REPORT ON PRELIMINARY INVESTIGATION

OF

FOUNDATION CONDITIONS

PROPOSED PORT MANN BRIDGE

for

C.B.A. ENGINEERING LTD.

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R.A. SPENCE, CONSULTING SOILS & FOUNDATION ENGINEERS

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I N D E X

A P P E N D I X

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1. INTRODUCTION

1.01 General: Under instructions of letter dated June 13, 1958, from Mr. L. K. Tempelman Kluit, General Manager, C.B.A. Engineering Ltd., work was undertaken to drill and sample the subsurface soil at potential sites for a bridge near Port Mann, B. C. In all, three locations, designated proposed centre lines A, B, and D, were tested under the direction of C.B.A. Engineering. As the program developed, location D was considered to be the more suitable and was therefore tested in somewhat greater detail. The drilling and sampling was contracted to Raymond Concrete Pile Co. Ltd.

The soil testing etc. was done by the undersigned, R. A. Spence, Consulting Soils & Foundation Engineers, who also supervised the drilling and sampling. As the work progressed we were asked by Mr. Tempelman Kluit and Mr. Westbroek to act in an advisory capacity on the analysis of subsurface conditions and foundation considerations.

Upon completion of the preliminary investigations a final alignment somewhat adjacent to the "D" line was selected upon a basis of geometric design, etc. A thorough subsurface drilling and laboratory testing program is now in progress on this final proposed alignment.

1.02 Scope of this Report: The scope of this report is to present the natural physical conditions at the site as indicated by the preliminary investigation, to present the foundation conditions and problems which have been brought out by this preliminary investigation, and to present the general problem for further study by secondary investigation.

The report is primarily concerned with the general area of the preliminary centreline D, since this location was given preference.

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APPENDIX

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PRELIMINARY

PORT MANN BRIDGE

STUDIES OF SETTLEMENT IN THE NORTH APPROACH AREA

1. Description of Soils:

The north approach of the proposed Port Mann Bridge will traverse a portion of the flood plain of the Fraser River. Ground elevations throughout this area are nearly constant. Soils exposed at the ground surface consist mainly of river silts, with some local deposits of peat or sand. The thickness of the upper silts ranges from 4 to 20 feet. A bed of sand approximately 100 feet thick underlies the silt. Static and dynamic penetration tests have shown this sand to be in a very loose state near the surface, but increasing in density in the lower elevations.

The sands are underlain by a layer of marine clay whose thickness varies from 15 to 70 feet. The greater thicknesses are found in the vicinity of bents 22 to 26; the clay layer diminishes in thickness riverward from these locations. The clay layer is comprised of three units, of which the upper-most is a highly sensitive material having Liquid Limits ranging from 30 to 40 with natural water contents consistently above this value. The middle unit of the clay layer is of higher plasticity, higher liquid limit, and has natural water contents generally below the liquid limit. The lower unit of the clay layer resembles the upper unit in plasticity and natural water content relationships, but is of a generally sandy texture with scattered pebbles. The clay layer is underlain by sand and gravel layers which in turn overlie glacial till.

A geologic section along the centerline of the bridge is shown in Fig. 1.

A report on the subsurface drilling, field and laboratory testing on the final proposed location somewhat adjacent to line "D" will be presented as an appendix to this report.

2. DESCRIPTION OF SITE

2-01 Location and Description: The area of the boring investigation for the proposed bridge was located generally between Fraser Mills and Douglas Island with proposed center line B just upstream from Fraser Mills, line A crossing over Douglas Island and line D crossing from immediately upstream of the C.N.Railway yards at Port Mann on the south side to the southerly end of Tree Island on the north side.

The area of center line D on the south side of the river is flat and swampy with second growth trees and underbush for about one thousand feet from the river where the ground surface rises approximately three hundred feet up to the upland. On the north side of the river, preliminary center line D curves around to the west about five thousand feet from the river to Cape Horne, a prominent bluff projecting out into the river valley from the general uplands, where it connects to the proposed Burnaby Thruway and Lougheed Highway. The terrain on the north side is flat with some of the area being farmed and the remainder, swampy underbush.

The Canadian National Railway mainline runs along the south shore of the river. Center line D is just east (upstream) from the CNR Yards at Port Mann. On the north side, the center line crosses the Canadian Pacific Railway line which parallels the Lougheed Highway. The topography of the general area is shown on drawing No. 59.

2-02 Climate: The site is within the inner West Coast Climate region. This is essentially Maritime with the prevailing westerly winds from the Pacific Ocean and the Coast Mountains (that is the mountain range along the northerly side of the Fraser River Valley) combining to produce moderate temperatures with plentiful precipitation. The extreme temperature range is from about 0° to 85° F. with a mean monthly temperature of about 35°F. in January and about 60°F. in July. The annual precipitation at the site is in the order of 50 inches per year with the bulk of this occuring during the winter rainy season. The rainfall varies from about 30 inches in the southerly part of the Fraser Delta to over 100 inches on the north part adjacent to the mountains.

2-03 Site Access: Center line D is fairly inaccessible in that the land areas are generally swampy with only one access road to the river on the north side along the dike around Colony Farm and one road leading to a construction fill just below the hill on the south side. During the winter rainy season access will be difficult due to the swampy conditions and undergrowth. Therefore access trails with some sand or other surface materials will be required.

3. GEOLOGY

3-01 General: Interpretation of the surficial geology of the Lower Fraser Valley is still not entirely sorted out, however interpretation to date is sufficiently advanced to permit correlation with foundation conditions at the proposed site.

The Fraser River occupies a post-glacial valley within relatively wide flat-topped uplands. The uplands (bounded on the north by the Coast Mountains and on the east by the Cascades) generally consist of geologically unconsolidated materials up to about the five hundred foot elevation, although three bedrock uplands within the unconsolidated materials rise in excess of one thousand feet. *

In this region there has been many advances of glacial ice. This glaciation was probably primarily of a modified mountain type with ice coming down mountain valleys onto the Fraser Lowlands. Each glacial advance laid down a ground till and compacted the underlying unconsolidated materials. During the final glacial advance the ice is thought to have been several thousands of feet thick.

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* J. E. Armstrong

By pebble count identification of the till it has been possible to surmise the origin and direction of many of these local glacial advances. However the complete inter-related picture of these movements have not as yet been worked out by investigators.

Some local glaciation could have caused gouging in a north-south direction within the Fraser Valley. Such depressions would create deeps in the valley in excess of the actual river bed proper. Such deeps were subsequently filled with the normal post glacial river and marine deposition.

The Fraser River itself has shifted course within the valley due to topography and ground conditions and due to obstructions created by glacial ice and debris. Formerly the river had a more southerly course and has only recently shifted to its present course.

The other factors complicating the soil types in this region are the variations in sea level relative to the land and the chemical and temperature changes of the water within which soil deposition took place. At the time of the retreat of the last glaciation the sea level had been up to about five hundred feet higher, relatively, than at present. Thus marine deposits such as marine clays, beach sands, etc. exist above the last glacial till to relatively high elevations. Also ice bergs probably rafted materials which were deposited and now appear as till like soils but are not tills. The general geological information is shown on drawing 39, and references will be made to the geologic materials shown on this drawing.

<u>3-02 Uplands Areas (Lower Mainland)</u>: The upland unconsolidated soil is composed of interbedded layers of water and glacial transported soils. In the region of this site, the most recent glacial till deposit is called the Surrey till, thus this till and older alluvial and marine deposits have all been consolidated under a very considerable glacial ice load.

Above the Surrey till are marine and alluvial deposits laid down in the sea during and following the glaciation and during the subsequent uplift of the land after the retreat of the ice. In the uplands region the post glacial deposits are much higher than the foundations with which we are concerned and are therefore not considered.

Glacial and interglacial deposits cover the complete range of mineral soils from clays to gravels and boulders. The glacial tills are very compact and range from relatively clean gravels and sands to clay-silts. These tills are generally well mixed together in varying proportions, although erratic pockets of individual types are often found. The interglacial deposits consist of normal water lain clays, gravels, sands, etc. with occasional organic layers. Generally in this region, the open gravels and sands are waterbearing and all of these have been compacted and consolidated under very high ice loads. In many instances the water in the deeper layer is under considerable head. This excess water pressure creates problems of uplift and instability of cuts in these soils.

The glacio marine clays which exist easterly of this area are compressible and of relatively low strength such that cuts in these soils are very susceptible to slides. Extreme care must be used in design in these regions. The Haney Clay Pit and areas around Fort Langley show excellent examples of the action of this upland glacio marine clay overlying the glacial tills etc.

<u>3-03 Post Glacial River Valley Deposits</u>: The post glacial deposits which primarily concern us are the glacio-marine, marine, alluvial and organic deposits which occur within the Fraser River Valley proper.

These soils had been laid down presumably upon the last glacial till with the glacio-marine and marine soils being laid down in the deeper water, and as the land rose the coarser and organic soils were deposited. The clays and silts are chiefly the product of mechanical abrasion by glaciers and to a minor extent have been influenced by chemical decomposition.

However during the time of deposition, temperature and chemical (salts) content of the water was changing together with the grain size components of deposition. This produced very non-homogeneous silt-clay soils; soils which may be quite similar in mineral consituents but of very different engineering properties.

When the water depths became lowered, organic growth became possible and hence organic deposits can be expected for some depth below the present ground surface. Information from other areas has indicated the deepest of these to be about 40 to 50 feet below present sea level.

Of course the river has shifted its channel within the present channel and therefore the alluvial deposits can vary from clays and silts to sands and gravels. Also pockets of organic material may be expected in former filled in channel areas.

This particular region is also affected by the tributaries — Coquitlam River, Pitt River and other local runoff streams — which enter the Fraser near the site. These tributaries and particularily the runoff streams may have caused channelling in the underlying preglacial deposits. These streams have a considerable gradient and consequently a high velocity, thus can move the considerably larger sizes which are dumped into the stream. This tends to confuse the bedding somewhat, especially near the side of the river valley where the streams enter.

There is no definite data as to the depth to the riverbed, that is the post glacial floor. Some information indicates 300 to 600 feet at some places considerably upstream from our site. There is however a good possibility that these deeps have been caused by local scour of a glacier moving south across the present River Valley. Therefore a much shallower riverbed could exist at our site than these few deep holes indicate.

3-04 Bedrock: The Coast Mountains rise up rapidly to about five thousand feet on the north of this general region. Conversely the bedrock dips quite rapidly to the south except for a few odd local bedrock outcrops. Thus it is considered at this time that bedrock cannot be considered as foundation support at this site due to its excessive depth.

4. FIELD AND LABORATORY INVESTIGATION

4-01 Field Investigation: A total of twenty drill holes were made at the three proposed centerlines A, B, and D. Of these, fourteen were made along centerline D with three being made on the north side of the river, one on Tree Island, one in the stream and the remaining nine being drilled on the south side. In all holes drive samples were taken in the sands, gravels and compact soils; and drive samples and thin wall tube samples were taken in the clays and silts. All samples were retained for laboratory testing and a record was maintained of sampler driving resistance on the drive samples.

The original intent was to drill up to about two hundred feet or to refusal of the drilling equipment. However in most instances the normally considered refusal resistance was exceeded in order to try to gain information on the underlying gravels and gravel silt clay mixtures. This has been very tough on the driller's equipment and drilling rate.

A record was maintained of water levels and particular attention was paid to possible excess hydrostatic pressure in the underlying glacial and preglacial soils. The location of the borings is shown on drawing No. 39.

Sampling in the lower CLAYS and SILTS was sometimes difficult, possibly due to the sensitivity etc. of the soils. This was particularly the case on the south side.

4-02 Laboratory Investigation: All samples obtained were visually classified in the laboratory and in addition, natural water contents, liquid and plastic limits, grain size, specific gravity, unconfined compressive strength, consolidation, permeability and pH tests were performed on representative samples in order to classify the soils and to determine the strength and consolidation characteristics, permeability and acidity of the soils.

The soil testing was mostly limited to samples from the D centerline holes. Also as the drilling proceeded the general soil deposition was noted and thus, in the light of the proposed structural foundation requirements, the testing was somewhat limited to the lower soil. This was particularly the case on the south side where few tests were made on the cohesive soils in the upper fifty feet or so.

5. RESULTS OF FIELD INVESTIGATION

5-01 North Side of River: The results of drilling is tabulated on the drilling logs shown on drawings Nos. 1 to 20. The logs show the interpretation of soil types, thickness of various layers or pockets, together with sample driving resistance, samples recovered, and notes relating to hydrostatic waterlevels.

Along the D centerline, the north side generally showed an upper zone of brown organic SILT with organic matter and grey SILT up to twenty foot depth, overlying SANDS with occasional thin layers of SILTS and GRAVELS down to a depth in excess of one hundred feet. At hole D 5 near the upland bluff, and Lougheed Highway, refusal was encountered in clayey SILT and GRAVEL at a depth of one hundred feet. Whereas at D 7 near Colony Farm the drilling encountered soft sensitive SILTS and CLAYS etc. at a depth of ninety seven feet down to one hundred and twenty feet where sandy SILT was drilled down to compact sandy gravelly SILT at one hundred and forty feet.

Hole D 2 was still in SAND at about one hundred and twenty feet and was stopped. This was the first hole completed in this area and as shown later probably stopped on a hard layer just above the clay.

From these preliminary holes it would therefore appear that below the organic surface soils, sands can be expected down to about one hundred and twenty feet or less, depending upon proximity to the upland bluffs. Below the sands, soft sensitive clays can be expected unless the hole is close to the upland bluffs. Or this may be otherwise hypothesized that probably within the post glacial soils in the river valley, soft sensitve cohesive soils — clays etc.— exist below about one hundred and twenty depth or so, unless the more compact preglacial soils have been encountered at higher elevations.

5-02 In the River Channel: Only two holes, D 1 and D 4 were made in the present river channel on the D centerline. Hole D 1 was still in SAND at ninety five feet, whereas D 4 was still in SAND at one hundred and seventeen feet. Therefore soil deposition below these depths is unknown. Clays should probably be anticipated below one hundred and twenty foot depth.

