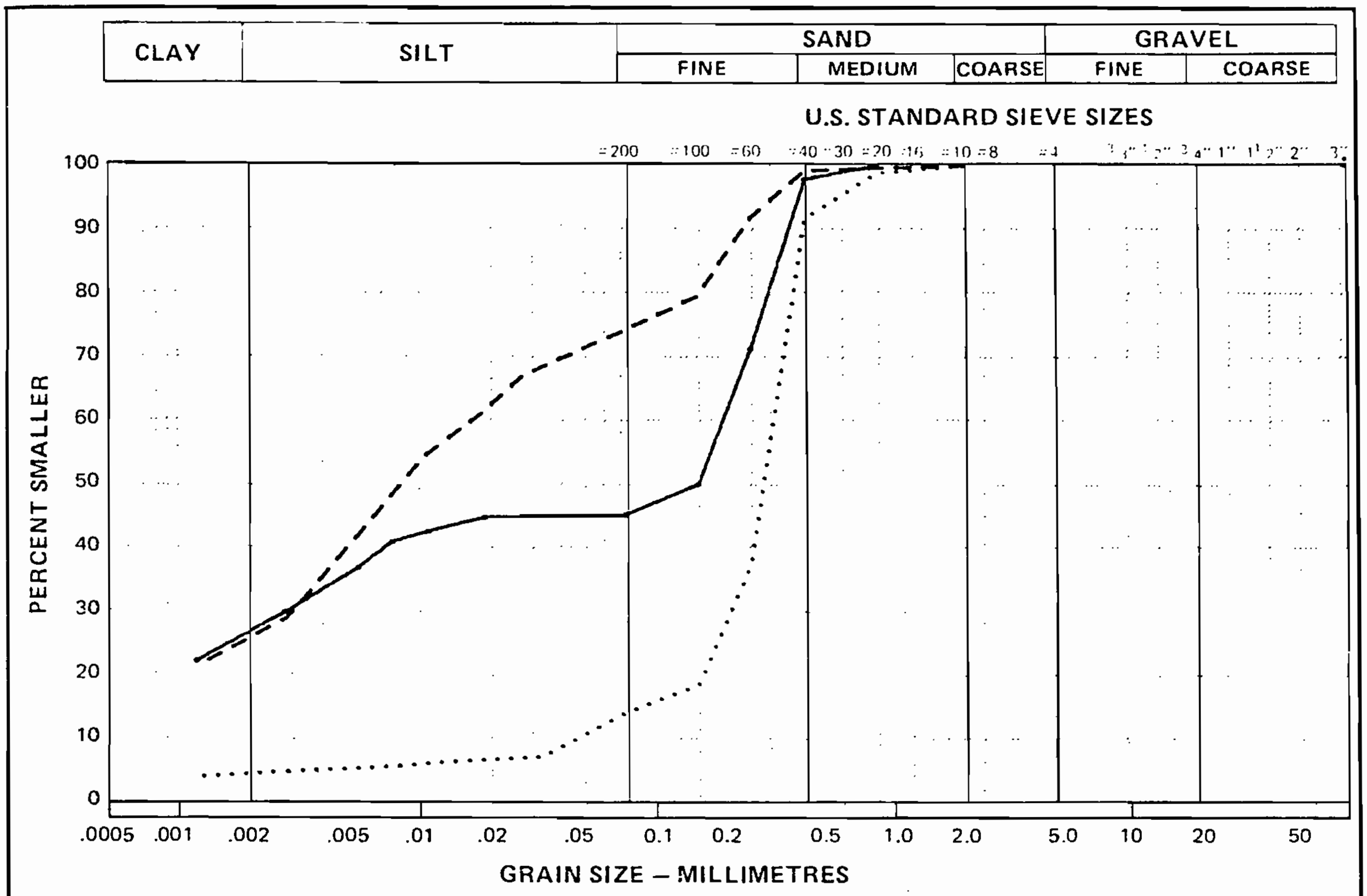
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 21	.65 - 1.75	-	5.7	94.3	0.0	2.1	1.3	SP-SM
· · · · ·	V: NER: 2: 21	2.65 - 2.65	-	6.0	94.0	0.0	2.2	1.4	SP-SM

JOB NO. 101 -3605 **DATE** 82-08-17

PARTICLE - SIZE ANALYSIS OF SOILS

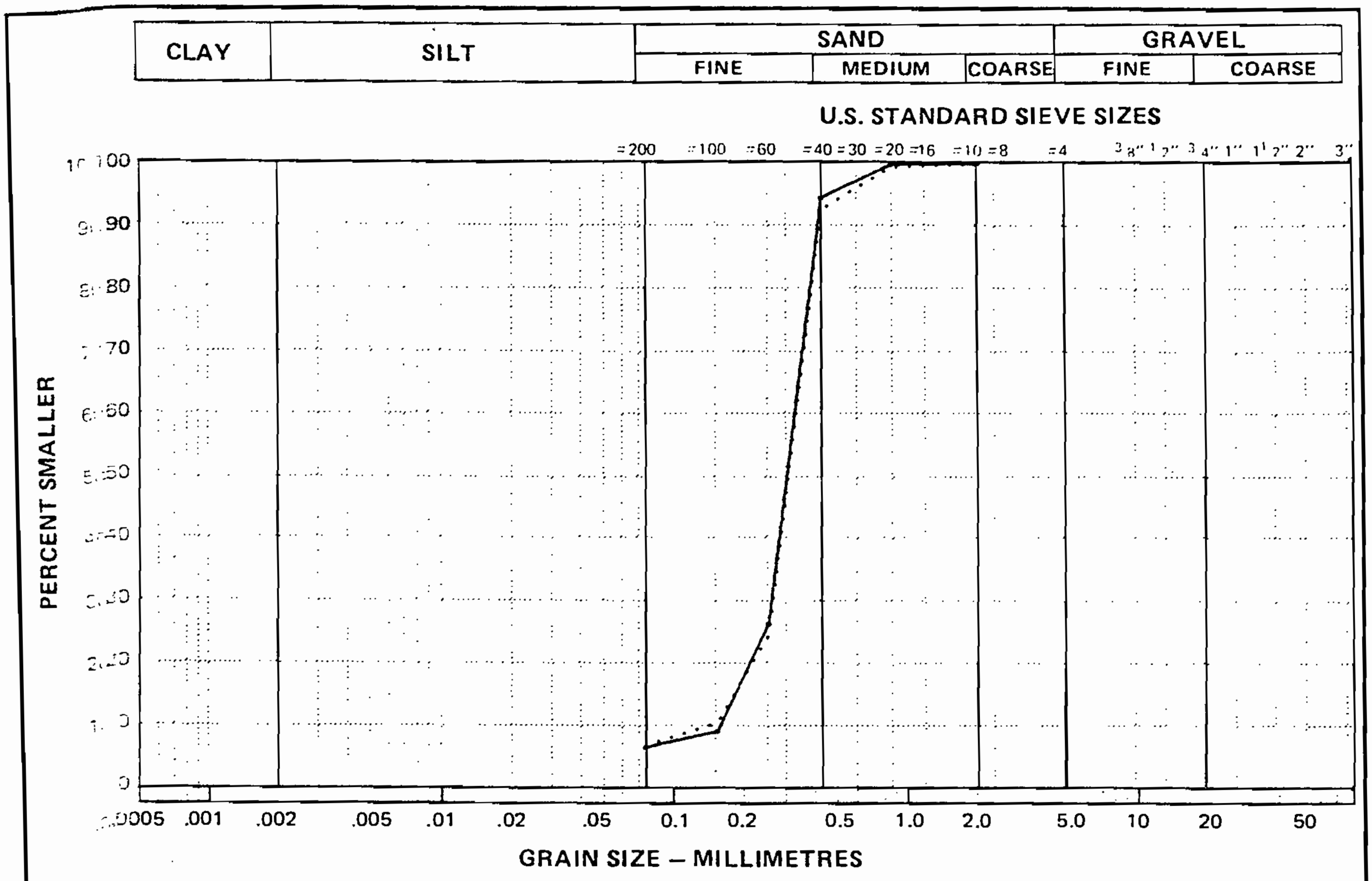


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	V:NER2:21	0.00 - .15	26.4	18.4	55.2	0.0	-	-	
·····	V:NER2:21	.15 - .50	3.9	9.3	86.8	0.0	6.2	2.8	SM
— — —	V:NER2:21	.50 - .60	25.4	48.8	25.8	0.0	-	-	

JOB NO. 101 -3605 DATE 82-11-15

2094a

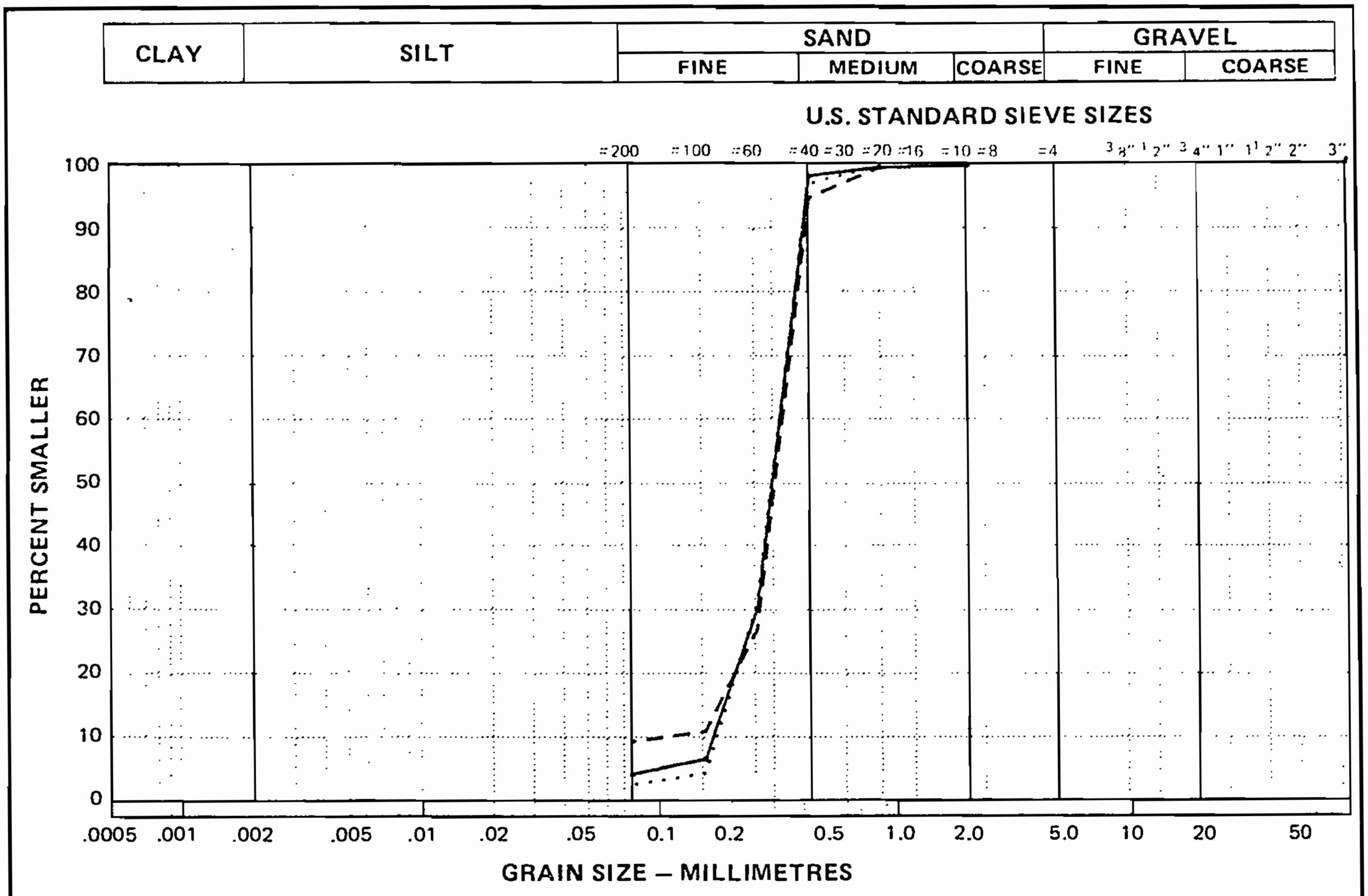
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
——	V: NER: 2: 21	.65 - 1.75	-	5.7	94.3	0.0	2.1	1.3	SP-SM
·····	V: NER: 2: 21	2.65 - 2.65	-	6.0	94.0	0.0.	2.2	1.4	SP-SM

JOB NO. 101 -3605 DATE 82-08-17

PARTICLE - SIZE ANALYSIS OF SOILS

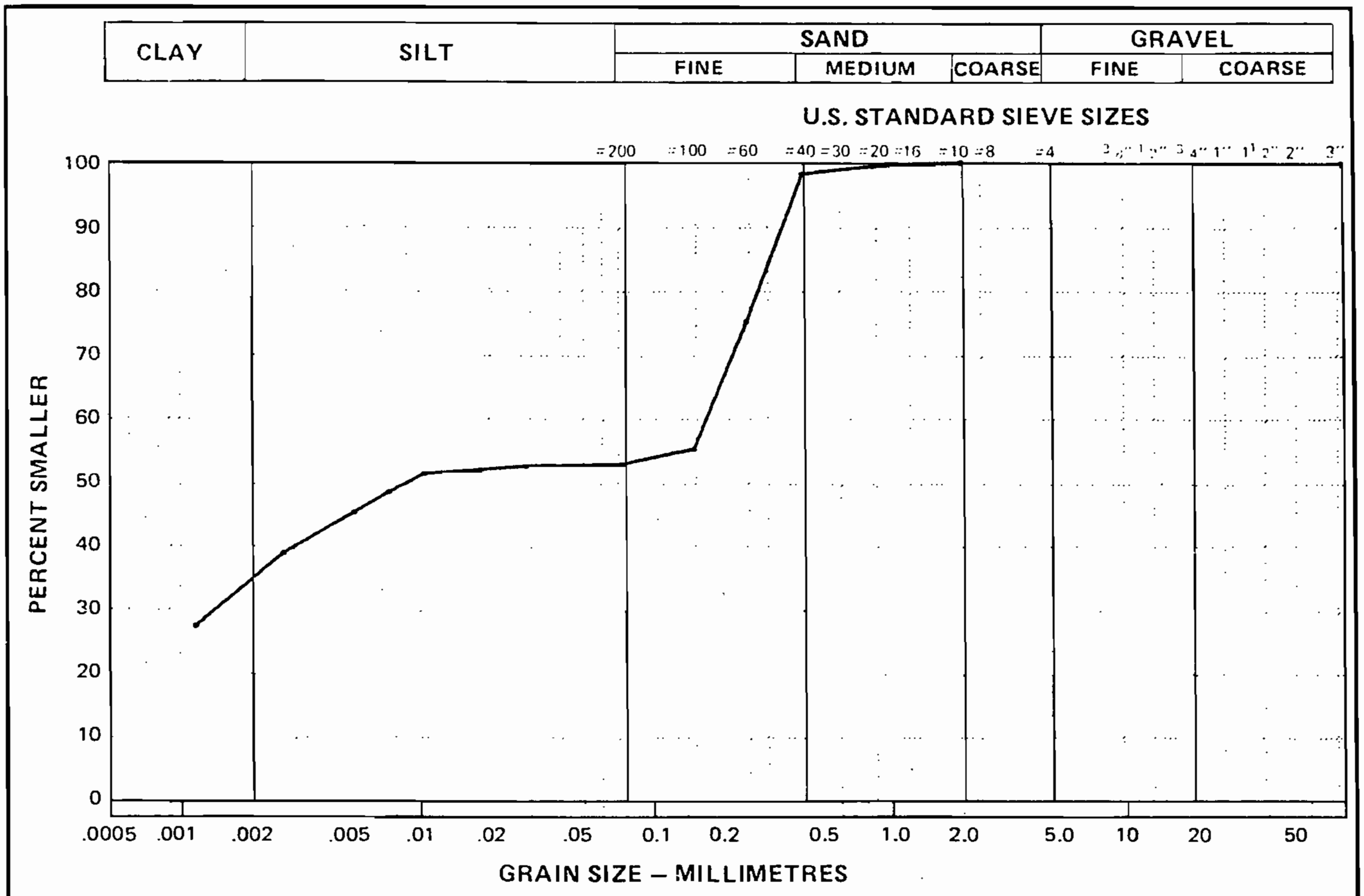


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER: 2: 22	1.50 - 1.80	-	3.4	96.6	0.0	1.9	1.2	SP
· · · · ·	V: NER: 2: 22	.30 - .30	-	1.7	98.3	0.0	1.9	1.1	SP
— — —	V: NER: 2: 22	3.30 - 3.66	-	8.6	91.4	0.0	2.3	1.4	SP-SM

JOB NO. 101 -3605

DATE 82-08-17

PARTICLE - SIZE ANALYSIS OF SOILS

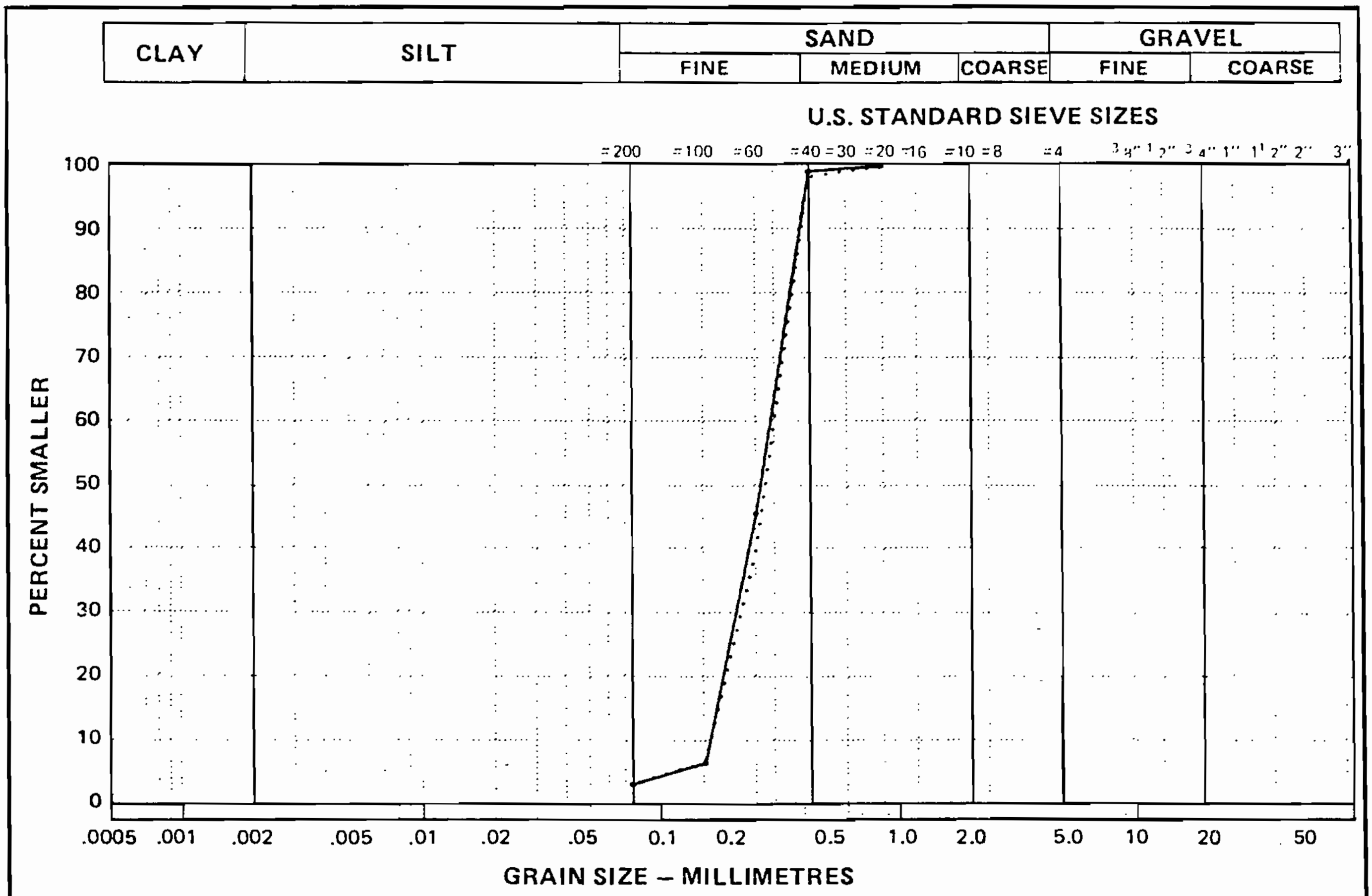


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	V: NER2: 23	0.00 - .30	33.8	18.4	47.8	0.0	-	-	

JOB NO. 101 -3605

DATE 82-11-15

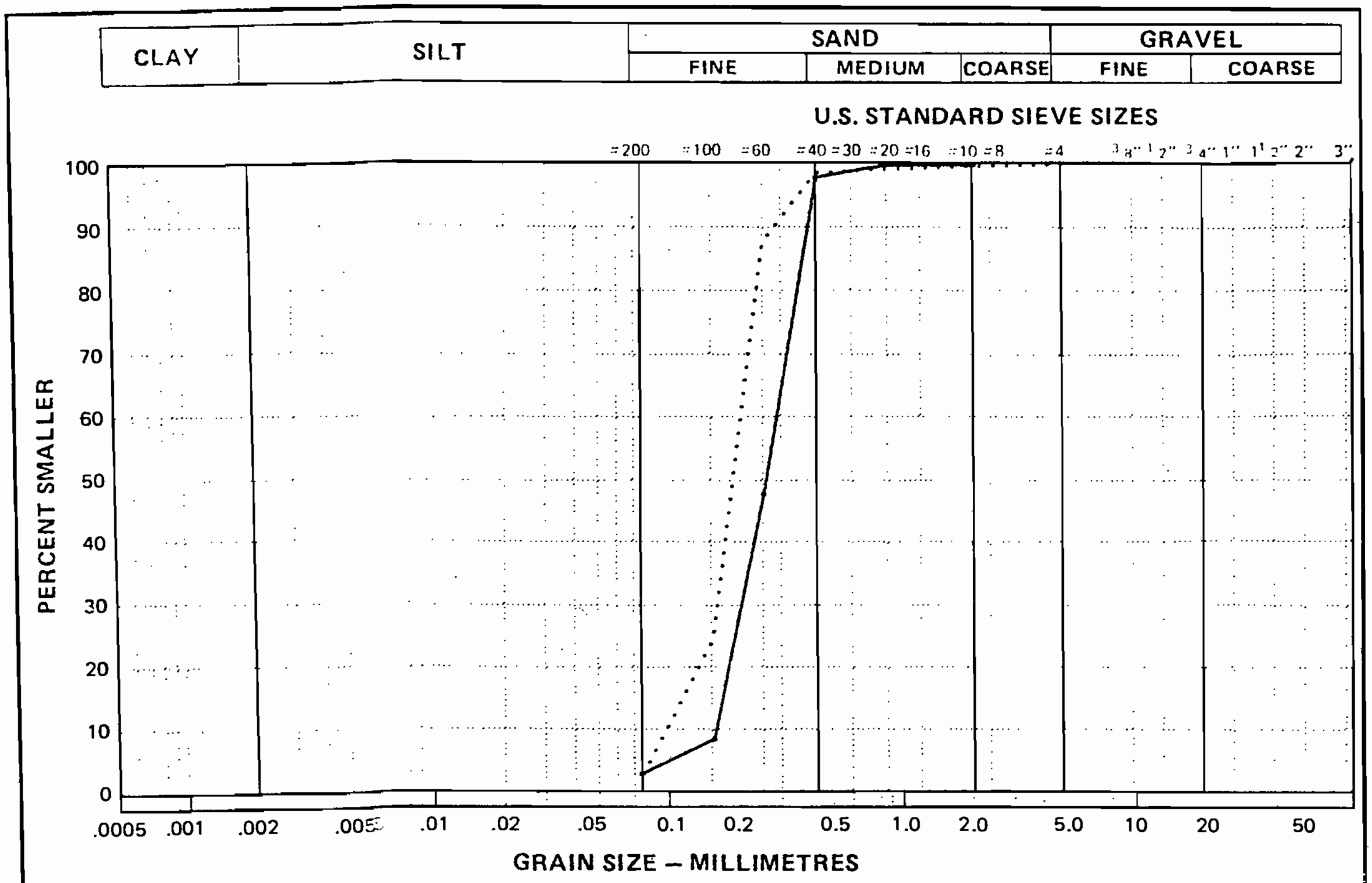
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	V: NER: 2: 23	.60 - .60	-	2.3	97.7	0.0	1.8	.9	SP
·····	V: NER: 2: 23.	1.50 - 1.50	-	2.4	97.6	0.0	1.9	1.0	SP

JOB NO. 101 -3605 **DATE** 82-08-17

PARTICLE - SIZE ANALYSIS OF SOILS



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<tr><th>CLAY (%)</th><th>SILT (%)</th><th>SAND (%)</th><th>GRAVEL (%)</th></tr>
<tr><td>———</td><td>V: NER: 2: 24</td><td>1.00 - 2.00.</td><td>-</td><td>2.0</td><td>98.0</td><td>0.0</td><td>1.8</td><td>.9</td><td>SP</td></tr>
<tr><td>· · · · ·</td><td>V: NER: 2: 24</td><td>2.80 - 3.80</td><td>-</td><td>1.5</td><td>98.5</td><td>0.0</td><td>2.1</td><td>1.3</td><td>SP</td></tr>
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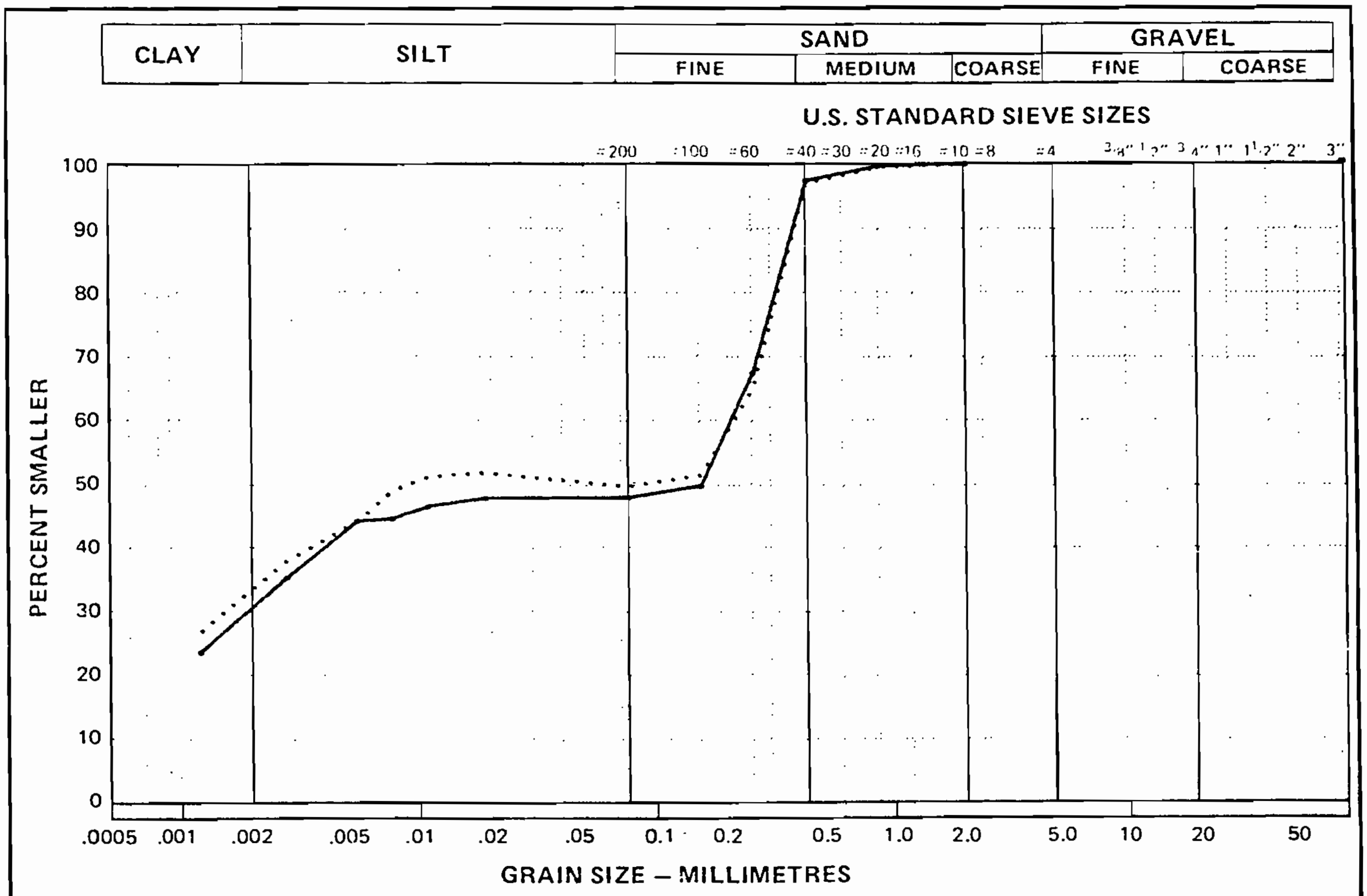
JOB NO. 101 -3605 **DATE** 82-08-17

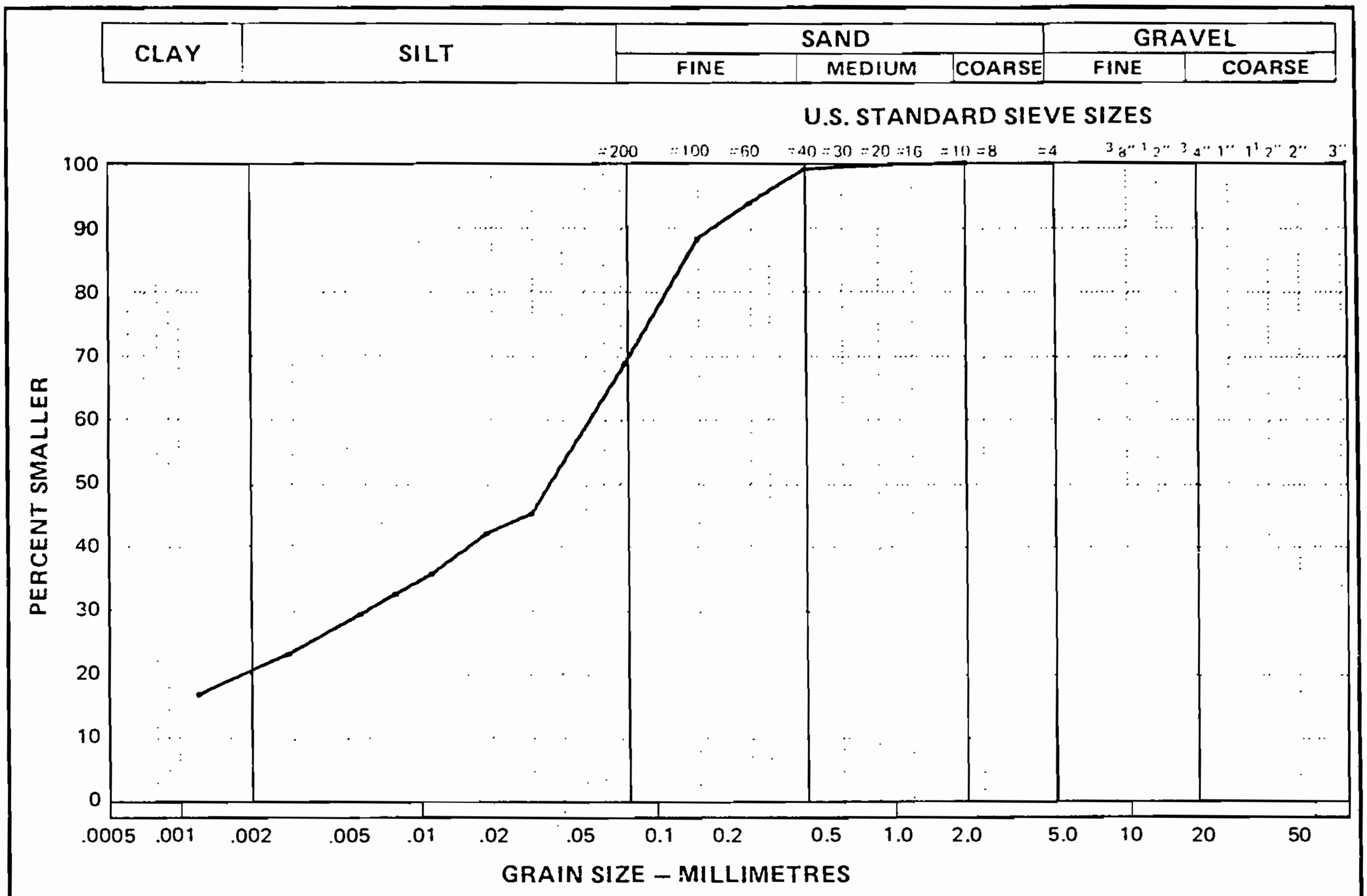
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	V: NER2: 25	.60 - .90	30.4	17.0	52.6	0.0	-	-	
· · · · ·	V: NER2: 25	1.80 - 2.10	33.3	15.9	50.8	0.0	-	-	

JOB NO. 101 -3605　DATE 82-11-16

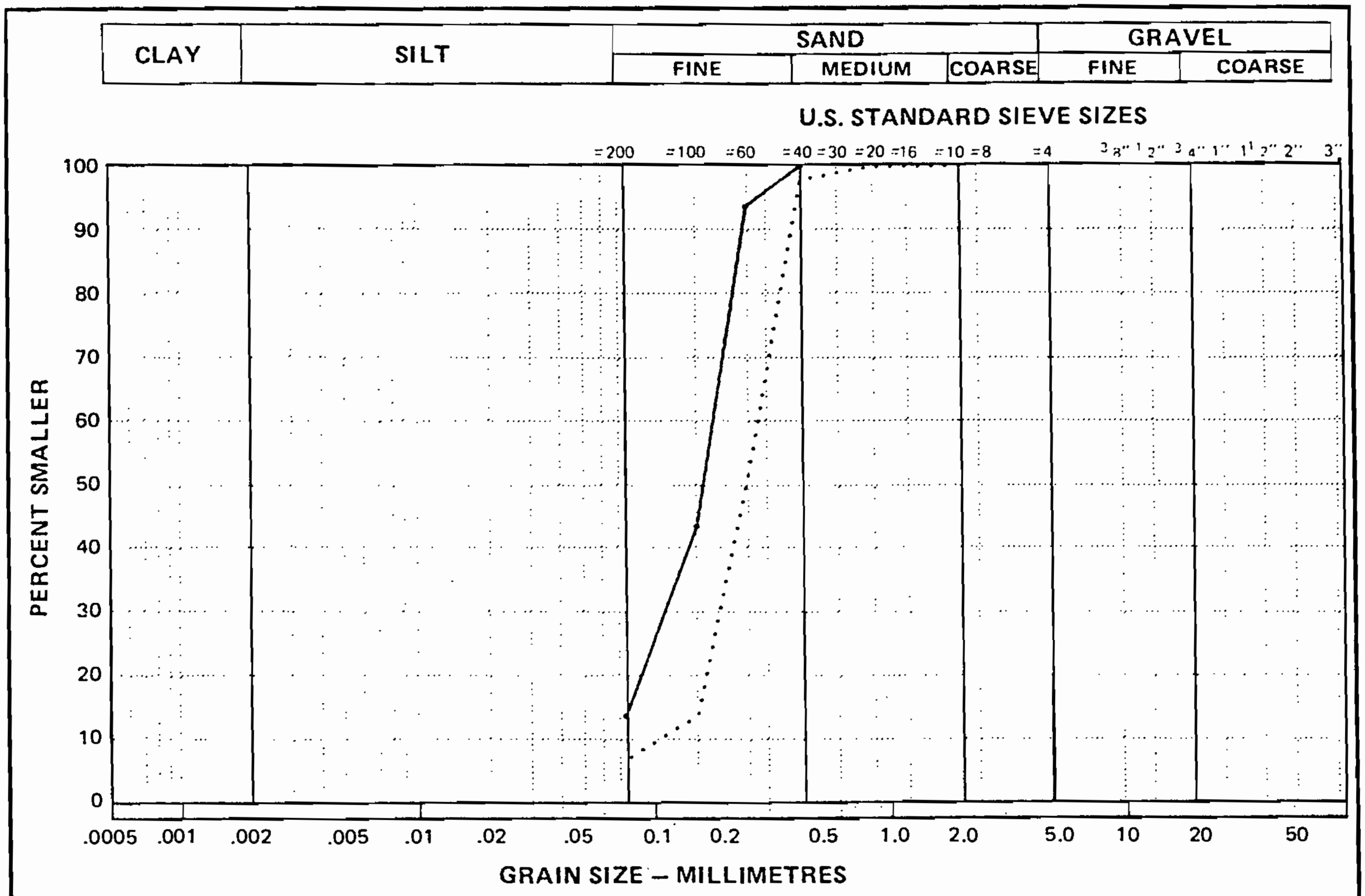
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	V: NER2: 26	.30 - .50	19.5	49.1	31.4	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-17

PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu .	Cc	U.S.C.
______	V: NER: 2: 26	2.00 - 2.00	-	12.9	87.1	0.0	-	-	
. . . . .	V: NER: 2: 26	3.00 - 3.00	-	5.9	94.1	0.0	2.5	1.2	SP-SM

JOB NO. 101 -3605 DATE 82-08-17

TABLE A2 NERLERK SITES INVESTIGATED

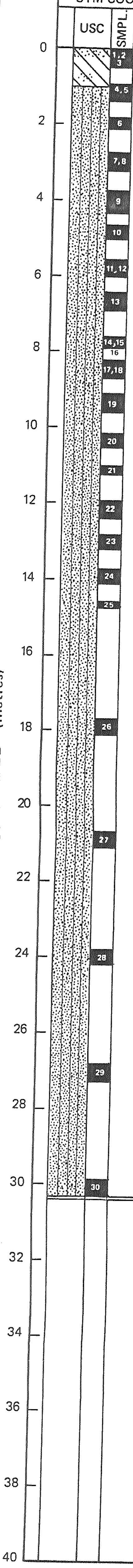
BOREHOLE NO.	UTM COORDINATES (m)	GEOGRAPHIC COORDINATES	WATER DEPTH (m)	PENETRATION (m)	DATE ADVANCED
B-NER 1:5	7,816,470N 562,315E	70°26'51"N 133°19'54"W	45.7	30.3	82-07-21
B-NER 2:1	7,816,919N 560,896E	70°27'7"N 133°22'9"W	45.7	30.1	82-07-31
B-NER 2:2	7,815,906N 560,936E	70°26'34"W 133°22'8"W	45.1	30.2	82-08-04
B-NER 2:10	7,816,484N 559,726E	70°26'54"N 133°24'3"W	45.7	31.1	82-08-09
B-NER 3:1	7,815,299N 563,257E	70°26'13"N 133°18'26"W	45.1	4.1	82-08-23
B-NER 3:1B	7,815,296N 563,243E	70°26'13"N 133°18'27"W	45.1	25.8	82-08-25
B-NER 3:2	7,815,498N 563,001E	70°26'19"N 133°18'50"W	45.4	31.5	82-08-26
B-NER 3:3	7,815,700N 562,596E	70°26'26"N 133°19'29"W	45.1	30.3	82-08-27
B-NER 3:4	7,815,552N 562,150E	70°26'22"N 133°20'12"W	44.8	29.4	82-08-28

TABLE A2 NERLERK SITES INVESTIGATED (Continued)

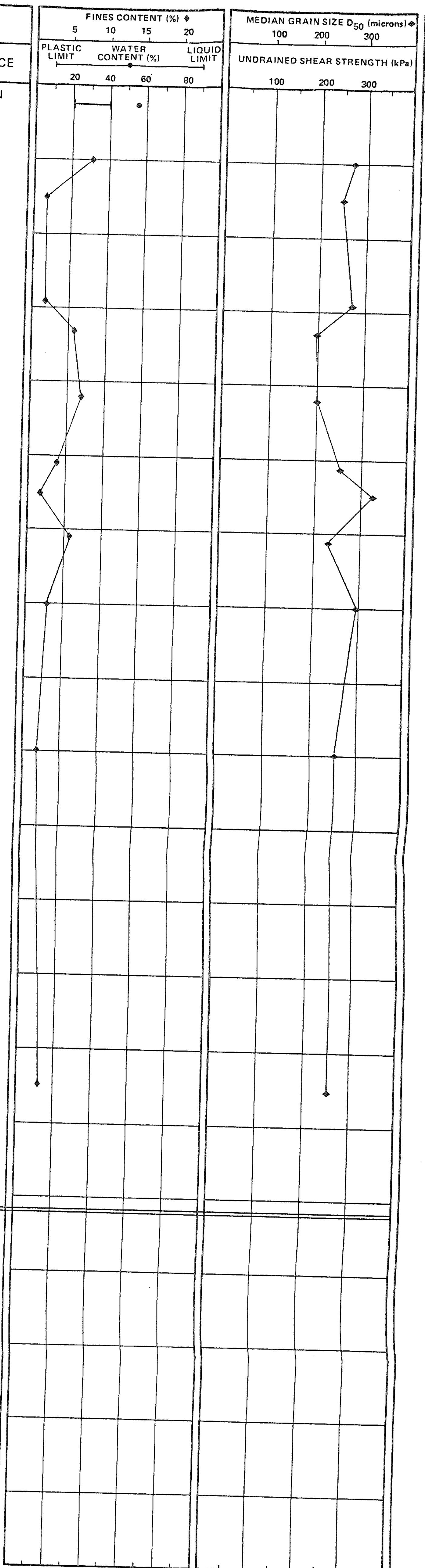
BOREHOLE NO.	UTM COORDINATES (m)	GEOGRAPHIC COORDINATES	WATER DEPTH (m)	PENETRATION (m)	DATE ADVANCED
B-NER 3:5	7,814,842N 561,552E	70°25'59"N 133°21'11"W	45.1	30.8	82-08-28
B-NER 3:6	7,815,199N 561,897E	70°26'11"N 133°20'37"W	44.5	31.5	82-08-29
B-NER 3:7	7,814,794N 561,889E	70°25'58"N 133°20'39"W	45.4	30.2	82-09-01
B-NER 3:8	7,814,987N 562,037E	70°26'4"N 133°20'24"W	44.3	31.8	82-09-02
B-NER 3:9	7,815,377N 561,771E	70°26'17"N 133°20'49"W	45.4	15.1	82-09-04
B-NER 3:10	7,815,397N 561,992E	70°26'15"N 133°20'28"W	44.8	15.0	82-09-05
B-NER 3:11	7,815,322N 562,224E	70°26'14"N 133°20'5"W	44.2	11.5	82-09-05
B-NER 3:12	7,814,503N 563,657E	70°25'47"N 133°17'50"W	44.2	13.4	82-09-12

LOCATION: NERLERK SITE
UTM COORDINATES: 7 816 470 m N. 562 315 m E. WATER DEPTH: 45.7 m

DEPTH BELOW SEABED (metres)



SOIL DESCRIPTION	GROUND ICE
CLAY (CL) - and SAND, trace of ORGANICS, very soft, low plasticity, dark grey - 300 mm thick SAND layer at 0.1 m 1.0 m(-46.7 m El.)	NOT FROZEN
SAND (SP) - traces of SILT, shell fragments and coal detritus, fine-grained, uniform, loose (estimated), dark greyish brown (SP - SM) (SP)- 25 mm thick SILT layers at 1.9 and 2.7 m - 25 mm thick SILT layer at 3.8 m - 25 mm thick SILT layer at 4.6 m - three 5 mm thick SILT layers at 5.6 m (SP - SM) - 10 mm thick ORGANIC layer every 25 mm at 7.9 m (SP) - trace of mica, 5 mm thick SILT layer (SP - SM) (SP) - 3 mm thick layer of coal detritus	
END OF BOREHOLE 30.3 m (-76.0 m El.) *Note: Borehole was completed to depth specified by Canmar*	



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/07/21
BOREHOLE DEPTH: 30.3 m (-76.0 m El.)
DRILLING RIG: F1500/Supplier V
LOG COMPILED BY: PMR/MDW

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

LEGEND

SHEAR STRENGTH
+ Torvane
× Min. Vane
∗ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

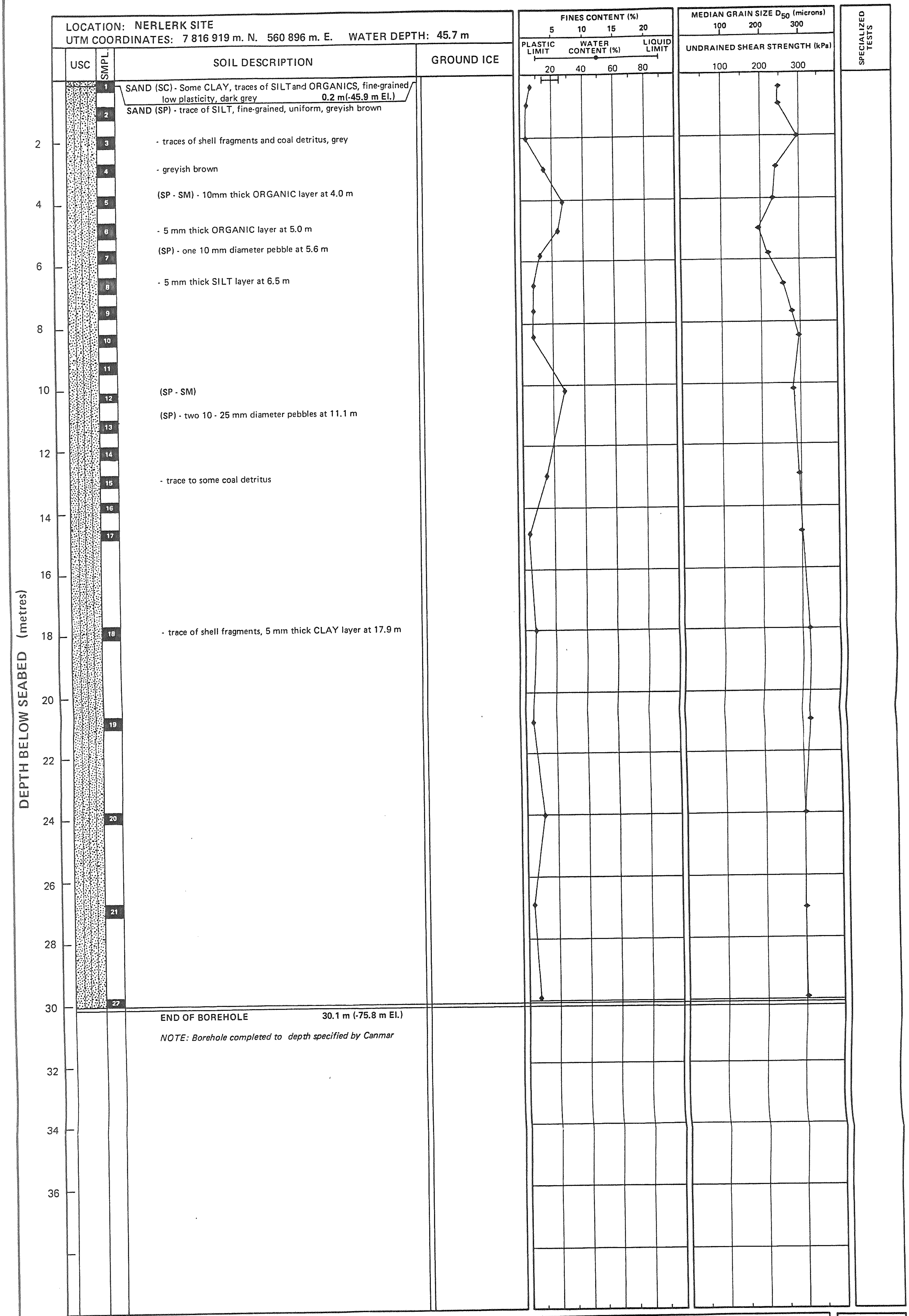
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B - NER 1:5

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 816 919 m. N. 560 896 m. E. WATER DEPTH: 45.7 m



SAND (SC) - Some CLAY, traces of SILT and ORGANICS, fine-grained low plasticity, dark grey 0.2 m (-45.9 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, greyish brown

- traces of shell fragments and coal detritus, grey

- greyish brown

(SP - SM) - 10mm thick ORGANIC layer at 4.0 m

- 5 mm thick ORGANIC layer at 5.0 m

(SP) - one 10 mm diameter pebble at 5.6 m

- 5 mm thick SILT layer at 6.5 m

(SP - SM)

(SP) - two 10 - 25 mm diameter pebbles at 11.1 m

- trace to some coal detritus

- trace of shell fragments, 5 mm thick CLAY layer at 17.9 m

END OF BOREHOLE 30.1 m (-75.8 m El.)

NOTE: Borehole completed to depth specified by Canmar

eba

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/07/31
BOREHOLE DEPTH: 30.1 m (-75.8 m El.)
DRILLING RIG: F1500/Supplier V
LOG COMPILED BY: PMR/KWJ

SOIL SYMBOLS

▨	▥	▧
SAND	SILT	CLAY

LEGEND

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
♦ Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TD - TDR	G - Gas Analysis
Ca - Calorimetry	

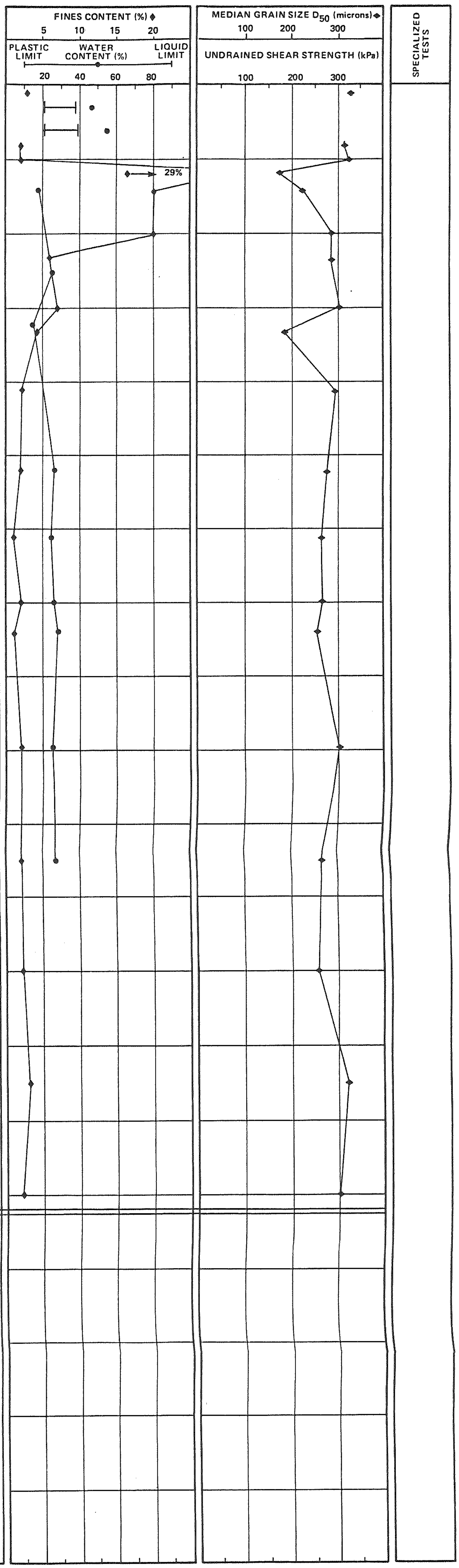
BOREHOLE NUMBER
B-NER 2:1

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 906 m. N. 560 936 m. E. WATER DEPTH: 45.1 m

DEPTH BELOW SEABED (metres)	SYM.	NO.	SOIL DESCRIPTION	GROUND ICE T (°C)
0		1	SAND (SP) - trace of SILT, fine-grained, uniform, brownish grey 0.2 m(-45.3 m El.)	NOT FROZEN
		2	CLAY (CL) - and SAND, some SILT, very soft to soft, low plasticity, dark grey 1.4 m(-46.5 m El.)	
2		3	SAND (SP) - trace of SILT, fine-grained, uniform, greyish brown (SM) - SILTY, dark greyish brown	
4		4, 5, 6	(SP - SM) - becoming trace of SILT - 6 mm thick SILT layer at 5.0 m - 10 mm thick SILT layer at 5.8 m	
6		7, 8	(SP)	
		9	(No recovery)	
8–12		10, 11, 12, 13, 14, 15		
14		16, 17	- trace of coal detritus at 13.7 m	
18–24		18, 19, 20		
26		21	- trace of shell fragments	
30		22		
			END OF BOREHOLE 30.3 m(-75.4 m El.) *Note: Borehole completed to depth specified by Canmar*	



JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/04
BOREHOLE DEPTH: 30.3 m(-75.4 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: PMR/KWJ

SOIL SYMBOLS
SAND SILT CLAY

LEGEND
SHEAR STRENGTH
+ Torvane
× Min. Vane
● Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

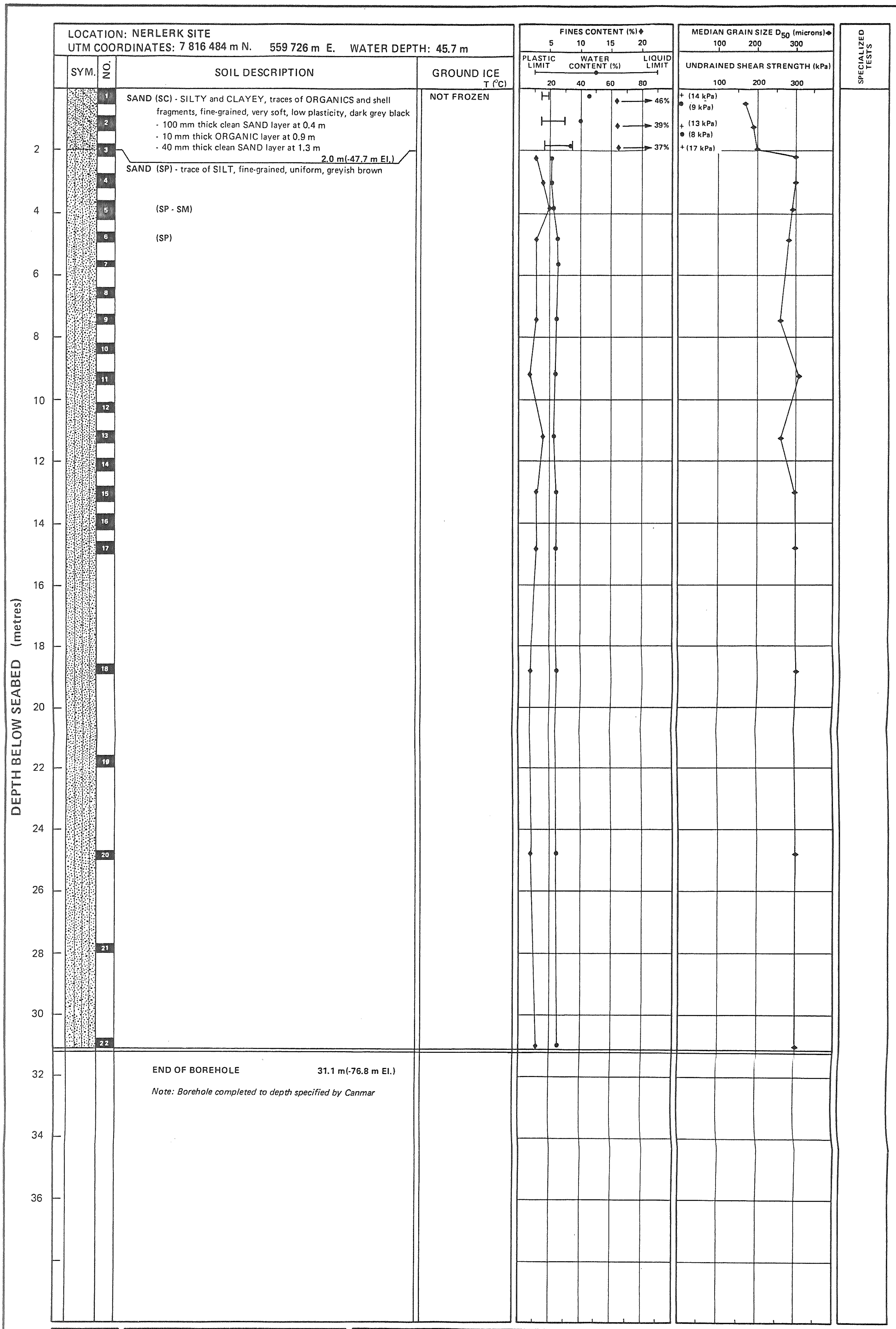
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 2:2

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 816 484 m N. 559 726 m E. WATER DEPTH: 45.7 m



SAND (SC) - SILTY and CLAYEY, traces of ORGANICS and shell fragments, fine-grained, very soft, low plasticity, dark grey black
- 100 mm thick clean SAND layer at 0.4 m
- 10 mm thick ORGANIC layer at 0.9 m
- 40 mm thick clean SAND layer at 1.3 m

2.0 m(-47.7 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, greyish brown

(SP - SM)

(SP)

NOT FROZEN

END OF BOREHOLE 31.1 m(-76.8 m El.)

Note: Borehole completed to depth specified by Canmar

eba

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/09
BOREHOLE DEPTH: 31.1 m(-76.8 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: PMR/KWJ

LEGEND

SOIL SYMBOLS

▨	▥	▧
SAND	SILT	CLAY

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
* Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

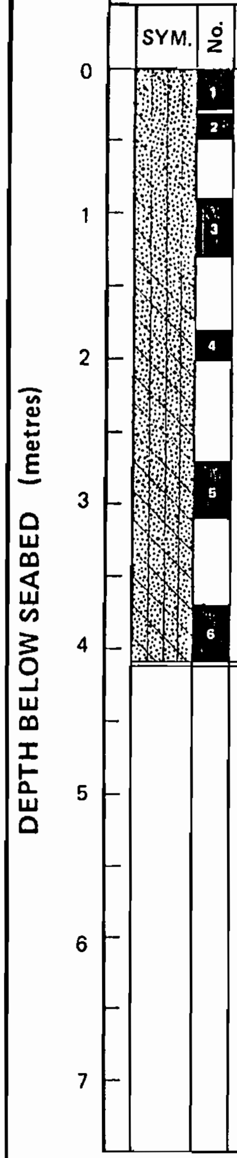
C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TD - TDR	G - Gas Analysis
Ca - Calorimetry	

BOREHOLE NUMBER
B-NER 2:10

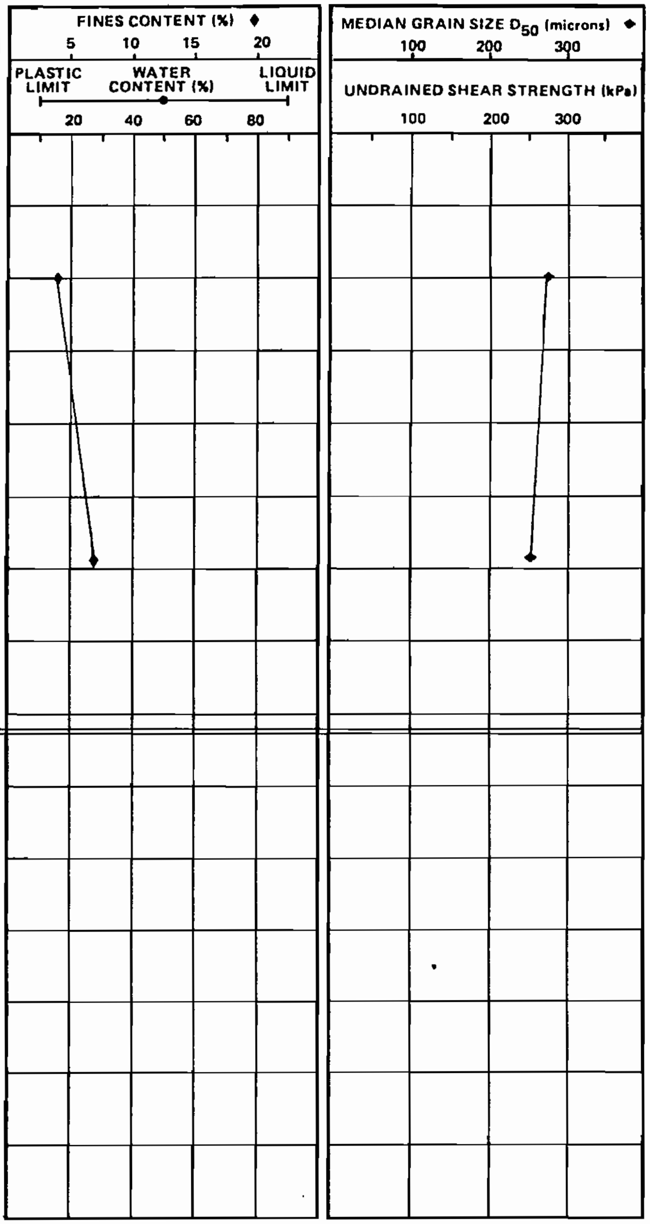
PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 299 m N. 563 257 m E. WATER DEPTH: 45.1 m



SOIL DESCRIPTION	GROUND ICE T (°C)
SAND (SM) - some SILT, traces of CLAY and shell fragments, fine-grained, dark grey brown - (SP) trace SILT below 0.3 m, uniform - (SP - SM) below 2.35 m (estimated)	NOT FROZEN
END OF BOREHOLE 4.1 m(-49.2 m El.) *Note: The 'Kelly Sub' sheared and the borehole had to be abandoned.*	



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/23
BOREHOLE DEPTH: 4.1 m(-49.2 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: BR/DY

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
◆ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

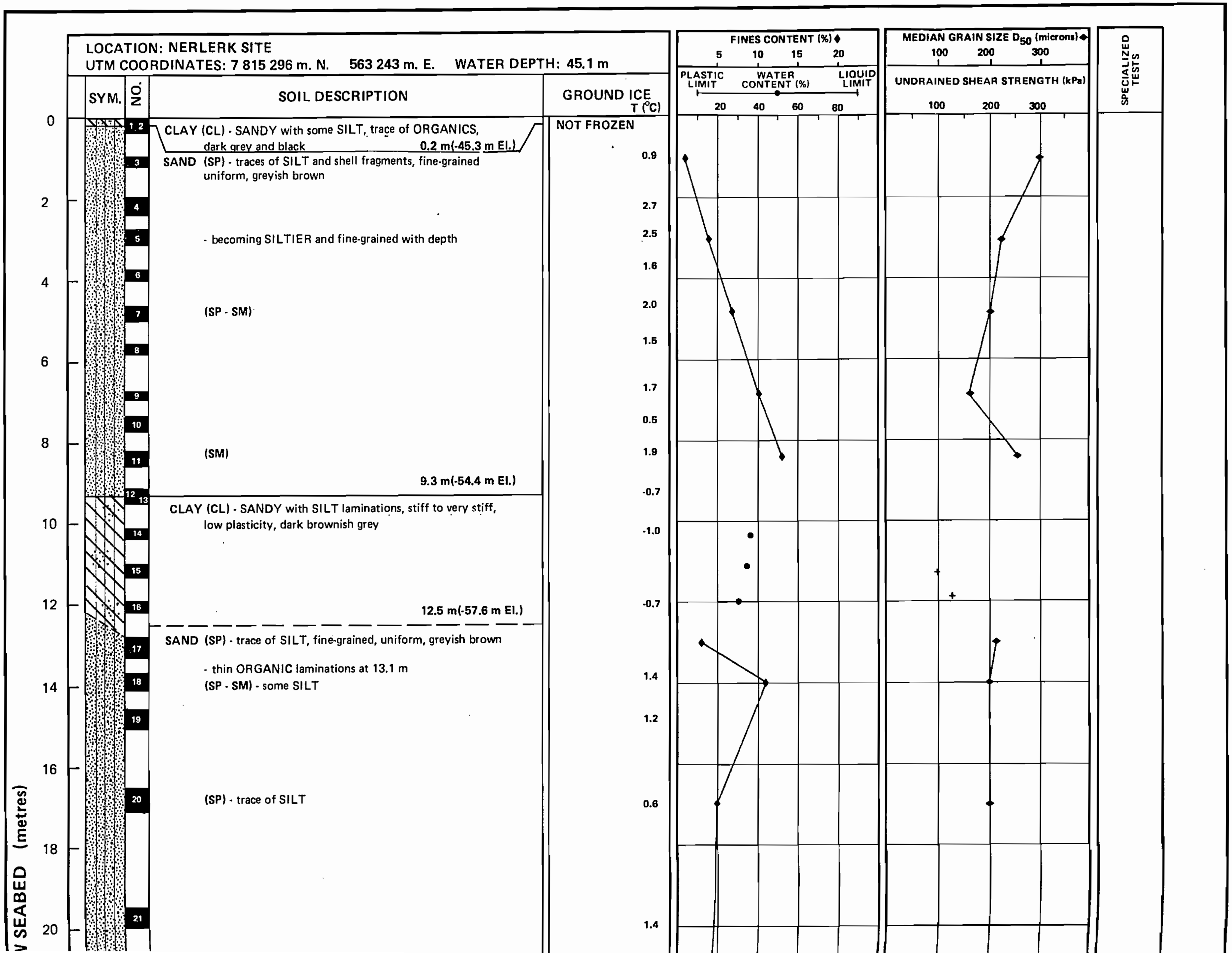
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:1

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 296 m. N.   563 243 m. E.   WATER DEPTH: 45.1 m



CLAY (CL) - SANDY with some SILT, trace of ORGANICS,
dark grey and black   0.2 m(-45.3 m El.)

SAND (SP) - traces of SILT and shell fragments, fine-grained
uniform, greyish brown

- becoming SILTIER and fine-grained with depth

(SP - SM)

(SM)

9.3 m(-54.4 m El.)

CLAY (CL) - SANDY with SILT laminations, stiff to very stiff,
low plasticity, dark brownish grey

12.5 m(-57.6 m El.)

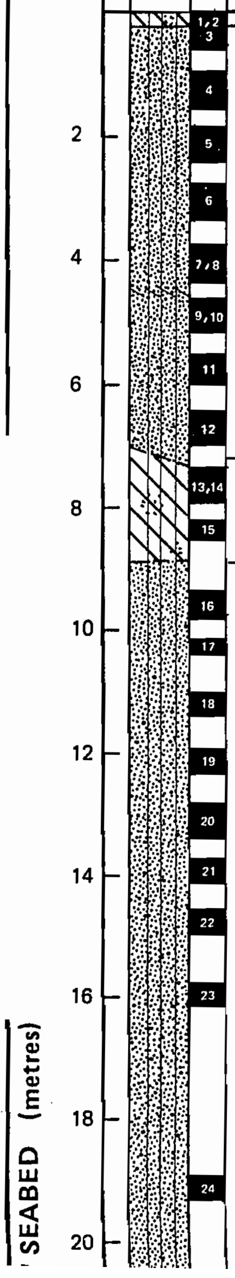
SAND (SP) - trace of SILT, fine-grained, uniform, greyish brown

- thin ORGANIC laminations at 13.1 m

(SP - SM) - some SILT

(SP) - trace of SILT

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 498 m. N. 563 001 m. E. WATER DEPTH: 45.4 m



SOIL DESCRIPTION

CLAY (CL) - SILTY, with some SAND, trace of ORGANICS
soft, low plasticity, dark greyish black **0.2 m(-45.6 m El.)**

SAND (SP) - traces of SILT and shell fragments, fine-grained,
uniform, dark greyish brown

(SP - SM) - thin ORGANIC laminations

(SM) - SILTY with some thin ORGANIC laminations,
dark grey

(SP - SM) - trace of SILT, greyish brown
- 220 mm thick (estimated) layer of SILTY CLAY at 4.5 m
- trace of SILT, greyish brown

(SM) - SILTY, dark greyish brown **7.2 m(-52.6 m El.)**

CLAY (CL) - and SILT, trace of SAND, firm, low plasticity,
dark brownish grey

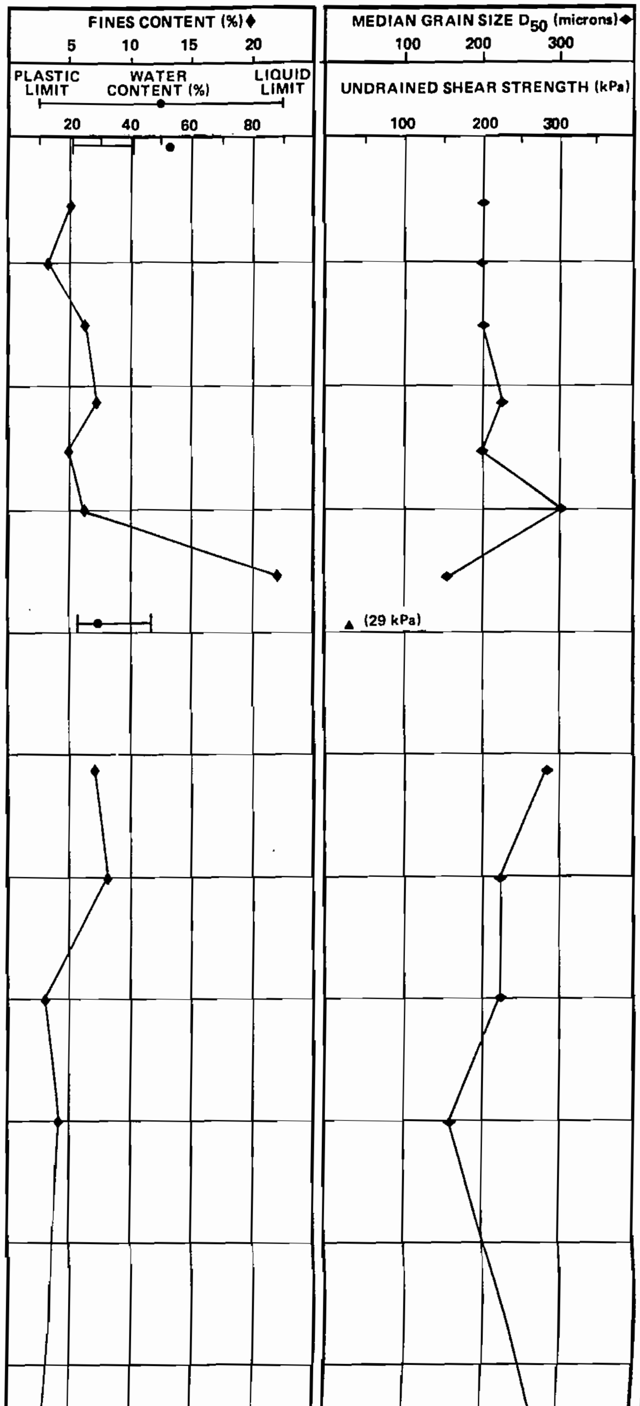
8.9 m(-54.3 m El.)

SAND (SP - SM) - trace of SILT, fine-grained, uniform
greyish brown

(SP)

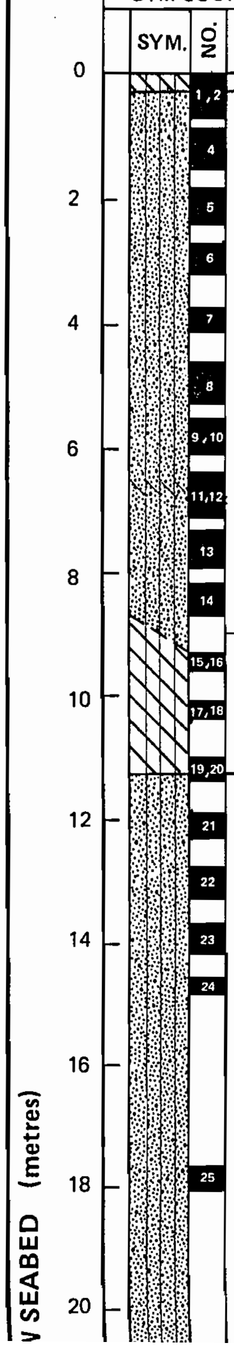
GROUND ICE
T (°C)

NOT FROZEN
1.0
0.6
1.1
1.1
1.8
1.7
0.9
-0.3
1.0
0.7
0.8
1.3
0.4
1.1
0.7
0.9



SPECIALIZED TESTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 700 m. N. 562 596 m. E. WATER DEPTH: 45.1 m



SOIL DESCRIPTION

CLAY (CH) - SILTY with some SAND, laminated, very soft to soft, high plasticity, dark grey

0.3 m(-45.4 m El.)

SAND (SP) - traces of SILT and ORGANICS, laminated, fine-grained, uniform, greyish brown

(SP - SM)

(SP)

(SP - SM)

- thin ORGANIC laminations with rootlets, black

(SM) - some SILT and ORGANICS with rootlets
- 5 mm thick CLAY layer at 6.6 m

(SP) - trace of SILT

9.0 m(-54.1 m El.)

CLAY (CL) - and SILT, very thin to thin laminations, very stiff, low plasticity, dark brownish grey

11.3 m(-56.4 m El.)

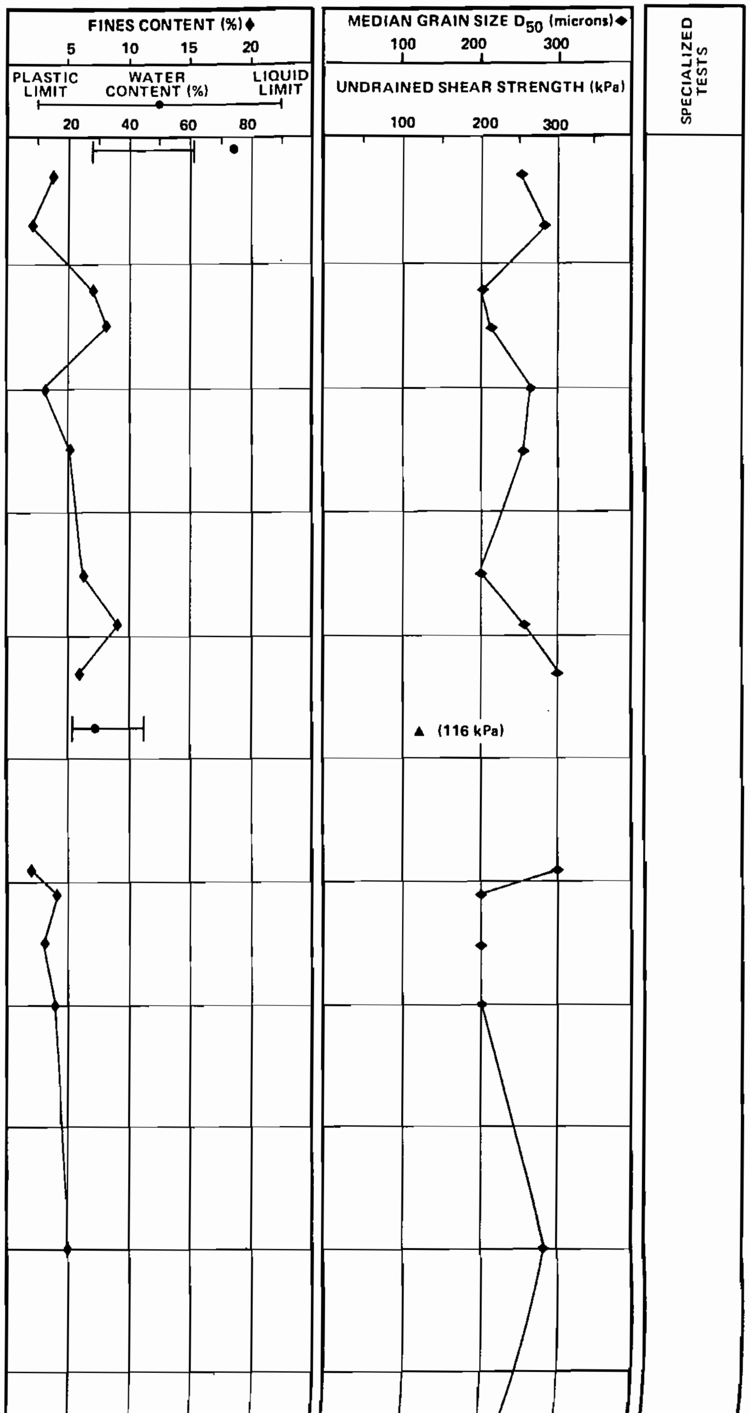
SAND (SP) - trace of SILT, fine-grained, uniform, greyish brown

- trace of coal detritus and mica flakes
- 3 mm thick coal detritus layers every 50 mm throughout sample

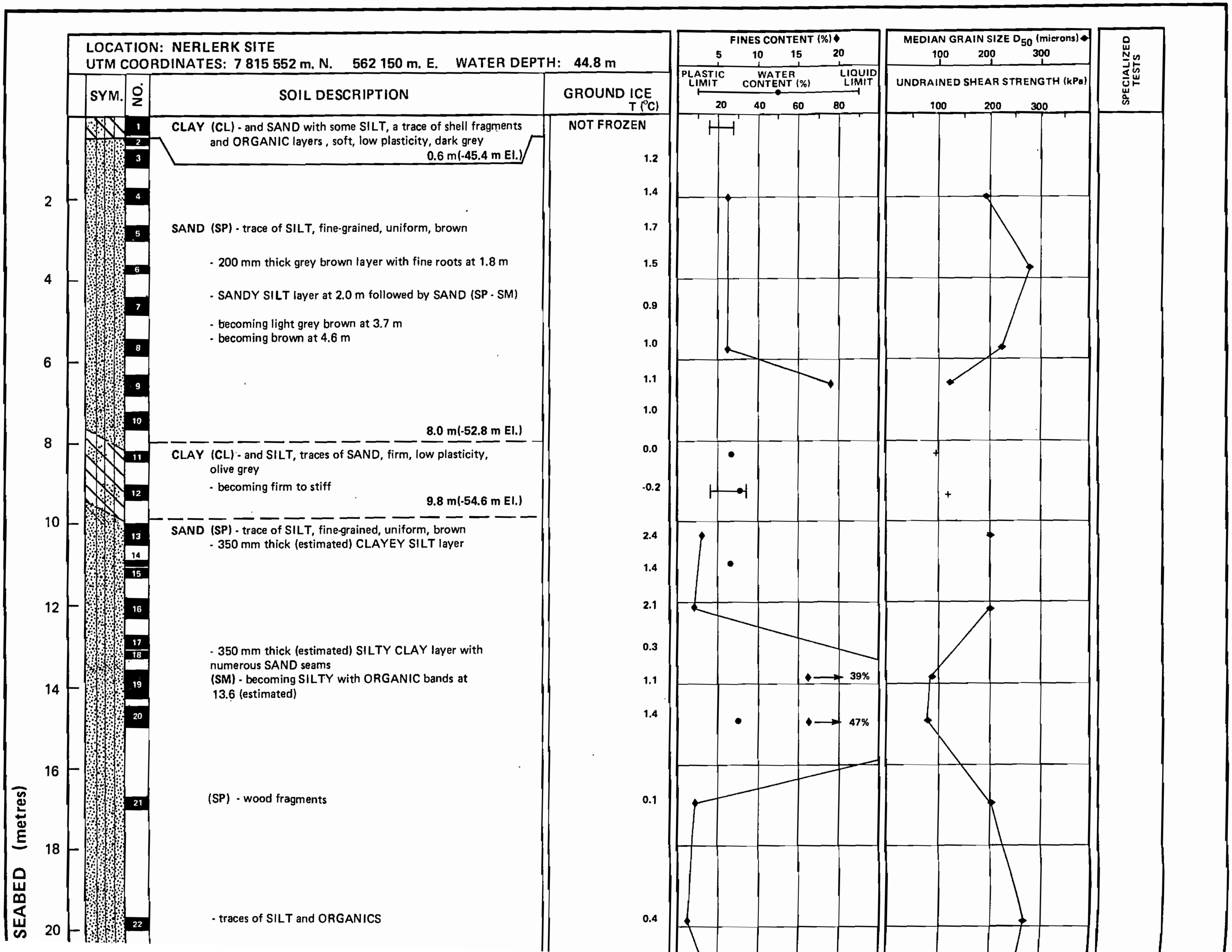
(SP - SM)

GROUND ICE
T (°C)

NOT FROZEN
0.9
1.0
1.0
1.4
0.6
1.3
0.7
0.8
1.6
-0.4
-0.3
1.4
1.5
1.5
1.8
1.5
1.8



LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 552 m. N. 562 150 m. E. WATER DEPTH: 44.8 m



SOIL DESCRIPTION

CLAY (CL) - and SAND with some SILT, a trace of shell fragments and ORGANIC layers, soft, low plasticity, dark grey

0.6 m(-45.4 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, brown

- 200 mm thick grey brown layer with fine roots at 1.8 m
- SANDY SILT layer at 2.0 m followed by SAND (SP - SM)
- becoming light grey brown at 3.7 m
- becoming brown at 4.6 m

8.0 m(-52.8 m El.)

CLAY (CL) - and SILT, traces of SAND, firm, low plasticity, olive grey

- becoming firm to stiff

9.8 m(-54.6 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, brown

- 350 mm thick (estimated) CLAYEY SILT layer
- 350 mm thick (estimated) SILTY CLAY layer with numerous SAND seams

(SM) - becoming SILTY with ORGANIC bands at 13.6 (estimated)

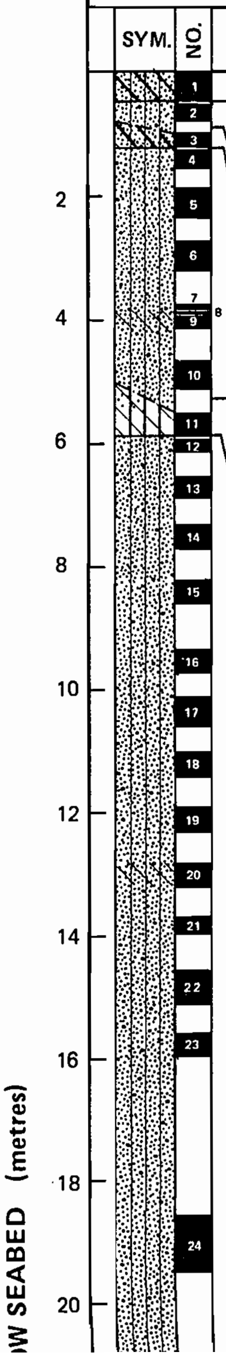
(SP) - wood fragments

- traces of SILT and ORGANICS

GROUND ICE
T (°C)

NOT FROZEN
1.2
1.4
1.7
1.5
0.9
1.0
1.1
1.0
0.0
-0.2
2.4
1.4
2.1
0.3
1.1
1.4
0.1
0.4

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 842 m. N. 561 552 m. E. WATER DEPTH: 45.1 m



SOIL DESCRIPTION

SAND (SC) - CLAYEY, some SILT, trace ORGANICS, fine-grained, firm, low plasticity, dark grey
0.5 m(-45.6 m El.)

SAND (SP) - traces of SILT and shell fragments, fine-grained, uniform, brown
0.9 m(-46.0 m El.)

SAND (SC) - CLAYEY, some SILT, fine-grained, firm, low plasticity, dark grey
1.2 m(-46.3 m El.)

SAND (SP) - traces of SILT and shell fragments, fine-grained, uniform, brown
(SM) - some SILT below 1.7 m (estimated)
- 2 mm thick SILT layer at 2.2 m
(SP - SM) - trace of SILT below 2.7 m
- thinly bedded SAND and SILT below 3.4 m (estimated)
- 100 mm thick SILT and CLAY (CL) layer at 4.0 m
(SP) - trace of SILT below 4.35 m (estimated)
5.3 m(-50.4 m El.)

SILT (ML) - some SAND, trace of CLAY, dense, dark grey brown, 50 mm thick ORGANIC-rich bed at 5.6 m (estimated)
5.9 m(-51.0 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform brown

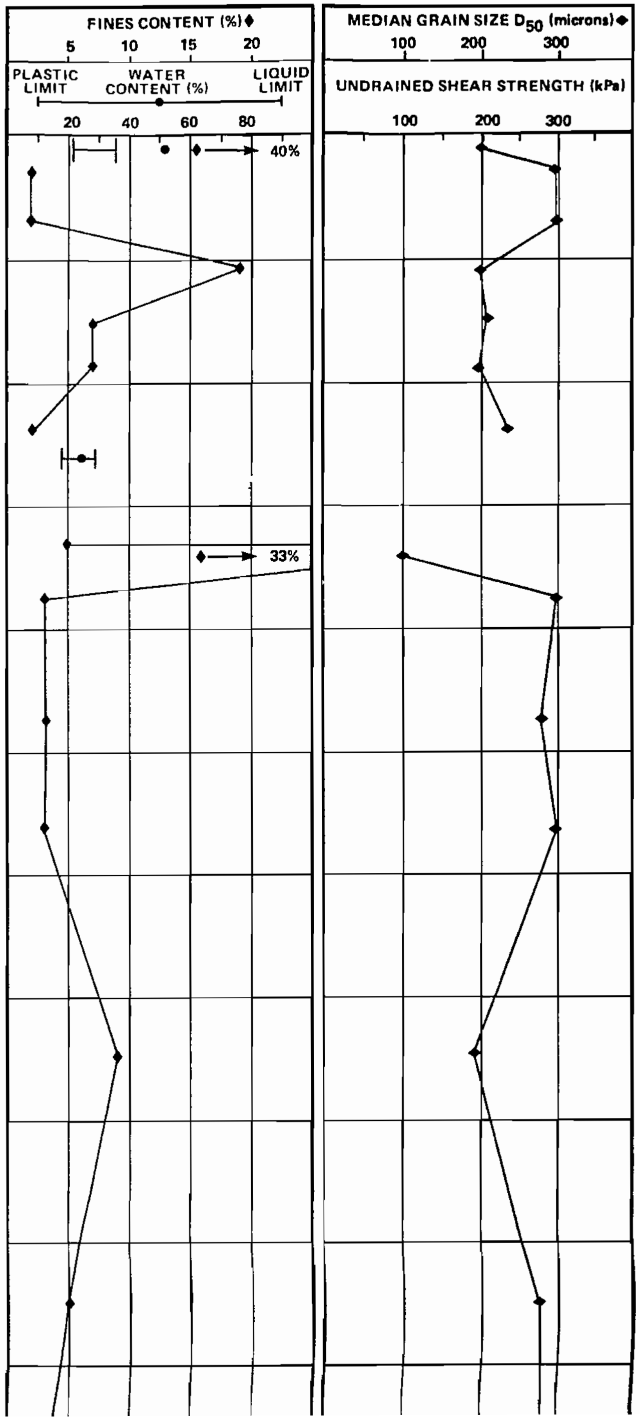
- 150 mm thick SILTY (SM) layer at 6.6 m

- CLAY lens at 13 m

GROUND ICE
T (°C)

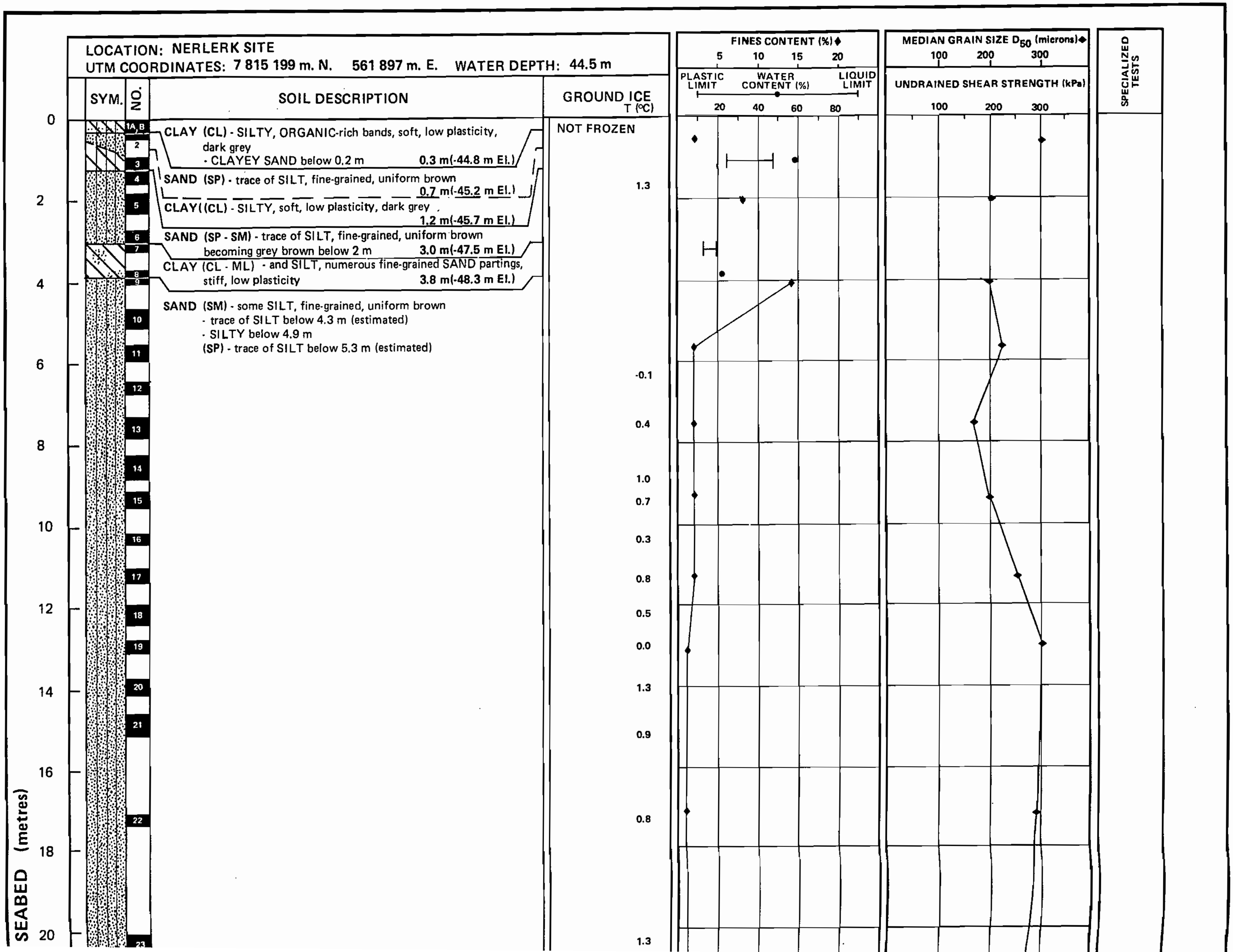
NOT FROZEN

0.4
0.0
0.2
0.7
1.3
1.7
1.0
0.8
2.3
1.7
2.6



SPECIALIZED TESTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 199 m. N.   561 897 m. E.   WATER DEPTH: 44.5 m

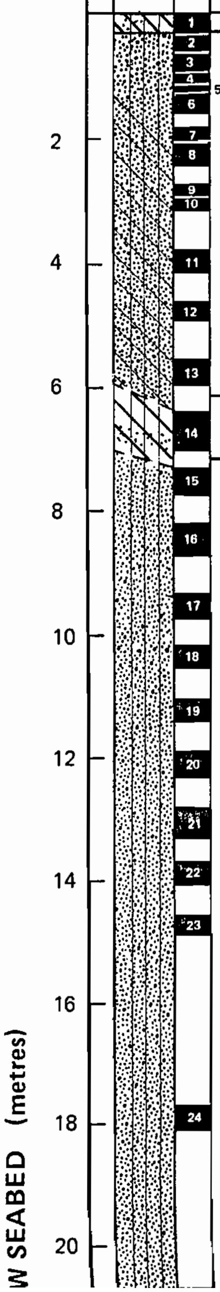


SOIL DESCRIPTION	
CLAY (CL) - SILTY, ORGANIC-rich bands, soft, low plasticity, dark grey - CLAYEY SAND below 0.2 m	0.3 m(-44.8 m El.)
SAND (SP) - trace of SILT, fine-grained, uniform brown	0.7 m(-45.2 m El.)
CLAY((CL) - SILTY, soft, low plasticity, dark grey	1.2 m(-45.7 m El.)
SAND (SP - SM) - trace of SILT, fine-grained, uniform brown becoming grey brown below 2 m	3.0 m(-47.5 m El.)
CLAY (CL - ML) - and SILT, numerous fine-grained SAND partings, stiff, low plasticity	3.8 m(-48.3 m El.)
SAND (SM) - some SILT, fine-grained, uniform brown - trace of SILT below 4.3 m (estimated) - SILTY below 4.9 m (SP) - trace of SILT below 5.3 m (estimated)	

GROUND ICE
T (°C)

NOT FROZEN
1.3
-0.1
0.4
1.0
0.7
0.3
0.8
0.5
0.0
1.3
0.9
0.8
1.3

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 794 m N. 561 887 m E. WATER DEPTH: 45.4 m



SOIL DESCRIPTION

CLAY (CL) - **SILTY, SANDY**, very soft, low plasticity, dark grey
0.4 m(-45.8 m El.) .)