Hole D 1 shows an increase in sampler resistance and therefore an increase in density of the sand at about seventy foot depth below the river bottom. This might have some correlation to scour and/or hydraulic uplift. At any rate, the sampler driving resistance increased from about six blows per foot to about twenty five blows per foot at about seventy feet below river bottom, i.e. about ninety feet below river surface.

5-03 South Side of River: The borings along the D centerline on the south side of the river showed a marked variation in soil deposition. Near the river bank the holes showed layers or pockets of PEAT, organic clayey SILT, down to about forty five feet. From forty five feet to about one hundred and twenty feet the hole showed SANDS with occasional thin layers or pockets of SILTS. At one hundred and twenty feet a relatively compact layer of GRAVEL and SAND was encountered. Below this compact layer at about one hundred and twenty feet soft sensitive CLAYS and SILTS with occasional pockets or layers of SANDS were encountered down to about one hundred and ninety feet. Very compact SANDS, gravelly SILTS were met at about one hundred and ninety to about one hundred and ninety five feet and drilling was stopped.

Farther inland--south from the river--the borings showed generally similar soil conditions, however the depths to the compact SAND, GRAVEL, SILTS gradually reduced until this soil was encountered al most at the surface at the upland bluff. In some holes, SANDS were encountered in the upper forty five feet and in some holes thick layers or pockets of soft sensitive CLAYS and SILTS were encountered in the forty five to the one hundred and twenty foot zone.

It is noteworthy that a compact peat layer was encountered at forty to forty five feet.

6. RESULTS OF LABORATORY INVESTIGATION

6-01 Test Results: The results of the laboratory tests are tabulated on the drilling log sheets. In addition a plot of liquid limit vs. plasticity index -plasticity chart- is shown on drawing No. 21, compression index vs. liquid limit on drawing No. 22, and % clay fraction vs. plasticity index on drawing No. 23. Grain Size distribution curves of the representative samples are shown on drawings Nos. 24 to 26, graphs of typical unconfined compression tests on the soft sensitive clays are shown on drawings Nos. 27 to 28, a plot of the results of the angle of internal friction against the void ratio for representative medium to fine sand is shown on drawing No. 28A, and graphs of representative consolidation test results are shown on drawings Nos. 29 to 31.

The results of tests on the SILT CLAY soil from about 120 to 180 feet are of particular importance due to their type and location. The plasticity chart shows most of the samples tested to be above the A-line and to range from low to high plasticity.

A ratio termed "activity ratio" which is the plasticity index divided by the percent clay fraction of the sample, is thought to give an indication of ease of remoulding of the undisturbed soil. An activity ratio of less than about 0.7 is considered very sensitive to remoulding and the results plotted on drawings No. 32 to 38 show values as low as 0.2. This points up the difficulty experienced in obtaining undisturbed samples. Thus judgement must be used in interpreting strength results as lower strengths would result in disturbed samples than would exist in the in-place soil. Similarly, consolidation test results could be expected to give somewhat lower values of preconsolidation pressure and compression index than would probably be obtained on truly undisturbed samples.

The plot of the Compression index C_c against liquid limit appears to indicate a higher value of compression index than would normally be expected. No probable explanation for this can be advanced.

The lower silt clays were highly corrosive in the steel sample tubes causing corrosion of the metal and chemical hardening of the soil. The corrosion of metal piles has been found to be excessive in Scandinavia in soils of similar type to the silt-clays found at this site. Therefore this corrosive problem must be studied by proper tests. It is probable that it may be associated with variation in salt content of the water at the time the soil was deposited. This salt content is known to vary considerably.

6-02 Typical Soil Profile South Side: These soils appear to be of a few general types which vary within certain limits. As an example of this the results of hole D 8 on the south side may be correlated as follows:

0 - 7 ft.	soft brown PEAT
7 -12 ft.	grey SILT with organic fibrous matter also probably organic colloids.
12-20 ft.	grey organic SILT with occasional thin partings of fine sand
20-40 ft.	grey fine sandy SILT, some organic matter, occasional hard whitish grey nodules. This zone has a relatively high water content which is due to the organic matter.
40-43 ft.	dark brown PEAT. This is a relatively compact peat. It was probably laid down at an earlier sea level and subsequently compressed.
43-57 ft.	grey SILT trace clay, occasional whitish grey nodules.
57-87 ft.	grey SAND vary from medium fine to coarse medium fine sand with traces of fine gravel and occasional thin partings of silt and pieces of wood.
87-98 ft.	grey fine sandy SILT with lenses or layers of clayey SILT
98-105 ft.	grey coarse medium fine SAND some coarse medium fine gravel

98-105 ft. (con't)	This layer or similar layer was noted in all holes on the north and south side at approximately this depth. The sampler driving resistance was invariably high, in this case, 98 and 67 blows for 6 inch penetration of the standard drive sampler.
105-125 ft.	grey clayey SILT with occasional partings of fine sand, occasional trace of fine gravel. This layer was extremely sensitive with a natural water content from 33 to 40% which was about 5 to 8% higher than the liquid limit. It is possible that this zone contained layers with higher clay content and some organic colloids. The grain size analysis showed as much as 75% clay sizes. Unconfined consolidation tests showed relatively high compressibility. The strength was in the order of 1000 p.s.f. Sampling in this zone was extremely difficult and it is suspected that the sampling caused some disturbance.
125-133 ft.	grey medium fine SAND, traces shell fragments
133-164 ft.	grey CLAY, with blue grey streaks of probable organic colloidial nature. This zone varied from a natural water content of 44 to 70% and liquid limits from about 30 to 72. From the variations in test results it appears that the clay and silt fraction varied and also the organic colloids content changed with different layers.
164-172 ft.	grey clayey SILT with some fine sand. This zone was of relatively high water content, however undisturbed sampling was difficult due to the presences of occasional gravel and some sand. Otherwise it appears similar to the compressible soils encountered above.
172-177 ft.	This zone consisted of thin layers of sands, gravels and occasional clay and silt layers. Excess water pressure was usually encountered in the lower sands or gravels immediately over the refusal layer.

177 to bottom This soil was very compact and only a few samples were obtained. These appeared to be glacial tills, however greater depth of penetration must be made and more samples obtained to establish the nature of this zone.

6-03 Typical Soil Profile North Side: The borings showed a zone of organic silts and clayey silts to about 10 to 15 feet depth where sands with occasional traces of silt and gravel were drilled to about 95 to 100 feet.

From about 100 to 115 feet a compact layer of sands and gravels which caused refusal in one or two of the holes. Below this compact layer, compressible SILT-CLAY (similar to the lower compressible soil on the south side) was encountered down to the sand and gravel layers over very compact soil (probably glacial till). This compressible SILT-CLAY had a scattering of pebbles which made undisturbed sampling difficult. Excess water pressure was noted in the lower gravel layers just above the till in holes close to the upland bank.

7. FOUNDATION PROBLEMS

7-01 South Side: The foundation problems for bridge foundations on the south side arise due to the following:

1. The considerable depth of soft compressible organic soils from the surface to a depth of about 50 feet near the river, are such that foundations cannot be supported on this zone.

2. A zone of sands exists below the organic soils down to about 90 feet where the dense sand and gravel layer exists from about 90 to 105 feet. This zone would provide good bearing if it were not underlain by soft compressible SILT-CLAYS from about 105 to as much as 190 feet. This zone of sand and gravel raises the problem of negative skin friction on any foundation system used to bypass the lower compressible SILT-CLAYS.

3. The SILT-CLAY zone below about 105 feet is compressible and

normally consolidated. There is an excess of hydrostatic pressure acting under it. This zone will settle considerably under relatively low additional stress.

4. The SILT-CLAY zone has some highly sensitive layers. In some cases remoulding caused the soil to become almost liquid. This extreme sensitivity was pointed up very effectively by the occasional "undisturbed" sample which had a good sample at each end of the steel sample tube but liquid soil in the middle such that it was poured out of the sample tube. This remoulded stato was undoubtably caused by the slight disturbance created during sample operations. This leads to the question of the potential stability of the zone. A study of this stability should include consideration of creep and creep strength. Creep strength relates to possible lower actual strength due to long time loading effects.

The slope of the underside of this clay zone is appreciable. Therefore the south shore might possibly be moving towards the river at a very slow rate. Such a slight movement would not help the structure.

5. The excess hydrostatic pressure in the gravels below the underlying SILT-CLAY zone is appreciable and could affect both the settlement and the possibility of lateral creep. Such water would also have to be considered if an open type foundation was lowered into these gravels.

6. Drilling refusal was met in a compact layer below the compressible SILT-CLAYS, this underlying soil is thought to be glacial till, however this must be definitely established.

7. There is also a problem of possible corrosion of steel and concrete due to acids in the organic soils and salts etc. in the SILT-CLAYS.

7-02 North Side: The north side foundation problems are not as severe as those on the south shore.

1. On the north side there is a very considerable depth of sands overlying a relatively thinner layer of the compressible soil.. Never-the-less effective loading on the SILT-CLAY will cause settlements.

2. In the stream scour must be considered. It has been indicated

by other studies that scour or uplift might be effective to as much as 60 feet below the river bottom. This means that foundations founded in the sand would have to be much closer to the compressible clay.

3. It is proposed that the bridge proper be abutted onto a 50 foot fill sand embankment on the north side. Such an embankment would be very wide and would thus produce a high effective stress on the compressible clay.

4. There is a compressible organic surface zone on the north shore of about 15 foot thickness which would have to be eliminated or bypassed.

5. Refusal to boring was met in what was thought to be glacial till below the compressible SILT-CLAYS; this must definitely be established.

6. Excess hydrostatic pressure was not encountered in holes near the river, however this should be checked by later investigation.

8. POTENTIAL FOUNDATION SYSTEMS

As a result of the preliminary investigation certain potential foundation types must be considered.

8-01. The main piers and anchor piers will have large loading and thus two possible foundation methods can be considered within economic range.

a. Floating type foundation. This involves excavation of a weight of soil equal to the load from the structure and weight of the foundations. This type of foundation makes it difficult to allow for live loads although live loads should be relatively small for a structure of this type. Such a foundation would have to be as light as possible and therefore hollow and watertight. This system would be complex to design. This foundation system would have to be founded below the organic soil.

b. Deep pile or Caisson type foundation. This type of foundation would by-pass the compressible soils and use the underlying glacial till for support. This would undoubtedly cause some disturbance and hence settlement in the underlying compressible SILT-CLAYS. Therefore negative friction on the piles would have to be considered, particularly due to the sands overlying the SILT-CLAYS. This would mean a very much reduced supporting power, or else a casing must be used which would isolate the supporting pile from the skin friction due to the surrounding soil. As a result of the isolation the flexibility of the pile would have to be considered from the point of view of the column effect. The maximum length of these piles or piers would be in excess of 200 feet. A large diameter pile would be best suited to such requirements in order to develop high load per pile.

Due to the sensitive nature of the lower silt-clay it would be adviseable to use an open ended hollow pile which would greatly reduce displacement and remoulding of the silt-clay. The pile could be filled with concrete after driving if desired.

The excess hydrostatic pressure will be a problem with open ended piles.

A prestressed cylindrical concrete shell pile would probably be most economical and would be desireable if corrosion is a problem.

On the south side a casing is definitely required around the bearing pile in the sands and silts from about 40 to 110 feet.to isolate it from the negative skin friction which could exceed the bearing capacity of the pile. Also further consideration must be given to possible negative skin friction in the lower silt-clays since this might be appreciable depending upon the circumference of of the pile.

On the north side it is probable that a casing will be required. However the thickness of compressible soil is not too great in the area of the main north piers and thus study may show that the casing can be avoided.

8-02. The abutment on the north side will be greatly affected by the high sand fill. Due to the high loading of the fill, large settlements can be expected.

If the abutment is founded so that it will settle at the same rate as the ground surface at the abutment then the first two or three bents of the structure must be of a type (simple span) that will take up the differential settlement without damage. It is possible that some lateral movement can be expected due to the large settlement which will take place at this abutment. Probably the fill will have to be tapered off under the structure to prevent abrupt differential settlements.

8-03. Structural Bent Foundations.

The loads from these bents is much lower than the main piers.

a. On the south side it may therefore be more feasible to float these bents on hollow floating foundation founded below the organic soils. Live loads and variation of free water level would of course create difficulties. Also future building development in the vicinity of the foundation would cause areal settlements.

b. On the south side the bents could be founded on a type piles similar to that referred to for the main piers.

c. On the north side, since the loads of the structural bents are not too large and the upper sand zone is relatively thick these foundations could be either placed on shallow friction piles or on compacted surface sand. The latter would entail removal of the 15 or so foot thick organic surface layer. The water bents on the north side will have to be founded deep enough to safeguard against scour and uplift.

9. CONCLUSIONS

From the results of the investigation and consideration of potential foundation types the following recommendations and conclusions are made:

9-01. Further exploration:

a. The soil profile along the final centreline must be determined.

b. Some of the drill holes must be deep enough to penetrate the underlying compact zone to establish the nature of this zone. It has been considered to be glacial till but this must be definitely confirmed. The till should be penetrated about 30 to 40 feet.

c. More complete data must be obtained regarding excess hydrostatic pressure in the underlying soils.

d. Samples of the very sensitive silt-clays should be obtained in as undisturbed a state as possible.

9-02. Soil Tests.

a. Due to the sensitive nature of the silt-clays, in-place vane shear strength tests should be made in order to correlate with laboratory strength tests on samples taken out of the ground.

b. Consolidation tests must be made so that settlement studies can be carried out.

c. The corrosive affect of these soils should be studied. Considerable corrosion was noted in the sample tubes.