SAND (SP) - traces of **SILT** and shell fragments, fine-grained, uniform, dark grey
(SM) - some SILT below 0.6 m
(SP - SM) - trace SILT below 1.0 m
(SM) - some SILT to SILTY, trace of CLAY below 1.2 m
(SP - SM) - trace of SILT with fine roots below 1.7 m (estimated), black
(SP) - trace of SILT below 2.1 m
- some SILT with fine roots and ORGANIC-rich beds below 2.45 m
(SP - SM) - trace of SILT, below 2.9 m, brown
(SP) - below 3.4 m (estimated)
(SP - SM) - below 4.35 m (estimated)
(SP) - below 6.15 m (estimated) 6.1 m(-51.5 m El.)

CLAY (CL) - and **SILT**, some **SAND**, stiff, low plasticity, grey brown
- **SAND** seam at 6.6 m
7.2 m(-52.6 m El.)

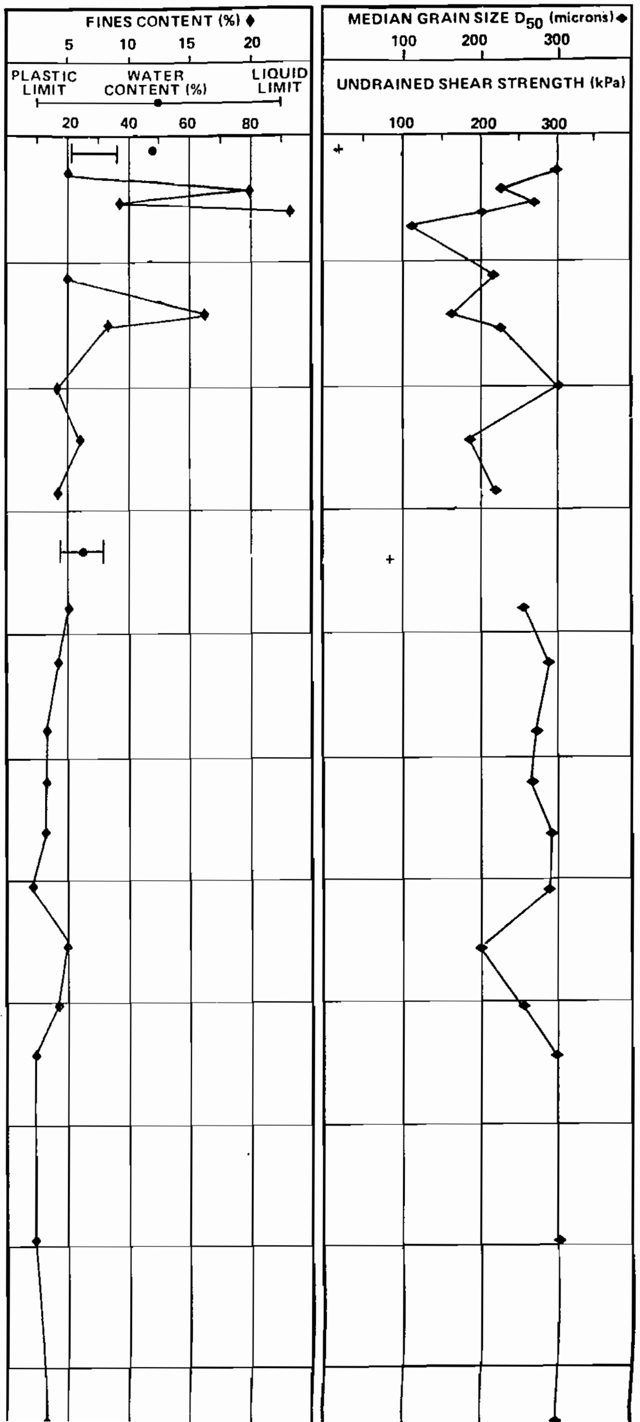
SAND (SP) - trace of **SILT**, fine-grained, uniform, brown
(SP - SM) - below 7.5 m
(SP) - below 7.95 m

(SP - SM)

(SP)

GROUND ICE
T (°C)

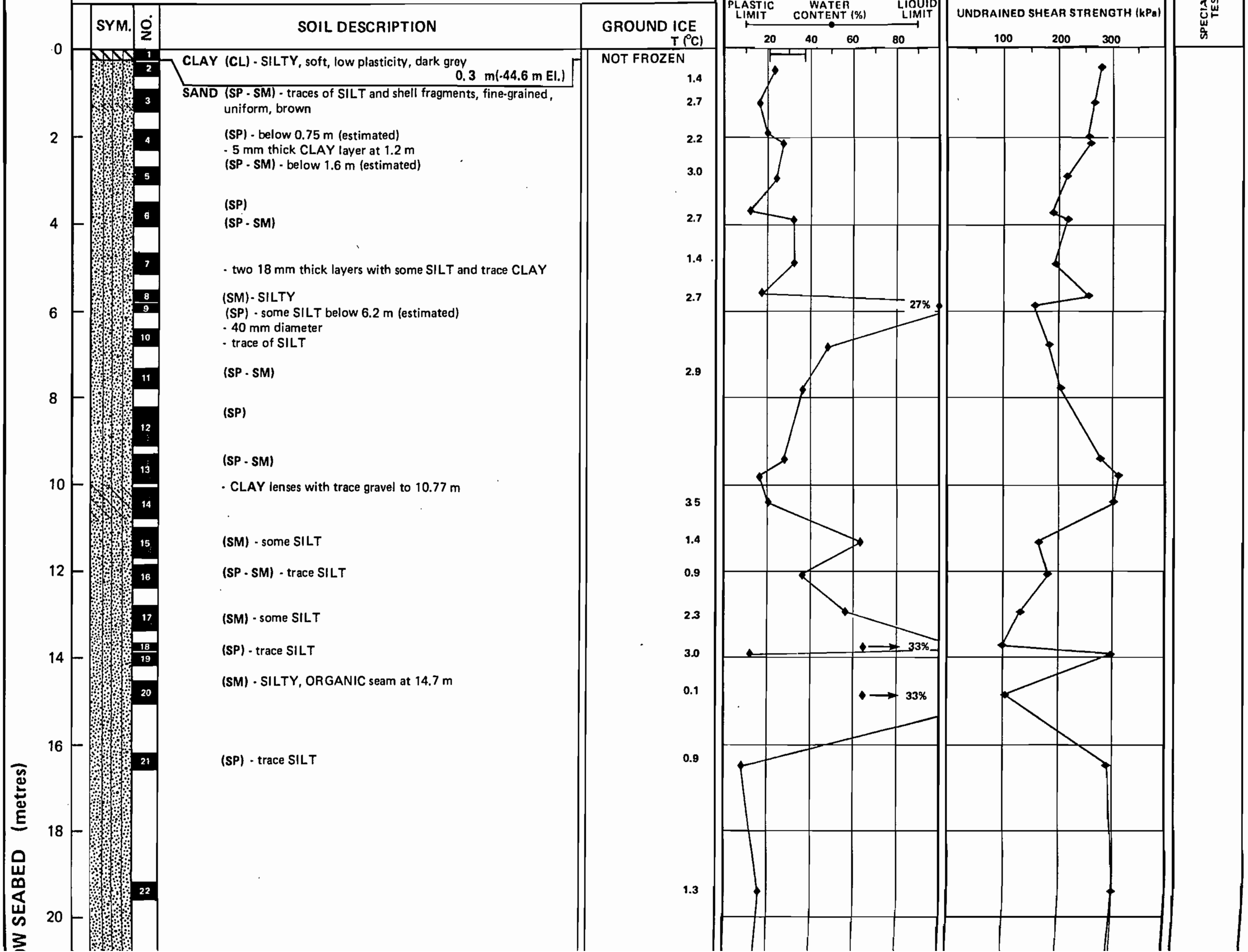
NOT FROZEN
1.5
1.3
1.8
1.5
1.9
1.9
2.0
0.3
0.5
2.2
1.9
2.3
2.8
1.7
2.1
3.1
2.8
1.9
3.0



SPECIALIZED TESTS

LOCATION: NERLERK SITE

UTM COORDINATES: 7 814 987 m. N. 562 037 m. E. WATER DEPTH: 44.3 m



CLAY (CL) - SILTY, soft, low plasticity, dark grey

0.3 m(-44.6 m El.)

SAND (SP - SM) - traces of SILT and shell fragments, fine-grained, uniform, brown

(SP) - below 0.75 m (estimated)

- 5 mm thick CLAY layer at 1.2 m

(SP - SM) - below 1.6 m (estimated)

(SP)

(SP - SM)

- two 18 mm thick layers with some SILT and trace CLAY

(SM) - SILTY

(SP) - some SILT below 6.2 m (estimated)

- 40 mm diameter

- trace of SILT

(SP - SM)

(SP)

(SP - SM)

- CLAY lenses with trace gravel to 10.77 m

(SM) - some SILT

(SP - SM) - trace SILT

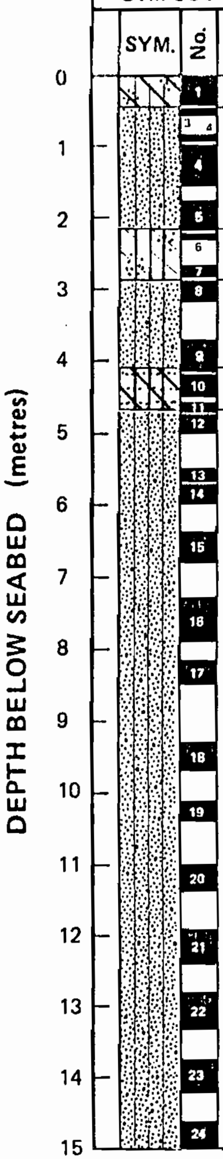
(SM) - some SILT

(SP) - trace SILT

(SM) - SILTY, ORGANIC seam at 14.7 m

(SP) - trace SILT

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 377 m N. 561 771 m E. WATER DEPTH: 45.4 m



SOIL DESCRIPTION

CLAY (CL) - and SILT, some SAND, soft, low plasticity, dark grey
0.5 m(-45.9 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, brown
2.2 m(-47.6 m El.)

SILT (ML) - SANDY, trace of CLAY, dense, brown
2.95 m(-48.4 m El.)

SAND (SP) - some SILT, fine-grained, uniform, brown
(SP - SM)
4.2 m(-49.6 m El.)

CLAY (CL - ML) and SILT - 20 mm beds of SAND spaced 100 mm apart, firm, dark grey
4.7 m(-50.1 m El.)

SAND (SM) - some SILT, fine-grained, uniform, brown
- 450 mm thick (estimated) SILT layer at 5.25 m, trace of SAND, dark grey
(SP) - trace of SILT below 5.7 m

(SP - SM)

(SP)

(Note: Thicknesses of stratigraphic units in first four metres below seabed may be erroneous due to excessive sea swell.)

(SP - SM)

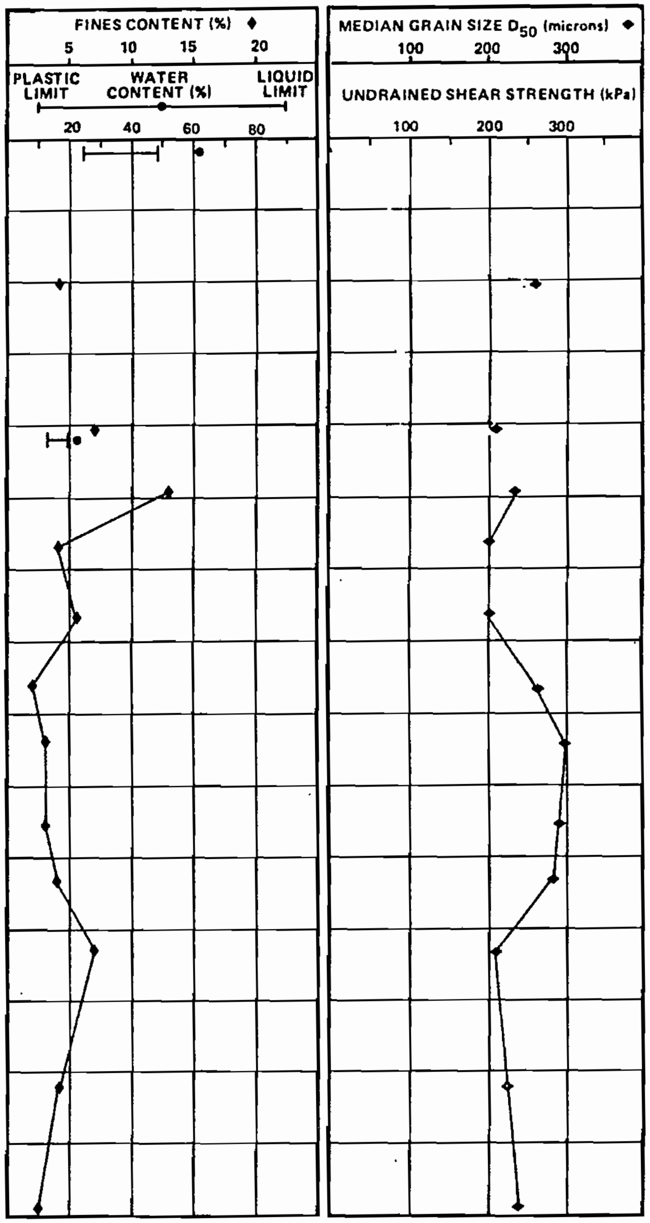
(SP)

Borehole was terminated at 15.1 metres because of rough seas

END OF BOREHOLE 15.1 m(-60.5 m El.)

GROUND ICE
T (°C)

NOT FROZEN
1.6
1.8
2.7
1.7
1.8
0.3
2.9
2.1
2.8
1.6
2.3
1.0
2.3
2.7
2.3
3.8



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/09/04
BOREHOLE DEPTH: 15.1 m(-60.5 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/BR

LEGEND

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
♦ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

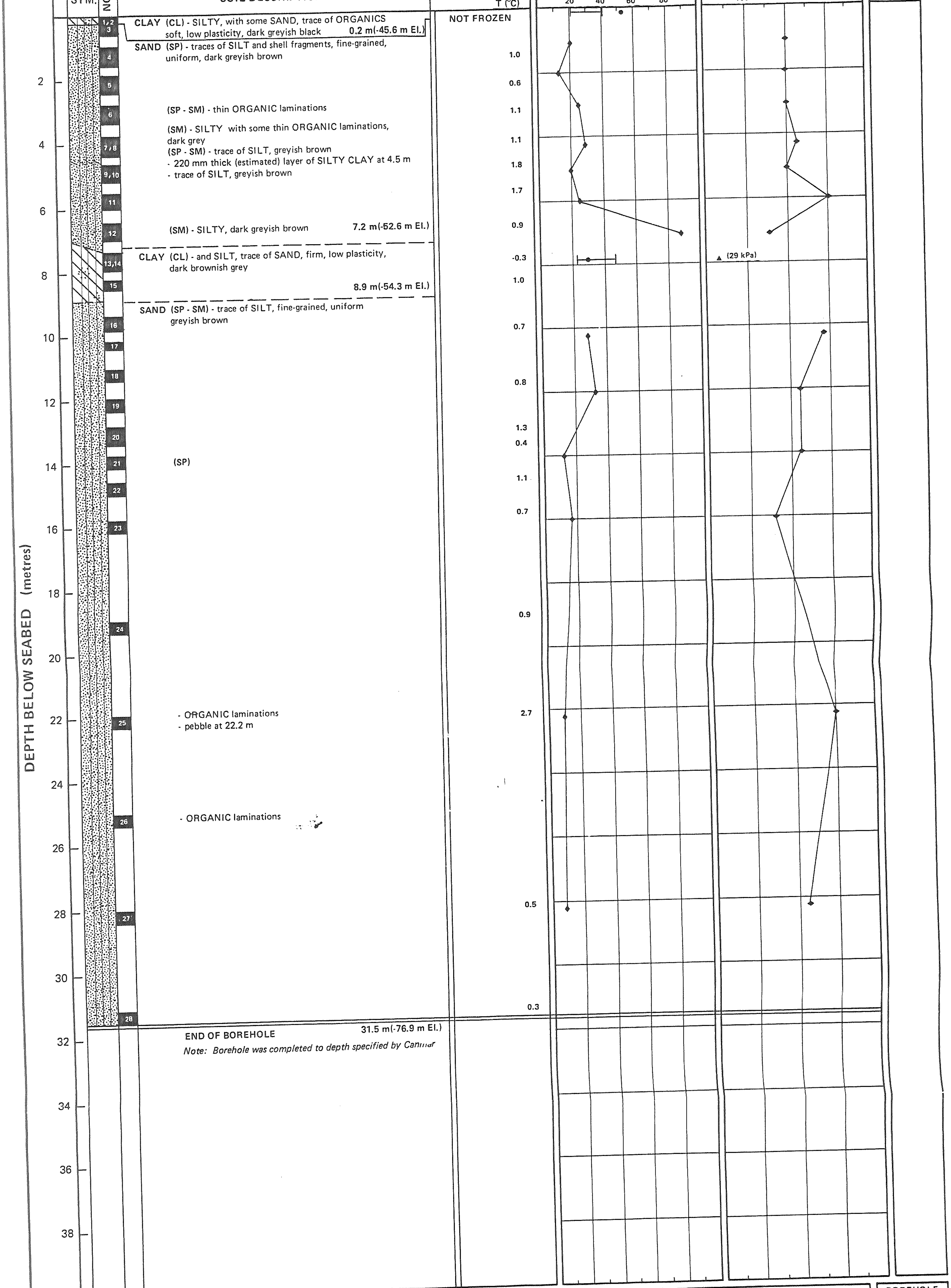
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:9

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 498 m. N. 563 001 m. E. WATER DEPTH: 45.4 m



SOIL DESCRIPTION

CLAY (CL) - SILTY, with some SAND, trace of ORGANICS
soft, low plasticity, dark greyish black 0.2 m(-45.6 m El.)

SAND (SP) - traces of SILT and shell fragments, fine-grained, uniform, dark greyish brown

(SP - SM) - thin ORGANIC laminations

(SM) - SILTY with some thin ORGANIC laminations, dark grey

(SP - SM) - trace of SILT, greyish brown

- 220 mm thick (estimated) layer of SILTY CLAY at 4.5 m

- trace of SILT, greyish brown

(SM) - SILTY, dark greyish brown 7.2 m(-52.6 m El.)

CLAY (CL) - and SILT, trace of SAND, firm, low plasticity, dark brownish grey

8.9 m(-54.3 m El.)

SAND (SP - SM) - trace of SILT, fine-grained, uniform greyish brown

(SP)

- ORGANIC laminations
- pebble at 22.2 m

- ORGANIC laminations

END OF BOREHOLE 31.5 m(-76.9 m El.)

Note: Borehole was completed to depth specified by Canmar

eba

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/26
BOREHOLE DEPTH: 31.5 m(-76.9 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/BR

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

LEGEND

SHEAR STRENGTH
+ Torvane
× Min. Vane
● Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

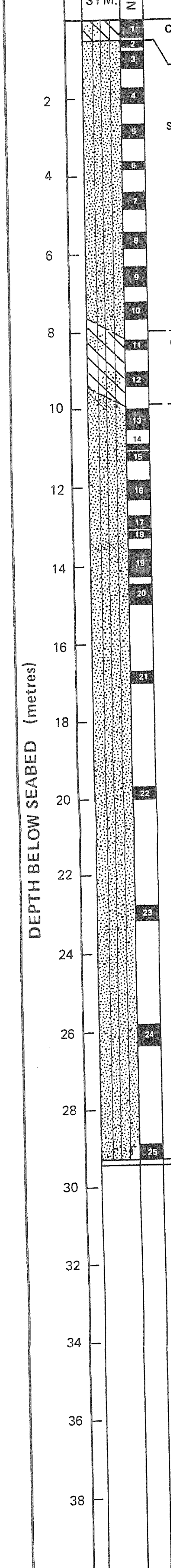
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:2

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 552 m. N. 562 150 m. E. WATER DEPTH: 44.8 m



SOIL DESCRIPTION

CLAY (CL) - and SAND with some SILT, a trace of shell fragments and ORGANIC layers, soft, low plasticity, dark grey
0.6 m(-45.4 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, brown
- 200 mm thick grey brown layer with fine roots at 1.8 m
- SANDY SILT layer at 2.0 m followed by SAND (SP - SM)
- becoming light grey brown at 3.7 m
- becoming brown at 4.6 m

8.0 m(-52.8 m El.)

CLAY (CL) - and SILT, traces of SAND, firm, low plasticity, olive grey
- becoming firm to stiff

9.8 m(-54.6 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, brown
- 350 mm thick (estimated) CLAYEY SILT layer

- 350 mm thick (estimated) SILTY CLAY layer with numerous SAND seams
(SM) - becoming SILTY with ORGANIC bands at 13.6 (estimated)

(SP) - wood fragments

- traces of SILT and ORGANICS

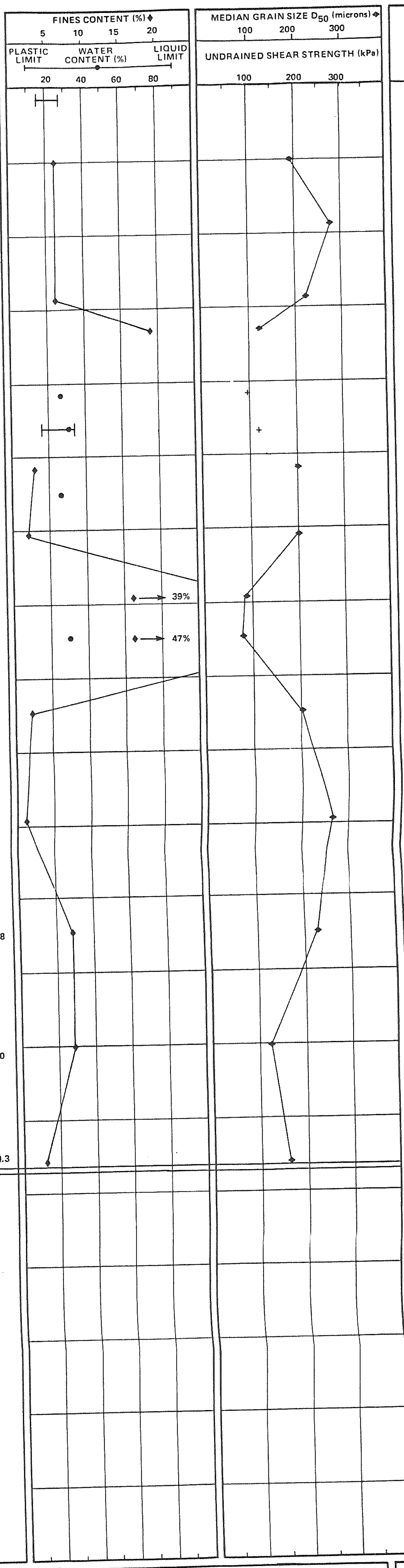
(SP - SM)

(SP)

END OF BOREHOLE 29.4 m(-74.2 m El.)

Note: Borehole completed to depth specified by Canmar

GROUND ICE
T (°C)
NOT FROZEN
1.2
1.4
1.7
1.5
0.9
1.0
1.1
1.0
0.0
-0.2
2.4
1.4
2.1
0.3
1.1
1.4
0.1
0.4
-0.8
0.0
-0.3



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/28
BOREHOLE DEPTH: 29.4 m(-74.2 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: BR/DY

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

LEGEND

SHEAR STRENGTH
+ Torvane
× Min. Vane
• Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

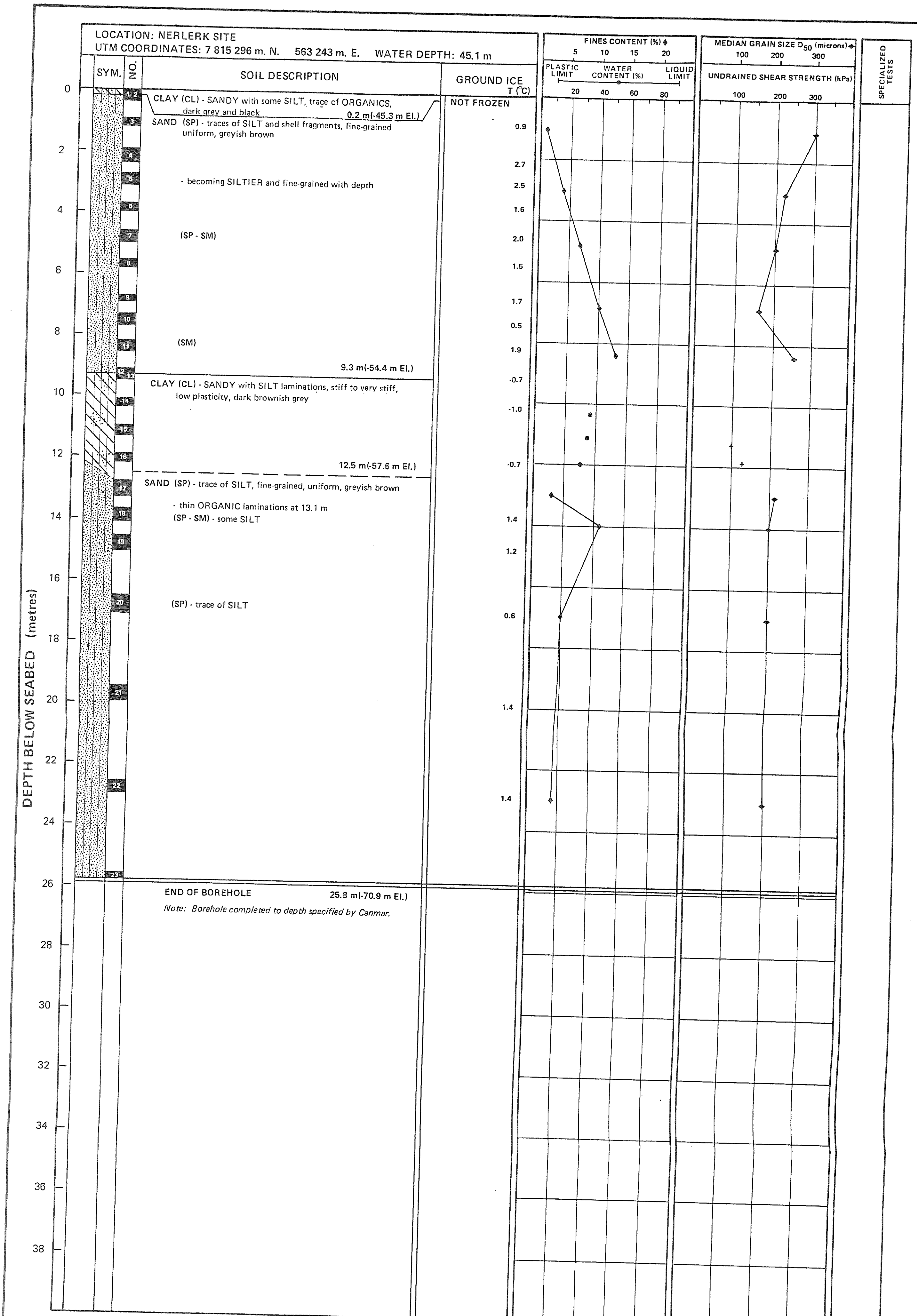
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:4

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 296 m. N. 563 243 m. E. WATER DEPTH: 45.1 m



JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/25
BOREHOLE DEPTH: 25.8 m(-70.9 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: DDY/BR

SOIL SYMBOLS

▨	▥	▧
SAND	SILT	CLAY

LEGEND

SHEAR STRENGTH
- \+ Torvane
- × Min. Vane
- ◆ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:1B

PAGE 1 OF 1

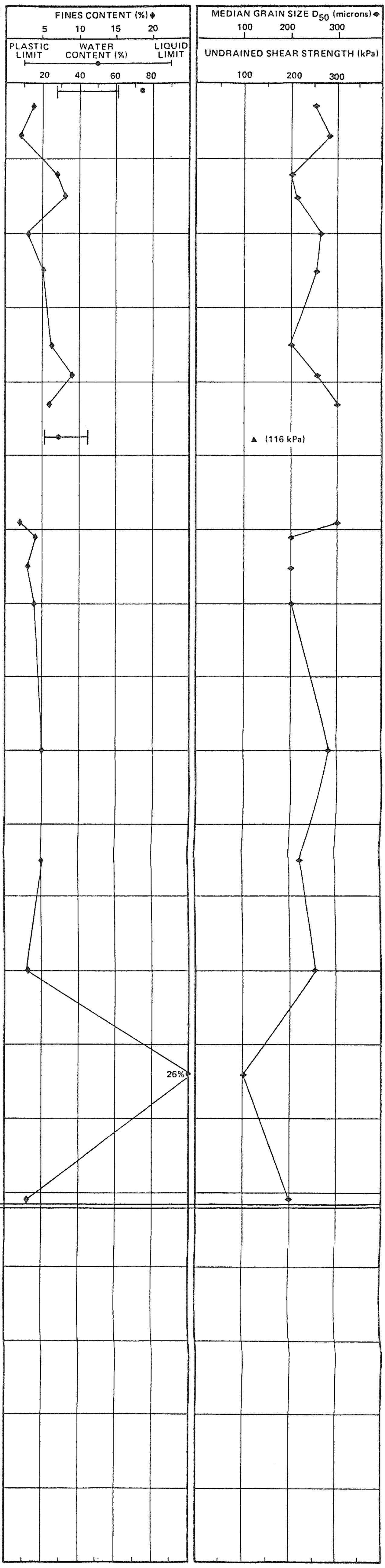
BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 700 m. N. 562 596 m. E. WATER DEPTH: 45.1 m

SYM.	NO.	SOIL DESCRIPTION	GROUND ICE T (°C)
	1,2	CLAY (CH) - SILTY with some SAND, laminated, very soft to soft, high plasticity, dark grey 0.3 m(-45.4 m El.)	NOT FROZEN 0.9
	4	SAND (SP) - traces of SILT and ORGANICS, laminated, fine-grained, uniform, greyish brown	1.0
	5	(SP - SM)	1.0
	6		1.4
	7	(SP)	0.6
	8	(SP - SM)	1.3
	9,10	- thin ORGANIC laminations with rootlets, black	0.7
	11,12	(SM) - some SILT and ORGANICS with rootlets - 5 mm thick CLAY layer at 6.6 m (SP) - trace of SILT	
	13		0.8
	14	9.0 m(-54.1 m El.)	1.6
	15,16	CLAY (CL) - and SILT, very thin to thin laminations, very stiff, low plasticity, dark brownish grey	-0.4
	17,18		-0.3
	19,20	11.3 m(-56.4 m El.)	1.4
	21	SAND (SP) - trace of SILT, fine-grained, uniform, greyish brown	1.5
	22	- trace of coal detritus and mica flakes	1.5
	23	- 3 mm thick coal detritus layers every 50 mm throughout sample	1.8
	24		1.5
	25	(SP - SM)	1.8
	26		2.3
	27		1.8
	28,29 30	(SM) - SILTY, dark greyish brown at 27.0 m (SP) - trace of SILT, greyish brown at 27.1 m	0.8
	31		
		END OF BOREHOLE 30.3 m(-75.4 m El.) *Note: Borehole was completed to depth specified by Canmar*	

DEPTH BELOW SEABED (metres)

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/27
BOREHOLE DEPTH: 30.3 m(-75.4 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/BR

SOIL SYMBOLS
SAND SILT CLAY

LEGEND

SHEAR STRENGTH
+ Torvane ● Fall Cone
× Min. Vane ▲ UU Triaxial
◆ Pilcon Vane ■ CU Triaxial
○ Halibut Vane

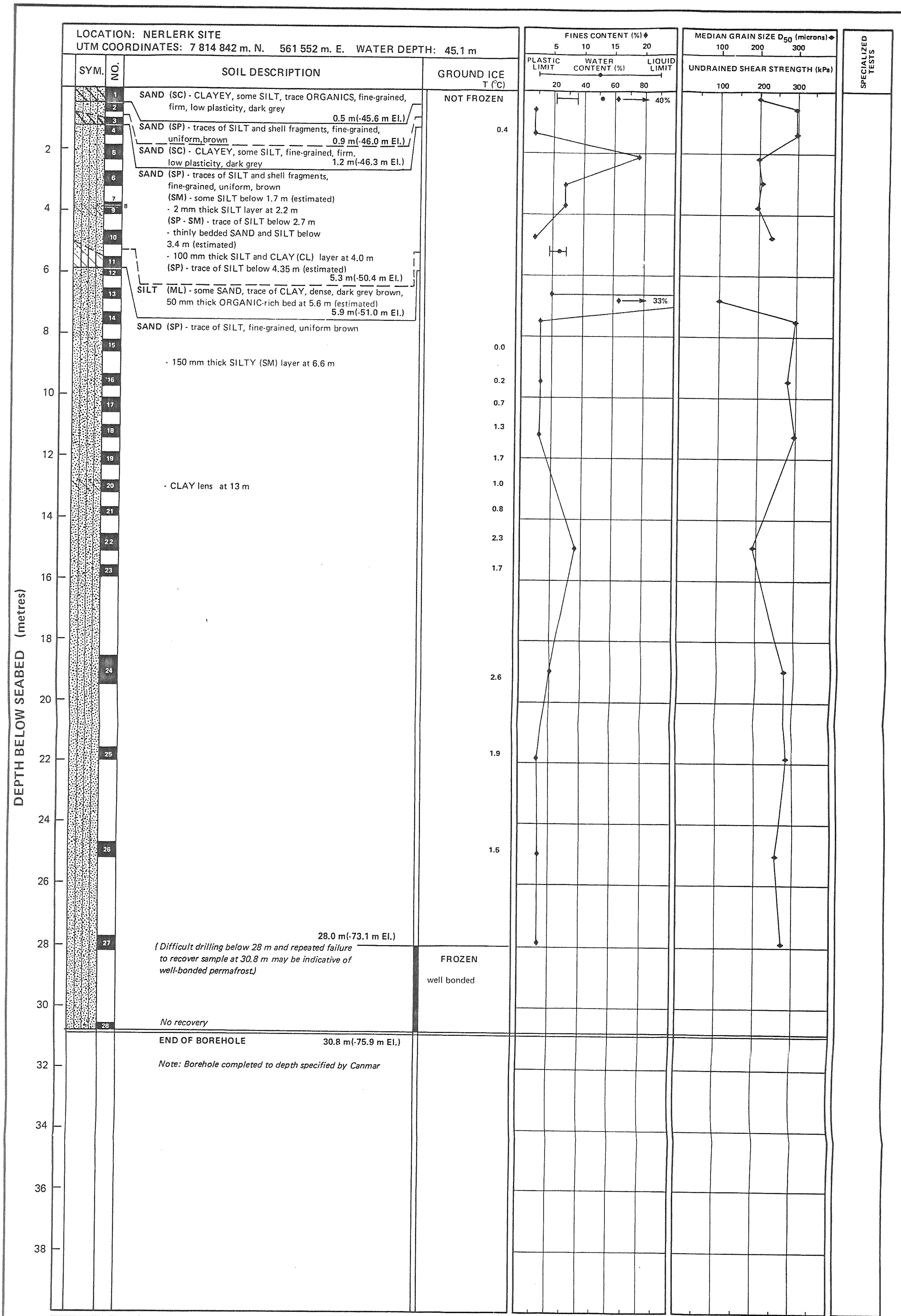
TEST IDENTIFICATION
C - Consolidation T - Triaxial Shear
DS - Direct Shear S - P.W. Salinity
TD - TDR G - Gas Analysis
Ca - Calorimetry

BOREHOLE NUMBER
B-NER 3:3

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 842 m. N. 561 552 m. E. WATER DEPTH: 45.1 m



SAND (SC) - CLAYEY, some SILT, trace ORGANICS, fine-grained, firm, low plasticity, dark grey
0.5 m(-45.6 m El.)

SAND (SP) - traces of SILT and shell fragments, fine-grained, uniform, brown
0.9 m(-46.0 m El.)

SAND (SC) - CLAYEY, some SILT, fine-grained, firm, low plasticity, dark grey
1.2 m(-46.3 m El.)

SAND (SP) - traces of SILT and shell fragments, fine-grained, uniform, brown
(SM) - some SILT below 1.7 m (estimated)
- 2 mm thick SILT layer at 2.2 m
(SP - SM) - trace of SILT below 2.7 m
- thinly bedded SAND and SILT below 3.4 m (estimated)
- 100 mm thick SILT and CLAY (CL) layer at 4.0 m
(SP) - trace of SILT below 4.35 m (estimated)
5.3 m(-50.4 m El.)

SILT (ML) - some SAND, trace of CLAY, dense, dark grey brown, 50 mm thick ORGANIC-rich bed at 5.6 m (estimated)
5.9 m(-51.0 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform brown

- 150 mm thick SILTY (SM) layer at 6.6 m

- CLAY lens at 13 m

28.0 m(-73.1 m El.)

(Difficult drilling below 28 m and repeated failure to recover sample at 30.8 m may be indicative of well-bonded permafrost.)

No recovery

END OF BOREHOLE 30.8 m(-75.9 m El.)

Note: Borehole completed to depth specified by Canmar

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/28
BOREHOLE DEPTH: 30.8 m(-75.9 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/DJ

LEGEND

SOIL SYMBOLS

▨	▥	▧
SAND	SILT	CLAY

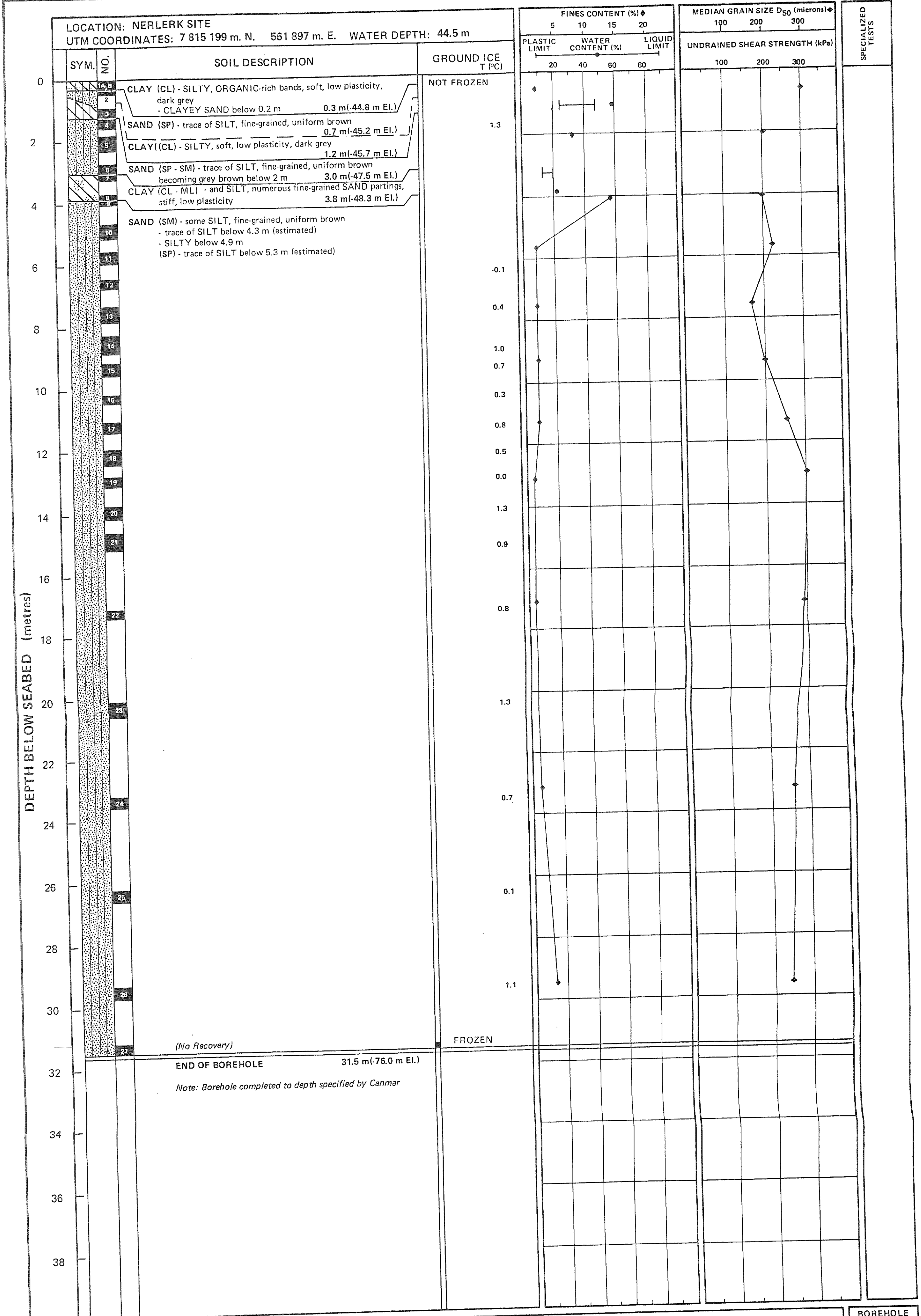
SHEAR STRENGTH
+ Torvane
× Min. Vane
• Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:5
PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 199 m. N.   561 897 m. E.   WATER DEPTH: 44.5 m



SOIL DESCRIPTION

CLAY (CL) - SILTY, ORGANIC-rich bands, soft, low plasticity, dark grey
- CLAYEY SAND below 0.2 m   0.3 m(-44.8 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform brown
0.7 m(-45.2 m El.)

CLAY((CL) - SILTY, soft, low plasticity, dark grey
1.2 m(-45.7 m El.)

SAND (SP - SM) - trace of SILT, fine-grained, uniform brown becoming grey brown below 2 m   3.0 m(-47.5 m El.)

CLAY (CL - ML) - and SILT, numerous fine-grained SAND partings, stiff, low plasticity   3.8 m(-48.3 m El.)

SAND (SM) - some SILT, fine-grained, uniform brown
- trace of SILT below 4.3 m (estimated)
- SILTY below 4.9 m
(SP) - trace of SILT below 5.3 m (estimated)

(No Recovery)

END OF BOREHOLE   31.5 m(-76.0 m El.)

Note: Borehole completed to depth specified by Canmar

GROUND ICE
T (°C)

NOT FROZEN

1.3

-0.1

0.4

1.0

0.7

0.3

0.8

0.5

0.0

1.3

0.9

0.8

1.3

0.7

0.1

1.1

FROZEN

eba

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/29
BOREHOLE DEPTH: 31.5 m(-76.0 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: BR/DY

LEGEND

SOIL SYMBOLS
SAND   SILT   CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
◆ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

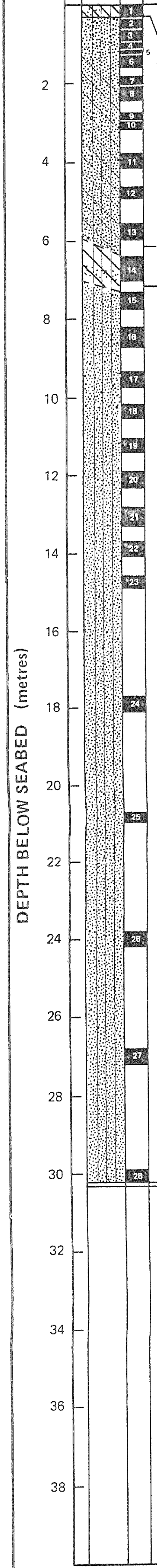
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:6

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 794 m N. 561 887 m E. WATER DEPTH: 45.4 m



SOIL DESCRIPTION

CLAY (CL) - SILTY, SANDY, very soft, low plasticity, dark grey 0.4 m(-45.8 m El.) .)

SAND (SP) - traces of SILT and shell fragments, fine-grained, uniform, dark grey
(SM) - some SILT below 0.6 m
(SP - SM) - trace SILT below 1.0 m
(SM) - some SILT to SILTY, trace of CLAY below 1.2 m
(SP - SM) - trace of SILT with fine roots below 1.7 m (estimated), black
(SP) - trace of SILT below 2.1 m
- some SILT with fine roots and ORGANIC-rich beds below 2.45 m
(SP - SM) - trace of SILT, below 2.9 m, brown
(SP) - below 3.4 m (estimated)
(SP - SM) - below 4.35 m (estimated)
(SP) - below 6.15 m (estimated) 6.1 m(-51.5 m El.)

CLAY (CL) - and SILT, some SAND, stiff, low plasticity, grey brown
- SAND seam at 6.6 m 7.2 m(-52.6 m El.)

SAND (SP) - trace of SILT, fine-grained, uniform, brown
(SP - SM) - below 7.5 m
(SP) - below 7.95 m

(SP - SM)

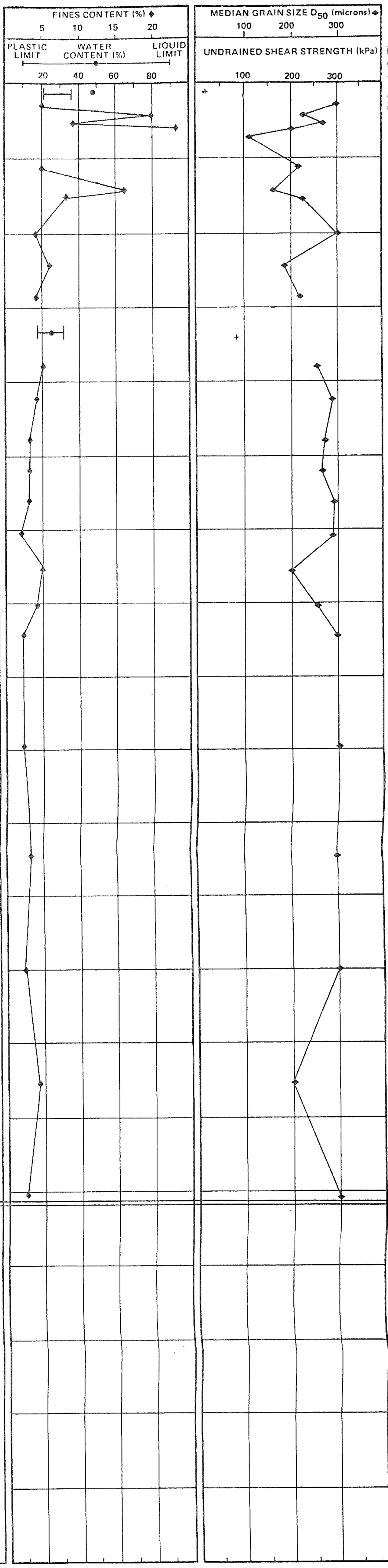
(SP)

END OF BOREHOLE 30.2 m(-75.6 m El.)

Note: Borehole completed to depth specified by Canmar

GROUND ICE
T (°C)

NOT FROZEN
1.5
1.3
1.8
1.5
1.9
1.9
2.0
0.3
0.5
2.2
1.9
2.3
2.8
1.7
2.1
3.1
2.8
1.9
3.0
3.3
2.2
3.4



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/09/01
BOREHOLE DEPTH: 30.2 m(-75.6 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/DJ

SOIL SYMBOLS
SAND
SILT
CLAY

LEGEND
SHEAR STRENGTH
+ Torvane
× Min. Vane
♦ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

TEST IDENTIFICATION
C Consolidation
DS Direct Shear
TD TDR
Ca Calorimetry
T Triaxial Shear
S P.W. Salinity
G Gas Analysis

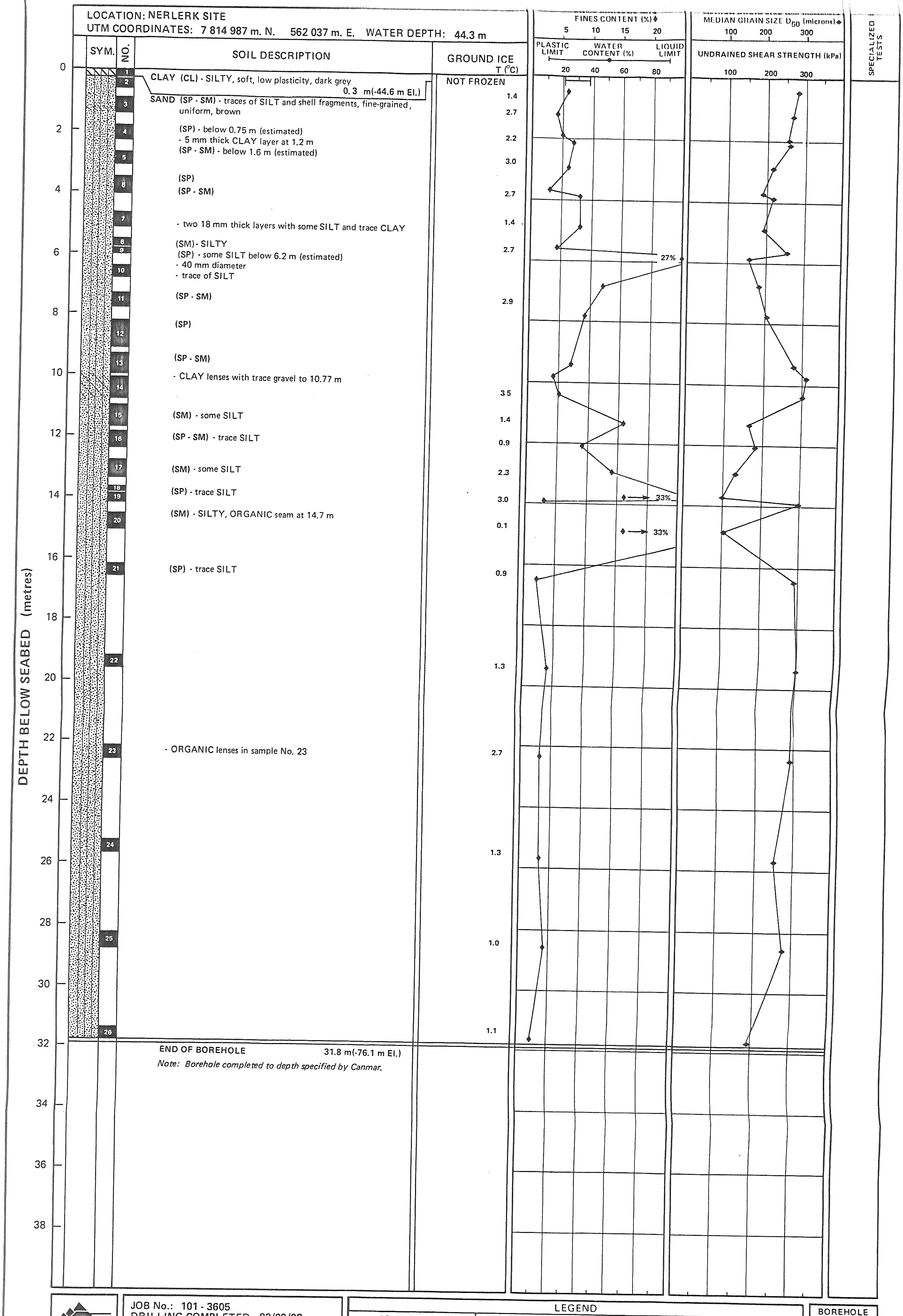
BOREHOLE NUMBER
B-NER 3:7

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE

UTM COORDINATES: 7 814 987 m. N. 562 037 m. E. WATER DEPTH: 44.3 m



CLAY (CL) - SILTY, soft, low plasticity, dark grey
0.3 m(-44.6 m El.)

SAND (SP - SM) - traces of SILT and shell fragments, fine-grained, uniform, brown

(SP) - below 0.75 m (estimated)
- 5 mm thick CLAY layer at 1.2 m
(SP - SM) - below 1.6 m (estimated)

(SP)
(SP - SM)

- two 18 mm thick layers with some SILT and trace CLAY

(SM) - SILTY
(SP) - some SILT below 6.2 m (estimated)
- 40 mm diameter
- trace of SILT

(SP - SM)

(SP)

(SP - SM)
- CLAY lenses with trace gravel to 10.77 m

(SM) - some SILT

(SP - SM) - trace SILT

(SM) - some SILT

(SP) - trace SILT

(SM) - SILTY, ORGANIC seam at 14.7 m

(SP) - trace SILT

- ORGANIC lenses in sample No. 23

END OF BOREHOLE 31.8 m(-76.1 m El.)

Note: Borehole completed to depth specified by Canmar.

eba

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/09/02
BOREHOLE DEPTH: 31.8 m(-76.1 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/BR/DY

SOIL SYMBOLS
▨ SAND
▥ SILT
▧ CLAY

LEGEND

SHEAR STRENGTH
+ Torvane
× Min. Vane
● Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

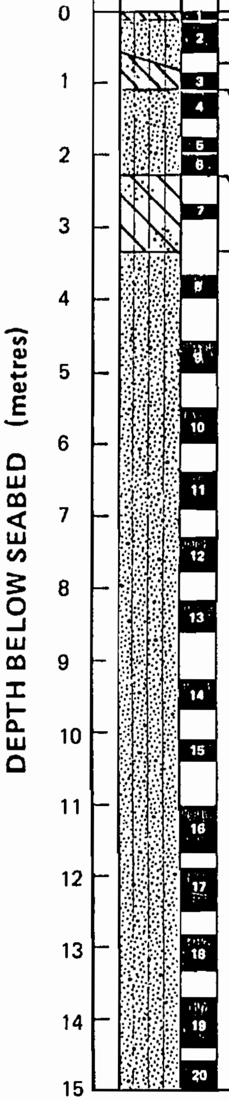
BOREHOLE NUMBER
B-NER 3:8

PAGE 1 OF 1

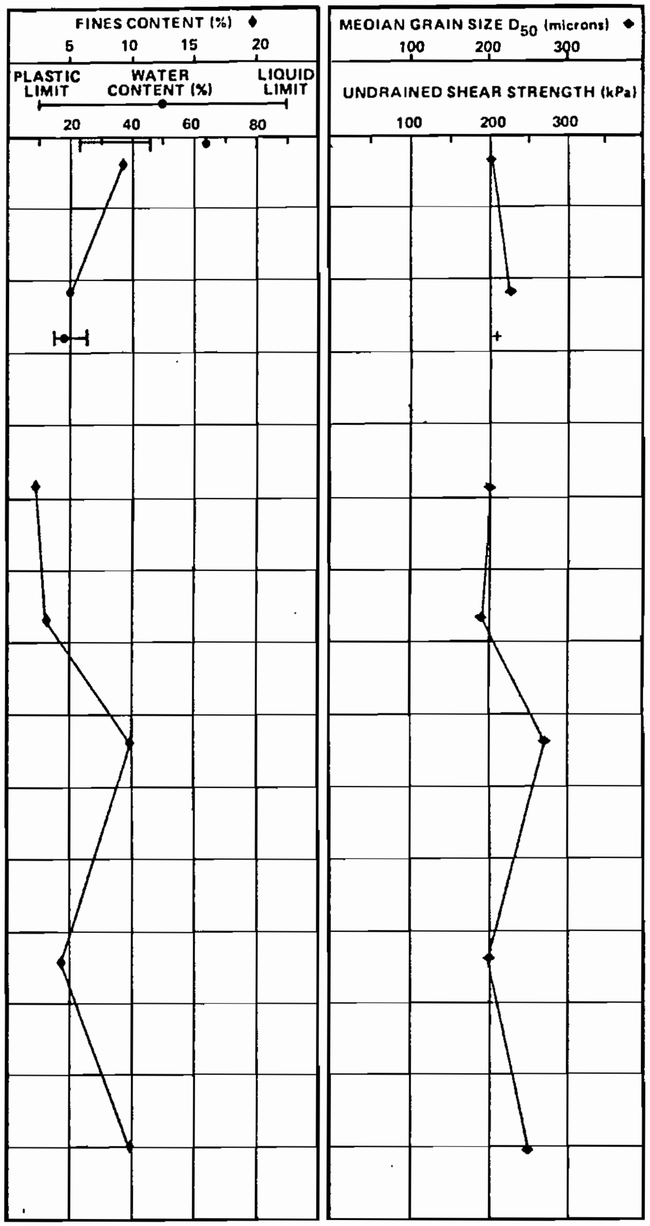
BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 397 m N. 561 992 m E. WATER DEPTH: 44.8 m

DEPTH BELOW SEABED (metres)



SOIL DESCRIPTION	GROUND ICE T (°C)
CLAY (CL) - SILTY and SANDY, soft, low plasticity, dark grey 0.2 m(-45.0 m El.)	NOT FROZEN 0.5
SAND (SP - SM) - trace of SILT, fine-grained, uniform, brown 0.8 m(-45.6 m El.)	1.1
CLAY (CL) - SILTY and SANDY, soft, low plasticity, dark grey 1.1 m(-45.9 m El.)	
SAND (SP) - trace of SILT, fine-grained, uniform, brown 2.3 m(-47.1 m El.)	
CLAY (CL) - SILTY, some SAND, hard, olive grey *(Material change noted by driller at 2.3 m)* 3.4 m(-48.2 m El.)	2.2
SAND (SP) - trace of SILT, fine-grained, uniform, brown	4.3
	4.0
	3.9
	1.5
	0.6
(SP - SM)	0.9
(SP)	2.9
	2.6
- 10 mm thick CLAY lens and one 13 mm diameter pebble	2.5
	1.9
	1.7
(SP - SM) - *Note: Borehole was teminated as specified by Canmar.*	1.3
END OF BOREHOLE 15.0 m(-59.8 m El.)	1.3



SPECIALIZED TESTS

ORGANIC CONTENT
5% at 1.9 m

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/09/05
BOREHOLE DEPTH: 15.0 m(-59.8 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/BR

LEGEND

SOIL SYMBOLS

▨	▥	▧
SAND	SILT	CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- ◆ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

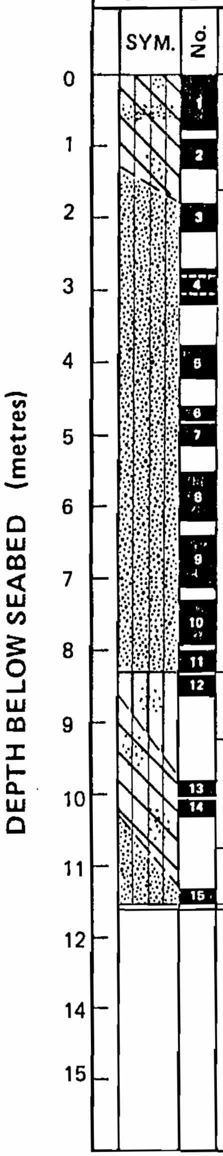
TEST IDENTIFICATION
- C - Consolidation
- DS - Direct Shear
- TD - TDR
- Ca - Calorimetry
- T - Triaxial Shear
- S - P.W. Salinity
- G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:10

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 322 m N. 562 224 m E. WATER DEPTH: 44.2 m



SOIL DESCRIPTION

CLAY (CL) - SILTY, SANDY, traces of shell fragments and ORGANICS, firm, low plasticity, dark grey
- CLAYEY SAND layer at 0.5 m

1.6 m(-45.8 m El.)

SAND (SP - SM) - trace of SILT, fine-grained, uniform, brown

- black ORGANIC lenses to 4.8 m

8.4 m(-52.6 m El.)

SILT (ML) - occassional thin beds of SILTY fine-grained SAND, compact to dense, dark grey

9.2 m(-53.4 m El.)

CLAY (CL) - and SILT, some SAND, very stiff, grey brown

10.8 m(-55.0 m El.)

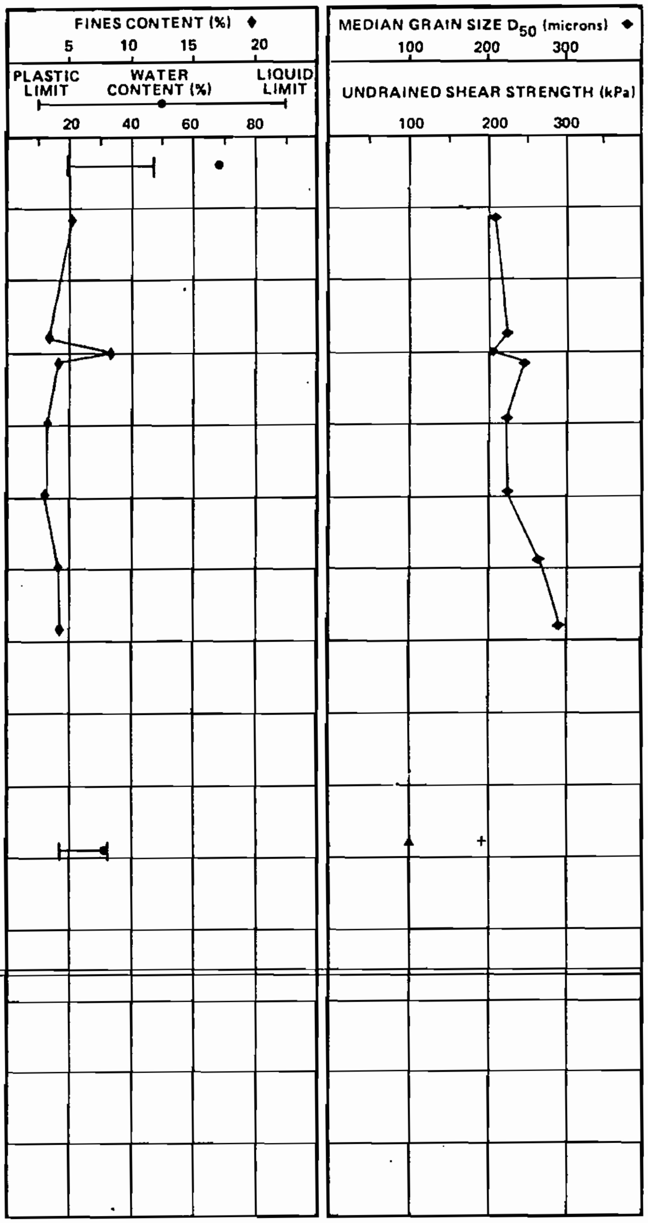
SAND (SP) - trace of SILT, fine-grained, uniform, brown

END OF BOREHOLE 11.5 m(-55.7 m El.)

Note: Borehole completed to depth specified by Canmar.

GROUND ICE
T (°C)

NOT FROZEN
0.0
0.0
2.1
2.0
2.5
1.8
2.6
2.6
2.8
1.6
2.0
2.7



SPECIALIZED TESTS

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/09/15
BOREHOLE DEPTH: 11.5 m(-55.7 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: MDW/DJ

LEGEND

SOIL SYMBOLS
- SAND
- SILT
- CLAY

SHEAR STRENGTH
- + Torvane
- × Min. Vane
- ♦ Pilcon Vane
- ○ Halibut Vane
- ● Fall Cone
- ▲ UU Triaxial
- ■ CU Triaxial

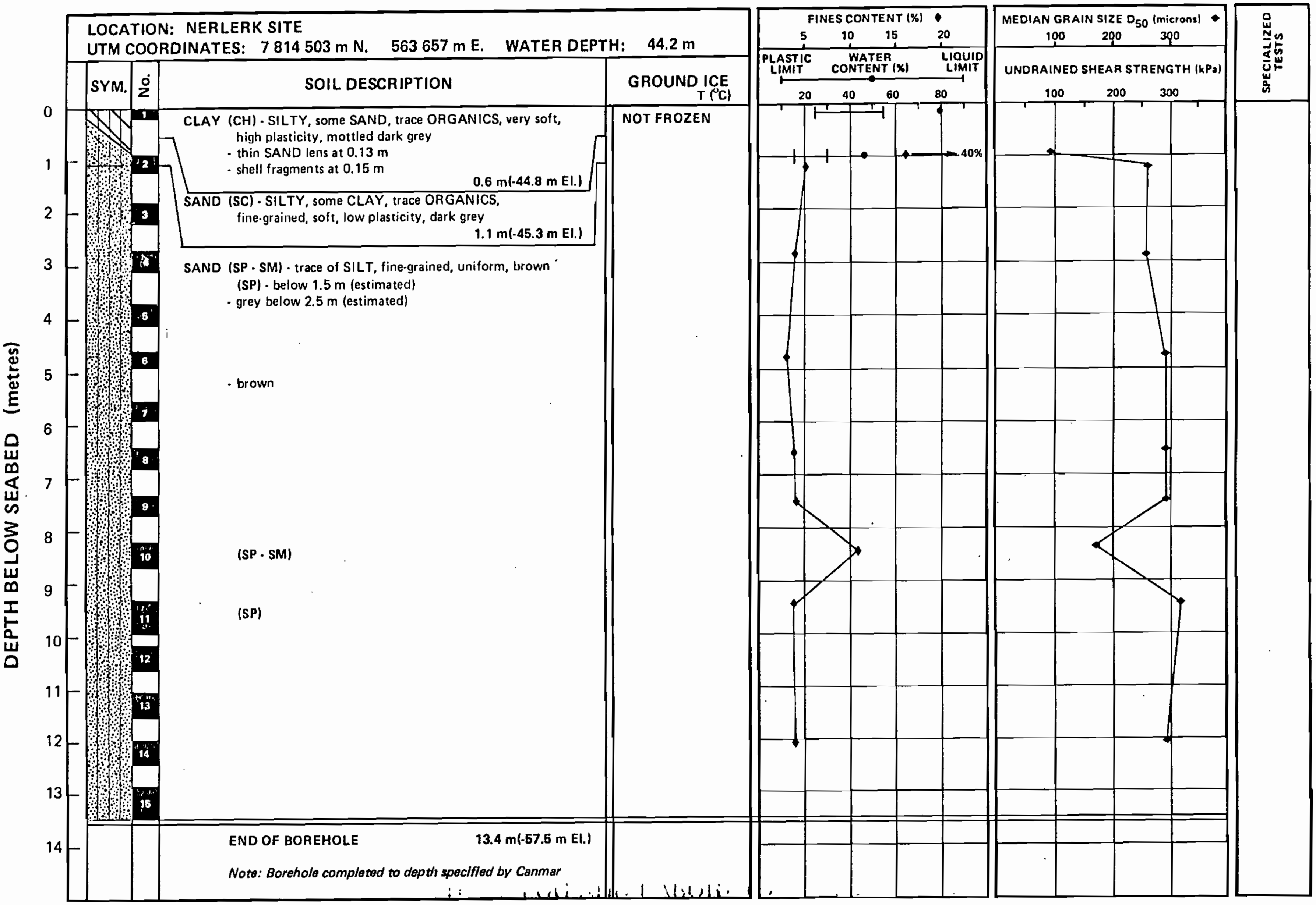
TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
B-NER 3:11

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

LOCATION: NERLERK SITE
UTM COORDINATES: 7 814 503 m N. 563 657 m E. WATER DEPTH: 44.2 m



CLAY (CH) - SILTY, some SAND, trace ORGANICS, very soft, high plasticity, mottled dark grey
- thin SAND lens at 0.13 m
- shell fragments at 0.15 m

0.6 m(-44.8 m El.)

SAND (SC) - SILTY, some CLAY, trace ORGANICS, fine-grained, soft, low plasticity, dark grey

1.1 m(-45.3 m El.)

SAND (SP - SM) - trace of SILT, fine-grained, uniform, brown
(SP) - below 1.5 m (estimated)
- grey below 2.5 m (estimated)

- brown

(SP - SM)

(SP)

END OF BOREHOLE 13.4 m(-57.5 m El.)

Note: Borehole completed to depth specified by Canmar

NOT FROZEN

eba

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/09/18
BOREHOLE DEPTH: 13.4 m(-57.5 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: KWJ/CHL

LEGEND

SOIL SYMBOLS

▨ SAND
▥ SILT
▧ CLAY

SHEAR STRENGTH

+ Torvane	● Fall Cone
× Min. Vane	▲ UU Triaxial
◆ Pilcon Vane	■ CU Triaxial
○ Halibut Vane	

TEST IDENTIFICATION

C - Consolidation	T - Triaxial Shear
DS - Direct Shear	S - P.W. Salinity
TD - TDR	G - Gas Analysis
Ca - Calorimetry	

BOREHOLE NUMBER
B-NER 3:12

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

SUMMARY OF TEST RESULTS

Borehole Number		Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER1:5																							
1	B	0.0-0.1																					
2	B	0.1-0.4				20																	
3	B	0.4-0.5	CL			55			40	20	34	20	46		8								
4	B	0.9-1.0																					
5	B	1.0-1.3																					
6	B	1.8-2.1	SP-SM										92	0	275								
7	B	2.7-2.8																					
8	B	2.8-3.2	SP										98	0	250								
9	B	3.7-4.3																					
10	B	4.6-5.0																					
11	B	5.5-6.0																					
12	B	5.6	SP										98	0	275								
13	B	6.4-6.9	SP-SM										94	0	200								
14	B	7.9																					
15	B	7.6-7.8																					
16	B	7.8-7.9																					
17	B	8.2-8.3																					
18	B	8.3-8.7	SP-SM										93	0	200								
19	B	9.1-9.6																					
20	B	10.1-10.5	SP										96	0	250								

LEGEND AND NOTES

B - Bag Sample
G - Gas Sample
L - Liner Sample
P - Piston Sample
NR - No Recovery
NS - No Sample Remaining

PF - Permafrost Sample
PW - Porewater Sample
T - Sample Stored in Tube
W - Waxed Sample
RC - Radiocarbon Sample

MV - Minivane
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TV - Torvane
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RV - Remote Vane

UU - Unconsolidated Undrained Triaxial
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O - Organic Content
S - Salinity
TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ________________ P.Eng.

Page 1 of 24

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER1:5(continued)																							
21	B	11.0-11.2	SP										98	0	325								
22	B	11.9-12.4	SP-SM										94	0	220								
23	B	12.8-13.2																					
24	B	13.7-14.1	SP										97	0	290								
25	B	14.6-14.8																					
26	B	17.7-18.1	SP										98	0	250								
27	B	20.7-21.1																					
28	B	23.8-24.2																					
29	B	26.8-27.3	SP										97	0	250								
30	B	29.9-30.3	SP-SM										93	0	200								

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER2:1																							
1A	B	*0.0-0.1	SC			31			24	16	18	9	73	0	270								
1B	B	*0.1-0.4	SP										98	0	250								
2A	B	*0.9-1.3	SP										99	0	250								
3A	B	*1.8-2.2	SP										99	0	300								
4A	B	*2.7-3.1	SP										96	0	240								
5A	B	*3.7-4.1	SP-SM										93	0	230								
6A	B	*4.6-5.1	SP-SM										89	0	200								
7A	B	*5.5-5.9	SP										97	0	220								
8A	B	*6.4-6.9	SP										98	0	260								
9A	B	*7.3-7.7	SP										98	0	280								
10A	B	*8.2-8.6	SP										98	0	300								
11A	B	*9.1-9.5																					
12A	B	*10.1-10.4	SP-SM										93	0	280								
13A	B	*11.0-11.4																					

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number		Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER2:1 (continued)																							
14A	B	*11.9-12.3																					
15A	B	*12.8-13.2	SP										96	0	300								
16A	B	*13.7-14.0																					
17A	B	*14.6-14.9	SP										99	0	360								
18A	B	*17.8-18.2	SP										99	0	320								
19A	B	*20.7-21.1	SP										99	0	320								
20A	B	*23.8-24.2	SP										97	0	300								
21A	B	*26.8-27.2	SP										99	0	300								
22	B	*29.8-30.0	SP										98	0	300								
B-NER2:2																							
1 A	B	*0.0-0.4	CL			53			37	20	35	22	43	0	8								
1B	B	*0.4-0.6	SP			45							97	0	320								
2A	B	*0.9-1.4	CL			52/41			39	18	33	20	47	0	10								
2B	B	*1.4-1.6	SP										98	0	310								
3A	B	*1.8-2.2	SP										98	0	320								
3B	B	*2.2-2.3	SM										71	0	160								
4A	B	*2.7-3.2	SM			17							80	0	220								
5A	B	*3.7-4.1	SM										80	0	280								
6A	B	*4.6-5.0	SP-SM										94	0	280								

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER2:2 (continued)																							
6B	B	*4.6-5.0				25																	
7A	B	*5.5-5.8	SP-SM										93	0	300								
7B	B	*5.8-5.9																					
7C	B	*5.9-6.1																					
8A	B	*6.4-6.8	SP			26							96	0	180								
9A	B	*7.3-																					
10A	B	*8.2-8.6	SP										98	0	290								
11A	B	*9.1-9.6																					
12A	B	*10.1-10.5	SP			26							98	0	270								
13A	B	*11.0-11.4																					
14A	B	*11.9-12.3	SP			25							99	0	260								
15A	B	*12.8-13.1																					
16A	B	*13.7-14.1	SP			26							98	0	260								
17A	B	*14.6-14.8	SP										99	0	250								
18A	B	*17.7-18.0	SP			25							98	0	300								
19A	B	*20.7-21.1	SP			25							98	0	260								
20A	B	*23.8-24.2	SP										98	0	250								
21A	B	*26.8-27.2	SP										97	0	320								
22A	B	*29.9-30.3	SP			26							98	0	300								

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER2:10																							
1A	B	*0.0-0.5	SC			45			20	15	25	21	54	0	170	TV	14		v. soft				
																FC	9		v. soft				
2A	B	*0.9-1.4	SC			46			30	15	26	15	59	0	190	TV	13		v. soft				
																FC	8		v. soft				
3A	B	*1.8-2.0	SC			33			34	17	23	14	63	0	200	TV	17		v. soft				
3B	B	*2.0-2.2	SP			23							97	0	300								
4A	B	*2.7-3.2	SP			22							96	0	300								
5A	B	*3.6-4.2	SP-SM			21							92	0	290								
6A	B	*4.6-4.9	SP			25							97	0	280								
7A	B	*5.5-5.7				26																	
8A	B	*6.4-6.7																					
9A	B	*7.3-7.6	SP			24							97	0	260								
10A	B	*8.2-8.5																					
11A	B	*9.1-9.5	SP			24							98	0	310								
12A	B	*10.1-10.4																					
13A	V	*11.0-11.4	SP			25							96	0	260								
14A	B	*11.9-12.3																					
15A	B	*12.8-13.3	SP			25							97	0	300								
16A	B	*13.7-14.2																					
17A	B	*14.6-15.0	SP			24							97	0	300								

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER2:10(continued)																							
18A	B	*18.6-18.9	SP			25							98	0	300								
19A	B	*21.6-22.0																					
20A	B	*24.7-25.0	SP			25							98	0	300								
21A	B	*27.7-28.0																					
22A	B	*30.8-31.1	SP			26							97	0	300								

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER3:1																							
1	B	*0.0-0.3																					
2	B	*0.3-0.5																					
3	B	*0.9-1.3	SP										96	0	270								
4	B	*1.8-2.0																					
5	B	*2.7-3.1	SP-SM										93	0	250								
6	B	*3.7-4.1																					
B-NER3:1B																							
1A	B	*0.0-0.1	CL			40			31	16	43	24	33	0	3								
	NS	*0.1-0.2																					
2	B	*0.2-0.4																					
3	B	*0.9-1.9	SP		0.9								99	0	300								
4	B	*1.9-2.3			2.7																		
5	B	*2.7-3.1	SP		2.5								96	0	220								
6	B	*3.7-4.0			1.6																		
7	B	*4.6-5.0	SP-SM		2.0								93	0	200								
8	B	*5.5-5.8			1.5																		
9	B	*6.4-6.9	SP-SM		1.7								90	0	160								
10	B	*7.3-7.7			0.5																		
11	B	*8.2-8.6	SM		1.9								87	0	250								

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1982 OFFSHORE GEOTECHNIAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:1B (continued)																							
12	B	*9.1-9.3																					
13	B	*9.3-9.5			-0.7																		
14	B	*10.1-10.4			-1.0	37																	
15	B	*11.0-11.3			-0.2	37										TV	100		stiff				
16	B	*11.9-12.2			-0.7	31										TV	124		v. stiff				
17	B	*12.8-13.3	SP										97	0	210								
18	B	*13.7-14.1	SM		1.4								89	0	200								
19	B	*14.6-15.1			1.2																		
20	B	*16.5-17.1	SP-SM		0.6								95	0	200								
21	B	*19.5-20.0			1.4																		
22	B	*22.6-23.0	SP		1.4								96	0	200								
23	B	*25.6-25.8																					
B-NER3:2																							
1	B	*0.0-0.2	CL			54			42	20	48	32	20	0	2								
2	B	*0.2-0.4																					
3	B	*0.4-0.6			2.2																		
4	B	*0.9-1.5	SP-SM		1.0								95	0	200								
5	B	*1.8-2.4	SP		0.6								97	0	200								
6	B	*2.7-2.3	SP-SM		1.1								94	0	200								

LEGEND AND NOTES

B	Bag Sample	PF	Permafrost Sample	MV	Minivane	UU	Unconsolidated Undrained Triaxial	O	Organic Content
G	Gas Sample	PW	Porewater Sample	FC	Fall Cone	UUp	UU Triaxial with Pore Pressure Measurements	S	Salinity
L	Liner Sample	T	Sample Stored In Tube	TV	Torvane	CU	Consolidated Undrained Triaxial	TS	Thaw Strain
P	Piston Sample	W	Waxed Sample	PV	Pilcon Vane	CUp	CU Triaxial with Pore Pressure Measurements	SG	Specific Gravity
NR	No Recovery	RC	Radiocarbon Sample	RV	Remote Vane	CD	Consolidated Drained Triaxial		
NS	No Sample Remaining								

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number		Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER3:2																							
7	B	*3.7-4.0																					
8	B	*4.0-4.3	SP-SM		1.1								93	0	220								
9	B	*4.6-4.7				70																	
10	B	*4.7-5.1	SP-SM		1.8								95	0	200								
11	B	*5.5-6.0	SP-SM		1.7								94	0	300								
12	B	*6.4-7.0	SM		0.9								78	0	150								
13	T	*7.6				30	1.76									UU	29	15	firm				
14	B	*7.3-7.9	CL		-0.3	30			45	23	51	43	6	0	2								
15	B	*8.2-8.5			1.0																		
16	B	*9.3-9.8																					
17	B	*10.1-10.4	SP-SM		0.7								93	0	280								
18	B	*11.0-11.4																					
19	PF	*11.9-12.3	SP-SM		0.8								92	0	210								
20	B	*12.8-13.4			1.3																		
21	B	*13.7-14.1			0.4																		
22	B	*14.6-15.0			1.1																		
23	B	*15.8-16.2	SP		0.7								96	0	155								
24	B	*18.9-19.3			0.9																		
25	B	*21.9-22.3	SP		2.7								98	0	300								
26	B	*25.0-25.4																					

LEGEND AND NOTES

B - Bag Sample
G - Gas Sample
L - Liner Sample
P - Piston Sample
NR - No Recovery
NS - No Sample Remaining

PF - Permafrost Sample
PW - Porewater Sample
T - Sample Stored in Tube
W - Waxed Sample
RC - Radiocarbon Sample

MV - Minivane
FC - Fall Cone
TV - Torvane
PV - Pilcon Vane
RV - Remote Vane

UU - Unconsolidated Undrained Triaxial
UUp - UU Triaxial with Pore Pressure Measurements
CU - Consolidated Undrained Triaxial
CUp - CU Triaxial with Pore Pressure Measurements
CD - Consolidated Drained Triaxial

O - Organic Content
S - Salinity
TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number		Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER3:2		(continued)																					
27	8	*28.0-28.4	SP		0.5								98	0	220								
28	B	*31.1-31.5			0.3																		
B-NER3:3																							
1	B	*0.0-0.3	CH			74			61	28	49	30	21	0	2								
2	B	*0.3-0.7	SP		0.9								96	0	250								
3	B	*0.9																					
4	B	*0.9-1.5	SP		1.0								98	0	280								
5	B	*1.8-2.4	SP-SM		1.0								93	0	200								
6	B	*2.7-3.2	SP-SM		1.4								92	0	210								
7	B	*3.7-4.1	SP		0.6								97	0	260								
8	B	*4.6-5.3	SP-SM		1.3								95	0	250								
9	B	*5.5-5.9																					
10	B	*5.9-6.1			0.7																		
11	B	*6.4-6.6																					
12	B	*6.6-7.1	SP-SM										94	0	200								
13	B	*7.3-7.9	SP-SM		0.8								91	0	250								
14	8	*8.2-8.7	SP-SM		1.6								94	0	300								
15	B	*9.5-9.6	CL		-0.4	29			43	21	49	50	1	0	2								
16	PF	*9.3-9.5				29	1.92									UU	116	12	v. stiff				

LEGEND AND NOTES

B - Bag Sample	PF - Permafrost Sample	MV - Minivane	UU - Unconsolidated Undrained Triaxial	O - Organic Content
G - Gas Sample	PW - Porewater Sample	FC - Fall Cone	UUp - UU Triaxial with Pore Pressure Measurements	S - Salinity
L - Liner Sample	T - Sample Stored in Tube	TV - Torvane	CU - Consolidated Undrained Triaxial	TS - Thaw Strain
P - Piston Sample	W - Waxed Sample	PV - Pilcon Vane	CUp - CU Triaxial with Pore Pressure Measurements	SG - Specific Gravity
NR - No Recovery	RC - Radiocarbon Sample	RV - Remote Vane	CD - Consolidated Drained Triaxial	
NS - No Sample Remaining				

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:3																							
17	PF	*10.3-																					
18	B	*10.1-10.4			-0.3	30																	
19	B	*11.0-11.3	CL			20			38	18	53	42	5	0	1.8								
20	B	*11.3-11.4			1.4																		
21A	B	*11.9-12.3	SP		1.5								98	0	300								
21B	B	*11.9-12.3	SP		1.5								96	0	200								
22	B	*12.8-13.3	SP		1.5								97	0	200								
23	B	*13.7-14.2	SP		1.8								96	0	200								
24	B	*14.6-14.9			1.5																		
25	B	*17.7-18.1	SP		1.8								95	0	280								
26	B	*20.7-21.1	SP-SM		2.3								95	0	220								
27	B	*23.8-24.2	SP		1.8								97	0	250								
28	B	*26.8-27.0	SM								4	46	50	0	75								
29	B	*27.0-27.1	SM										74	0	100								
30	B	*27.1-27.6			0.8																		
31	B	*29.9-30.3	SP		1.7								97	0	200								
B-NER3:4																							
1	B	*0.0-0.6	CL			45			27	14	32	18	50	0	14								
2	B	*0.6-0.8																					

LEGEND AND NOTES

B	· Bag Sample	PF	· Permafrost Sample	MV	· Minivane	UU	· Unconsolidated Undrained Triaxial	O	· Organic Content
G	· Gas Sample	PW	· Porewater Sample	FC	· Fall Cone	UUp	· UU Triaxial with Pore Pressure Measurements	S	· Salinity
L	· Liner Sample	T	· Sample Stored in Tube	TV	· Torvane	CU	· Consolidated Undrained Triaxial	TS	· Thaw Strain
P	· Piston Sample	W	· Waxed Sample	PV	· Pilcon Vane	CUp	· CU Triaxial with Pore Pressure Measurements	SG	· Specific Gravity
NR	· No Recovery	RC	· Radiocarbon Sample	RV	· Remote Vane	CD	· Consolidated Drained Triaxial		
NS	· No Sample Remaining								

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:4		(continued)																					
3	B	*0.9-1.3			1.2																		
4	B	*1.8-2.3	SP-SM		1.4								94	0	190								
5	B	*2.7-3.1			1.7																		
6	B	*3.7-3.9	SP-SM		1.5								94	0	270								
7	B	*4.6-5.0			0.9																		
8	B	*5.5-5.9	SP-SM		1.0								94	0	220								
9	B	*6.4-6.9	SM		1.1								81	0	130								
10	B	*7.3-7.7			1.0																		
11	B	*8.2-8.5			0.0	27										TV	96		stiff				
12	B	*9.1-9.4	CL		-0.2	30			34	17	43	53	4	0	3	TV	115		v. stiff				
13	B	*10.1-10.6	SP		2.4								97	0	200								
14	B	*11.0-11.5				26																	
15	B	*11.2-11.4			1.4																		
16	B	*11.9-12.4	SP		2.1								98	0	200								
17	B	*12.8-13.2																					
18	B	*13.2-13.4			0.3																		
19	B	*13.7-14.4	SM		1.1								61	0	90								
20	B	*14.6-15.2	SM		1.4	28							53	0	70								
21	B	*16.8-17.1	SP		0.1								95	0	220								
22	B	*19.8-20.1	SP		0.4								99	0	280								

LEGEND AND NOTES

B - Bag Sample
G - Gas Sample
L - Liner Sample
P - Piston Sample
NR - No Recovery
NS - No Sample Remaining

PF - Permafrost Sample
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T - Sample Stored in Tube
W - Waxed Sample
RC - Radiocarbon Sample

MV - Minivane
FC - Fall Cone
TV - Torvane
PV - Pilcon Vane
RV - Remote Vane

UU - Unconsolidated Undrained Triaxial
UUp - UU Triaxial with Pore Pressure Measurements
CU - Consolidated Undrained Triaxial
CUp - CU Triaxial with Pore Pressure Measurements
CD - Consolidated Drained Triaxial

O - Organic Content
S - Salinity
TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:4 (continued)																							
23	B	*22.9-23.3	SP-SM		-0.8								93	0	225								
24	B	*25.9-26.5	SP-SM		0.0								93	0	120								
25	B	*29.0-29.4	SP		-0.3								97	0	160								
B-NER3:5																							
1	B	*0.0-0.5	SC			51			36	21	25	15	60	0	200								
2	B	*0.5-0.8	SP										98	0	300								
3	B	*0.9-1.2																					
4	B	*1.2-1.5	SP		0.4								98	0	300								
5	B	*1.8-2.3	SM										81	0	200								
6	B	*2.7-3.2	SP-SM										93	0	210								
7	B	*3.7-3.8	SP-SM										93	0	200								
8	B	*3.8-4.0																					
9	B	*4.0-4.1	CL			25			30	18													
10	B	*4.6-5.1	SP										98	0	230								
11	B	*5.5-5.9	ML			27					7	81	12	0	36								
12	B	*5.9-6.1																					
13A	B	*6.4-6.9	SP										95	0	200								
13B	B	*6.4-6.9	SM										67	0	100								
14	B	*7.3-7.7	SP										97	0	300								

LEGEND AND NOTES

B · Bag Sample
G · Gas Sample
L · Liner Sample
P · Piston Sample
NR · No Recovery
NS · No Sample Remaining

PF · Permafrost Sample
PW · Porewater Sample
T · Sample Stored in Tube
W · Waxed Sample
RC · Radiocarbon Sample

MV · Minivane
FC · Fall Cone
TV · Torvane
PV · Pilcon Vane
RV · Remote Vane

UU · Unconsolidated Undrained Triaxial
UUp · UU Triaxial with Pore Pressure Measurements
CU · Consolidated Undrained Triaxial
CUp · CU Triaxial with Pore Pressure Measurements
CD · Consolidated Drained Triaxial

O · Organic Content
S · Salinity
TS · Thaw Strain
SG · Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:5	(continued)																						
15	B	*8.2-8.6			0.0																		
16	B	*9.3-9.7	SP		0.2								97	0	290								
17	B	*10.1-10.6			0.7																		
18	B	*11.0-11.4	SP		1.3								97	0	300								
19	B	*11.9-12.3			1.7																		
20	B	*12.8-13.2			1.0																		
21	B	*13.7-14.0			0.8																		
22	B	*14.6-15.1	SP-SM		2.3								91	0	190								
23	B	*15.6-16.0			1.7																		
24	B	*18.6-19.5	SP		2.6								95	0	270								
25	B	*21.6-22.0	SP		1.9								97	0	280								
26	B	*24.7-25.2	SP		1.5								97	0	250								
27	B	*27.7-28.2	SP										97	0	270								
B-NER3:6																							
1A	B	*0.0-0.2				45																	
1B	NS	*0.2-0.3																					
2	B	*0.3-0.4	SP			24							98	0	300								
3	B	*0.9-1.2	CL			59			47	24													
4	B	*1.2-1.6			1.3																		

LEGEND AND NOTES

B - Bag Sample
G - Gas Sample
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P - Piston Sample
NR - No Recovery
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PF - Permafrost Sample
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RC - Radiocarbon Sample

MV - Minivane
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RV - Remote Vane

UU - Unconsolidated Undrained Triaxial
UUp - UU Triaxial with Pore Pressure Measurements
CU - Consolidated Undrained Triaxial
CUp - CU Triaxial with Pore Pressure Measurements
CD - Consolidated Drained Triaxial

O - Organic Content
S - Salinity
TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm-3)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:6		(continued)																					
5	B	*1.8-2.3	SP-SM										92	0	200								
6	B	*2.7-3.0																					
7	B	*3.0-3.2	CL-ML			18			19	13	23	48	29	0	30								
8	B	*3.7-3.8				21																	
9	B	*3.8-4.0	SM										86	0	200								
10	B	*4.6-5.1																					
11	B	*5.5-5.9	SP										98	0	220								
12	B	*6.4-6.7			-0.1																		
13	B	*7.3-7.8	SP		0.4								98	0	160								
14	B	*8.2-8.8			1.0																		
15	B	*9.1-9.5	SP		0.7								98	0	200								
16	B	*10.1-10.3			0.3																		
17	B	*11.0-11.3	SP		0.8								98	0	250								
18	B	*11.9-12.4			0.5																		
19	B	*12.8-13.1	SP		0.0								99	0	300								
20	B	*13.7-14.1			1.3																		
21	B	*14.6-15.0			0.9																		
22	B	*17.1-17.4	SP		0.8								99	0	290								
23	B	*20.1-20.5			1.3																		
24	B	*23.2-23.5	SP		0.7								99	0	250								

LEGEND AND NOTES

- B - Bag Sample
- G - Gas Sample
- L - Liner Sample
- P - Piston Sample
- NR - No Recovery
- NS - No Sample Remaining

- PF - Permafrost Sample
- PW - Porewater Sample
- T - Sample Stored in Tube
- W - Waxed Sample
- RC - Radiocarbon Sample

- MV - Minivane
- FC - Fall Cone
- TV - Torvane
- PV - Pilcon Vane
- RV - Remote Vane

- UU - Unconsolidated Undrained Triaxial
- UUp - UU Triaxial with Pore Pressure Measurements
- CU - Consolidated Undrained Triaxial
- CUp - CU Triaxial with Pore Pressure Measurements
- CD - Consolidated Drained Triaxial

- O - Organic Content
- S - Salinity
- TS - Thaw Strain
- SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:6		(continued)																					
25	B	*26.2-26.6			0.1																		
26	B	*29.3-29.7	SP		1.1								97	0	270								
B-NER3:7																							
1	B	*0.0-0.4	CL			48			37	20	39	27	34	0	3	TV	12		v. soft				
2	B	*0.4-0.6	SP										95	0	300								
3	B	*0.6-0.9	SM		1.5								81	0	220								
4	B	*0.9-1.4	SP-SM										91	0	260								
5	B	*1.1-1.2	SM										77	0	200								
6	B	*1.4-1.6	SM		1.3								75	0	110								
7	B	*1.8-2.0																					
8	B	*2.0-2.4	SP		1.8								95	0	210								
9	B	*2.7-2.9	SM										84	0	160								
10	B	*2.9-3.1	SP-SM		1.5								92	0	220								
11	B	*3.7-4.1	SP		1.9								96	0	300								
12	B	*4.6-4.9	SP-SM		1.9								94	0	180								
13	B	*5.5-5.9	SP		2.0								96	0	215								
14	B	*6.4-7.0	CL		0.3	26			30	18	38	50	12	0	4	TV	84		stiff				
15	B	*7.3-7.7	SP-SM		0.5								95	0	250								
16	B	*8.2-8.7	SP		2.2								96	0	280								

LEGEND AND NOTES

B	Bag Sample	PF	Permafrost Sample	MV	Minivane	UU	Unconsolidated Undrained Triaxial	O	Organic Content
G	Gas Sample	PW	Porewater Sample	FC	Fall Cone	UUp	UU Triaxial with Pore Pressure Measurements	S	Salinity
L	Liner Sample	T	Sample Stored in Tube	TV	Torvane	CU	Consolidated Undrained Triaxial	TS	Thaw Strain
P	Piston Sample	W	Waxed Sample	PV	Pilcon Vane	CUp	CU Triaxial with Pore Pressure Measurements	SG	Specific Gravity
NR	No Recovery	RC	Radiocarbon Sample	RV	Remote Vane	CD	Consolidated Drained Triaxial		
NS	No Sample Remaining								

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number		Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER3:7		(continued)																					
17	B	*9.3-9.7	SP		1.9								97	0	265								
18	B	*10.1-10.5	SP		2.3								97	0	260								
19	B	*11.0-11.4	SP		2.8								97	0	290								
20	B	*11.9-12.3	SP		1.7								98	0	290								
21	B	*12.8-13.3	SP		2.1								95	0	200								
22	B	*13.7-14.1	SP		3.1								96	0	245								
23	B	14.6-14.9	SP		2.8								98	0	300								
24	B	17.7-18.1	SP		1.9								98	0	300								
25	B	20.7-21.0	SP		3.0								97	0	300								
26	B	23.8-24.2	SP		3.3								98	0	300								
27	B	26.8-27.2	SP		2.2								96	0	200								
28	B	29.9	SP		3.4								98	0	300								
B-NER3:8																							
1	B	0.0-0.3	CL						38	20													
2	B	*0.3-0.6	SP-SM		1.4								94	0	270								
3	B	*0.9-1.4	SP		2.7								96	0	260								
4A	B	*1.8-2.3	SP-SM										95	0	250								
4B	B	*1.8-2.3	SP-SM		2.2								93	0	250								
5	B	*2.7-3.1	SP-SM		3.0								94	0	210								

LEGEND AND NOTES

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CD - Consolidated Drained Triaxial

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TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:8		(continued)																					
6A	B	*3.7-4.1	SP		2.7								97	0	185								
6B	B	*3.7-4.1	SP-SM		2.7								92	0	215								
7	B	*4.6-5.1	SP-SM		1.4								92	0	190								
8	B	*5.5-5.8	SP										96	0	250								
9	B	*5.8-6.0	SM		2.7								73	0	150								
10	B	*6.4-6.8	SM										88	0	180								
11	B	*7.3-7.8	SP-SM		2.9								91	0	200								
12	B	*8.2-9.1																					
13A	B	*9.3-10.0	SP-SM										93	0	270								
13B	B	*9.3-10.0	SP										96	0	310								
14	B	*10.1-10.8	SP-SM		3.5								95	0	300								
15	B	*11.0-11.7	SM		1.4								84	0	160								
16	B	*11.9-12.4	SP-SM		0.9								91	0	180								
17	B	*12.B-13.4	SM		2.3								86	0	130								
18	B	*13.7-13.9	SM										67	0	100								
19	B	*13.9-14.2	SP		3.0								97	0	300								
20	B	*14.6-15.1	SM		0.1								67	0	105								
21	B	*16.2-16.6	SP		0.9								98	0	290								
22	B	*19.2-19.6	SP		1.3								96	0	300								
23	B	*22.2-22.6	SP		2.7								97	0	290								

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:8 (continued)																							
24	B	*25.3-25.7	SP		1.3								97	0	245								
25	B	*28.3-28.6	SP		1.0								96	0	270								
26	B	*31.4-31.8	SP		1.1								98	0	190								
B-NER3:9																							
1	B	*0.0-0.5	CL			62			49	24	33	55	12	0	30								
2	B	*0.5-0.6			1.6																		
3	B	0.9-1.0																					
4	B	1.1-1.6																					
5	B	*1.8-2.2	SP										96	0	255								
6	B	2.2-2.3			1.8																		
7	B	*2.7-2.9	ML			18					8	66	26	0	50								
8	B	*2.9-3.2			2.7																		
9	B	*3.7-4.2	SP-SM										93	0	205								
10	B	*4.2-4.5	CL-ML		1.7	21			19	13	12	46	42	0	40								
11	B	*4.6-4.7																					
12	B	*4.7-5.0	SM		1.8								87	0	235								
13	B	*5.5-5.7																					
14	B	*5.7-6.0	SP		0.3								96	0	200								
15	B	*6.4-6.8	SP-SM		2.9								94	0	200								

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:9		(continued)																					
16	B	*7.3-7.9	SP		2.1								98	0	255								
17	B	*8.2-8.5	SP		2.8								97	0	300								
18	B	*9.3-9.7	SP		1.6								97	0	290								
19	B	*10.1-10.4	SP		2.3								96	0	280								
20	B	*11.0-11.4	SP-SM		1.0								93	0	210								
21	B	*11.9-12.4			2.3																		
22	B	*12.8-13.3	SP		2.7								96	0	245								
24	B	*13.7-14.2			2.3																		
25	B	*14.6-15.1	SP		3.8								98	0	235								
B-NER3:10																							
1	B	*0.0-0.1	CL			64			45	23	41	24	35	0	4								
2	B	*0.1-0.6	SP-SM		0.5								91	0	200								
3	B	*0.9-1.1			1.1																		
4	B	*1.1-1.5																					
5	B	*1.8-2.0	SM			19					5	27	68	0	130								0=5%
6	B	*2.0-2.3	SP										95	0	225								
7	B	*2.7-2.9	CL		2.2	18/19		2.1	25	15	26	58	16		9	TV	208		hard				
8	B	*3.7-4.0			4.3																		
9	B	*4.6-5.0	SP		4.0								98	0	200								

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER3:10 (continued)																							
10	B	*5.5-6.0			3.9																		
11	B	*6.4-6.9	SP		1.5								97	0	190								
12	B	*7.3-7.8			0.6																		
13	B	*8.2-8.6	SP-SM		0.9								90	0	270								
14	B	*9.3-9.7	SP		2.9								96	0	295								
15	B	*10.1-10.4			2.6																		
16	B	*11.0-11.8	SP-SM		2.5								94	0	195								
17	B	*11.9-12.5			1.9																		
18	B	*12.8-13.3	SP		1.7								96	0	245								
19	B	*13.7-14.4	SP-SM		1.3								90	0	250								
20	B	*14.6-15.0			1.3																		
B-NER3:11																							
1	B	*0.0-0.8	CL		0.0	58			46	19	40	25	35	0	4								
2	B	*0.9-1.3	SP-SM		0.0								95	0	205								
3	B	*1.8-2.2			2.1																		
4A	B	*2.7-3.2	SP										97	0	220								
4B	B	*2.7-3.2	SP-SM		2.0								92	0	200								
4C	B	*2.7-3.2	SP										96	0	240								
5	B	*3.7-4.2	SP		2.5								97	0	220								

LEGEND AND NOTES

B	Bag Sample	PF	Permafrost Sample	MV	Minivane	UU	Unconsolidated Undrained Triaxial	O	Organic Content
G	Gas Sample	PW	Porewater Sample	FC	Fall Cone	UUp	UU Triaxial with Pore Pressure Measurements	S	Salinity
L	Liner Sample	T	Sample Stored in Tube	TV	Torvane	CU	Consolidated Undrained Triaxial	TS	Thaw Strain
P	Piston Sample	W	Waxed Sample	PV	Pilcon Vane	CUp	CU Triaxial with Pore Pressure Measurements	SG	Specific Gravity
NR	No Recovery	RC	Radiocarbon Sample	RV	Remote Vane	CD	Consolidated Drained Triaxial		
NS	No Sample Remaining								

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
B-NER3:11		(continued)																					
6	B	*4.6-4.8																					
7	B	*4.8-5.1	SP		1.6								97	0	220								
8	B	*5.5-6.2	SP		2.6								96	0	260								
9	B	*6.4-7.1	SP		2.6								96	0	290								
10	B	*7.3-7.9			2.8																		
11	B	*8.0-8.3																					
12	B	*8.3-8.6			1.6																		
13	B	*9.8-10.3	CL			31			31	16	31	56	13	0	6	TV	196		v. stiff				
14	W	*10.0-10.2			2.0											UU	101		stiff				
15	B	*11.3-11.5			2.7																		
B-NER3:12																							
1	B	*0.0-0.2	CH			80			55	25													
2A	B	*0.9-1.1	SC			46			30	16	18	22	60	0	90								
2B	B	*1.1-1.2	SP			18							95	0	260								
3	B	*1.8-2.2																					
4	B	*2.7-3.1	SP			21							96	0	255								
5	B	*3.7-4.1																					
6	B	*4.6-4.9	SP			19							97	0	290								
7	B	*5.5-5.9																					

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number		Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
B-NER3:12		(continued)																					
8	B	*6.4-6.8	SP			22							96	0	290								
9	B	*7.3-7.7	SP										96	0	290								
10	B	*8.2-8.7	SP-SM			20							89	0	175								
11	B	*9.3-9.9	SP			22							96	0	320								
12	B	*10.1-10.6				21																	
13	B	*11.0-11.5																					
14	B	*11.9-12.4	SP			25							96	0	290								
15	B	*12.8-13.4																					
16	B	*13.7-14.2																					
17	B	*14.6-15.2																					

LEGEND AND NOTES

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1982 OFFSHORE GEOTECHNIAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

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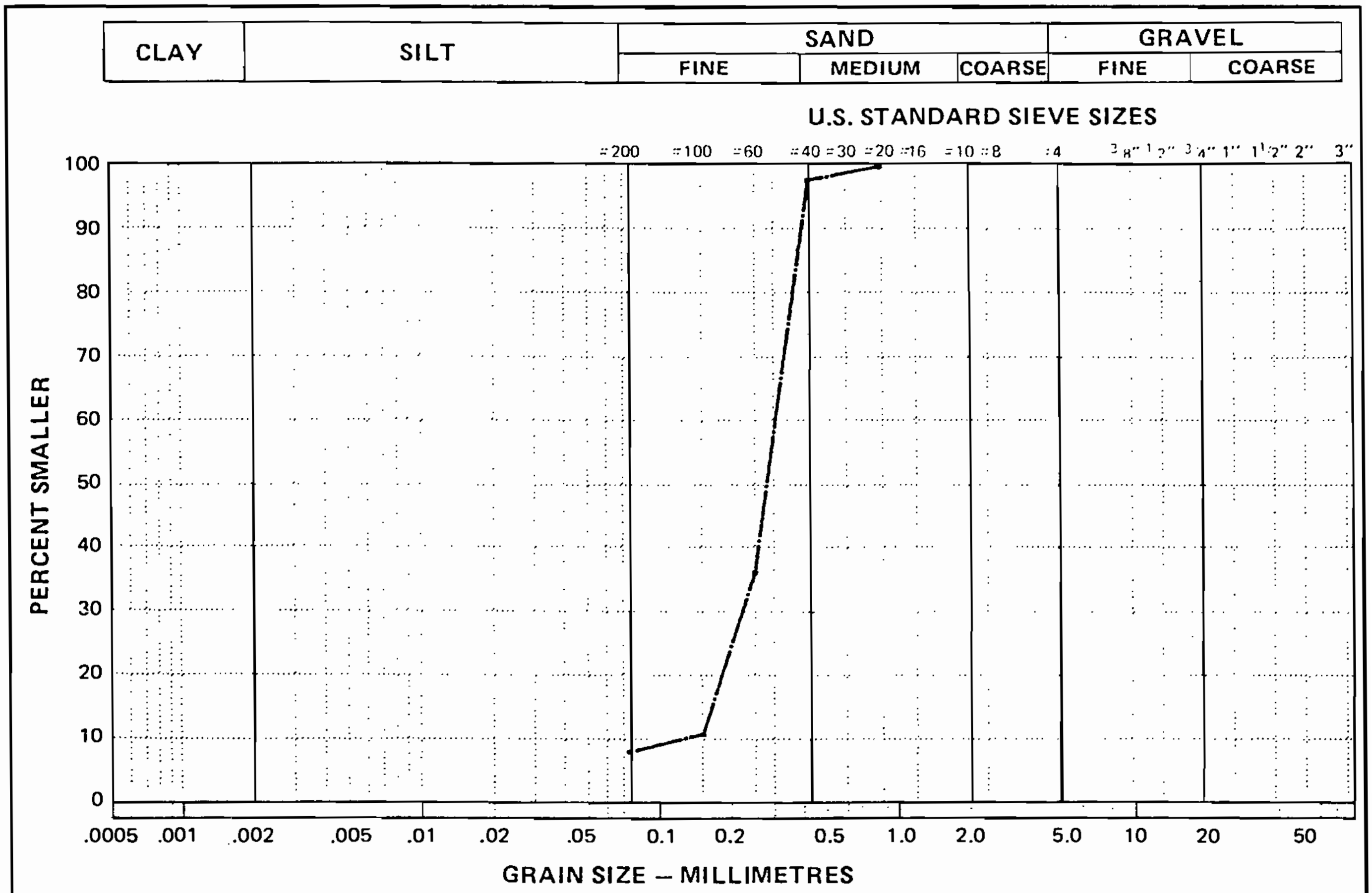
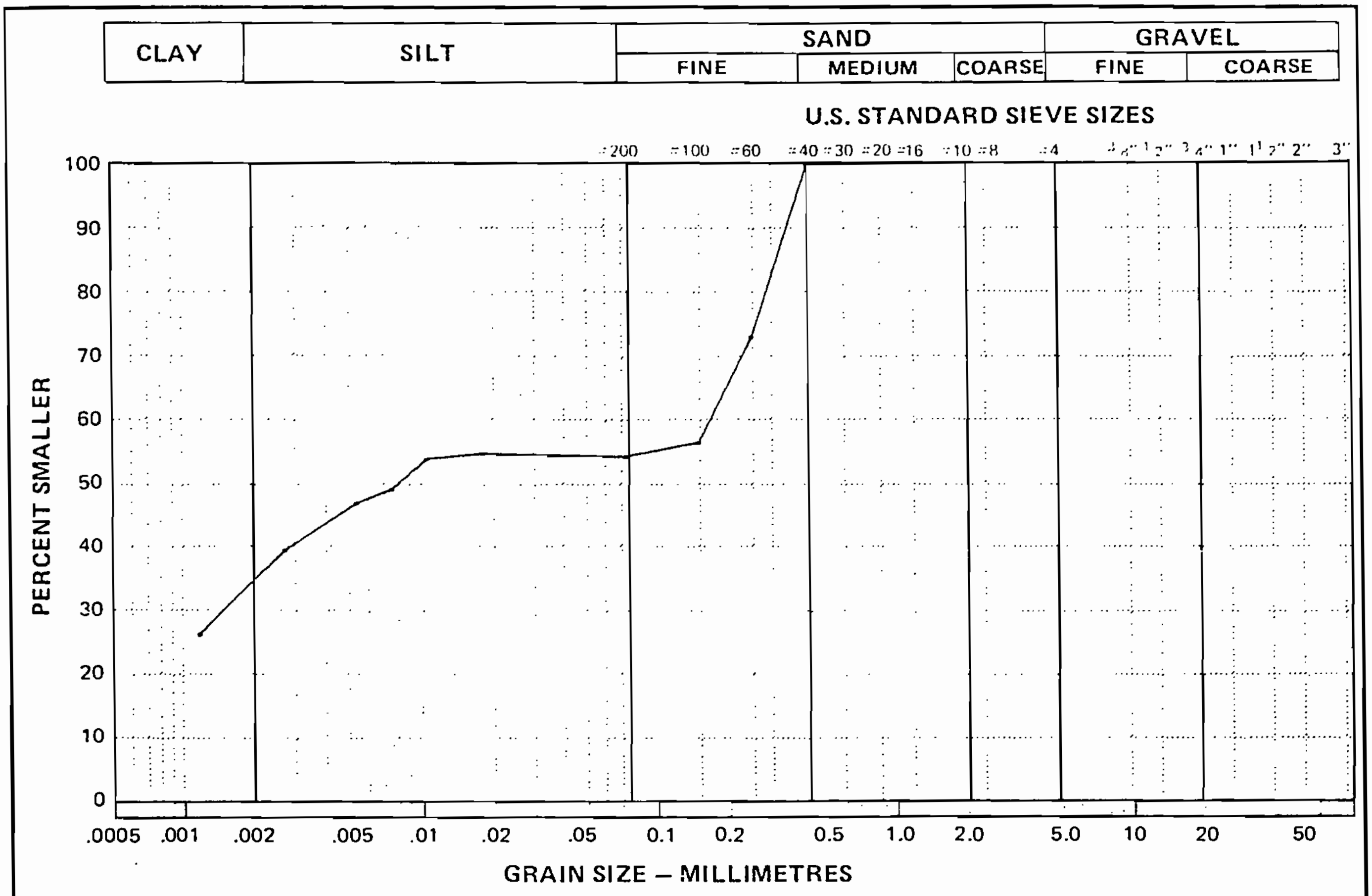
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
——	B:NER1:5	.07 - .36	-	7.3	92.7	0.0	2.1	1.1	SP-SM

JOB NO. 101-3605 **DATE** 1982 09 30

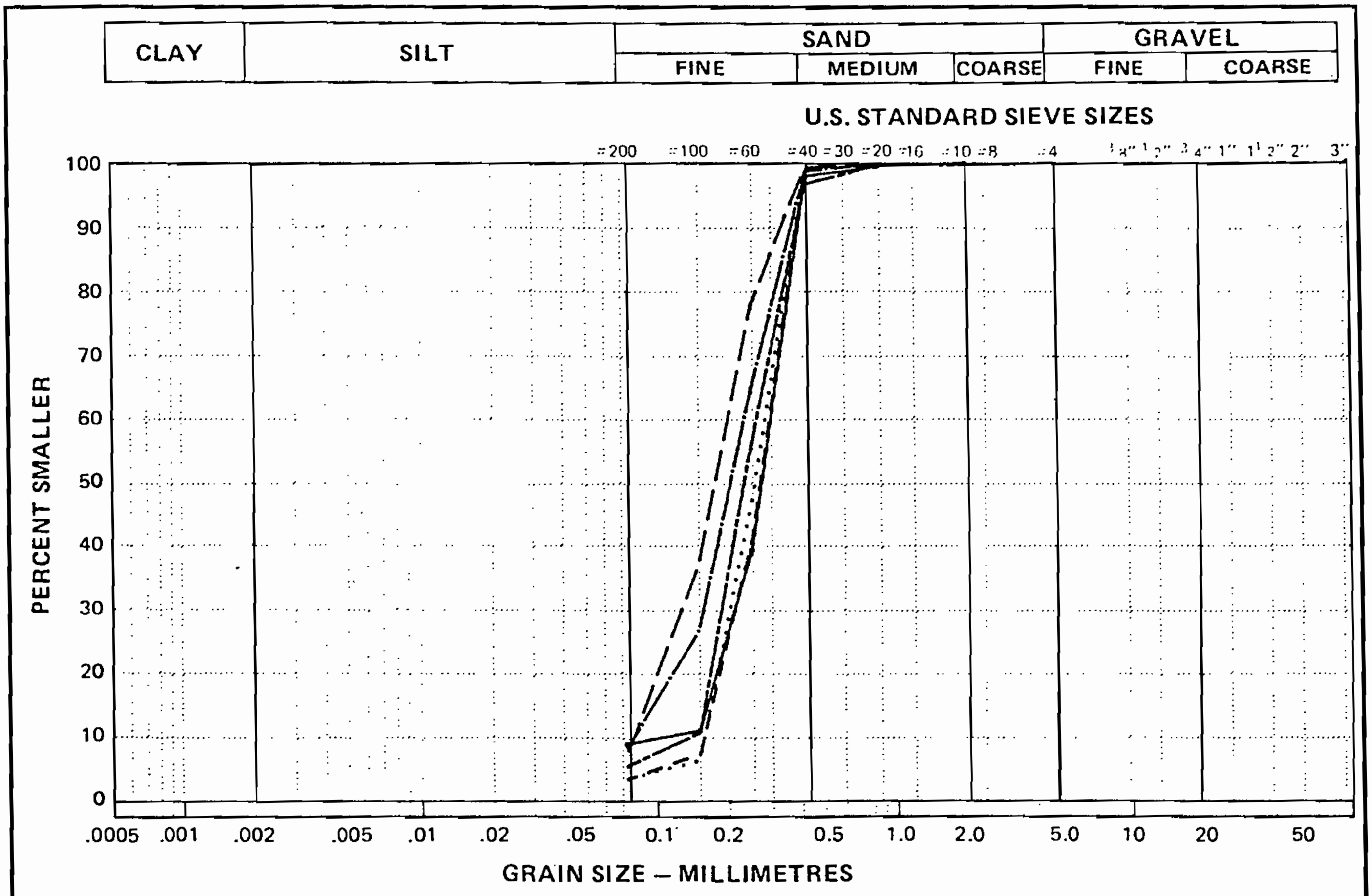
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	DESCRIPTION SILT (%)	DESCRIPTION SAND (%)	DESCRIPTION GRAVEL (%)	Cu	Cc	U.S.C.
	B: NER1: 5	.40 - .50	33.6	19.9	46.5	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-15

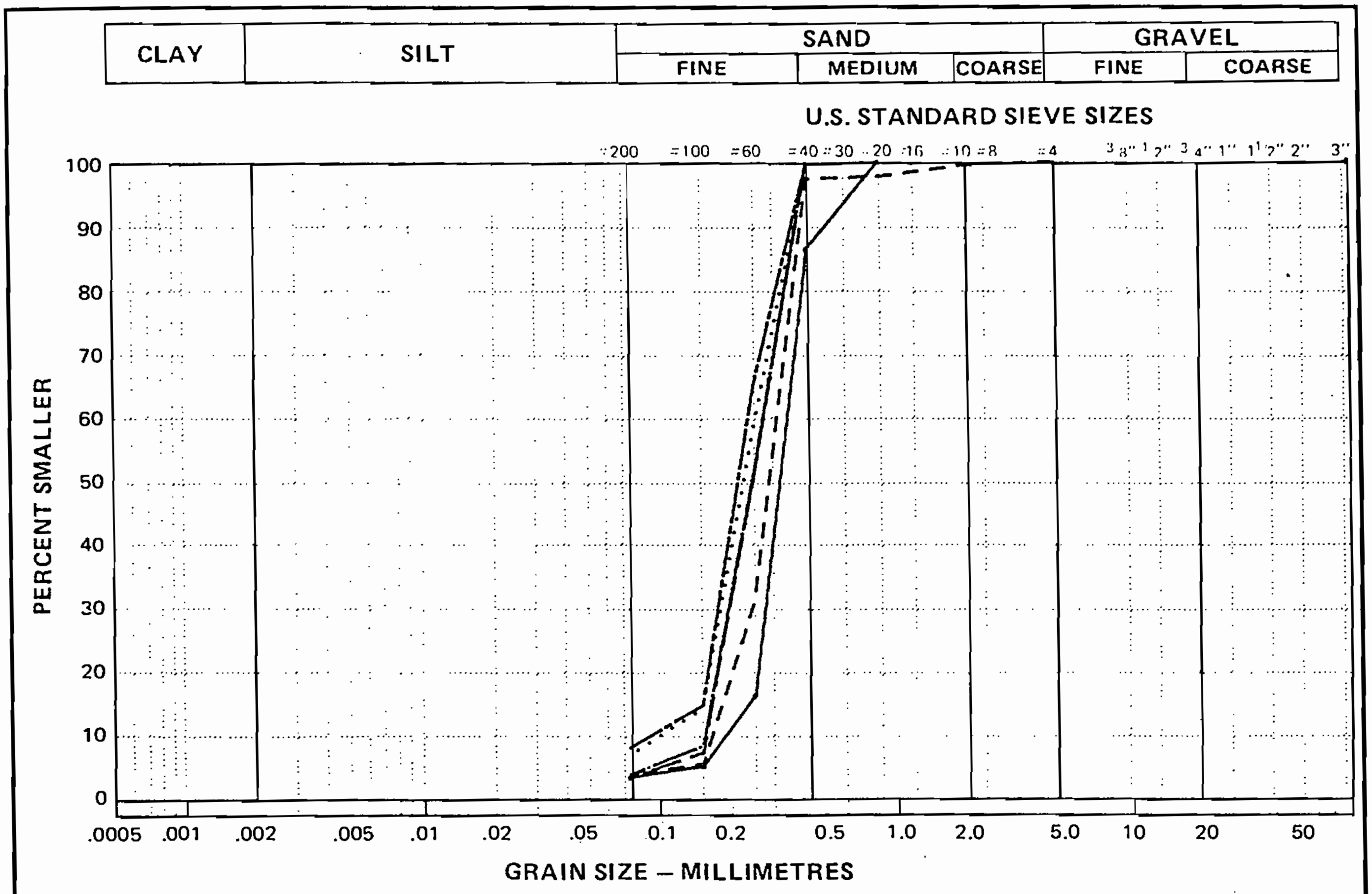
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 1: 5	1.80 - 1.98	-	7.9	92.1	0.0	2.0	1.0	SP-SM
.....	B: NER: 1: 5	3.10 - 3.15	-	2.3	97.7	0.0	1.8	.9	SP
— — —	B: NER: 1: 5	5.50 - 5.60	-	2.2	97.8	0.0	1.9	1.0	SP
—— ——	B: NER: 1: 5	6.50 - 6.50	-	6.4	93.6	0.0	2.5	1.0	SP-SM
——.—	B: NER: 1: 5	8.60 - 8.70	-	7.3	92.7	0.0	2.9	1.3	SP-SM
——..—	B: NER: 1: 5	10.20 - 10.20	-	4.3	95.7	0.0	1.8	.9	SP

JOB NO. 101 -3605 **DATE** 82-07-22

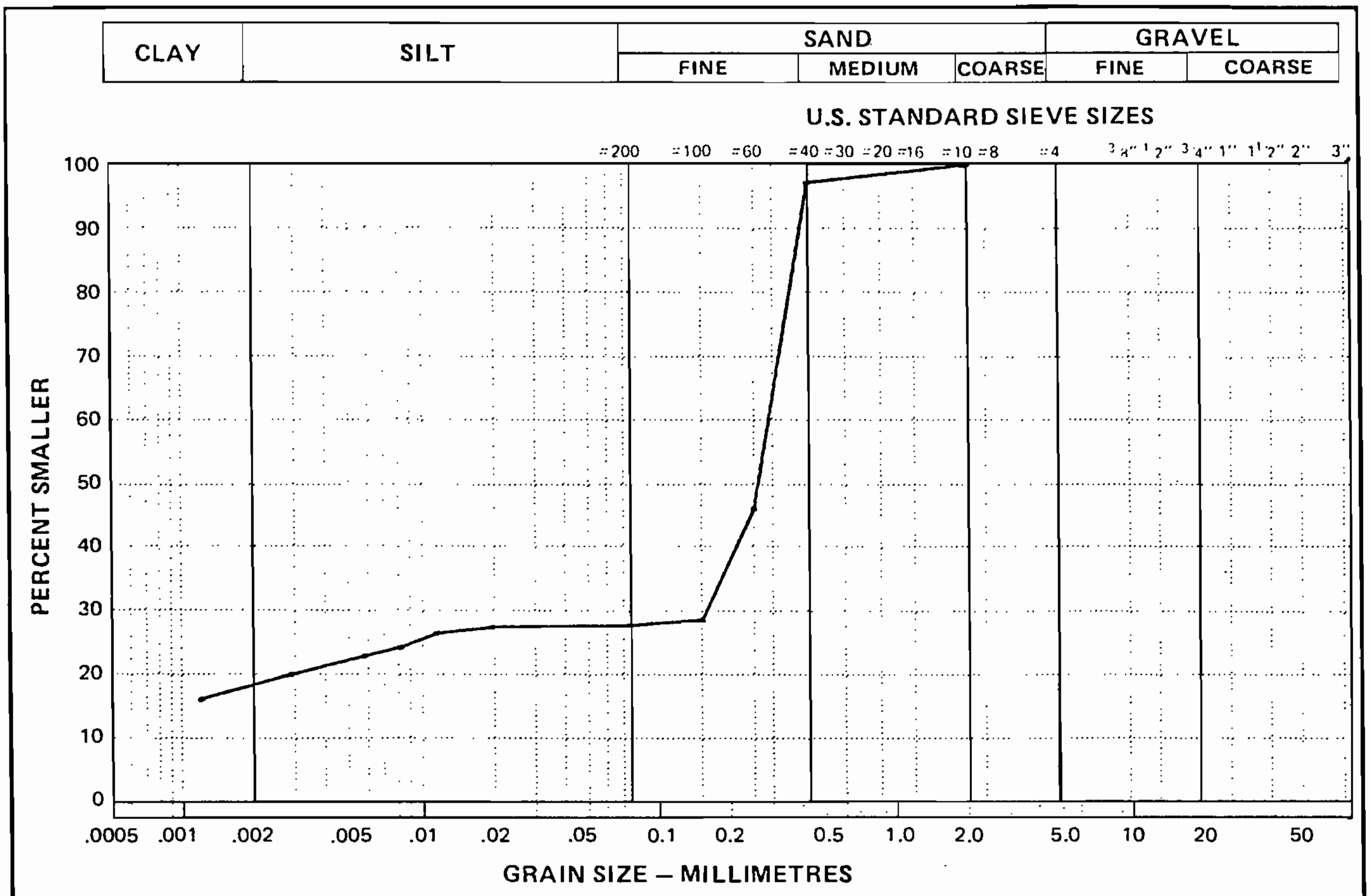
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER: 1: 5	11.20 - 11.20	-	2.2	97.8	0.0	1.8	1.1	SP
.....	B: NER: 1: 5	12.40 - 12.40	-	5.9	94.1	0.0	2.3	1.2	SP-SM
— — —	B: NER: 1: 5	13.70 - 13.70	-	2.6	97.4	0.0	1.9	1.2	SP
—— ——	B: NER: 1: 5	17.90 - 17.90	-	2.2	97.8	0.0	1.8	.9	SP
——.—	B: NER: 1: 5	26.80 - 26.80	-	2.7	97.3	0.0	1.8	.9	SP
——-—	B: NER: 1: 5	30.30 - 30.30	-	7.0	93.0	0.0	2.4	1.3	SP-SM

JOB NO. 101 -3605 DATE 82-07-22

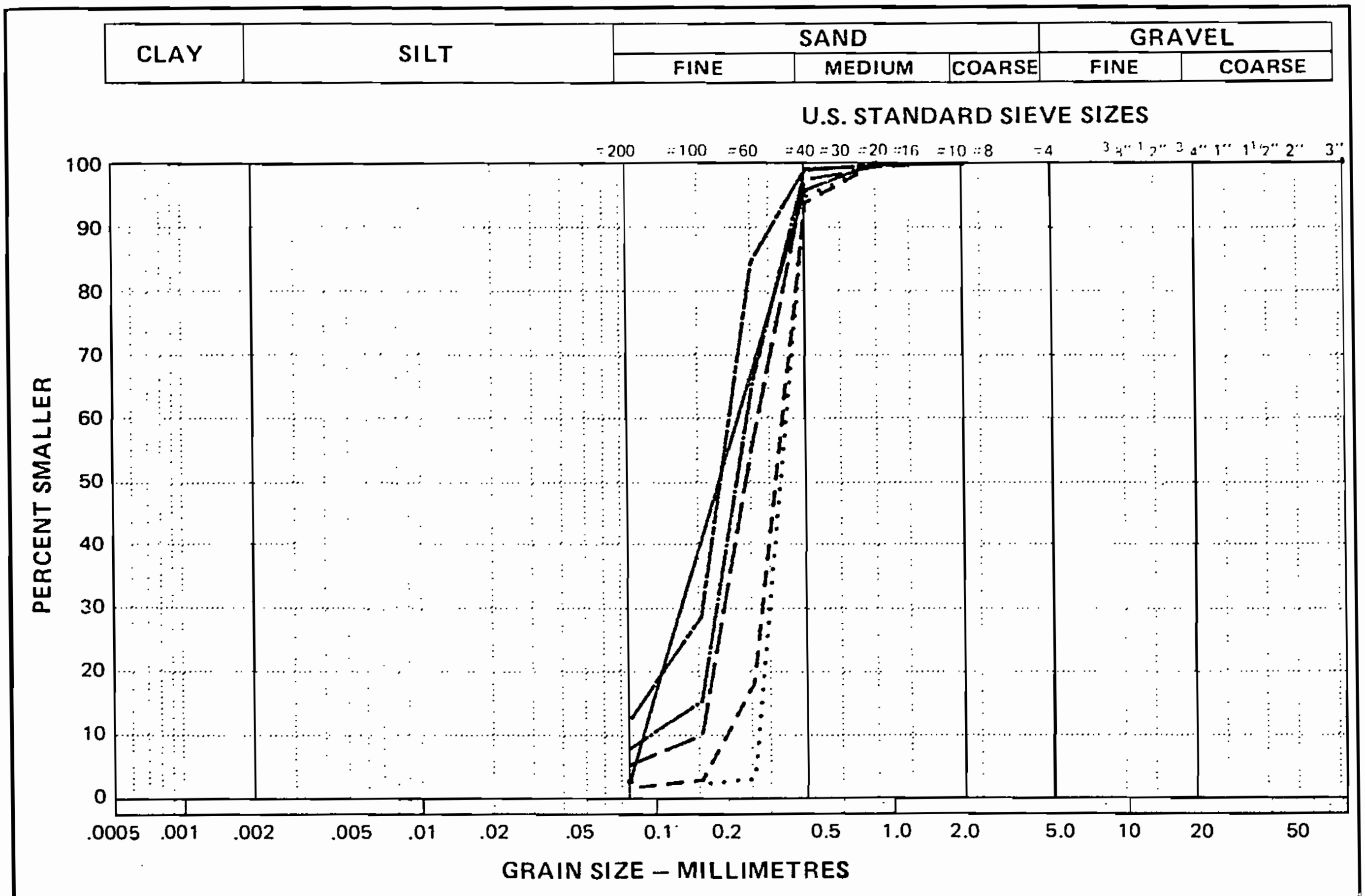
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
______	B: NER2: 1	0.00 - .14	18.1	9.0	72.9	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-09-30

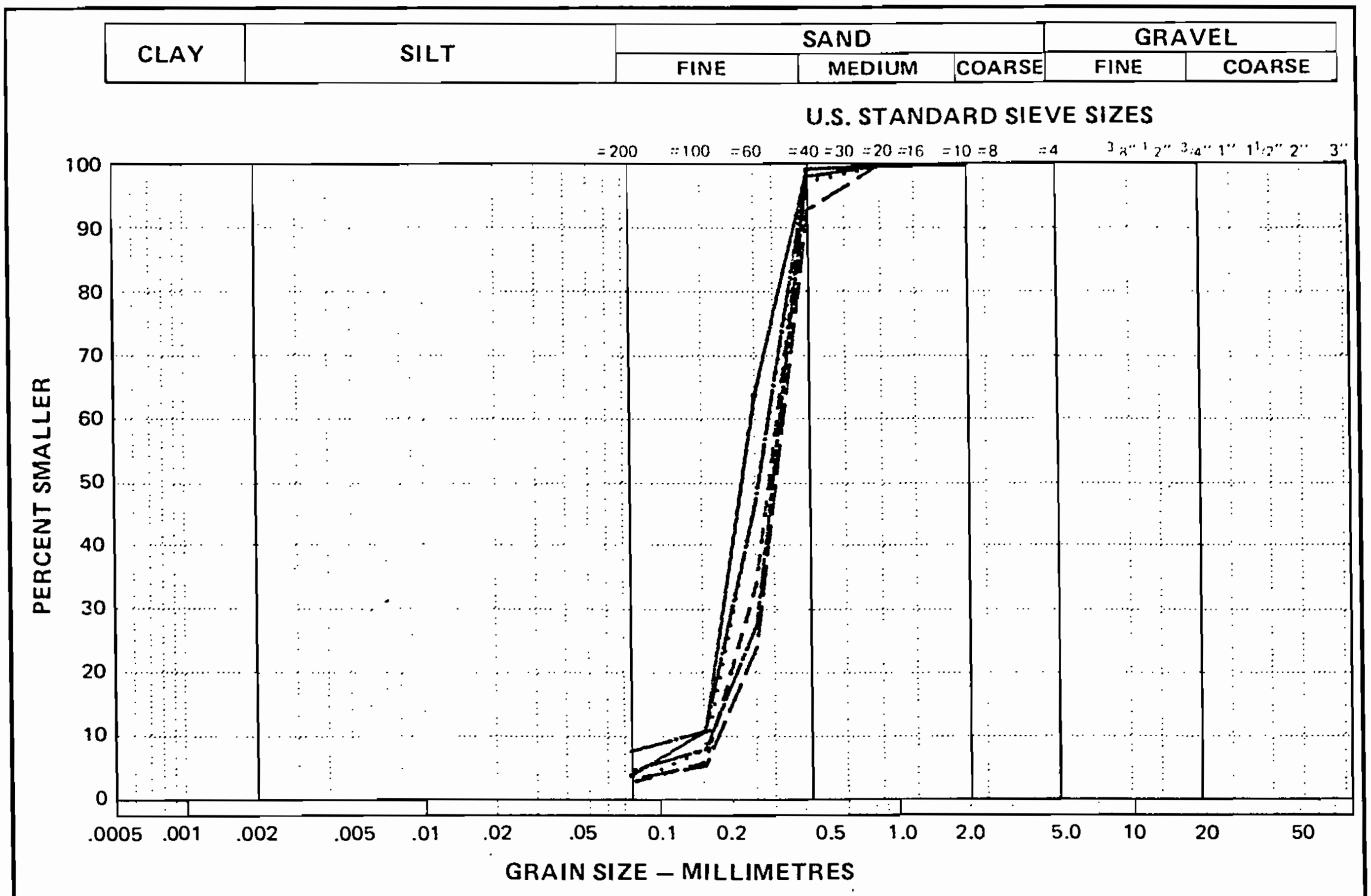
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	B: NER: 2: 1	.14 - .24	-	1.7	98.3	0.0	1.3	.9	SP
. . . . .	B: NER: 2: 1	.99 - 1.09	-	100.	0.0	0.0	1.3	.9	
_ _ _	B: NER: 2: 1	1.95 - 2.05	-	.6	99.4	0.0	1.7	1.1	SP
__ __	B: NER: 2: 1	2.79 - 2.89	-	4.3	95.7	0.0	1.7	.9	SP
____._	B: NER: 2: 1	3.76 - 3.86	-	6.9	93.1	0.0	2.4	1.3	SP-SM
____.._	B: NER: 2: 1	4.80 - 4.90	-	11.3	88.7	0.0	-	-	

JOB NO. 101 -3605 DATE 82-07-22

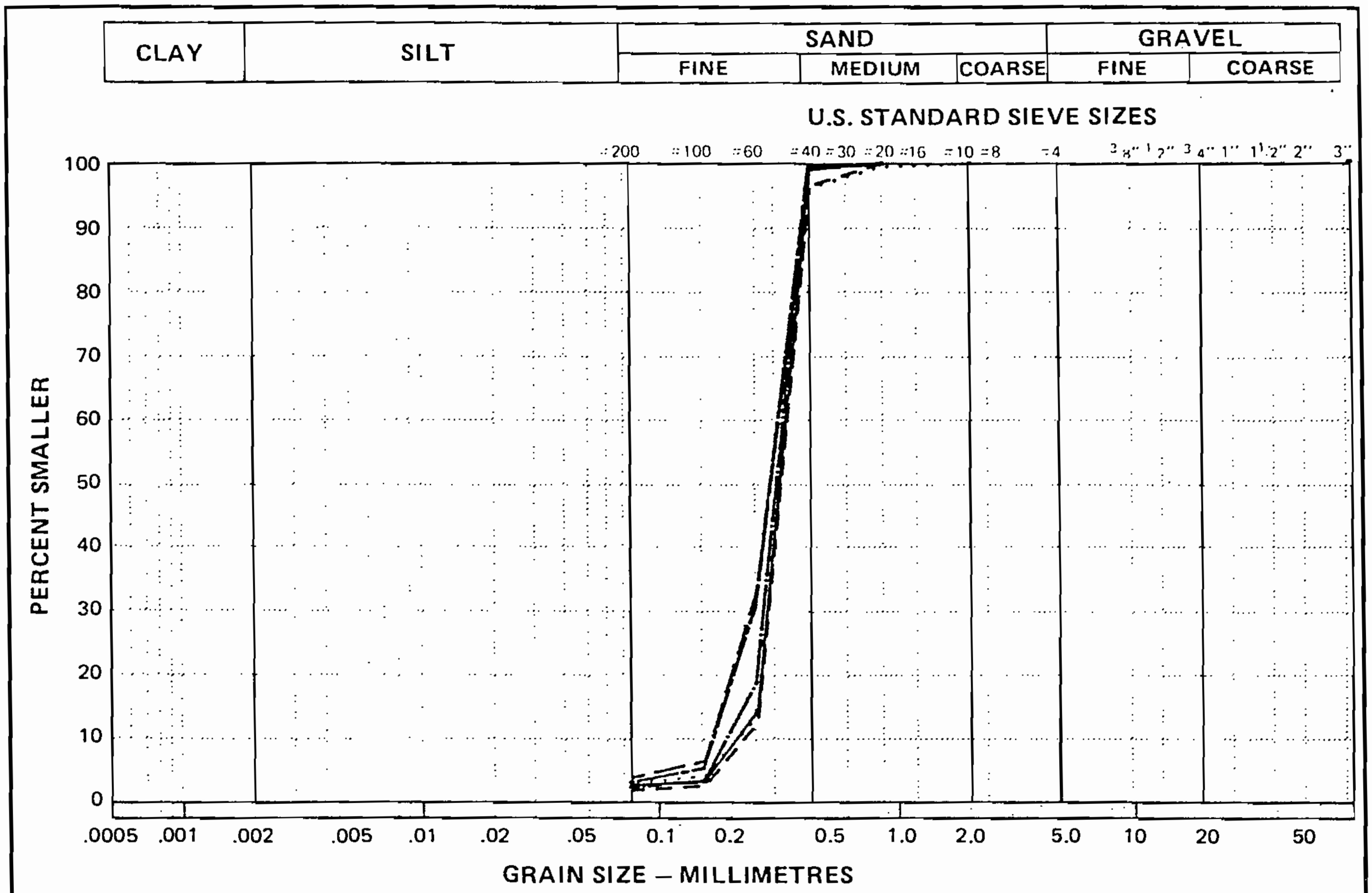
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER: 2: 1	5.69 - 5.71	-	3.0	97.0	0.0	1.6	.9	SP
· · · · ·	B: NER: 2: 1	6.30 - 6.60	-	1.8	98.2	0.0	1.8	.9	SP
— — —	B: NER: 2: 1	7.50 - 7.60	-	1.8	98.2	0.0	1.9	1.1	SP
—— ——	B: NER: 2: 1	8.40 - 8.70	-	2.4	97.6	0.0	1.9	1.2	SP
———··	B: NER: 2: 1	10.10 - 10.50	-	6.8	93.2	0.0	1.9	.9	SP-SM
——— — —	B: NER: 2: 1	12.80 - 12.90	-	3.7	96.3	0.0	2.0	1.3	SP

JOB NO. 101 -3605 DATE 82-07-22

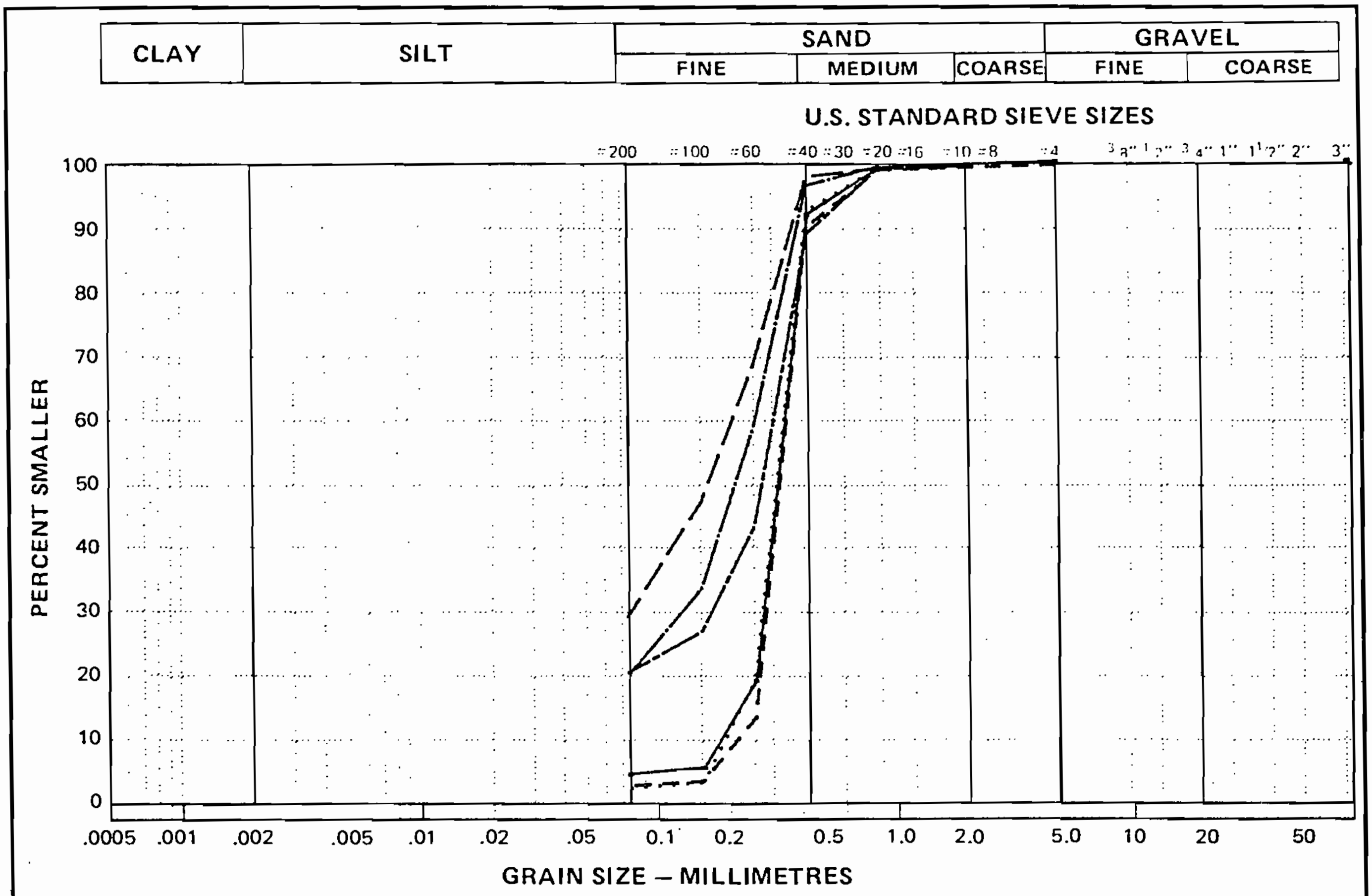
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	B:NER:2:1	14.60 - 14.90	-	1.4	98.6	0.0	1.5	1.1	SP
......	B:NER:2:1	17.80 - 18.16	-	1.8	98.2	0.0	1.5	1.1	SP
— — —	B:NER:2:1	20.70 - 21.10	-	.6	99.4	0.0	1.4	1.0	SP
—— ——	B:NER:2:1	23.80 - 24.20	-	2.6	97.4	0.0	1.9	1.1	SP
____._	B:NER:2:1	27.00 - 27.00	-	1.2	98.8	0.0	1.7	1.1	SP
____ _ _	B:NER:2:1	29.80 - 30.05	-	2.0	98.0	0.0	1.9	1.2	SP

JOB NO. 101 -3605 DATE 82-07-22

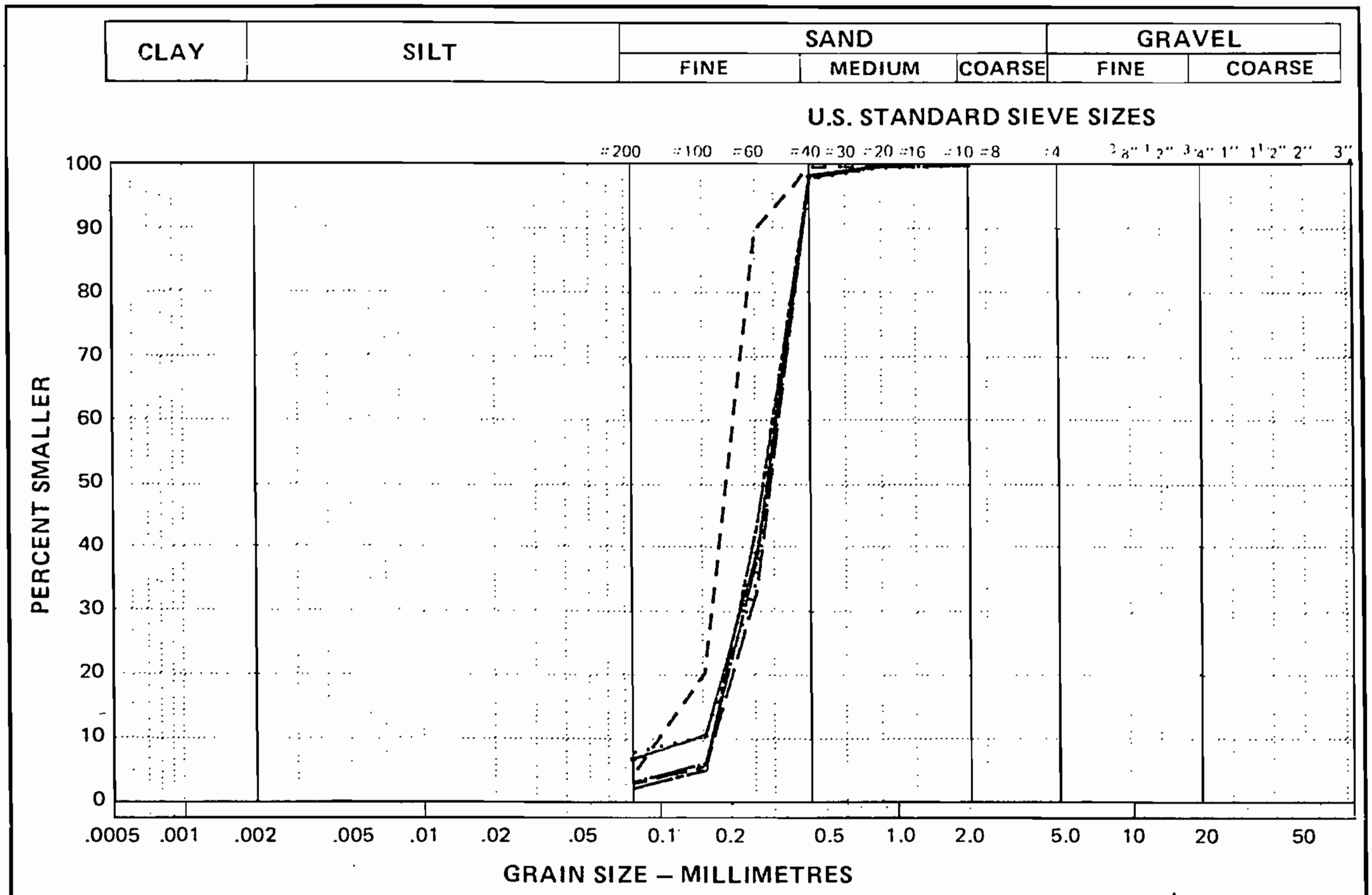
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER: 2: 2	.45 - .65	-	3.3	96.7	0.0	1.8	1.2	SP
· · · · · ·	B: NER: 2: 2	1.41 - 1.51	-	1.6	98.4	0.0	1.8	1.2	SP
— — —	B: NER: 2: 2	1.83 - 1.95	-	2.0	98.0	0.0	1.6	1.1	SP
—— ——	B: NER: 2: 2	2.18 - 2.25	-	28.9	71.1	0.0	-	-	
——·—	B: NER: 2: 2	2.85 - 2.95	-	19.6	80.4	0.0	-	-	
——··—	B: NER: 2: 2	3.80 - 3.90	-	20.0	80.0	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-08-01

PARTICLE - SIZE ANALYSIS OF SOILS

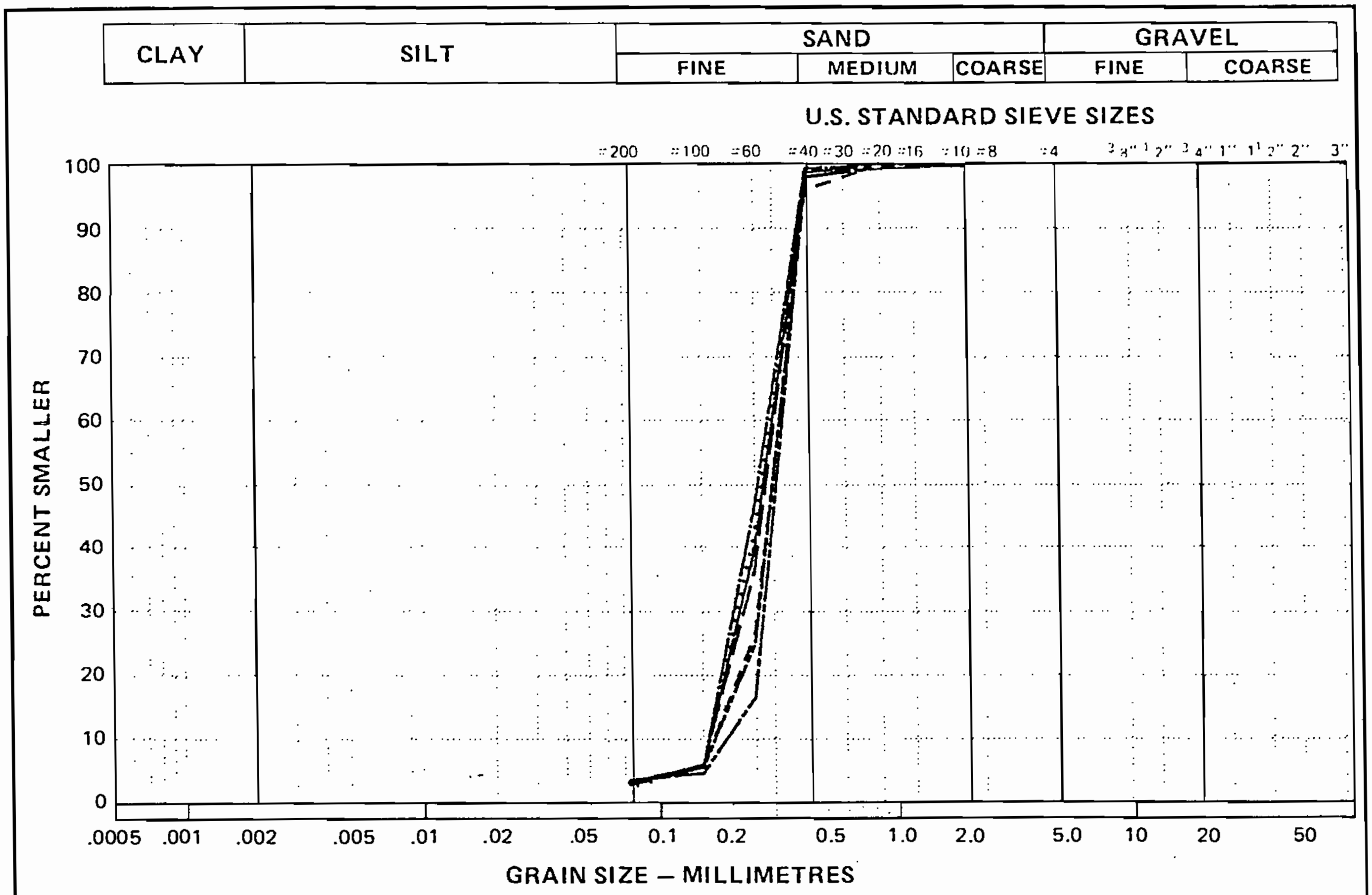


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 2: 2	4.60 - 4.70	-	6.1	93.9	0.0	2.0	1.0	SP-SM
·····	B: NER: 2: 2	5.31 - 5.60	-	7.1	92.9	0.0	2.0	1.1	SP-SM
— — —	B: NER: 2: 2	6.40 - 6.80	-	3.5	96.5	0.0	2.0	1.3	SP
—— ——	B: NER: 2: 2	8.30 - 8.40	-	2.1	97.9	0.0	1.9	1.1	SP
——·—	B: NER: 2: 2	10.10 - 10.50	-	2.3	97.7	0.0	1.9	1.0	SP
———··	B: NER: 2: 2	11.90 - 12.30	-	1.3	98.7	0.0	1.8	.9	SP

JOB NO. 101 -3605

DATE 82-08-05

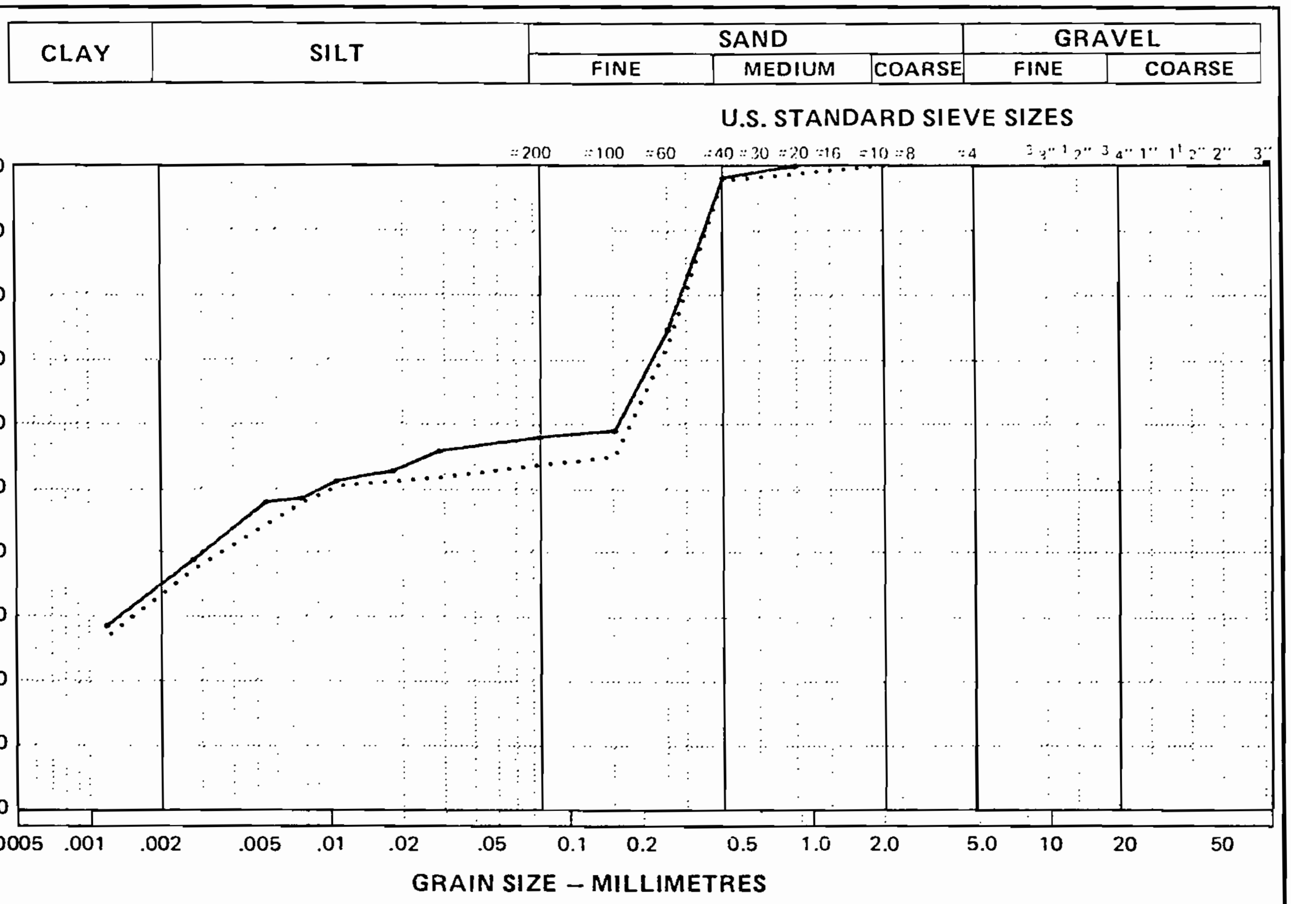
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 2: 2	13.70 - 14.00	-	2.3	97.7	0.0	1.9	1.0	SP
· · · · ·	B: NER: 2: 2	14.60 - 14.80	-	1.4	98.6	0.0	1.8	1.0	SP
— — —	B: NER: 2: 2	17.70 - 18.00	-	2.4	97.6	0.0	1.9	1.2	SP
—— ——	B: NER: 2: 2	20.70 - 21.10	-	1.9	98.1	0.0	1.9	1.0	SP
——·—	B: NER: 2: 2	23.80 - 24.20	-	2.2	97.8	0.0	1.8	.9	SP
————	B: NER: 2: 2	26.80 - 27.20	-	2.6	97.4	0.0	1.7	1.2	SP
——— —	B: NER: 2: 2	29.90 - 30.30	-	1.9	98.1	0.0	1.9	1.2	SP

JOB NO. 101 -3605 DATE 82-08-05

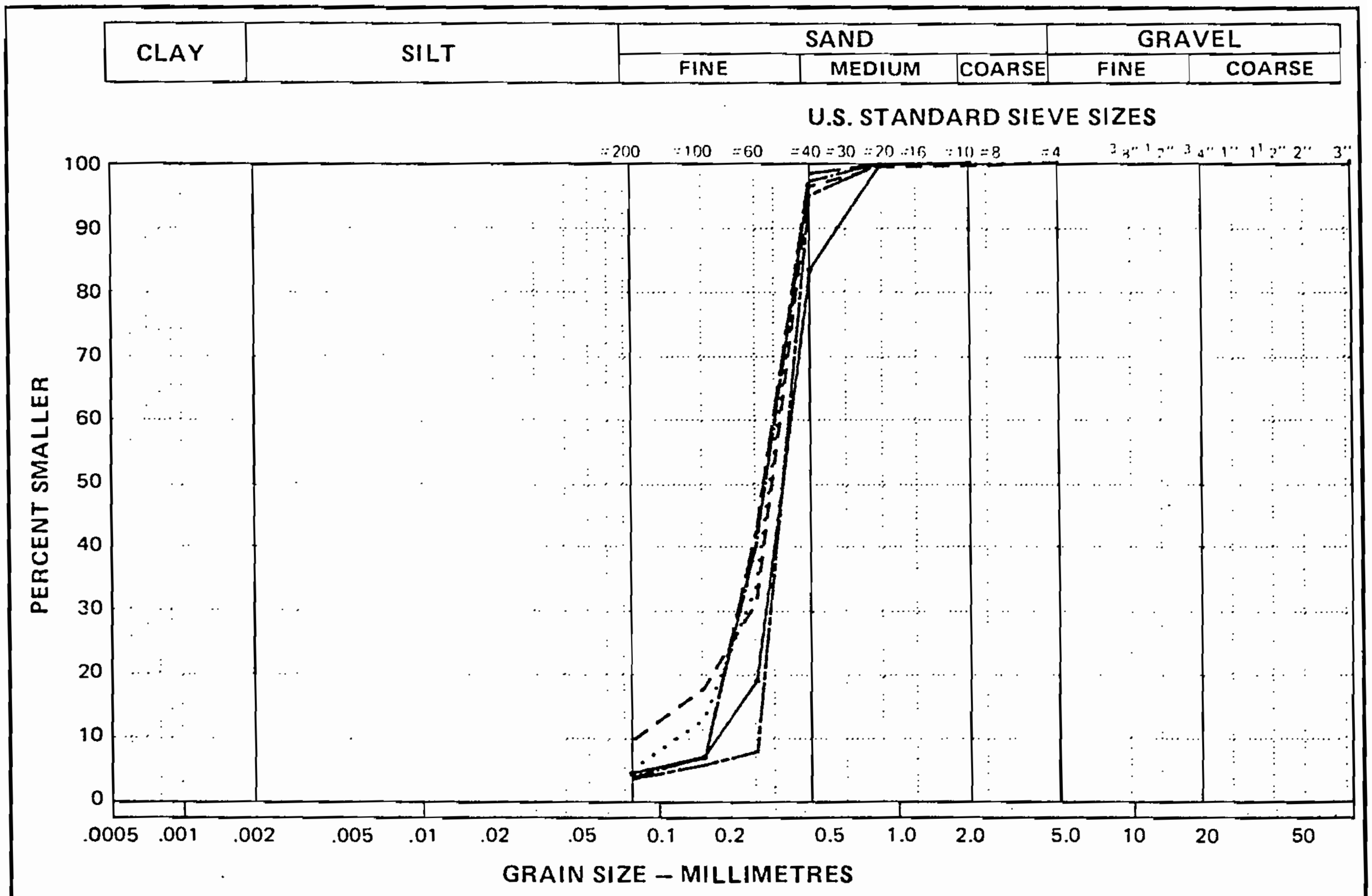
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	 SILT (%)	 SAND (%)	 GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER2: 2	0.00 - .45	35.1	22.4	42.5	0.0	-	-	
. . . . . .	B: NER2: 2	.91 - 1.41.	33.5	19.7	46.8	0.0	-	-	

JOB NO. 101 -3605 DATE 82-08-30

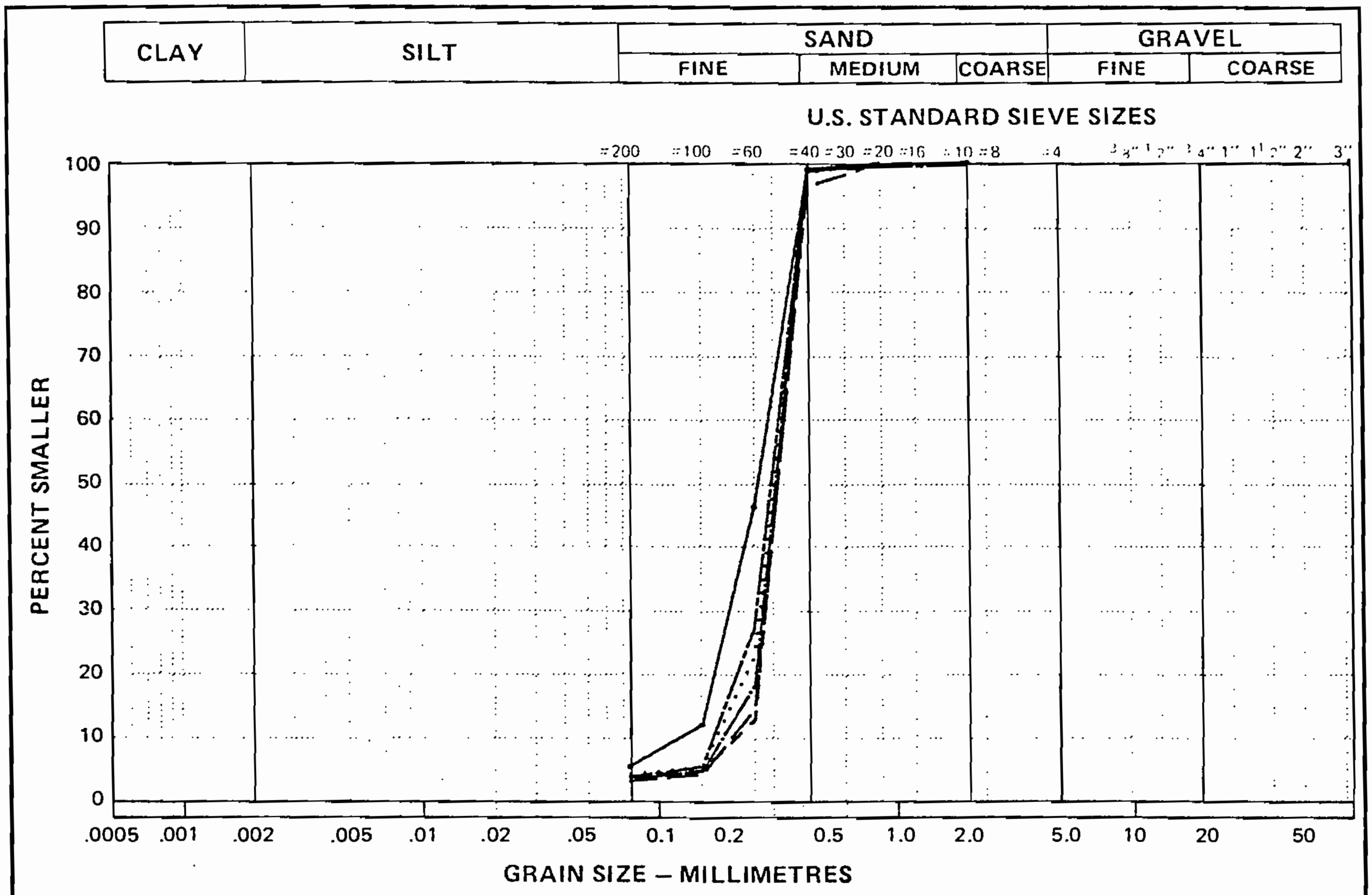
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
————	B: NER: 2: 10	2.00 - 2.20	-	3.3	96.7	0.0	2.0	1.2	SP
· · · · · ·	B: NER: 2: 10	2.70 - 3.20	-	3.9	96.1	0.0	2.5	1.4	SP
— — —	B: NER: 2: 10	3.70 - 4.10	-	8.4	91.6	0.0	3.8	2.3	SP-SM
—— ——	B: NER: 2: 10	4.60 - 4.90	-	3.4	96.6	0.0	1.9	.9	SP
———·—	B: NER: 2: 10	7.31 - 7.60	-	2.6	97.4	0.0	1.9	1.0	SP
—————	B: NER: 2: 10	9.17 - 9.50	-	2.3	97.7	0.0	1.4	.9	SP

JOB NO. 101 -3605 **DATE** 82-08-05

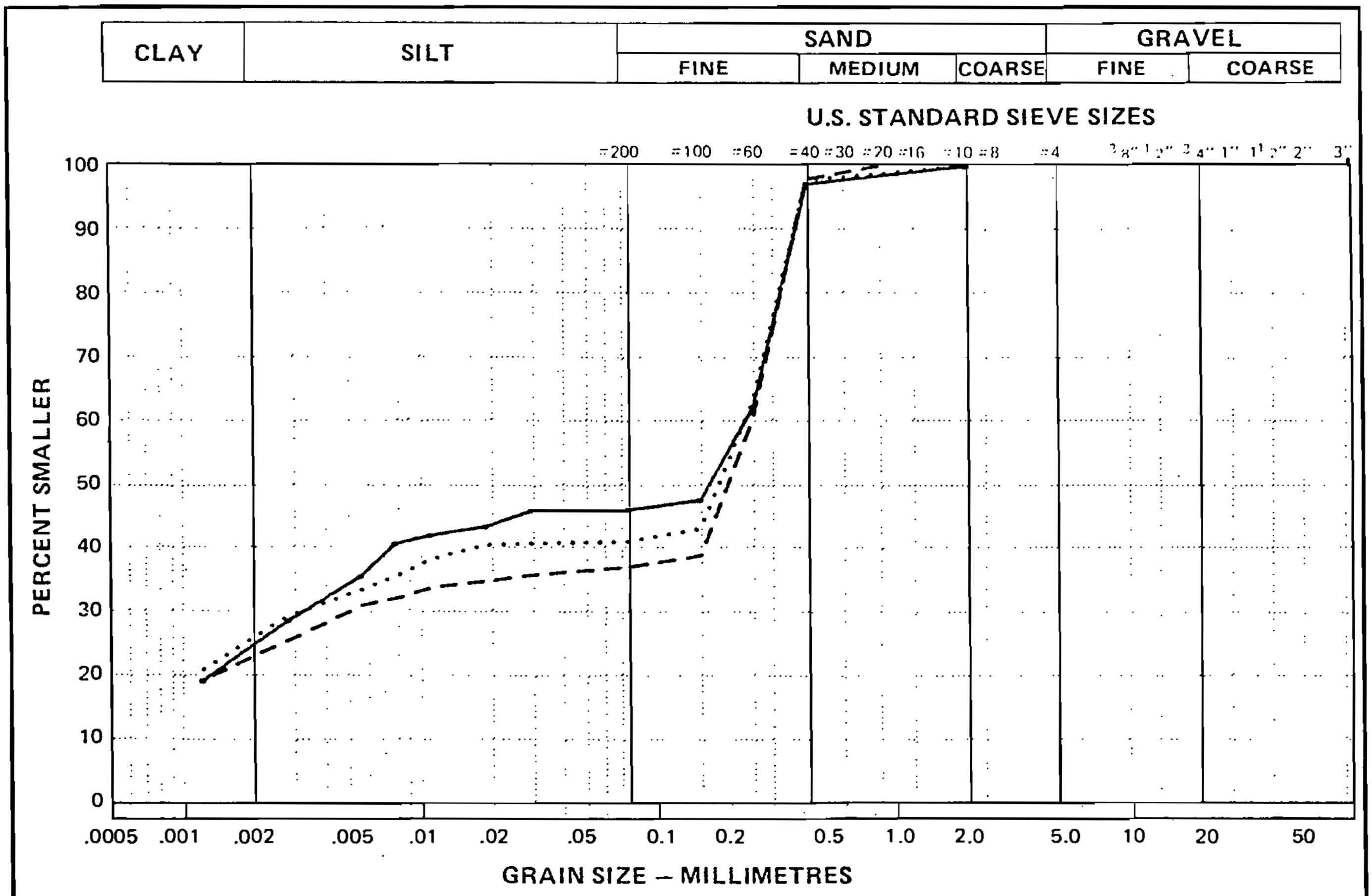
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 2: 10	10.97 - 11.40	-	4.2	95.8	0.0	2.1	1.0	SP
. . . . .	B: NER: 2: 10	12.80 - 13.34	-	3.1	96.9	0.0	1.8	1.2	SP
— — —	B: NER: 2: 10	14.63 - 15.00	-	2.5	97.5	0.0	1.5	1.0	SP
—— ——	B: NER: 2: 10	18.60 - 18.90	-	1.8	98.2	0.0	1.6	1.1	SP
——·—	B: NER: 2: 10	24.70 - 25.00	-	2.1	97.9	0.0	1.7	1.2	SP
———	B: NER: 2: 10	3.08 - 3.11	-	3.0	97.0	0.0	1.9	1.2	SP

JOB NO. 101 -3605 DATE 82-08-05

PARTICLE - SIZE ANALYSIS OF SOILS

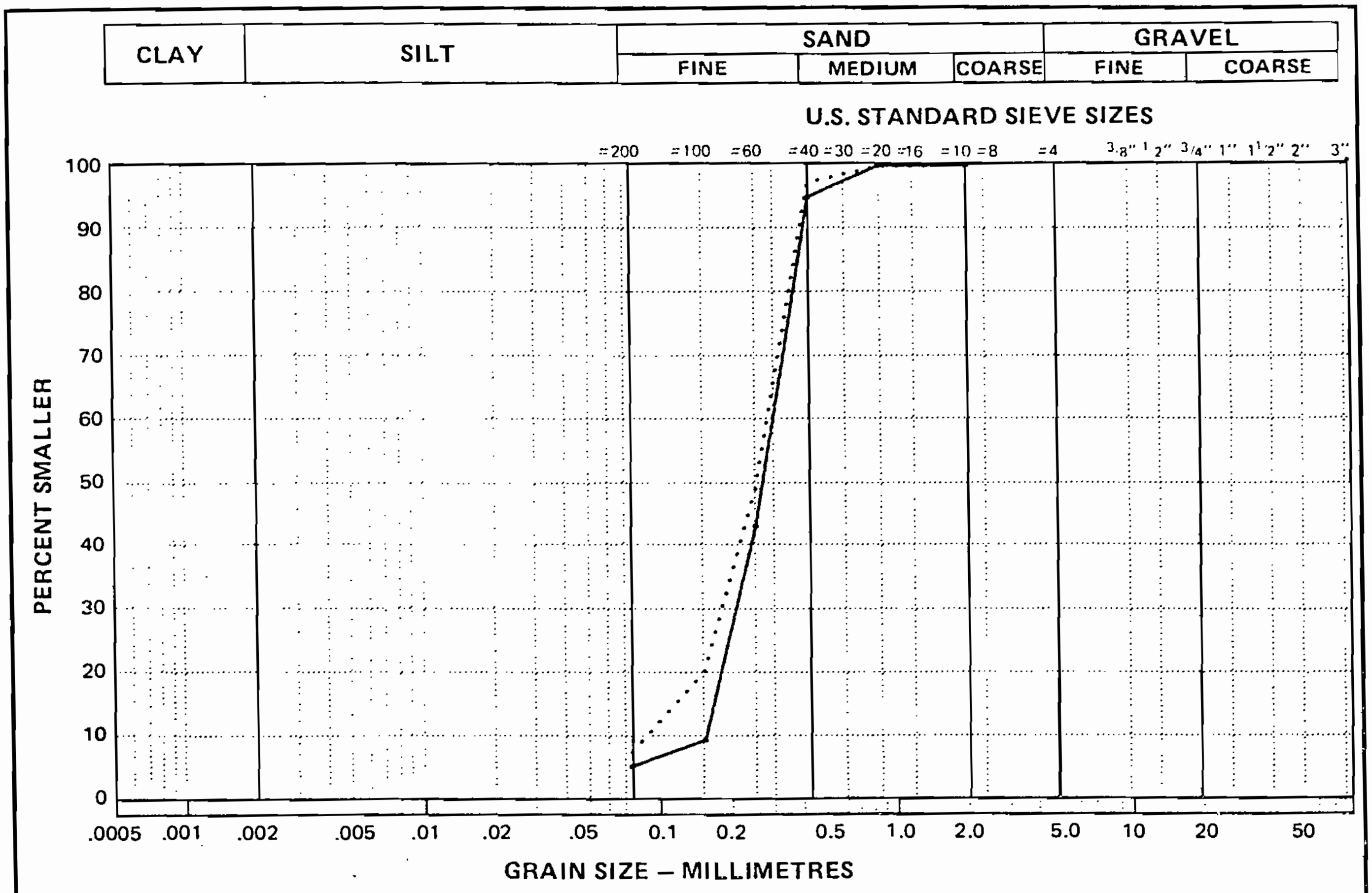


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER2: 10	0.00 - .50	24.7	21.0	54.3	0.0	-	-	
......	B: NER2: 10	.91 - 1.40	25.7	14.9	59.4	0.0	-	-	
— — —	B: NER2: 10	1.82 - 2.00	22.7	13.8	63.5	0.0	-	-	

JOB NO. 101 -3605

DATE 82-09-22

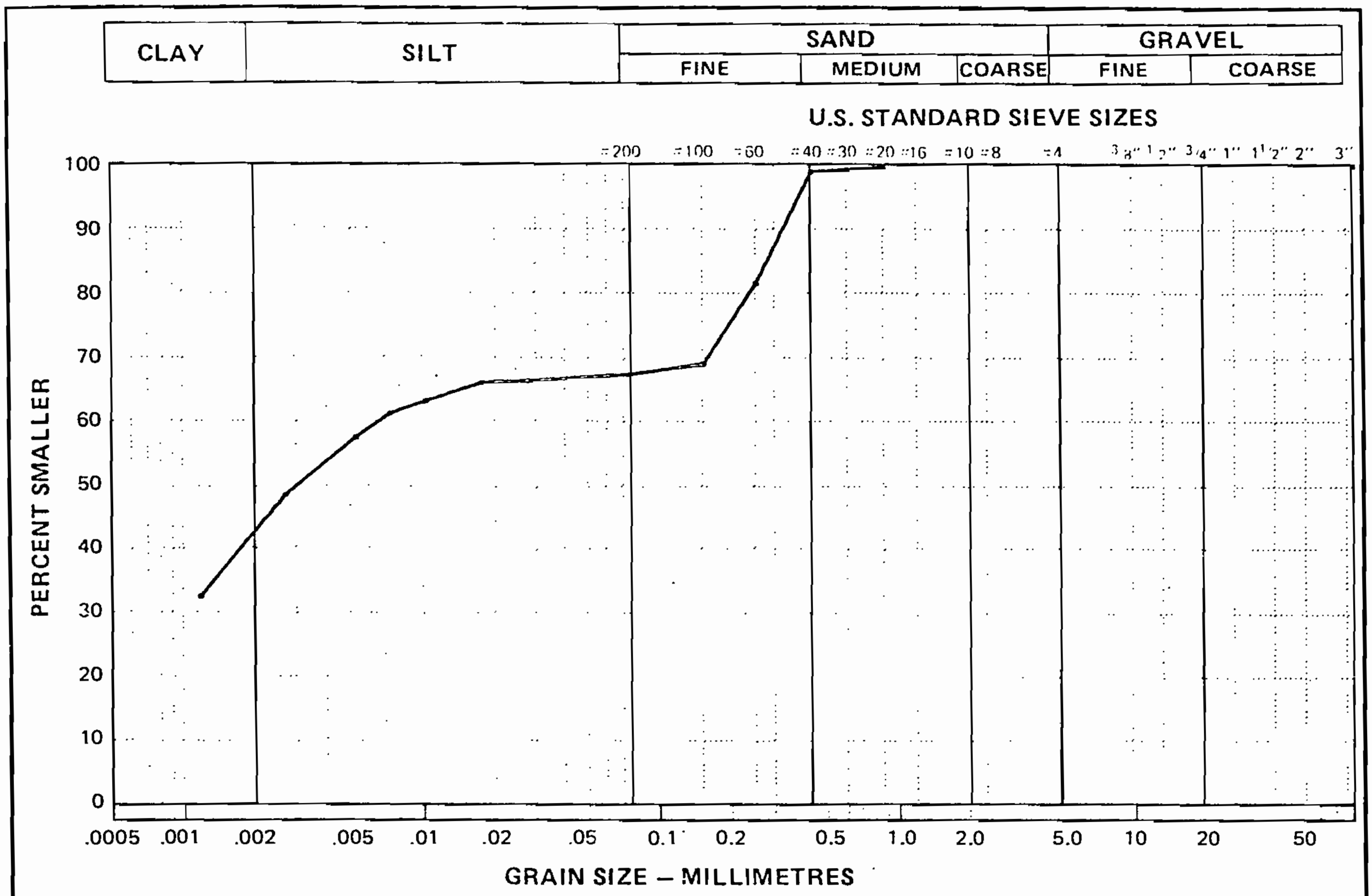
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B. NER. 3.1	.91 - 1.30	-	4.4	95.6	0.0	1.9	.9	SP
......	B. NER. 3.1	2.74 - 3.10	-	6.6	93.4	0.0	3.2	1.3	SP-SM