9-03. General.

a. It is possible and probable that the south shore may be creeping at a very slow rate towards the river. Studies of soil strength, under such conditions, and analysis of potential creep should be undertaken. Future areal development and loading could accentuate such a problem.

b. The depth to which river flow will affect the foundations should be determined. The depth of looser sands on the north side might be an indication of scour affects but if so it seems relatively high.

c. The lower SILT-CLAYS which underlie the considerable thickness (up to about 120 ft.) of sands, silts and organic soil and overlie the very compact soil (which appears to be glacial till) is highly compressible and of relatively low strength and high sensitivity. Any increase in stress on this soil will cause settlements, therefore studies must be made to determine loading conditions due to the bridge, and also possible future development adjacent to the bridge. Future development could create loads on the compressible soils which could seriously affect certain foundation types. Further if a foundation system is used which will bypass this compressible SILT-CLAY (piles or piers) then frictional drag on such foundation system due to the weight of the upper soils must be taken into account.

d) A system of deep, high capacity piles with slip casings to eliminate frictional drag, appear most feasible for the south side and heavier foundations on the north side. Such piles would probably be large diameter prestressed concrete and would bear on the glacial till (to be proved). The lighter structural bents on the north side could be founded on shallow piles or compacted soil foundations in order to be as high as possible. Adjacent to the north abuttment very large settlements must be expected due to the embankment fill. Thus a structural type compatible with large settlements must be used or else deep foundations will be required.

May 1958

R.A. Spence, P.Eng.

BORING NO. BSI-1

LOCATION BENT S-1

GROUND SURFACE ELEV. APPROX. + 38.00' V.C.D.

GROUND WATER ELEV. ___
(AT TIME OF BORING) ___

METHOD OF SAMPLING: ROTARY, FAILING 1500 USING DRILLING MUD

CASING ___ O.D., HAMMER ___ LBS., DROP ___ INCH

☐ DRIVE SAMPLE ___ I.D., HAMMER ___ LBS., DROP ___ INCH
(BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, ___ O.D. AND ___ O.D.

▮ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	
0–7				sandy SILT		
7–17				PEAT, etc.		
17–42				org SILT, etc		NOTE: LOG AND SAMPLING STARTED AT 120' SEE LOG BS-1C NOTE: HOLE CAVED FROM ABOUT 30' DEPTH JUST BEFORE LAST SAMPLE TAKEN. COULD NOT RE-LOCATE HOLE IN GRAVEL AT 120' BY DRILLING.
42–46				PEAT (Compact)		
46–70				SAND		

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PROPOSED
PORT MANN CROSSING
NEAR FRASER MILLS

SUBSURFACE EXPLORATION
LOG - BORING NO. BSI-1 SHEET 1

DATE DRILL'G: OCT 16 to NOV 7 '58
REPORT: NOV 28 '58
DWG.

BORING NO. BS1-1 (CONT'D)

METHOD OF SAMPLING: ROTARY, FAILING 1500 USING DRILLING MUD

LOCATION BENT S-1

GROUND SURFACE ELEV. APPROX. +08.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

CASING ____ O.D., HAMMER ____ LBS., DROP ____ INCH

☐ DRIVE SAMPLE ____ I.D., HAMMER ____ LBS., DROP ____ INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, ____ O.D. AND ____ O.D.

▯ PISTON SAMPLE 5" I.D. MODIFIED WITH PLASTIC LINERS AND EXTENDED EXTRA THIN WALL CUTTING SECTION

X LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	LENGTH OF RECOVERY	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3 kg/cm²	COMPR. STRENGTH P_c kg/cm²	CONSOLID. C_c	CONSOLID. P_p kg/cm²
70–120				SAND, etc. NOTE. HOLE WAS DRILLED TO THE GRAVEL LAYER AT 120' AS QUICKLY AS POSSIBLE AND NO CAREFUL LOG OR DIFFERENTIATION WAS MADE OF UPPER LAYERS SEE LOG OF BS-1C										
120–130				gy. c-m-f sandy m-f GRAVEL										
130–134	push	X		gy SILT, tr. clay	1									
					2		31.6 32.6 33.9	36.7	24.3				0.33	~4.2
134–140	push			gy clayey SILT, occ. small pkts. f. sand, occ. pebble occ. darker markings?	3		44.1 45.5 41.3							
	push push				4		33.8 43.6 45.6							

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PROPOSED
PORT MANN CROSSING
NEAR FRASER MILLS

SUBSURFACE EXPLORATION
LOG - BORING NO. BS1-1 SHEET 2

DATE DRILL'G: Nov 7 '58
REPORT: Nov 28 '58
DWG.:

BORING NO. BS 1-1 (CONT'D) METHOD OF SAMPLING: ROTARY, FAILING 1500 USING DRILLING MUD

LOCATION BENT S-1

GROUND SURFACE ELEV. APPROX. +58.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

CASING ____ O.D., HAMMER ____ LBS., DROP ____ INCH
DRIVE SAMPLE ____ I.D., HAMMER ____ LBS., DROP ____ INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)
THINWALL SHELBY, ____ O.D. AND ____ O.D.
PISTON SAMPLE 3" I.D., MODIFIED WITH PLASTIC LINERS AND EXTENDED EXTRA THIN WALL CUTTING SECTION
LOST SAMPLE
W.S. WASH SAMPLE
H.M.F DIAMOND DRILL

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	BLOWS /FT ON CASING	DESCRIPTION	SAMPLE NO.	LENGTH OF RECOVERY	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3 kg/cm²	COMPR. STRENGTH P_c kg/cm²	CONSOLID. C_c	CONSOLID. P_r kg/cm²
140	push			4									
				5		36.4 35.2							
150	push		gy. CLAY, generally with darker markings	6		65.3 61.7 60.1 62.6	76.5	34.3				0.85	~4.4
160	push			7		54.1 56.7 52.9 57.0							
170	push		gy. silty CLAY.	8		63.5 61.7 60.3 53.7	48.0	23.7				0.5	~6.0
180	push		gy. silty m f SAND, c m f SAND and clayey SILT in layers scattered m f gravel throughout.	9		25.8 31.4							
			gy silty c m f sandy m f GRAVEL tr. clay, occ cobbles & boulders (till-like, compact)	10	0'								
				11	0'								
200				12	0'								
			gy. SILT; f. sandy SILT; f. SAND tr. gy. CLAY; sandy clayey SILT, in layers of varying thickness scattered gravel throughout (appears reworked, compact)	13	14"	12.6 13.0			SEE GRAPH (2 TESTS)	4.22	19.9		
				14	2.0'	14.0 15.4 23.1 24.6 19.6 16.3			SEE GRAPH (3 TESTS)	2.61	21.2	.104 .163	
210				15	0'								

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PROPOSED PORT MANN CROSSING NEAR FRASER MILLS

SUBSURFACE EXPLORATION LOG - BORING NO. BS1-1 SHEET 3

DATE DRILL'G: Nov 7 '58 REPORT: Nov 28 '58

DWG.:

BORING NO. BS1-1 (CONT'D)

LOCATION BENT S-1

GROUND SURFACE ELEV. APPROX. 98.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: ROTARY, FAILING 1500 USING DRILLING MUD

CASING ____ O.D., HAMMER ____ LBS., DROP ____ INCH

☐ DRIVE SAMPLE $2\frac{1}{4}$ I.D. $2\frac{3}{4}$ O.D. HAMMER 225 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

THINWALL SHELBY, ____ O.D. AND ____ O.D.

PISTON SAMPLE

LOST SAMPLE

W.S. WASH SAMPLE

H.M.F. DIAMOND DRILL

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	LENGTH OF RECOVERY	WATER CONTENT	GRAIN SIZE	REMARKS
210			gy. SILT, f. sandy SILT, f. SAND; br. gy. CLAY, sandy clayey SILT, in layers of varying thickness, scattered gravel throughout (compact). These layers appear reworked; in some samples layering was in vertical position	16	14"	16.3	SEE GRAPH	
				17				
	79/6, 180/4			18	8"			
				19	0"			
220				20	0			COBBLE JAMMED IN BIT
				21	2"			
				22	2"			
230				23	?			Some gravel & sand recovered appeared washed
				24	?			
240			gy. c. sandy m-f GRAVEL					GRAVEL CAVING INTO HOLE
	49/6, 61/2			25	8"			
	48, 76, 60		gy. silty c-m-f sandy c-m-f GRAVEL, tr. clay (compact, till-like)	26	6"			UPPER PORTION IN CAVED MATERIAL, 6" IN PLACE SOIL RECOVERED.
	43, 38			27	0			
				28	0			PIECES COBBLE BLOCKED IN BIT
250	100/3/4"			29	0			
				30	2"			
	200/1"			31	1"			
260	200/2½"			32	0"			
	75/3, 100/0			33	2"			
			BOTTOM OF BORING. HOLE CAVED FROM 30' JUST BEFORE LAST SAMPLE WAS TO BE TAKEN					
270								
280								

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PROPOSED PORT MANN CROSSING NEAR FRASER MILLS

SUBSURFACE EXPLORATION LOG - BORING NO. BS1-1 SHEET 4

DATE DRILL'G: Nov 7 '58
REPORT: Nov 28 '58
DWG.:

BORING NO. BS1A

LOCATION MAIN PIER SOUTH

GROUND SURFACE ELEV. +99.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING 4" O.D., HAMMER 350 LBS., DROP ___ INCH

□ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3" O.D. AND ___ O.D.

▮ PISTON SAMPLE

X LOST SAMPLE.

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3	COMPR. STRENGTH P_c	CONSOLID. C_c	CONSOLID. P_r
0				gy. c.m.f. SAND, sm. org. mat'l									
				gy. SILT, tr. clay, tr. org. mat'l									
	2, 1½, 1				1	124. 208.							
				br. PEAT, sm. org. silt									
10	PUSH												
	PUSH				2	50.2							
	PUSH				3	46.8							
20	PUSH				4	71.2							
	PUSH			gy. org. SILT, tr. clay with org. mat'l	5	67.2	82.2	43.3					
30	PUSH				6	63.2	76.4	32.9					
	PUSH				7	38.1	35.3	27.4					
40	1, 2, 6 350# H.				8	206.							
				dk. br. PEAT									
	PUSH				9	37.2	37.1	27.2					
				gy. clayey SILT with layers gy. silt, tr. clay, occ. pcs. m.f. gravel & pebbles of silt									
50	9, 10, 12				10								
60	9, 9, 10				11								
				gy. c.m.f. silty SAND									
70													

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PROPOSED PORT MANN CROSSING NEAR FRASER MILLS

SUBSURFACE EXPLORATION LOG - BORING NO. BS1-A SHEET 1

DATE DRILL'G: MAR 26/58 REPORT: APR. 9/58

DWG.:

BORING NO. BS1-A

LOCATION MAIN PIER SOUTH

GROUND SURFACE ELEV. + 99.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING SEE NOTE O.D., HAMMER 350 LBS., DROP ____ INCH

☐ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30" INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3" O.D. AND 2" O.D.

▮ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

NOTE: 4" CASING 0-120', 2½" CASING 120' TO BOTTOM BOR'G

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3	P_c	CONSOLID C_c	P_p
70	8,9,11			gy. c.m.f. silty SAND	12								
80	10,11,13				13								
90	10,13,9			gy. c.m.f. SAND, sm. silt, with pckts. or thin layers of clayey silt	14	34.8							
	11,19,23			gy. compacted c.m.f. SAND, tr. f. gravel	15								
100	1½,1½,2			gy. clayey SILT, with thin layers of gy. silt	16	31.4	29.6	21.6					
	PUSH				17	36.4	38.1	20.8	SEE GRAPH			SEE GRAPH	
110	PUSH				18	32.4	29.3	21.6					
(~115)	PUSH				19	32.4	34.8	21.7	SEE GRAPH			SEE GRAPH	
				gy. clayey SILT									
120	20,16,13			gy. c.m. sandy m.f. GRAVEL, tr. shell	20								
	23,19,17			gy. m.f. GRAVEL, tr. sand, tr. silt	21								
130	2,1,1½			gy. silty CLAY	22								
	PUSH				23	32.0	29.4	17.3					
140				bl. gy. silty CLAY with darker streaks									

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PROPOSED PORT MANN CROSSING NEAR FRASER MILLS

SUBSURFACE EXPLORATION
LOG - BORING NO. BS1-A SHEET 2

DATE DRILL'G: MAR. 26/58 REPORT: APR. 3/58

DWG.:

BORING NO. BSI-A

LOCATION MAIN PIER SOUTH

GROUND SURFACE ELEV. +99.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING 2½" O.D., HAMMER 350 LBS., DROP ____ INCH

☐ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 2" O.D. AND ____ O.D.

▯ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3	COMPR. STRENGTH P_c	CONSOLID. C_c	CONSOLID. P_p
140	PUSH			bl. gy. silty CLAY with darker streaks	24	38.8	34.1	21.5	SEE GRAPH			.495	4.1
	PUSH				25	56.4	59.0	30.4					
150	PUSH				26	66.8	69.0	31.6	SEE GRAPH			.91	3.5
	PUSH				27	57.6	77.0	32.4					
160	PUSH				28								
	PUSH				29	58.4	84.6	35.3					
170	PUSH				30	57.8	67.6	33.2	SEE GRAPH			1.25	4.6
	1½,2,3			gy. silty CLAY, gy. clayey SILT, & sandy m.f. GRAVEL in layers,	31	35.9	42.7	23.2					
180	2,2½,2				32	36.5	60.9	30.6					
	4,4½,5				33	21.1	24.0	15.1					
190	8/4½, 60, 40/2				34	31.1	30.0	17.8					
	120/2"			c.m.f. gy. silty SAND and GRAVEL	35								
				BOTTOM OF BORING									
200													

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PROPOSED PORT MANN CROSSING NEAR ...

SUBSURFACE EXPLORATION
LOG - BORING NO BSI-A SHEET 3

DATE DRILL'G: MAR. 26/58 REPORT: APR. 3/58

BORING NO. BS1B

LOCATION MAIN PIER SOUTH

GROUND SURFACE ELEV. + 97.00' V.C.D.

GROUND WATER ELEV. ____
(AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING 4 O.D., HAMMER 350 LBS., DROP ____ INCH

□ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3" O.D. AND ____ O.D.