JOB NO. 101 -3605 **DATE** 82-09-20

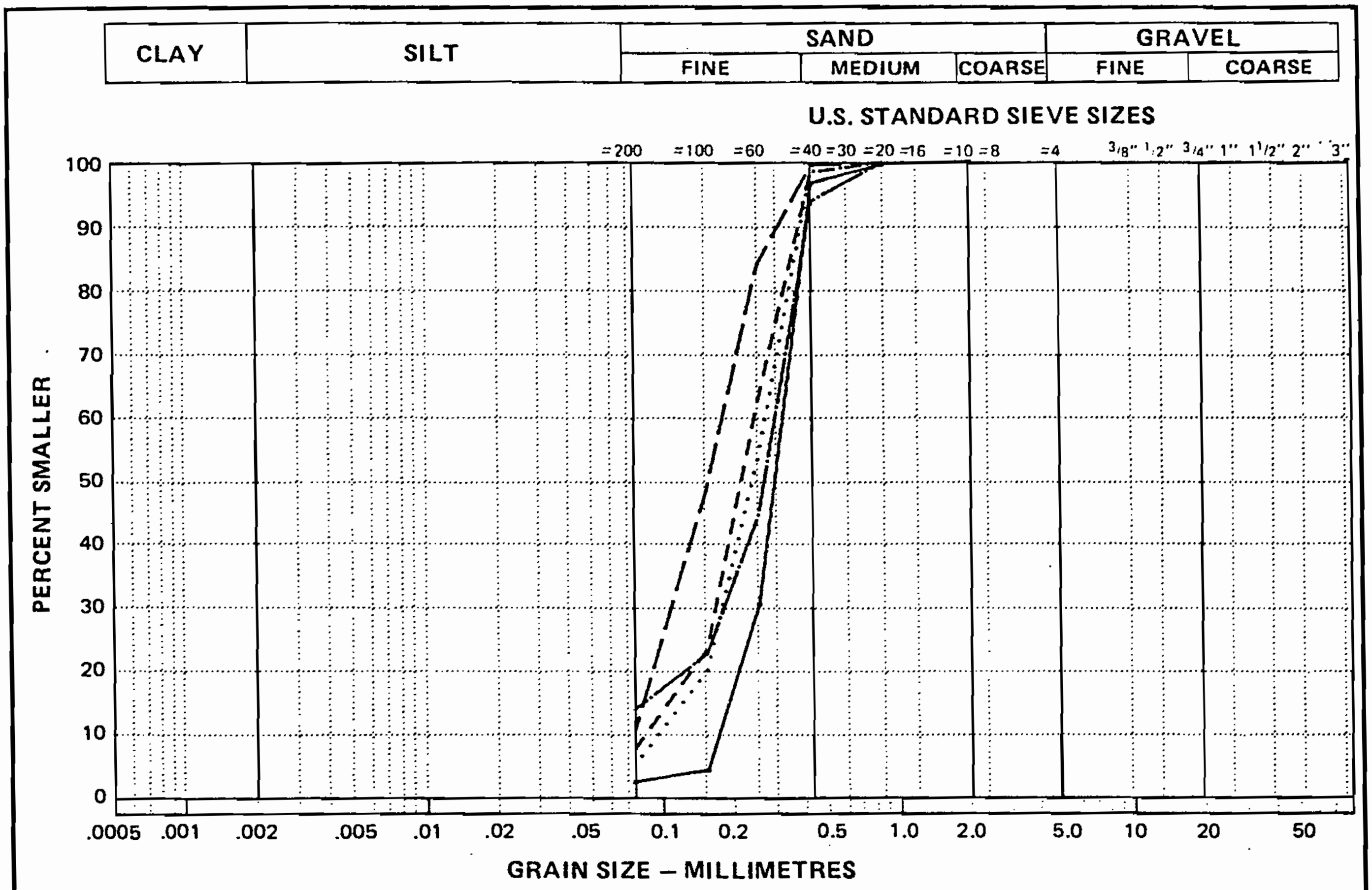
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B:NER3:1B	0.00 - .12	43.1	24.4	32.5	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-18

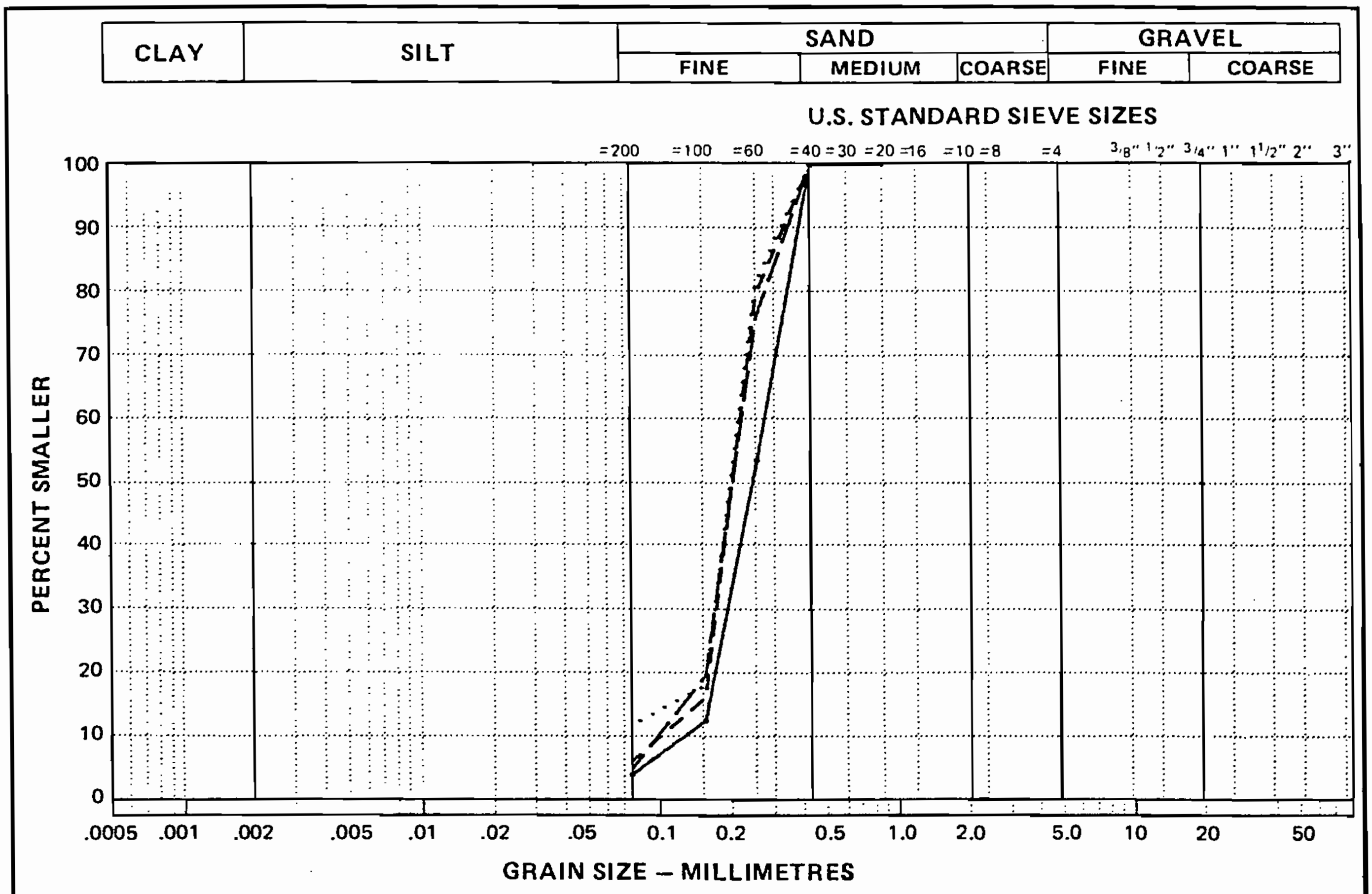
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 1B	1.50 - 1.50	-	1.3	98.7	0.0	1.9	1.2	SP
. . . . .	B: NER: 3: 1B	3.00 - 3.00	-	4.1	95.9	0.0	2.8	1.2	SP
— — —	B: NER: 3: 1B	4.75 - 4.75	-	6.7	93.3	0.0	2.8	1.3	SP-SM
—— ——	B: NER: 3: 1B	6.50 - 6.50	-	9.7	90.3	0.0	2.4	.9	SP-SM
——.—	B: NER: 3: 1B	8.50 - 8.50	-	12.9	87.1	0.0	-	-	

JOB NO. 101 -3605 DATE 82-09-20

PARTICLE - SIZE ANALYSIS OF SOILS

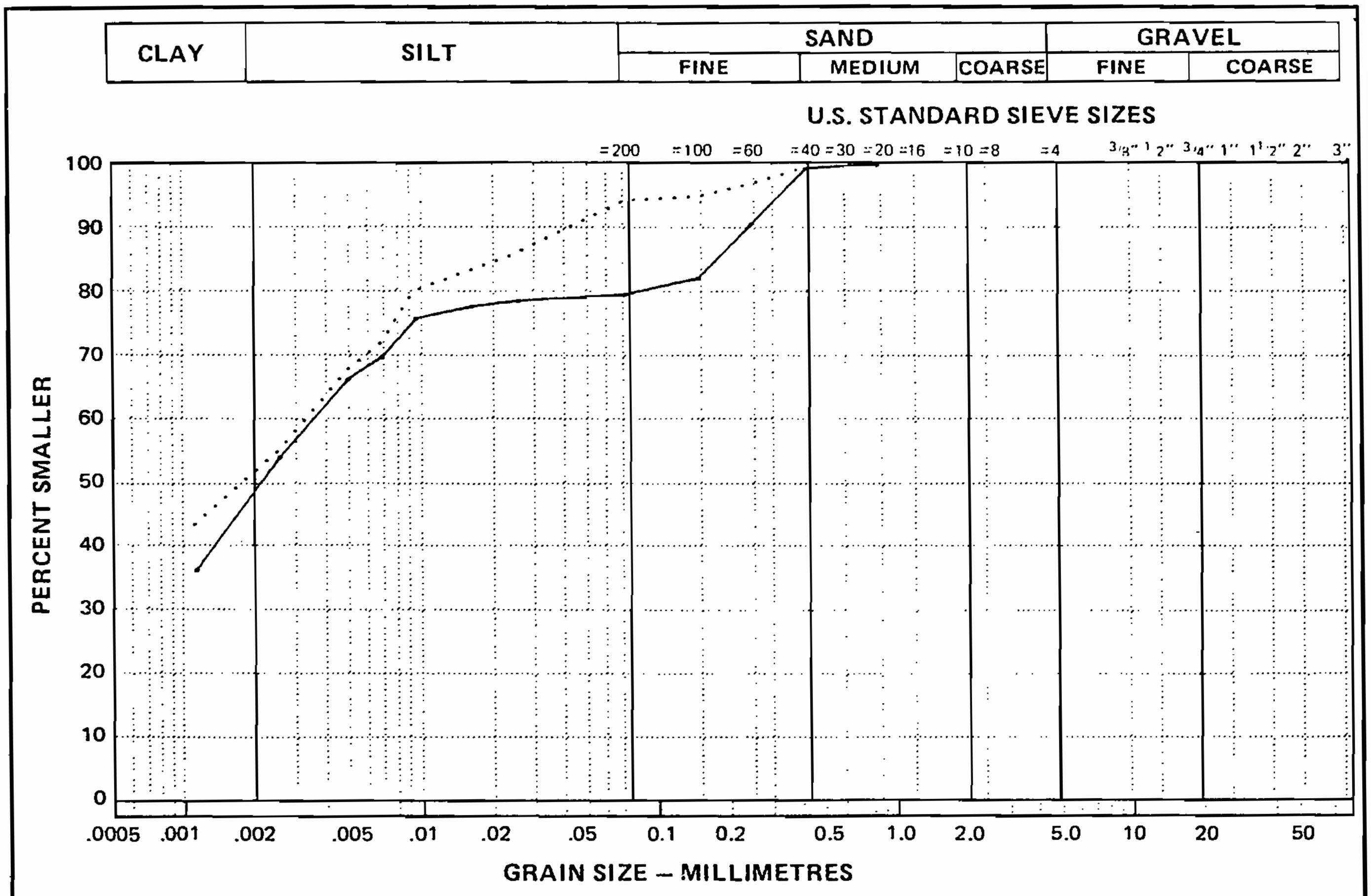


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 1B	13.00 - 13.00	-	3.0	97.0	0.0	2.0	1.0	SP
·····	B: NER: 3: 1B	14.00 - 14.00	-	10.8	89.2	0.0	-	-	
— — —	B: NER: 3: 1B	16.25 - 16.25	-	5.1	94.9	0.0	2.1	1.3	SP-SM
—— ——	B: NER: 3: 1B	22.75 - 22.75	-	3.9	96.1	0.0	2.2	1.3	SP

JOB NO. 101 -3605

DATE 82-09-20

PARTICLE - SIZE ANALYSIS OF SOILS



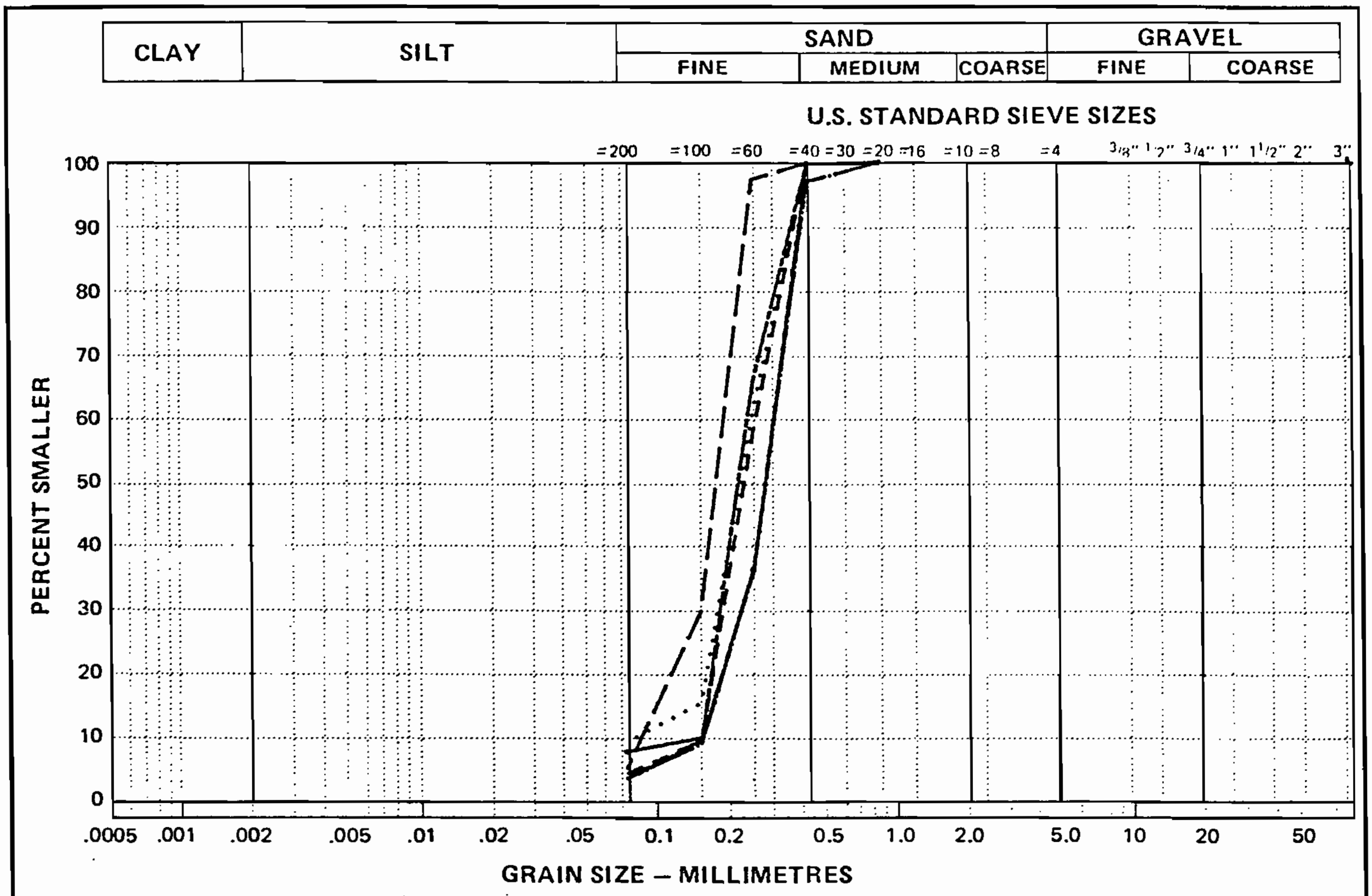
SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER3: 2	0.00 - .20	48.0	31.7	20.3	0.0	-	-	
. . . . .	B: NER3: 2	7.30 - 7.90	51.4	43.3	5.3	0.0	-	-	

JOB NO. 101 -3605

DATE 82-11-15

2094a

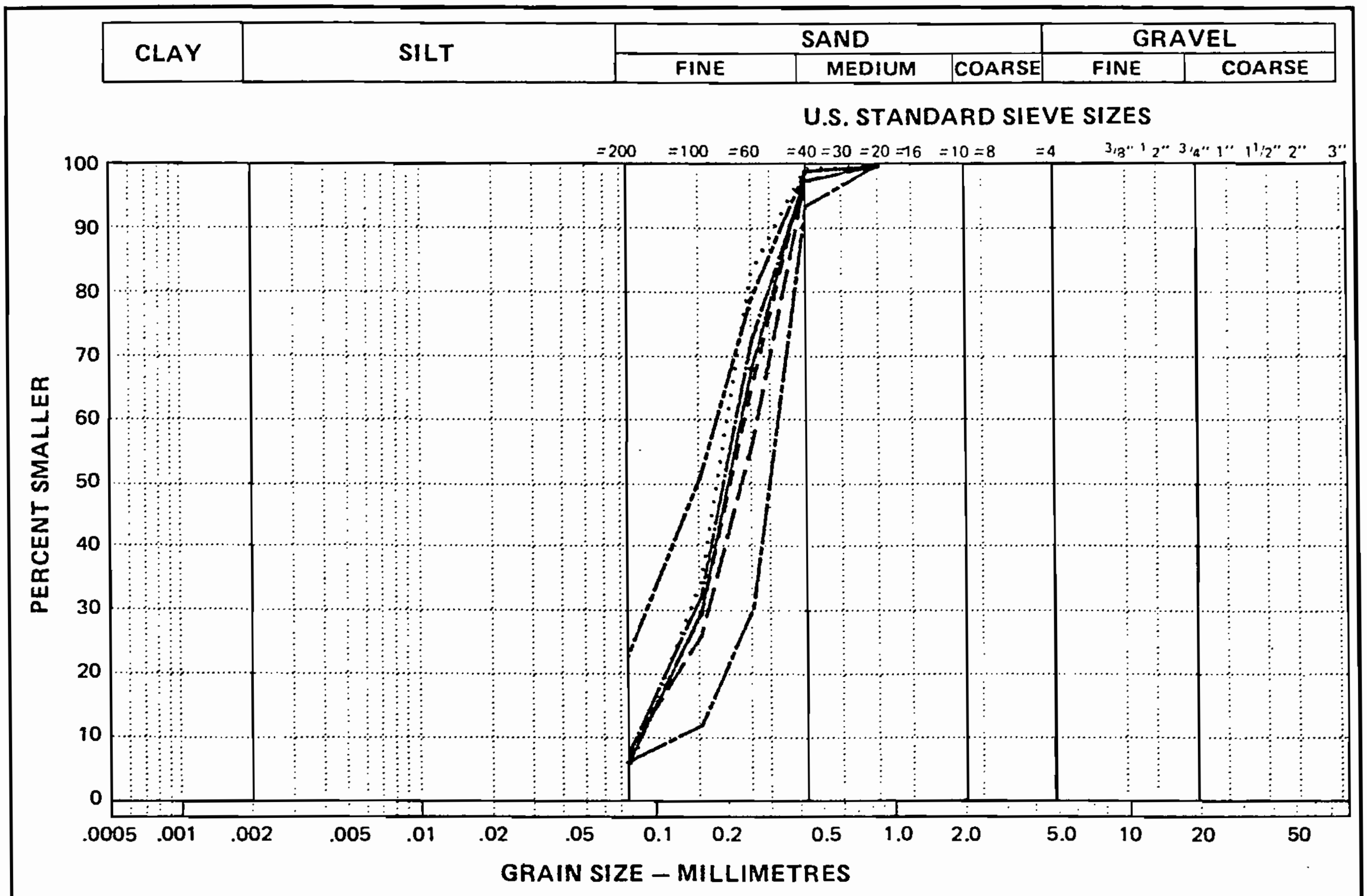
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B:NER:3:2	10.30 - 10.30	-	6.7	93.3	0.0	2.0	1.1	SP-SM
· · · · ·	B:NER:3:2	12.00 - 12.00	-	8.3	91.7	0.0	2.8	1.4	SP-SM
— — —	B:NER:3:2	14.00 - 14.00	-	3.2	96.8	0.0	1.7	.9	SP
—— ——	B:NER:3:2	16.00 - 16.00	-	4.1	95.9	0.0	2.2	1.4	SP
——·—	B:NER:3:2	22.00 - 22.00	-	2.4	97.6	0.0	2.0	1.1	SP
————	B:NER:3:2	28.20 - 28.20	-	2.4	97.6	0.0	1.6	.9	SP

JOB NO. 101 -3605 DATE 82-08-07

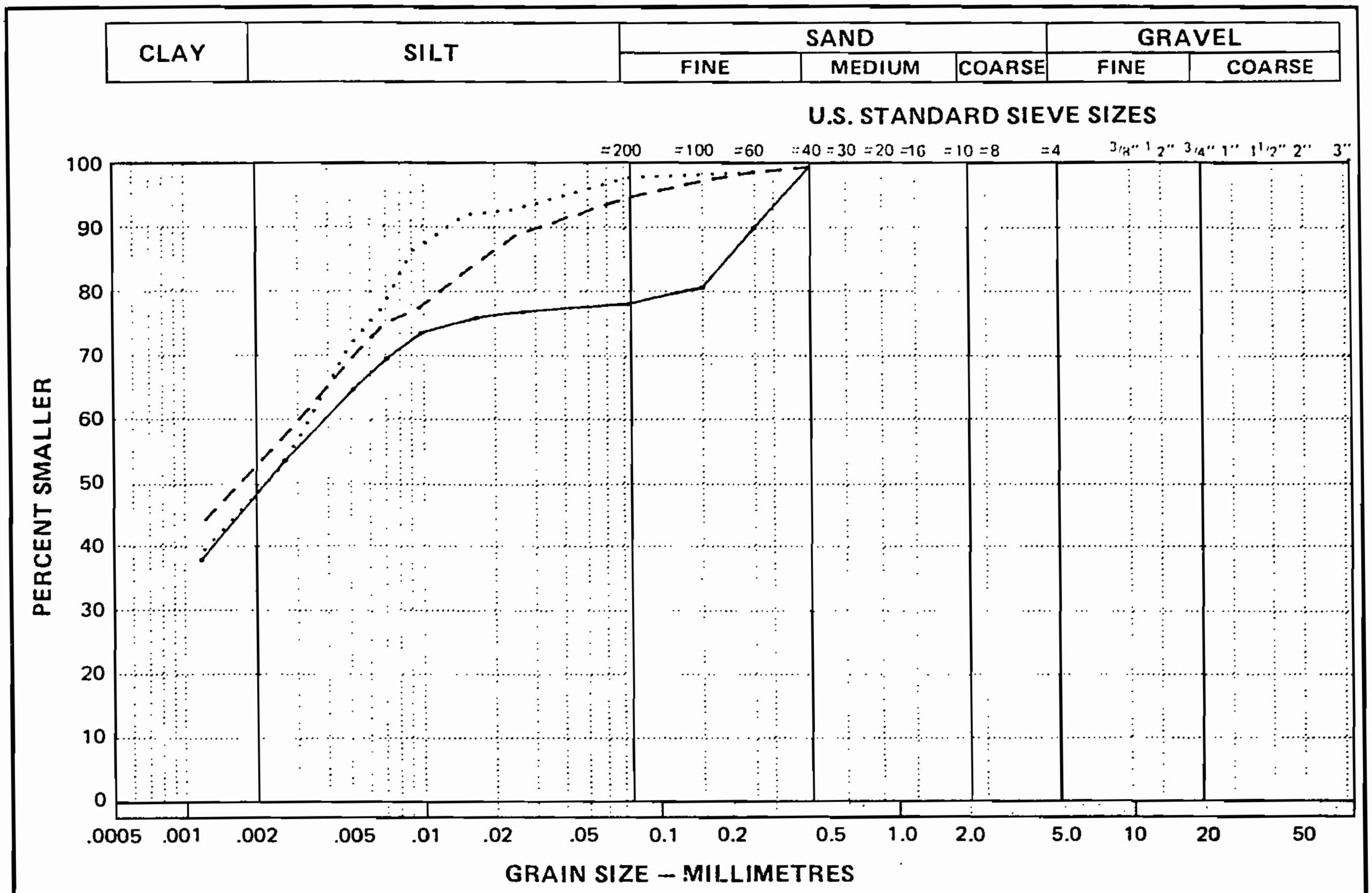
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	DESCRIPTION SILT (%)	DESCRIPTION SAND (%)	DESCRIPTION GRAVEL (%)	Cu	Cc	U.S.C.
______	B: NER: 3: 2	1.10 - 1.10	-	5.4	94.6	0.0	2.7	1.2	SP-SM
. . . . .	B: NER: 3: 2	1.80 - 1.90	-	4.0	96.0	0.0	2.3	1.1	SP
_ _ _	B: NER: 3: 2	3.00 - 3.00	-	5.7	94.3	0.0	2.8	1.2	SP-SM
__ __	B: NER: 3: 2	4.10 - 4.10	-	7.2	92.8	0.0	3.2	1.2	SP-SM
_____._	B: NER: 3: 2	5.00 - 5.00	-	6.7	93.3	0.0	2.6	1.2	SP-SM
____-_	B: NER: 3: 2	5.80 - 5.80	-	5.5	94.5	0.0	2.5	1.5	SP-SM
___-_-_	B: NER: 3: 2	6.70 - 6.70	-	22.3	77.7	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-09-20

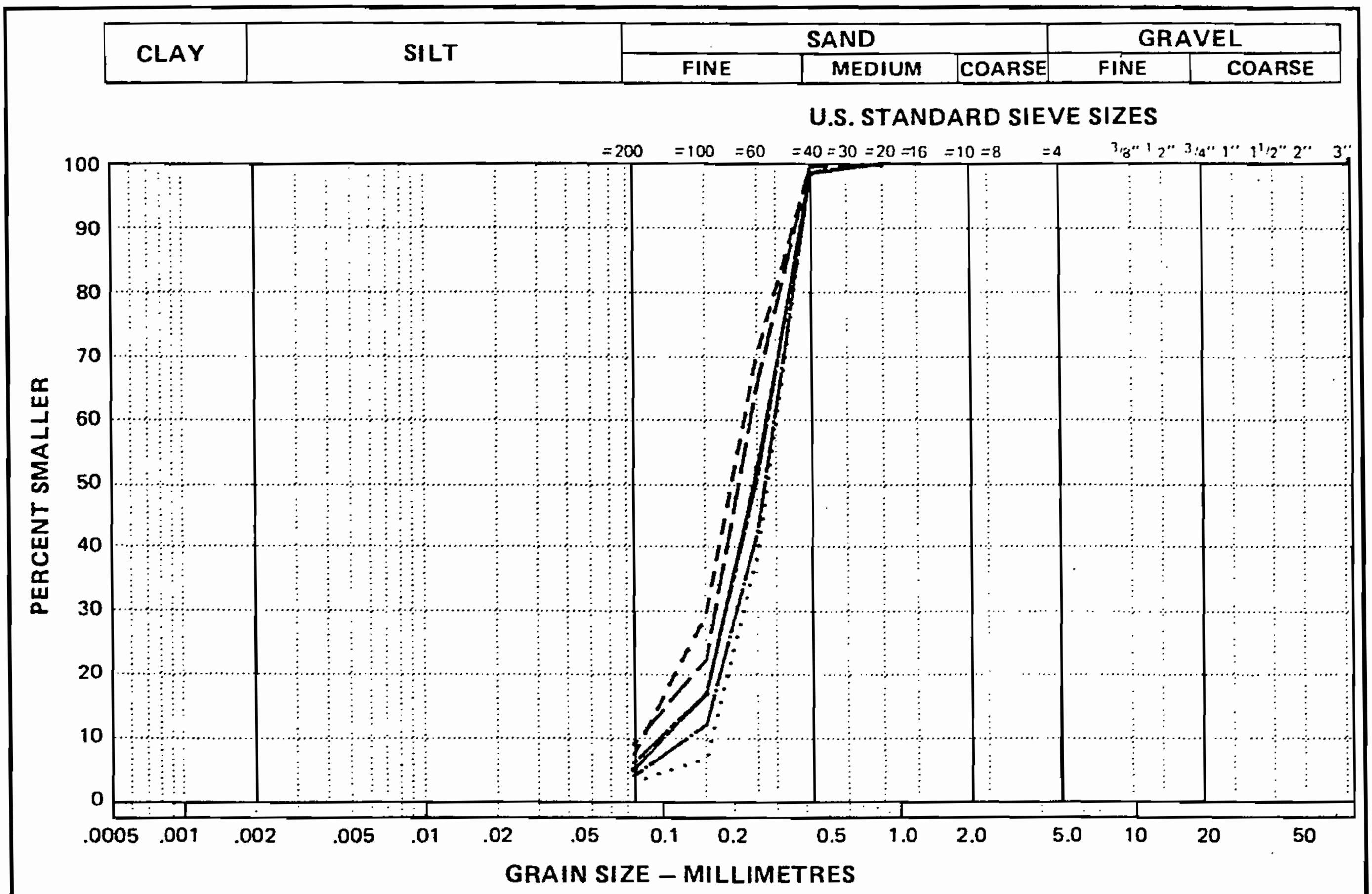
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	DESCRIPTION SILT (%)	DESCRIPTION SAND (%)	DESCRIPTION GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER3: 3	0.00 - .30	49.0	29.7	21.3	0.0	-	-	
. . . . .	B: NER3: 3	9.30 - 9.60	49.0	49.7	1.3	0.0	-	-	
— — —	B: NER3: 3	11.00 - 11.30	53.4	42.1	4.5	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-22

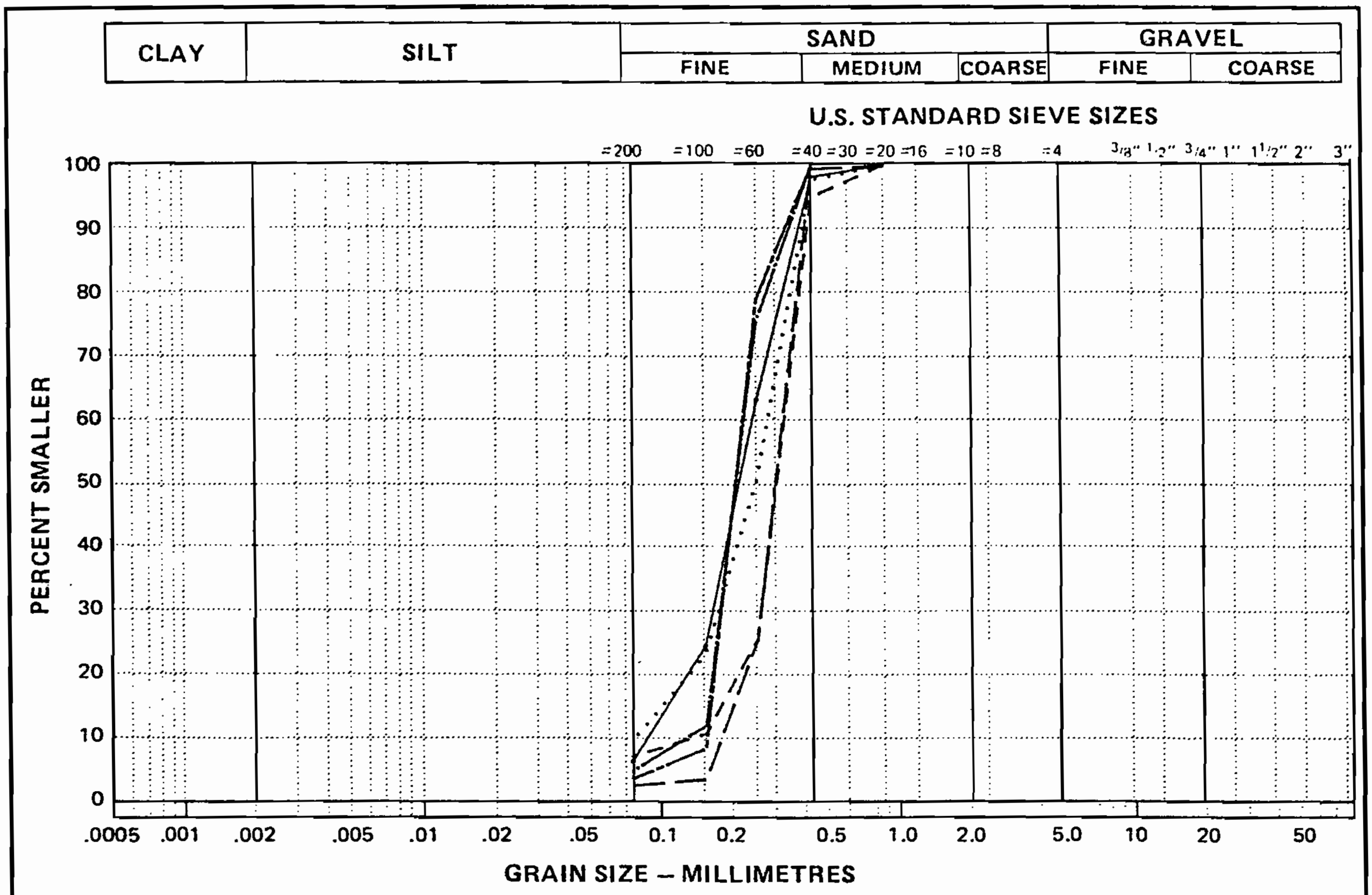
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	B: NER: 3: 3	.60 - .60	-	4.1	95.9	0.0	2.6	1.2	SP
. . . . .	B: NER: 3: 3	1.20 - 1.20	-	2.0	98.0	0.0	1.9	1.0	SP
_ _ _	B: NER: 3: 3	2.00 - 2.00	-	6.5	93.5	0.0	2.7	1.3	SP-SM
__ __	B: NER: 3: 3	3.00 - 3.00	-	8.1	91.9	0.0	2.9	1.4	SP-SM
____._	B: NER: 3: 3	4.00 - 4.00	-	3.0	97.0	0.0	2.2	1.1	SP
_____--	B: NER: 3: 3	5.00 - 5.00	-	5.0	95.0	0.0	2.7	1.2	SP-SM

JOB NO. 101 -3605 DATE 82-08-27

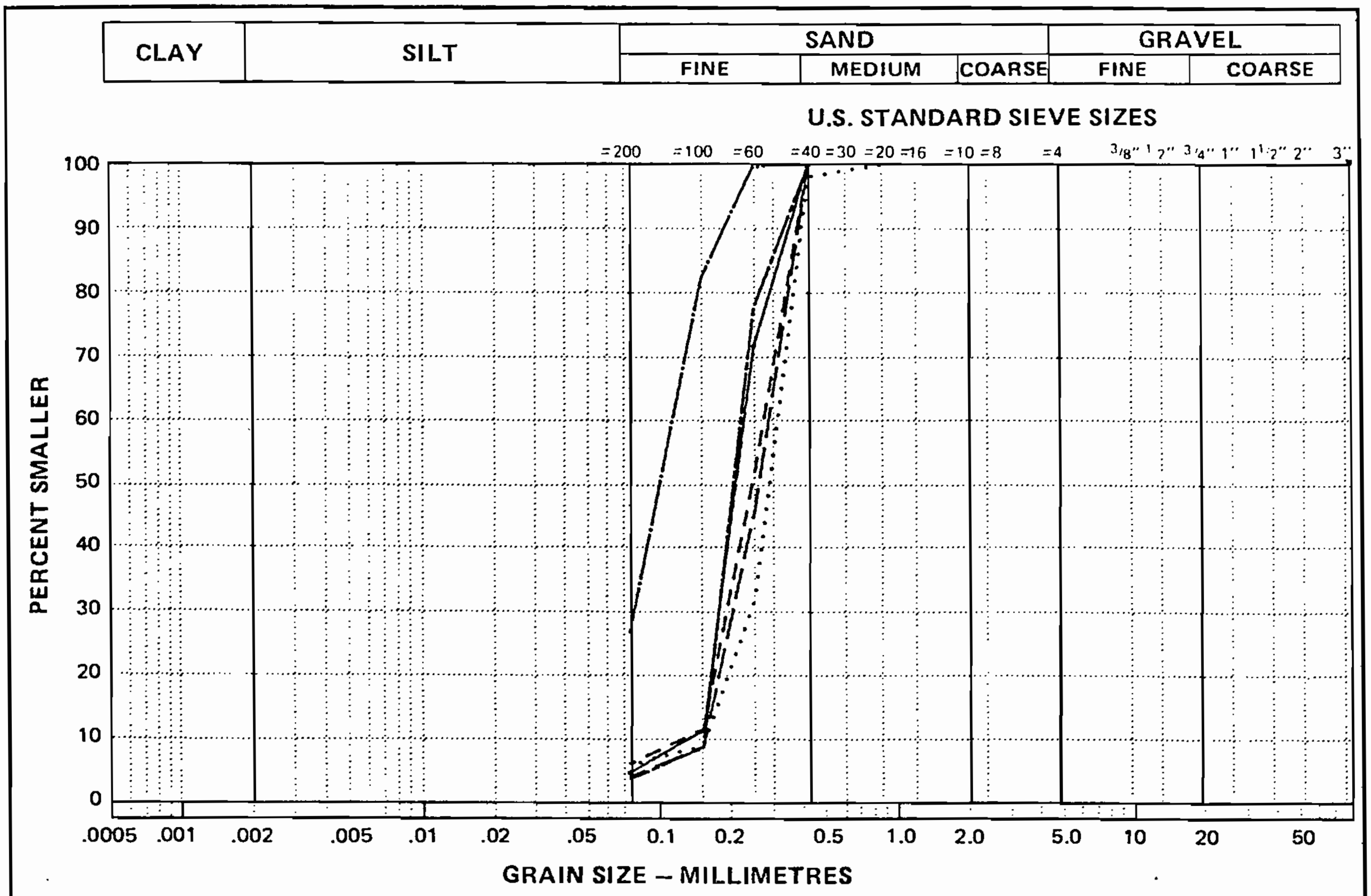
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 3	7.00 - 7.00	-	5.6	94.4	0.0	2.7	1.3	SP-SM
. . . . .	B: NER: 3: 3	7.70 - 7.70	-	8.8	91.2	0.0	3.6	1.4	SP-SM
— — —	B: NER: 3: 3	8.50 - 8.50	-	6.3	93.7	0.0	2.2	1.4	SP-SM
—— ——	B: NER: 3: 3	11.90 - 11.90	-	1.6	98.4	0.0	1.8	1.2	SP
——·—	B: NER: 3: 3	12.30 - 12.30	-	4.0	96.0	0.0	1.6	1.0	SP
———--	B: NER: 3: 3	13.00 - 13.00	-	2.7	97.3	0.0	1.4	.9	SP

JOB NO. 101 -3605 **DATE** 82-08-17

PARTICLE - SIZE ANALYSIS OF SOILS

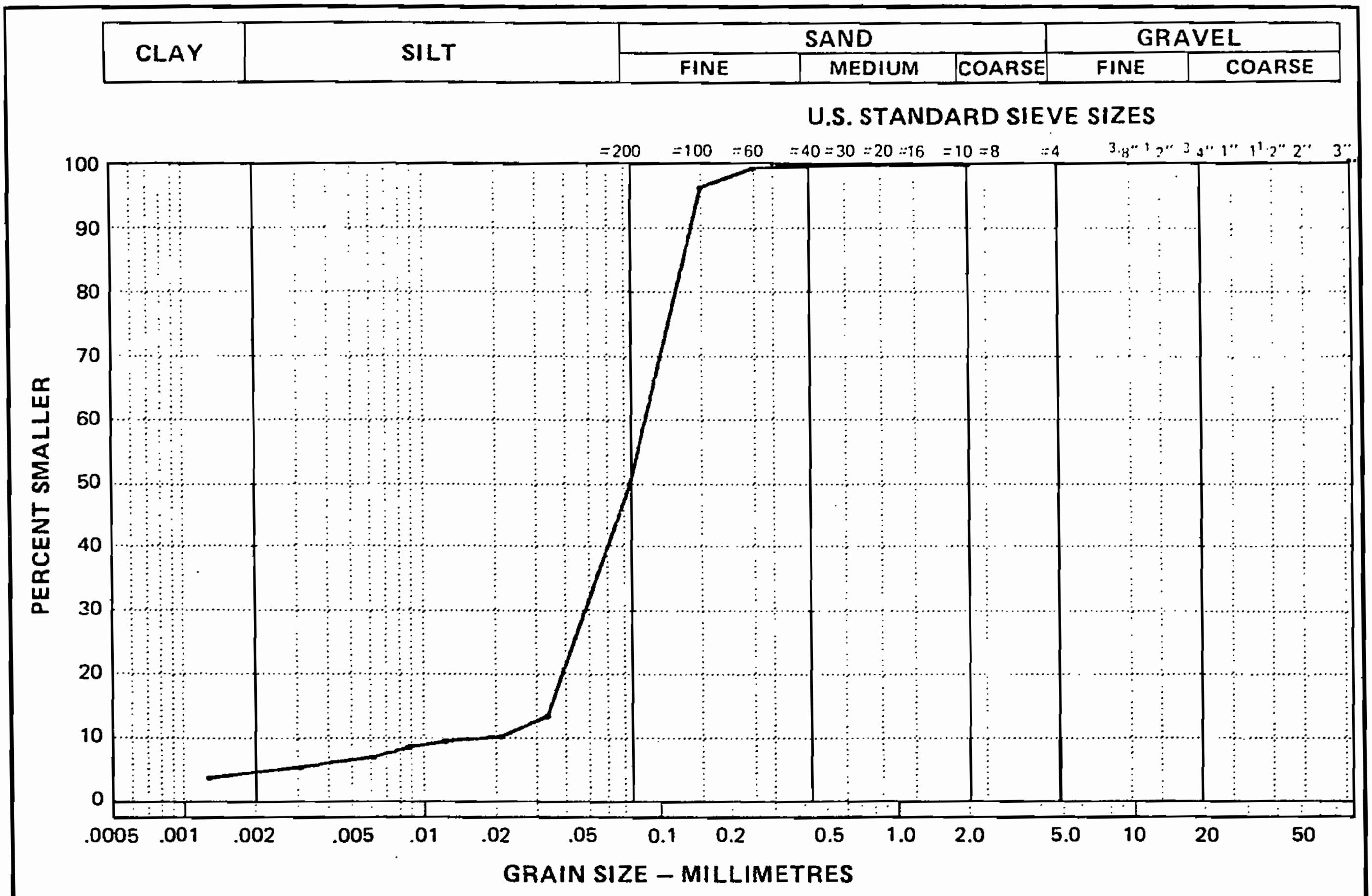


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	B:NER:3:3	14.00 - 14.00	-	3.7	96.3	0.0	1.6	.9	SP
. . . . .	B:NER:3:3	18.00 - 18.00	-	4.9	95.1	0.0	2.0	1.2	SP
_ _ _	B:NER:3:3	21.00 - 21.00	-	5.1	94.9	0.0	2.0	1.0	SP-SM
__ __	B:NER:3:3	24.00 - 24.00	-	3.0	97.0	0.0	1.9	.9	SP
____._	B:NER:3:3	27.00 - 27.00	-	25.9	74.1	0.0	-	-	
____-_	B:NER:3:3	30.00 - 30.00	-	2.6	97.4	0.0	1.4	.9	SP

JOB NO. 101 -3605 **DATE** 82-08-17

2094a

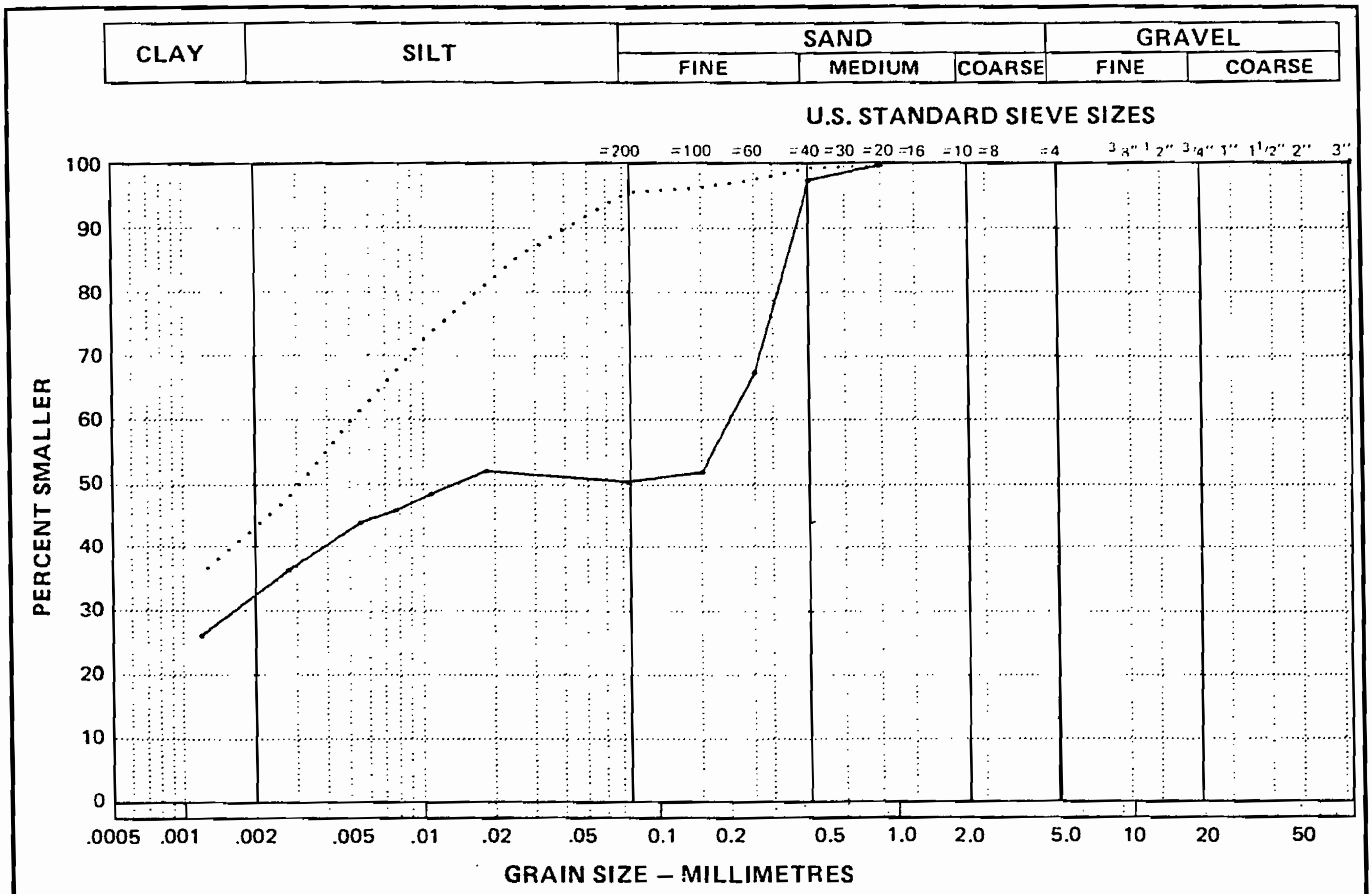
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
————	B: NER3: 3	26.80 - 27.00	4.0	45.5	50.5	0.0	3.8	1.2	SM

JOB NO. 101 -3605 **DATE** 82-09-30

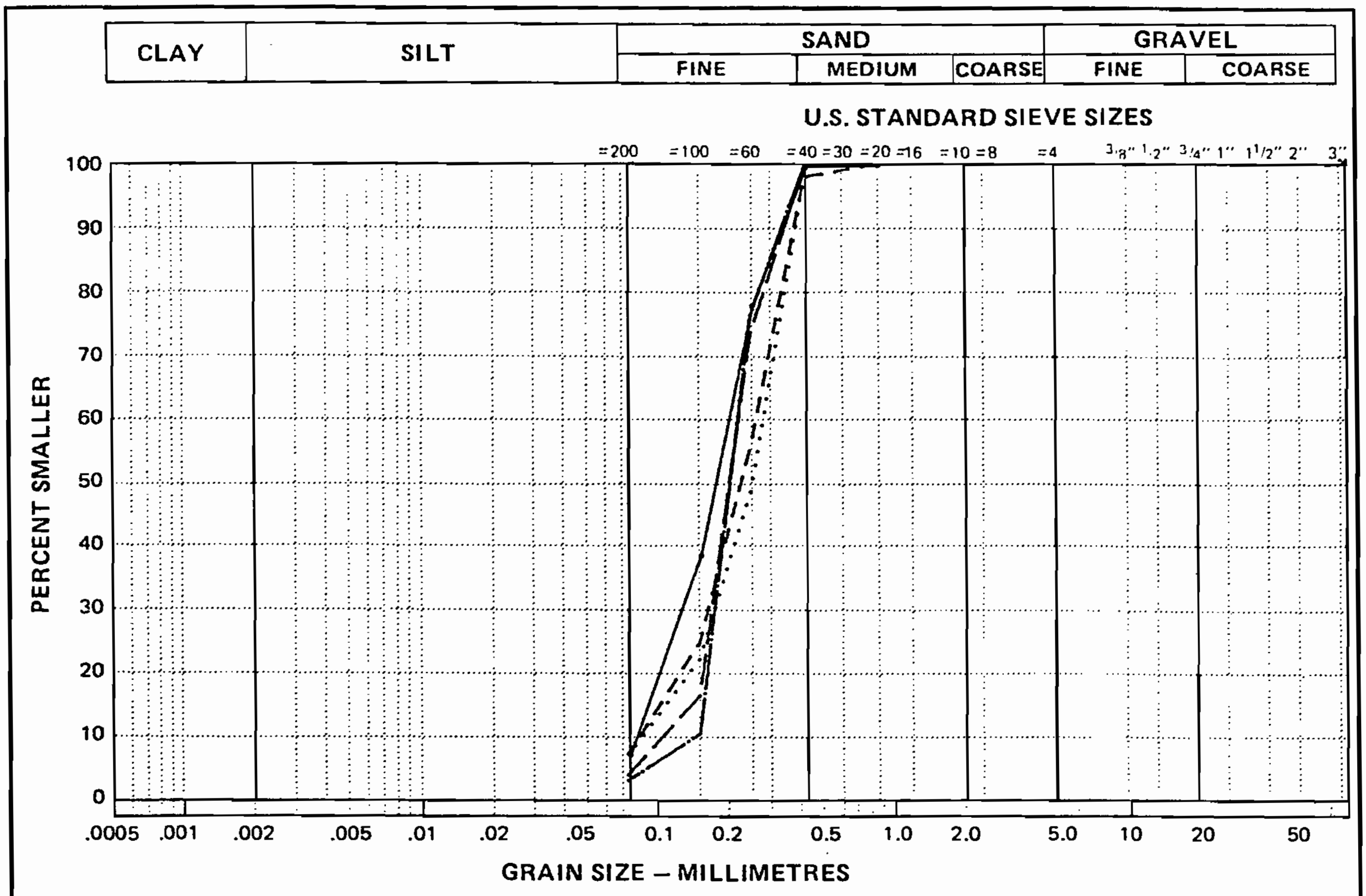
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
——	B:NER3:4	0.00 - .60	32.3	17.7	50.0	0.0	-	-	
. . . . .	B:NER3:4	9.10 - 9.40	43.2	52.9	3.9	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-18

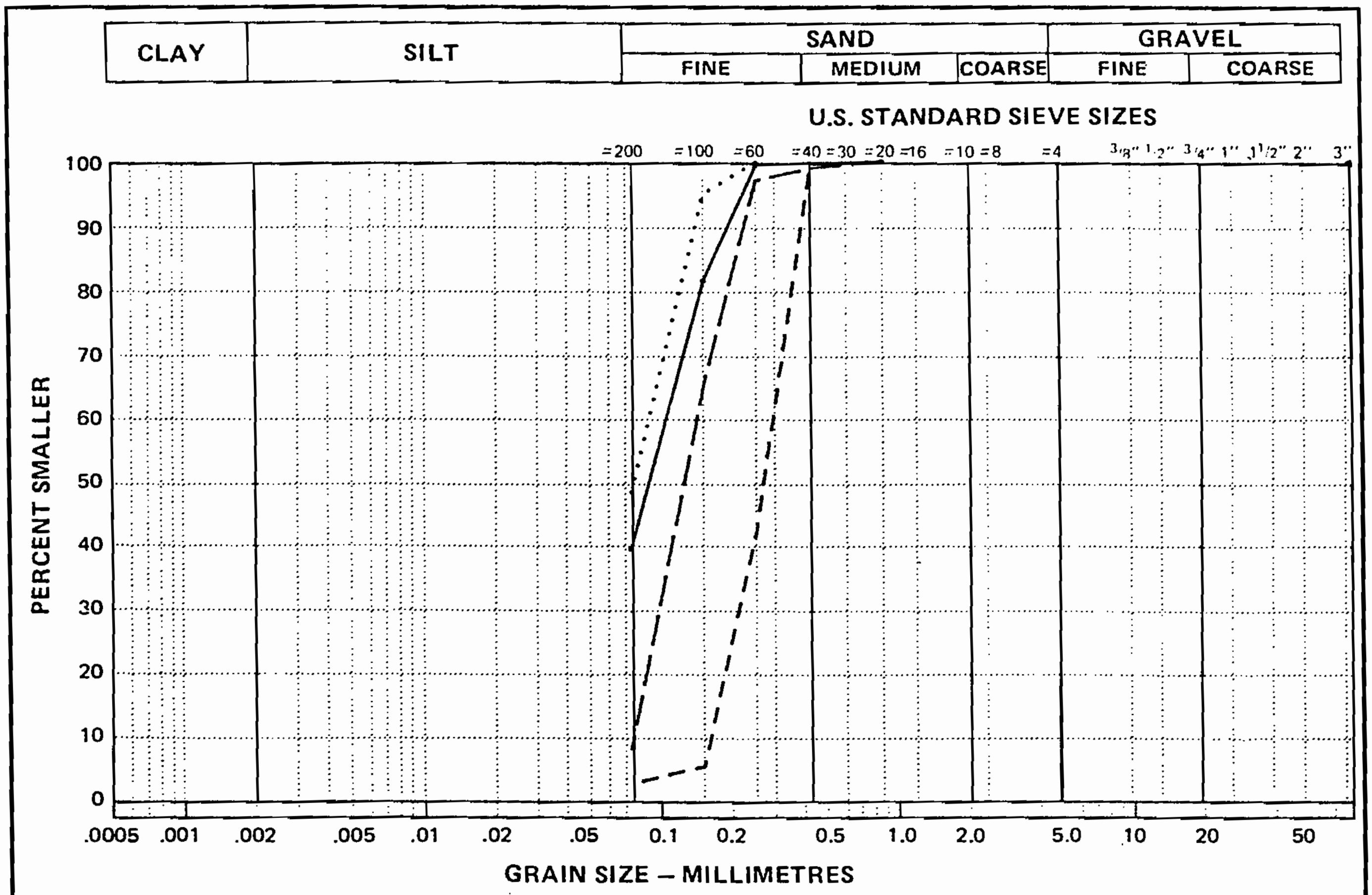
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER: 3: 4	2.00 - 2.00	-	6.3	93.7	0.0	2.5	1.0	SP-SM
. . . . .	B: NER: 3: 4	3.75 - 3.75	-	6.0	94.0	0.0	3.2	1.2	SP-SM
— — —	B: NER: 3: 4	5.75 - 5.75	-	6.2	93.8	0.0	3.1	1.2	SP-SM
—— · ——	B: NER: 3: 4	10.50 - 10.50	-	2.9	97.1	0.0	2.0	1.2	SP
———·—	B: NER: 3: 4	12.00 - 12.00	-	2.0	98.0	0.0	1.5	.9	SP

JOB NO. 101 -3605 **DATE** 82-08-21

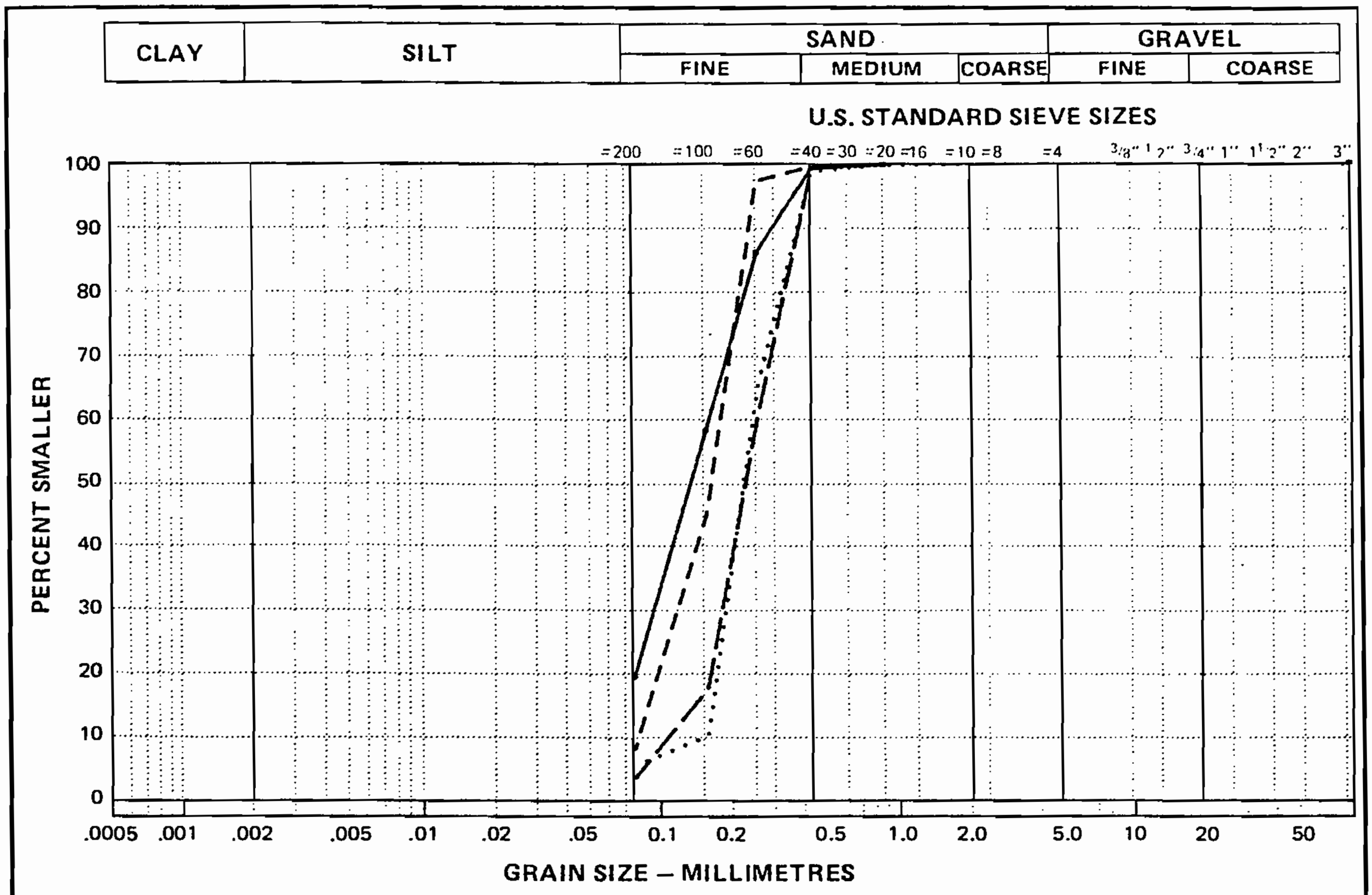
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 4	14.00 - 14.00	-	38.7	61.3	0.0	-	-	
. . . . .	B: NER: 3: 4	14.75 - 14.75	-	47.3	52.7	0.0	-	-	
— — —	B: NER: 3: 4	20.00 - 20.00	-	1.2	98.8	0.0	1.8	1.0	SP
—— ——	B: NER: 3: 4	24.00 - 24.00	-	6.8	93.2	0.0	1.8	.9	SP-SM

JOB NO. 101 -3605 **DATE** 82-08-21

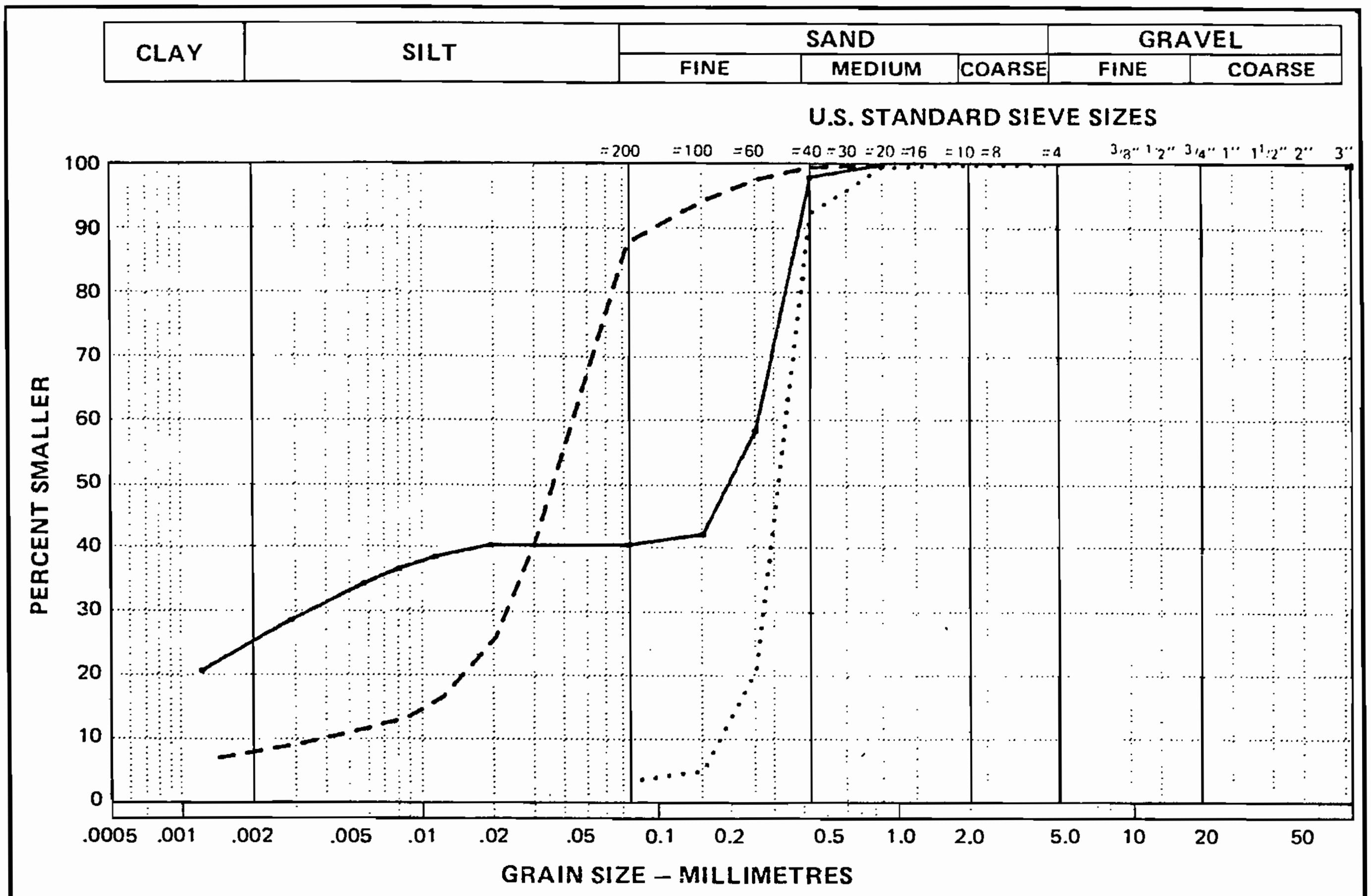
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B:NER3:4	6.40 - 6.91	-	18.8	81.2	0.0	-	-	
· · · · ·	B:NER3:4	16.80 - 17.10	-	4.6	95.4	0.0	1.6	.9	SP
— — —	B:NER3:4	22.90 - 23.26	-	7.3	92.7	0.0	2.2	1.0	SP-SM
—— ——	B:NER3:4	29.00 - 29.35	-	2.6	97.4	0.0	2.3	1.2	SP

JOB NO. 101 -3605 DATE 82-09-30

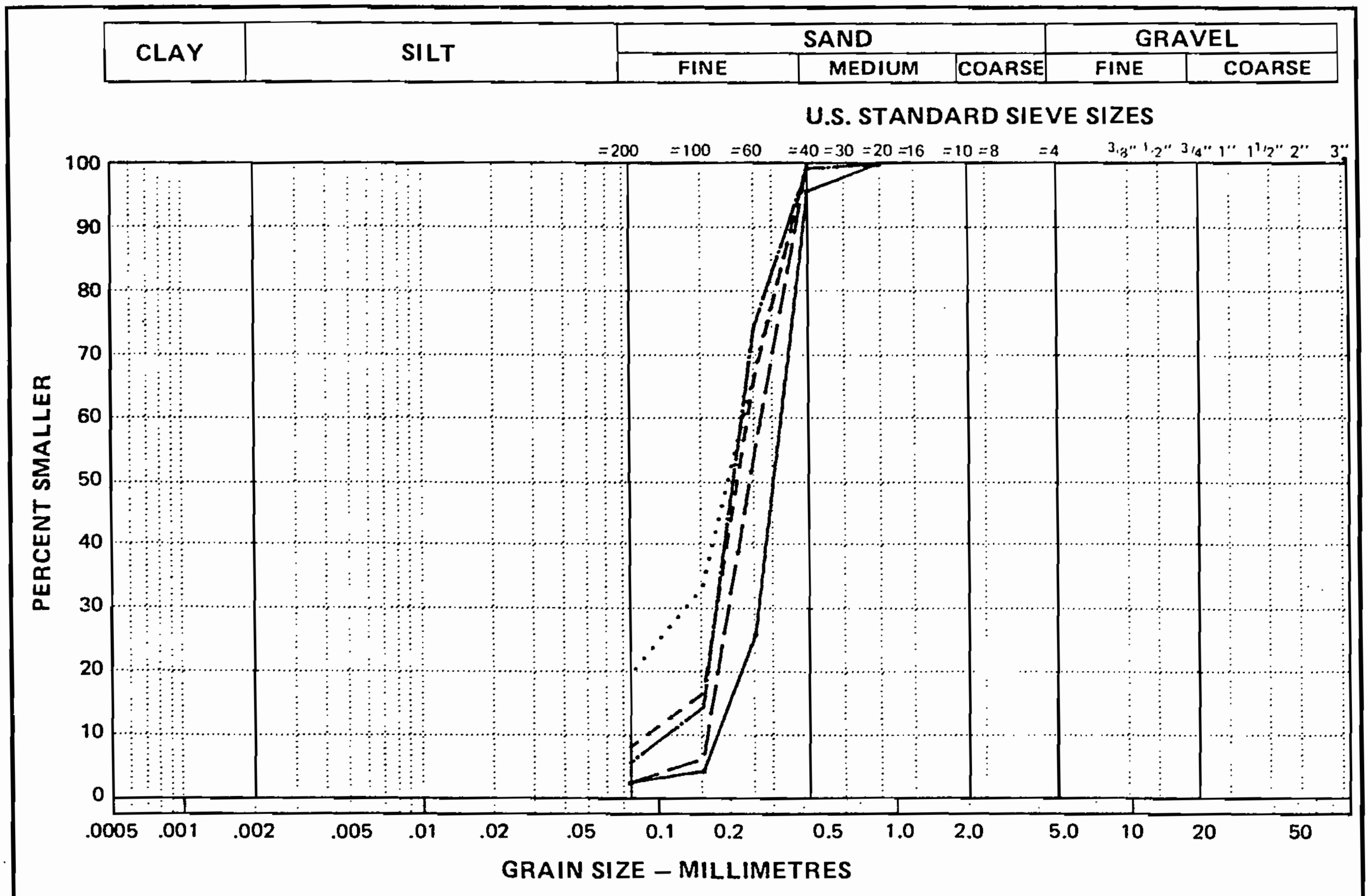
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B:NER3:5	0.00 - .50	25.0	15.0	60.0	0.0	-	-	
. . . . .	B:NER3:5	.50 - .80	-	2.4	97.6	0.0	1.8	1.2	SP
— — —	B:NER3:5	5.50 - 5.90	7.3	80.7	12.0	0.0	9.7	2.7	

JOB NO. 101 -3605 DATE 82-11-30

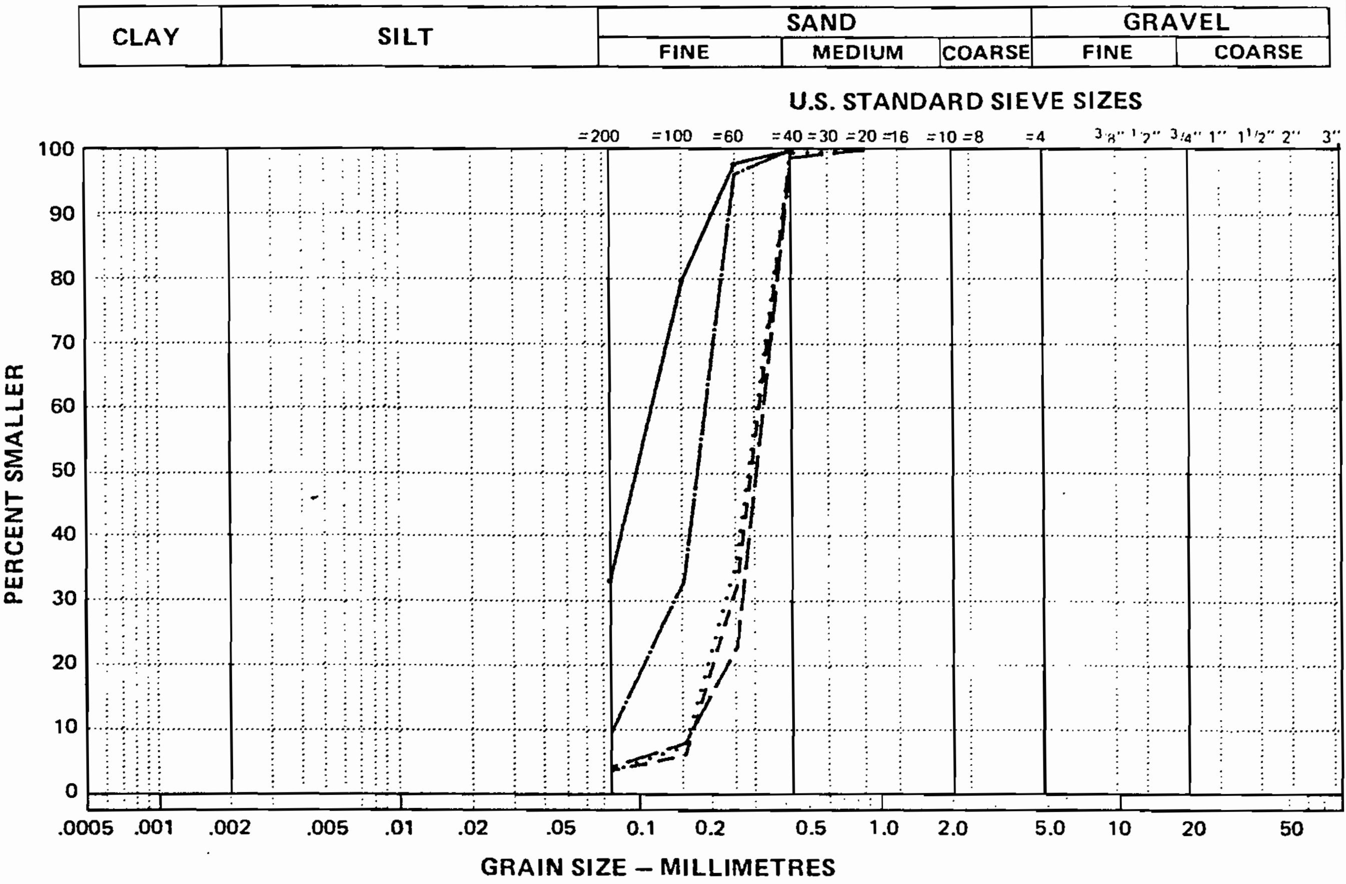
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
————	B: NER: 3: 5	1.50 - 1.50	-	1.5	98.5	0.0	1.9	1.2	SP
· · · · ·	B: NER: 3: 5	2.00 - 2.00	-	18.6	81.4	0.0	-	-	
— — —	B: NER: 3: 5	3.00 - 3.00	-	7.2	92.8	0.0	2.5	1.4	SP-SM
—— ——	B: NER: 3: 5	4.60 - 4.60	-	1.5	98.5	0.0	1.7	.9	SP
——·—	B: NER: 3: 5	6.40 - 6.40	-	4.7	95.3	0.0	2.0	1.2	SP

JOB NO. 101 -3605 **DATE** 82-08-29

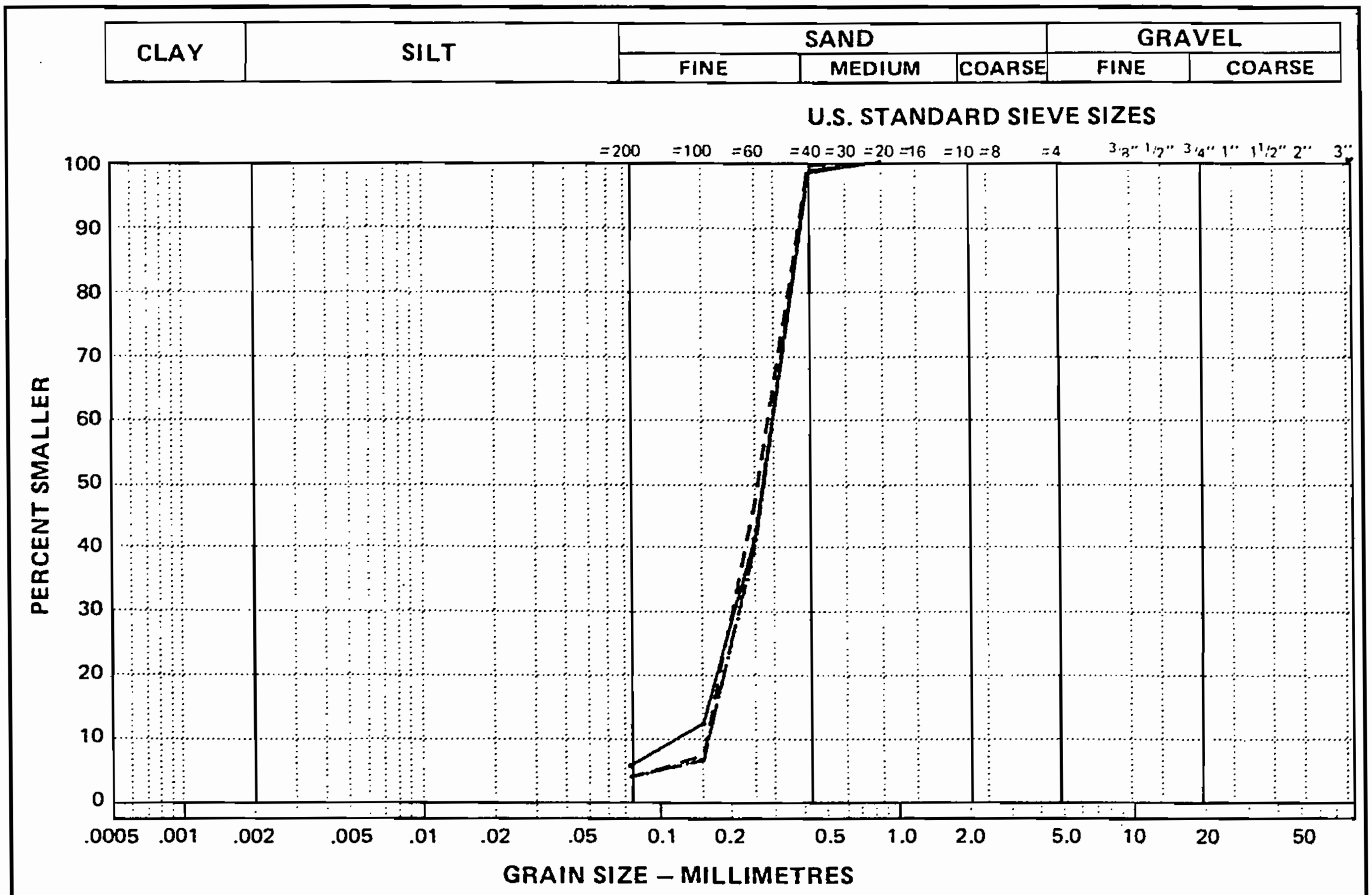
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	DESCRIPTION SILT (%)	DESCRIPTION SAND (%)	DESCRIPTION GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER: 3: 5	6.60 - 6.60	-	32.6	67.4	0.0	-	-	
· · · · ·	B: NER: 3: 5	7.50 - 7.50	-	2.6	97.4	0.0	1.9	1.1	SP
— — —	B: NER: 3: 5	9.50 - 9.50	-	2.7	97.3	0.0	1.9	1.1	SP
—— ——	B: NER: 3: 5	11.30 - 11.30	-	3.2	96.8	0.0	2.0	1.3	SP
——·—	B: NER: 3: 5	15.00 - 15.00	-	8.6	91.4	0.0	2.4	1.4	SP-SM

JOB NO. 101 -3605 **DATE** 82-08-29

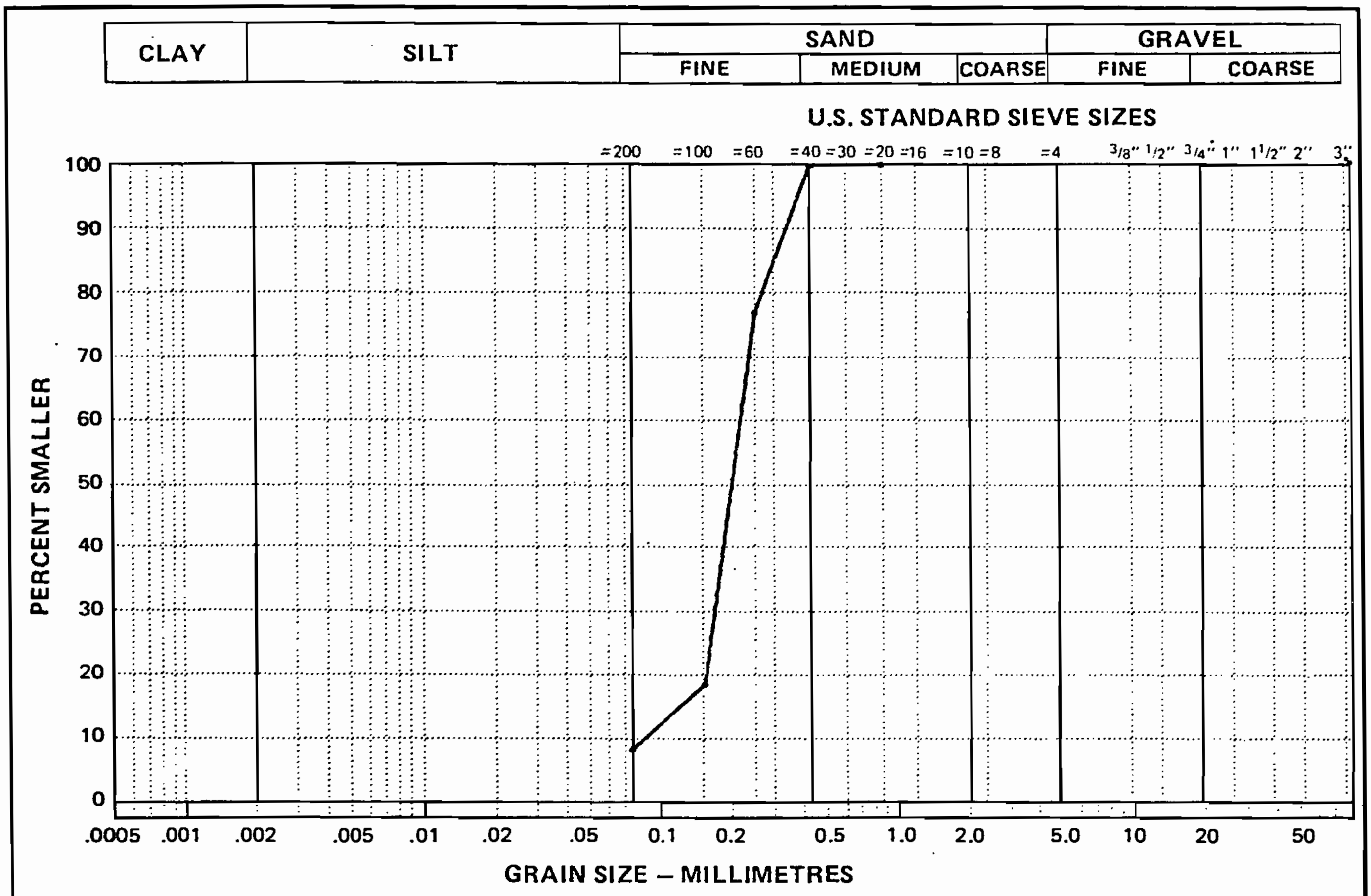
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	B: NER: 3: 5	19.00 - 19.00	-	4.6	95.4	0.0	2.3	1.1	SP
. . . . .	B: NER: 3: 5	22.00 - 22.00	-	2.7	97.3	0.0	1.9	1.0	SP
_ _ _	B: NER: 3: 5	25.00 - 25.00	-	2.7	97.3	0.0	1.8	.9	SP
__ __	B: NER: 3: 5	28.00 - 28.00	-	2.8	97.2	0.0	1.9	1.0	SP

JOB NO. 101 -3605 **DATE** 82-08-29

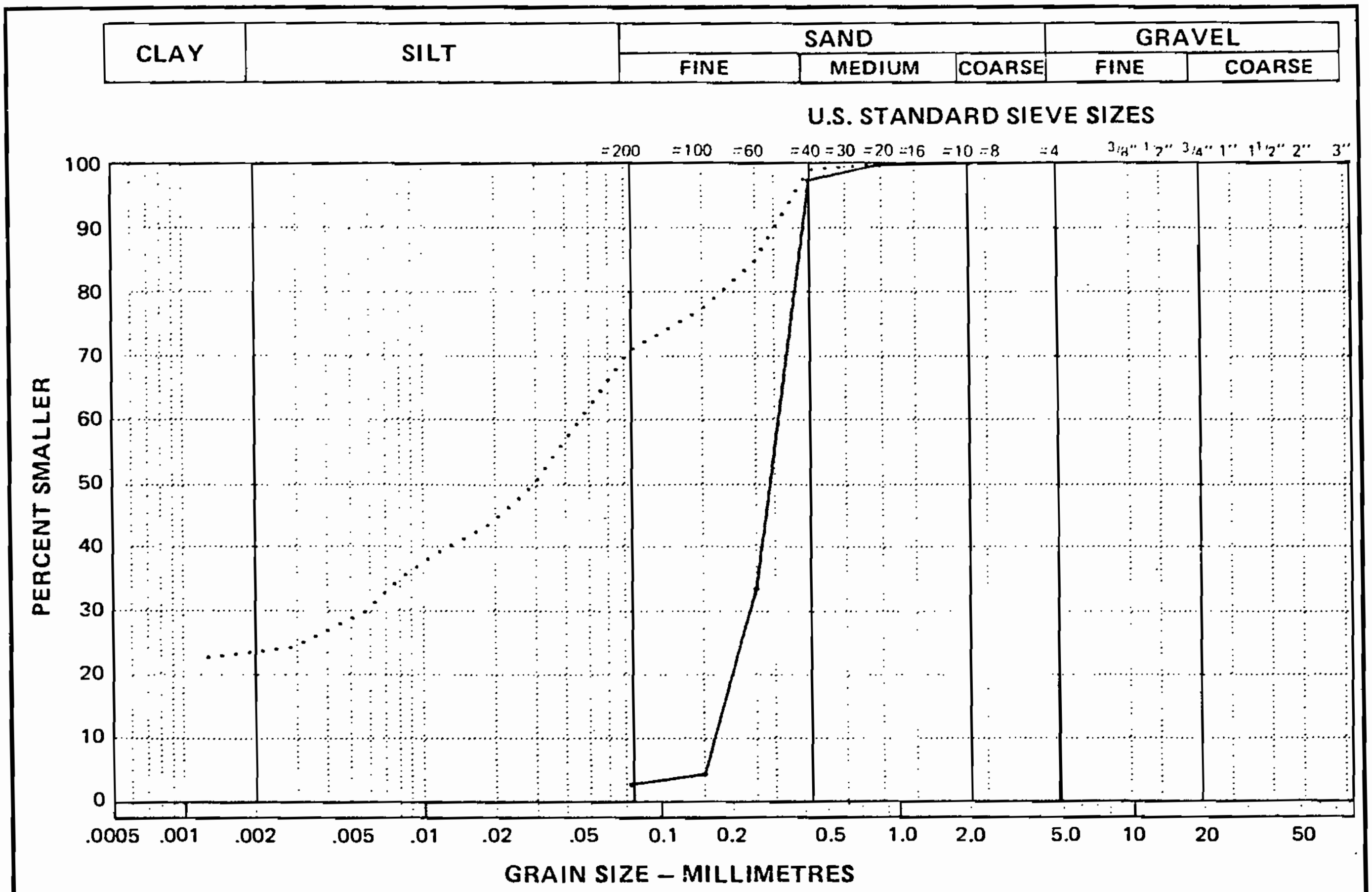
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER3: 5	3.66 - 3.81	-	7.3	92.7	0.0	2.4	1.5	SP-SM

JOB NO. 101 -3605 **DATE** 82-09-30

PARTICLE - SIZE ANALYSIS OF SOILS

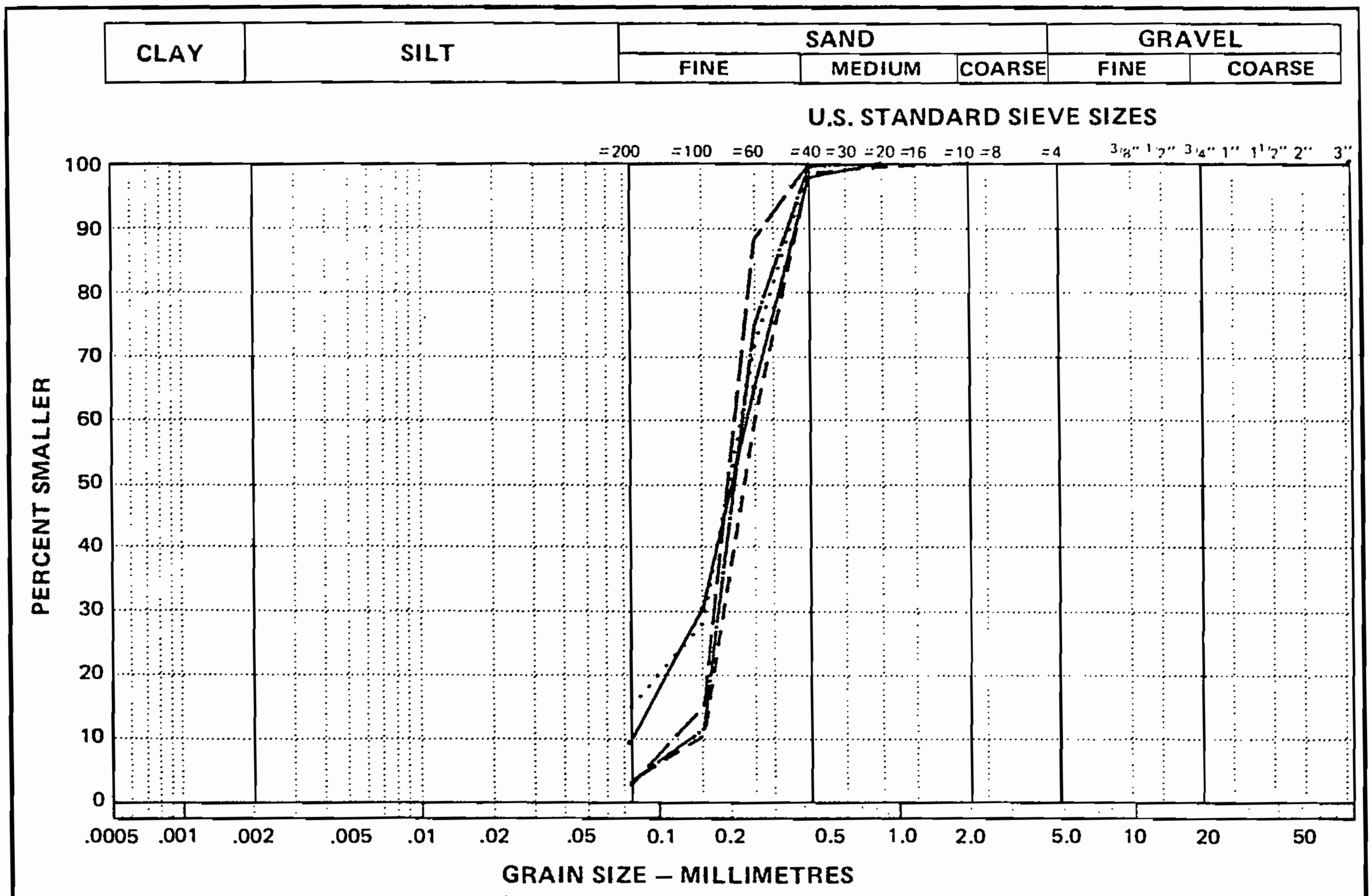


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER3: 6	.30 - .40	-	1.5	98.5	0.0	1.9	1.1	SP
. . . . .	B: NER3: 6	3.00 - 3.20	22.9	47.6	29.5	0.0	-	-	

JOB NO. 101 -3605

DATE 82-11-19

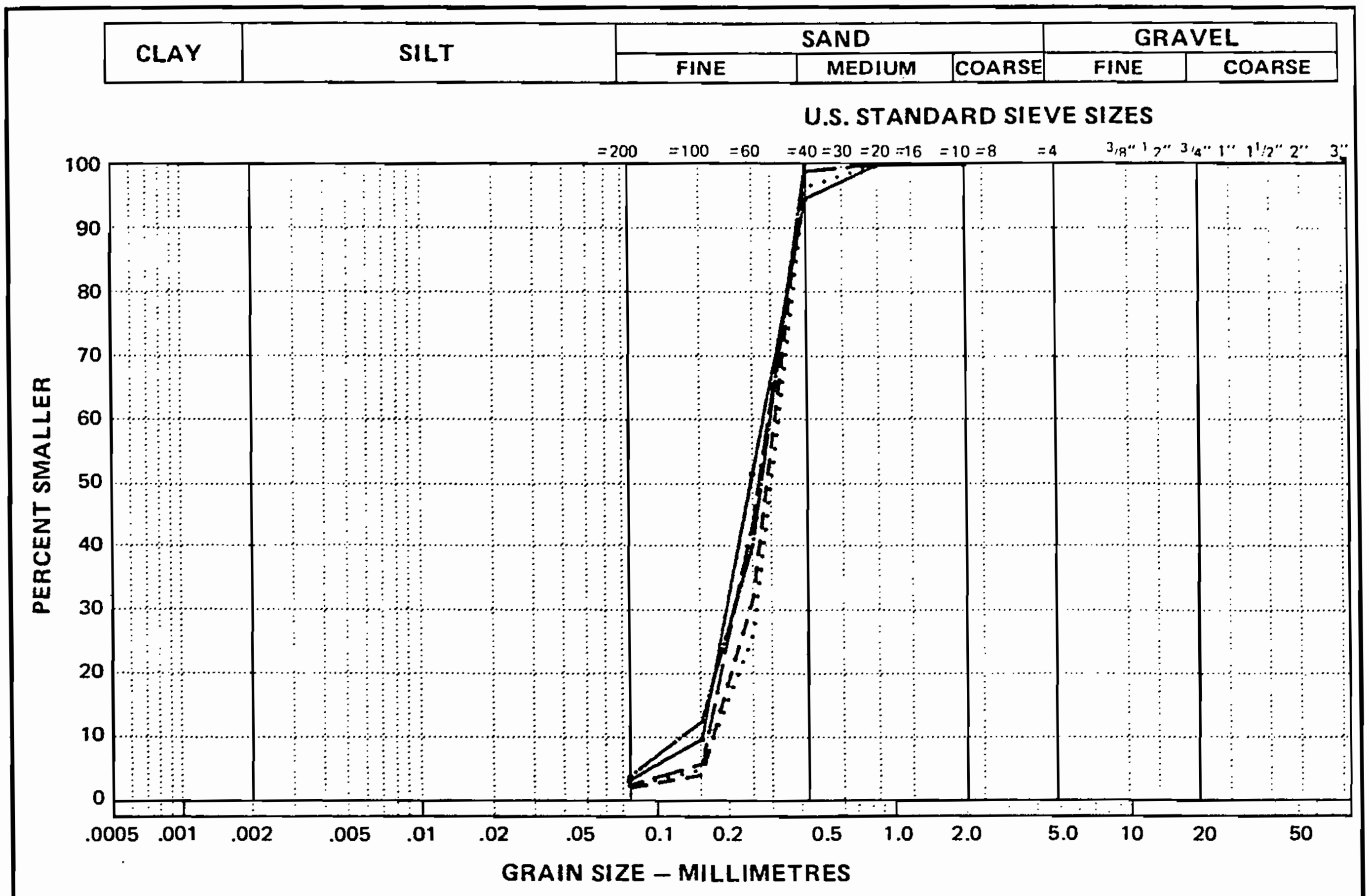
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	B: NER: 3: 6	2.10 - 2.10	-	8.4	91.6	0.0	3.0	1.3	SP-SM
. . . . .	B: NER: 3: 6	3.90 - 3.90	-	13.8	86.2	0.0	-	-	
_ _ _	B: NER: 3: 6	5.60 - 5.60	-	2.1	97.9	0.0	1.7	.9	SP
__ __	B: NER: 3: 6	7.50 - 7.50	-	1.5	98.5	0.0	1.7	1.1	SP
____._	B: NER: 3: 6	9.50 - 9.50	-	2.0	98.0	0.0	1.5	1.0	SP

JOB NO. 101 -3605 **DATE** 82-08-29

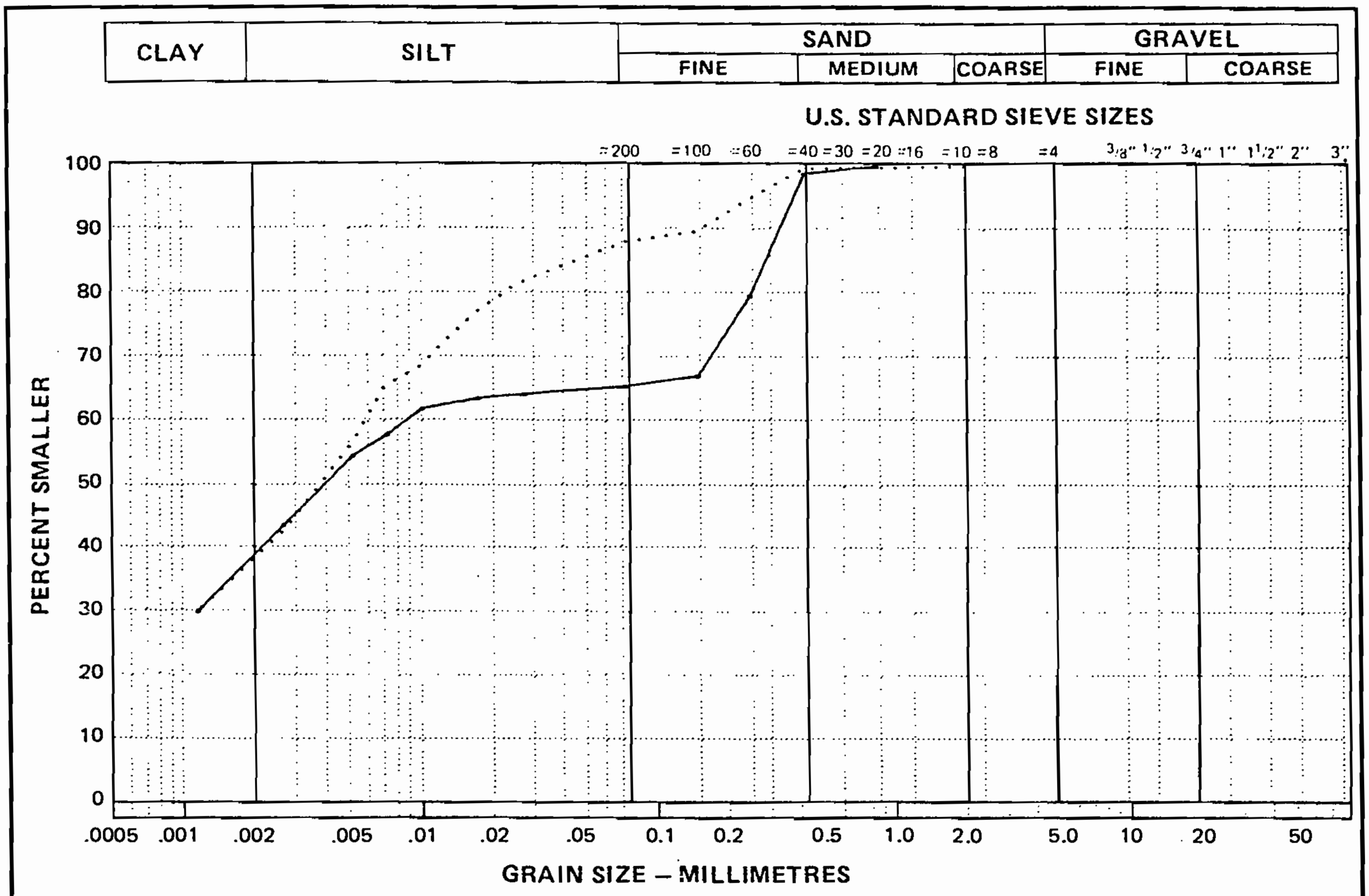
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 6	11.25 - 11.25	-	2.2	97.8	0.0	1.8	.9	SP
.....	B: NER: 3: 6	13.00 - 13.00	-	1.2	98.8	0.0	1.9	1.2	SP
— — —	B: NER: 3: 6	17.25 - 17.25	-	1.0	99.0	0.0	1.8	1.1	SP
—— ——	B: NER: 3: 6	23.35 - 23.35	-	1.4	98.6	0.0	1.8	.9	SP
——.—	B: NER: 3: 6	29.50 - 29.50	-	2.8	97.2	0.0	2.3	1.1	SP

JOB NO. 101 -3605 DATE 82-08-29

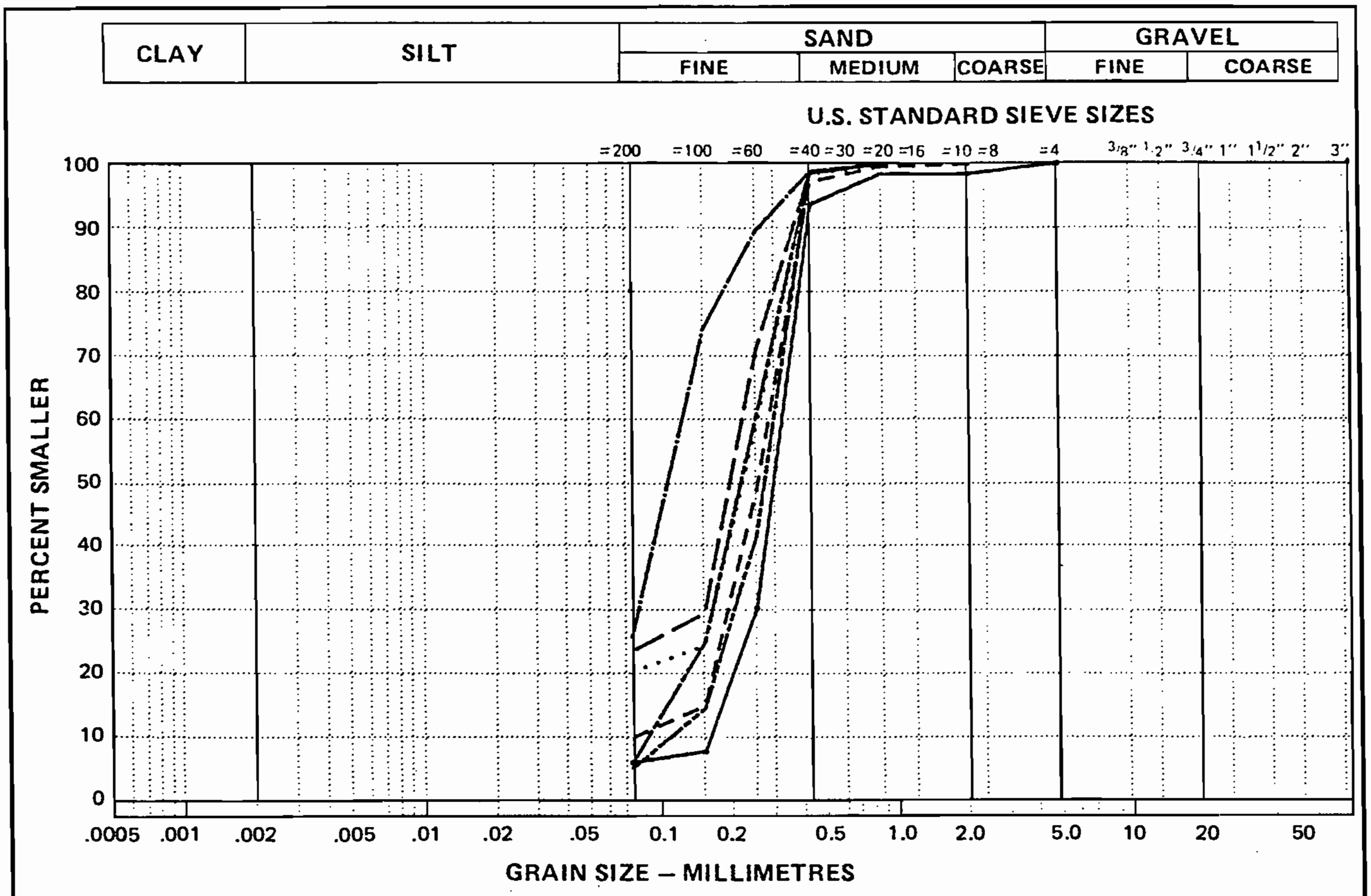
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
——	B: NER3: 7	0.00 - .35	38.8	26.7	34.5	0.0	-	-	
· · · · ·	B: NER3: 7	6.40 - 7.00	38.1	50.4	11.5	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-18

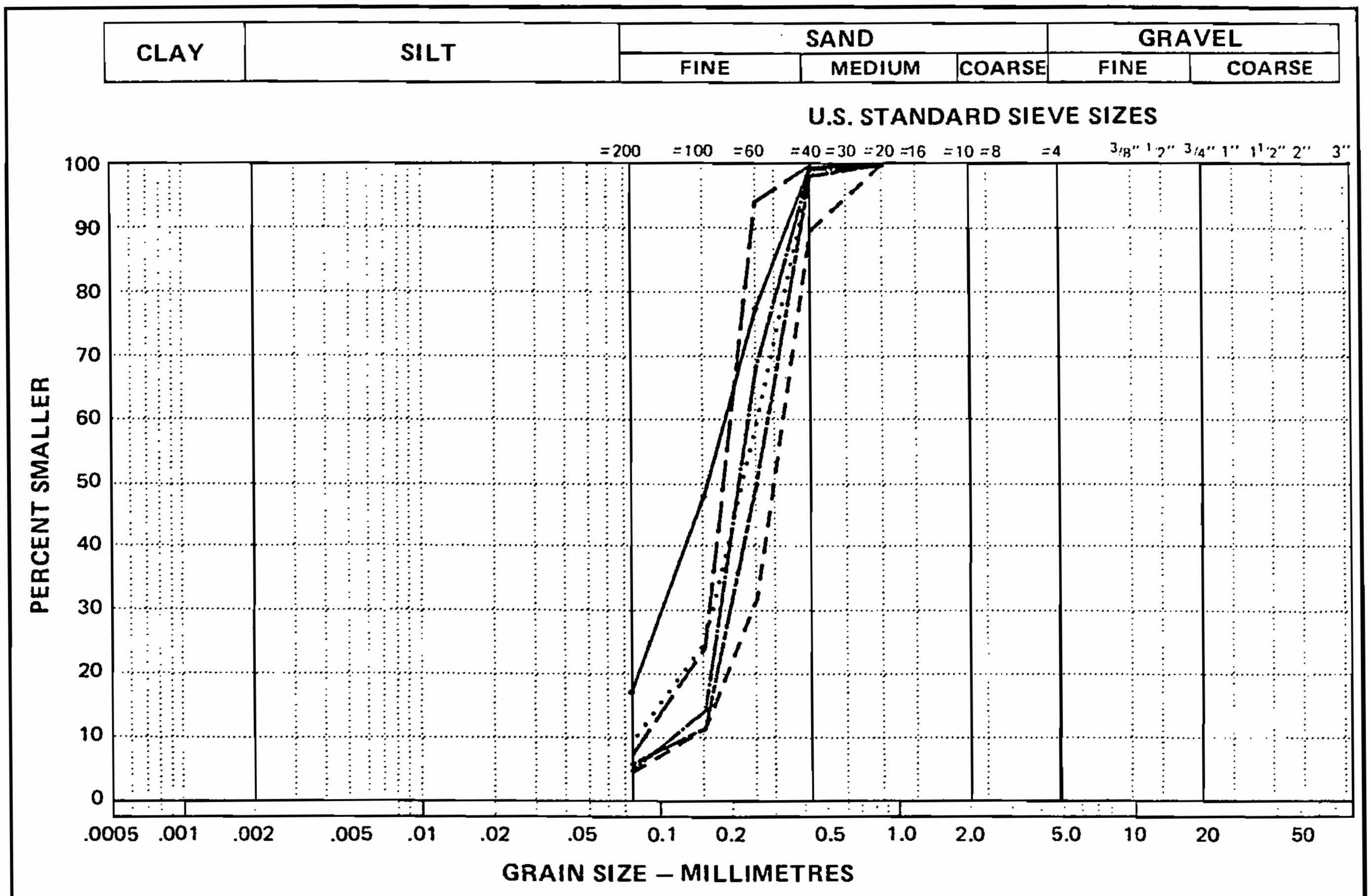
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER: 3: 7	.35 - .60	-	4.9	95.1	0.0	2.0	1.2	SP
·····	B: NER: 3: 7	.60 - .85	-	19.4	80.6	0.0	-	-	
– – –	B: NER: 3: 7	1.00 - 1.00	-	8.9	91.1	0.0	3.3	1.5	SP-SM
—— ——	B: NER: 3: 7	1.10 - 1.20	-	22.6	77.4	0.0	-	-	
——·—	B: NER: 3: 7	1.40 - 1.55	-	24.9	75.1	0.0	-	-	
———-—	B: NER: 3: 7	2.18 - 2.18	-	4.9	95.1	0.0	2.8	1.2	SP
———--—	B: NER: 3: 7	2.39 - 2.39	-	4.0	96.0	0.0	2.6	1.2	SP

JOB NO. 101 -3605 **DATE** 82-08-29

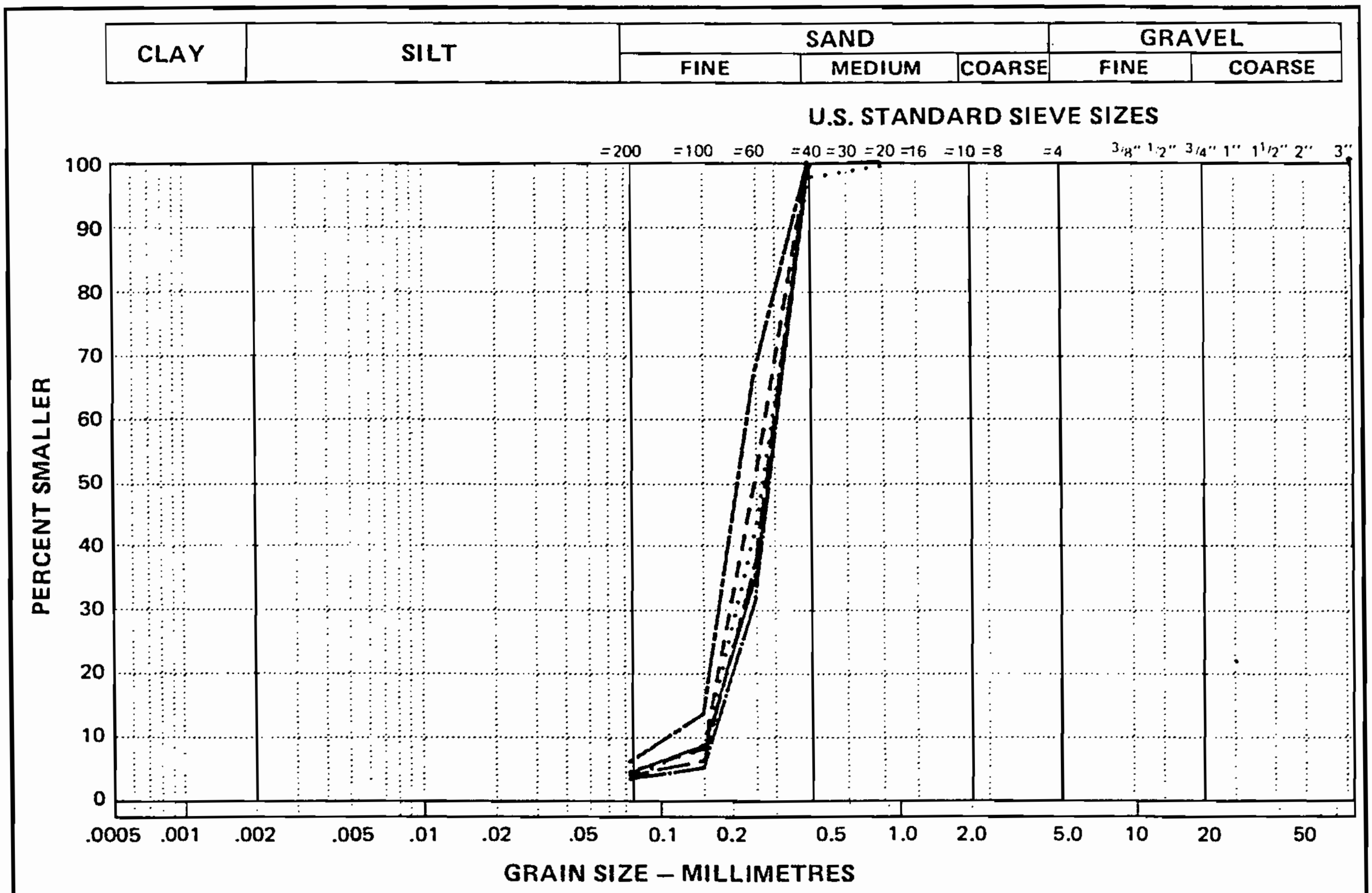
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
______	B: NER: 3: 7	2.80 - 2.80	-	16.5	83.5	0.0	-	-	
. . . . .	B: NER: 3: 7	2.89 - 3.14	-	8.4	91.6	0.0	3.2	1.3	SP-SM
_ _ _	B: NER: 3: 7	3.80 - 3.80	-	3.6	96.4	0.0	2.3	1.3	SP
__ __	B: NER: 3: 7	4.75 - 4.75	-	6.4	93.6	0.0	2.3	1.5	SP-SM
___._	B: NER: 3: 7	5.50 - 5.85	-	4.0	96.0	0.0	2.0	1.1	SP
___ _	B: NER: 3: 7	7.50 - 7.50	-	5.0	95.0	0.0	2.0	1.0	SP-SM

JOB NO. 101 -3605 DATE 82-08-29

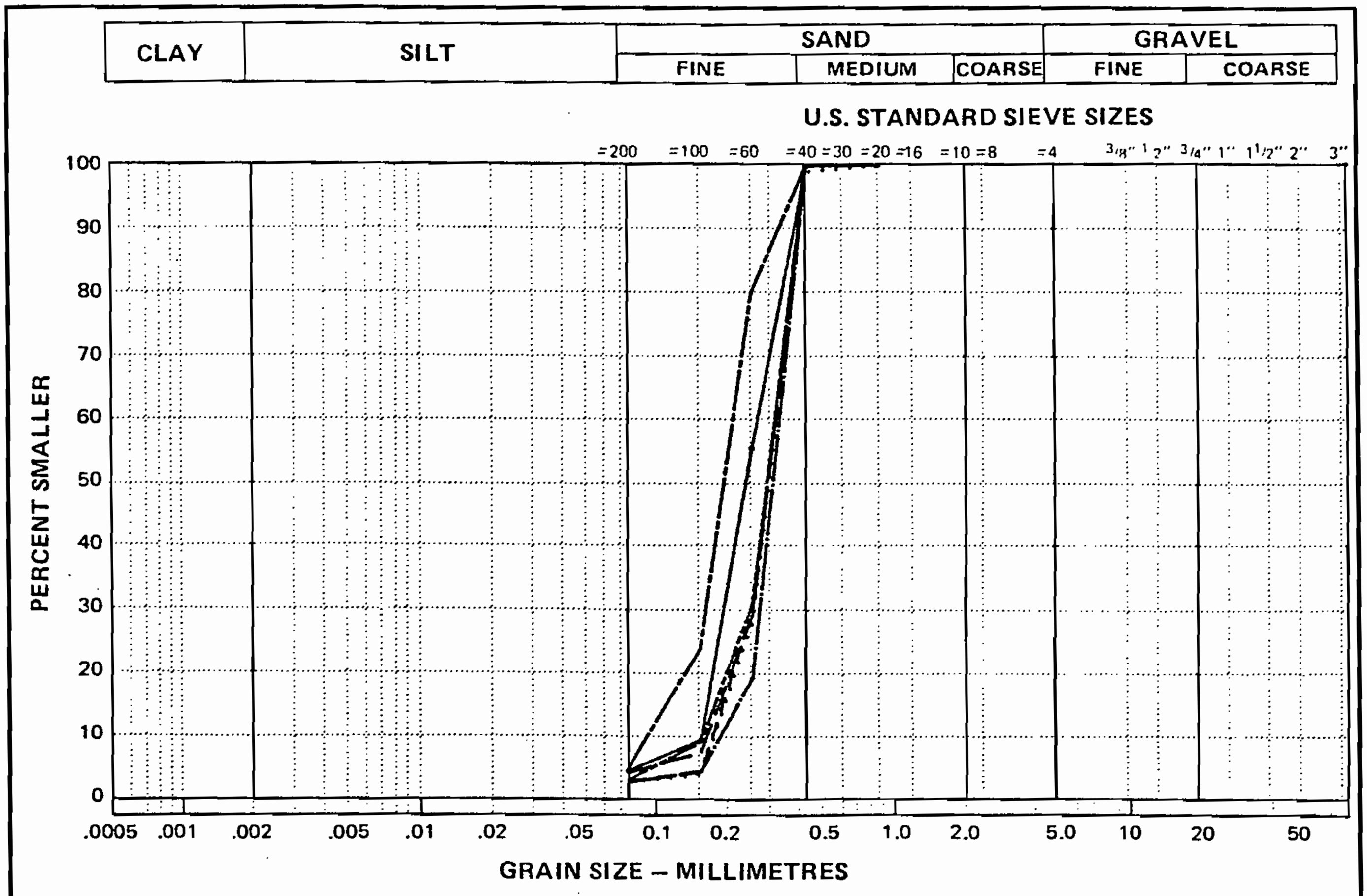
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 7	8.50 - 8.50	-	3.8	96.2	0.0	2.0	1.1	SP
·····	B: NER: 3: 7	9.30 - 9.65	-	2.9	97.1	0.0	1.9	.9	SP
— — —	B: NER: 3: 7	10.25 - 10.25	-	3.3	96.7	0.0	1.8	.9	SP
—— ——	B: NER: 3: 7	11.00 - 11.40	-	2.6	97.4	0.0	1.9	1.0	SP
——·—	B: NER: 3: 7	12.00 - 12.00	-	2.0	98.0	0.0	1.9	1.2	SP
———— —	B: NER: 3: 7	13.00 - 13.00	-	4.8	95.2	0.0	2.0	1.1	SP

JOB NO. 101 -3605 DATE 82-08-29

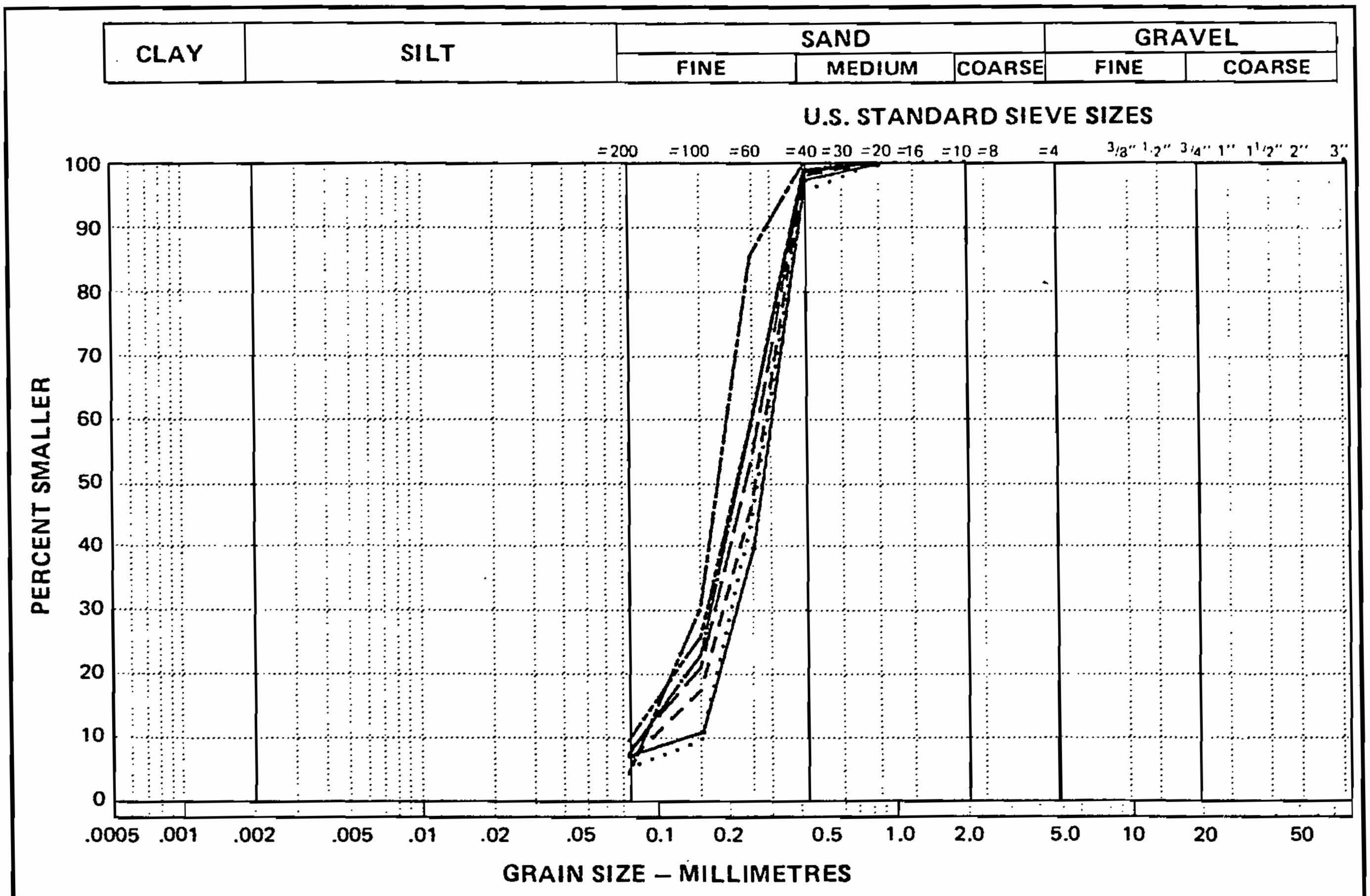
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
————	B: NER: 3: 7	13.70 - 14.10	-	3.6	96.4	0.0	1.7	.9	SP
·····	B: NER: 3: 7	14.60 - 14.90	-	1.8	98.2	0.0	1.8	1.2	SP
– – –	B: NER: 3: 7	17.75 - 17.75	-	1.9	98.1	0.0	1.8	1.2	SP
—— ——	B: NER: 3: 7	20.75 - 20.75	-	3.2	96.8	0.0	1.9	1.2	SP
——·—	B: NER: 3: 7	24.00 - 24.00	-	1.7	98.3	0.0	1.7	1.2	SP
——— –	B: NER: 3: 7	27.00 - 27.00	-	4.1	95.9	0.0	2.3	1.3	SP
——--	B: NER: 3: 7	30.00 - 30.00	-	2.1	97.9	0.0	2.0	1.3	SP

JOB NO. 101 -3605 **DATE** 82-08-17

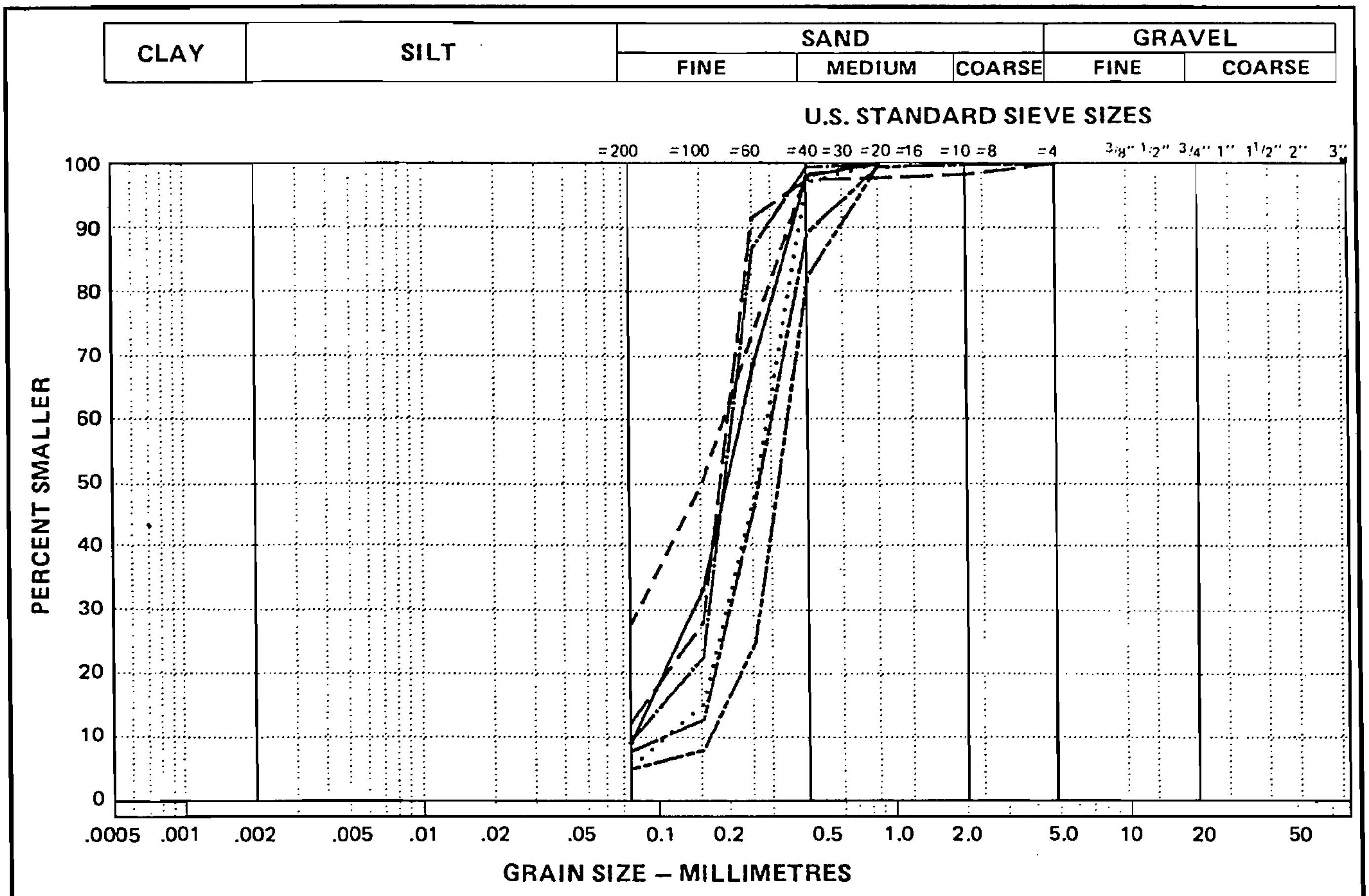
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 8	.50 - .50	-	6.3	93.7	0.0	2.0	1.0	SP-SM
·····	B: NER: 3: 8	1.00 - 1.00	-	4.0	96.0	0.0	1.9	.9	SP
— — —	B: NER: 3: 8	1.80 - 1.80	-	5.1	94.9	0.0	2.9	1.2	SP-SM
—— ——	B: NER: 3: 8	2.25 - 2.25	-	6.6	93.4	0.0	3.1	1.3	SP-SM
———·—	B: NER: 3: 8	3.00 - 3.00	-	6.1	93.9	0.0	2.9	1.3	SP-SM
————	B: NER: 3: 8	3.70 - 3.70	-	3.0	97.0	0.0	2.2	1.3	SP
————	B: NER: 3: 8	4.00 - 4.00	-	8.3	91.7	0.0	3.2	1.3	SP-SM

JOB NO. 101 -3605 **DATE** 82-08-29

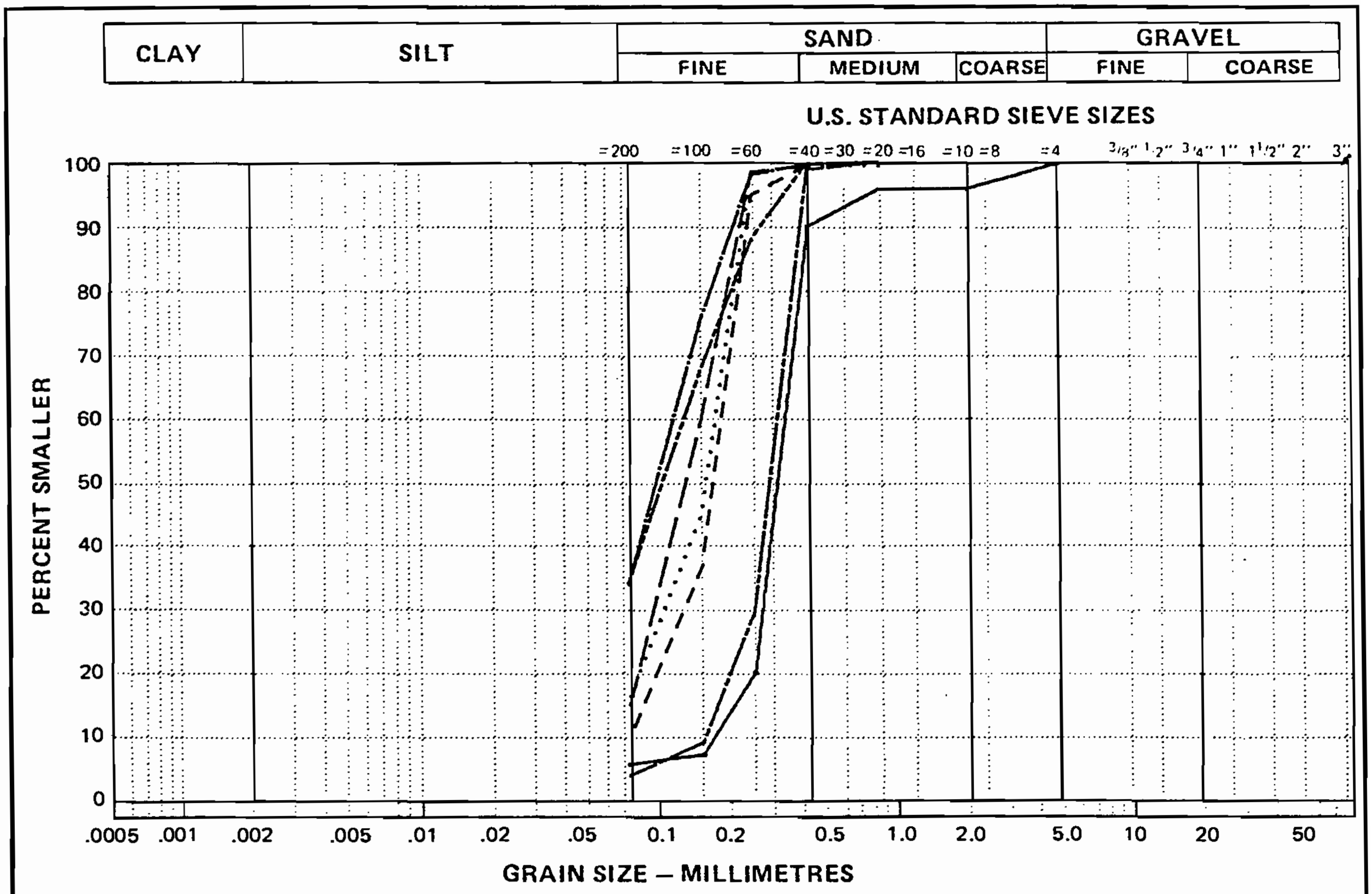
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 8	4.57 - 5.12	-	8.4	91.6	0.0	2.9	1.1	SP-SM
·····	B: NER: 3: 8	5.50 - 5.50	-	4.4	95.6	0.0	2.6	1.2	SP
— — —	B: NER: 3: 8	6.00 - 6.00	-	26.9	73.1	0.0	-	-	
—— ——	B: NER: 3: 8	6.40 - 6.75	-	11.5	88.5	0.0	-	-	
——·—	B: NER: 3: 8	7.50 - 7.50	-	8.6	91.4	0.0	2.5	1.6	SP-SM
——–—	B: NER: 3: 8	9.30 - 10.00	-	6.9	93.1	0.0	2.6	1.1	SP-SM
——-–-	B: NER: 3: 8	9.50 - 9.50	-	4.1	95.9	0.0	2.1	1.2	SP

JOB NO. 101 -3605 **DATE** 82-09-02

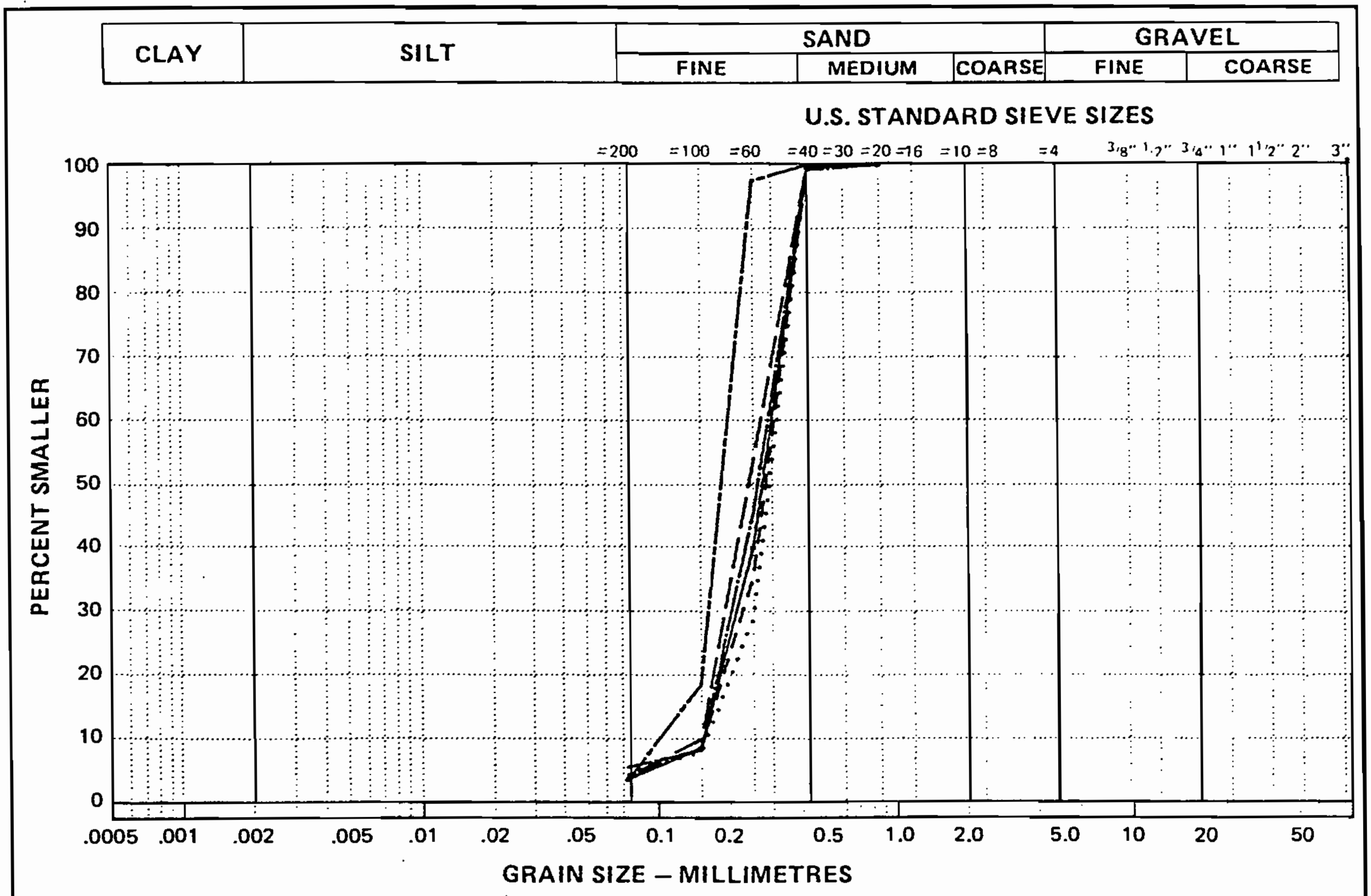
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 8	10.10 - 10.70	-	5.0	95.0	0.0	2.0	1.3	SP-SM
· · · · ·	B: NER: 3: 8	11.50 - 11.50	-	15.5	84.5	0.0	-	-	
– – –	B: NER: 3: 8	11.90 - 12.40	-	9.2	90.8	0.0	2.4	1.2	SP-SM
—— ——	B: NER: 3: 8	13.00 - 13.00	-	14.0	86.0	0.0	-	-	
——·—	B: NER: 3: 8	13.70 - 13.80	-	33.2	66.8	0.0	-	-	
———	B: NER: 3: 8	13.90 - 14.20	-	2.7	97.3	0.0	2.0	1.3	SP
––––	B: NER: 3: 8	15.00 - 15.00	-	33.3	66.7	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-09-04

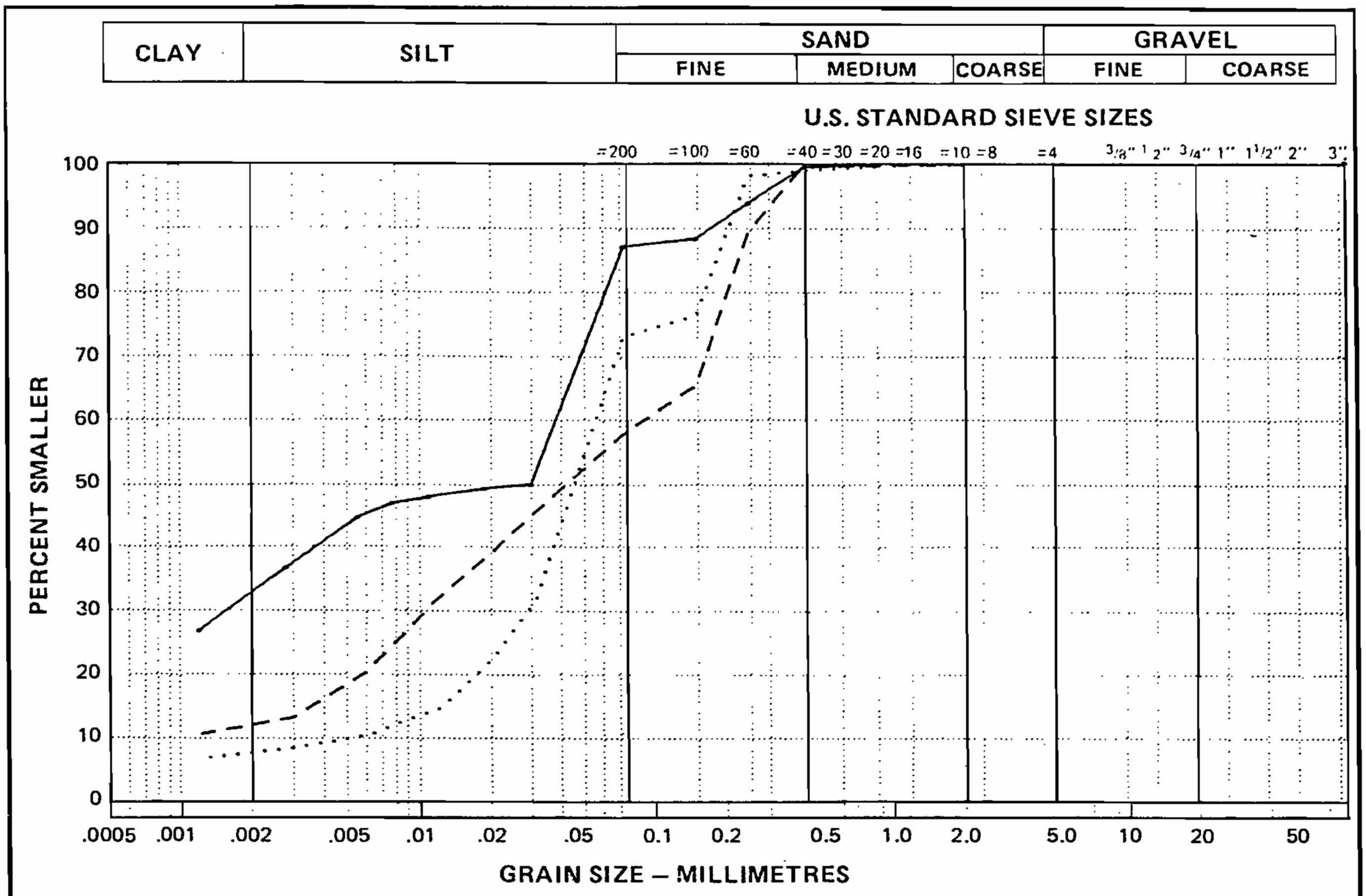
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 8	16.20 - 16.60	-	2.5	97.5	0.0	1.9	1.0	SP
· · · · ·	B: NER: 3: 8	19.50 - 19.50	-	3.5	96.5	0.0	2.0	1.3	SP
— — —	B: NER: 3: 8	22.20 - 22.60	-	3.1	96.9	0.0	2.0	1.1	SP
—— ——	B: NER: 3: 8	25.50 - 25.50	-	2.9	97.1	0.0	1.8	.9	SP
——·—	B: NER: 3: 8	28.30 - 28.70	-	4.4	95.6	0.0	1.9	.9	SP
———·—	B: NER: 3: 8	31.50 - 31.50	-	2.4	97.6	0.0	1.9	1.3	SP

JOB NO. 101 -3605 **DATE** 82-09-04

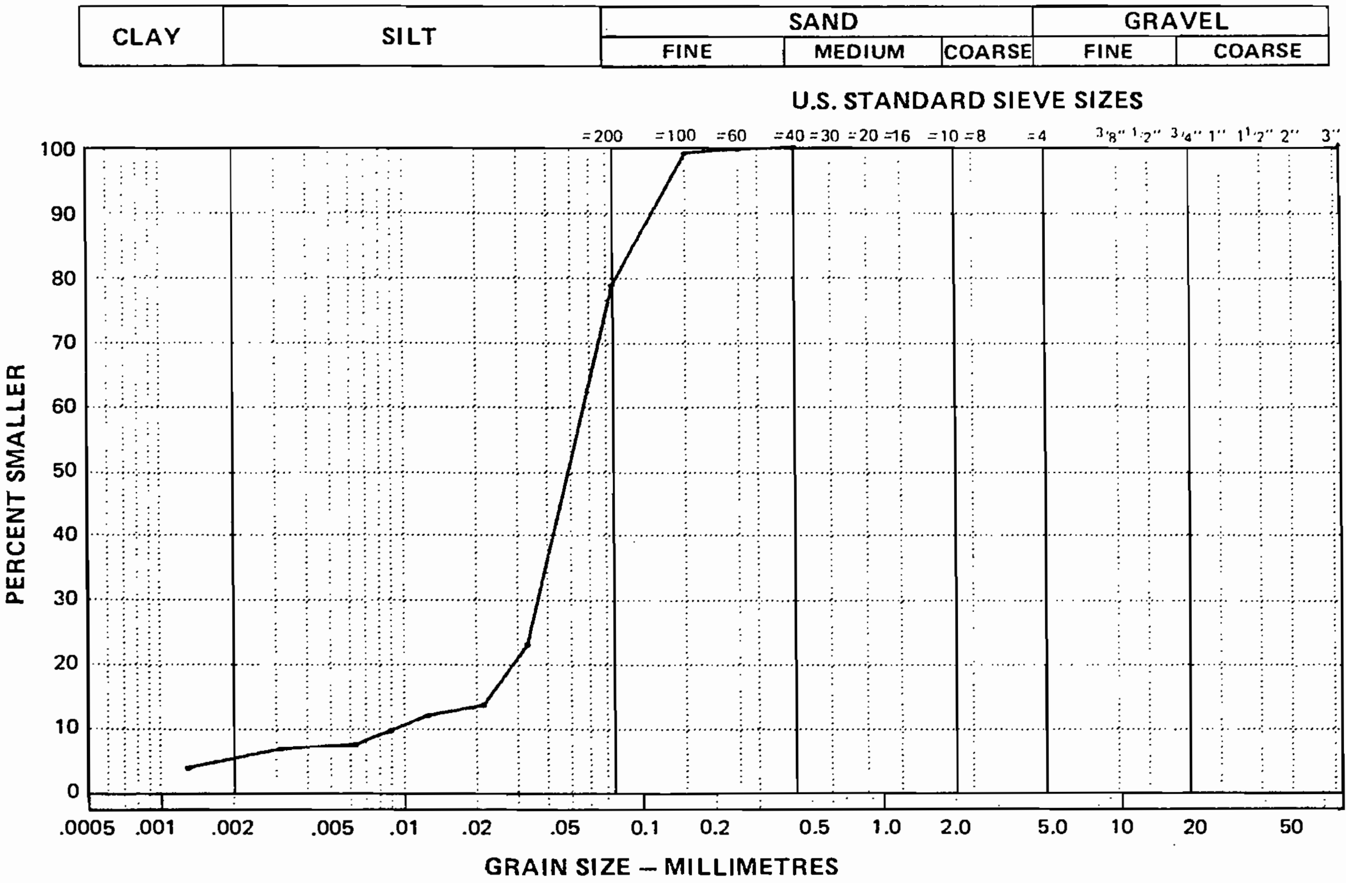
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER3: 9	0.00 - .50	32.5	54.7	12.8	0.0	-	-	
·····	B: NER3: 9	2.70 - 2.90	7.5	65.9	26.6	0.0	9.8	2.6	
— — —	B: NER3: 9	4.20 - 4.50	11.5	46.1	42.4	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-22

PARTICLE - SIZE ANALYSIS OF SOILS

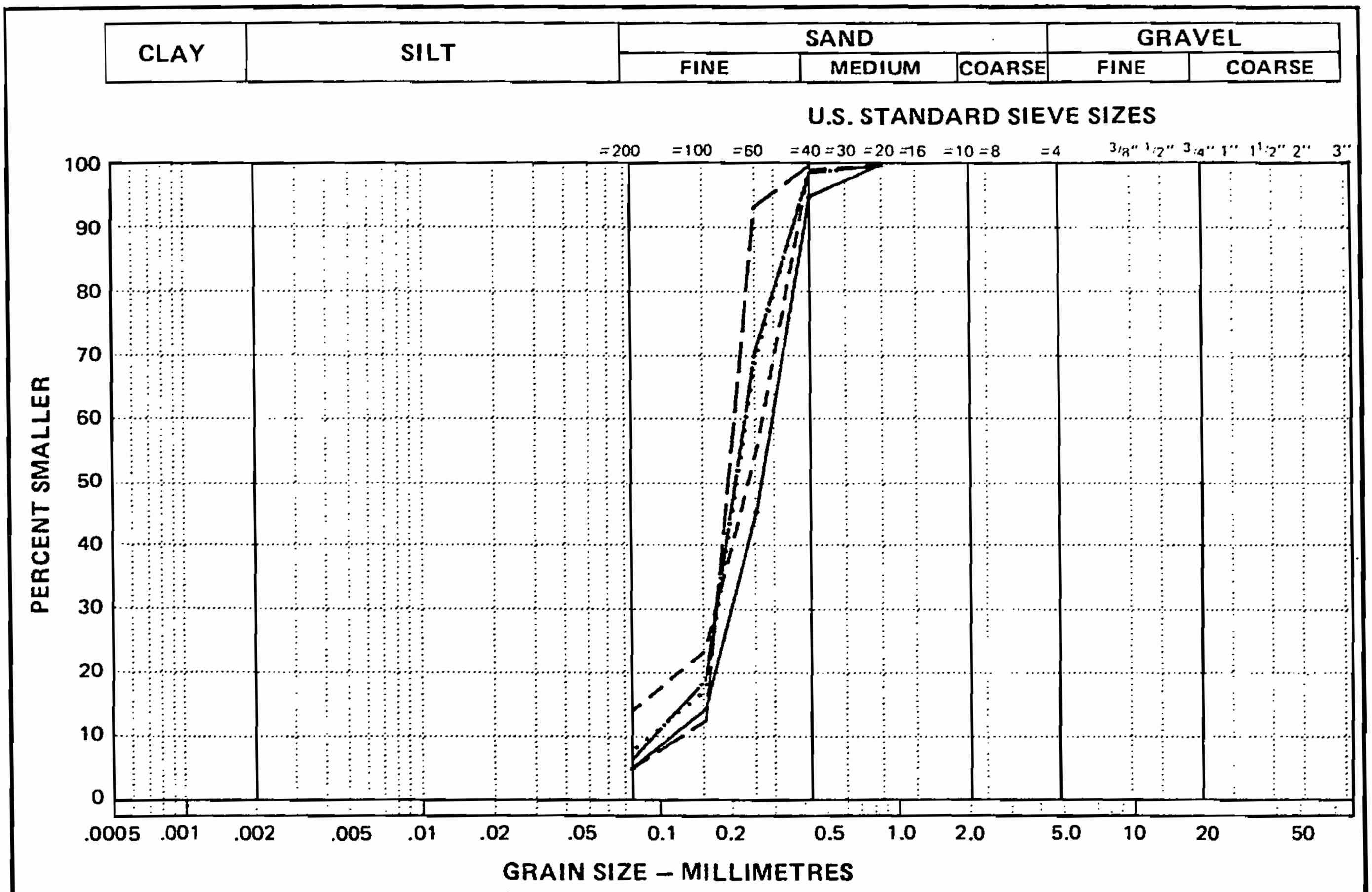


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER3: 9	2.74 - 2.94	4.6	74.1	21.3	0.0	5.5	2.3	

JOB NO. 101 -3605

DATE 82-09-22

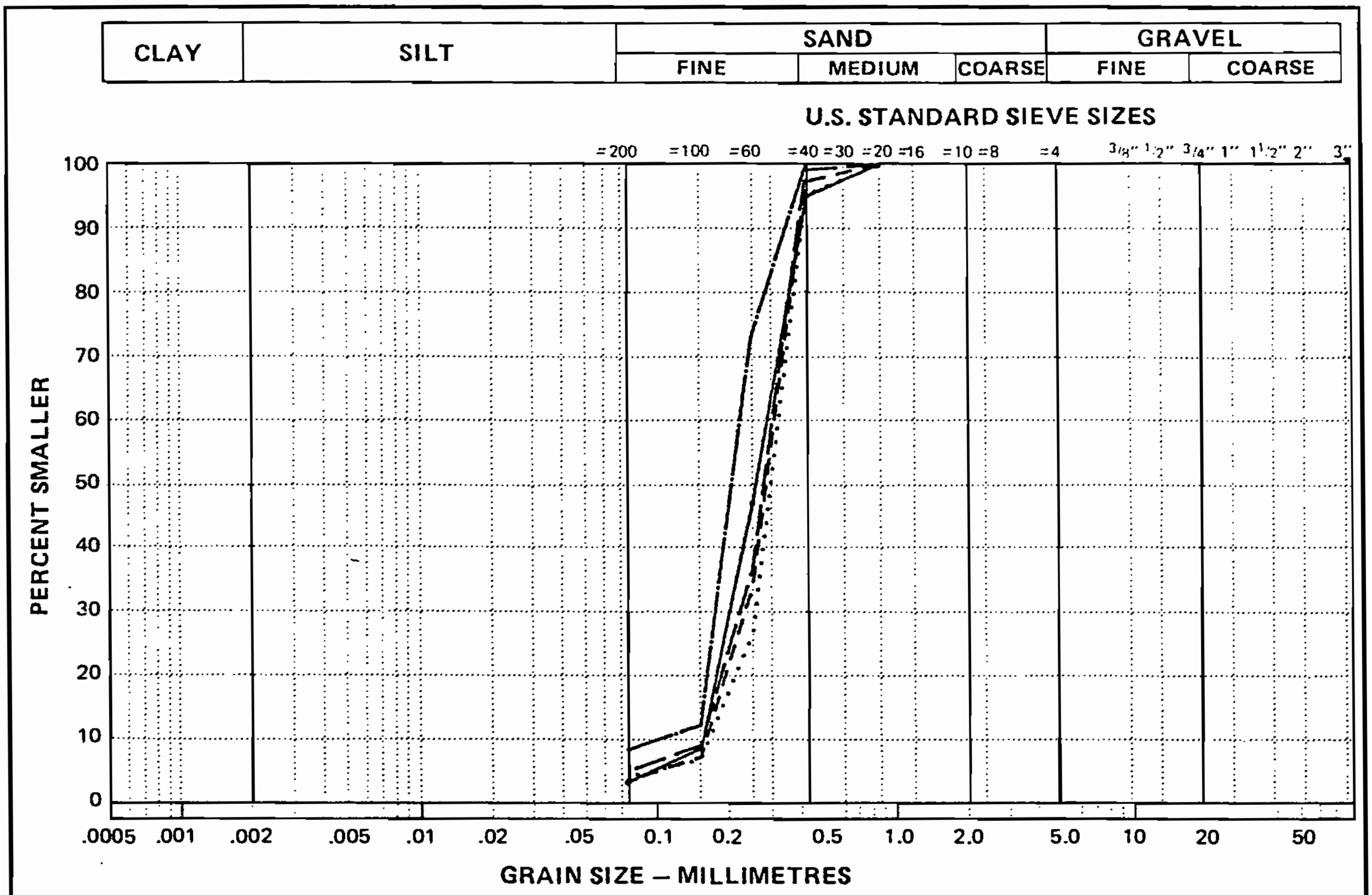
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
______	B: NER: 3: 9	1.70 - 1.70	-	4.3	95.7	0.0	2.6	1.1	SP
. . . . .	B: NER: 3: 9	3.75 - 3.75	-	7.1	92.9	0.0	2.5	1.4	SP-SM
_ _ _ _	B: NER: 3: 9	5.00 - 5.00	-	13.4	86.6	0.0	-	-	
___ ___	B: NER: 3: 9	5.75 - 5.75	-	4.3	95.7	0.0	1.6	1.1	SP
_____._	B: NER: 3: 9	6.75 - 6.75	-	5.7	94.3	0.0	2.4	1.3	SP-SM

JOB NO. 101 -3605 **DATE** 82-09-05

PARTICLE - SIZE ANALYSIS OF SOILS

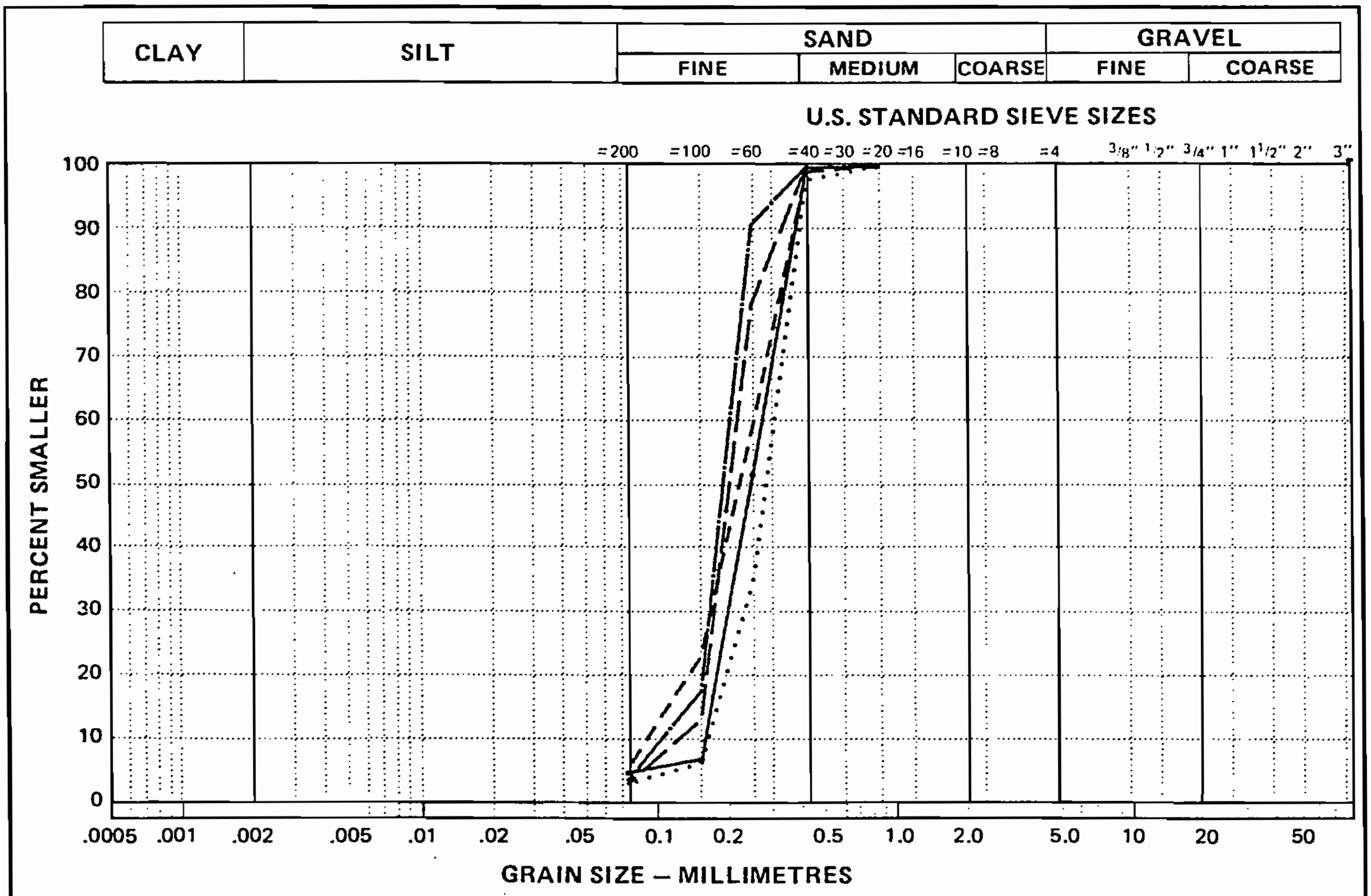


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
————	B: NER: 3: 9	7.50 - 7.50	-	2.4	97.6	0.0	1.9	.9	SP
. . . . .	B: NER: 3: 9	8.50 - 8.50	-	3.2	96.8	0.0	1.9	1.2	SP
— — —	B: NER: 3: 9	9.50 - 9.50	-	2.5	97.5	0.0	1.9	1.1	SP
—— ——	B: NER: 3: 9	10.25 - 10.25	-	4.0	96.0	0.0	2.0	1.1	SP
———.—	B: NER: 3: 9	11.25 - 11.25	-	7.4	92.6	0.0	1.9	1.2	SP-SM

JOB NO. 101 -3605

DATE 82-09-05

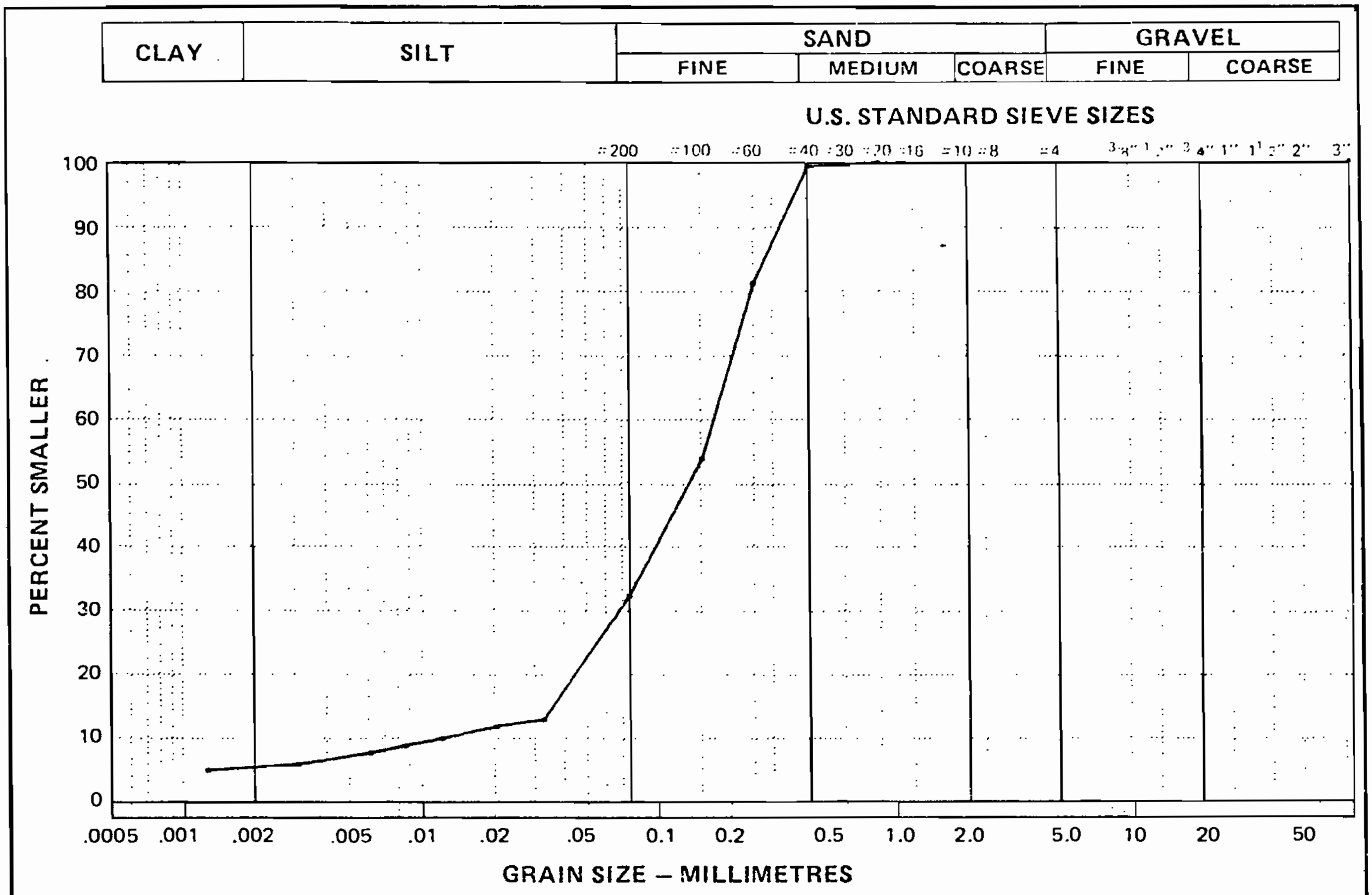
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER: 3: 9	12.80 - 12.80	-	4.0	96.0	0.0	1.8	.9	SP
· · · · ·	B: NER: 3: 9	14.75 - 14.75	-	2.3	97.7	0.0	1.9	1.1	SP
— — —	B: NER: 3: 10	2.10 - 2.10	-	4.7	95.3	0.0	2.8	1.2	SP
—— ——	B: NER: 3: 10	4.75 - 4.75	-	2.2	97.8	0.0	1.7	1.1	SP
——·—	B: NER: 3: 10	6.60 - 6.60	-	2.8	97.2	0.0	1.9	1.3	SP

JOB NO. 101 -3605 DATE 82-09-05

PARTICLE - SIZE ANALYSIS OF SOILS

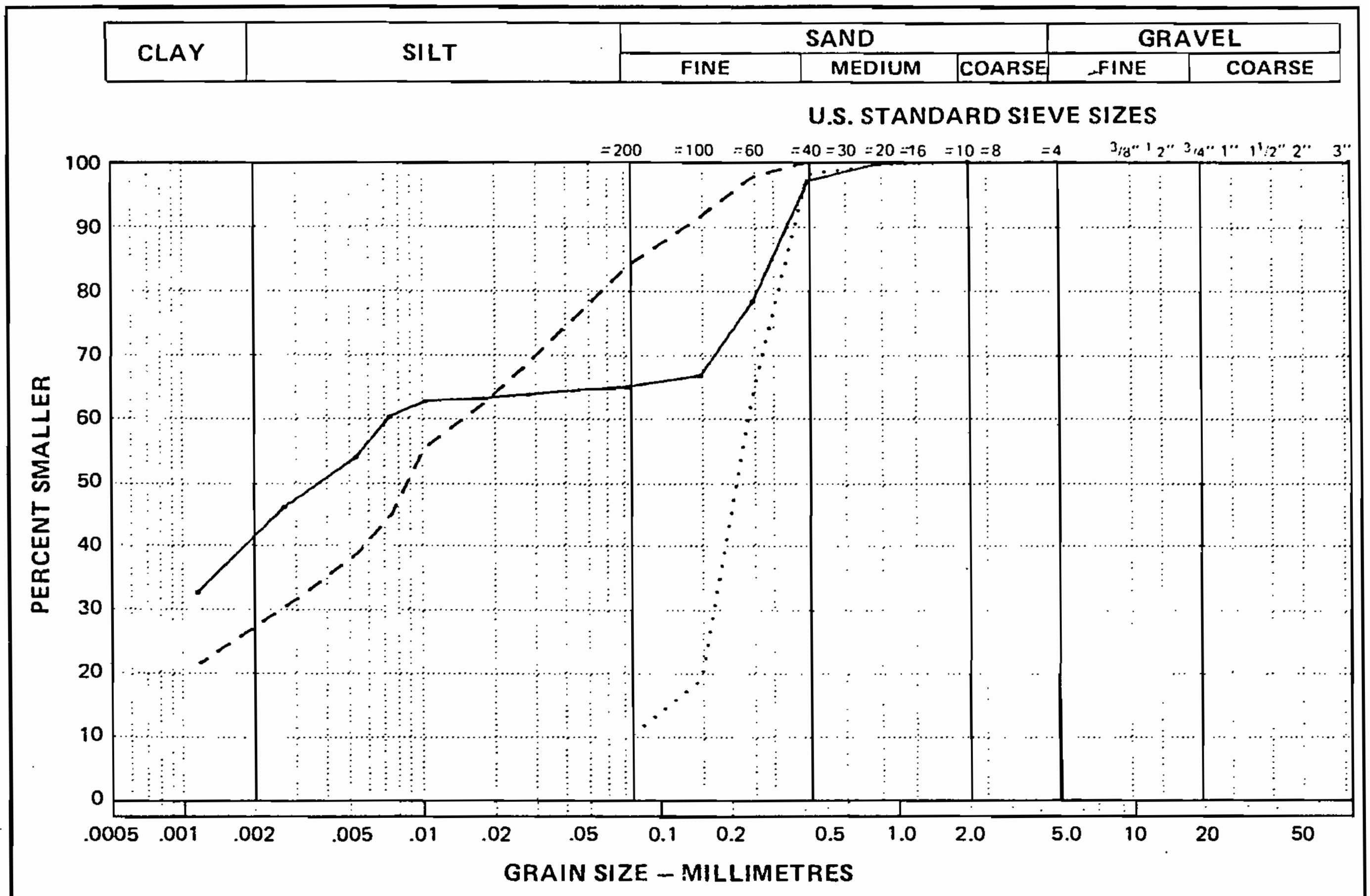


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
—	B: NER3: 10	1.83 - 1.98	4.6	26.9	68.5	0.0	10.9	1.8	SM

JOB NO. 101 -3605

DATE 82-10-18

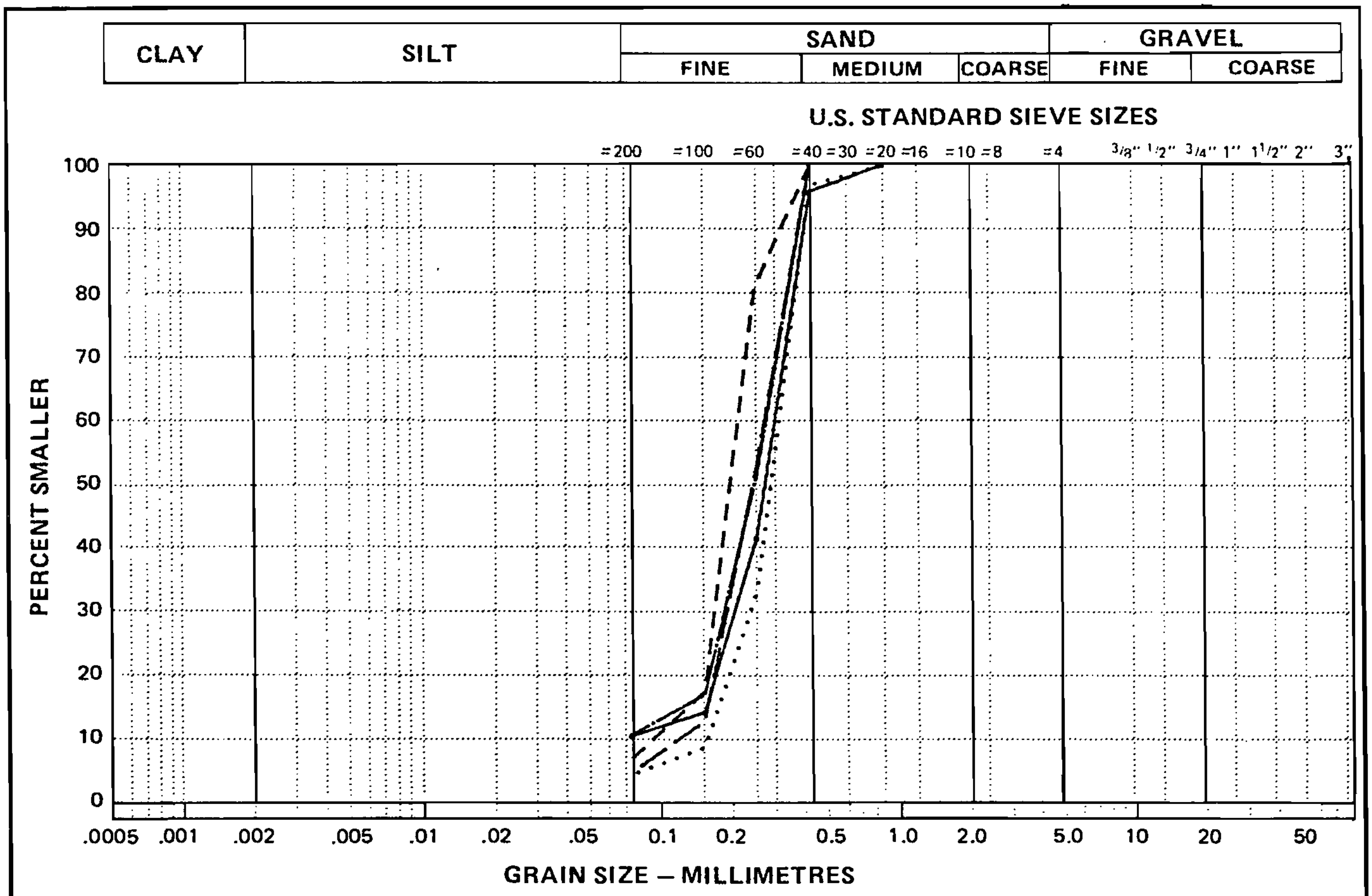
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER3: 10	0.00 - .10	40.5	24.0	35.5	0.0	-	-	
. . . .	B: NER3: 10	.10 - .60	-	8.5	91.5	0.0	2.9	1.5	SP-SM
— — —	B: NER3: 10	2.70 - 2.90	26.0	57.6	16.4	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-11-15

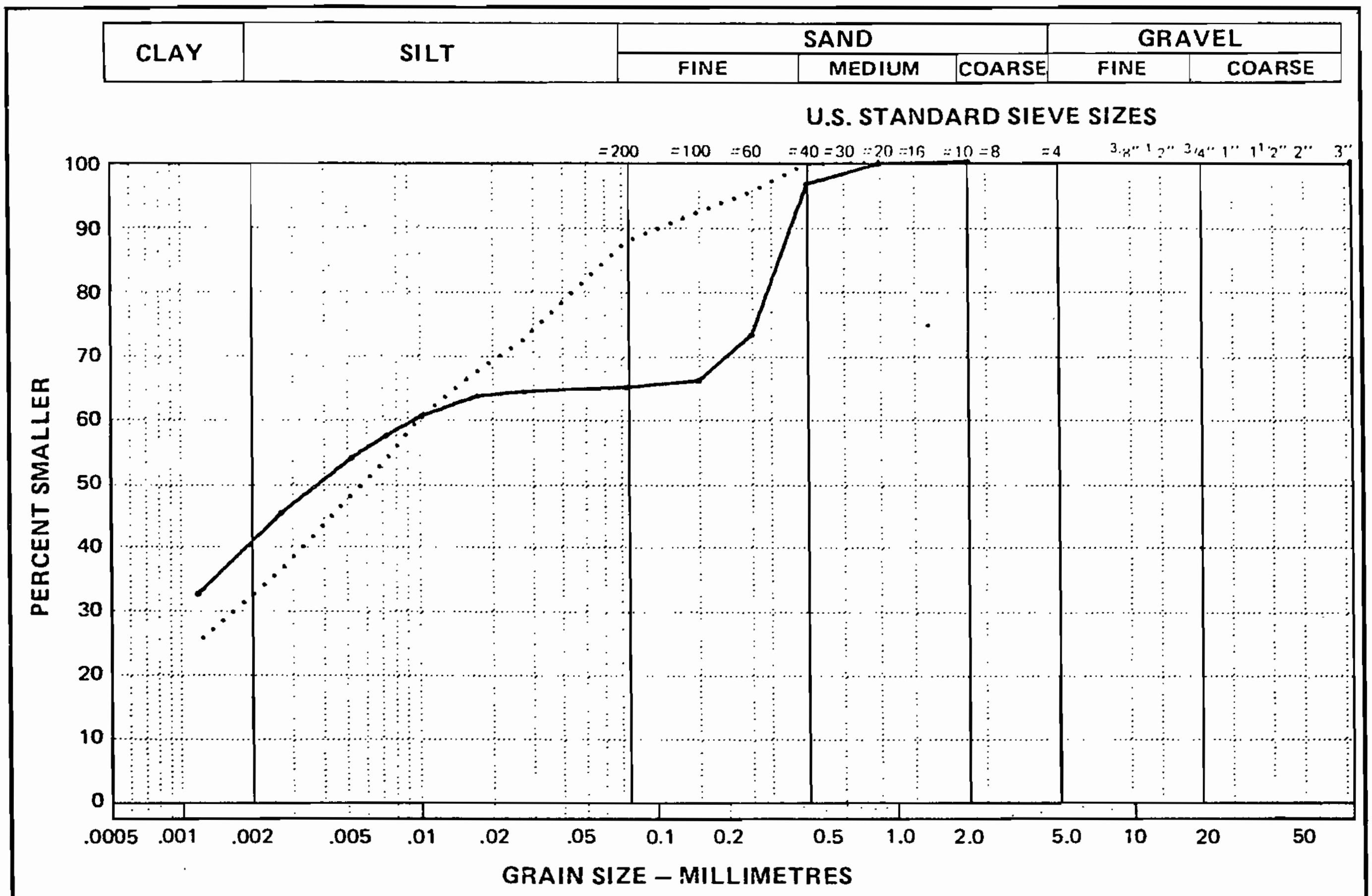
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	DESCRIPTION SILT (%)	DESCRIPTION SAND (%)	DESCRIPTION GRAVEL (%)	Cu	Cc	U.S.C.
———	B: NER: 3: 10	8.50 - 8.50	-	9.7	90.3	0.0	3.9	1.8	SP-SM
·····	B: NER: 3: 10	9.50 - 9.50	-	3.6	96.4	0.0	2.0	1.2	SP
– – –	B: NER: 3: 10	11.50 - 11.50	-	6.1	93.9	0.0	2.2	1.4	SP-SM
—— ——	B: NER: 3: 10	13.00 - 13.00	-	3.9	96.1	0.0	2.2	1.0	SP
——·—	B: NER: 3: 10	14.00 - 14.00	-	9.9	90.1	0.0	3.7	1.7	SP-SM

JOB NO. 101 -3605 **DATE** 82-09-06

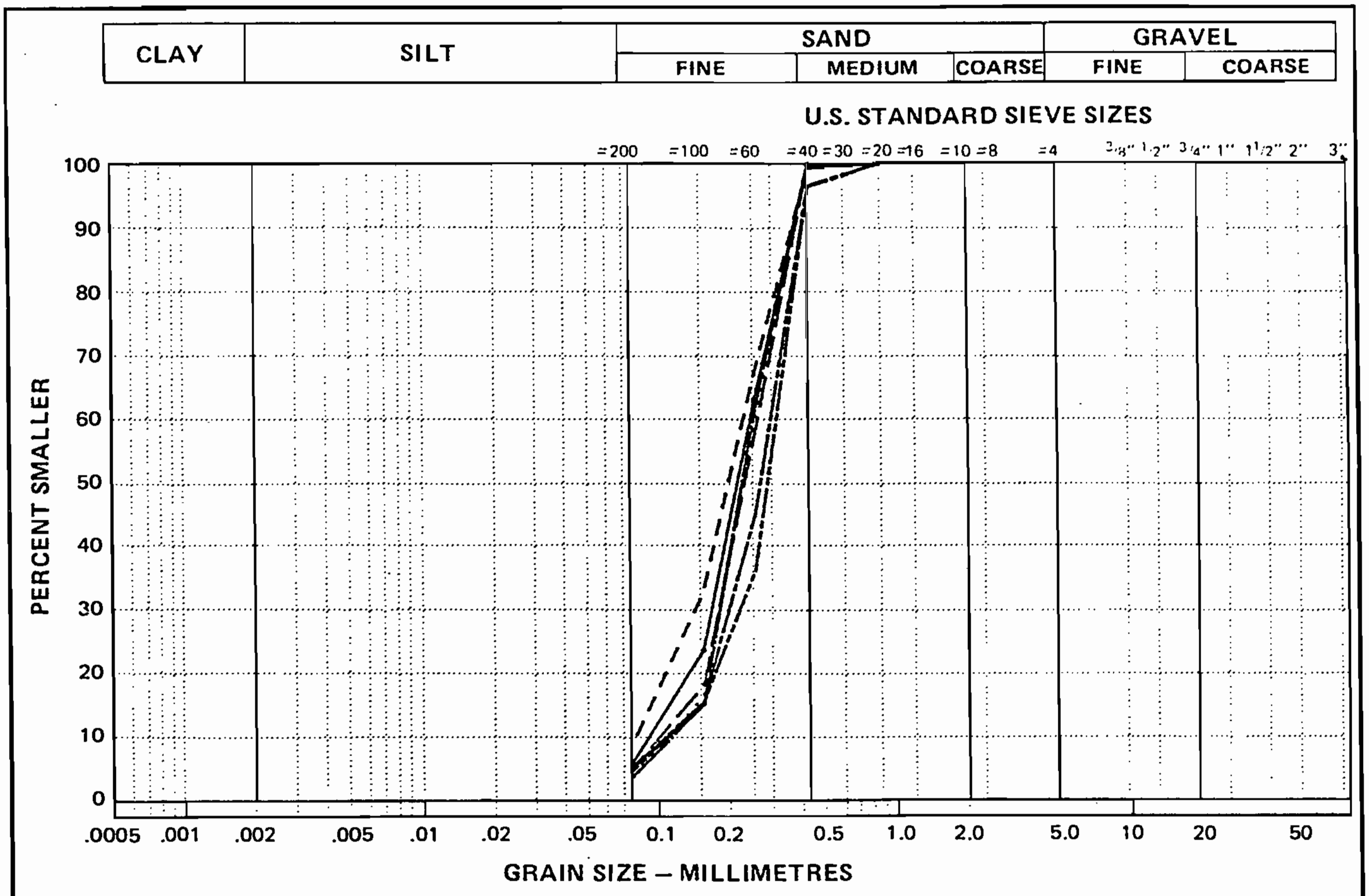
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B:NER3:11	0.00 - .80	39.9	24.6	35.5	0.0	-	-	
· · · · ·	B:NER3:11	9.80 - 10.30	31.4	56.2	12.4	0.0	-	-	

JOB NO. 101 -3605 DATE 82-11-18

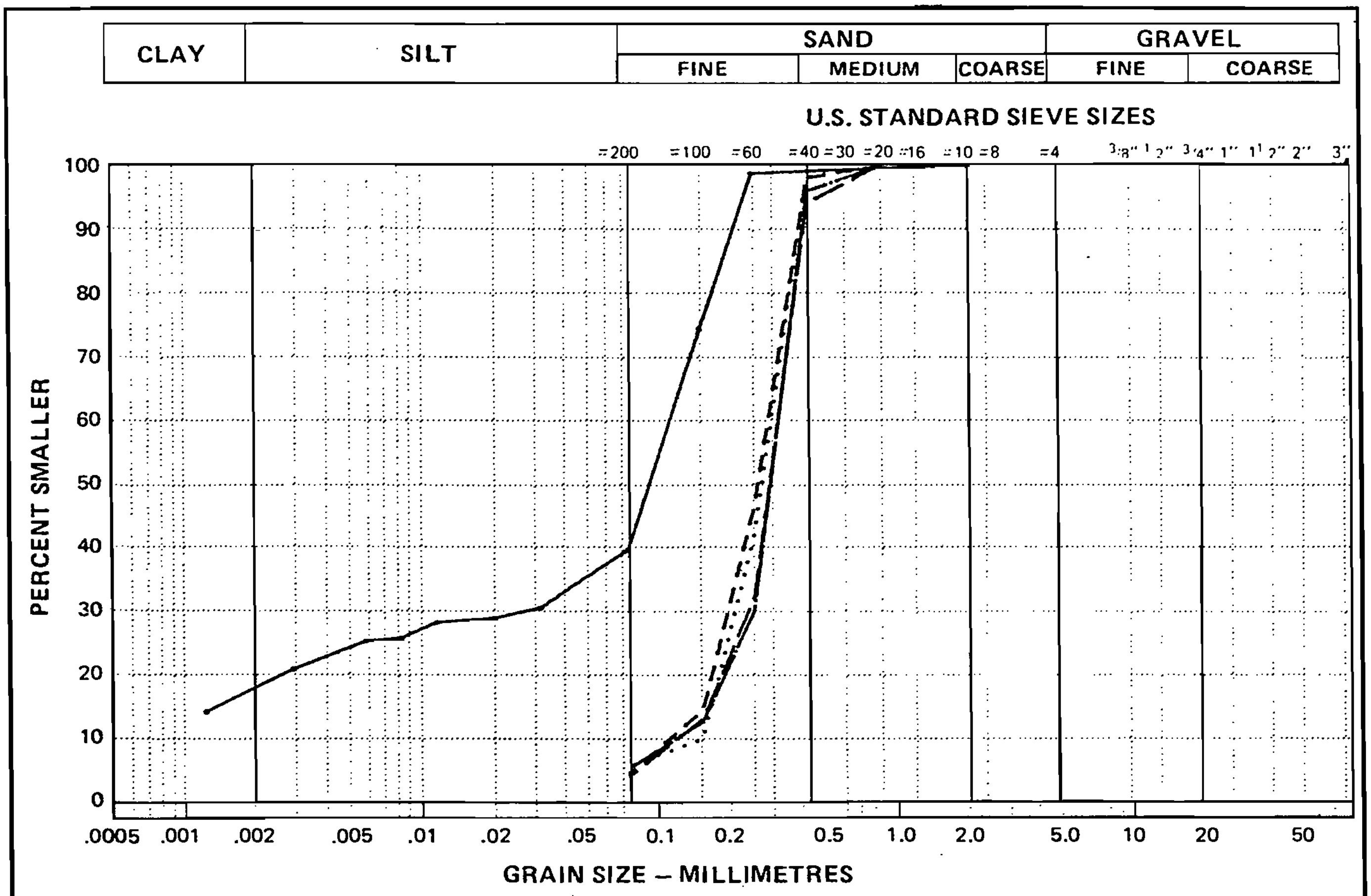
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———————	B: NER: 3: 11	1.90 - 1.90	-	5.0	95.0	0.0	2.7	1.2	SP-SM
· · · · ·	B: NER: 3: 11	2.35 - 2.35	-	2.7	97.3	0.0	2.3	1.1	SP
— — —	B: NER: 3: 11	2.90 - 2.90	-	7.9	92.1	0.0	2.9	1.1	SP-SM
—— ——	B: NER: 3: 11	3.20 - 3.20	-	4.0	96.0	0.0	2.5	1.2	SP
————·—	B: NER: 3: 11	4.90 - 4.90	-	2.6	97.4	0.0	2.1	1.1	SP
———————	B: NER: 3: 11	6.00 - 6.00	-	4.3	95.7	0.0	2.7	1.2	SP
————--	B: NER: 3: 11	7.00 - 7.00	-	3.7	96.3	0.0	2.8	1.4	SP

JOB NO. 101 -3605 **DATE** 82-09-06

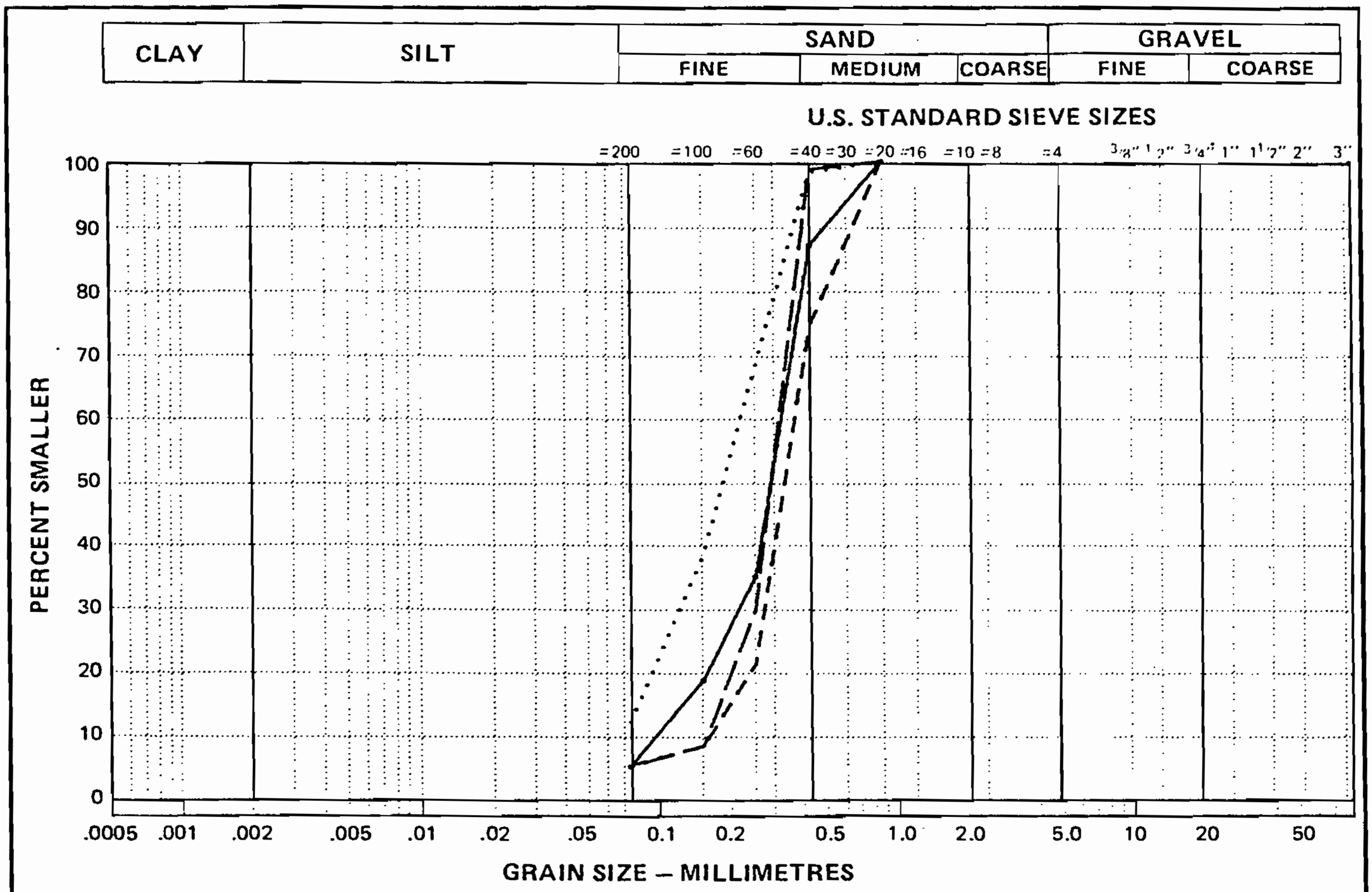
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER3: 12	.90 - 1.06	17.7	21.5	60.8	0.0	-	-	
· · · · ·	B: NER3: 12	1.06 - 1.16	-	4.8	95.2	0.0	2.0	1.0	SP
– – –	B: NER3: 12	2.74 - 3.10	-	3.7	96.3	0.0	2.5	1.1	SP
—— ——	B: NER3: 12	4.57 - 4.93	-	3.2	96.8	0.0	2.5	1.4	SP
——·—	B: NER3: 12	6.40 - 6.75	-	4.5	95.5	0.0	2.5	1.6	SP

JOB NO. 101 -3605 **DATE** 82-10-.7

PARTICLE - SIZE ANALYSIS OF SOILS



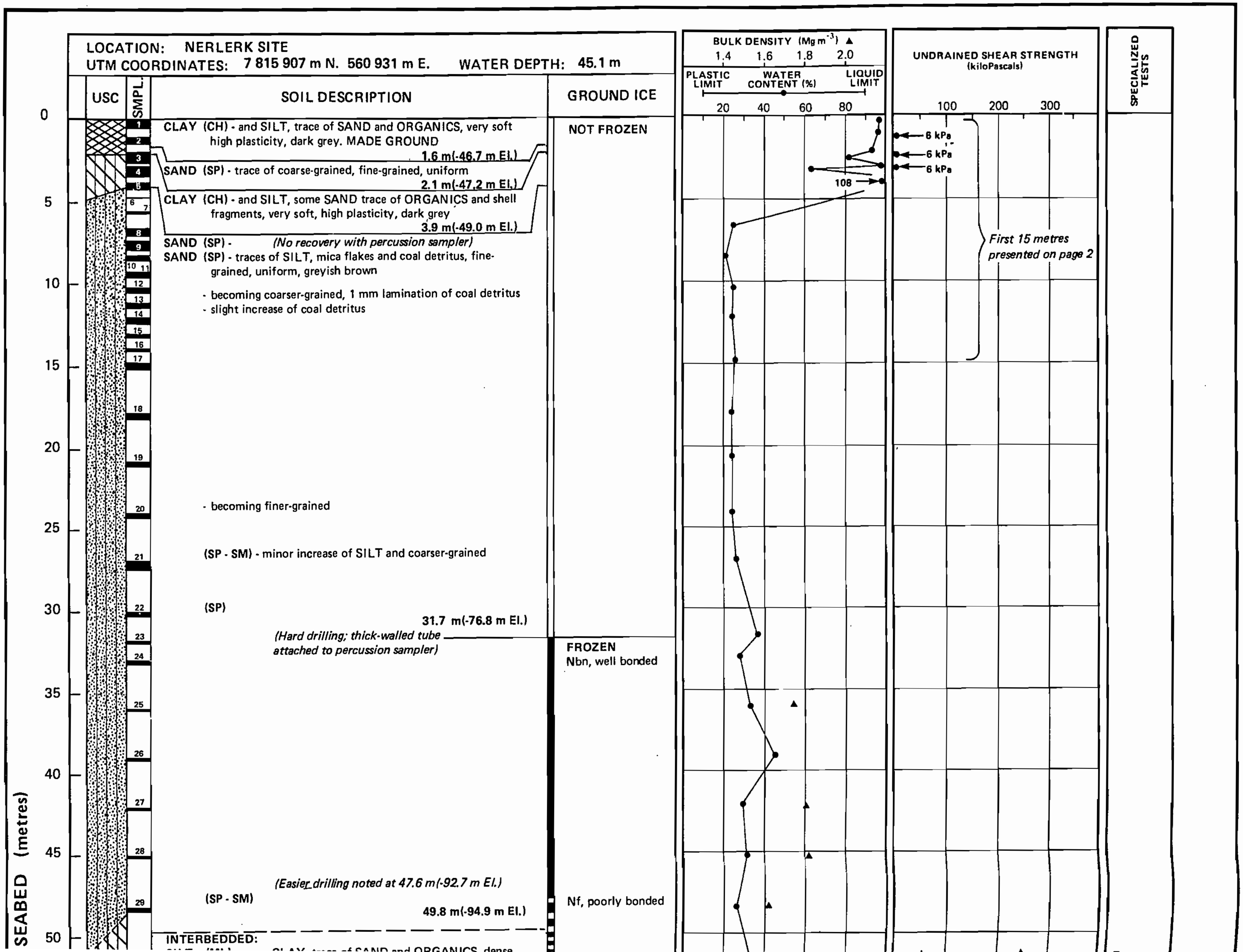
SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
———	B: NER3: 12	7.31 - 7.66	-	3.8	96.2	0.0	3.2	1.5	SP
· · · · ·	B: NER3: 12	8.23 - 8.70	-	10.7	89.3	0.0	-	-	
— — —	B: NER3: 12	9.30 - 9.90	-	3.9	96.1	0.0	2.2	1.2	SP
—— ——	B: NER3: 12	11.90 - 12.40	-	3.7	96.3	0.0	2.0	1.2	SP

JOB NO. 101 -3605 **DATE** 82-10-15

TABLE A1 NERLERK SITES INVESTIGATED

BOREHOLE NO.	UTM COORDINATES (m)	GEOGRAPHIC COORDINATES	WATER DEPTH (m)	PENETRATION (m)	DATE ADVANCED
F-NER 2:3	7,815,907N 560,931E	70°26'34"N 133°22'8"W	45.1	121.6	82-08-05

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 907 m N. 560 931 m E. WATER DEPTH: 45.1 m



CLAY (CH) - and SILT, trace of SAND and ORGANICS, very soft high plasticity, dark grey. MADE GROUND

1.6 m(-46.7 m El.)