▯ PISTON SAMPLE

X LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT
0				br. c.m.f. silty SAND				
				br. & gy. SILT, tr. clay, tr. f. sand, tr. org. mat'l.	1	54.9		
	1,1,1			br. PEAT, sm. org. silt				
10	PUSH			gy. org. SILT, tr. clay with fibrous org. mat'l, occ. small pcs. wood	2	62.4		
	PUSH				3	47.6		
20	PUSH				4	78.0		
	PUSH				5	47.8	53.0	27.7
30	PUSH				6	50.4	56.4	32.1
	PUSH				7	35.6	34.5	26.4
40	PUSH.				8 T	95.4		
	1½,1½,3			dk. br. compact PEAT, tr. silt	9 C	466.		
					B	199.		
					10 T	44.4		
	PUSH			gy. clayey SILT, tr. org. mat'l, sm. pebbles of hard dry compact clayey SILT, m.s. 1"	B	39.9	48.1	25.7
50	PUSH,3,4			gy. f. silty SAND, with pckts. or layers silt, tr. clay	11			
	7,8,8			gy. m.f. silty SAND, occ. tr. org. mat'l.	12			
60	10,8,7,7				13			
70								

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PROPOSED
PORT MANN CROSSING
NEAR FRASER MILLS

SUBSURFACE EXPLORATION
LOG - BORING NO. BS1B SHEET 1

DATE DRILL'G: MAR. 6/58
REPORT: MAR. 17/58

DWG.

BORING NO. BS1B

LOCATION MAIN PIER SOUTH

GROUND SURFACE ELEV. + 97.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING 2½ O.D., HAMMER 350 LBS., DROP ____ INCH

□ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 2" O.D. AND ____ O.D.

▯ PISTON SAMPLE

X LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3 kg/cm²	COMPR. STRENGTH P_c kg/cm²	CONSOLID. C_c	CONSOLID. P_r kg/cm²
70	4,6,6,7			gy. m.f. silty SAND, occ. tr. org. mat'l.	14								
80	9,12,13				15								
90	10,17,20			gy. m.f. silty SAND, occ. small pckts. gy. silt, and occ. thin layers gy. silt, tr. clay	16								
100	1,1,1				17	31.6	33.0	21.7					
		X		gy. SILT, tr. clay, with thin layers f. silty sand	18								
	3,3,2				19	31.8	34.2	21.6					
110													
	PUSH				20	33.2	32.4	20.4					
				gy. SILT, tr. clay, sm. m.f. gravel									
120	10,20,17,17				21								
				gy. c.m.f. sandy m.f. GRAVEL, sm. silt, tr. shells									
	27,25,23				22								
130	PUSH, 1, 1½			gy. SILT, tr. clay, and f. SAND in layers	23	29.8	25.9	14.3					
	PUSH	■		gy. silty CLAY	24	35.4	31.4	21.6	SEE GRAPH	2.11 0	1.10 1.20	.26	4.5
140													

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R. A. SPENCE, SOILS & FOUNDATION ENGINEERS
1564 ROBSON STREET VANCOUVER, B.C.

PROPOSED
PORT MANN CROSSING
NEAR FRASER MILLS

SUBSURFACE EXPLORATION
LOG - BORING NO. BS1B SHEET 2

DATE DRILL'G: MAR. 6/58
REPORT: MAR. 17/58

BORING NO. B S I B

LOCATION MAIN PIER SOUTH

GROUND SURFACE ELEV. + 97.00' V.C.D.

GROUND WATER ELEV. (AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING 2½" O.D., HAMMER 350 LBS., DROP ____ INCH

☐ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

▪ THINWALL SHELBY, 2" O.D. AND ____ O.D.

▮ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3 kg/cm²	COMPR. STRENGTH P_c kg/cm²	CONSOLID. C_c	CONSOLID. P_p kg/cm²
140	PUSH		gy. silty CLAY	25	42.4	35.0	22.5		1.41 2.11 0	1.22 1.29 1.05		
	PUSH		gy. CLAY	26	70.0	58.7	30.3	SEE GRAPH	2.11 0	0.92 1.14	1.31	3.85
150	PUSH			27	60.5	66.0	34.5	SEE GRAPH	0 0	1.71 REM'D 0.05	1.7	4.5
	PUSH 1½,2,3½		gy. CLAY and SAND, tr. f. gravel	28 29	48.0	77.4	29.9					
160	PUSH		gy. CLAY	30	56.4	78.9	32.2		2.11 1.41	1.04 0.92		
	PUSH			31								
170	PUSH	70/12		32								
	PUSH	50/12		33	51.2 40.6	43.5	22.1					
	PUSH	40/12 37/12 40/12	gy. SILT, tr. clay, sm. c.m.f. sand, sm. f. gravel	34	34.2 32.2	22.6	18.6	SEE GRAPH			.32	3.6
180	4,4½,4½			35	12.6	10.8	8.8					
	3,4½,6			36	13.0 31.9	40.1	19.8					
			gy. f. sandy silty CLAY with thin layers m.f. sand (compact)									
190	9,14,60		gy. silty CLAY and gy. m.f. SAND in thin layers	37	27.0	47.7	19.8					
	150/2½		gy. silty c.m.f. sandy m.f. GRAVEL, tr. (-) clay	38								
			BOTTOM OF BORING									
200												

WATER PRESSURE
@ 1:30 PM - 1 psi
@ 4:00 PM - 2.5 psi

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R. A. SPENCE, SOILS & FOUNDATION ENGINEERS
1564 ROBSON STREET VANCOUVER, B.C.

PROPOSED
PORT MANN CROSSING

SUBSURFACE EXPLORATION
LOG - BORING NO. BS1B SHEET 3

DATE DRILL'G: MAR. 14/58
REPORT: MAR. 24/58

DWG.

BORING NO. BSI-C

LOCATION BENT S-1

GROUND SURFACE ELEV. APPROX. +98.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING 4" O.D., HAMMER ____ LBS., DROP ____ INCH

☐ DRIVE SAMPLE 1⅜" I.D., HAMMER 225 LBS, DROP 19 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3½" O.D. AND ____ O.D.

▮ PISTON SAMPLE

X LOST SAMPLE

⊡ STANDARD 1⅜" I.D. SAMPLER WITH BRASS LINERS.

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT
0–4				silty SAND				
4–14				dk. br. fibrous PEAT, tr. silt, pcs. decayed wood	1			
14–41				gy. org. SILT, tr. clay occ. pkts. org mat'l	2	48.2	47.5	28.7
					3		34.7	24.8
41–45				dk. br. PEAT, thin layers silty f. sand. (compact)	4 T B	45.4	50.5	28.4
45–70	30/12			gy. m.f. SAND, occ. tr. silt	5			
	27/12				6			

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R. A. SPENCE, SOILS & FOUNDATION ENGINEERS
1564 ROBSON STREET VANCOUVER, B.C.

PROPOSED PORT MANN CROSSING

SUBSURFACE EXPLORATION
LOG - BORING NO. BSI-C SHEET

DATE DRILL'G: JULY 12/58 REPORT: AUG. 21/58

BORING NO. BSI-C

LOCATION BENT S-1'

GROUND SURFACE ELEV. APPROX. +58.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: ROTARY (JOY DIAMOND DRILL) AND WASH BORING (MUD)

CASING 4" O.D., HAMMER ____ LBS., DROP ____ INCH

☐ DRIVE SAMPLE 1 3/8" I.D., HAMMER 225 LBS., DROP 19" INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, ____ O.D. AND ____ O.D.

▮ PISTON SAMPLE

╳ LOST SAMPLE

⊡ STANDARD 1 3/8" I.D. SAMPLER WITH BRASS LINERS

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	
70				gy. m.f. SAND, occ. tr. silt					
	28/12				7				
80				gy. m.f. SAND, pckts. of sandy clay, and gy. f. sandy SILT, thin layers org. mat'l, in layers					
	21/12				8	29.2	30.0	26.4	
90									
	19/12				9				
100									
	push			gy. clayey SILT, sm. f. sand, thin layers of silty f. sand	10	52.1	34.0	19.5	
110									
					11				
120				gy. c-m f-sandy m-f GRAVEL					
	43				12				HOLE CAVING LOOSING DRILLING WATER
					13	27.0	25.3	15.4	
130				dk. gy. f. sandy SILT, traces org. mat'l thin layers f. sand					
					14	28.9	25.9	15.5	
				gy. clayey SILT, tr. f. sand, tr. f. gravel					
140									

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PROPOSED PORT MANN CROSSING

SUBSURFACE EXPLORATION

LOG - BORING NO BSI-C SHEET 2

DATE DRILL'G: JULY 12/58 REPORT: AUG. 21/58

DWG.

BORING NO. BSI-C

LOCATION BENT S-1

GROUND SURFACE ELEV. APPROX. +88.00' V.C.D

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: ROTARY (JOY DIAMOND DRILL) AND WASH BORING (MUD)

CASING 4" O.D., HAMMER ____ LBS., DROP ____ INCH

□ DRIVE SAMPLE 1⅜" I.D., HAMMER 225 LBS., DROP 19 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3½" O.D. AND ____ O.D.

▮ PISTON SAMPLE

X LOST SAMPLE

⊡ STANDARD 1⅜" I.D. SAMPLER WITH BRASS LINERS

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAIN SIZE	COMPR. STRENGTH σ_3 kg/cm²	P_c kg/cm²
140		gy. clayey SILT, tr. f. sand, tr. f. gravel	15	31.8	35.3	21.6			
		gy. silty CLAY, occ. lighter & darker markings, occ. lenses sandy f. gravel	16	43.5	40.8	31.4	SEE GRAPH		
	PUSH		17	65.6	62.1	34.5			
150									
	PUSH	gy. CLAY,	18	59.3	64.0	34.8		3.52	0.27
160	PUSH		19	54.2 DRIED OUT	78.1	30.7			
	PUSH		20	60.9	76.5	35.3			
170	PUSH		21	64.1	64.0	35.0		2.81 4.22	0.72 0.55
	PUSH	gy. silty CLAY, tr f sand, thin layers f. sand	22	35.9	42.2	23.3	SAMPLES PROBABLY DRIED SLIGHTLY (LOW WATER CONT'T)		
	PUSH		23	44.3 DRIED OUT	51.4	27.7			
180			24	31.4 41.1	20.3 26.2	16.4 20.2			
		gy. clayey SILT, sm. c. to f. sand, occ. tr. f. gravel	25	33.9	32.4	18.3			
			26	27.8	32.6	19.5			
	PUSH		27	32.8	35.0	21.5		4.22	0.08
190	PUSH, 85/5		28	32.1	50.0	21.2			
		BOULDER gy. cm-f. SAND, [illegible]							
	95/11	gy. clayey SILT, tr. f. sand, tr. m. f. gravel, pckts. or layers m. f. sand; occ. boulders (compact)	29	19.7	26.8	19.1			
200									
	100		30						
210	87/12		31	16.0	33.5	15.1			

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PROPOSED PORT MANN CROSSING NEAR FRASER MILLS

SUBSURFACE EXPLORATION
LOG - BORING NO. BSI-C SHEET 3

DATE DRILL'G: JULY 12/58 REPORT: AUG. 21/58

BORING NO. BSI-C

LOCATION BENT 5-1

GROUND SURFACE ELEV. APPROX. +38.00' V.C.D.

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: ROTARY (JOY DIAMOND DRILL) AND WASH BORING (MUD)

CASING 4" O.D., HAMMER ____ LBS., DROP ____ INCH

□ DRIVE SAMPLE 1⅜" I.D., HAMMER 225 LBS., DROP 19 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 2" O.D. AND ____ O.D.

▮ PISTON SAMPLE

X LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT.	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	
210				gy. clayey SILT, tr. f. sand, tr. m.f. gravel, pckts or layers m.f. sand, occ. boulder (compact)					
	100/5				32	25.2	24.0	18.3	
	15" DROP			gy. f. SAND, sm. silt with some siltier pkts or layers					
220	100/4				33	18.8			
	43, 100/5, 30" DROP			gy. c.m.f. SAND and m.f. GRAVEL (compact)	34				
230	100				35				
	140/10			gy. m.f. GRAVEL and gy. silty c.m.f. SAND, pckts. sandy silt	36	20.3			water content of sandy silt pkt
				← BOTTOM OF BORING					
240									

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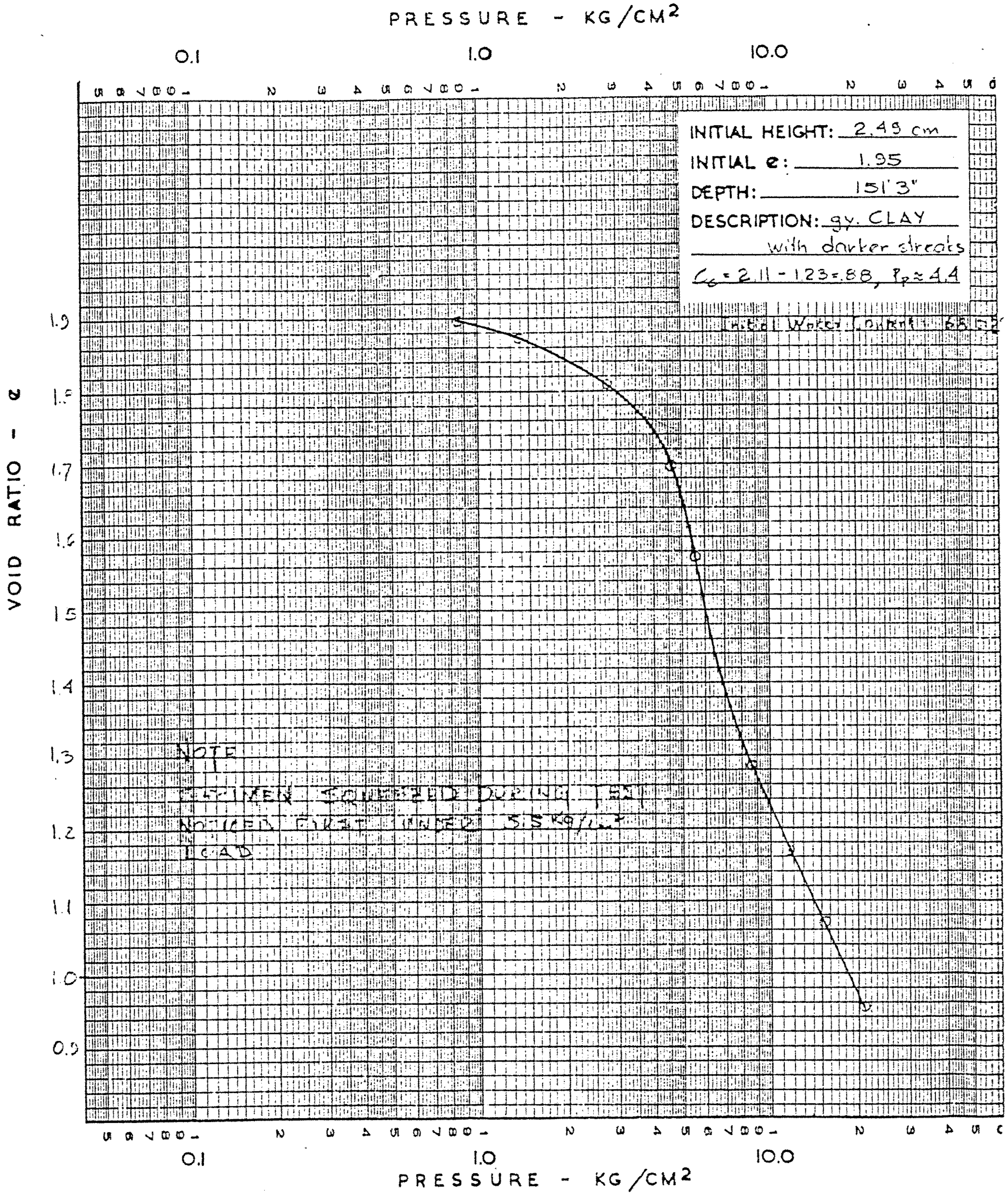
VANCOUVER, B.C.