SAND (SP) - trace of coarse-grained, fine-grained, uniform

2.1 m(-47.2 m El.)

CLAY (CH) - and SILT, some SAND trace of ORGANICS and shell fragments, very soft, high plasticity, dark grey

3.9 m(-49.0 m El.)

SAND (SP) - *(No recovery with percussion sampler)*

SAND (SP) - traces of SILT, mica flakes and coal detritus, fine-grained, uniform, greyish brown

- becoming coarser-grained, 1 mm lamination of coal detritus
- slight increase of coal detritus

- becoming finer-grained

(SP - SM) - minor increase of SILT and coarser-grained

(SP)

31.7 m(-76.8 m El.)

(Hard drilling; thick-walled tube attached to percussion sampler)

(Easier drilling noted at 47.6 m(-92.7 m El.)

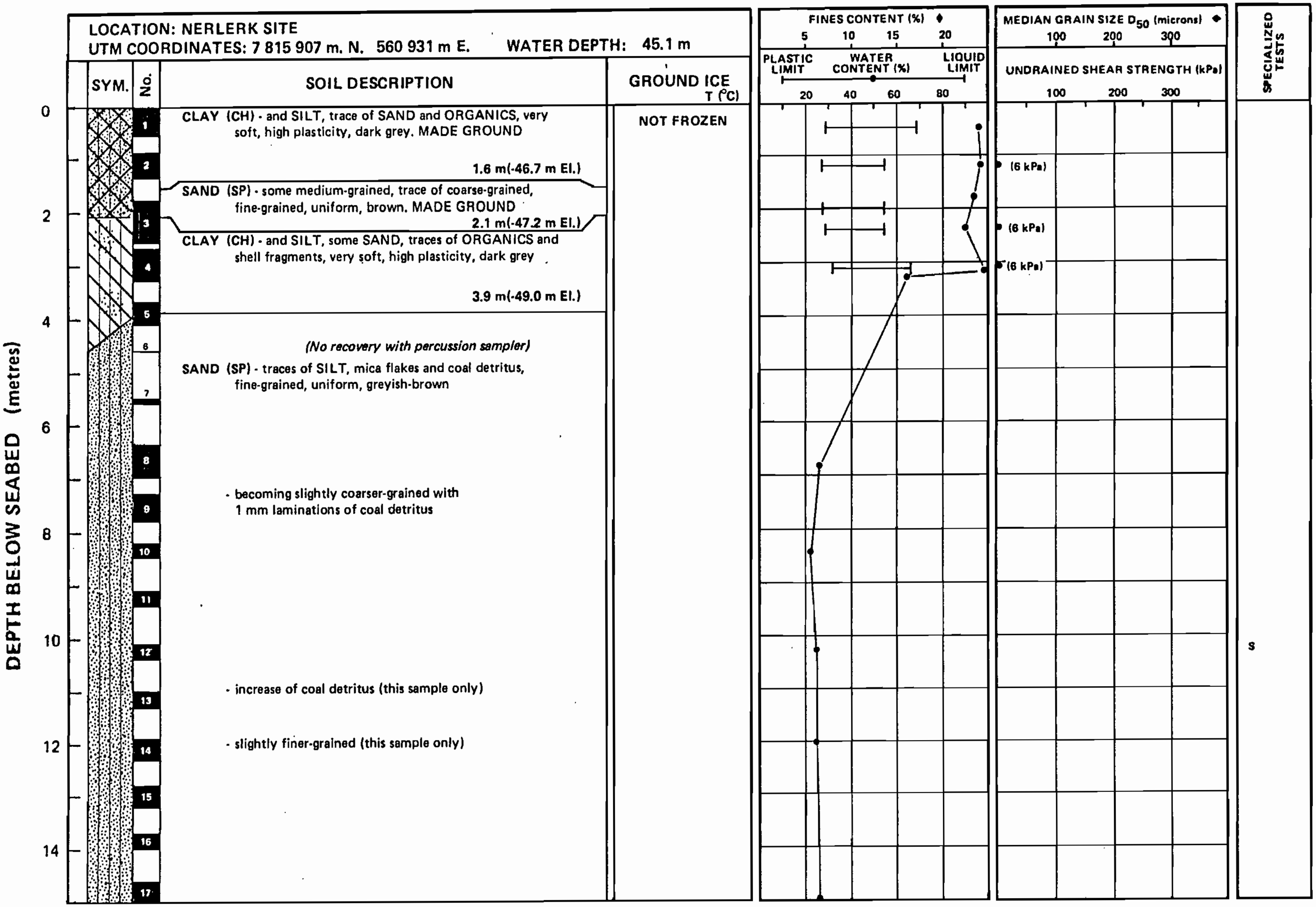
(SP - SM)

49.8 m(-94.9 m El.)

INTERBEDDED:

CLAY, trace of SAND and ORGANICS, dense

LOCATION: NERLERK SITE
UTM COORDINATES: 7 815 907 m. N. 560 931 m E. WATER DEPTH: 45.1 m



CLAY (CH) - and SILT, trace of SAND and ORGANICS, very soft, high plasticity, dark grey. MADE GROUND

1.6 m(-46.7 m El.)

SAND (SP) - some medium-grained, trace of coarse-grained, fine-grained, uniform, brown. MADE GROUND

2.1 m(-47.2 m El.)

CLAY (CH) - and SILT, some SAND, traces of ORGANICS and shell fragments, very soft, high plasticity, dark grey

3.9 m(-49.0 m El.)

(No recovery with percussion sampler)

SAND (SP) - traces of SILT, mica flakes and coal detritus, fine-grained, uniform, greyish-brown

- becoming slightly coarser-grained with 1 mm laminations of coal detritus

- increase of coal detritus (this sample only)

- slightly finer-grained (this sample only)

JOB No.: 101 - 3605
DRILLING COMPLETED: 82/08/07
BOREHOLE DEPTH: 121.6 m(-166.7 m El.)
DRILLING RIG: F 1500/Supplier V
LOG COMPILED BY: PMR/KWJ

LEGEND

SOIL SYMBOLS: SAND, SILT, CLAY

SHEAR STRENGTH
+ Torvane
× Min. Vane
∗ Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

TEST IDENTIFICATION
C - Consolidation
DS - Direct Shear
TD - TDR
Ca - Calorimetry
T - Triaxial Shear
S - P.W. Salinity
G - Gas Analysis

BOREHOLE NUMBER
F-NER 2:3

PAGE 2 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
F-NER2:3																							
1	B	*0.0-0.6	CH			77/97			68	29	53	40	7	0	2.0	TV	1		v. soft				
2	B	*0.9-1.4	CH			83/98			54	27	53	36	11	0	2.0	FC	6		v. soft				
3A	NS	*1.8-2.1	SP			95							98	0	380								
3B	B	*2.1-2.6	CH			90/83			55	27	52	38	10	0	2.0	FC	6		v. soft				
4A	B	*2.7-3.2	CH			82/100			66	33	56	43	1	0	1.7	FC	6		v. soft				
4B	B	*3.2-3.3				64																	
5A	B	*3.7-3.8				(108)																	
5B	B	*3.8-4.1																					
6	NR	4.6-																					
7	NS	*5.5-5.6	SP										98	0	210								
8	B	*6.4-7.0	SP			26							98	0	250								
9	B	*7.3-7.8																					
10	B	*8.2-8.5	SP			22							99	0	310								
11	B	*9.1-9.4																					
12	B	*10.1-10.4	SP			25							98	0	300								S
13	B	*11.0-11.3																					0=1%
14	B	*11.9-12.3	SP			24							98	0	240								
15	B	*12.8-13.2																					
16	B	*13.7-14.0																					
17	B	*14.6-15.0	SP			25							97	0	300								

LEGEND AND NOTES

B - Bag Sample
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CD - Consolidated Drained Triaxial

O - Organic Content
S - Salinity
TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

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SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
F-NER2:3		(continued)																					
18	B	*17.7-18.1																					
19	B	*20.7-21.0	SP			23							98	0	300								S
20	B	*23.8-24.1	SP			27		2.7SG					97	0	190								0=2..
21	B	*26.8-27.3	SP-SM			27							95	0	260								
22	B	*29.9-30.2																					
23	PF	*31.7-31.8		Nbn		36																	
24	PF	*32.9-33.1		Nbn		29		1.5															
25	NS	*36.0-36.1	SP			33		1.8					99	0	300								
26	PF	*39.0-39.1		Nbn		48																	
27	PF	*42.1-42.2		Nbn		31		1.8															
28	NS	*45.1-45.2	SP	Nbn		34		1.8					98	0	275								
29	PF	*48.2-48.4	SP-SM	Nbn-Nf		28		1.6					95	0	200								
30	PF	*51.2-51.4	ML	Nf		30										TV	54		stiff				
						25		1.93								UU	250		hard				
31	B	*51.8-52.2	ML			29/26			29	24	13	86	1	0	2	TV	46		firm				
32	B	*52.5-52.8				31										PV	90		stiff				
33	B	*53.1-53.5	CL			27/30		2.1	34	22	18	82	0	0	13	TV	63		stiff				
34	B	54.3-54.6				33										TV	35		firm				
																PV	14		soft				
35	B	*55.0-55.4				35										PV	200		hard				

LEGEND AND NOTES

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UUp - UU Triaxial with Pore Pressure Measurements
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CUp - CU Triaxial with Pore Pressure Measurements
CD - Consolidated Drained Triaxial

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TS - Thaw Strain
SG - Specific Gravity

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number		Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
Sample Number	Sample Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
F-NER2:3	(continued)																						
35A	G	55.0-55.4																					G
35B	PW	55.0-55.4																					S
36B	T	55.8-56.4				26		1.96								UU	117	13	v. stiff				
						26		1.95								UU	55	20	stiff				
						30		1.95												500	520	0.20	
36A	B	*56.4-56.6	CL			31			36	23	25	75	0	0	8								
37A	W	*57.3-57.5				29		1.99								UU	108	6	v. stiff				
37B	B	57.5-57.6				30										PV	35		firm				
38A	B	*60.4-60.5	CL			30			32	22	29	71	0	0	10	TV	25		firm				
38B	B	*60.5-60.6				34																	
38C	W	*60.6-60.7						2.69SG															
38D	B	*60.7-60.9	CL-ML			28/30			28	21	19	81	0	0	18								
39A	B	*63.4-63.4				30		2.0															
39B	W	*63.4-63.6				29		1.98								UU	114	12	v. stiff				
						27		1.95												660	850	0.35	
39C	G	*63.6-63.7														TV	93		stiff				G
39C	PW	63.6-63.7																					S
40A	B	*66.4-66.6	CL			31/33			35	21	31	69	0	0	6								
40B	B	*66.6-66.6	ML			31			non plastic		7	93	0	0	20								
40C	B	*66.6-66.8	CL																				

LEGEND AND NOTES

B · Bag Sample	PF · Permafrost Sample	MV · Minivane	UU · Unconsolidated Undrained Triaxial	O · Organic Content
G · Gas Sample	PW · Porewater Sample	FC · Fall Cone	UUp · UU Triaxial with Pore Pressure Measurements	S · Salinity
L · Liner Sample	T · Sample Stored in Tube	TV · Torvane	CU · Consolidated Undrained Triaxial	TS · Thaw Strain
P · Piston Sample	W · Waxed Sample	PV · Pilcon Vane	CUp · CU Triaxial with Pore Pressure Measurements	SG · Specific Gravity
NR · No Recovery	RC · Radiocarbon Sample	RV · Remote Vane	CD · Consolidated Drained Triaxial	
NS · No Sample Remaining				

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
F-NER2:3 (continued)																							
40D	B	*66.8-67.0				31																	
41A	B	*69.5-69.8	CL			29			30	20	21	79	0	0	17								
41B	G	69.8-69.9																					G
41B	PW	69.8-69.9																					S
42A	B	*72.4-72.9	CL			29			49	24	53	47	0	0	2								
42B	W	72.5-72.7				26		2.02								UU	171	17	v. stiff				
42C	W	72.7-72.9				23		2.04								PV	78		stiff	600	910	0.21	0=11
						25		2.02								UU	198	5	v. stiff				
43A	B	*75.6-75.7	CL			32			45	23	44	56	0	0	3	PV	>200		hard				
																FC	(108)		v. stiff				
43B	W	75.7-75.9				27		1.98								UU	166	4	v. stiff				
44A	B	*78.6-78.7				30										PV	>200		hard				
								2.73SG								FC	>200		hard				
44B	W	78.7-78.9						2.0															
						27		1.97								UU	245	5	hard				
45A	G	*81.7-81.9						2.0															G
45A	PW	81.7-81.9																					S
45B	W	*81.9-82.1				26		1.96								UU	230	9	hard				
						26		2.01												700	1000	0.29	

LEGEND AND NOTES

B	Bag Sample	PF	Permafrost Sample	MV	Minivane	UU	Unconsolidated Undrained Triaxial	O	Organic Content
G	Gas Sample	PW	Porewater Sample	FC	Fall Cone	UUp	UU Triaxial with Pore Pressure Measurements	S	Salinity
L	Liner Sample	T	Sample Stored in Tube	TV	Torvane	CU	Consolidated Undrained Triaxial	TS	Thaw Strain
P	Piston Sample	W	Waxed Sample	PV	Pilcon Vane	CUp	CU Triaxial with Pore Pressure Measurements	SG	Specific Gravity
NR	No Recovery	RC	Radiocarbon Sample	RV	Remote Vane	CD	Consolidated Drained Triaxial		
NS	No Sample Remaining								

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
F-NER2:3 (continued)																							
45C	B	*81.7-82.1				32																	
46A	B	*84.7-84.8				34																	
46B	T	84.8-85.2				24		2.01								UU	118	11	v. stiff				
						26		2.01												750	850	0.21	
47A	B	*87.8-88.2	CL			32			44	26	49	51	0	0	2								
47B	W	*84.8-88.0		Vs 2 mm		28		1.98								UU	137	12	v. stiff				
				thick ice lens																			
48A	B	*90.8-91.0	CL	Nbn		31/34		1.9	48	23	52	48	0	0	2								
48B	PF	*91.0-91.1		Nbn		29		1.91								UU	196	11	v. stiff				
				Nbn												FC	160		v. stiff				
48C	W	*91.1-91.2		Nbn		29		1.96								UU	238	9	hard				
				Nbn				2.75SG															
48D	G	91.2-91.3		Nbn																			G
48D	PW	91.2-91.3		Nbn																			S
49A	B	*93.9-94.0	CH	Nbn		32/37		2.0	52	28	58	42	0	0	1.3								
49B	W	*94.0-94.2		Nbn		32		1.94												820	1000	0.17	
				Nbn																			
50A	PF	*96.9-97.1		Nbn-Nf	1	24		2.00								UU	234	20	hard				O=8
				Nbn-Nf																			
50B	B	*97.1-97.3		Nbn-Nf		38																	

LEGEND AND NOTES

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G - Gas Sample	PW - Porewater Sample	FC - Fall Cone	UUp - UU Triaxial with Pore Pressure Measurements	S - Salinity
L - Liner Sample	T - Sample Stored in Tube	TV - Torvane	CU - Consolidated Undrained Triaxial	TS - Thaw Strain
P - Piston Sample	W - Waxed Sample	PV - Pilcon Vane	CUp - CU Triaxial with Pore Pressure Measurements	SG - Specific Gravity
NR - No Recovery	RC - Radiocarbon Sample	RV - Remote Vane	CD - Consolidated Drained Triaxial	
NS - No Sample Remaining				

1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ____________________ P.Eng.

SUMMARY OF TEST RESULTS

Borehole Number									ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			
Sample Number	Sample Type	Depth (metres) *Sample Photographed	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm⁻³)	Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
F-NER2:3		(continued)																					
51A	PF	*100.0-100.2		Nbn-Nf																880			
51B	B	*100.2-100.3	CH	Nbn-Nf		30/36			53	24	41	58	1	0	3								
51C	PF	*100.3-100.4		Nbn-Nf		30		1.82								UU	167	11	v. stiff				
52	B	*103.0-103.5		Nbn		26																	
53	PF	*106.1-106.3	SM/SC	Nbn		27		1.8					71	0	100								S
54	B	*106.8-107.1	SP-SM	Nbn		30		2.73SG					93	0	190								0=4.
55	NS	*109.2-109.3	SP	Nbn									98	0	250								
56	NS	*112.2-112.3	SP	Nbn		30		2.1					98	0	250								
57	NS	*115.3-115.4	SP	Nbn		31		1.8					98	0	260								
58	NS	*118.3-118.4	SP	Nbn		36		1.8					98	0	300								
59	PF	*121.4-121.6	SM/SC	Nbn		31							74	0	100								

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1982 OFFSHORE GEOTECHNICAL SITE INVESTIGATION
NERLERK SITE, BEAUFORT SEA

Project Number: 101-3605

Reviewed By: ______________ P.Eng.

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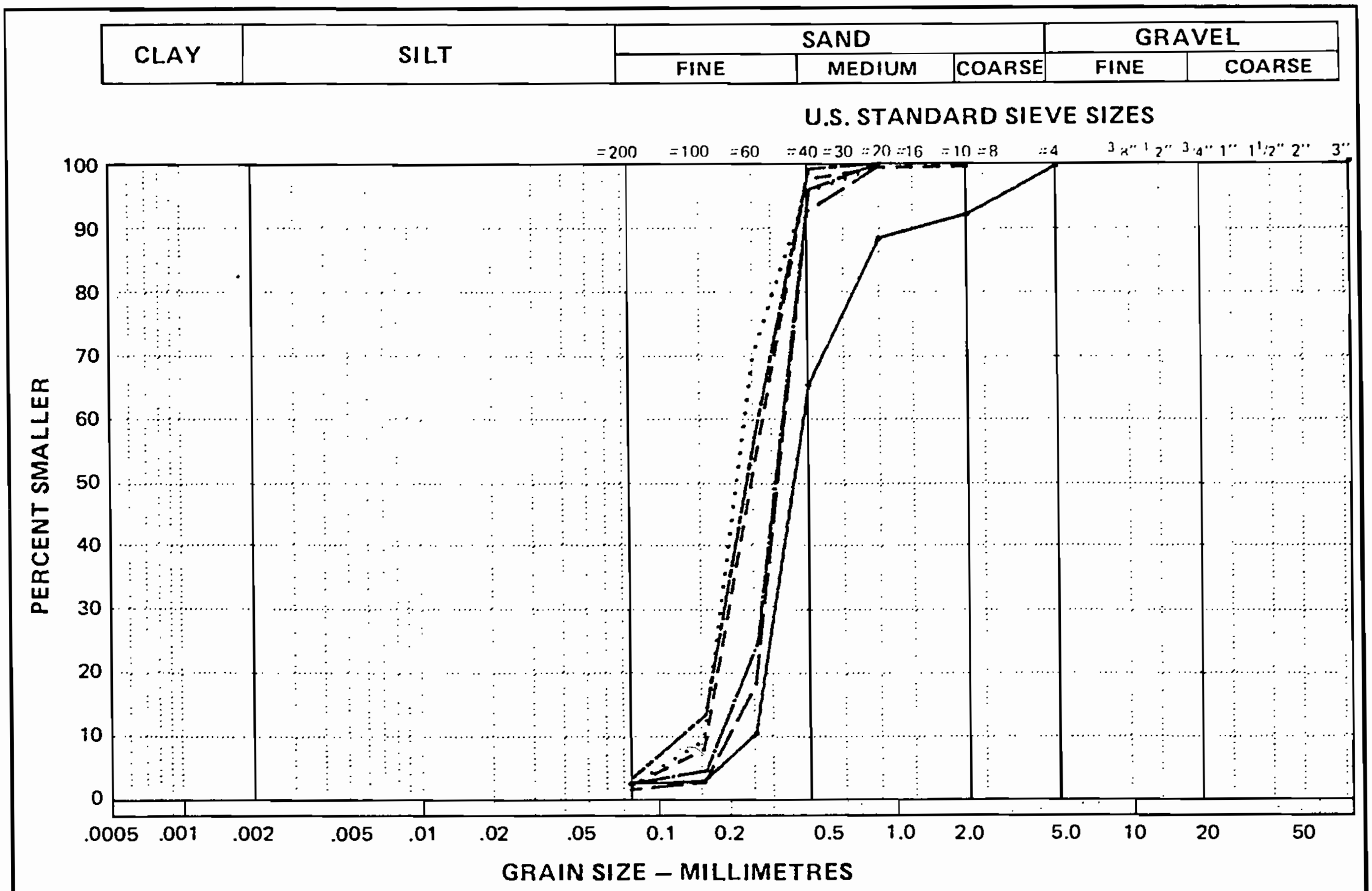
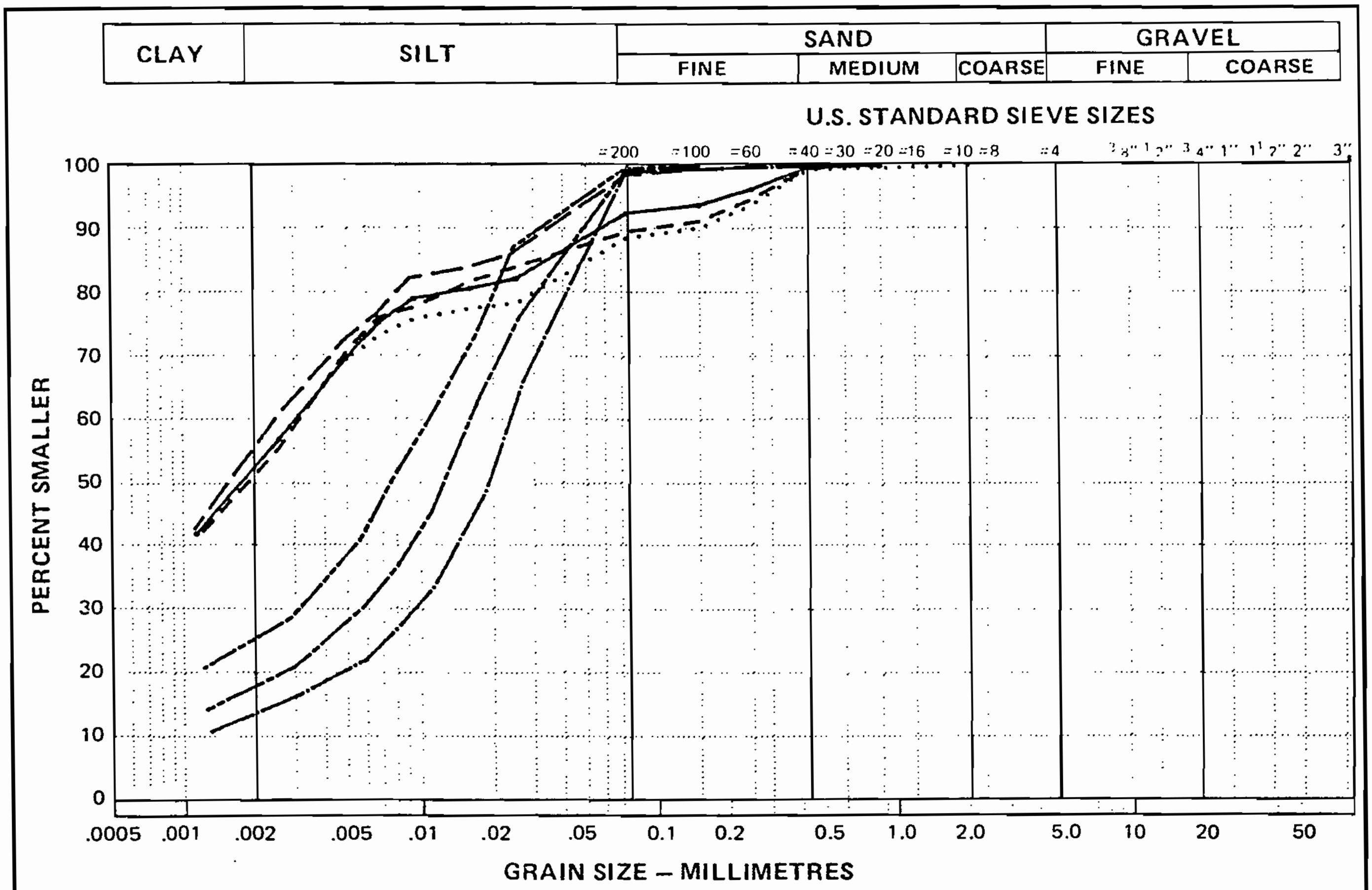
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
————	F: NER: 2: 3	1.83 - 2.06	-	1.9	98.1	0.0	1.6	.9	SP
·····	F: NER: 2: 3	5.49 - 5.60	-	1.6	98.4	0.0	1.5	.9	SP
– – –	F: NER: 2: 3	6.40 - 7.00	-	1.6	98.4	0.0	1.8	.9	SP
—— ——	F: NER: 2: 3	8.20 - 8.50	-	.9	99.1	0.0	1.7	1.1	SP
——·—	F: NER: 2: 3	10.10 - 10.40	-	1.4	98.6	0.0	1.8	1.2	SP
——--	F: NER: 2: 3	11.90 - 12.26	-	2.3	97.7	0.0	2.0	1.0	SP

JOB NO. 101 -3605 DATE 82-08-05

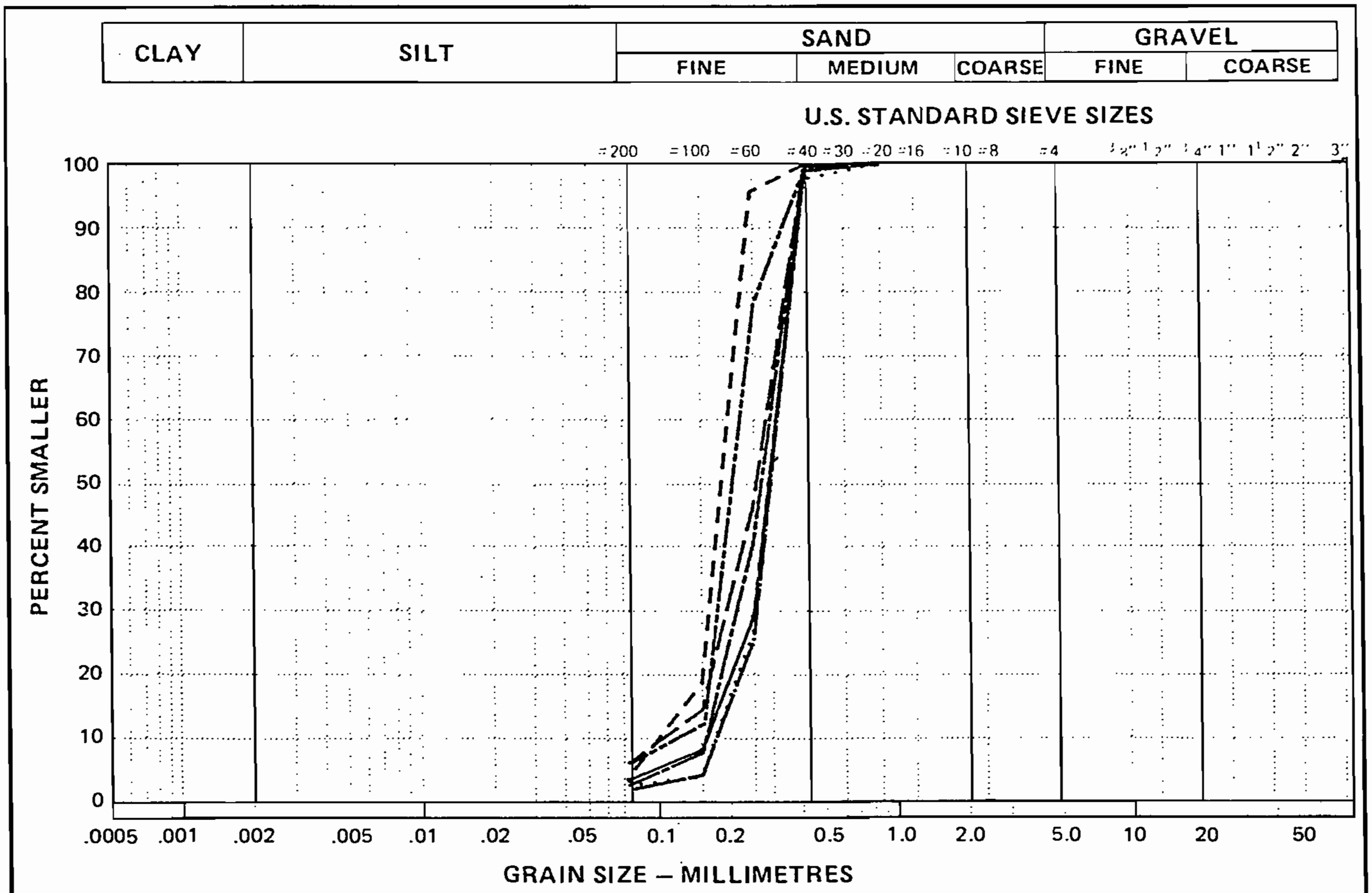
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	F: NER2: 3	0.00 - .55	53.0	39.9	7.1	0.0	-	-	
· · · · ·	F: NER2: 3	.91 - 1.41	52.8	36.2	11.0	0.0	-	-	
— — —	F: NER2: 3	2.06 - 2.55	51.5	38.2	10.3	0.0	-	-	
—— ——	F: NER2: 3	2.74 - 3.34	55.9	42.8	1.3	0.0	-	-	
——·—	F: NER2: 3	51.80 - 52.15	13.4	85.6	1.0	0.0	-	-	
——·–·–	F: NER2: 3	53.10 - 53.50	17.7	81.7	.6	0.0	-	-	
——---	F: NER2: 3	56.40 - 56.60	25.3	74.6	.1	0.0	-	-	

JOB NO. 101 -3605 **DATE** 82-08-22

PARTICLE - SIZE ANALYSIS OF SOILS

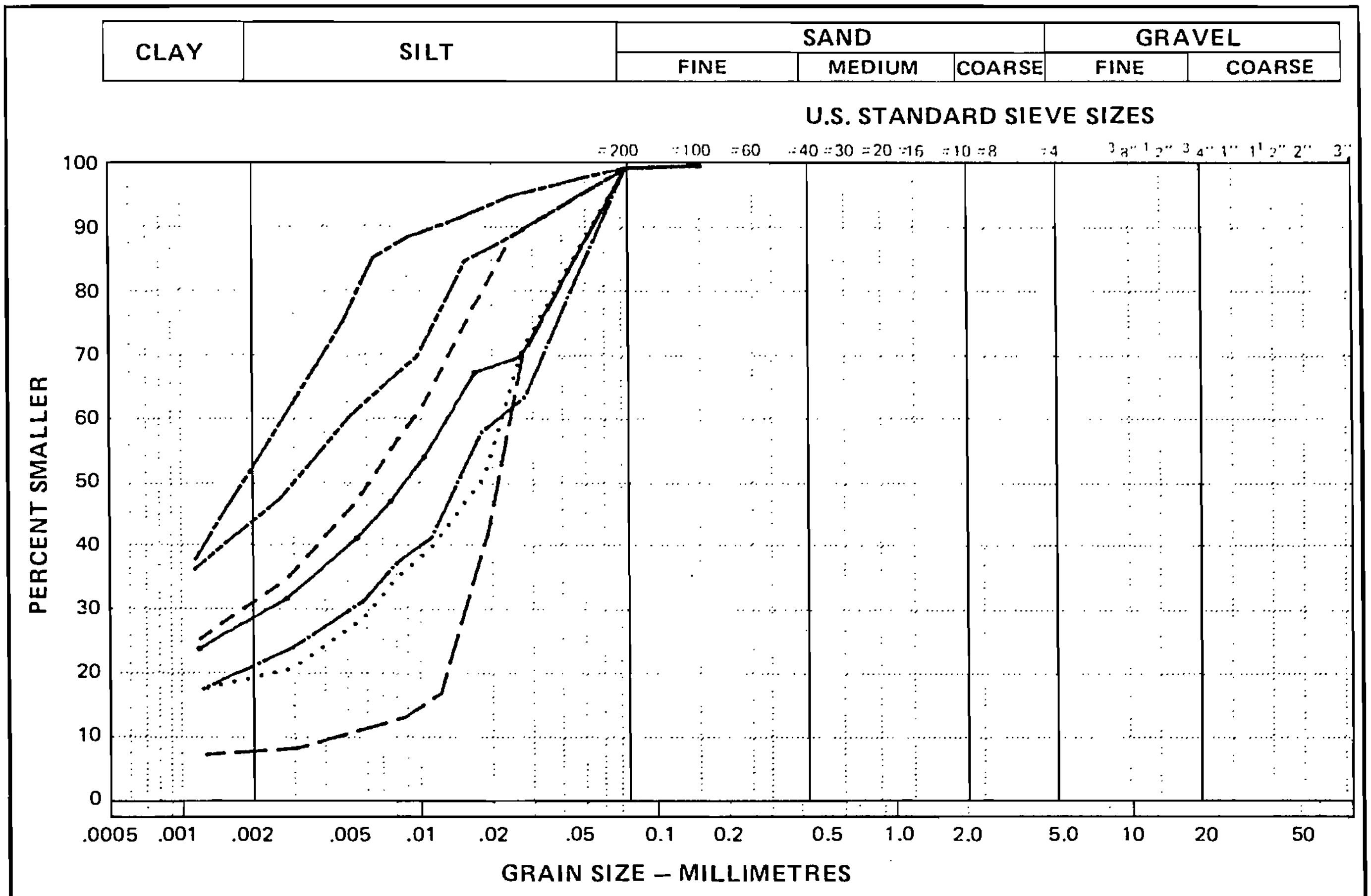


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
————	F: NER: 2: 3	14.60 - 15.00	-	2.5	97.5	0.0	2.0	1.3	SP
· · · · ·	F: NER: 2: 3	20.70 - 21.04	-	1.6	98.4	0.0	1.8	1.2	SP
— — —	F: NER: 2: 3	23.80 - 24.10	-	3.1	96.9	0.0	1.9	1.3	SP
—— ——	F: NER: 2: 3	26.80 - 27.30	-	5.2	94.8	0.0	2.6	1.2	SP-SM
——·—	F: NER: 2: 3	36.00 - 36.00	-	.8	99.2	0.0	1.8	1.2	SP
————	F: NER: 2: 3	45.10 - 45.15	-	1.6	98.4	0.0	1.9	1.0	SP
————	F: NER: 2: 3	48.20 - 48.35	-	5.0	95.0	0.0	1.7	1.0	SP-SM

JOB NO. 101 -3605

DATE 82-08-06

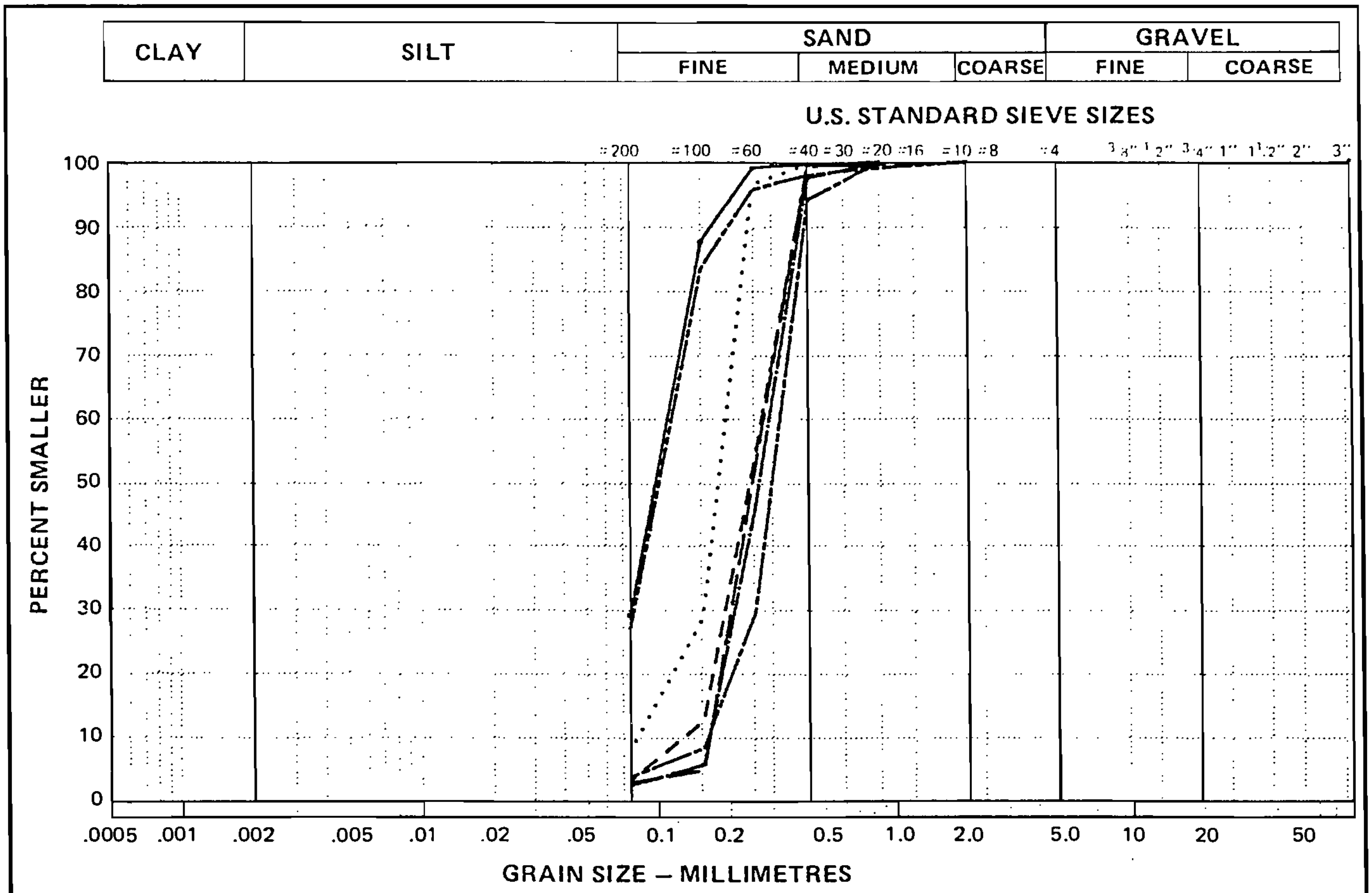
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Cu	Cc	U.S.C.
———	F: NER2: 3	60.40 - 60.47	28.7	71.0	.3	0.0	-	-	
.....	F: NER2: 3	60.71 - 60.93	19.2	80.7	.1	0.0	-	-	
— — —	F: NER2: 3	66.40 - 66.55	31.3	68.4	.3	0.0	-	-	
—— ——	F: NER2: 3	66.55 - 66.60	7.4	92.5	.1	0.0	5.0	2.1	
——·—	F: NER2: 3	69.50 - 69.80	21.1	78.8	.1	0.0	-	-	
——-—	F: NER2: 3	72.40 - 72.90	52.9	47.0	.1	0.0	-	-	
——-—-	F: NER2: 3	75.60 - 75.70	44.1	55.6	.3	0.0	-	-	

JOB NO. 101 -3605 DATE 82-09-22

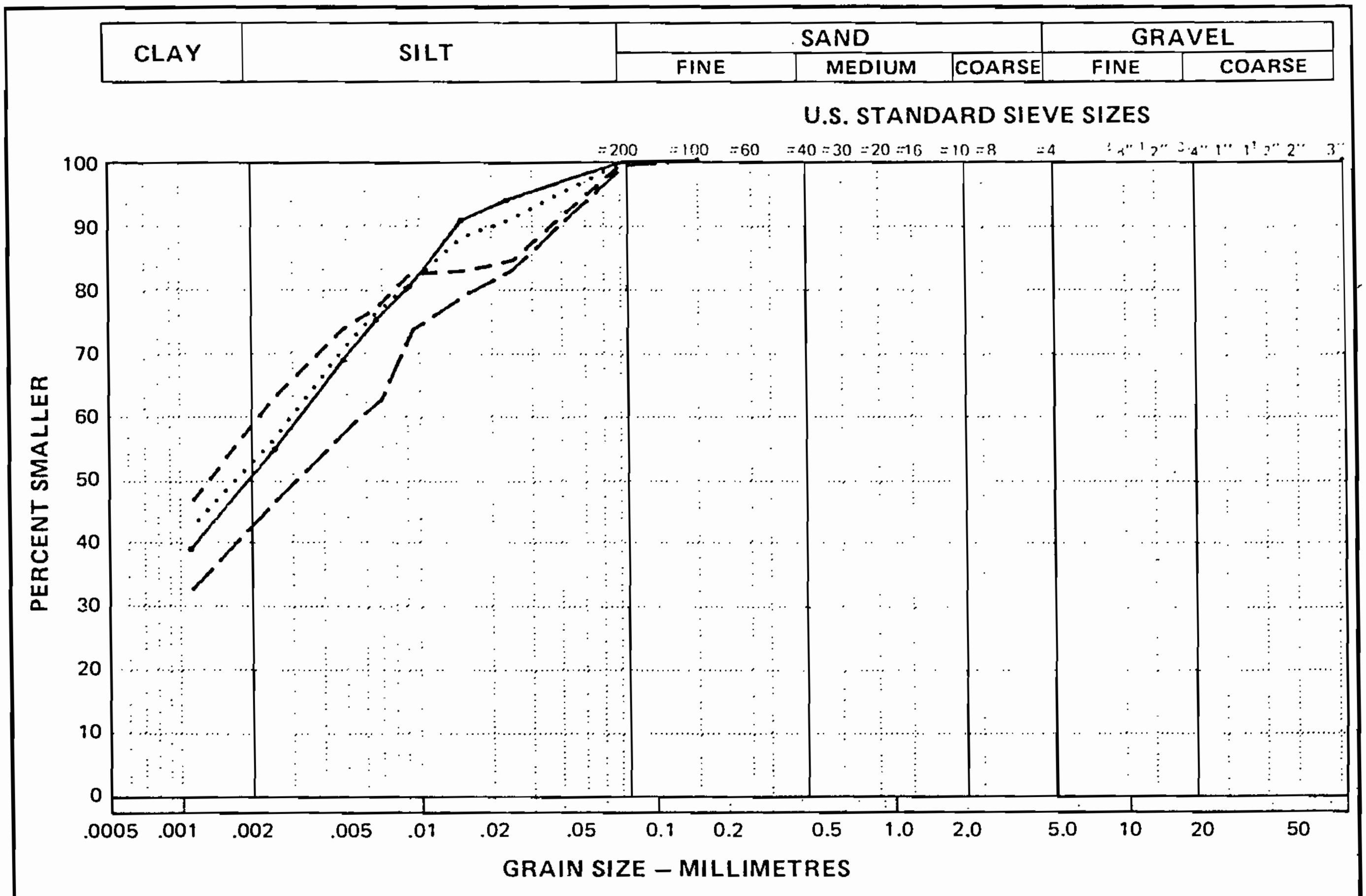
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
______	F: NER: 2: 3	106.10 -106.30	-	28.4	71.6	0.0	-	-	
.....	F: NER: 2: 3	106.80 -107.10	-	7.0	93.0	0.0	2.3	1.5	SP-SM
_ _ _	F: NER: 2: 3	109.20 -109.30	-	2.2	97.8	0.0	2.0	1.0	SP
__ __	F: NER: 2: 3	112.20 -112.30	-	1.7	98.3	0.0	1.7	.9	SP
____._	F: NER: 2: 3	115.30 -115.40	-	1.3	98.7	0.0	1.8	.9	SP
_____ _	F: NER: 2: 3	118.30 -118.30	-	2.7	97.3	0.0	2.0	1.2	SP
____ _ _	F: NER: 2: 3	121.40 -121.60	-	26.2	73.8	0.0	-	-	

JOB NO. 101 -3605 DATE 82-08-06

PARTICLE - SIZE ANALYSIS OF SOILS



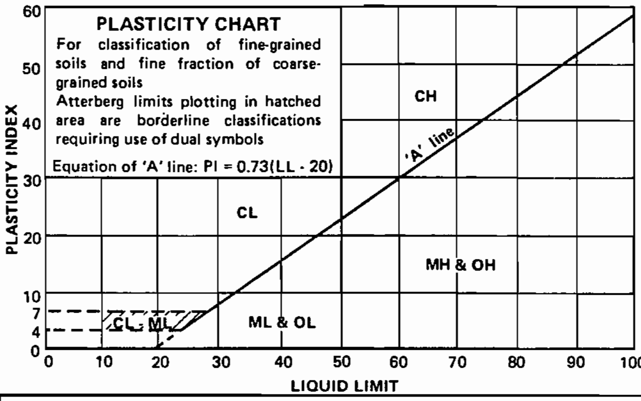
SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
————	F:NER2:3	87.80 - 88.15	49.3	50.6	.1	0.0	-	-	
·····	F:NER2:3	90.80 - 90.96	51.7	48.2	.1	0.0	-	-	
– – –	F:NER2:3	93.90 - 94.00	57.5	42.4	.1	0.0	-	-	
—— ——	F:NER2:3	100.20 -100.30	41.4	57.6	1.0	0.0	-	-	

JOB NO. 101 -3605 DATE 82-09-22

APPENDIX A

BOREHOLE LOGS

UNIFIED SOIL CLASSIFICATION†

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve GW, GP, SW, SP More than 12% pass No. 200 sieve GM, GC, SM, SC 5% to 12% pass No. 200 sieve Borderline classification requiring use of dual symbols	$C_u = D_{60}/D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly-graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below 'A' line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly-graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below 'A' line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7	
FINE-GRAINED SOILS 50% or more passes No. 200 sieve*	SILTS AND CLAYS	Liquid limit 50% or less	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	SILTS AND CLAYS	Liquid limit greater than 50%	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic silts of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
HIGHLY ORGANIC SOILS			PT	Peat, muck and other highly organic soils	*Based on the material passing the 3 in. (75 mm) sieve †ASTM Designation D 2487, for identification procedure see D 2488		

PLASTICITY CHART

For classification of fine-grained soils and fine fraction of coarse-grained soils

Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols

Equation of 'A' line: PI = 0.73(LL - 20)

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

GROUP SYMBOLS	SYMBOLS	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable	▨
	Nbn	No excess ice, well-bonded	▨
	Nbe	Excess ice, well - bonded	▨

NOTE:

1. *Dual symbols are used to indicate borderline or mixed ice classifications*
2. *Visual estimates of ice contents indicated on borehole logs ± 5%*
3. *This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes*

LEGEND

Soil ☐ Ice ■

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOLS	SYMBOLS	SUBGROUP DESCRIPTION	
V	Vx	Individual ice crystals or inclusions	▨
	Vc	Ice coatings on particles	▨
	Vr	Random or irregularly oriented ice formations	▨
	Vs	Stratified or distinctly oriented ice formations	▨

VISIBLE ICE GREATER THAN 50% BY VOLUME

ICE	ICE + Soil Type	Ice with soil inclusions	▨
	ICE	Ice without soil inclusions (greater than 25 mm (1 in.) thick)	■

SYSTEM INTERNATIONAL CONVERSIONS

AREA

1 km²	= 3.861×10^{-1} mi²	1 km² = 100 hectares
1 km²	= $2.471 \times 10^{+2}$ acre	
1 m²	= 1.196 yd²	
1 m²	= $1.076 \times 10^{+1}$ ft²	
1 mm²	= 1.550×10^{-3} in²	see note 1

DENSITY

1 Mg/m³	= $6.243 \times 10^{+1}$ lb_m/ft³	see note 2
1 kg/m³	= 6.243×10^{-2} lb_m/ft³	

FORCE

1 N	= 2.248×10^{-1} lb_f

HEAT

ENERGY (E)		
1 kJ	= 9.478×10^{-1} BTU (IST)	1 BTU = 252 cal
1 J	= 2.388×10^{-1} cal (IST)	
HEAT FLUX (Q)		
1 W/m²	= 3.170×10^{-1} BTU/(ft² · hr)	
SPECIFIC HEAT CAPACITY (c)		
1 kJ/(kg · C°)	= 2.388×10^{-1} BTU/(lb_m · F°)	
THERMAL CONDUCTIVITY (k)		
W/(m · C°)	= 5.778×10^{-1} BTU/(ft · hr · F°)	
COEFFICIENT OF HEAT TRANSFER (c_s)		
1 W/(m² · C°)	= 1.761×10^{-1} BTU/(ft² · hr · F°)	see note 3

LENGTH

1 km	= 6.214×10^{-1} mi (statute)
1 m	= 1.094 yd
1 m	= 3.281 ft
1 mm	= 3.937×10^{-2} in

MASS

1 Mg	= 1.102 T	1 T = 2000 lb_m
1 Mg	= 2.205×10^3 lb_m	Mg is equivilant to tonne
1 kg	= 2.205 lb_m	

POWER

1 W	= 1.341×10^{-3} HP	1 HP = 550 ft · lb_f/s

PRESSURE, STRESS or ELASTIC MODULI

1 MPa	= $1.044 \times 10^{+1}$ T_f/ft² [TSF]	see note 4
1 kPa	= 1.044×10^{-2} T_f/ft² [TSF]	
1 kPa	= 1.450×10^{-1} lb_f/in² [psi]	
1 kPa	= 3.346×10^{-1} ft of water	hydrostatic pressure of water at 1 ft. depth
1 Pa	= 2.089×10^{-2} lb_f/ft² [psf]	

TEMPERATURE

°C	= (°F - 32)/1.8	0°C = 273.15° K
C°	= 1.8 F°	1 C° = 1 K°

TIME

1 Ms	= 3.171×10^{-2} yr	for one year equal to 365 days
1 ks	= 1.157×10^{-2} day	
1 s	= 3.171×10^{-8} yr	

VISCOSITY

DYNAMIC (η)	
1 Pa · s	= $1.000 \times 10^{+3}$ centipoise
KINEMATIC (ν)	
1 mm²/s	= 1.000 cenistoke

VOLUME

1 m³	= 8.107×10^{-4} acre · ft	
1 m³	= 1.308 yd³	
1 m³	= $3.531 \times 10^{+1}$ ft³	
1 m³	= $2.200 \times 10^{+2}$ gal (Imperial)	1 m³ = 1000 L
1 cm³	= 3.520×10^{-2} fl oz	see note 1
1 cm³	= 6.102×10^{-2} in³	

VOLUME RATE OF FLOW

1 m³/s	= 1.901×10^{-1} mgpd (Imperial)
1 m³/s	= $3.531 \times 10^{+1}$ ft³/s

COEFFICIENTS

VOLUME COMPRESSIBILITY OR SWELLING (m_v or m_s)		
1 m²/MN;	= 9.579×10^{-2} ft²/T_f	
CONSOLIDATION OR SWELLING (c_v or c_s)		
1 m²/yr	= $1.076 \times 10^{+1}$ ft²/yr	
1 m²/yr	= 2.949×10^{-2} ft²/day	
1 m²/yr	= 3.171×10^{-4} cm²/s	
HYDRAULIC CONDUCTIVITY (k)		
1 m/s	= $2.835 \times 10^{+5}$ ft/day	see note 5

NOTES:

1. *The use of cm² and cm³ for area and volume is permissible.*
2. *To convert mass density (ρ) to weight per unit volume use:*
   $F = ma_g$
   i.e. $\rho \mathrm{Mg/m^3} \times 9.807\ \mathrm{m/s^2} = 9.807\rho \frac{\mathrm{Mg \cdot m}}{\mathrm{s^2 \cdot m^3}} = 9.807\rho \frac{\mathrm{kN}}{\mathrm{m^3}}$
   kg_f/m^3 is not a valid SI density unit.
3. *The inverse of the 'coefficient of heat transfer' is 'thermal resistance' or the 'R' value.*
4. *kg_f/m^2 is not a valid SI stress unit.*
5. *Hydraulic conductivity is a proportionality coefficient defined in Darcy's Law:* $v \cdot k_w \frac{\partial h}{\partial s}$, *where* v · *velocity of flow*
   $\frac{\partial h}{\partial s}$ = *hyrdraulic gradient*
6. *All conversion factors have been rounded to four significant figures.*

SYSTEM INTERNATIONAL UNITS

QUANTITY	NAME	SYMBOL	EXPRESSED IN TERMS OF OTHER SI UNITS	EXPRESSED IN TERMS OF BASE AND SUPPLEMENTARY UNITS
SI UNITS				
length	metre	m		
mass	kilogram	kg		
time	second	s		
electric current	ampere	A		
thermodynamic temperature	kelvin	K		
amount of substance	mole	mol		
luminous intensity	candela	cd		
SI SUPPLEMENTARY UNITS				
plane angle	radian	rad		
solid angle	steradian	sr		
EXAMPLES OF SI DERIVED UNITS WITH SPECIAL NAMES				
frequency	hertz	Hz	1/s	s^{-1}
force	newton	N	$m \cdot kg/s^2$	$m \cdot kg \cdot s^{-2}$
pressure, stress	pascal	Pa	N/m^2	$m^{-1} \cdot kg \cdot s^{-2}$
energy, work, quantity of heat	joule	J	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
power, radiant flux	watt	W	J/s	$m^2 \cdot kg \cdot s^{-3}$
EXAMPLES OF SI DERIVED UNITS WITHOUT SPECIAL NAMES				
velocity - linear	metre per second		m/s	$m \cdot s^{-1}$
- angular	(radian per second)		rad/s	$rad \cdot s^{-1}$
acceleration - linear	(metre per second) per second		m/s^2	$m \cdot s^{-2}$
- angular	(radian per second) per second		rad/s^2	$rad \cdot s^{-2}$
concentration (of amount of substance)	mole per cubic metre		mol/m^3	$mol \cdot m^{-3}$
dynamic viscosity	pascal second		$Pa \cdot s$	$m^{-1} \cdot kg \cdot s^{-1}$
moment of force	newton metre		$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
surface tension	newton per metre		N/m	$kg \cdot s^{-2}$
heat flux density, irradiance	watt per square metre		W/m^2	$kg \cdot s^{-3}$
heat capacity, entropy	joule per kelvin		J/K	$m^2 \cdot s^{-2}\ K^{-1}$
specific heat capacity, specific entropy	joule per kilogram kelvin		$J/(kg \cdot K)$	$m^2 \cdot s^{-2} \cdot K^{-1}$
specific energy	joule per kilogram		J/kg	$m^2 \cdot s^{-2}$
thermal conductivity	watt per metre kelvin		$W/(m \cdot K)$	$m \cdot kg \cdot s^{-3} \cdot K^{-1}$

OTHER UNITS PERMITTED FOR USE WITH SI

QUANTITY	NAME	SYMBOL	DEFINITION
time	minute	min	1 min = 60 s
	hour	h	1 h = 3,600 s
	day	d	1 d = 86,400 s
	year	a	
plane angle	degree	°	1° = (π/180) rad
	minute	′	1′ = (π/10,800) rad
	second	″	1″ = (π/648,000) rad
area	hectare	ha	$1\ ha = 10{,}000\ m^2$
volume	litre	L	$1{,}000\ L = 1\ m^3$
temperature	degree Celsius	°C	0° C = 273.15° K temperature interval 1 C° ≡ 1 K°
mass	tonne	t	1 t = 1,000 kg = 1 Mg

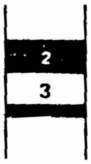
MULTIPLYING FACTOR	PREFIX	SYMBOL	MULTIPLYING FACTOR	PREFIX	SYMBOL
$1{,}000{,}000{,}000{,}000{,}000{,}000 = 10^{18}$	exa	E	$0.1 = 10^{-1}$	deci*	d
$1{,}000{,}000{,}000{,}000{,}000 = 10^{15}$	peta	P	$0.01 = 10^{-2}$	centi*	c
$1{,}000{,}000{,}000{,}000 = 10^{12}$	tetra	T	$0.001 = 10^{-3}$	milli	m
$1{,}000{,}000{,}000 = 10^{9}$	giga	G	$0.000{,}001 = 10^{-6}$	micro	μ
$1{,}000{,}000 = 10^{6}$	mega	M	$0.000{,}000{,}001 = 10^{-9}$	nano	n
$1{,}000 = 10^{3}$	kilo	k	$0.000{,}000{,}000{,}001 = 10^{-12}$	pico	p
$100 = 10^{2}$	hecto*	h	$0.000{,}000{,}000{,}000{,}001 = 10^{-15}$	femto	f
$10 = 10^{1}$	deca*	da	$0.000{,}000{,}000{,}000{,}000{,}001 = 10^{-18}$	atto	a

* *to be avoided where possible*

SYMBOLS AND ABBREVIATIONS USED ON BOREHOLE LOGS

SOIL SAMPLE

- represented by sample identification number which increase sequentially from the top of the hole; thickness of block is equivalent to sample recovery



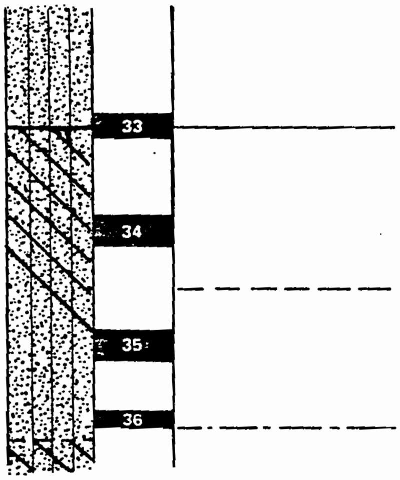
SOIL BOUNDARIES

- have been indicated using the following system

- stratum boundary observed within sample

- stratum boundary assumed to occur within ± 0.5m of the marked level and is probably gradational between the two samples

- stratum boundary assumed to occur within ± 1.0m of the marked level



- stratum boundary notation for both depth below seabed (41.5 metres) and elevation below sealevel (uncorrected for tides) (-64.6 metres El.)

41.5 m (-64.6 m El.)

SOIL DESCRIPTION

UNIFIED SOIL CLASSIFICATION **USC**

- determined in accordance with chart on following page

TEXTURAL DESCRIPTION

- determined in accordance with attached sheet and used to augment Unified Soil Classification

Special terms used include:

e.g. - "becoming trace of/with some CLAY" indicating an overall change in a feature of the stratum not sufficient to change the total description

- "trace of/with some CLAY" indicating small feature displayed in that sample only

GROUND ICE DESCRIPTION

- determined in accordance with chart on following page; extra effort has been made to better describe the degree and extent of soil bonding and also a value of core temperature ($^{\circ}C$) at that level

- see also definition of terms in text

e.g. FROZEN - 2.3
- Nf - Nbn
- poorly to slightly bonded

SAND: Nbn - 2.8
CLAY: not frozen

TEST RESULTS

- see legend at bottom of borehole log

CONSISTENCY

Fine-Grained Soils

Major portion passing No. 200 Sieve. Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silt. Consistency is rated according to shear strength, as indicated by penetrometer readings or vane shear readings.

Descriptive Term	Unconfined Compressive Strength kPa	Equivalent Blows per Foot (N)
Very Soft	less than 25	0 - 2
Soft	25 to 50	2 - 4
Firm	50 to 100	4 - 8
Stiff	100 to 200	8 - 16
Very Stiff	200 to 400	15 - 50
Hard	400 and higher	>50

Coarse-Grained Soils

Major portion retained in No. 200 Sieve. Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

Descriptive Term	Relative Density	Equivalent Blows per foot (N)
Very Loose	0 - 20%	0 - 4
Loose	20 - 40%	4 - 10
Compact or Medium	40 - 75%	10 - 30
Dense	75 - 90%	30 - 50
Very Dense	90 - 100%	50 +

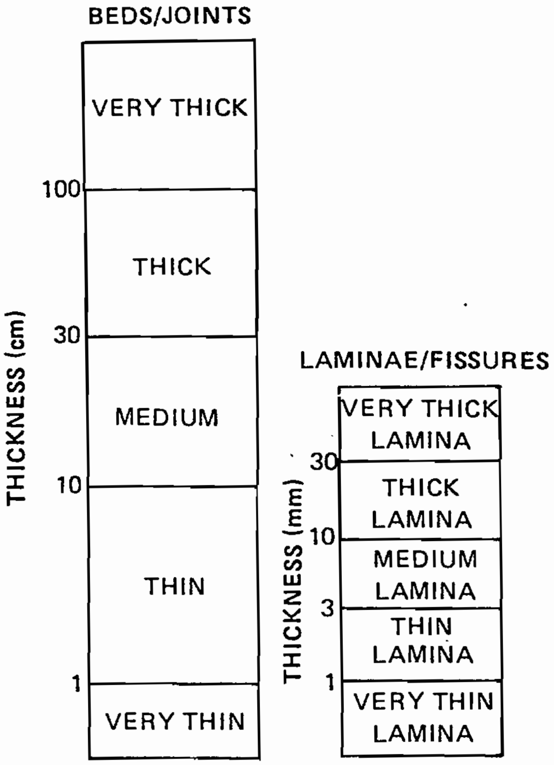
The number of blows (N) on a 2" O.D. split spoon sampler by a 140 lbs. weight falling 30" required to drive the sample a distance of 1' (in accordance with ASTM D1586).

PLASTICITY

Low - Liquid limit less than 50
High - Liquid limit greater than 50

DESCRIPTION OF SEDIMENTARY STRUCTURES

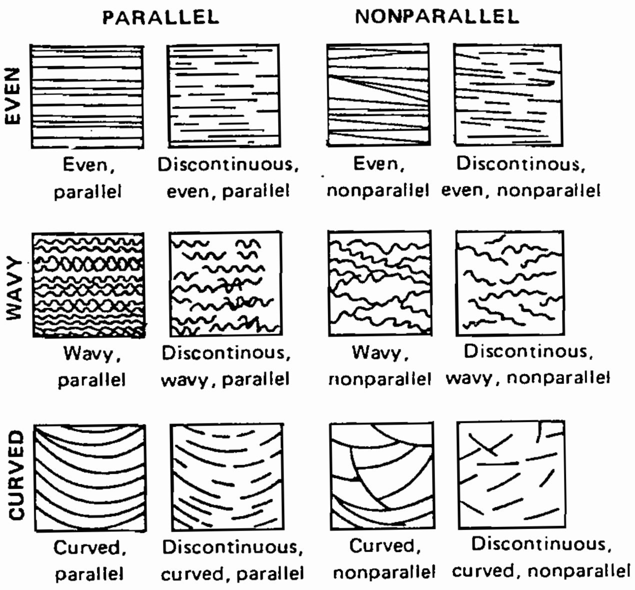
BEDS	SEDIMENTATION UNITS DEPOSITED UNDER ESSENTIALLY CONSTANT PHYSICAL CONDITIONS, SEPARATED BY BEDDING PLANES WHICH ARE RECOGNIZABLE BY TEXTURAL OR COMPOSITIONAL CHANGES RESULTING FROM PERIODS OF NON-DEPOSITION OR EROSION, OR ABRUPT CHANGES IN DEPOSITIONAL CONDITIONS. BEDS MAY BE INTERNALLY HOMOGENEOUS, OR COMPOSED OF SMALLER UNITS-LAMINAE
LAMINAE	THE SMALLEST MEGASCOPIC LAYERS IN A SEDIMENTARY SEQUENCE, REPRESENTING MINOR FLUCTUATIONS IN PHYSICAL CONDITIONS DURING THE DEPOSITION OF BEDS. LAMINAE ARE RELATIVELY UNIFORM IN TEXTURE AND COMPOSITION AND GENERALLY LACK MEGASCOPIC INTERNAL LAYERING.



e.g. Thick bed
Thickly spaced joint

e.g. Thin lamina
Thinly spaced fissures

(Modified after Ingram, 1954 and Campbell, 1967)



(After Campbell, 1967)