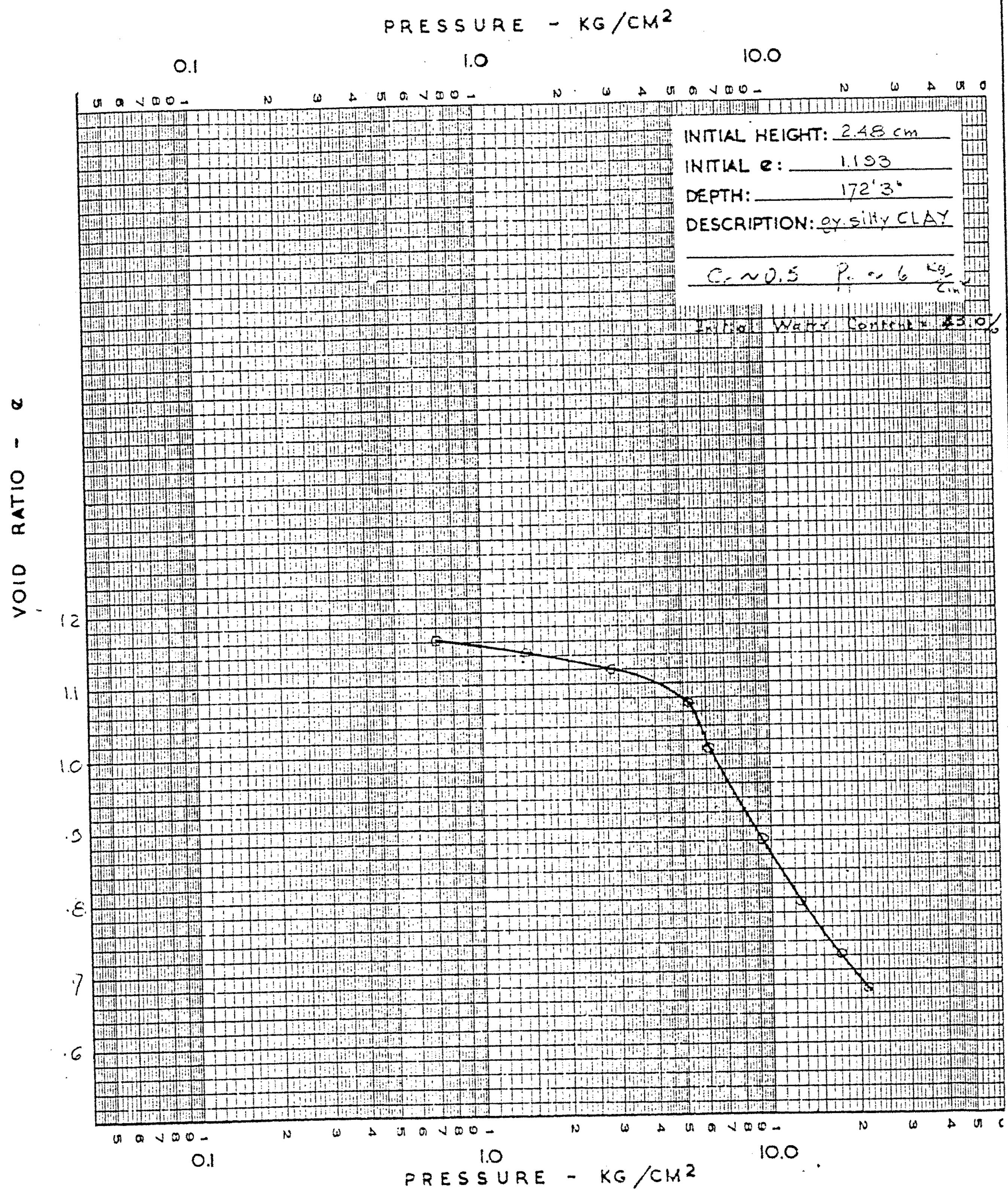
PROPOSED
PORT MANN CROSSING

SUBSURFACE EXPLORATION
LOG - BORING NO. BSI-C SHEET 4

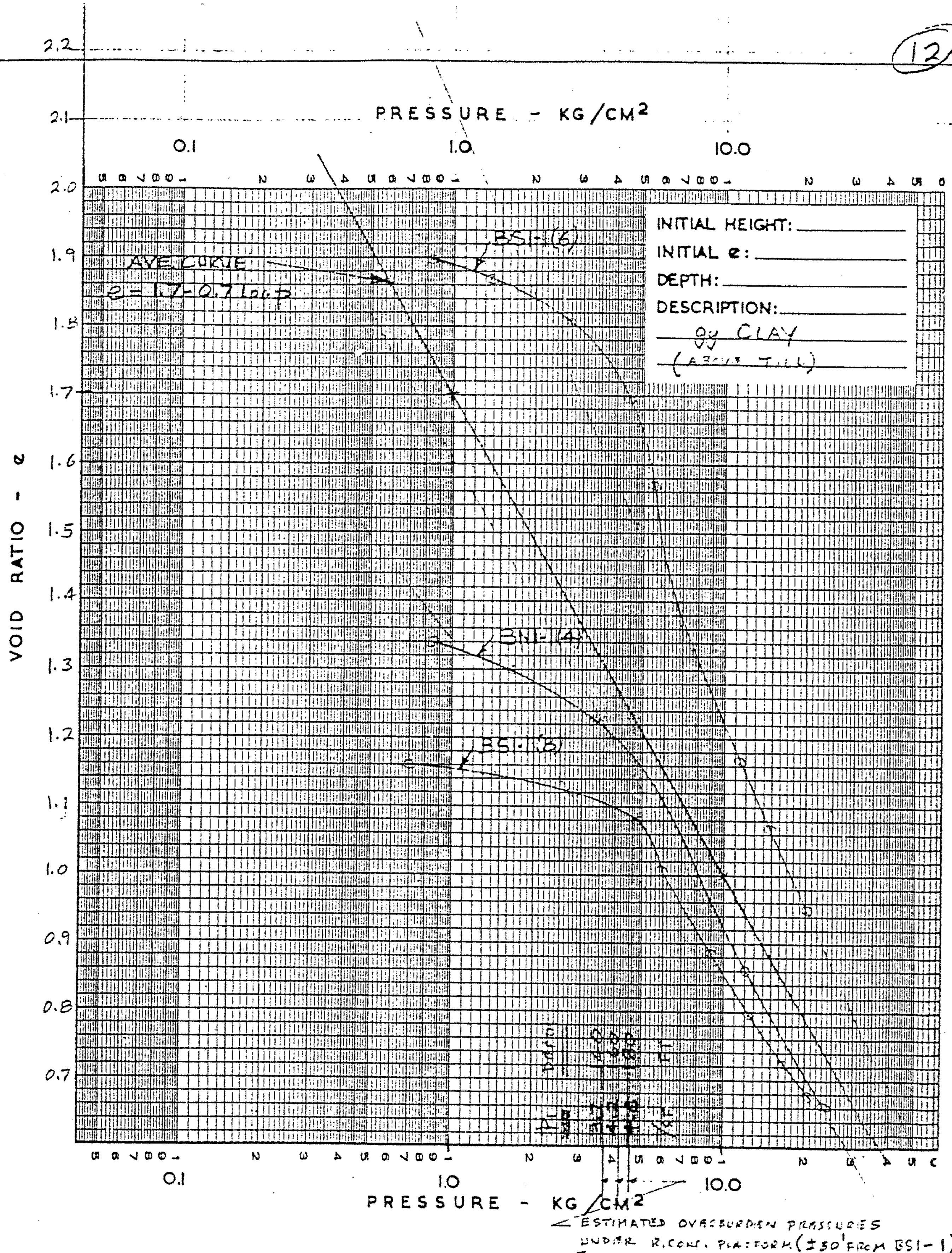
DATE DRILL'G: JULY 12/56
REPORT: AUG 21/56



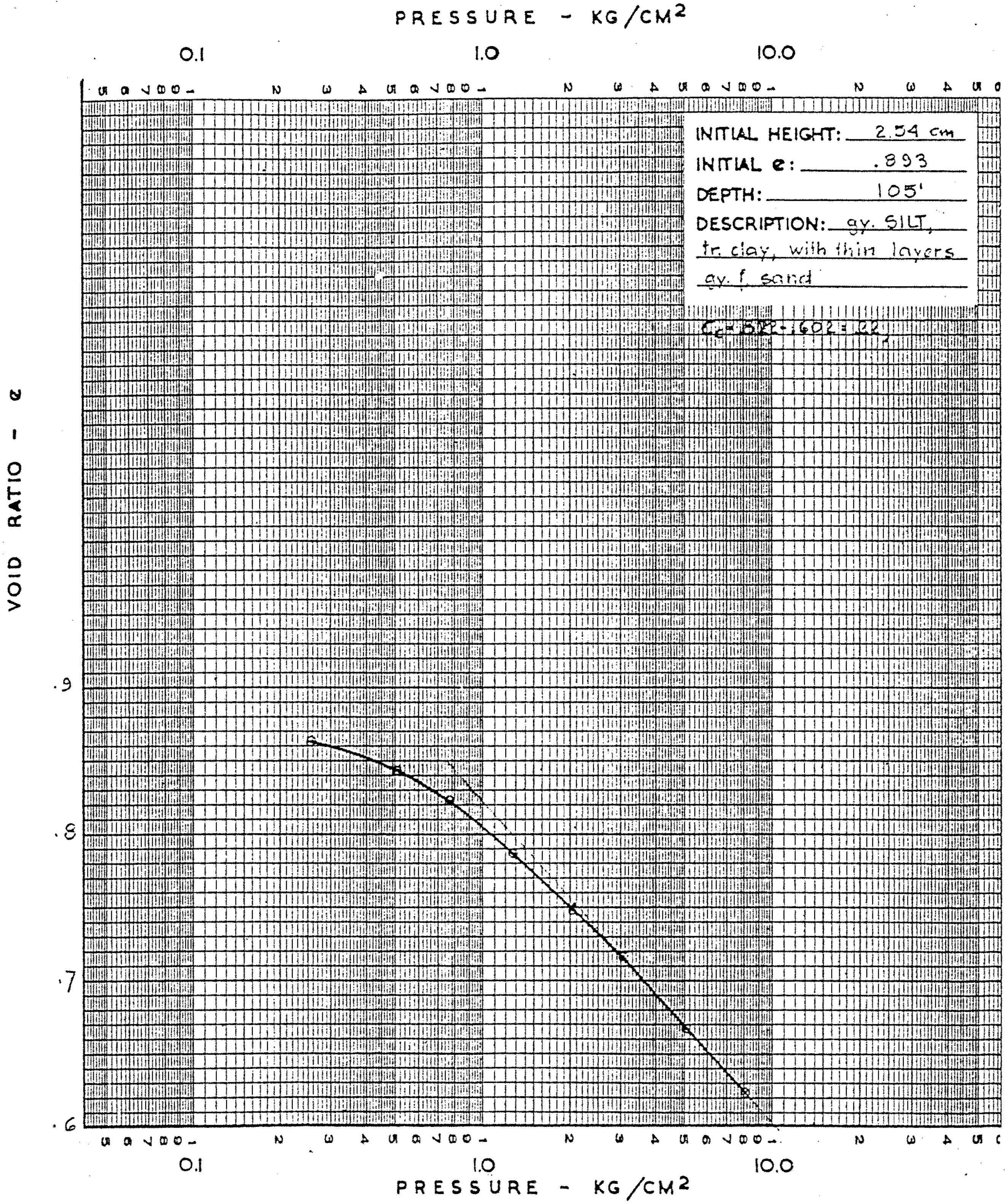
PORT MANN	CONSOLIDATION TEST	JOB NO: 37
R.A. SPENCE, P.ENG.	HOLE BS1-1 SAMPLE 6	DATE: NOV.18/58