APPENDIX B

DIAGNOSTIC PROFILES

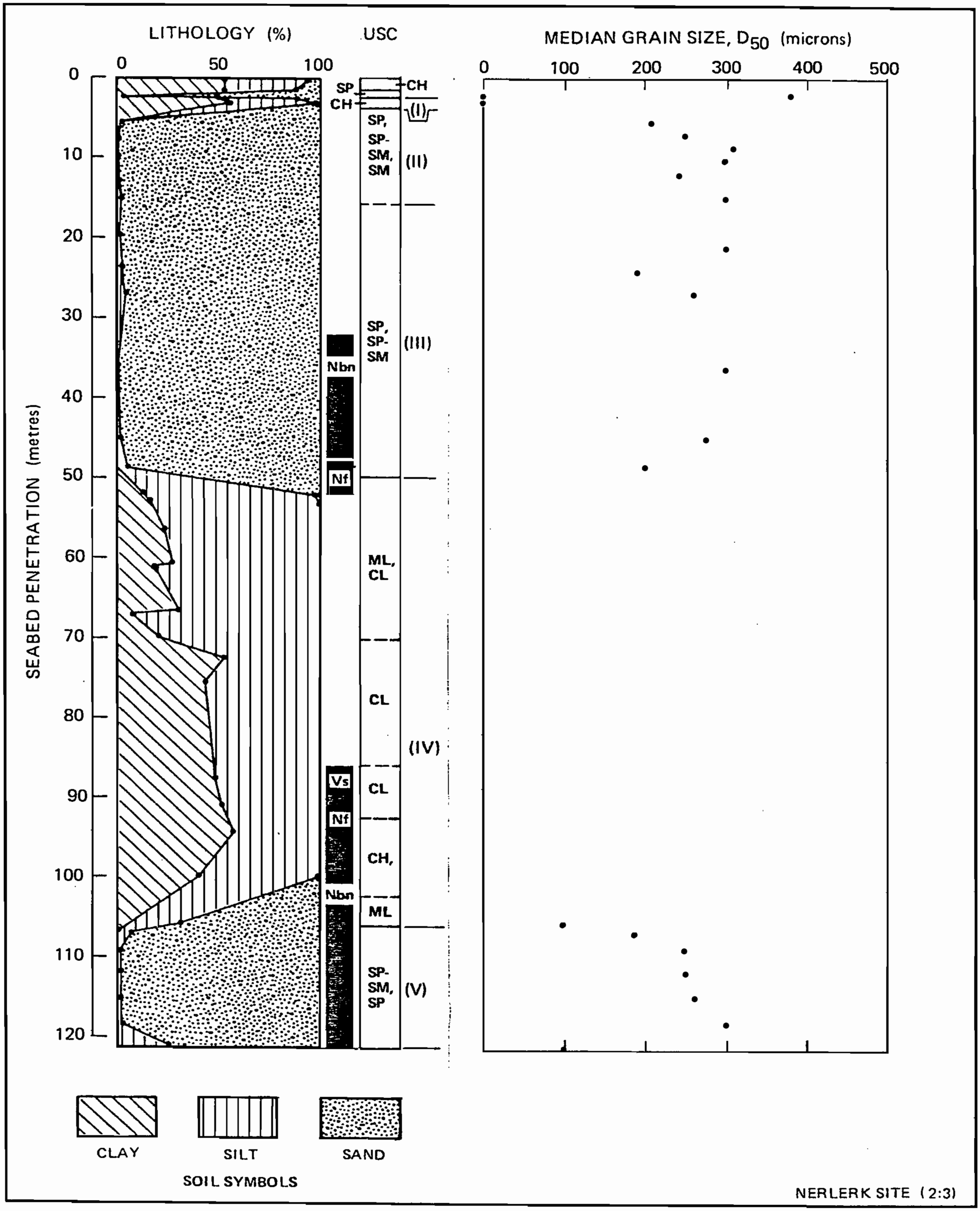


FIGURE B.1 MEDIAN GRAIN SIZE PROFILE

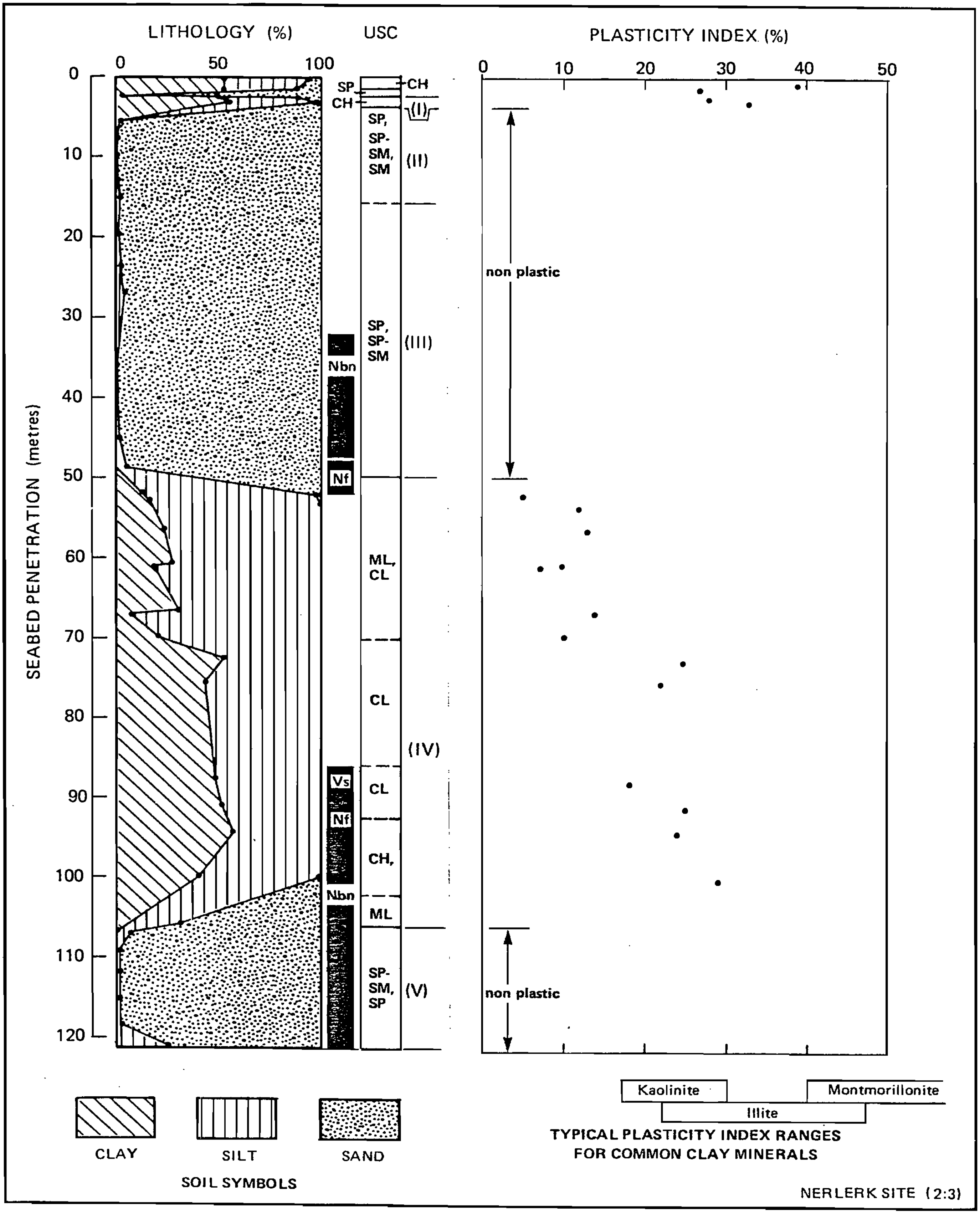


FIGURE B.2 PLASTICITY INDEX PROFILE

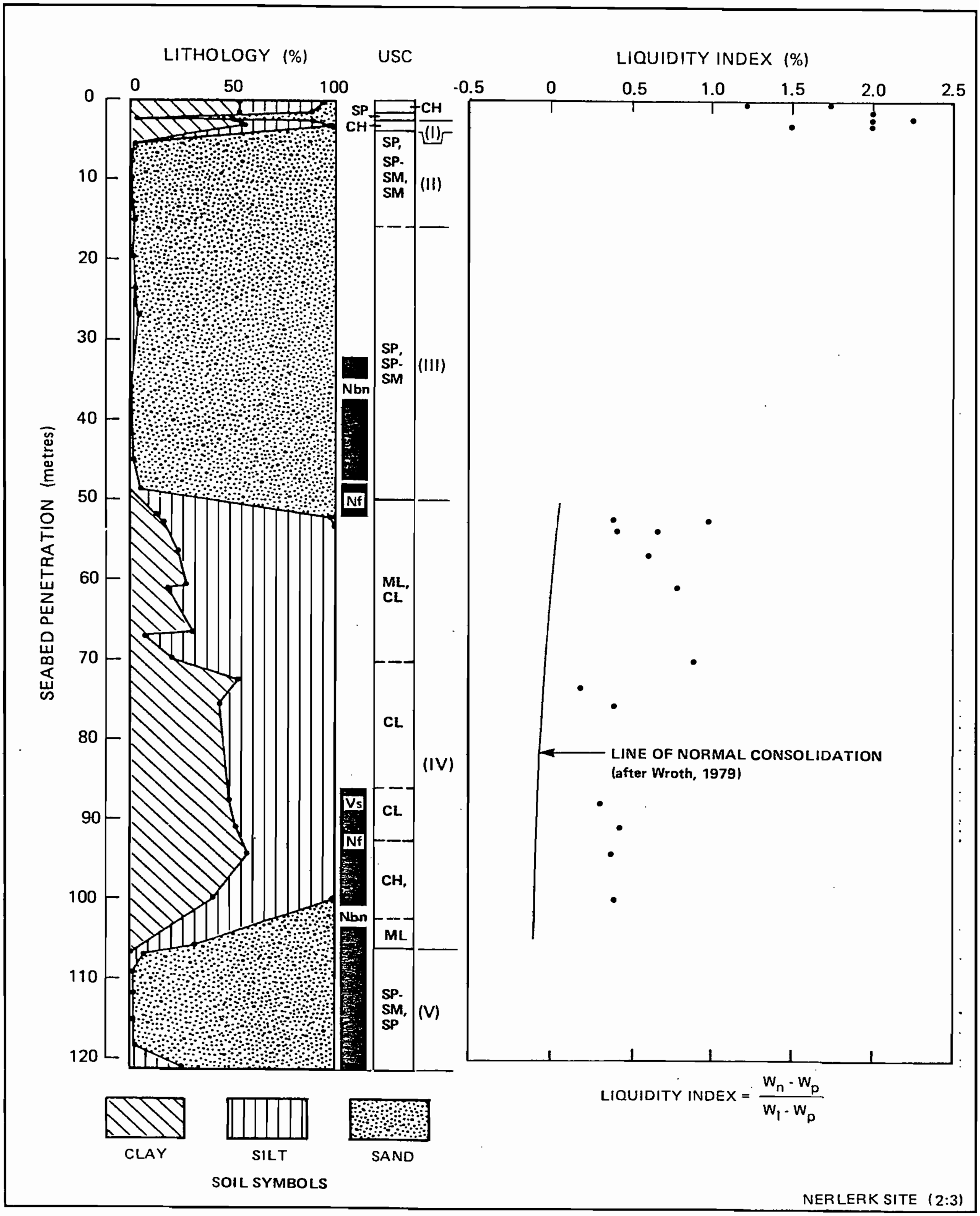


FIGURE B.3 LIQUIDITY INDEX PROFILE

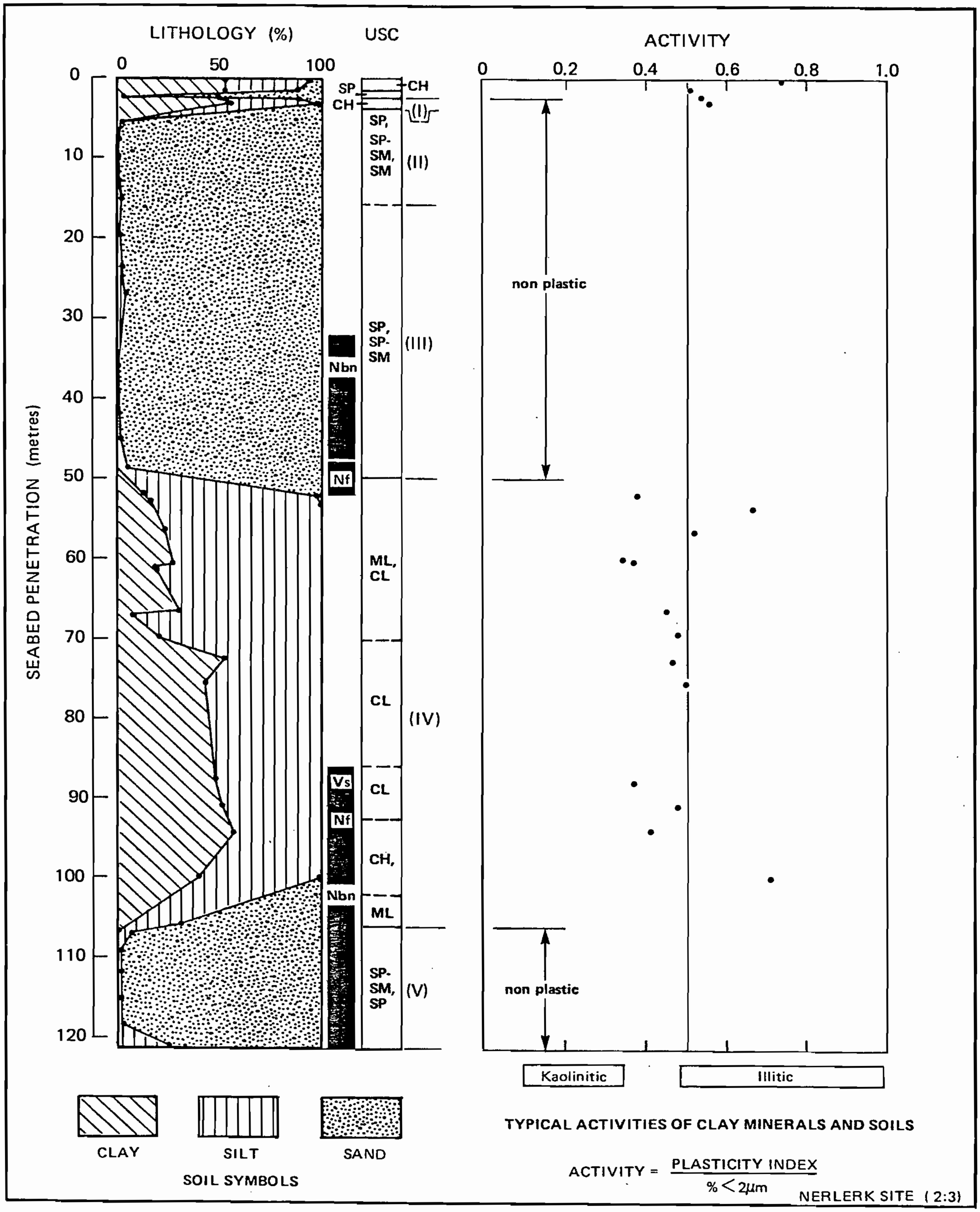


FIGURE B.4 ACTIVITY PROFILE

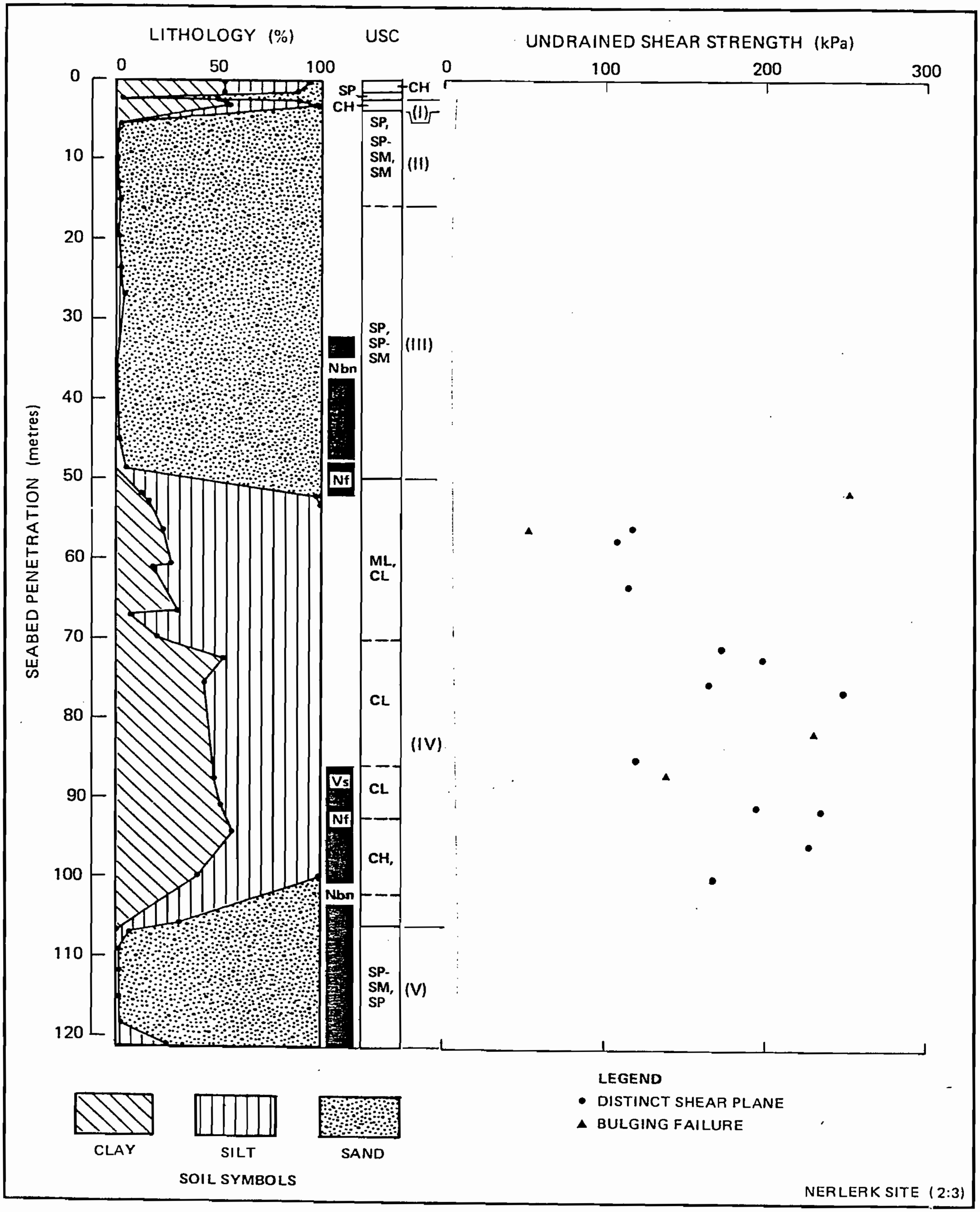


FIGURE B.5 UNDRAINED SHEAR STRENGTH PROFILE

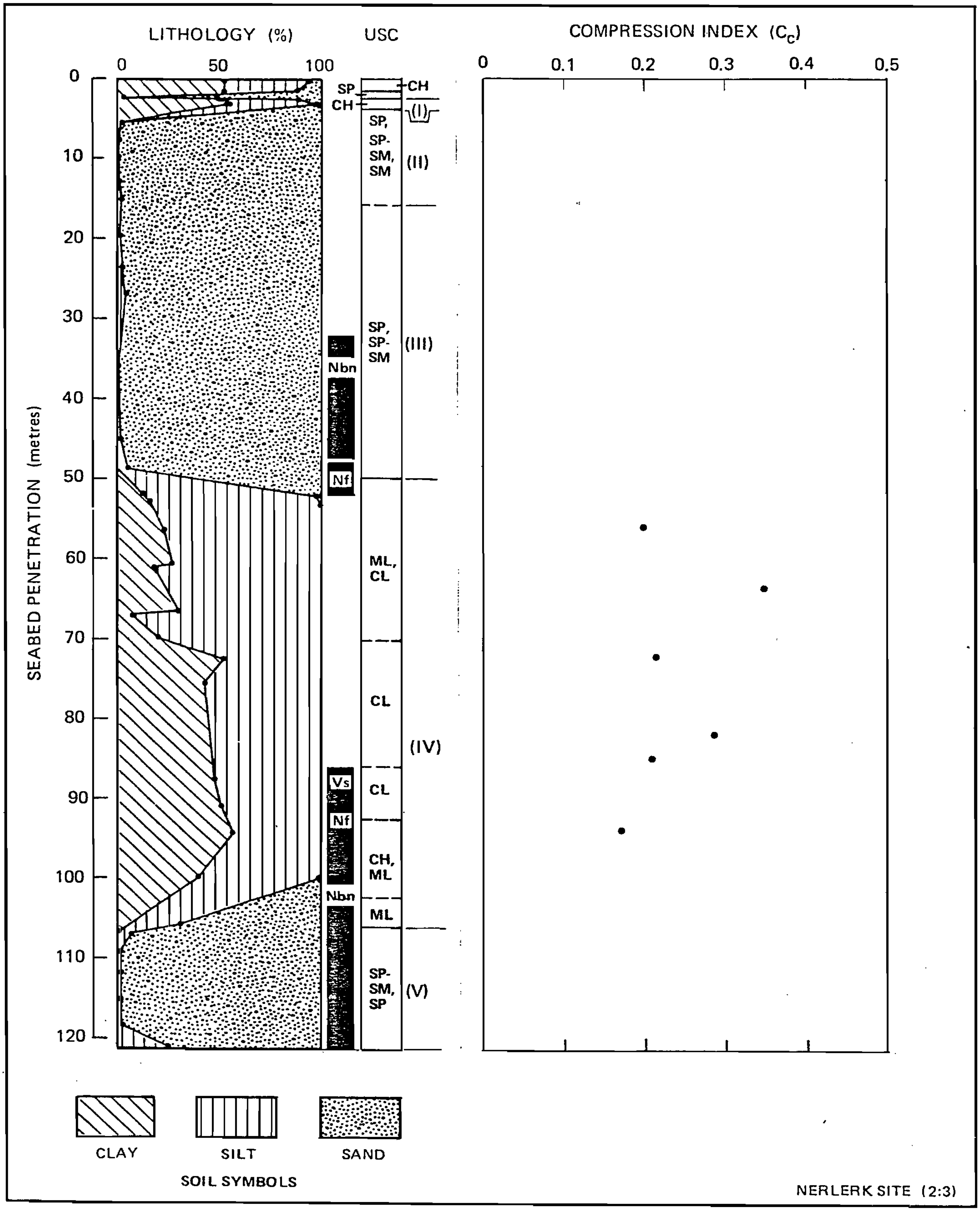


FIGURE B.6 COMPRESSION INDEX PROFILE

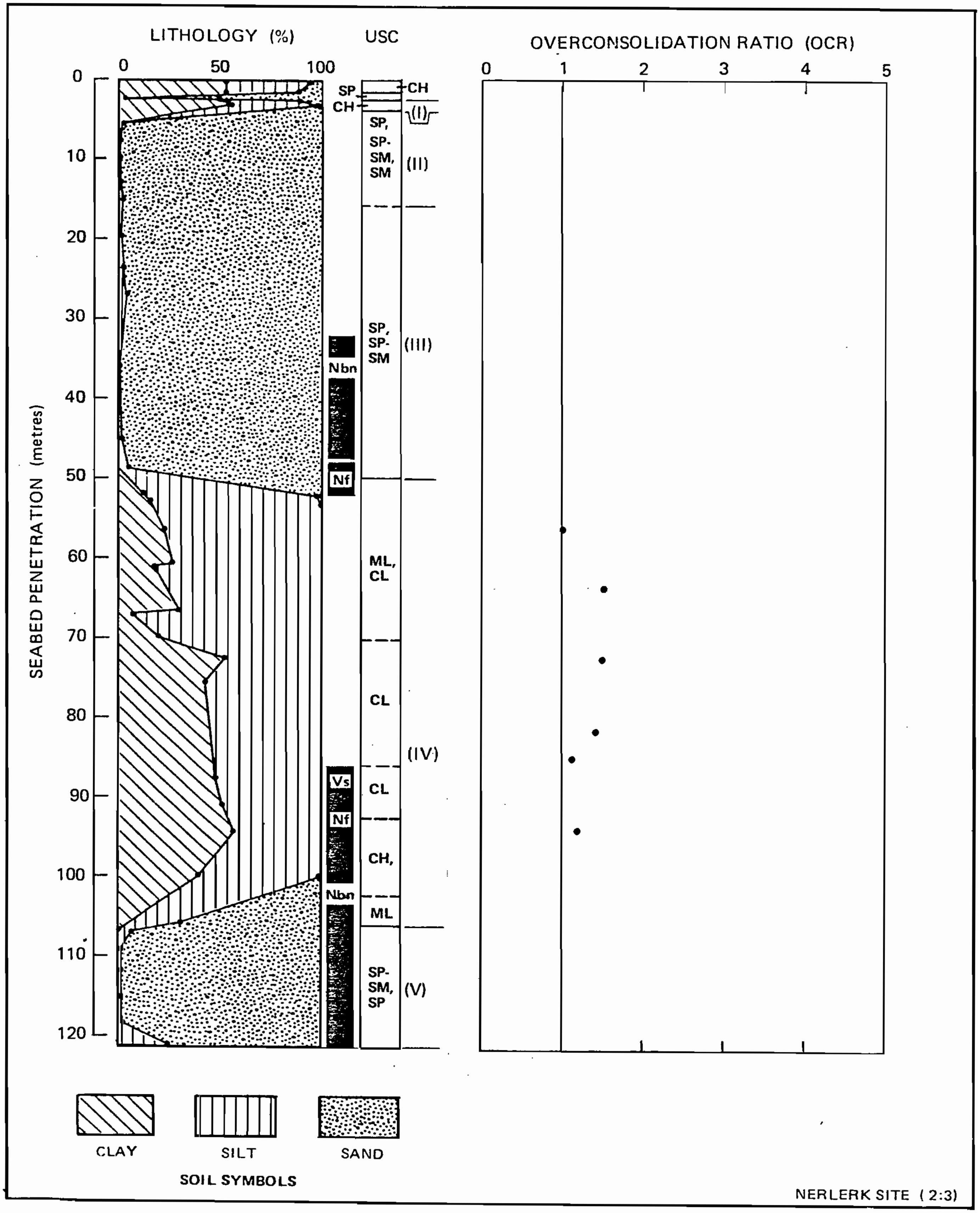


FIGURE B.7 OVERCONSOLIDATION RATIO PROFILE

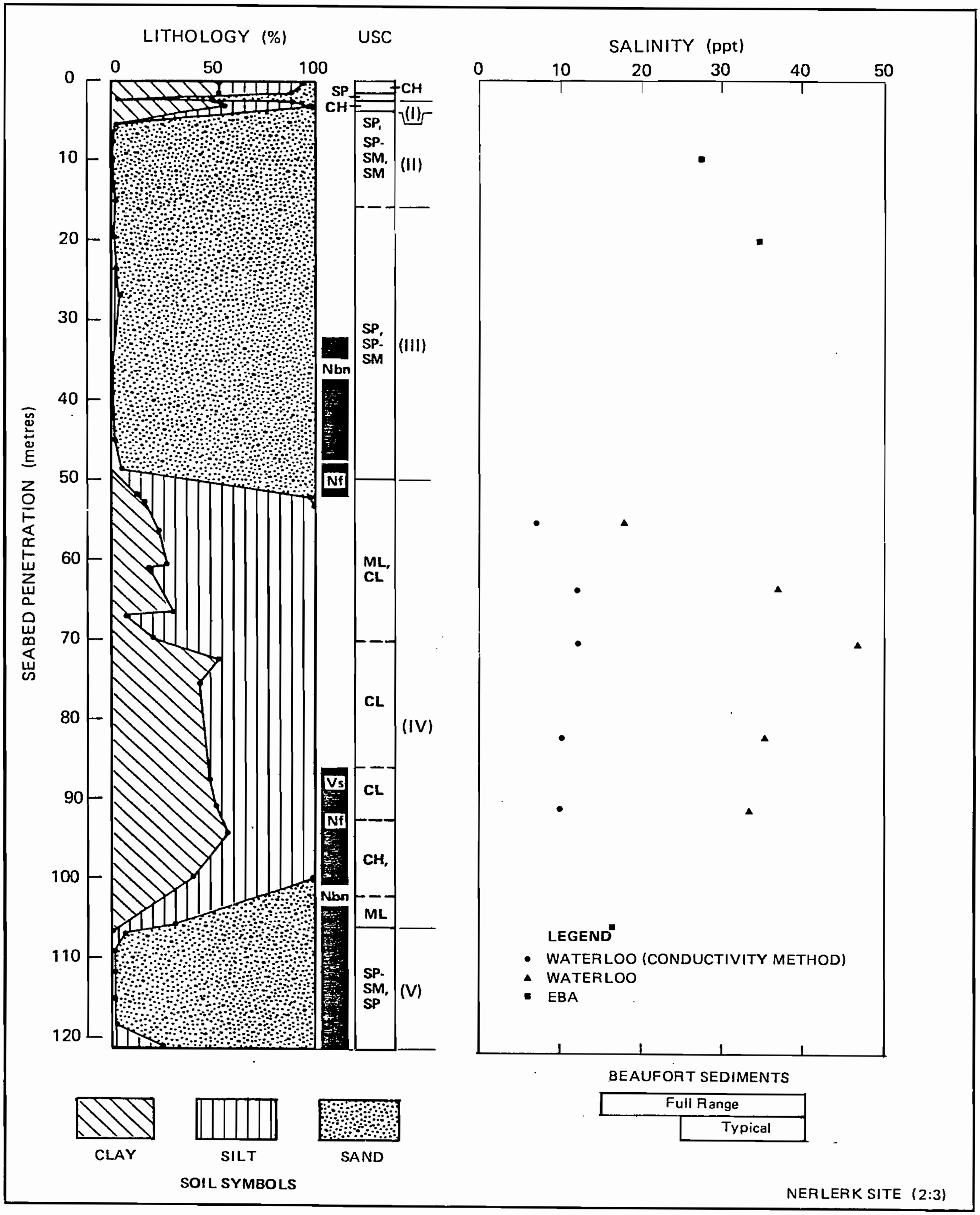


FIGURE B.8 SALINITY PROFILE

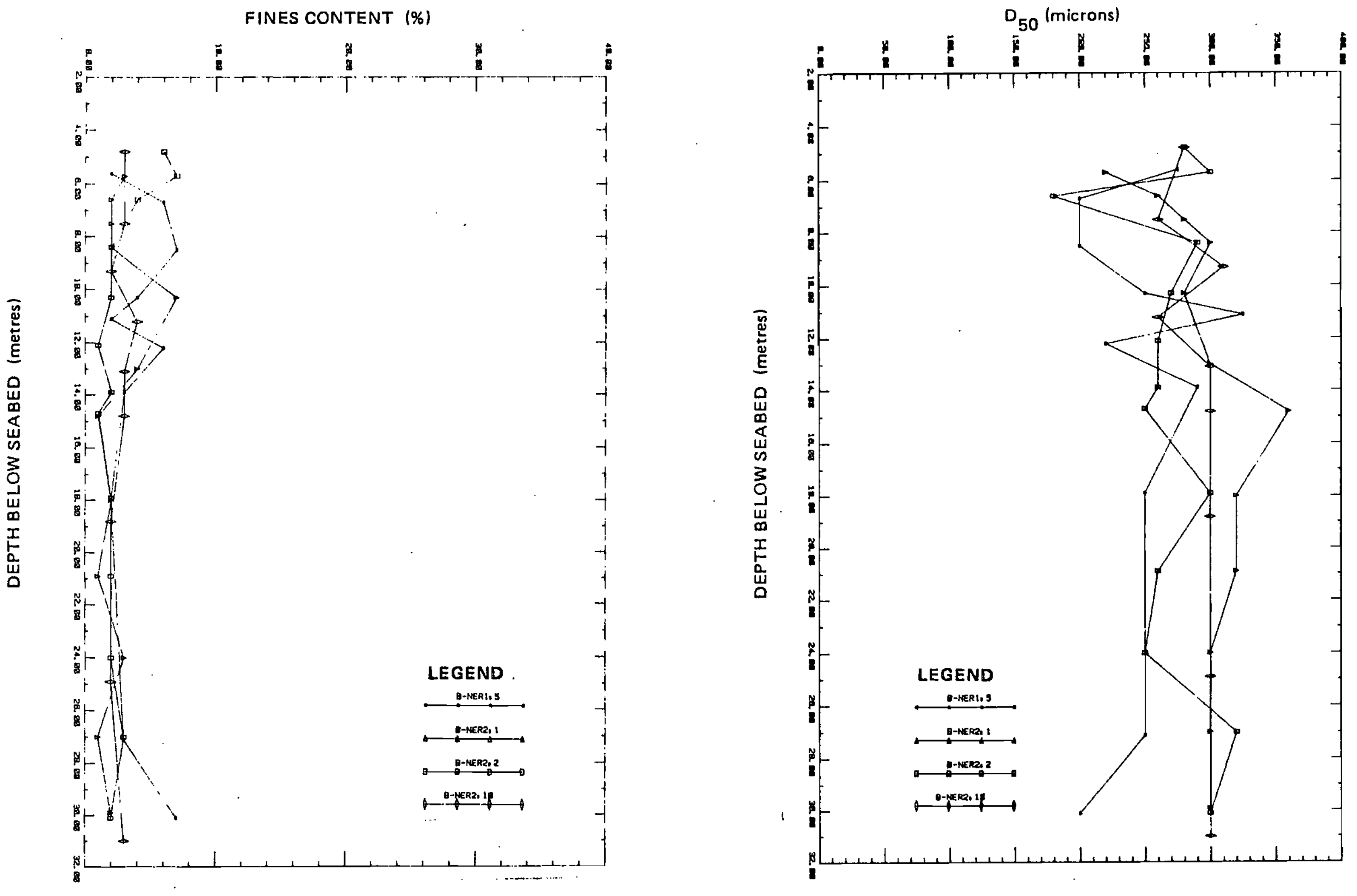


FIGURE B.9 D_{50} AND PERCENT FINES DISTRIBUTION WITH DEPTH AT NERLERK SITE

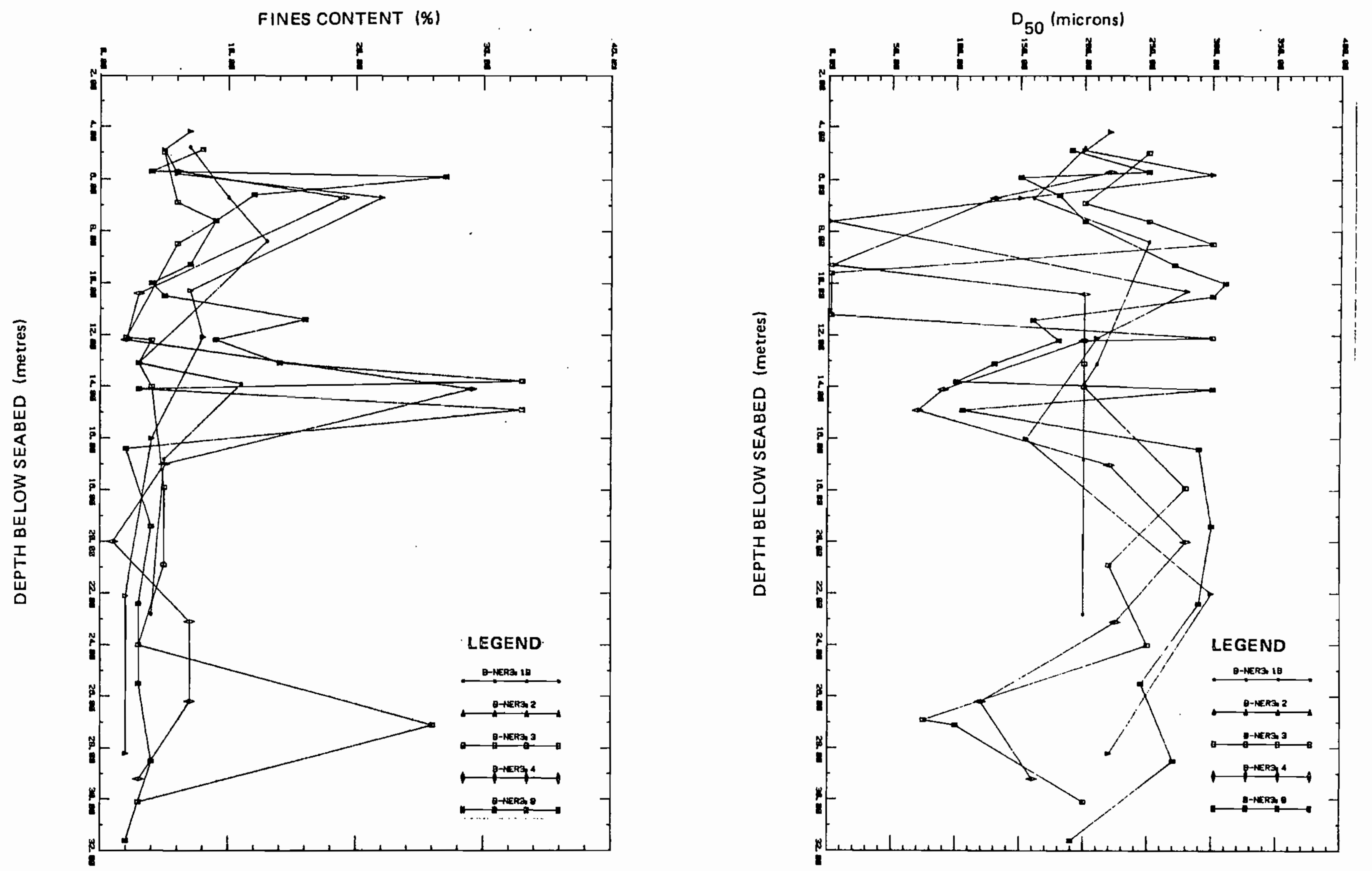


FIGURE B.10 D_{50} AND PERCENT FINES DISTRIBUTION WITH DEPTH AT NERLERK SITE

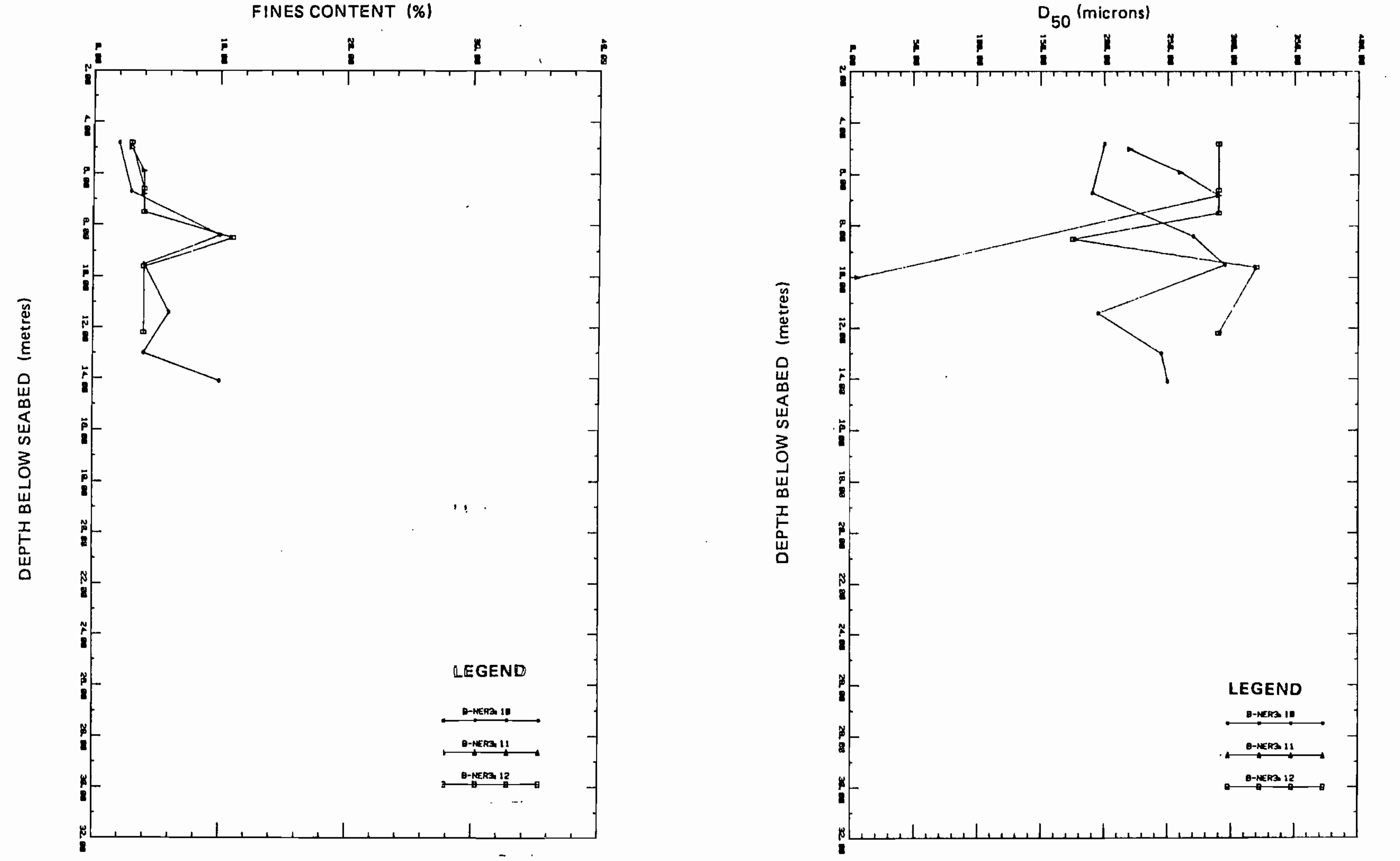


FIGURE B.12 D_{50} AND PERCENT FINES DISTRIBUTION WITH DEPTH AT NERLERK SITE

APPENDIX C

CLASSIFICATION AND INDEX TEST RESULTS

APPENDIX D

SHEAR STRENGTH TEST RESULTS

TABLE D1 SUMMARY OF SHEAR STRENGTH RESULTS, NERLERK SITE

BOREHOLE NO.	DEPTH INTERVAL (m)	TEST TYPE	USC	WATER CONTENT (%)	INITIAL WET DENSITY (Mg/m^{-3})	CONFINING PRESSURE (kPa)	AXIAL STRAIN AT FAILURE (%)	UNDRAINED SHEAR STRENGTH (kPa)	MODE OF FAILURE
F-NER 2:3	51.2-51.4	UU	ML	25	1.93	980	19	251B	Bulge
	55.8-56.4	UU	CL	26	1.96	800	13	117	65° Shear Plane
	55.8-56.4	UU	CL	26	1.95	1040	20(A)	55	Bulge
	57.3-57.5	UU	CL	29	1.99	1050	6	108	65° Shear Plane
	63.5-63.6	UU	CL	29	1.98	1130	12	114	60° Shear Plane
	72.5-72.7	UU	CL	26	2.02	1200	17	171	50° Shear Plane
	72.7-72.9	UU	CL	25	2.02	1250	5	198	50° Shear Plane
	75.7-75.9	UU		27	1.98	1280	4	166	60° Shear Plane
	78.7-79.9	UU	CL	27	1.97	1300	5	245	50° Shear Plane
	81.9-82.1	UU	CL	26	1.96	1350	9	230	Bulge
	84.8-85.2	UU	CL	24	2.01	1400	11	118	60° Shear Plane
	87.8-88.1	UU	CL	28	1.98	1450	12	137	Bulge
	91.0-91.1	UU	CL	29	1.91	1500	11	196(B)	60° Shear Plane
	91.1-91.3	UU	CL	29	1.96	1500	9	238	55° Shear Plane
	96.9-97.1	UU	CH	24	2.00	1500	20(A)	234	50° Shear Plane
	100.3-100.5	UU	CH	30	1.82	1600	11	167(B)	65° Shear Plane
B-NER3:3	9.3	UU	CL	29	1.92	469	12	116	55° Shear Plane
B-NER3:11	10.0-10.15	UU	CL	26	1.97	400	8	101	50° Shear Plane

Note: A. No apparent peak stress, reported shear strength taken at 20% strain in accordance with ASTM standard D2850-70

B. Trace amounts of visible ice observed before thawing prior to shearing

Project

Address

Job No 101-3605

Date Tested 02-10-21 By RB

Client

Attention:

Test No: 17

Test Hole No: F,NER 2,3, 30

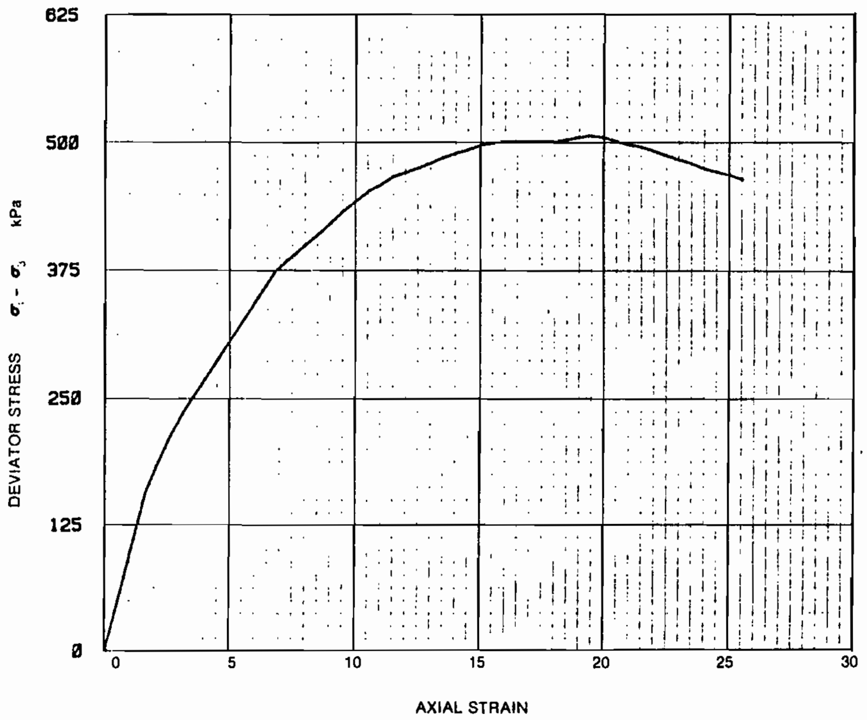
Depth of Sample m: 51.2-51.4 m

Confining Pressure kPa: 800.0

Water Content %: 25.01

Wet Density Mg/m³: 1.93

Peak Stress kPa: 501.8



Reviewed by ____________ P.Eng.

Project:

Address:

Job No 101-3605

Date Tested 82-10-13 By RB

Client

Attention:

Test No 3

Test Hole No F NER 2 ; 3 30

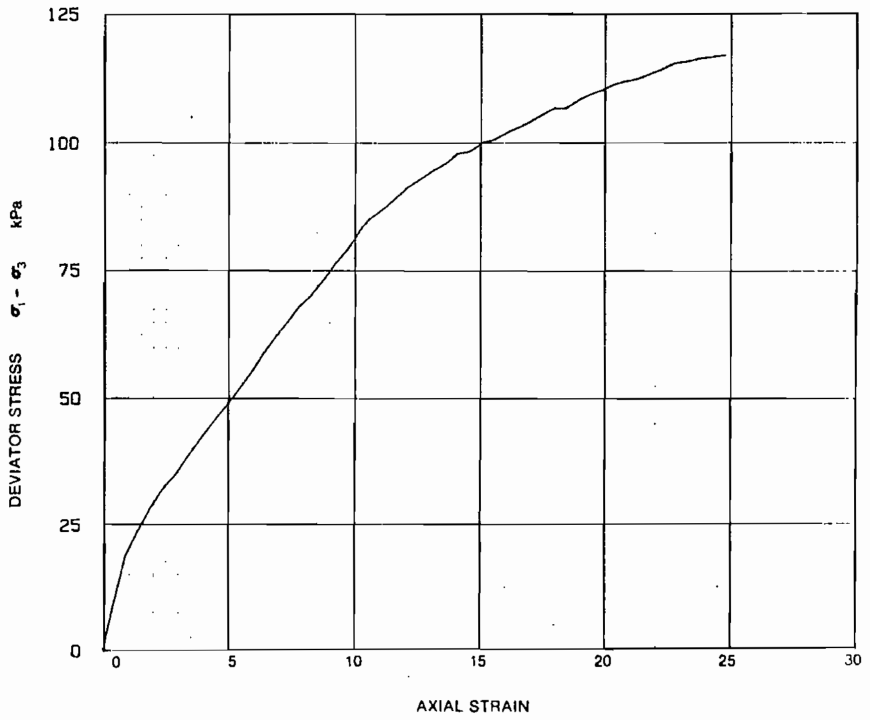
Depth of Sample m 55.8-56.4

Confining Pressure kPa 1640.0

Water Content % 26.40

Wet Density Mg/m³ 1.95

Peak Stress kPa: 115.8



Reviewed by ____________ P Eng

NERLERK SITE

FIGURE D.1 SHEAR STRENGTH TEST RESULTS

Project

Address

Test No: 4

Test Hole No: F-NER 2 ; 3 NO. 36B

Job No: 101-3605

Depth of Sample m: 55.8-56.4

Date Tested: 82-10-14 By: RB

Confining Pressure kPa: 800.0

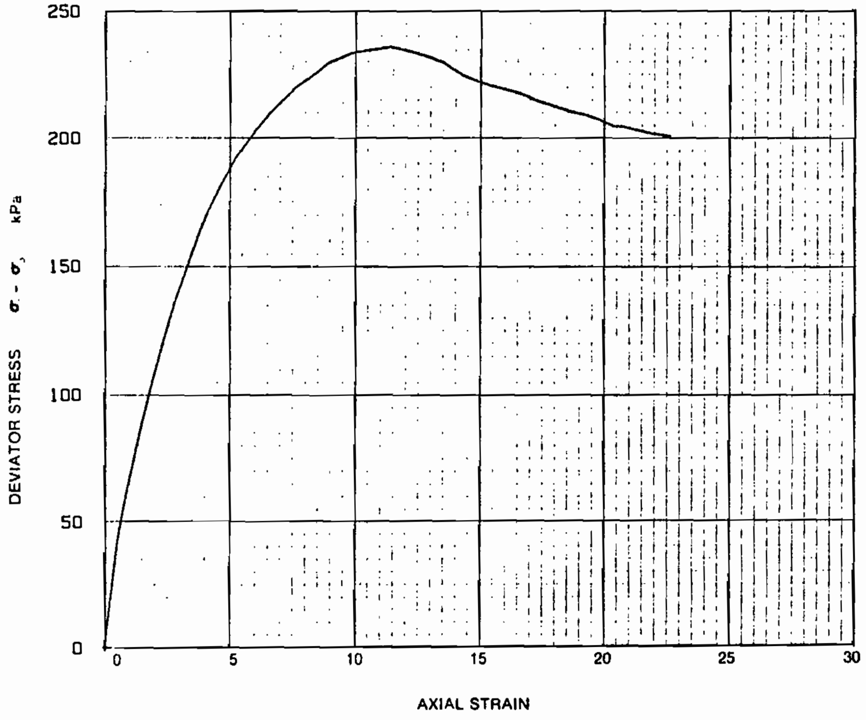
Client

Water Content %: 25.78

Wet Density Mg/m³: 1.96

Attention:

Peak Stress kPa: 234.5



Reviewed by P.Eng.

Project:

Address

Test No: 1

Test Hole No: F-NER 2 ; 3 No. 37A

Job No.: 101-3605

Depth of Sample m: 57.3-57.5

Date Tested: 82-10-13 By SK

Confining Pressure kPa: 1050.0

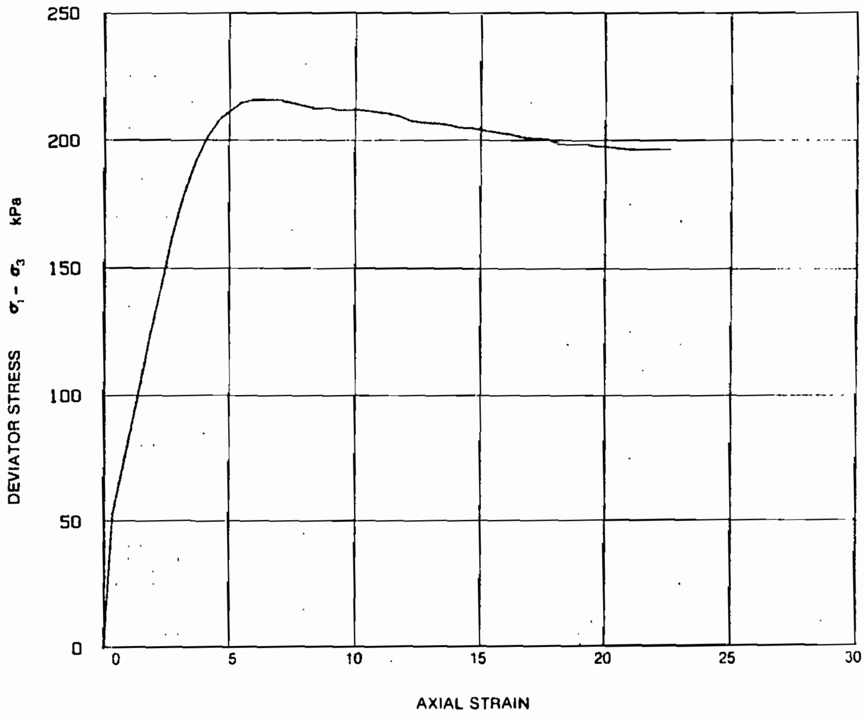
Client:

Water Content %: 28.63

Wet Density Mg/m³: 1.99

Attention:

Peak Stress kPa: 215.4

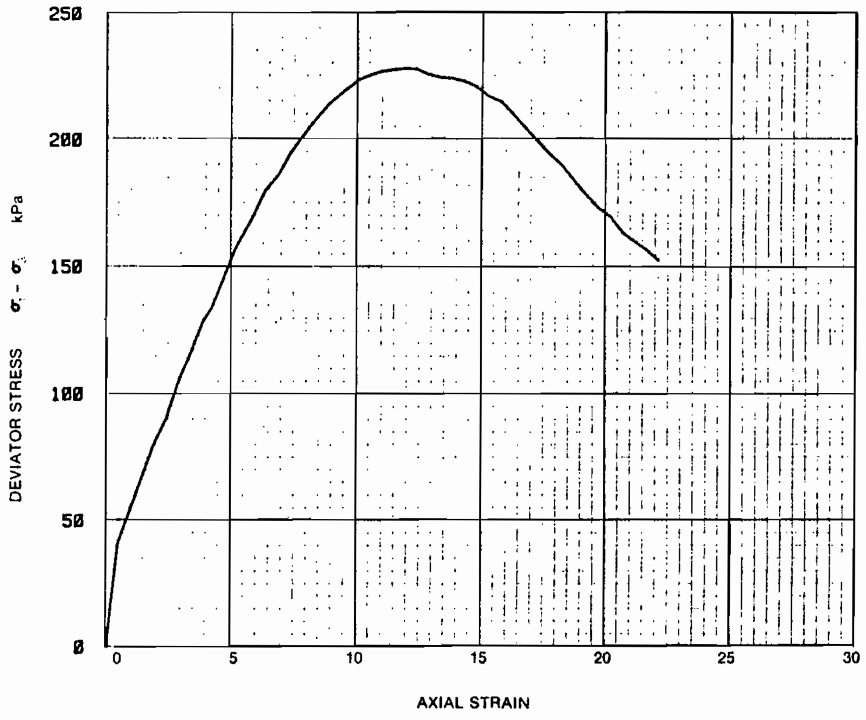


Reviewed by P Eng

NERLERK SITE

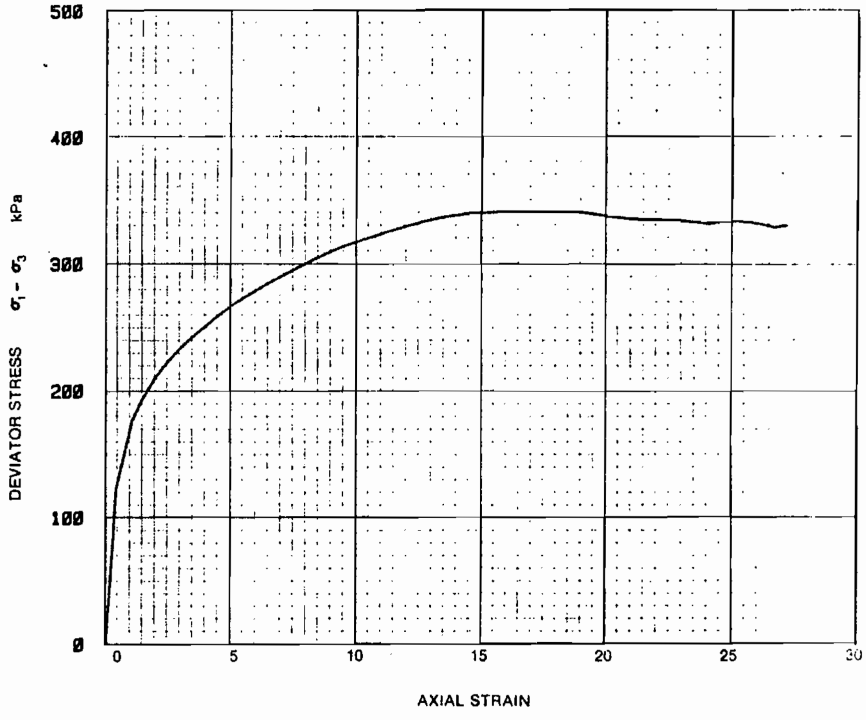
FIGURE D.2 SHEAR STRENGTH TEST RESULTS

Project
Address
Test No.: 5
Test Hole No.: F,NER 2,3, 39B
Job No 101-3605
Depth of Sample m.: 63.45-63.60 m
Date Tested: 82-10-14 By: RB
Confining Pressure kPa: 1130.0
Client.
Water Content %: 29.20
Wet Density Mg/m³: 1.98
Attention:
Peak Stress kPa: 227.2



Reviewed by P.Eng.

Project
Address
Test No 32
Test Hole No. F-NER 2,3 42B
Job No. 101-3605
Depth of Sample m 72.50 - 72.70 m
Date Tested 83 01 12 By GJB
Confining Pressure kPa 1200.0
Client.
Water Content % 25.90
Wet Density Mg m 2.02
Attention:
Peak Stress kPa 341.3

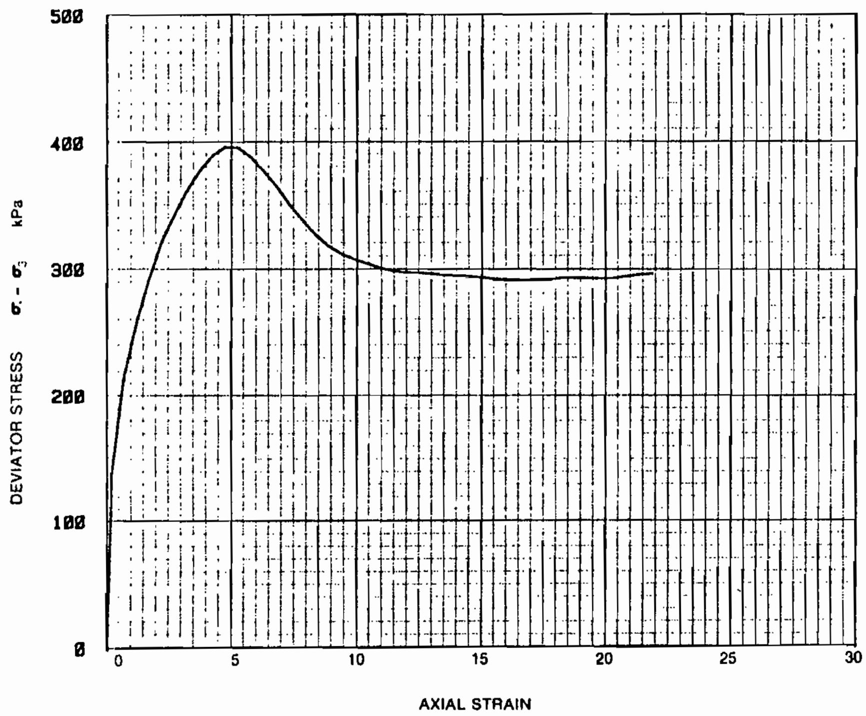


Reviewed by P Eng

NERLERK SITE

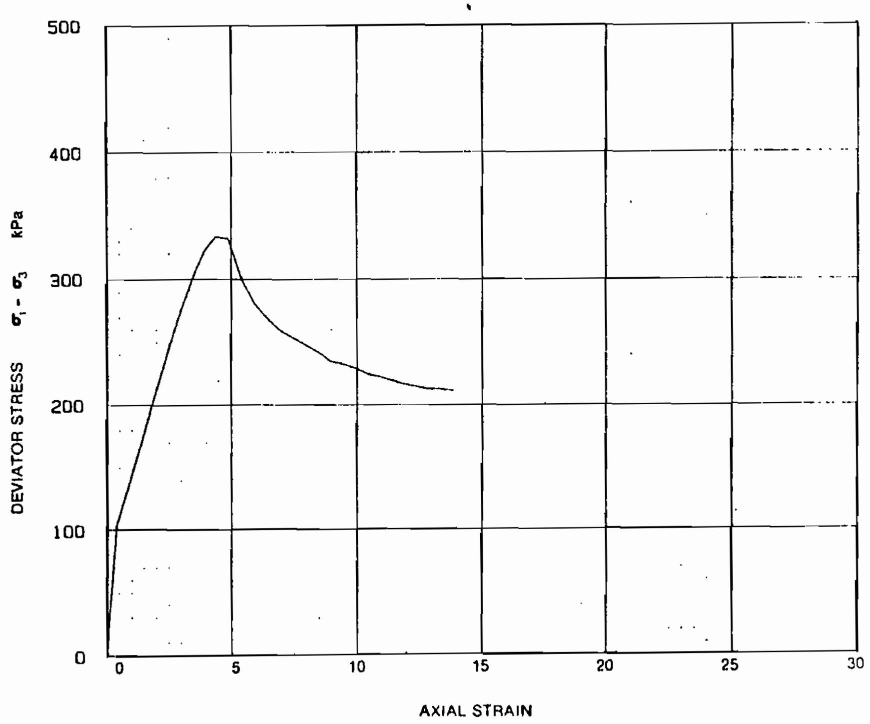
FIGURE D.3 SHEAR STRENGTH TEST RESULTS

Project:
Address
Test No.: 24
Test Hole No.: F-NER 2:3 42C
Job No 101-3605
Depth of Sample m.: 72.70 - 72.90 m
Date Tested 83 01 10 By. GJB
Confining Pressure kPa: 1250.0
Client
Water Content %: 25.38
Wet Density Mg/m³: 2.02
Attention
Peak Stress kPa: 398.5



Reviewed by ____________ P.Eng.

Test No: 2
Test Hole No: F-NER 2 : 3 43m
Job No: 101-3605
Depth of Sample m: 75.7-75.9
Date Tested 82-10-13 By SK
Confining Pressure kPa: 1280.0
Water Content %: 26.51
Wet Density Mg m³: 1.98
Attention:
Peak Stress kPa: 332.0

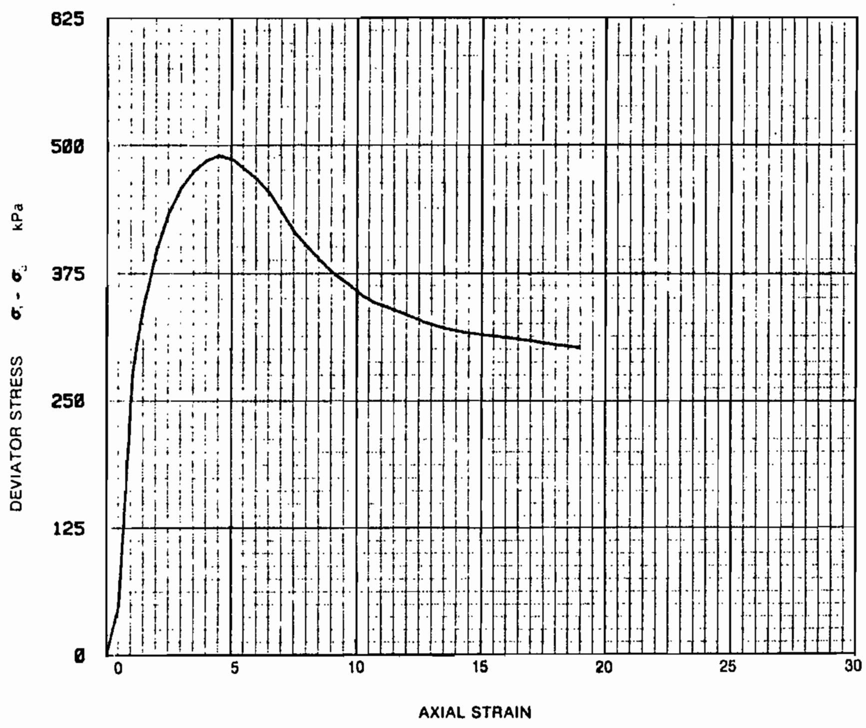


Reviewed by ____________ P Eng

NERLERK SITE

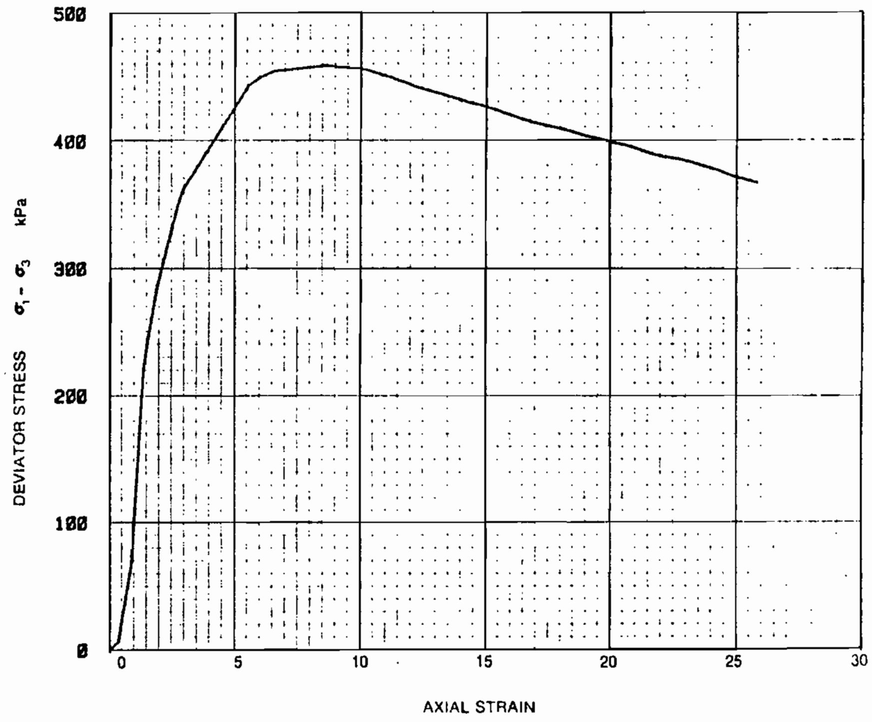
FIGURE D.4 SHEAR STRENGTH TEST RESULTS

Project
Address
Test No.: 33
Test Hole No.: F-NER 2,3 . 44B
Job No 101-3605
Depth of Sample m : 78.70 - 78.80 m
Date Tested 83 01 12 By: GJB
Confining Pressure kPa: 1300.0
Client
Water Content %: 27.42
Wet Density Mg/m³: 1.97
Attention:
Peak Stress kPa. 488.8



Reviewed by ______________ P.Eng.

Project
Address
Test No 25
Test Hole No F-NER 2,3 45B
Job No 101-3605
Depth of Sample m 81.90 - 82.10 m
Date Tested 83 01 10 By GJB
Confining Pressure kPa 1350.0
Client
Water Content % 26.13
Wet Density Mg/m 1.96
Attention:
Peak Stress kPa: 458.0

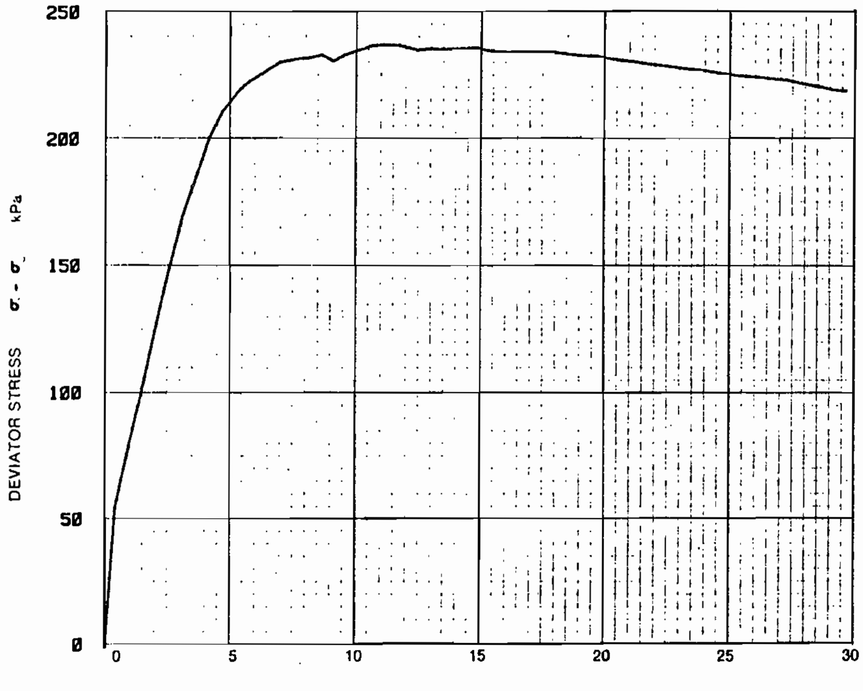


Reviewed by ______________ P.Eng

NERLERK SITE

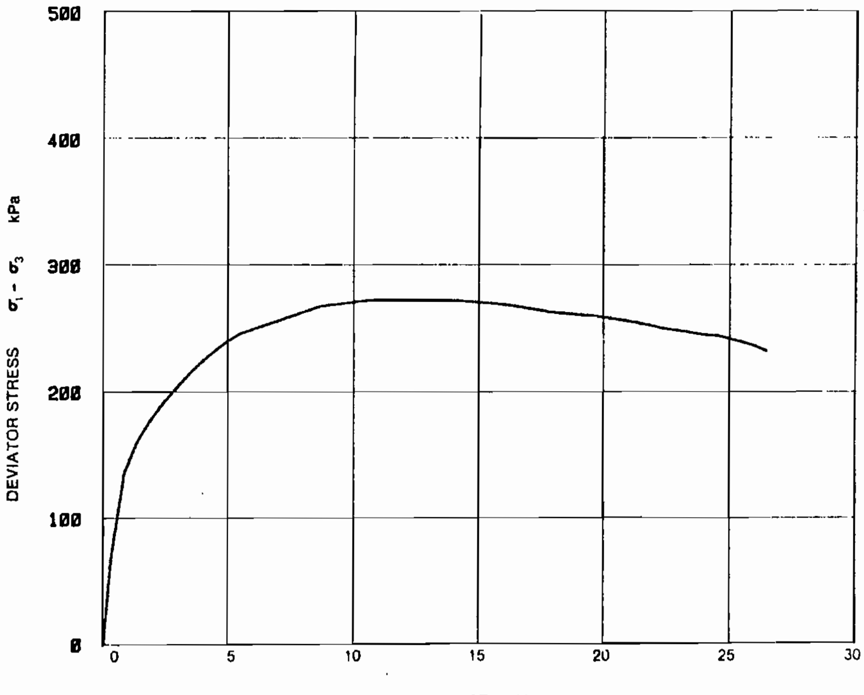
FIGURE D.5 SHEAR STRENGTH TEST RESULTS

Project:
Address: Test No.: 19
Test Hole No.: F, NER 2, 3, 46B
Job No.: 101-3605 Depth of Sample m.: 84, 8-85. 2 m
Date Tested: 82-10-21 By: RB Confining Pressure kPa: 1400. 0
Client: Water Content %: 24. 18
Wet Density Mg/m³: 2. 01
Attention: Peak Stress kPa: 236, 2



Reviewed by ________________ P.Eng.

Project:
Address: Test No.: 34
Test Hole No: F-NER 2, 3 47B
Job No: 101-3605 Depth of Sample m: 87. 84 - 88. 04 m
Date Tested: 83 01 12 By: CJB Confining Pressure kPa: 1450. 0
Client: Wat. Content %: 27. 84
Wet Density Mg/m³: 1. 98
Attention: Peak Stress kPa: 273. 4



Reviewed by ________________ P.Eng.

NERLERK SITE

FIGURE D.6 SHEAR STRENGTH TEST RESULTS

Project

Address

Job No 101-3605

Date Tested 82-10-27 By: RB

Client

Attention

Test No 20

Test Hole No. F ,NER 2 ,3 48B

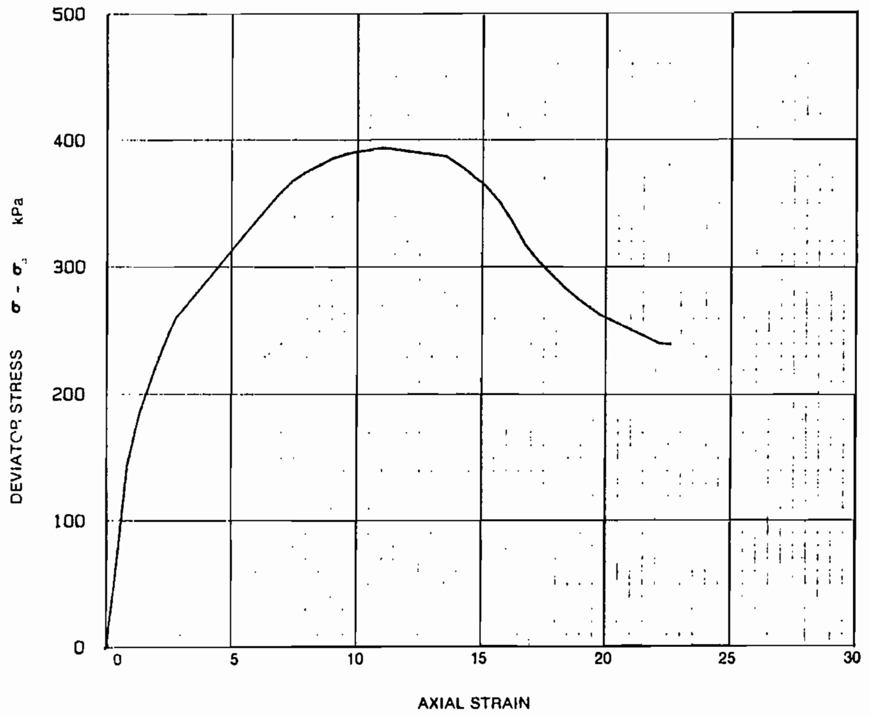
Depth of Sample m 90.96 91.05 m

Confining Pressure kPa: 1500.0

Water Content %: 29.43

Wet Density Mg/m³: 1.91

Peak Stress kPa: 392.4



Reviewed by ______________ P.Eng.

Project

Address

Job No 101-3605

Date Tested 83 01 12 By. GJB

Client:

Attention:

Test No 35

Test Hole No F-NER 2,3 48C

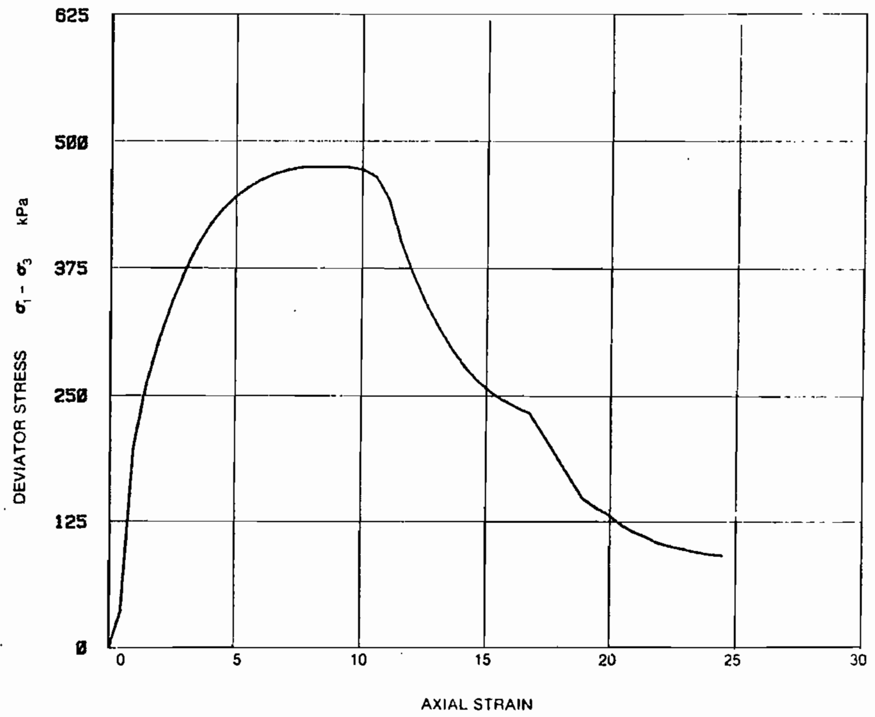
Depth of Sample m 91.05 - 91.25 m

Confining Pressure kPa 1500.0

Water Content % 28.88

Wet Density Mg/m 1.96

Peak Stress kPa 475.4



Reviewed by ______________ P.Eng

NERLERK SITE

FIGURE D.7 SHEAR STRENGTH TEST RESULTS

Project

Address Test No.: 26

Test Hole No.: F-NER 2:3 50A

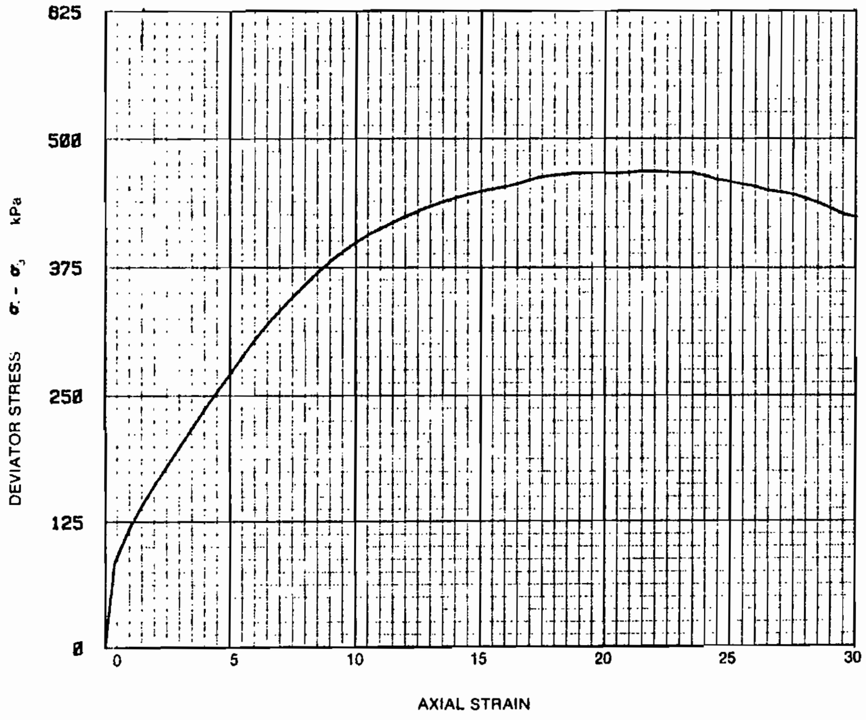
Job No. 101-3605 Depth of Sample m.: 96.90 - 97.10 m

Date Tested 83 01 10 By: GJB Confining Pressure kPa: 1550.0

Client Water Content %: 23.49

Wet Density Mg/m³: 2.00

Attention Peak Stress kPa. 467.1



Reviewed by ______________ P.Eng.

Project:

Address Test No 22

Test Hole No F: NER 2: 3, 51C

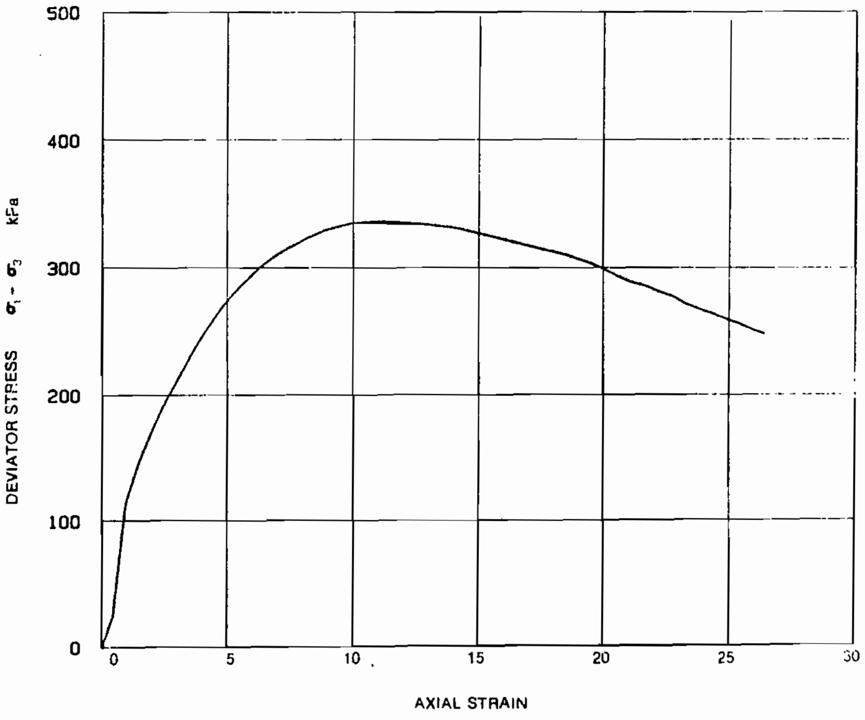
Job No. 101-3605 Depth of Sample m 100.3-100.45

Date Tested 82-10-26 By RB Confining Pressure kPa 1600.0

Client Water Content % 29.54

Wet Density Mg/m 1.82

Attention: Peak Stress kPa 334.7



Reviewed by ______________ P.Eng

NERLERK SITE

FIGURE D.8 SHEAR STRENGTH TEST RESULTS

Project:

Address:

Test No.: 14

Test Hole No.: B, NER 3, 3 16

Job No.: 101-3605

Depth of Sample m.: 9.3 m

Date Tested: 82-10-20 By: RB

Confining Pressure kPa: 489.0

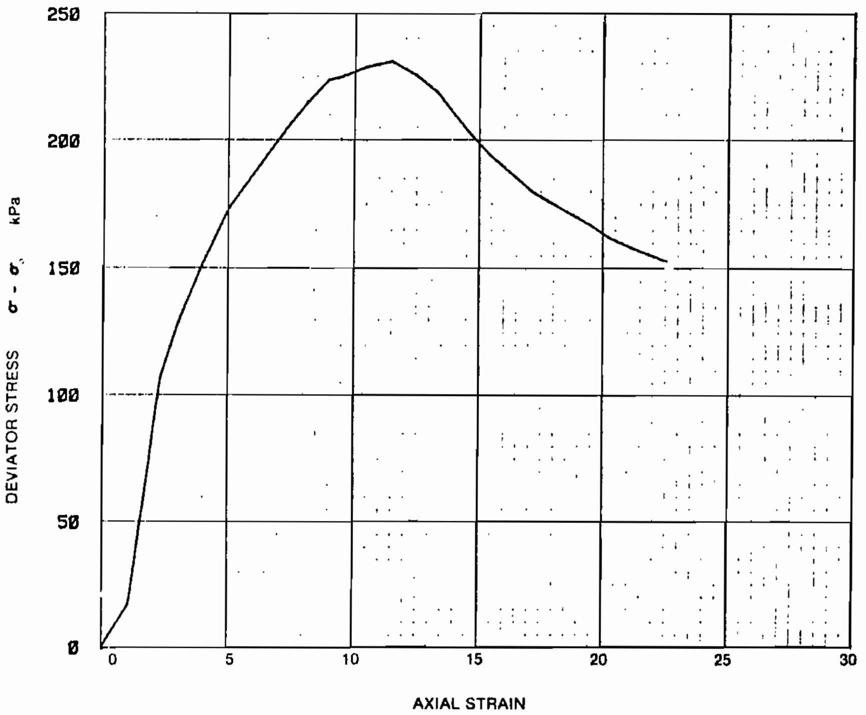
Client

Water Content %: 29.12

Wet Density Mg/m³: 1.92

Attention

Peak Stress kPa: 231.0



Reviewed by P.Eng.

Project:

Address:

Test No.: 6

Test Hole No.: B, NER 3, 11, 14

Job No.: 101-3605

Depth of Sample m: 10.0-10.15 m

Date Tested: 82-10-14 By: RB

Confining Pressure kPa: 400.0

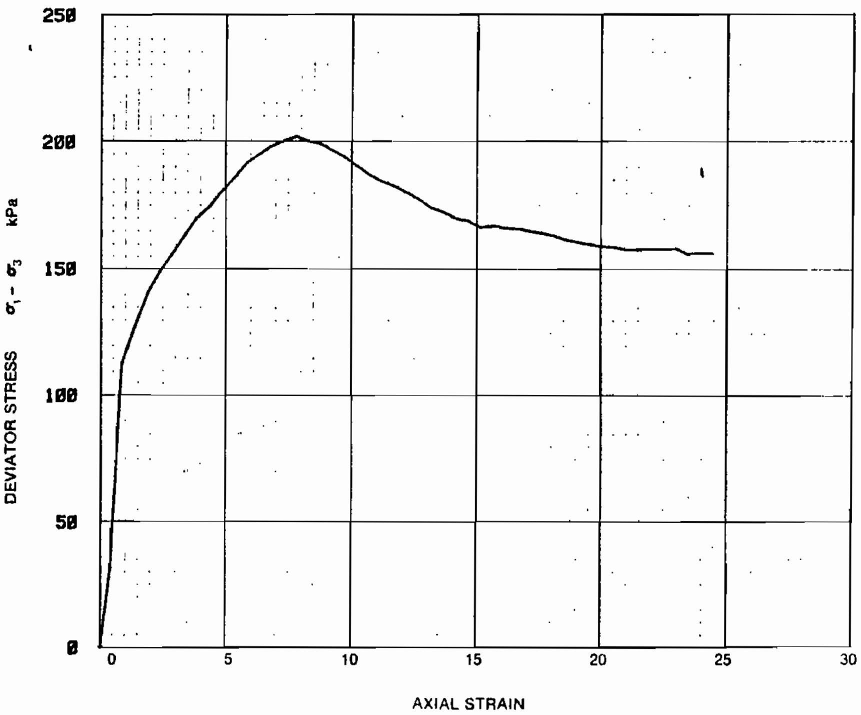
Client:

Water Content %: 25.73

Wet Density Mg/m³: 1.97

Attention:

Peak Stress kPa: 201.6



Reviewed by P Eng

NERLERK SITE

FIGURE D.9 SHEAR STRENGTH TEST RESULTS

APPENDIX E

CONSOLIDATION TEST RESULTS

TABLE E1 SUMMARY OF CONSOLIDATION TEST RESULTS, NERLERK SITE

BOREHOLE NO.	DEPTH INTERVAL (m)	USC	EFFECTIVE OVERBURDEN PRESSURE (kPa)	ESTIMATED PRECONSOLIDATION PRESSURE (kPa)	OVERCONSOLIDATION RATIO	COMPRESSION INDEX	$\hat{c}_u$
F-NER2:3	55.8-56.4	CL	500	200-520	0.4-1.0	0.20	55 - 117
	63.4-63.6	CL	550	600-850	1.1-1.3	0.35	114
	72.7-72.9	CL	600	910	1.5	0.21	178-198
	81.9-82.1	CL	700	900-1000	1.3-1.4	0.29	230
	84.8-85.2	CL	750	400-850	0.5-1.1	0.21	118
	94.0-94.2	CH	820	-1000	1.2	0.17	—
	100.0-100.2	CH	880	700-1000	0.8-1.1	0.23	—

```
                 CONSOLIDATION TEST DATA

Date Computed.........10:39 AM  MON., 17  JAN., 1983

Date Tested...........82 10 14

Job Number............101-3605


Test Hole.............F-NER 2:3  388
Depth.................55.80 - 56.40 m
Test Number...........1

ROOT Fit


                         INITIAL   FINAL

Height            (mm)   25.26    22.46
Water Content      (%)   30.49    23.51
Wet Density (Mg/cu.m)     1.95     2.08
Dry Density (Mg/cu.m)     1.49     1.68
Void Ratio               .8289    .6302
Saturation         (%)   98.56   100.00 (Assumed)


Load (KPa)  Void ratio  CV(sq.m/yr)   MV(sq.m/MN)       K(m/s)
    0.00      .8289      .000E+00      .000E+00      .000E+00
   50.00      .7551      .262E+01      .841E+00      .888E-09
  100.00      .7252      .433E+01      .347E+00      .488E-09
  200.00      .6891      .567E+01      .213E+00      .376E-09
  400.00      .6437      .418E+01      .136E+00      .180E-09
  100.00      .6534      .000E+00      .000E+00      .000E+00
  150.00      .6517      .401E+02      .203E-01      .253E-09
  225.00      .6487      .523E+02      .242E-01      .394E-09
  335.00      .6435      .434E+02      .287E-01      .388E-09
  500.00      .6274      .132E+02      .601E-01      .247E-09
  750.00      .8002      .104E+02      .660E-01      .220E-09
 1600.00      .5355      .130E+02      .495E-01      .200E-09
 3200.00      .4767      .165E+02      .249E-01      .128E-09
  400.00      .4887      .000E+00      .000E+00      .000E+00
   50.00      .5404      .000E+00      .000E+00      .000E+00
    1.00      .6302      .000E+00      .000E+00      .000E+00
```

Project:

Address:

Project No.: 101-3605

Date Tested: 82-10-26

By: SK

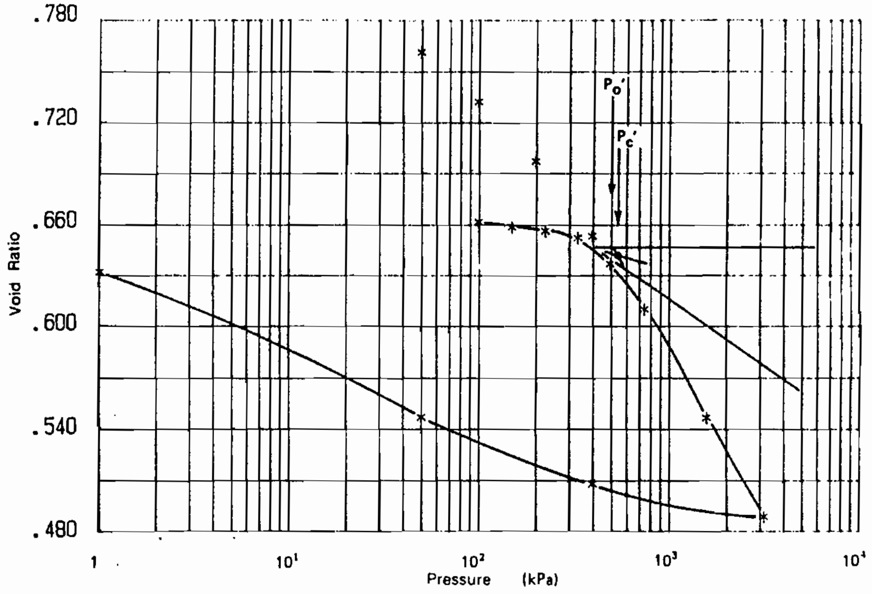
Test No.: 1

Borehole No.: F : NER 2 : 3 368

Depth (m): 55.8-56.4 m

Diameter (mm): 63.52

Specific Gravity: 2.68



	INITIAL	FINAL
Height (mm):	25.26	22.47
Water Content (%):	30.49	23.51
Wet Density (Mg/m³):	1.95	2.08
Dry Density (Mg/m³):	1.49	1.68
Void Ratio	.8285	.6302
Saturation (%):	98.62	100.00

Sample Description: Dark gray silty clay

Overburden Pressure	P_o	500	kPa
Swelling Pressure	P_s		kPa
Pre-Consolidation Pressure	P_c	200 - 520	kPa
Compression Index	C_c	0.20	
	OCR =	0.4 - 1.0	

NERLERK SITE

FIGURE E.1 — CONSOLIDATION TEST DATA AND RESULTS

```
                 CONSOLIDATION TEST DATA

Date Computed.........10:51 AM  MON., 17  JAN., 1983

Date Tested...........82 10 14

Job Number............101-3605


Test Hole.............F-NER 2:3  398
Depth.................63.45 - 63 60 m
Test Number...........2

ROOT Fit


                            INITIAL   FINAL

Height              (mm)    25.74     24.44
Water Content       (%)     26.77     26.27
Wet Density (Mg/cu.m)        1.95      2.04
Dry Density (Mg/cu.m)        1.53      1.62
Void Ratio                  .7926     .7042
Saturation          (%)     90.51    100.00 (Assumed)


Load (KPa)  Void ratio  CV(sq.m/yr)    MV(sq.m/MN)      K(m/s)
    0.00      .7926      .000E+00       .000E+00      .000E+00
   50.00      .7753      .491E+02       .198E+00      .289E-08
  100.00      .7666      .544E+02       .978E-01      .166E-08
  200.00      .7516      .362E+02       .857E-01      .965E-09
  400.00      .7248      .308E+02       .774E-01      .741E-09
  100.00      .7399      .000E+00       .000E+00      .000E+00
  150.00      .7375      .430E+02       .286E-01      .382E-09
  225.00      .7324      .352E+02       .385E-01      .422E-09
  335.00      .7255      .326E+02       .364E-01      .369E-08
  500.00      .7120      .322E+02       .479E-01      .480E-09
  750.00      .6900      .200E+02       .520E-01      .324E-09
 1125.00      .6480      .874E+01       .680E-01      .185E-09
 2250.00      .5551      .900E+01       .531E-01      .149E-09
 4500.00      .4560      .793E+01       .303E-01      .746E-10
  800.00      .4898      .000E+00       .000E+00      .000E+00
  100.00      .5631      .000E+00       .000E+00      .000E+00
   10.00      .6507      .000E+00       .000E+00      .000E+00
    1.00      .7042      .000E+00       .000E+00      .000E+00
```

Project:

Address::

Test No : 2

Borehole No.: F:NER 2:3 39B

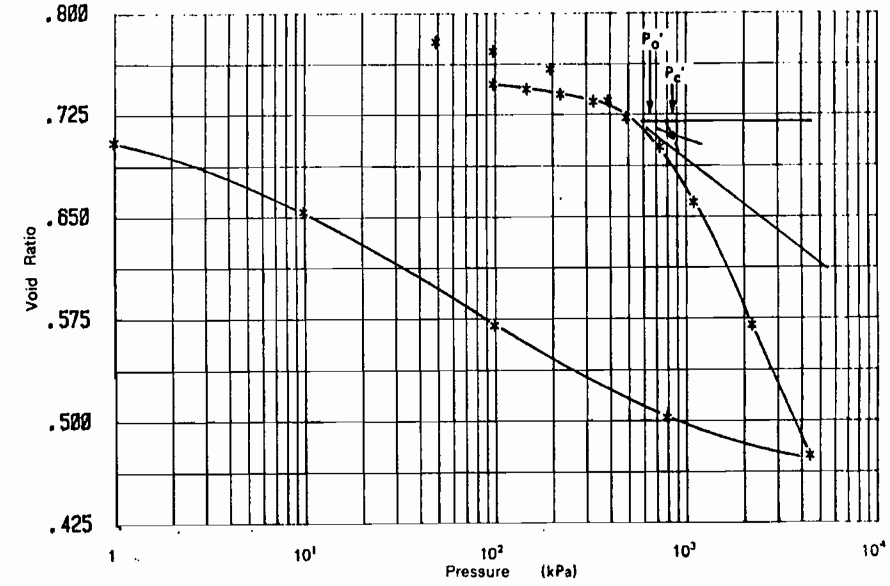
Depth (m): 63.45 - 63.60 m

Project No.: 101-3605

Diameter (mm): 63.46

Date Tested: 82 10 14 By: GJB

Specific Gravity: 2.68



	INITIAL	FINAL
Height (mm):	25.74	24.44
Water Content (%):	26.77	26.27
Wet Density (Mg/m³):	1.95	2.04
Dry Density (Mg/m³):	1.53	1.62
Void Ratio	.7920	.7042
Saturation (%):	90.59	100.00

Sample Description: CLAY, some silt
dark grey, veining

Overburden Pressure	P_o	550	kPa
Swelling Pressure	P_s		kPa
Pre-Consolidation Pressure	P_c	600 - 850	kPa
Compression Index	C_c	0.35	

OCR = 1.1 - 1.3

NERLERK SITE

FIGURE E.2 CONSOLIDATION TEST DATA AND RESULTS

```
                    CONSOLIDATION TEST DATA

Date Computed......... 1:34 PM  MON., 17  JAN., 1983

Date Tested...........83-01-17

Job Number............101-3605


Test Hole.............F-NER 2:3  42C
Depth.................72.7-72.9 m
Test Number...........11

ROOT Fit


                      INITIAL   FINAL

Height          (mm)   25.24    25.72
Water Content    (%)   23.05    25.68
Wet Density (Mg/cu.m)   2.04     2.05
Dry Density (Mg/cu.m)   1.68     1.63
Void Ratio              .6575    .6883
Saturation       (%)   93.96    100.00 (Assumed)


Load (KPa)  Void ratio  CV(sq.m/yr)    MV(sq.m/MN)      K(m/s)
    0.00      .6575       .000E+00      .000E+00       .000E+00
   50.00      .6519       .535E+02      .673E-01       .112E-08
  100.00      .6486       .638E+02      .401E-01       .795E-09
  200.00      .6435       .775E+02      .315E-01       .759E-09
  400.00      .6360       .723E+02      .227E-01       .510E-09
  100.00      .6497       .000E+00      .000E+00       .000E+00
  150.00      .6493       .830E+02      .559E-02       .144E-09
  225.00      .6471       .731E+02      .174E-01       .396E-08
  340.00      .6428       .699E+02      .228E-01       .495E-09
  510.00      .6369       .867E+02      .213E-01       .443E-09
  760.00      .6273       .590E+02      .236E-01       .432E-09
 1500.00      .5902       .318E+02      .316E-01       .312E-09
 3000.00      .5243       .204E+02      .288E-01       .183E-09
  400.00      .5518       .000E+00      .000E+00       .000E+00
   50.00      .5970       .000E+00      .000E+00       .000E+00
    1.00      .6883       .000E+00      .000E+00       .000E+00
```

Project:

Address

Test No. 11

Hole No. F NER 2:3 42C

Depth (m) 72.7-72.9 m

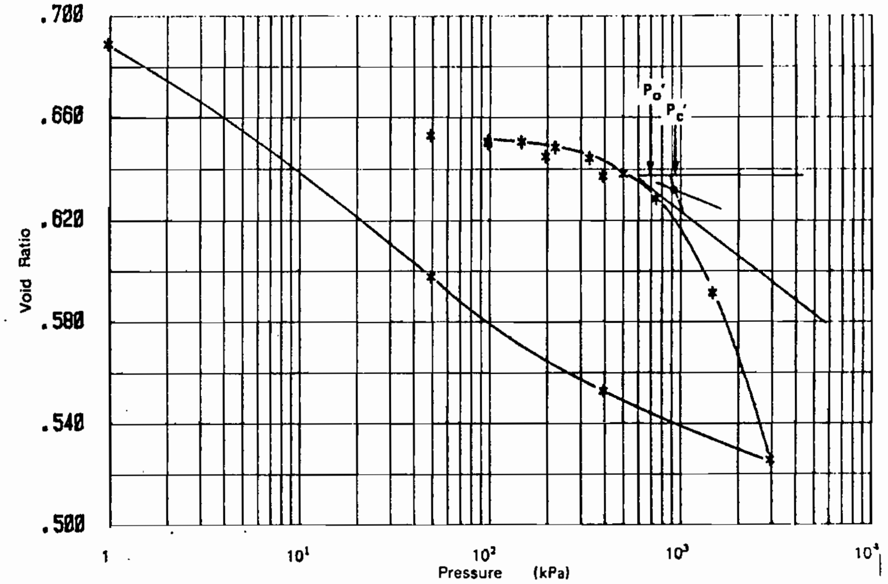
Project No.: 101-3605

Date Tested. 83-01-17

By: SK

Diameter (mm): 63.50

Specific Gravity: 2.68



	INITIAL	FINAL
Height (mm):	25.24	25.72
Water Content (%):	23.05	25.68
Wet Density (Mg/m^3):	2.04	2.05
Dry Density (Mg/m^3):	1.68	1.63
Void Ratio	.6575	.6883
Saturation (%):	93.96	100.00

Sample Description: Dark gray silty clay

Overburden Pressure	P_o	600	kPa
Swelling Pressure	P_s		kPa
Pre-Consolidation Pressure	P_c	910	kPa
Compression Index	C_c	0.21	

NERLERK SITE

FIGURE E.3 CONSOLIDATION TEST DATA AND RESULTS

```
                    CONSOLIDATION TEST DATA

Date Computed......... 3:41 PM  MON., 17  JAN., 1983

Date Tested...........83-01-17

Job Number............101-3605


Test Hole.............F-NER 2:3  458
Depth.................81.9-82.1 m
Test Number...........12

ROOT Fit


                          INITIAL   FINAL

Height              (mm)   25.72    25.80
Water Content        (%)   26.29    28.36
Wet Density (Mg/cu.m)       2.01     2.04
Dry Density (Mg/cu.m)       1.59     1.59
Void Ratio                 .7548    .7602
Saturation           (%)   93.34   100.00 (Assumed)


Load (KPa)  Void ratio  CV(sq.m/yr)    MV(sq.m/MN)       K(m/s)
    0.00       .7548      .000E+00      .000E+00       .000E+00
   50.00       .7473      .867E+02      .859E-01       .232E-08
  100.00       .7429      .700E+02      .496E-01       .106E-08
  200.00       .7365      .894E+02      .372E-01       .104E-08
  400.00       .7260      .794E+02      .305E-01       .752E-09
  600.00       .7163      .708E+02      .282E-01       .621E-09
  200.00       .7312      .000E+00      .000E+00       .000E+00
  300.00       .7291      .649E+02      .126E-01       .254E-09
  450.00       .7241      .589E+02      .191E-01       .350E-09
  675.00       .7150      .491E+02      .238E-01       .360E-09
 1000.00       .6962      .249E+02      .342E-01       .265E-09
 2000.00       .6268      .182E+02      .427E-01       .242E-09
 4000.00       .5378      .128E+02      .289E-01       .116E-09
  400.00       .5887      .000E+00      .000E+00       .000E+00
   50.00       .6520      .000E+00      .000E+00       .000E+00
    1.00       .7602      .000E+00      .000E+00       .000E+00
```