PORT MANN	CONSOLIDATION TEST	JOB NO: 87
R.A. SPENCE, P.ENG.	HOLE BSH SAMPLE 8	DATE: NOV.18/58

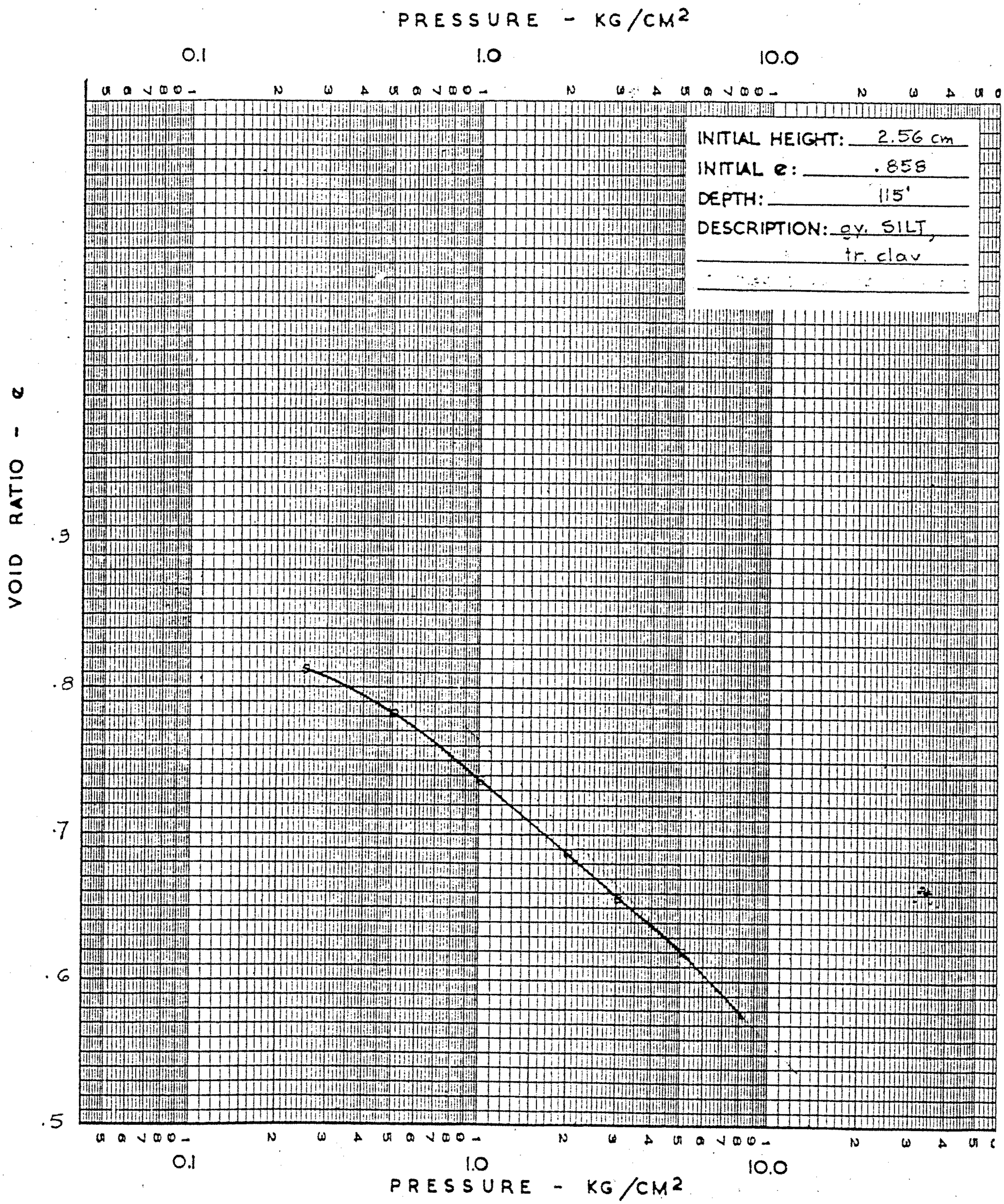


	CONSOLIDATION TEST	JOB NO: 144
R.A. SPENCE, P. ENG.	HOLE BS1-1 (6) — 151' BS1-1 (3) SAMPLE 72' BN1-1 (4) — 135' JOB No 87	DATE:



CLAYEY SILT

PORT MANN	CONSOLIDATION TEST	JOB NO: 87
R.A. SPENCE, P. ENG.	HOLE BS1A SAMPLE 17	DATE: MAY 21/58



CLAYEY SILT

PORT MANN	CONSOLIDATION TEST	JOB NO: 87
R.A. SPENCE, P. ENG.	HOLE BS1A SAMPLE 19	DATE: MAY 20/58

BORING NO. B 1

LOCATION see location dwg 200' W Bridge ℄

GROUND SURFACE ELEV.

GROUND WATER ELEV. (AT TIME OF BORING)

METHOD OF SAMPLING: WASH BORING

CASING 4 O.D., HAMMER 350 LBS., DROP ___ INCH

☐ DRIVE SAMPLE 1 3/8" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3" O.D. AND ___ O.D.

▮ PISTON SAMPLE

X LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	UNCONF. COMP. STRENGTH (Kg/cm²)	CONSOLIDAT'N
0	push			brown fibrous PEAT	1	622.				
	push				2	418.				
10	push				3	873.				
	push				4	924.				
	push			gy. org. SILT, mixed with organic fibrous mat'l, occasional pkts peat and m-f sand.	5	92.5 81.5 74.8			0.37 0.36	see graph
20	push				6	45.4				
	push				7	151. 182.			0.31	see graph
30	push			gy f. sandy SILT	8					
	push, 1, 1				9					
	1, 1, 1				10	28.8				
	2, 2½, 2½				11	33.1				
40	DRIVEN			dk br to black PEAT, pockets & thin layers clayey silt	12	218.				
				BOTTOM OF BORING						
50										
60										

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PORT MANN BRIDGE
PROPOSED RELOCATION C.N.R.
PORT MANN B.C.

R. A. SPENCE, SOILS & FOUNDATION ENGINEERS
1564 ROBSON STREET VANCOUVER, B.C.

SUBSURFACE EXPLORATION
LOG - BORING NO. B1 SHEET 1

DATE DRILL'G: Feb '59 REPORT: Mar '59

DWG.:

BORING NO. B 2

LOCATION see location dwg. ¢ of BRIDGE

GROUND SURFACE ELEV.

GROUND WATER ELEV.
(AT TIME OF BORING)

METHOD OF SAMPLING: WASH BORING

CASING 4 O.D., HAMMER 350 LBS., DROP ___ INCH

☐ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3" O.D. AND ___ O.D.

PISTON SAMPLE

X LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	UNCONF. COMPRESS. STRENGTH	CONSOLIDAT'N
0										
	push			brown fibrous PEAT.	1	587.				
	push				2	455.				See graph
10	push				3	713.				
	push				4	70.3 39.9				
20	push			gy. org SILT, mixed with organic fibrous material occ. pkts. peat and m-f sand.	5	146				
	push				6	65.9				
30	push				7	38.7				
	2.2½.3			gy f. sandy SILT.	8	36.0				
40	4.4.5			dk br to black PEAT. pkts or layers clayey silt.	9	193				
				BOTTOM OF BORING						
50										
60										

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PORT MANN BRIDGE
PROPOSED RELOCATION CNR.

R. A. SPENCE, SOILS & FOUNDATION ENGINEERS
1564 ROBSON STREET VANCOUVER, B. C.

SUBSURFACE EXPLORATION

DATE DRILL'G: Feb '53
REPORT: MAR '53

BORING NO. B 3

LOCATION see location dwg 200' E. of bridge ℄

GROUND SURFACE ELEV.

GROUND WATER ELEV.

(AT TIME OF BORING)

METHOD OF SAMPLING: WASH BORING

CASING 4 O.D., HAMMER 350 LBS., DROP ___ INCH

☐ DRIVE SAMPLE 1⅜ I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 3" O.D. AND ___ O.D.

▐ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	UNCONF. COMP. STRENGTH	CONSOLIDAT'N
						%			Kg/cm²	
0	push			br. fibrous PEAT	1					
	push				2	703. / 783. / 340.			0.42 / 0.18 / 0.30	
	push				3					
10	push				4					
	push			gy. org. SILT, mixed with org. fibrous mat'l, occ. pkts peat and m-f. sand.	5					
20	push				6					
	1½, 1½, 2			dk. br. PEAT, pkts. clayey silt relatively compact	7					
30	push			gy. SILT, tr. org. material occ. pcs. wood, occ. thin layers or lenses f. sand.	8	46.3			0.78	
	push			gy. f. sandy SILT occ. thin parting m-f sand	9					
40	driven 2,3,5			black PEAT, pkts clayey silt relatively compact	10					
				BOTTOM OF BORING						
50										
60										

C.B.A ENGINEERING LTD.

PORT MANN BRIDGE
PROPOSED RELOCATION OF C.N.R.

R. A. SPENCE, SOILS & FOUNDATION ENGINEERS
1564 ROBSON STREET VANCOUVER, B.C.

SUBSURFACE EXPLORATION
LOG - BORING NO. B3 SHEET 1

DATE DRILL'G: Mar '59
REPORT: Apr '59
DWG.:

BORING NO. B 4.

LOCATION see location dwg 500' EAST OF BRIDGE ℄

GROUND SURFACE ELEV. ______

GROUND WATER ELEV. ______ (AT TIME OF BORING) ______

METHOD OF SAMPLING: WASH BORING

CASING 2½ O.D., HAMMER 300 LBS., DROP ___ INCH

□ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

▮ THINWALL SHELBY, 2 O.D. AND ___ O.D.

▯ PISTON SAMPLE

X LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	NATURAL WATER CONTENT
0–10	push (lost)			br. fibrous PEAT	1	
	push				2	638
10–25	push			gy. org SILT, tr. org. fibrous mat'l, tr. f. sand.	3	87.6
	push				4	47.8
	push				5	42.0
25–33	push			gy. org. SILT, considerable fibrous org. mat'l.	6	110.
	push				7	49.5
33–41	1,1,1½			gy. f sandy SILT, occ v. thin layers m-f. sand.	8	32.9
41–43	2½,2½,4			black PEAT, pkts gy. clayey silt, relatively compact.	9	256.

BOTTOM OF BORING

C.B.A. ENGINEERING LTD.	R. A. SPENCE, SOILS & FOUNDATION ENGINEERS 1564 ROBSON STREET VANCOUVER, B.C.	
PORT MANN BRIDGE PROPOSED RELOCATION C.N.R. PORT MANN B.C.	SUBSURFACE EXPLORATION LOG - BORING NO. B4 SHEET 1	DATE DRILL'G: MAR '59 REPORT: APR '59 DWG.:

BORING NO. B.5

LOCATION see location dwg. 750' EAST OF BRIDGE ℄

GROUND SURFACE ELEV. ____

GROUND WATER ELEV. ____ (AT TIME OF BORING) ____

METHOD OF SAMPLING: WASH BORING

CASING 2½ O.D., HAMMER 350 LBS., DROP ____ INCH

☐ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

■ THINWALL SHELBY, 2 O.D. AND ____ O.D.

▯ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

DEPTH-FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	UNCONF. COMP. STRENGTH (Kg/cm²)	CONSOLIDAT'N
0				br. fibrous PEAT						
	push				1					
10	push				2	63.5, 242, 319, 240, 156			0.54, 0.76, 0.76, 0.98, 0.38	
	push			gy. org SILT, scattered pcs & pkts org. fibrous material	3					
20	push				4					
	push				5					
30	push				6					
	2,2,4			gy. f sandy SILT, occ. thin layers or lenses m-f. sand.	7					
40	2,2,3			black PEAT, pkts gy. clayey silt, relatively compact	8					
				BOTTOM OF BORING						
50										
60										

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PORT MANN BRIDGE
PROPOSED RELOCATION C.N.R.
PORT MANN, B.C.

SUBSURFACE EXPLORATION
LOG - BORING NO. B5 SHEET 1

DATE DRILL'G: MAR 59
REPORT: APR 59

DWG.:

BORING NO. B6

LOCATION see location dwg 1000' EAST OF BRIDGE ℄

GROUND SURFACE ELEV.

GROUND WATER ELEV. (AT TIME OF BORING)

METHOD OF SAMPLING: WASH BORING.

CASING 4 O.D., HAMMER 350 LBS., DROP ___ INCH

☐ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

▪ THINWALL SHELBY, 3" O.D. AND ___ O.D.

▮ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	UNCONF. COMP. STRENGTH Kg/cm²	CONSOLIDAT'N
0	push			br. fibrous PEAT	1	726.				
10	push				2					
	push				2A	229.				
	push			gy. org. SILT, tr. org. fibrous mat'l, tr f. sand.	3	50.8				
20	push			br. fibrous PEAT, tr. silt.	4	84.8 392.				
	push			gy. org SILT, sm. org. fibrous mat'l in pkts, etc	5	87.0				
30	push				6	36.4				
	2,3,4			gy. f. sandy SILT occ. thin layers or pkts m-f sand.	7	35.6				
40	DRIVEN			black PEAT, pkts gy. clayey silt. relatively compact.	8	320.?				
	push			gy. clayey SILT, occ. partings m-f sand	9	40.0 33.9			0.98	see graph
50	9,11,14			gy. m-f. SAND	10					
				BOTTOM OF BORING						
60										

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1564 ROBSON STREET VANCOUVER, B.C.

PORT MANN BRIDGE
PROPOSED RELOCATION OF C.N.R.

SUBSURFACE EXPLORATION
LOG - BORING NO B6 SHEET 1

DATE DRILL'G: MAR '59
REPORT: APR '59

BORING NO. B-7

LOCATION see location dwg 410' WEST OF BRIDGE ℄

GROUND SURFACE ELEV.

GROUND WATER ELEV.

(AT TIME OF BORING)

METHOD OF SAMPLING: WASH BORING

CASING 2½ O.D., HAMMER 350 LBS., DROP ___ INCH

□ DRIVE SAMPLE 1⅜" I.D., HAMMER 140 LBS., DROP 30 INCH (BLOWS PER 6" PENETRATION UNLESS OTHERWISE NOTED)

▮ THINWALL SHELBY, 2" O.D. AND ___ O.D.

▮ PISTON SAMPLE

╳ LOST SAMPLE

W.S. WASH SAMPLE

DEPTH - FT	BLOWS ON SAMPLER (ELEV.)	SYMBOL	BLOWS/FT ON CASING	DESCRIPTION	SAMPLE NO.	
	push			brown fibrous PEAT	1	
10	push				2	
	push			gy. org. SILT, mixed with org. fibrous material occ. pkts of peat and m.f. sand	3	
20	push				4	
	push				5	
30	push				6	
	3,4,5			gy. f. sandy SILT	7	
40	1,3,5			black PEAT, pkts clay silt relatively compact	8	
				gy. SILT, tr. org. material, small pkts peat, partings f. sand	9	
50	1,2,2			m. f. SAND		
				BOTTOM OF BORING		

C.B.A. ENGINEERING LTD.