Project:

Address::

Project No.: 101-3605

Date Tested: 83-01-17 By: SK

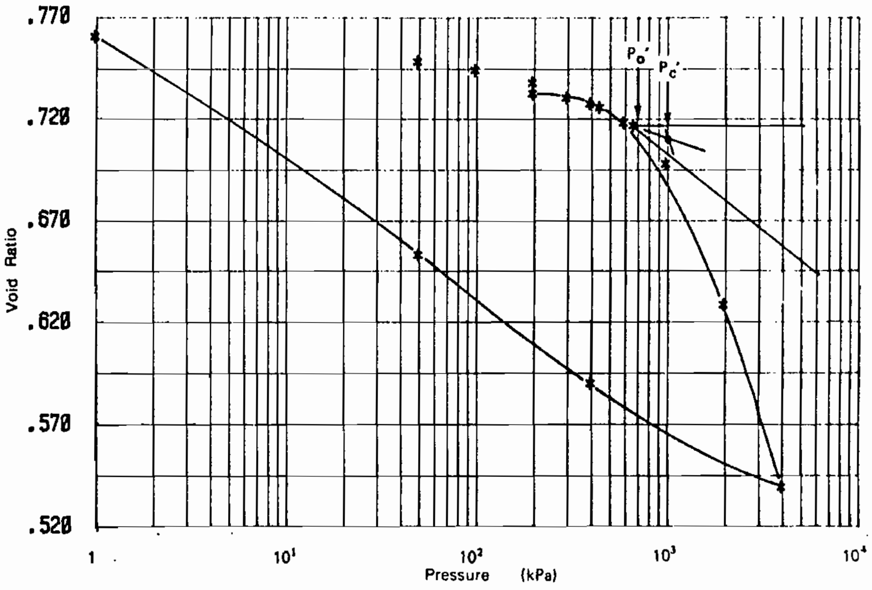
Test No.: 12

Borehole No.: F-NER 2:3 458

Depth (m): 81.9-82.1 m

Diameter (mm): 63.34

Specific Gravity: 2.68



	INITIAL	FINAL
Height (mm):	25.72	25.80
Water Content (%):	26.29	28.36
Wet Density (Mg/m³):	2.01	2.04
Dry Density (Mg/m³):	1.59	1.59
Void Ratio	.7548	.7602
Saturation (%):	93.34	100.00

Sample Description: Dark gray silty clay

Overburden Pressure	P_o	700	kPa
Swelling Pressure	P_s		kPa
Pre-Consolidation Pressure	P_c	900 - 1000	kPa
Compression Index	C_c	0.29	

OCR = 1.3 - 1.4

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FIGURE E.4 CONSOLIDATION TEST DATA AND RESULTS

```
                 CONSOLIDATION TEST DATA

Date Computed.........11:07 AM  MON., 17  JAN., 1983

Date Tested...........82 10 27

Job Number............101-3605


Test Hole.............F-NER 2:3  468
Depth.................84.80 - 85.20 m
Test Number...........3

ROOT Fit


                             INITIAL   FINAL

Height            (mm)       25.26     24.33
Water Content      (%)       26.66     25.65
Wet Density (Mg/cu.m)         2.01      2.07
Dry Density (Mg/cu.m)         1.58      1.64
Void Ratio                    .7497     .6874
Saturation         (%)       95.29    100.00 (Assumed)


Load (KPa)  Void ratio  CV(sq.m/yr)      MV(sq.m/MN)       K(m/s)
    0.00       .7497      .000E+00         .000E+00        .000E+00
   50.00       .7318      .514E+02         .208E+00        .332E-08
  100.00       .7178      .270E+02         .162E+00        .136E-08
  200.00       .6931      .510E+02         .146E+00        .232E-08
  400.00       .6629      .135E+02         .806E-01        .380E-09
  600.00       .6436      .137E+02         .590E-01        .251E-08
  200.00       .6544      .000E+00         .000E+00        .000E+00
  300.00       .6518      .573E+02         .157E-01        .281E-09
  450.00       .6468      .321E+02         .202E-01        .201E-09
  675.00       .6349      .266E+02         .322E-01        .266E-09
 1000.00       .6116      .104E+02         .446E-01        .144E-09
 1500.00       .5820      .127E+02         .374E-01        .148E-09
 3000.00       .5150      .919E+01         .295E-01        .842E-10
  400.00       .5486      .000E+00         .000E+00        .000E+00
   50.00       .6037      .000E+00         .000E+00        .000E+00
    1.00       .6874      .000E+00         .000E+00        .000E+00
```

Project:

Address:

Project No.: 101-3605

Date Tested: 82-11-02 By: SK

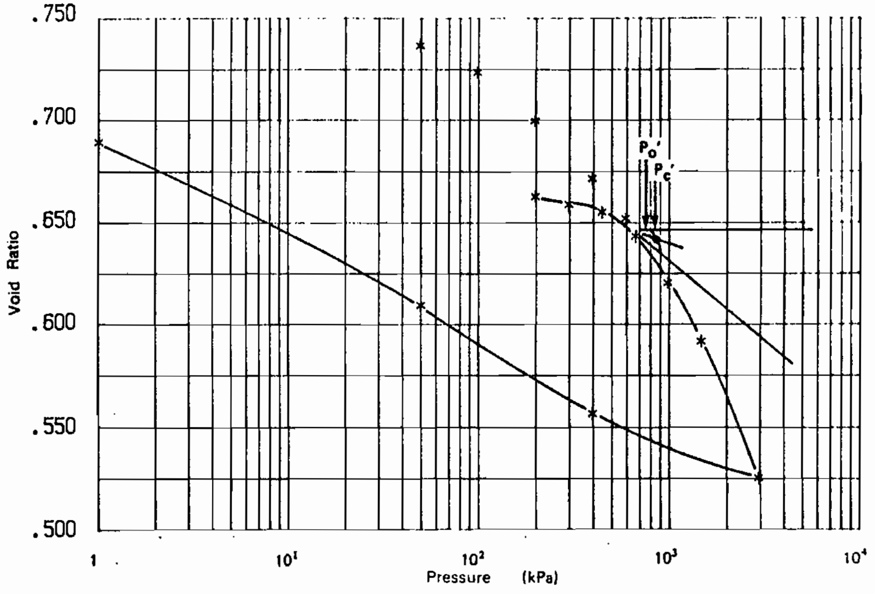
Test No.: 3

Borehole No.: F : NER 2 : 3 468

Depth (m): 84.8-85.2 m

Diameter (mm): 63.52

Specific Gravity: 2.68



	INITIAL	FINAL
Height (mm):	25.26	24.34
Water Content (%):	26.66	25.65
Wet Density (Mg/m³):	2.01	2.07
Dry Density (Mg/m³):	1.58	1.64
Void Ratio	.7493	.6874
Saturation (%):	95.35	100.00

Sample Description: Dark gray silty clay

Overburden Pressure	P_o	750	kPa
Swelling Pressure	P_s		kPa
Pre-Consolidation Pressure	P_c	400 - 850	kPa
Compression Index	C_c	0.21	
	OCR =	0.5 - 1.1	

NERLERK SITE

FIGURE E.5 CONSOLIDATION TEST DATA AND RESULTS

```
                    CONSOLIDATION TEST DATA

Date Computed.........11:16 AM  MON., 17  JAN., 1983

Date Tested...........82 11 01

Job Number............101-3605


Test Hole.............F-NER 2:3  498
Depth.................94.02 - 84.22 m
Test Number...........4

ROOT Fit


                            INITIAL   FINAL

Height            (mm)       25.26    26.23
Water Content      (%)       31.73    35.07
Wet Density (Mg/cu.m)         1.94     1.91
Dry Density (Mg/cu.m)         1.47     1.42
Void Ratio                   .8701    .9400
Saturation         (%)       87.72   100.00 (Assumed)


Load (KPa)  Void ratio  CV(sq.m/yr)    MV(sq.m/MN)      K(m/s)
   0.00       .8701      .000E+00       .000E+00     .000E+00
 100.00       .8634      .111E+03       .381E-01     .124E-08
 200.00       .8553      .732E+02       .439E-01     .999E-09
 400.00       .8491      .632E+02       .167E-01     .328E-09
 700.00       .8380      .513E+02       .202E-01     .322E-09
 200.00       .8553      .000E+00       .000E+00     .000E+00
 300.00       .8525      .485E+02       .153E-01     .230E-09
 450.00       .8465      .305E+02       .218E-01     .207E-08
 675.00       .8376      .315E+02       .215E-01     .210E-09
1000.00       .8171      .173E+02       .347E-01     .186E-09
1500.00       .7810      .138E+02       .405E-01     .174E-09
3000.00       .6797      .746E+01       .402E-01     .933E-10
 400.00       .7341      .000E+00       .000E+00     .000E+00
  50.00       .8145      .000E+00       .000E+00     .000E+00
   1.00       .9400      .000E+00       .000E+00     .000E+00
```

Project:

Address::

Project No 101-3605

Date Tested: 82-11-10 By. SK

Test No.: 4

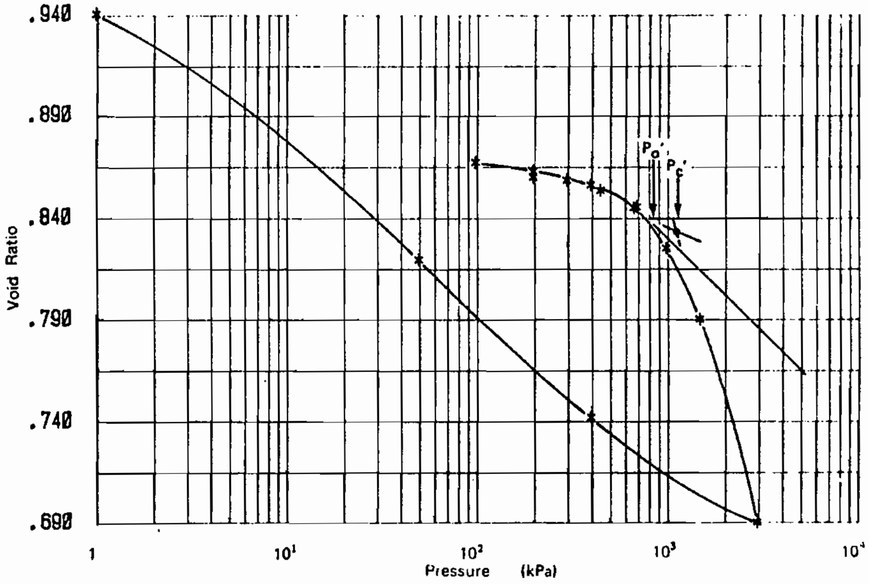
Borehole No.: F ; NER 2 ; 3 498

Depth (m): 94.02-94.22 m

[illegible] 63 52

[illegible] (mm) 63.52

Specific Gravity. (A) 2.68



	INITIAL	FINAL
Height (mm):	25.26	26.24
Water Content (%):	31.73	35.07
Wet Density (Mg/m³):	1.94	1.91
Dry Density (Mg/m³):	1.47	1.42
Void Ratio	.8696	.9400
Saturation (%):	97.78	100.00

Sample Description: Dark gray clay trace of silt

Overburden Pressure	P_o	820	kPa
Swelling Pressure	P_s		kPa
Pre-Consolidation Pressure	P_c	1000	kPa
Compression Index .	C_c	0.17	
	OCR = 1.2		

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FIGURE E.6 CONSOLIDATION TEST DATA AND RESULTS

```
Test Hole.............F-NER 2:3  51A
Depth.................100.0 - 100.2 m
Test Number...........10

ROOT Fit

                         INITIAL   FINAL

Height            (mm)    25.30    25.28
Water Content      (%)    25.47    26.58
Wet Density (Mg/cu.m)      2.01     2.03
Dry Density (Mg/cu.m)      1.61     1.61
Void Ratio                .7137    .7124
Saturation         (%)    95.63   100.00 (Assumed)


Load (KPa)  Void ratio  CV(sq.m/yr)     MV(sq.m/MN)       K(m/s)
    0.00      .7137       .000E+00       .000E+00       .000E+00
   25.00      .7133       .170E+39       .955E-02       .505E+27
   50.00      .7122       .169E+03       .268E-01       .141E-08
  100.00      .7078       .493E+02       .508E-01       .780E-09
  200.00      .7002       .370E+02       .447E-01       .515E-09
  400.00      .6877       .527E+02       .370E-01       .606E-09
  600.00      .6772       .350E+02       .313E-01       .341E-09
  200.00      .6843       .000E+00       .000E+00       .000E+00
  300.00      .6828       .849E+02       .925E-02       .244E-09
  450.00      .6793       .793E+02       .138E-01       .341E-09
  675.00      .6735       .553E+02       .154E-01       .265E-09
 1000.00      .6583       .241E+02       .283E-01       .212E-09
 1500.00      .6325       .194E+02       .316E-01       .190E-09
 3000.00      .5643       .131E+02       .291E-01       .119E-09
  400.00      .6018       .000E+00       .000E+00       .000E+00
   50.00      .6472       .000E+00       .000E+00       .000E+00
    1.00      .7124       .000E+00       .000E+00       .000E+00
```

Project:

Address:

Project No.: 101-3605

Date Tested: 82 12 08 By: GJB

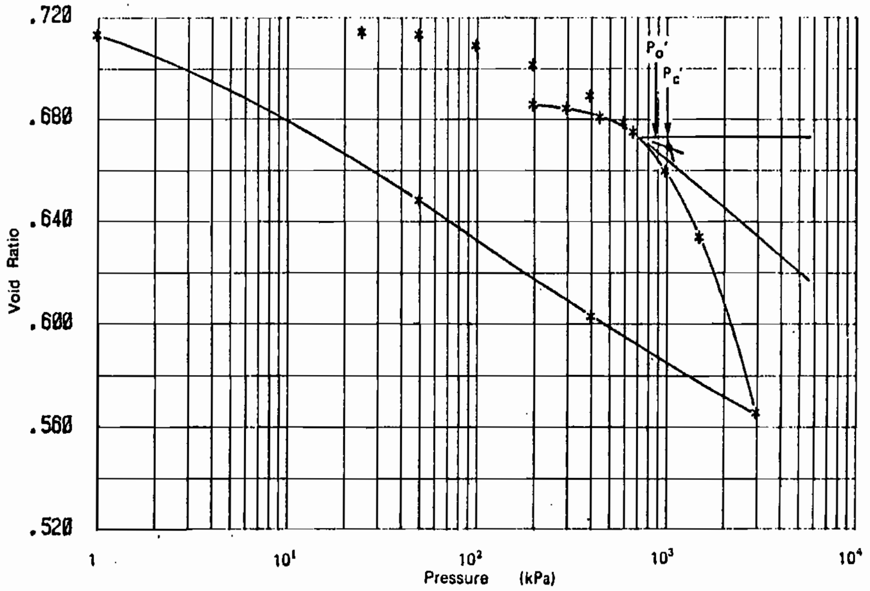
Test No.: 10

Borehole No.: F-NER 2:3 51A

Depth (m): 100.0 - 100.2 m

Diameter (mm): 63.40

Specific Gravity: 2.68



	INITIAL	FINAL
Height (mm):	25.30	25.28
Water Content (%):	25.47	26.58
Wet Density (Mg/m³):	2.01	2.03
Dry Density (Mg/m³):	1.61	1.61
Void Ratio	.7137	.7124
Saturation (%):	95.63	100.00

Sample Description: CLAY, tr sand, some silt, seams, Nbn

Overburden Pressure	P_o	880	kPa
Swelling Pressure	P_s		kPa
Pre-Consolidation Pressure	P_c	700 - 1000	kPa
Compression Index	C_c	0.23	
	OCR =	0.8 - 1.1	

NERLERK SITE

FIGURE E.7 CONSOLIDATION TEST DATA AND RESULTS

APPENDIX F

SUBCONSULTANTS REPORTS

Hydrocarbon Gases and Pore Water Chemistry -
Nerlerk and Natiak Borings

For EBA Engineering Consultants Ltd.
P. M. Romerill, P.Eng.

By Dr. J. F. Barker
Assistant Professor
Department of Earth Sciences
University of Waterloo

December 22, 1982

INTRODUCTION

Selected sediment samples (14) from two shallow borings were collected as part of the Dome Beaufort Sea Project. Hydrocarbon gas content and selected geochemical parameters were determined and the results discussed as to their potential effect upon geotechnical properties.

Terminology and interpretation has been kept similar to previous reports by other authors so as to minimize confusion over terms or values.

SUMMARY OF CONCLUSIONS

1. Minor amounts of hydrocarbon gases exist in the sediments from both the Nerlerk and Natiak borings. This gas is dissolved in the pore water. It has a dominantly biogenic origin. Sulphate is not yet depleted in this sediment and so little production of biogenic methane has occurred.

2. Although considerable potential for methane generation exists in these sediments, the methane produced is unlikely to be sufficient to form a gas phase and so its production should not significantly influence the geotechnical properties of the sediments.

METHODS

Sediment samples for hydrocarbon gas analysis were quickly canned at the drill site to prevent loss of volatile components. In the laboratory, a head space was introduced by replacing 100 cm^3 of water with helium via silicone septa in the can lids. The sediment/water/helium was homogenized by vigorous agitation so that essentially all the hydrocarbon gases originally present in and also from chloride concentrations of pore waters using experimental salinity-chlorinity data, both data being reported in the Handbook of Chemistry and Physics, 56th Ed., CRC Press, 1974. Salinity is reported in units of parts per thousand (°/₀₀). Normal open sea-water has a salinity of about 35 °/₀₀ and a chlorinity of about 19.3 °/₀₀.

Salinity calculated from conductivity is shown in Table 2. Table 4 compares salinity values calculated from conductivity and from chlorinity. The latter values are always considerably greater. Chloride concentrations are less likely to be modified by chemical reactions following sedimentation then are the concentration of ions such as Ca^{2+}, Mg^{2+}, SO_4^{2-} and HCO_3^- - all of which contribute to conductivity. Thus, the salinity values calculated from chlorinity data are considered more appropriate. Table 4 shows that most pore waters approach the salinity of normal sea water (35 °/₀₀), one is about one-half this value, and two pore water samples considerably exceed this value and so are hypersaline. Sample 41B from the Nerlerk boring is an unfrozen seem and sample 41C + D is just below an unfrozen zone in the Natiak boring. Perhaps the unfrozen nature of the sediment is due, in part, to the hypersaline pore water present.

The sulphate deficit, S_d, can be expressed as the difference between the measured pore water sulphate values and the conservative sea-water sulphate value corrected for simple dilution by fresh water using salinity values.

Then:

$$S_d = \frac{(0.007C - S_0)}{96.06\ (d)} \times 10^3$$

where S_d = sulphate deficit in 10^{-3} moles/l, C = pore water salinity in ppt, S_o = measured pore water sulphate concentration (ppt or 10^3 ppm) and d = density of sea-water at salinity C. If no loss of sulphate has occurred via microbial sulphate reduction, S_d = 0. Maximum sulphate deficit is indicated when S_o = 0. For average sea-water, S_d can reach a maximum value of about 27.4 mmoles/l.

The amount of methane that can be generated microbially in the sediment was calculated as the theoretical methane value (M_T) as follows:

$$M_T = (2 S_d - (DIC - DIC_{SW})) \times 22.4$$

where M_T = theoretical methane concentration in ml per litre of pore water, S_d = sulphate deficit, DIC = measured DIC in pore water (mmoles/l or 0.083 mg/l), DIC_{SW} = dissolved inorganic carbon contributed by sea-water (mmoles/l or 0.083 mg/l). Calculated values of S_d, M_T and methane solubility as a function of present hydrostaltic pressure are shown in Table 3 and in Table 4.

This calculation is based on a number of assumptions, the most important of which are discussed below. The model is based on the generation of methane by bacteria from DIC via reactions such as:

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

The assumption is that all the available DIC (as CO_2 in the above equation) can theoretically be converted to methane. Then, the amount of DIC that can be generated in the pore water must be derived as it equals the amount of methane that can be produced (i.e. M_T).

DIC can come from a number of sources including:

1) the original DIC in the pore water - presumably sea-water DIC,
2) biological reactions following deposition, especially sulphate reduction but potentially including many other reactions
3) dissolution (dissolving) of detrital carbonate minerals,
4) influx of DIC in groundwaters.

DIC can also be removed from pore waters through processes such as:

1) precipitation of calcite (Ca CO_3)
2) influx of groundwaters low in DIC
3) biological reactions, especially methane generation
4) degassing of CO_2

For the purposes of calculating M_T, previous authors have assumed that all the DIC came from sea water and from sulphate reduction. The amount of this DIC has been represented in the term (2Sd - (DIC - DIC_{SW}) in the calculation of M_T. The term 2Sd represents the DIC which has already been added to the pore water during the sulphate reduction which is assumed to account for the decrease in observed sulphate values from that of the original pore fluid - sea-water. The term (DIC - DIC_{SW}) represents the difference between the measured DIC and that of the original pore fluid (sea-water). If bacterial sulphate reduction was responsible for the decrease in sulphate concentration, calculated as Sd, then the DIC produced (2Sd) should be equal to the observed increase in DIC, i.e. equal to (DIC - DIC_{SW}). The fact that calculated M_T values are greater then zero could be due to loss of DIC through calcite precipitation. In other cases, the apparent loss of DIC could reflect methane generation.

For the sediments analyzed, the highest concentration of methane observed was 2.2 x 10^4 ppm or 22 ml CH_4/l (Natiak sample 26). The calculated M_T value for all samples exceeded 400 ml CH_4/l. Clearly, the theoretical in situ methane generation has not been attained. This suggests that the M_T value is not very meaningful in these sediments and that other "sinks" for DIC are likely.

The M_T value also cannot be used to predict the volume of methane that could be produced in the sediment in the future. As the calculation is defined, it can only be used to evaluate the theoretical production of methane that could have occurred to date in the sediments. It does not account for possible future generation of methane, nor was it intended to (Whelan et al., 1976, Bull. Internat. Assoc. Engin. Geol., 14, pp. 55-64).

Fortunately, a direct method exists to predict the amount of methane that, theoretically, could be produced in the sediment in the future (M_T^*). The DIC potentially available to methane-generating bacteria can be assumed to have two sources:

1) the DIC already present in the pore waters and so measured directly
2) the DIC that could be generated by sulphate-reducing bacteria utilizing the sulphate still present in the pore waters and so also measured directly.

The latter DIC can be calculated by assuming, as previous authors have, that for each mole of sulphate reduced, 2 moles of DIC are produced. This is consistent with reactions such as:

$$2CH_2O \text{ (carbohydrate)} + SO_4^{2-} \rightarrow 2HCO_3^- + H_2S$$

where the bicarbonate (HCO_3^-) would be part of the DIC. So the calculation of M_T^* would be as follows:

$$M_T^* = [DIC + 2(SO_4^{2-})] \times 22.4$$

where M_T^* = theoretical in situ methane, cm^3/l of pore water

DIC = measured dissolved inorganic carbon, mmoles/l of pore water when mg/l DIC/12 - mmoles DIC/l

SO_4^{2-}= measured dissolved sulphate mmoles/l of pore water where mg/l $SO_4^{2-}/96$ = mmoles/l SO_4^{2-}

The value 22.4 represents the ml of methane per mmole of methane.

The various estimates of theoretical in situ methane are tabulated in Table 5. As previously stated, the values of M_T based on chlorinity are considered more representative than M_T values based on conductivity. The M_T^* values are considered by this author to be more direct and appropriate estimates of potentially generated methane. M_T values are presented only for comparison with previous reports. In only two cases, samples 39 and 41B of the Nerlerk boring, does there appear to be any potential for methane to exist in excess of likely solubility values. The solubility of methane in water as a function of temperature, pressure and salinity is not well documented. Methane solubility increases as temperature decreases, as pressure increases and as salinity decreases. For this report, a temperature of 25°C and fresh water salinities were assumed and the present hydrostatic pressures of the samples were calculated from their depth below sea level. Where actual temperature was lower and salinities higher, these assumptions still provide reasonable estimates of gas solubility since the errors in assumptions are somewhat negating.

Sample Calculation of S_d and M_T

Given the pore water data at 85.6 m penetration at Natiak boring (sample 26)

pH 8.2, conductivity = 14.9 mmhos DOC = 185 mg/l, DIC = 67 mg/l, SO_4^{2-} = 72.2 mg/l

Salinity, C = 9.4 ppt S_o = 0.722 ppt

d = 1.007 and $DIC_{SW} = \frac{142}{61} \times \frac{C}{35°/_{oo}} = 0.626$

Then the sulphate deficit, S_d

$$S_d = \frac{(0.077 \times 9.4 - 0.722)}{96.06 \times 1.007} = 6.7 \text{ moles} \times 10^{-3}/l$$

And the theoretical methane value, M_T

$$M_T = (2S_d - (DIC - DIC_{SW}) \times 22.4 \times 10^3$$

$$= (2 \times 6.7 - 5.58 - 0.626) \times 22.4 \times 10^3$$

$$= 190 \times 10^3 \text{ microlitres } CH_4/l \text{ pore water}$$

$$= 190 \text{ ml } CH_4/l \text{ pore water}$$

DISCUSSION OF RESULTS

Nerlerk Boring

Low contents of hydrocarbon gases were present in the core samples, with methane comprising essentially all the hydrocarbon gas with only traces of ethane and ethylene. Methane was highest in the shallowest sample. This distribution suggests a dominantly (perhaps exclusively) biogenic origin of these gases with little leakage of petrogenic gases into these sediments. Samples lowest in sulphate have the most methane. This is also consistent with a biogenic or microbial origin of the methane, since sulphate depletion proceeds major biogenic methane production.

All samples except the deepest were from an unfrozen section made up of clayey-silt (35) and silty-clay (39-48). No significant changes in pore water chemistry can be attributed to these variations, however.

Pore water pH values are around 8 which is common in marine sediments. The dissolved inorganic carbon (DIC) exists dominantly as bicarbonate (HCO_3^-). Salinities are generally near that of sea water, with sample 41B actually hypersaline and the sample 35 considerably diluted. Sulphate deficiency (S_d) ranges from 13.1 to 27.0 mmoles/l indicating that significant sulphate reduction has occurred especially at depth. Theoretical methane values (M_T^*) (Table 5) suggest that a vapour phase could develop in the organic bearing, unfrozen clays at a depth of 61 to 80m. On the other hand, if the organic matter (both dissolved and solid) became a "food-source" for methane-producing bacteria, more than 500 ml of methane could be produced thus creating a significant increase in pore pressures. Such a conversion is highly unlikely, as it has not been observed in studies of recent marine or nonmarine sediments.

Natiak Boring

Higher concentrations of methane are found in the Natiak sediments compared to those from Nerlerk. Values range from 6.2 x 10^3 to 2.2 x 10^4 ppm (v/v). Higher values occur near the top and bottom of this boring. Again, traces of ethane and ethylene and no propane or propylene are formed. Sulphate concentrations and high S_d values (22.7 to 38.2 mmoles/l) suggest some sulphate-reduction has occurred. The hydrocarbon gases, almost exclusively methane, in this upper segment are almost certainly biogenic. Biogenic methane probably dominates in the lower samples. The occasional trace of ethylene supports a biogenic origin. Minor influx of petrogenic gas is possible especially in the lower samples.

Calculated salinity for pore waters from these samples again approach that of sea-water indicating no major influx of fresh water. Sample 41 C+D is strongly hypersaline (salinity of 51.6 °/₀₀) and may account for the unfrozen zone at 80 to 86 m.

Considerable potential for methane generation exists, especially in the deepest sediment from the Natiak boring. M_T^* values do not exceed the likely solubility of methane in any of these samples, however (see Table 5). Once again, if the dissolved or solid carbon became a carbon source for methane-producing bacteria, methane sufficient to produce bubbles and to increase pore pressures could be generated. This is highly unlikely, however.

Table 1. Hydrocarbon Gas Content of Sediments (ppm, v/v)

Sample	Methane CH_4	Ethane C_2H_6	Ethylene C_2H_4	Propane C_3H_8	Propylene C_3H_6
		Nerlerk			
35	4.8×10^3	0.7	-	-	-
39C	8.8×10^1	1	-	-	-
41B	2.9×10^1	0.7	<0.8	-	-
45A	1.1×10^2	-	-	-	-
48D	5.2×10^2	1	-	-	-
		Natiak			
26	1.2×10^4	-	-	-	-
28	2.2×10^4	-	-	-	-
30	1.2×10^4	3	-	-	-
32	7.1×10^3	7	-	-	-
34	6.2×10^3	10	2	-	-
36	4.8×10^3	4	-	-	-
38	7.2×10^3	3	-	-	-
41C + D	1.5×10^4	3	-	-	-
43D + C	1.4×10^4	7	< 0.8	-	-

Note: - indicates component was not detected (< 0.7 ppm)

Table 2. Pore Water and Sediment Geochemistry

Sample	Pore Waters						Sediment
	pH	DIC (mg/l)	DOC (mg/l)	COND. mmhos/cm	SALINITY (°/oo)	SO_4^{2-} mg/l	TOC (%,weight)
				Nerlerk			
35	8.30	79	150	11.5	7.0	167,67	2.0
39C	7.95	110	190	17.9	11.7	527	1.2
41B	7.80	68	150	17.8	11.6	1040	0.8
45A	8.15	76	180	16.3	10.4	45	1.0, 1.3
48D	7.65	71	270	15.0	9.5	103	1.4
				Natiak			
26	8.20	67	190	14.9	9.4	72	1.3
28	7.65	88	110	17.5	11.5	65.2	1.2
30	7.95	67	190	15.1	9.6	39	0.9
32	8.25	82	120	14.8	9.3	112	1.2
34	7.45	66	140	16.9	10.7	327	
36	7.90	88	170	13.8	8.3	251	
38	8.05	86	150	12.0	7.5	147	
41C + D	8.20	49	200	12.1	7.6	170	1.0
43B + C	7.95	110	150	16.1	10.3	352	1.5

NOTE: Conductivity estimates of salinity are reported but considered inappropriate. Chlorinity estimates of salinity are preferred.

Table 3. Sulphate Deficiency and Theoretical Methane Values Calcuated Using Conductivity Estimates of Salinity (see also Table 4).

Sample	Depth (m)	S_d (mmoles/l)	M_T (ml CH_4/l pore water)	CH_4 Solubility (ml CH_4/l)
		Nerlerk (water depth 45.1 m)		
35	55.2	3.9 (4.9)	43 (77)	280
39C	63.6	3.9	negative	290
41B	69.8	0	negative	330
45A	81.8	7.8	220	370
48D	91.3	6.5	170	380
		Natiak (water depth 43.9 m)		
26	41.7	6.7	190	250
28	47.6	8.5	230	270
30	54.1	7.3	210	280
32	60.2	6.2	140	310
34	66.0	5.1	120	320
36	72.4	4.0	28	330
38	78.3	4.5	50	360
41C + D	78.7	4.3	110	360
43B + C	93.4	4.6	22	390

Note: bracketed value represents a subsample whose pore waters contained a very different SO_4^{2-} concentration (see Table 2).

NOTE: Conductivity estimates of salinity are reported but considered inappropriate. Chlorinity estimates of salinity are preferred.

Table 4. Variation of Salinity-Dependent Parameters Due to the Two Estimates of Pore Water Salinity

Sample	Conductivity-Based			Chlorinity-Based			
	Salinity (°/oo)	S_d	M_T	Chlorinity (°/oo)	Salinity (°/oo)	S_d	M_T
				Nerlerk			
35	7.0	3.9	43	9.7	17.4	13.1	460
39C	11.7	3.9	-	20.3	36.6	23.2	860
41B	11.6	0	-	25.5	46.0	25.2	1070
45A	10.4	7.8	220	19.4	35.0	27.0	1120
48D	9.5	6.5	170	18.2	32.8	24.7	990
				Natiak			
26	9.4	6.7	190	-	-	-	-
28	11.5	8.5	230	19.6	35.3	27.0	1110
30	9.6	7.3	210	20.6	37.1	28.6	1210
32	9.3	6.2	140	18.9	34.1	25.3	1030
34	10.7	5.1	120	18.9	34.1	23.4	980
36	8.3	4.0	28	18.2	32.8	23.2	920
38	7.5	4.5	50	17.1	30.8	22.7	900
41C + D	7.6	4.3	110	28.6	51.6	38.2	1700
43B + C	10.3	4.6	22	19.6	35.3	24.0	930

NOTE: Conductivity estimates of salinity are reported but considered inappropriate. Chlorinity estimates of salinity are preferred.

Table 5. Comparison of Theoretical In Situ Methane Values. M_T^* Values Are Used to Predict Future Methane Generation

Sample	CH_4 Solubility (ml CH_4/l)	M_T (ml CH_4/l) Conductivity	M_T (ml CH_4/l) Chlorinity	M_T^* (ml CH_4/
		Nerlerk		
35	280	43	460	230
39C	290	-	860	450
41B	330	-	1070	610
45A	370	220	1120	160
48D	380	170	990	180
		Natiak		
26	250	190	-	160
28	270	230	1110	190
30	280	210	1210	140
32	310	140	1030	210
34	320	120	980	280
36	330	28	920	280
38	360	50	900	230
41 C + D	360	110	1700	170
43 B + C	390	22	930	360

NOTE: Conductivity estimates of salinity are reported but considered inappropriate. Chlorinity estimates of salinity are preferred.

TDR REPORT 1982

Report to

EBA ENGINEERING CONSULTANTS LTD.
EDMONTON, ALBERTA

Prepared by

MR. C.H. LEWIS

TDR REPORT 1982

1. INTRODUCTION

This report was undertaken to provide Canadian Marine Drilling Limited (Canmar) with some feedback on the progress that has been made in developing the time domain reflectometry (TDR) equipment and technique into a field logging tool to detect frozen porewater (ice) in warm permafrost. Relict permafrost exists in the Beaufort Sea sediments at temperatures between 0°C and -3°C and depending upon its lithology and porewater salinity may or may not have some frozen porewater. It is the frozen porewater or visible ice in permafrost that is the cause of engineering concern if the soil thaws. EBA Engineering Consultants Ltd. (EBA) classify soil as frozen only if it is permafrost with visible ice or ice bonding. The TDR analysis technique was identified by Canmar as a more quantitative method of establishing the existence of frozen porewater. Canmar purchased the TDR equipment in June of 1981 and commissioned EBA to contact M.W. Smith at Carleton University with incorporating the TDR into the 1981 Offshore Site Investigation Program.

The application of TDR has become an established and reliable method for determining the liquid water content in both frozen and unfrozen soils (Topp, Davis and Annan, 1980; Smith and Patterson, 1980; and Patterson, 198[illegible]). The present study was undertaken to assess the usefulness of the TDR technique as a field logging tool to determine the unfrozen water content in saline permafrost. The Beaufort Sea sediments investigated can be split into two broad categories. The first category includes those samples existing at temperatures above 0°C and those that are at temperatures below 0°C but with no ice bonding or ice in the porewater. The second category includes sediments that exist at temperatures below 0°C and have an ice/water phase or frozen porewater. It was hoped that the TDR readings on both these categories of samples would give an estimate of the volumetric liquid water content and an estimate of the ice content where appropriate. Readings were also taken with the sample in the second trial field season during the summer of 1982.

2.0 BACKGROUND INFORMATION

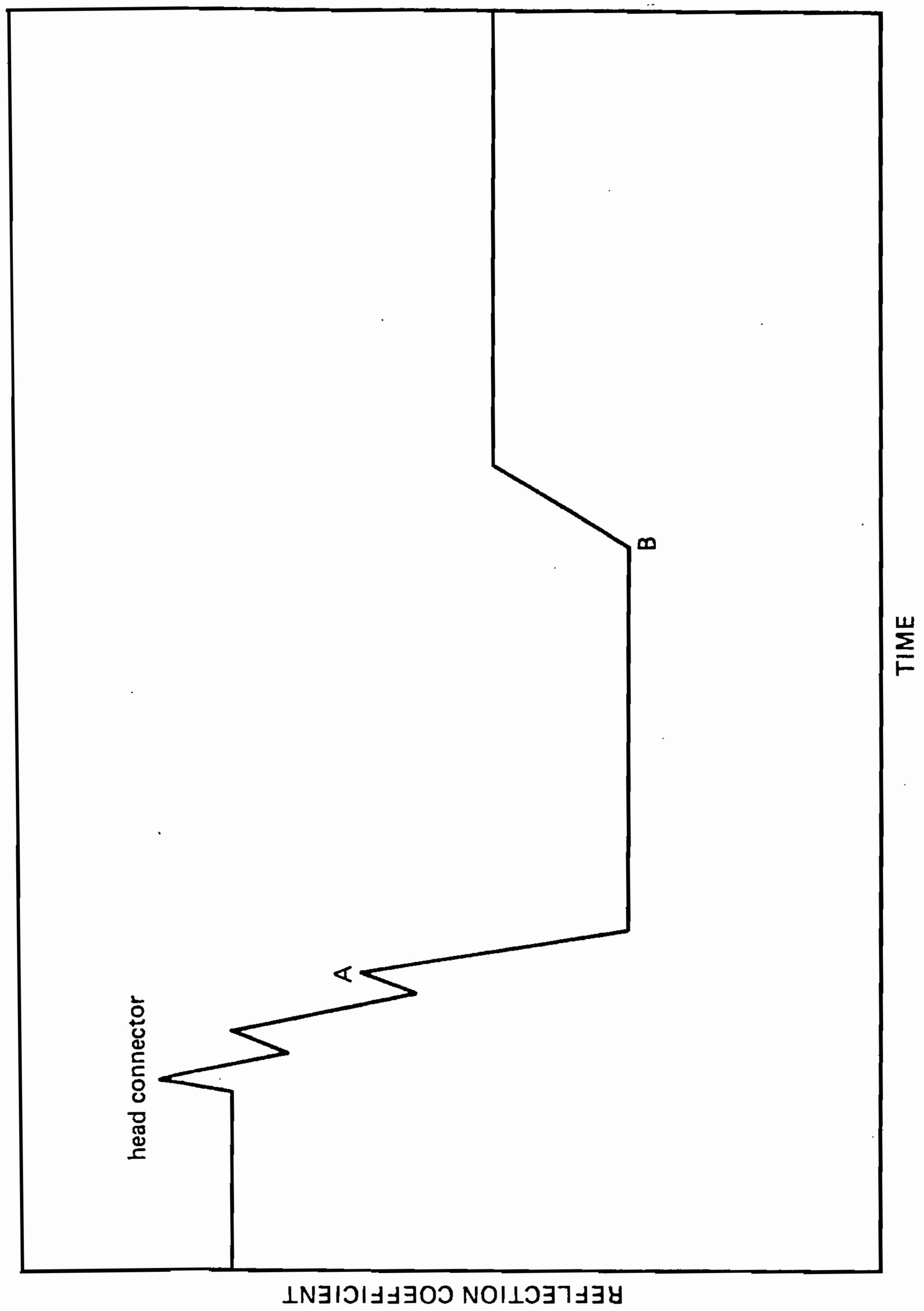
2.1 Theory

Time domain reflectometry (TDR) is a new field technique for determining the volumetric unfrozen water content of frozen soils by measuring the dielectric property. The dielectric constant is determined by measuring the velocity of propagation of electromagnetic waves transmitted between parallel transmission lines embedded in soil, using time domain reflectometry. The dielectric constants of soil and ice are similar, whereas water is quite different, so variations of unfrozen water content directly affect the measured travel times (ie. apparent dielectric constant). Smith and Patterson (1981) successfully applied the TDR technique to the measurement of unfrozen water contents in frozen soils.

The field equipment package used in this investigation was modelled after the experimental equipment utilized by M.W. Smith in his research studies at Carleton University. The TDR unit is a commercially available "cable tester" (we use the Tektronix 1502 purchased by Canmar). It consists of a pulse generator which produces a fast rise time step voltage, a sampler which transforms a high frequency signal into a lower frequency output, and an oscilloscope or recording device. TDR measurements are made by launching the step signal into a medium and measuring the travel time. More detailed descriptions of the working principles of the TDR technique can be found in Topp et al., (1980) and Smith and Patterson (1980).

Briefly, when a parallel line is embedded in a soil sample a trace, as shown in Figure 1 (a stylized theoretical trace used for descriptive purposes only) appears on an oscilloscope and can be permanently recorded on an X-Y recorder. The point A in Figure 1 is the start of the transmission and point B is the location of the open circuit. The A to B distance is then used to determine the one way travel time, tt, along a known line length, L. To find the apparent dielectric constant, Ka, the following relationship is used:

Figure 1:   Stylized TDR trace.



$$Ka = \left(\frac{tt \ X \ c}{L}\right)^2$$

where $c = 3 \ X \ 10^8$ m/s

Ka can then be translated to volumetric unfrozen water content, θ_{uf}, from empirically derived tables.

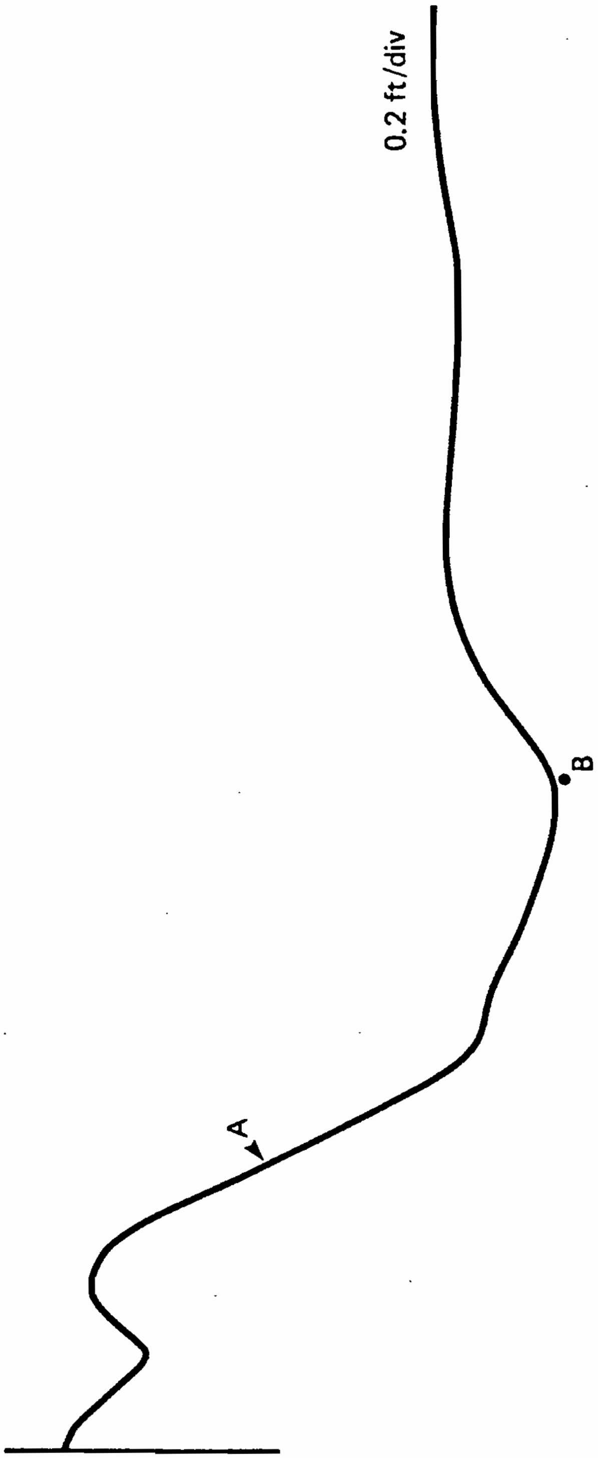
A typical trace obtained from the saline Beaufort Sea permafrost soil is shown in Figure 2. The distance between points A and B is characteristic of the dielectric properties of the material.

2.2 TDR Testing in Saline Environment

The problems associated with measuring highly saline porewater with the TDR was not a major concern in the literature mentioned above. The effects of soluble salts on the Ka-Θv relationship has been examined by Topp, Davis and Annan (1980). Their findings indicate that no significant errors were introduced in the relationship when a 2000 ppm NaCl solution was used; however, signal attenuation increased making the Ka estimates more difficult.

Patterson and Lewis (1981) report on the effects of high porewater salinities on water content estimates obtained via the TDR technique. A wide range of salinities was covered and tested with various probe lengths and at various temperatures. The results of this testing showed that the greater porewater salinity the greater the difficulties associated in determining Ka. This is due to the lack of a clear reflection at the open circuit (see Figure 3). It was also found that for a given salinity, a clearer B point could be produced by decreasing the probe length. The effect of decreasing temperature for a given salinity also acted to give a clearer rise time. It is important to note however that in this investigation the salinities ranged from 3 to 7 grams per litre of NaCl. Therefore, the testing of soils with porewater salinities of the order of 33 ppt offers its own unique problems. The average porewater salinities measured from Beaufort Sea sediment range between 30 ppt and 40 ppt.

Figure 2: Typical saline Beaufort Sea TDR trace.
Sample 36, Natiak (F:NAT 1:1)



Source: Patterson and Lewis, 1981.

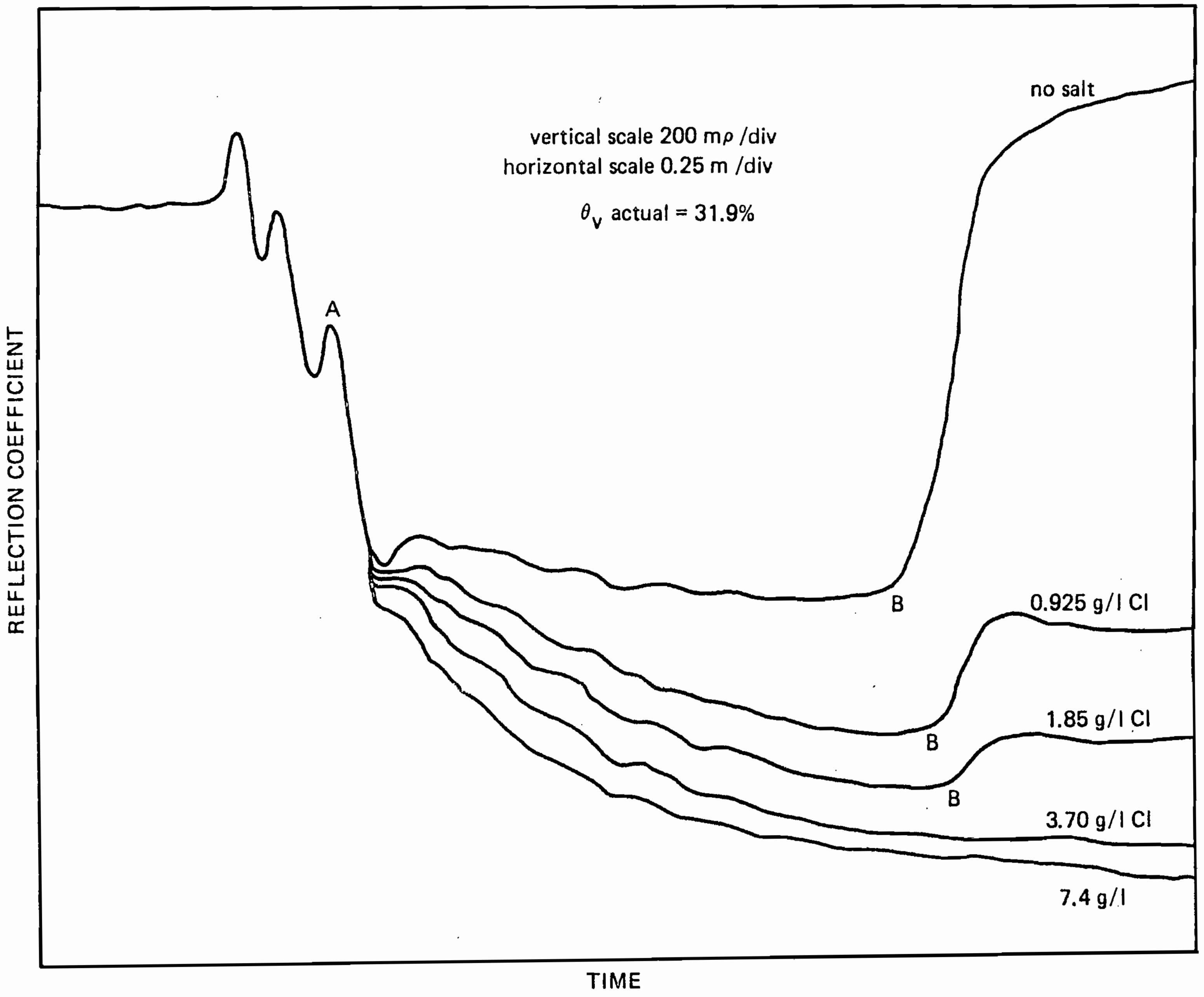


Figure 3

In order to use the TDR technique in the Beaufort Sea sediments it was necessary to reduce line length to 10 cm so that the open circuit response (B point) could be located. Also varying the scale setting was found useful (see section on 1982 field season).

Patterson and Smith (1982) have used the TDR technique to obtain freezing characteristic data (temperature versus volumetric unfrozen water content) in highly saline soils (greater than 10 gNaCl/l).

3.0 FIELD OPERATIONS

3.1 TDR Equipment

A complete guide to the use of the Tektronix 1502 TDR Unit is supplied in Appendix 1. This has been adapted from the Tektronix Operation Manual and Patterson, (1980).

3.2 1981 Field Season

The 1981 field season represented a first attempt by EBA Engineering to utilize the TDR technique. This was part of the Canmar 1981 offshore site investigation program. EBA personnel were trained to a basic level in the use of the TDR equipment and data reduction techniques. The data recording methods and procedures were developed by EBA and M.W. Smith, D. Patterson of the Carleton University Geotechnical Laboratories. Data was collected at both the Uviluk and Tarsiut sites. An attempt was made to correlate the TDR by calorimetry. However, it was found that calorimetry did not provide reliable results in the field.

The data collected during this time was limited (ie., one plot per sample) making interpretation difficult. Generally, inexperience with a new technique in addition to working with the problems of saline sediments contributed to problems with the TDR field program. However, some reasonable results were obtained and it was decided to try to refine the field procedures and equipment for the following season.

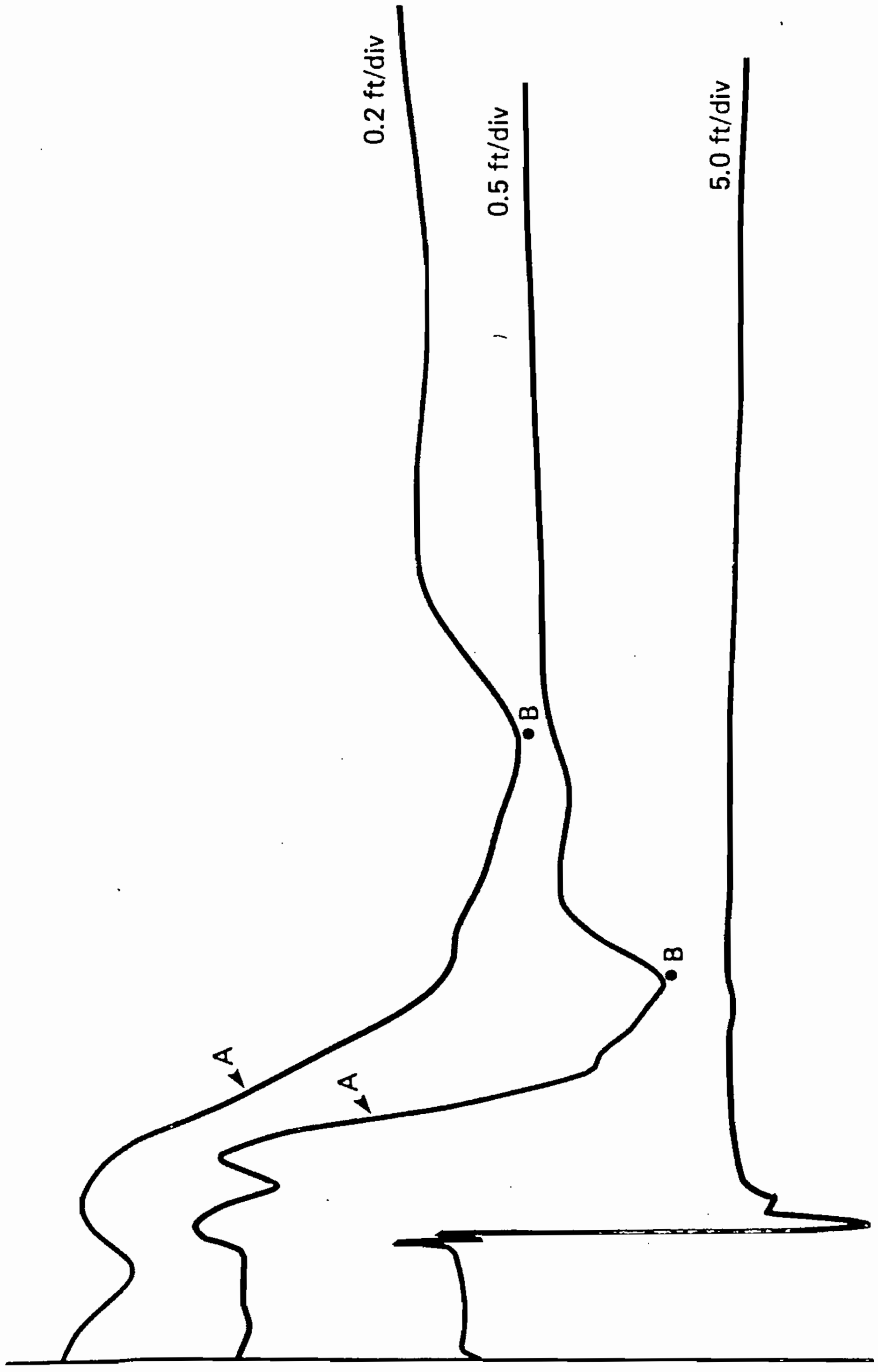
3.3 1982 Field Season

The basic equipment used in the 1982 field program was the same as in 1981. The X-Y recorder was rented from Genstar. The TDR probe were rented from the Carleton Laboratories. This seems to be a reasonable approach since new probe designs are evolving with continued research. The probes used in the 1982 field season followed the typical parallel line design but with certain modifications. The geometry of the probes was designed to 200 ohms. The overall length of the line was 10 cm, the probe spacing was 1.5 cm with a line diameter of 0.4 cm. An ANZAC TP-103 RF pulse transformer is mounted on a printed circuit board. This is attached to a 58AU coaxial cable and connected to the TDR with a UG 88/U BNC connector. The transformer board is cast with Scotchcast Electrical Insulating Resin No. 4. It was found that this design makes location of the A point easier. The 10 cm length has been found ideal for working in highly saline materials. Also, for theoretical considerations the 200 ohm line is more appropriate than other line configurations (see section 5.1 and section 5.2 on new probe designs.)

TDR traces were obtained on various cores for the Natiak and Nerlerk foundation holes. The author was in the field during the drilling of both these holes. Since interpretation problems were to be expected, due to the high pore water salinity, it was decided to collect as much corroborating information as possible. This information was to include dry and wet bulk density, gravimetric moisture content, temperature of the sample, and salinity. Therefore with these results on hand, TDR estimates of water content could be checked and the accuracy of the results determined. The following is a brief description of the field procedure used.

Before the start of testing the calibration of the X-Y recorder was checked with the TDR unit. The probes were then calibrated and hard copy produced. The vertical scale was set at 200 mp and left untouched throughout testing. While the sample was still in the shelby tube a temperature was taken. The sample was brought into the coring shack and the TDR probes inserted in the end of the sample. Three traces (see Fig. 4)

Figure 4: Series of three TDR traces taken from Beaufort Sea. Sample 36, Natiak (F:NAT 1:1).



were taken as quickly as possible, the first trace at 0.2 ft/div, another at 0.5 ft/div trace is used to help in locating the open circuit since it compresses the time scale and produces a more distinct response. The last trace is used for determining the low frequency conductivity. If the sample could be extruded quickly enough, and without damage, another set of traces was taken at a different location along the core. Following this, samples were taken for water content, bulk density and pore water salinity estimates.

EBA personnel were more experienced with the equipment and techniques in the 1982 field season. C.H. Lewis (now representing M.W. Smith Geoscience Ltd.) was on contract to assist in personnel training, procedure modification and collection of data in the field. By having someone on site who was intimately familiar with the technique prevention of unfortunate 'user' errors could be avoided.

4.0 DISCUSSION OF RESULTS

4.1 Field Data From the 1982 Field Program

Tables I and II summarize the TDR data for the Natiak and Nerlerk foundation boreholes. Since the greatest range of data was obtained from Natiak (F:NAT 1:1) these results will be discussed in greater detail.

Column 4 shows the value of the apparent dielectric constant, Ka, as determined from the TDR. Both the traces at 0.2 ft/div and 0.5 ft/div were used to confirm this value. Column 5 shows the values of the volumetric unfrozen water content that are obtained from the tables of Ka and θ_{uf} (see Appendix II). Column 6 gives the values of θ_{uf} calculated from the dry bulk density and gravimetric water contents of the sample. These values shown in column 6 assume the 'thawed' state. Column 7 gives the values of the conductivity as measured from the long travel time of the sample.

Referring to columns 5 and 7 it can be seen that at sample 34 there is

BEAUFORT SEA TDR RESULTS

TABLE 1

NATIAK FOUNDATION HOLE (F NAT 1:1)

1 SAMPLE	2 DEPTH (M)	3 TEMP (^oC)	4 Ka from TDR	5 θ_{wF} (TDR)	6 θ_{uF} THAWED SAMPLE CALCULATE	7 CONDUCTIVITY TDR S/M	8 ESTIMATE VOL. ICE CONTENT (%)	9 BULK DENSITY WET	DRY	10 GRAVIMETRIC MOISTURE CONTENT	11 SALINITY FROM WATERLOO
17	15.0		28.1	43.2	39.0	3.99×10^{-1}			1.38	28	
20	23.5	1.5	26.2	41.2	46.1	4.78×10^{-1}			1.44	32	
22	29.8	-1.7	28.1	43.2	46.2	4.78×10^{-1}			1.49	31	
24	35.65	-2.1	26.7	41.2	42	$4\text{-}78 \times 10^{-1}$			1.50	38	
25B	38.65	-2.1	28.75	43.9	49.5	4.53×10^{-1}		1.9	1.50	33	
28B	47.95	-.6	26.85	41.8	44.95	4.53×10^{-1}		2.0	1.45	31	11.5
34	66.25	-2.3	9.3	18.6	36.1	9.86×10^{-2}	17.5	2.0	1.64	22	10.7
36	72.5	-1.1	10.05	19.9	34.8	1.13×10^{-1}	14.9	1.8	1.45	24	8.3
38	78.6	-1.4	9.3	18.6	38.3	1.16×10^{-1}	19.7	1.8	1.42	27	7.5
39	81.6	-2.0	11.2	20.2	46.3	1.60×10^{-1}	26.1	-	1.42	32	-
41	87.8	-2.9	14.3	26.8	38.3	1.59×10^{-1}	11.5	1.8	1.42	27	7.6
42B	90.6	-2.9	11.65	22.6	31.2	1.24×10^{-1}	8.6	1.8	1.49	21	-

BEAUFORT SEA TDR RESULTS

TABLE 2

NERLERK FOUNDATION HOLE (FNER 2:3)

1 SAMPLE	2 DEPTH	3 TEMP	4 Ka from TDR	5 θ_{uf} TDR	6 θ_{uf} THAWED SAMPLE CALCULATED	7 CONDUCTIVITY TDR S/M	8 VOL. ICE CONTENT	9 BULK DENSITY		10 GRAVIMETRIC MOISTURE CONTENT	11 SALINITY FROM WATERLOO
								WET	DRY		
34	54.6		31.8	47.2	47.1	4.78×10^{-1}				33	
35	55.4		25.0	39.8	48.6	3.56×10^{-1}				35	7.0
39	63.71		27.5	42.5	46.1	4.78×10^{-1}		2.0	1.54	30	
45	82.1		30.1	45.0	48.4	3.90×10^{-1}		2.0	1.52	32	10.4
48	91.3		30.1	45	48.2	3.72×10^{-1}		1.9	1.42	34	9.5

Figure 5a: Volumetric Water Content vs. Depth, Natiak.

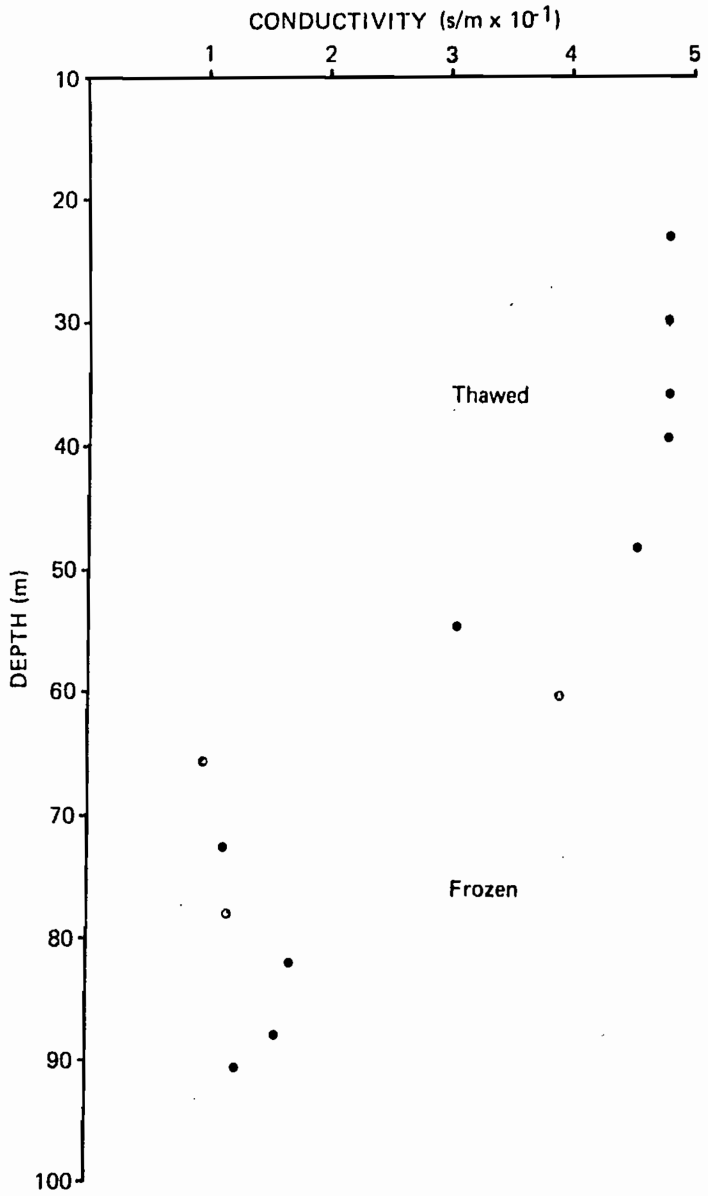
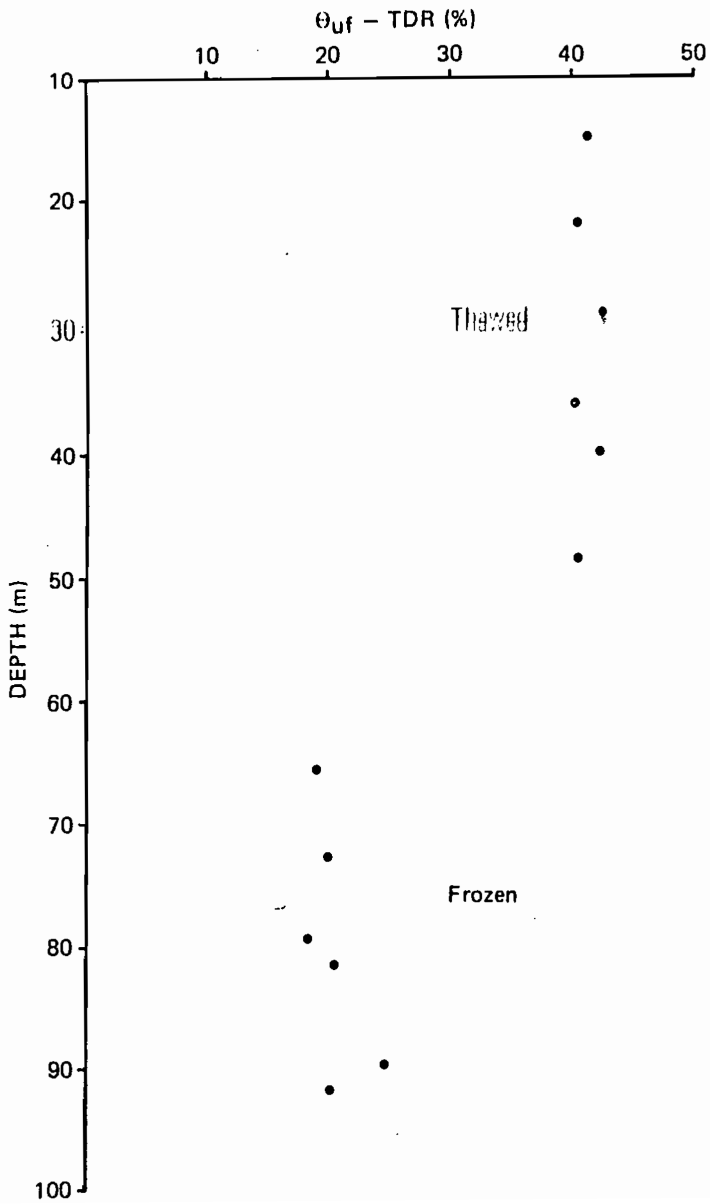


Figure 5b: Conductivity vs. Depth, Natiak.



a reduced value of water content along with a sharp change in the values of conductivity. These changes are presumably attributed to the presence of ice in the sample. Figures 5A and B show the changes in conductivity and water content with depth at the Natiak site. The sharp change in both parameters is clearly seen. Therefore, an estimate of the ice content can be made by calculating a value of the unfrozen water content for a thawed saturated sample (column 6) and subtracting the value of water content derived from the TDR (column 5). The estimates of the volumetric ice content are shown in column 8.

The results of the Nerlerk site seem to lack the presence of ice throughout the column. The values of water content from the TDR and those calculated agree well, except in sample 35.

4.2 Discussion of TDR Result Error

Three types of error can be attributed to the TDR, systematic, measurement or user error, and error due to the lossiness (salinity) of the samples.

There is a ± 2% systematic error in the value of water content derived from the measured dielectric constant. This is in the error band of ± 95%. Patterson (1980) reports that the accuracy of the horizontal axis if ± 2% of the travel time represented by ten divisions on the TDR crt for any particular scale setting. The certainty in θ_{uf} from Ka, based upon this possible source of error is about ± 1.7%.

However, the location of the open circuit, necessary in determining Ka, has proven to be affected by pore water salinity (Patterson and Lewis, 1981). The reflection at the open circuit decreases in magnitude and becomes rounded due to lossiness of the material. There also appears to be an apparent increase in travel time which could be real or experimental (e.g. uncertainties in locating the B point due to the rounded nature of the open circuit). By selecting appropriate horizontal and vertical scale setting it is possible to improve the appearance of the open circuit thereby removing some uncertainty. This approach was used successfully in the 1982 field season.

An exact value of percentage error is very heard to ascribe for the effects of salinity. Patterson and Lewis show that for salinities in the 3 to 6 g/l range for a 13.8 cm probe at 2.3°C the TDR measured value was 2% greater than the actual value of θ_{uf} for that sample. Reductions in conductivity with decreasing temperature or reduced water content will improve accuracy of the TDR trace interpretation. In saturated, thawed soil samples the increase in salinity will decrease the accuracy of the readings, especially with the parallel lines. This is why the development of the monoline probe (see 5.2) by M.W. Smith Geoscience is potentially very exciting since this design will help reduce the effect of electrical losses.

The importance of user error can also not be overlooked. Improper calibration of the TDR to the X-Y recorder can be a large potential source of error, since this will lead to a distortion of the travel time. In addition improper recording of scale settings, marking incorrect A and B points and lack of a systematic procedure are all potential sources of user error.

The value of ice contents shown in the results can only be considered, at the present time, as estimates. Until further experimentation is completed to corroborate the TDR derived values with some other method for measuring ice content the accuracy of these values will not be fully known. However, based on the reduction in water content seen in the traces along with the change in the values of conductivity the ice contents presented here should be a good approximation of reality.

5.0 DISCUSSION OF TDR ISSUES

5.1 Vertical Axis Analysis

A new method was suggested using a measurement of the reflection coefficient, p, for the interpretation of Ka. The value of p will change (increase or decrease) as the value of Ka changes. The relationship between the time axis and the vertical axis can be shown as following

$$Ka = \left(\frac{C \times tt}{2}\right)^2 = \left(\frac{1 - p}{1 + p}\right)^2 \left(\frac{Z1}{Z2}\right)^2$$

where p is the reflection coefficient, Z1 is the characteristic impedance of the line, and Zo is the characteristic impedance of the system (for the probes used in 1982 Z1 = Zo = 200 ohms)

The measurement of the dielectric constant from the vertical axis presents certain problems. In the first place, most natural earth materials have electrical losses, essentially due to conductivity. This is usually caused by the presence of ions in the soil water. On a TDR trace this will manifest itself as a downward ramp along the trace as the signal is continually conducted away.

In high loss materials as in the saline environment of the Beaufort Sea, distance will become slightly elongated, but in terms of water content the error is small. However in similar materials measurement errors on the vertical axis can produce large errors in Ka and hence in water content. Hopefully work in progress will help sort out some of these problems but at this time determining Ka via travel time (horizontal axis) is the more reliable method.

5.2 Development of New Probe Design

A new monoline probe is now being tested in the laboratory. Since during the previous field season this design had not been fully investigated it was felt premature to use this design in the field. The monoline probe should make field measurements much easier and reduce the effect of electrical losses thereby permitting one to use a longer probe length. A longer probe length will potentially improve measurement accuracy. The data obtained with the new probe design offers the potential for better quality since it should reduce the effects of losses for a given probe length and remove some of the user errors associated with determining the A and B points.

5.5 Freezing Characteristic Curves

Full freezing characteristic data may be a useful tool, however there are conditions which must be considered:-

1. In deep water sediments the ice bonded samples could represent relict permafrost. That is the ice formed under a different temperature regime than the present. Therefore the ice that is present may be degrading due to the infiltration of saline water into the sample.

2. If a structure (artificial island, pipeline, etc.) will cause the sediments to cool to a temperature of -3 to -4°C then the pore water of the soil will begin to freeze, the amount of ice formed will be a function then of particles size, assuming sea-water salinities.

3. In the near shore areas saline sediments can experience annual freezing. In these sediments, freezing characteristic curves would be useful.

In regards to eliminating the TDR technique in the field it is impossible to make a general statement, since the environment along with historical environment of deposition will dictate whether ice exists, not just temperature (e.g., relict permafrost).

It is not a question of doing or not doing freezing characteristic curves but a question of identifying the use of the data:-

1. Is the data being used as a geophysical site description?
2. Is it being used to assess the effects of freezing of the sediments to temperatures colder than presently exist?

6.0 RECOMMENDATIONS AND CONCLUSIONS

A tremendous amount of progress has taken place in developing the TDR technique as both a laboratory tool and as a field logging tool. This is especially true in the area of saline permafrost where the need for accurate and reliable methods in measuring ice and water contents is very important.

The continued use of trained and experienced personnel to oversee field operations using the TDR should continue. This key factor is the deciding element as to whether or not the TDR field program will be successful. Continued research and development of into new probe designs, especially the monoline probe should continue in earnest. M.W. Smith Geoscience hopes the type of work can continue. Of utmost importance is the need for further experimentation to help access the ability of the TDR system to measure ice content in soil samples. Detailed proposals along this line will be presented in the near future.

The values of volumetric water content seem to agree with the calculated values for each particular samples. It was possible to delineate a zone containing ice (Natiak) in the soil column by measuring the changes in water content and conductivity with the TDR. There ia a +/- 2% error that is systematic in the system. Additional errors can be attributed to pore water salinity and user based error.

APPENDIX 1

USING THE TEKTRONIX 1502 TDR UNIT

1.1 Introduction

Figure 1.1 and Table 1.1, in this appendix have been included to familiarize the reader with the Tektronix 1502 TDR control panel.

The Tektronix 1502 TDR has been used since it is reasonably priced and field portable. This TDR unit provides the CABLE connector with a 200 mV step-voltage which has an incident rise time of less than 0.1 ns. This rise time contains a wide bandwidth of frequencies up to a possible maximum of 3.5 GHz. The TDR's crt is calibrated in units of m ρ/DIV vertically and FT/DIV horizontally. The vertical scale represents the ratio of the reflected to incident voltage (or voltage reflection coefficient, ρ). If a cable is open circuited (i.e. infinite impedance), $\rho = 1$; for a short circuited cable (zero impedance), $\rho = -1$. When a cable is terminated with its characteristic impedance there is no reflection and $\rho = 0$. One can convert the reflected pulse amplitude to impedance since ρ is dependent upon the characteristic impedance, Z_O, of the line under test and the load on the cable, R_L, (or the impedance of a discontinuity within a cable):

$$\rho = \frac{R_L - Z_O}{R_L + Z_O} \qquad (1)$$

therefore,

$$R_L = Z_O \frac{1 + \rho}{1 - \rho} \qquad (2)$$

TDR MAINFRAME

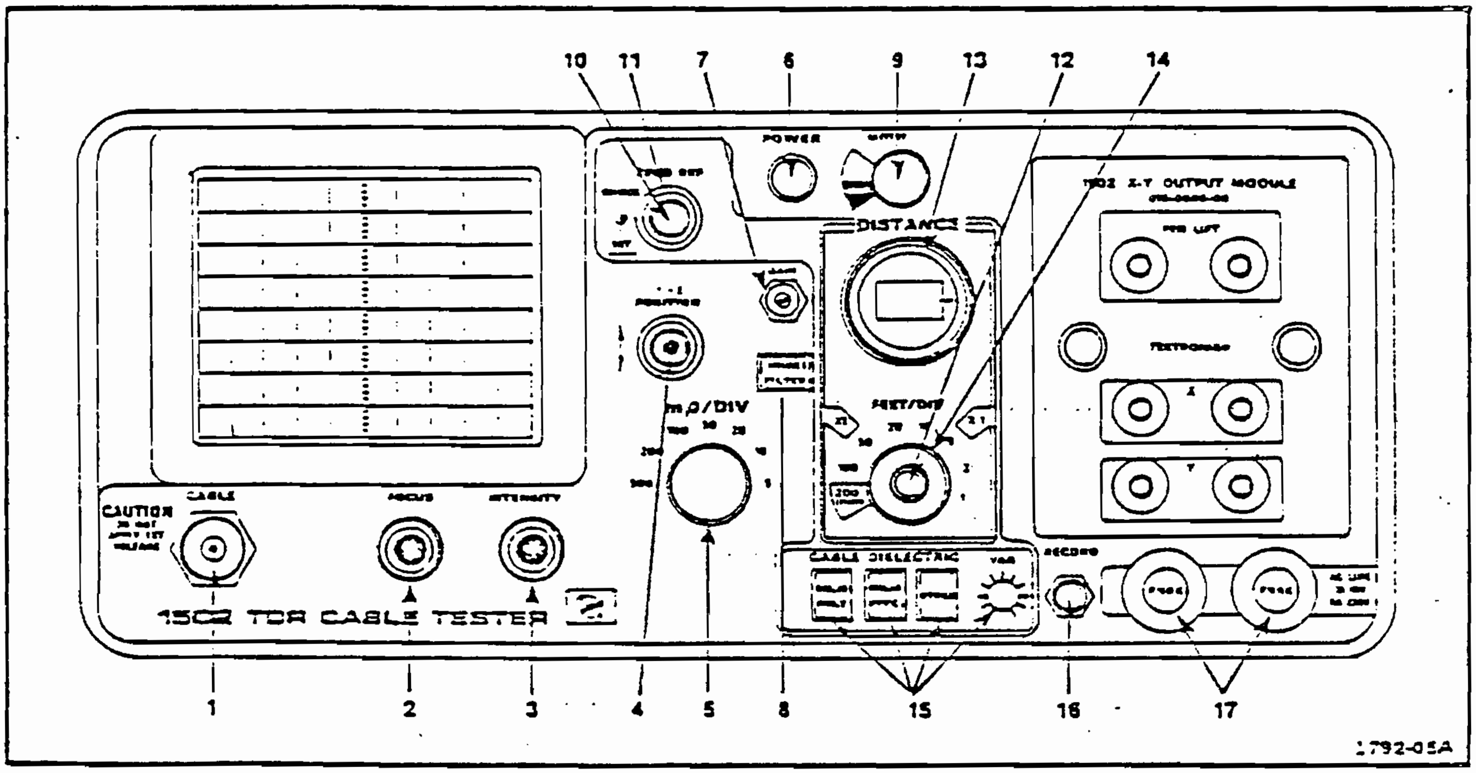


TABLE 1.1

CONTROLS FOR TEKTRONIX 1502 TDR

1.	CABLE	BNC connector, delivers 110 ps rise pulse and received reflected pulse
2.	FOCUS	visual controls for crt
3.	INTENSITY	visual controls for crt
4.	POSITION/FINE	vertical position control of the crt
5.	m ρ/DIV	vertical scaling control
6.	POWER	ON-OFF
7.	GAIN	for adjusting gain of the vertical amplifier
8.	NOISE FILTER	reduces noise and improves trace appearance
9.	BATTERY	battery level indicator
10.	ZERO REF CHECK	returns trace to reference setting
11.	ZERO REF SET	horizontal position control
12.	MULTIPLIER	horizontal scale setting factor: 0.1 or 1.0
13.	DISTANCE	moves crt display to any location in cable
14.	FEET/DIV	horizontal scale selector
15.	CABLE DIELECTRIC	permits selection of v_p (velocity of propagation)
16.	RECORD	activates X-Y or Y-t recorder
17.	AC LINE FUSES	

The horizontal axis is readily converted to a time axis from the following when CABLE DIELECTRIC is set for air (all buttons out):

$$\text{time/division} = \frac{\text{feet/division}}{0.984 \text{ f ns}^{-1}}$$

There are several other pieces of information which can be determined from the display on the TDR's crt. First, the impedance of a transmission line can be determined (or an impedance mismatch within a line) from (2) above, where Z_o is the impedance of a 'known' cable (or impedance at any point along the trace displayed on the crt can be determined. Also, the length of a cable can be determined directly off the crt display in the CABLE DIELECTRIC is set for the type of cable being tested. The dielectric constant of an 'unknown' cable can also be determined if the cable length (L) is known, from the following equation:

$$Ka = \left(\frac{c \times tt}{L}\right)^2$$

where tt is travel time in nanoseconds and c is equal to 30 cm ns^{-1}.

1.2 TDR Operational Procedure

The first step in the procedure is to calibrate the device which records the information presented on the TDR's crt. Photographing the crt can be used in the field unless a Y-t module is used (the 1502 TDR has this option).

Operational Procedure

1. Set the TDR for air dielectric (VARIABLE control fully clockwise or all the CABLE DIELECTRIC buttons in the default position);

2. Pull the power switch on.

   If remote X-Y recorder is used:

3. Connect a two-wire cable to the X-axis jacks on the TDR and the X-Y recorder;

for various horizontal scale settings.

12. Adjust the DISTANCE dial and the POSITION control until the open circuit appears on the crt.

13. Set the mρ/DIV scale so that the trace appears completely on the screen vertically.

14. Record the crt display.

By superimposing both traces, the point of divergence (point A) can be determined (Figure 1.2). Once determined, it remains a characteristic of the probe (line) on all traces. We determine point B as the intersect of two tangents to the trace where it encounters the open or short circuit (see also Figure 4).

4. Set the X and Y axis scales on the X-Y recorder to accommodate 1 V full scale.

5. Push up the RECORD switch on the TDR; this initiates the recorder of the trace displayed on the crt. The length of the trace will equal 10 divisions on the TDR's crt. Set the Y-axis on the X-Y recorder to the same setting as used for the X-axis.

If a Y-t recorder is used:

6. Since the horizontal axis is time, connect the X cables from the TDR to the Y connectors on the Y-t recorder. Set the chart speed of the Y-t recorder somewhere between 20 to 60 cm min^{-1}.

7. Set the Y-axis scale on the Y-t recorder to accept 1 V.

8. Push up the RECORD switch on the TDR. The slow ramp which will appear on the Y-t recorder represents the 100 mV/DIV that the TDR produces. The distance from the start to the end of the ramp equals 10 division on the TDR's crt.

Once the scaling factor is determined (i.e. trace length on the recorder used, divided by 10 divisions on the TDR), the starting point of the transmission line used (i.e. coaxial or parallel line) must be known. This is the A point shown in Figure 4.

9. Connect a 50Ω cable to the transmission line (for parallel lines, the cable is an integral part of the line).

10. Drain static charge from the line by connecting a 50Ω terminator and cable adapter (supplied with the TDR) to the end of the cable.

11. Connect the cable to the CABLE connector of the TDR. Repeat the following steps 12 to 14 for the transmission line system with and without the actual lines of transmission connected to the probe head

for various horizontal scale settings.

12. Adjust the DISTANCE dial and the POSITION control until the open circuit appears on the crt.

13. Set the mρ/DIV scale so that the trace appears completely on the screen vertically.

14. Record the crt display.

By superimposing both traces, the point of divergence (point A) can be determined (Figure 1.2). Once determined, it remains a characteristic of the probe (line) on all traces. We determine point B as the intersect of two tangents to the trace where it encounters the open or short circuit (see also Figure 4).

APPENDIX G

INDEX TO CORE PHOTOGRAPHY

CORE PHOTOGRAPHY

The 1982 season core photography is collected in a two volume binder set. Two sets of this core photography were delivered to Canmar on 1982-10-27. Samples with photographs available are indicated on the laboratory testing summary sheets in Appendix C.

APPENDIX H

LABORATORY TEST PROCEDURES

LABORATORY TEST PROCEDURES

Procedures Specified

1. Classification and Index Tests
2. Triaxial Shear Tests
3. Direct Shear Tests
4. Laboratory Miniature Vane
5. Swedish Fall Cone Shear Strength Determination
6. Consolidation Tests
7. Porewater Salinity Tests
8. Organic Content Determination
9. Radiography

LABORATORY TEST PROCEDURES

1. CLASSIFICATION AND INDEX TESTS

These tests are quite routine and the standard ASTM procedures employed are listed below:

TEST	ASTM DESIGNATION
Moisture Content	D 2216
Liquid Limit (1)	D 423
Plastic Limit and Plasticity Index	D 424
Grain Size	D 421 & 422
Specific Gravity	D 854
Relative Density	D 2049
Unified Soil Classification	D 2487

NOTE: 1. All liquid limits reported were obtained from 3 point determinations.

2. SHEAR STRENGTH TESTS

Procedure #1 - Unconfined Compression

Procedure #2 - Unconsolidated Undrained Triaxial
With and without pore pressure measurement

Test specimen is mounted in triaxial cell and jacketed. Cell pressure equivalent to estimated in situ total horizontal stress (Ko = 0.7) is applied without sample drainage. A pore pressure response test is carried out prior to shear. If $B < 0.95$, sample is loaded to failure at rate of 1%/min with no pore pressure measurement. If $B > 0.95$ specimen loaded to failure at rate of 0.02%/min with pore pressures monitored continuously. Frozen samples are permitted to thaw (undrained condition) prior to measurement of B value.

For quick UU tests, data is presented in the form of stress-strain curves. Where pore pressure is monitored, the following curves are obtained:

1. Stress-strain
2. Effective stress ratio-strain
3. Excess pore pressure-strain
4. P/Q stress path

CONSOLIDATED-UNDRAINED TRIAXIAL TESTS

Procedure 1 - Sample is mounted in triaxial cell and jacketed. A pore pressure response test is carried out prior to shearing. If further saturation is required, back pressure can be applied to the sample. Frozen samples are placed in a pre-chilled triaxial cell, then permitted to thaw before commencing consolidation. Cell pressure equivalent to estimated total horizontal stress is applied with drainage allowed. Once consolidation is complete, drainage is shut off. Samples are sheared by increasing axial stress at controlled rate of strain based on the consolidation characteristics of the material determined during the consolidation phase of the test. Stress-strain curve and other diagnostic plots are produced.

CONSOLIDATED-DRAINED TRIAXIAL TESTS

Procedure 1 - Sample is mounted in triaxial cell and jacketed, then thawed under a nominal pressure of 35 kPa. A pore pressure response test is carried out prior to shearing. If further saturation is required, back pressure can be applied to the sample. Sample is consolidated to cell pressure equivalent to estimated mean horizontal in situ effective stress. With drainage open, sample is sheared by increasing the axial stress at a controlled rate of strain. The rate of strain is selected on the basis of consolidation properties of the soil determined during the consolidation phase of the test. Stress-strain curve and other diagnostic plots are produced.

Procedure 2 - Lack of undisturbed samples of sand from certain strata necessitate reconstituting disturbed samples for strength testing. Relative density test is conducted on the sand and reconstituted samples are then prepared to approximately 70% relative density. A pore pressure response test is carried out prior to shearing. If saturation is required, back pressure is applied to the sample. Sample is consolidated to cell pressure equivalent to the estimated in situ mean horizontal effective stress. With the drainage open, the sample is sheared by increasing the axial stress at a controlled rate of strain as detailed in Procedure 1. Stress-strain curve and other diagnostic plots are produced.

NOTES:
1. Standard UU triaxial procedure ASTM D2850.
2. Standard CU and CD triaxial procedures taken from Bishop & Henkel (1969).
3. Samples reconstituted according to procedures outlined in Bjerrum, Kringstad, and Kummeneje (1961).

3. DIRECT SHEAR TESTS

Procedure 1 - Standard direct shear procedure. Frozen samples are permitted to thaw and consolidate under applied normal pressure before commencing shear. Resheared strength is measured on plane cut after peak strength has been determined. Generally, a minimum of 3 tests are performed on each material type to define effective stress parameters c' and 0'. Shear stress - deformation curve and other diagnostic plots produced.

Procedure 2 - If no undisturbed sample is available, an appropriate sample may be reconstituted for testing following the same general procedure indicated above.

NOTES:
1. Standard direct shear procedure ASTM D 3080.
2. Samples reconstituted according to procedures outlined in Bjerrum, Kringstad, and Kummeneje (1961).

4. LABORATORY MINIATURE VANE

Procedure 1 - Sample is either retained in sampling tube or extruded into split ring. Vane is lowered into sample ensuring total submergence of the vane. Vane is rotated at 10 degrees/min. Test is run until steady post-peak value is reached. Stress-strain curves, peak and post-peak shear strengths are produced.

5. FALL-CONE SHEAR STRENGTH DETERMINATION

Procedure 1 - Small portion of sample is extruded into testing cup. Cone is selected with reference to expected shear strength of soil. Cone is lowered to contact the surface of the sample and is then released. Depth of penetration of cone is measured. Shear strength is interpreted from cone strength correlation charts.

6. STANDARD OEDOMETER/CONSOLIDATION TESTS

Procedure 1 - Sample is set up in oedometer with dry stones. Standard incremental loading is applied done to a specified vertical effective stress that exceeds the in situ effective overburden pressure. The oedometer is then flooded with a saline solution similar to that of the soil unloaded and permitted to rebound. After rebound, the specimen is reloaded in increments of 50% increase a specified vertical effective stress, is reached. Thereafter, the standard doubling of pressures is resumed to test completion. All load increments are left on for a time interval determined by the root time method. e-log-p' curve, c_v, k, m_v, and P_c' data produced.

Procedure 2 - Sample is set up frozen in oedometer, then moved from cold room to standard apparatus. Stress is applied to seat load cap and sample is then thawed under nominal pressure. Procedure continues as for Procedure 1. e-log-p' curve, c_v, k, m_v, and p'c data produced.

NOTE: 1. Modifications made to standard procedure (ASTM D 2435) are taken from Andresen et al. (1979) and Broms (1980), as recommended for overconsolidated soils. Procedure is appropriate in view of large reduction in total stress that typically occurs upon sampling.

In addition to the specific procedures described above, all samples programmed for testing may have other basic tests performed as follows:

1. Moisture content
2. Bulk density
3. Core photography (where practical)
4. Detailed description of sedimentological features, and
5. Identification and preservation of discrete organic matter when present.

7. POREWATER SALINITY TESTS

Procedure 1 - Sample is trimmed to remove disturbed material. Porewater is extruded from thawed sample and chloride titration is performed to establish equivalent salinity (NaCl). All of these procedures are conducted at room temperature.

NOTES: 1. A silver nitrate titration is performed to determine the chloride ion content (ASTM D 512 Method B).

2. Chloride ion content was converted to an equivalent salinity using the following empirical relationship.

Salinity (o/oo) = 0.03 + (1.805 x Chlorinity (o/oo))

8. ORGANIC CONTENT DETERMINATION

Procedure 1 - Small portion of sample is weighed then oven dried at 60°C to a constant weight. Dried sample is then heated to 650°C for 30 minutes and allowed to cool at room temperature. Loss in weight is inferred as organic content.

9. RADIOGRAPHY

Procedure 1 - Samples are transported to be radiographed on subcontractors premises. Samples are returned with procesed film negatives.

Procedure 2 - Samples are radiographed at EBA. Samples are removed from storage area and returned immediately. Film is processed on site and results reviewed.

NOTE: 1. For report presentation, radiography subcontractor can prepare high quality B/W prints from film negatives.

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