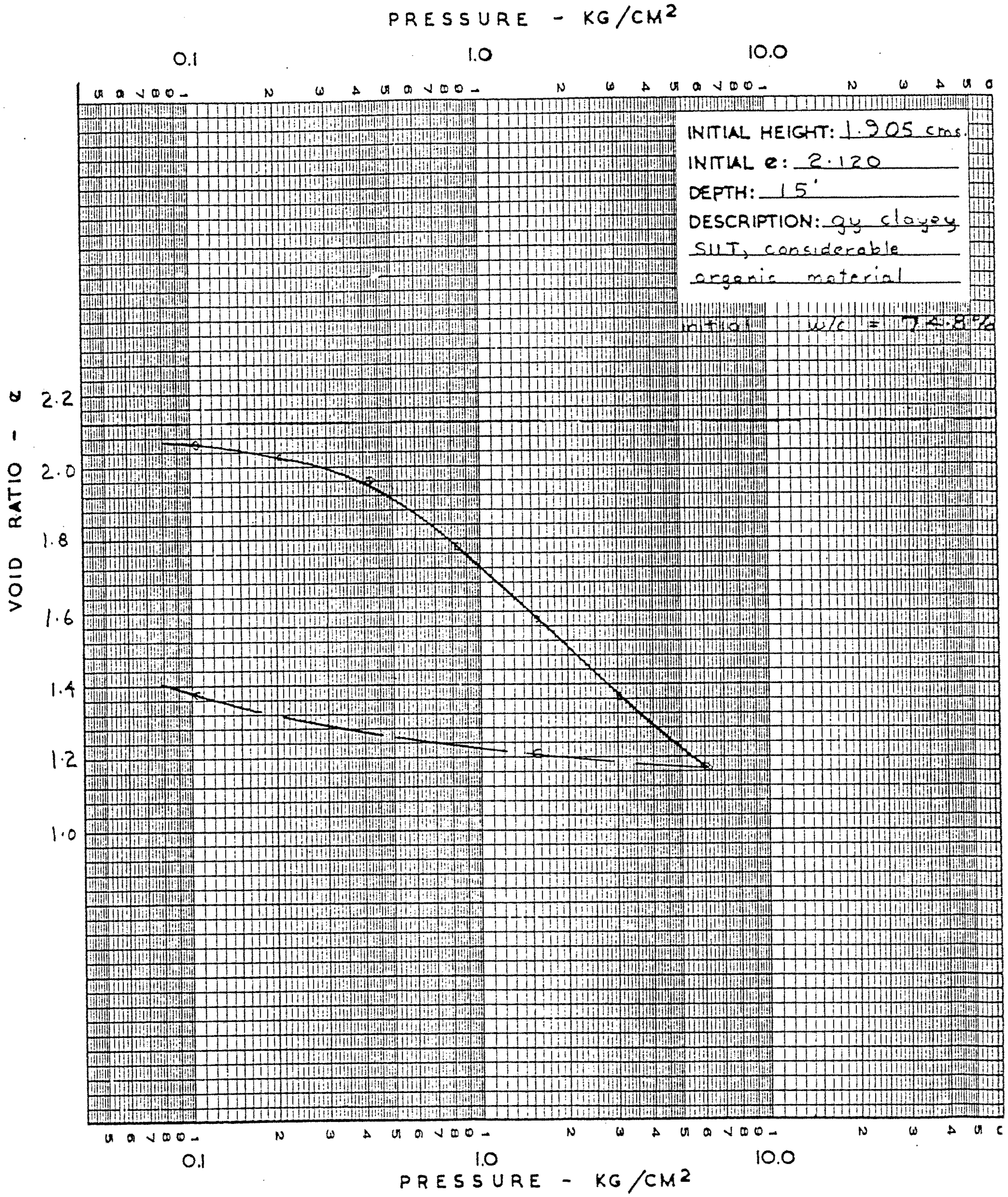
PORT MANN BRIDGE
PROPOSED C.N.R. RELOCATION
PORT MANN, B.C.

R. A. SPENCE, SOILS & FOUNDATION ENGINEERS
1564 ROBSON STREET VANCOUVER, B.C.

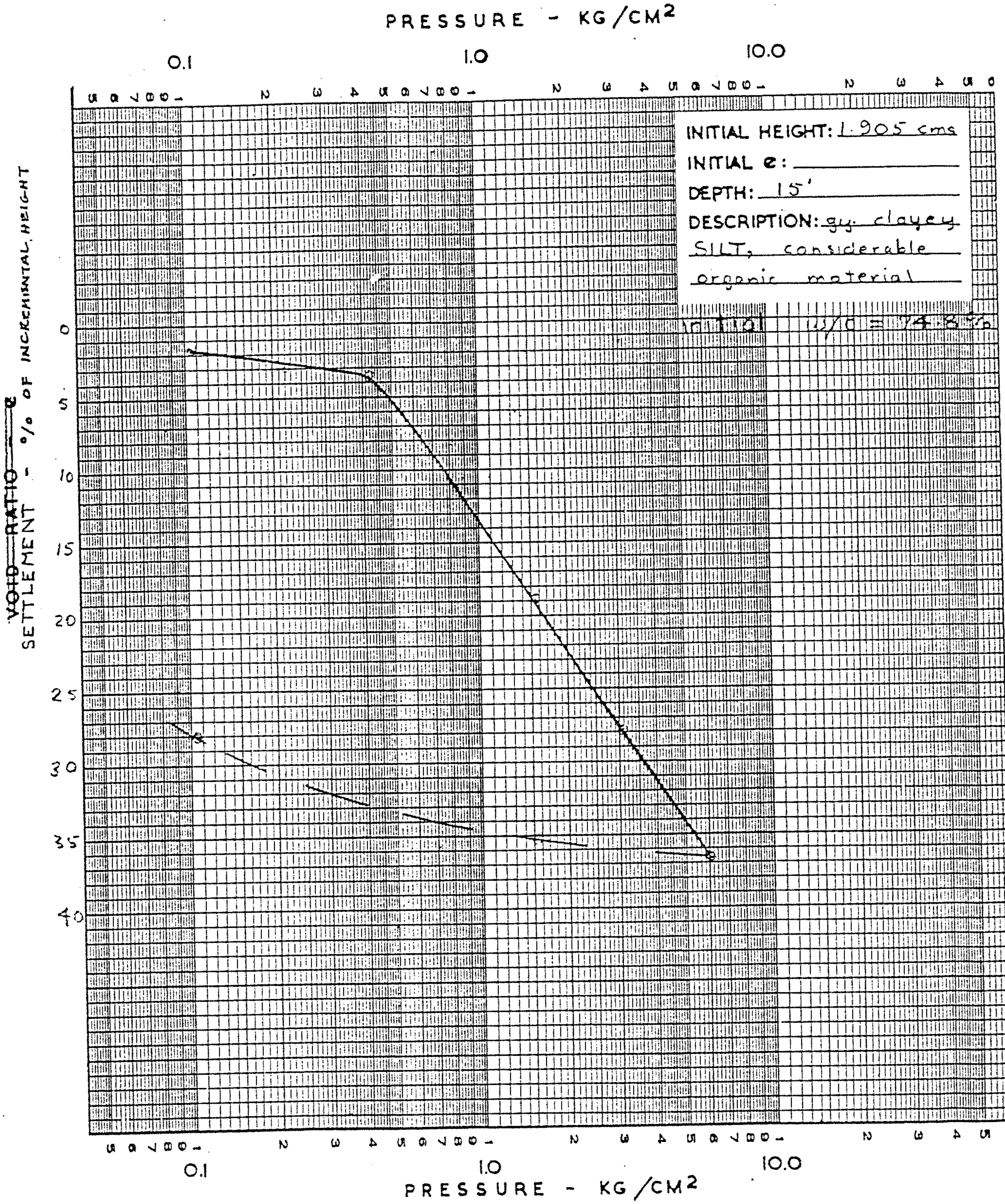
SUBSURFACE EXPLORATION
LOG - BORING NO. B-7 SHEET 1

DATE DRILL'G: FEB '59 REPORT: MAY '59

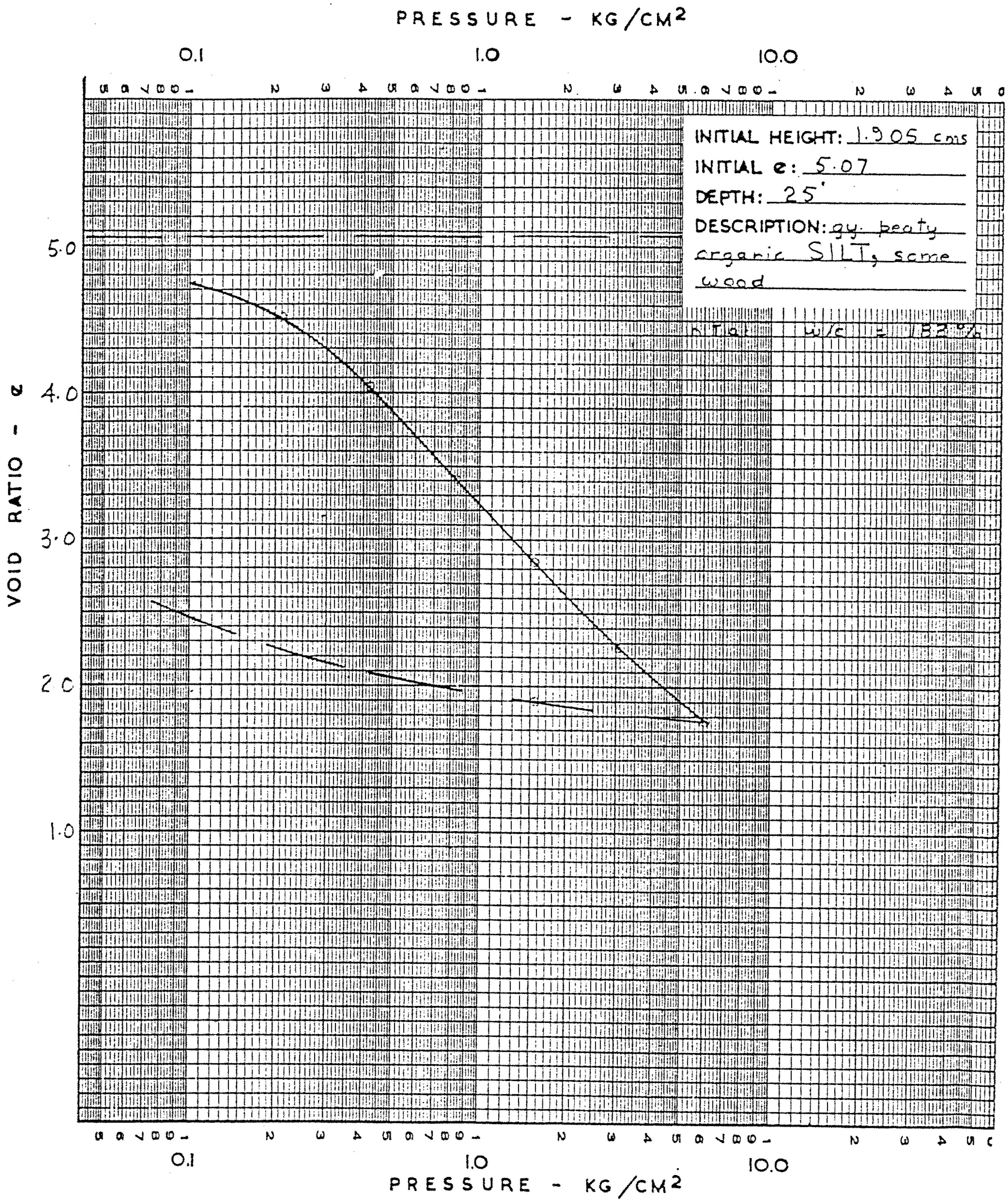
DWG.:



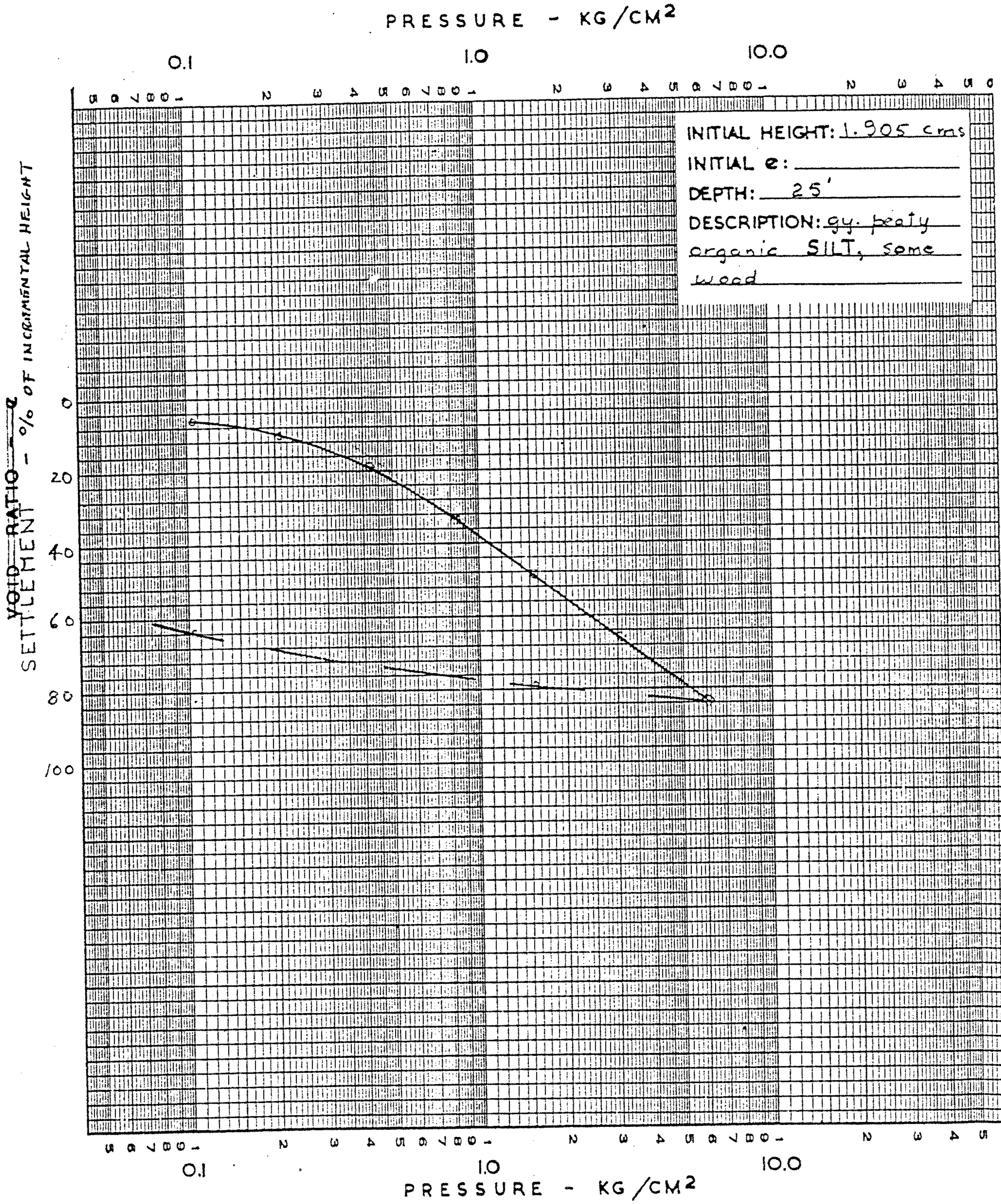
C.N.R. RELOCATION PORT MANN	CONSOLIDATION TEST	JOB NO: 144
R. A. SPENCE, P. ENG.	HOLE 1 SAMPLE 5	DATE: Mar 24/59



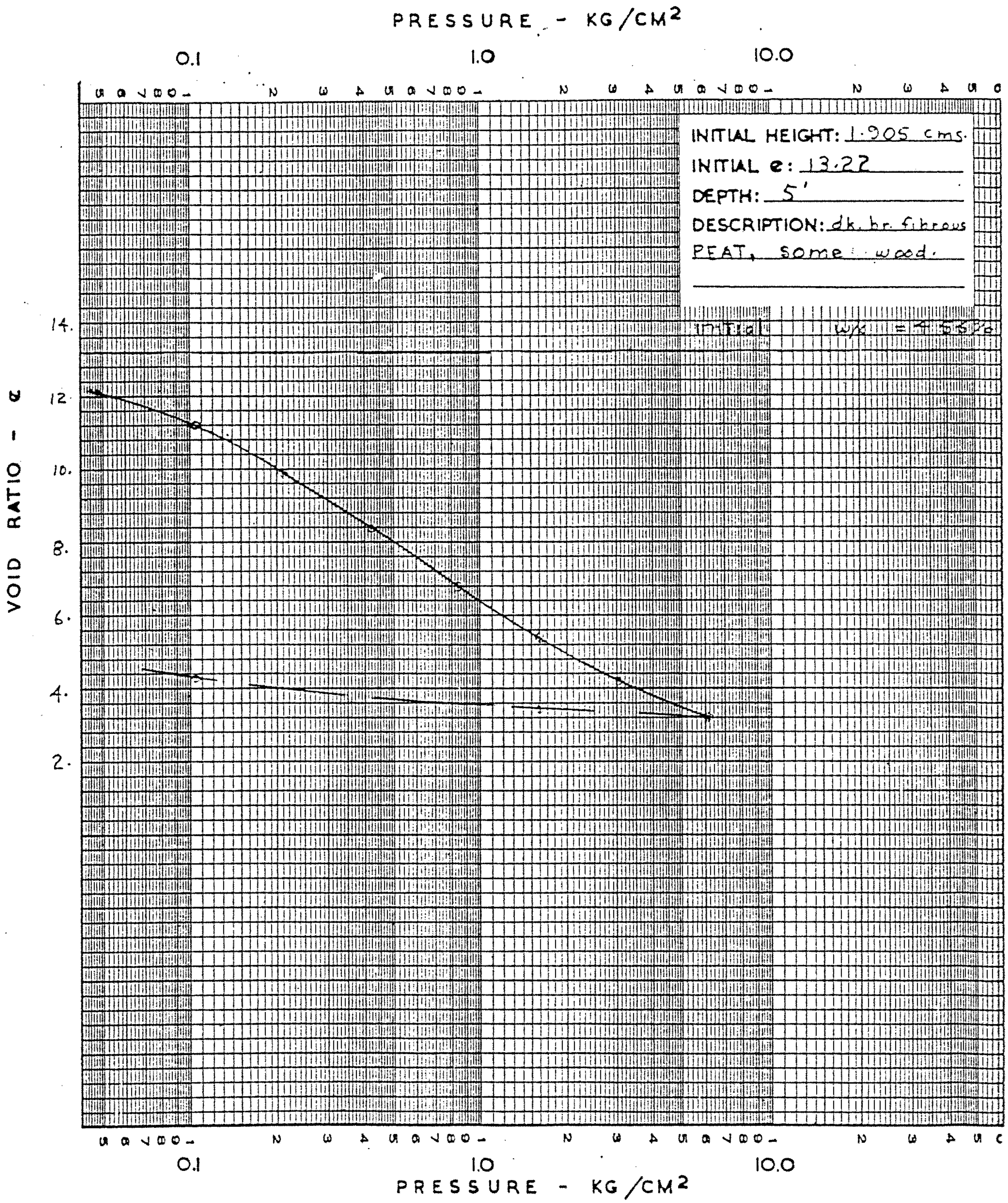
C.N.R. RELOCATION PORT MANN	CONSOLIDATION TEST	JOB NO: 144
R.A. SPENCE, P. ENG.	HOLE 1 SAMPLE 5	DATE: Mar 24/59



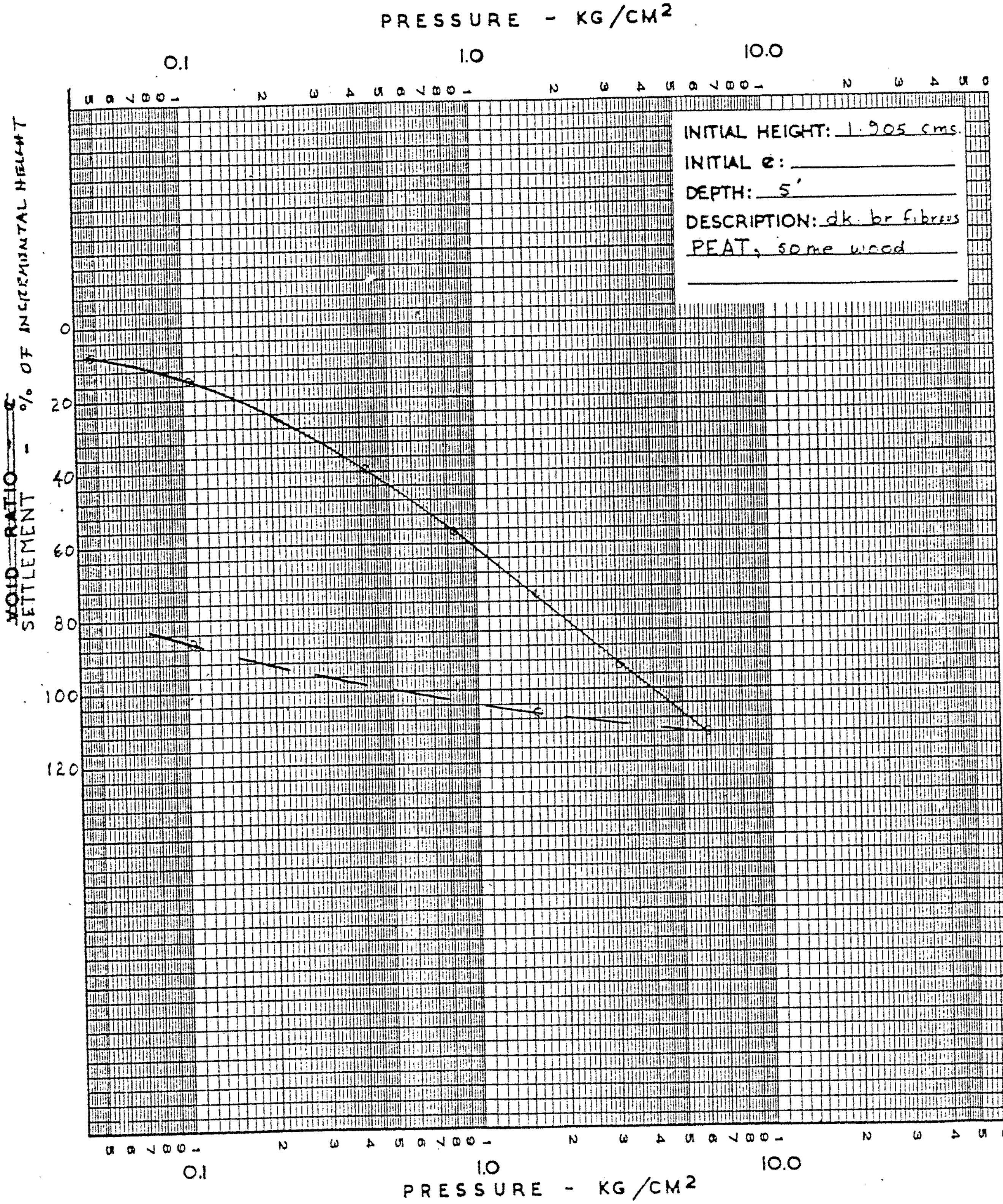
C.N.R. RELOCATION PORT MANN	CONSOLIDATION TEST	JOB NO: 144
R.A. SPENCE, P. ENG.	HOLE 1 SAMPLE 7	DATE: Mar 16, 1959



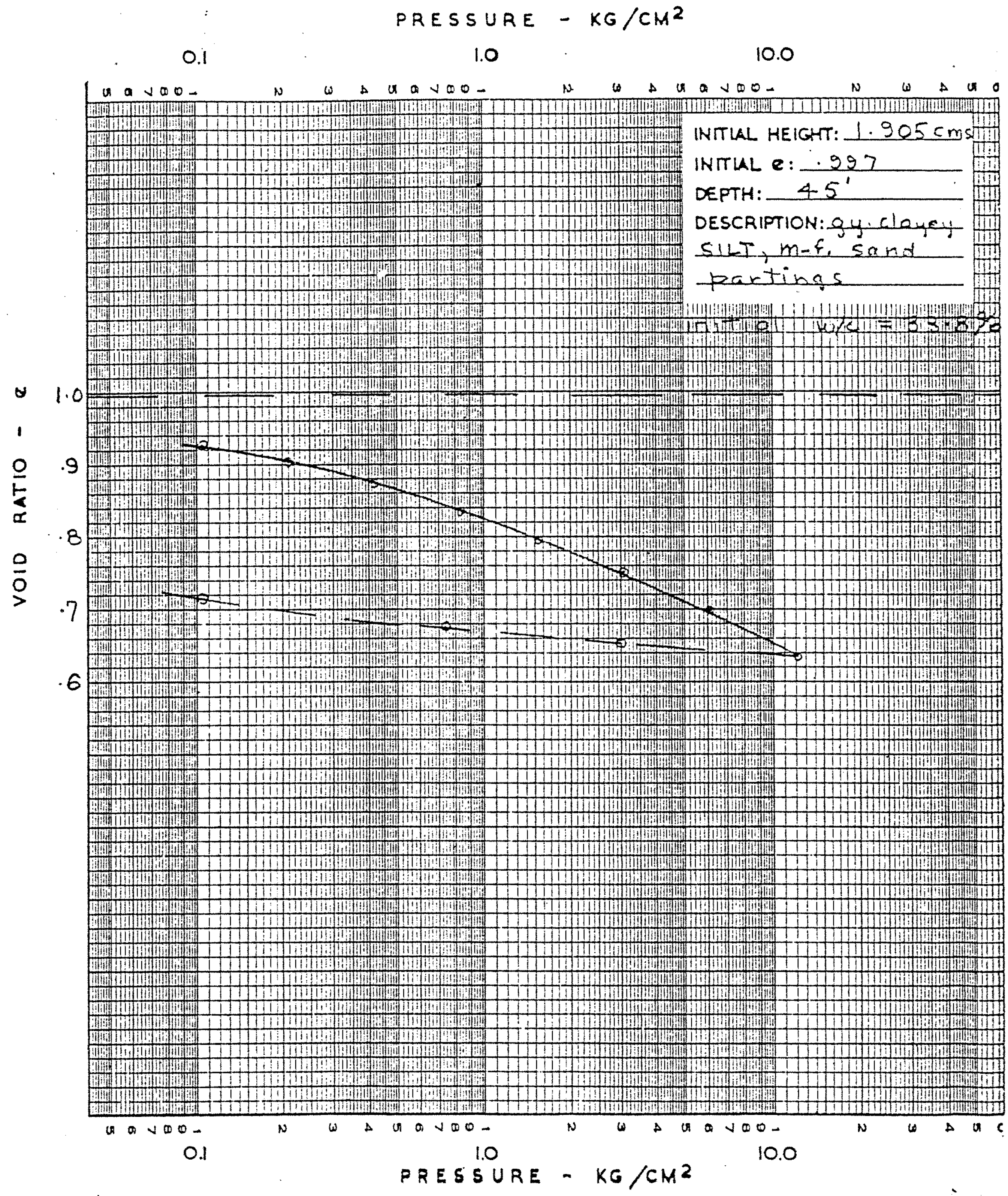
C.N.R. RELOCATION PORT MANN	CONSOLIDATION TEST	JOB NO: 144
R.A. SPENCE, P. ENG.	HOLE 1 SAMPLE 7	DATE: Mar 17/59



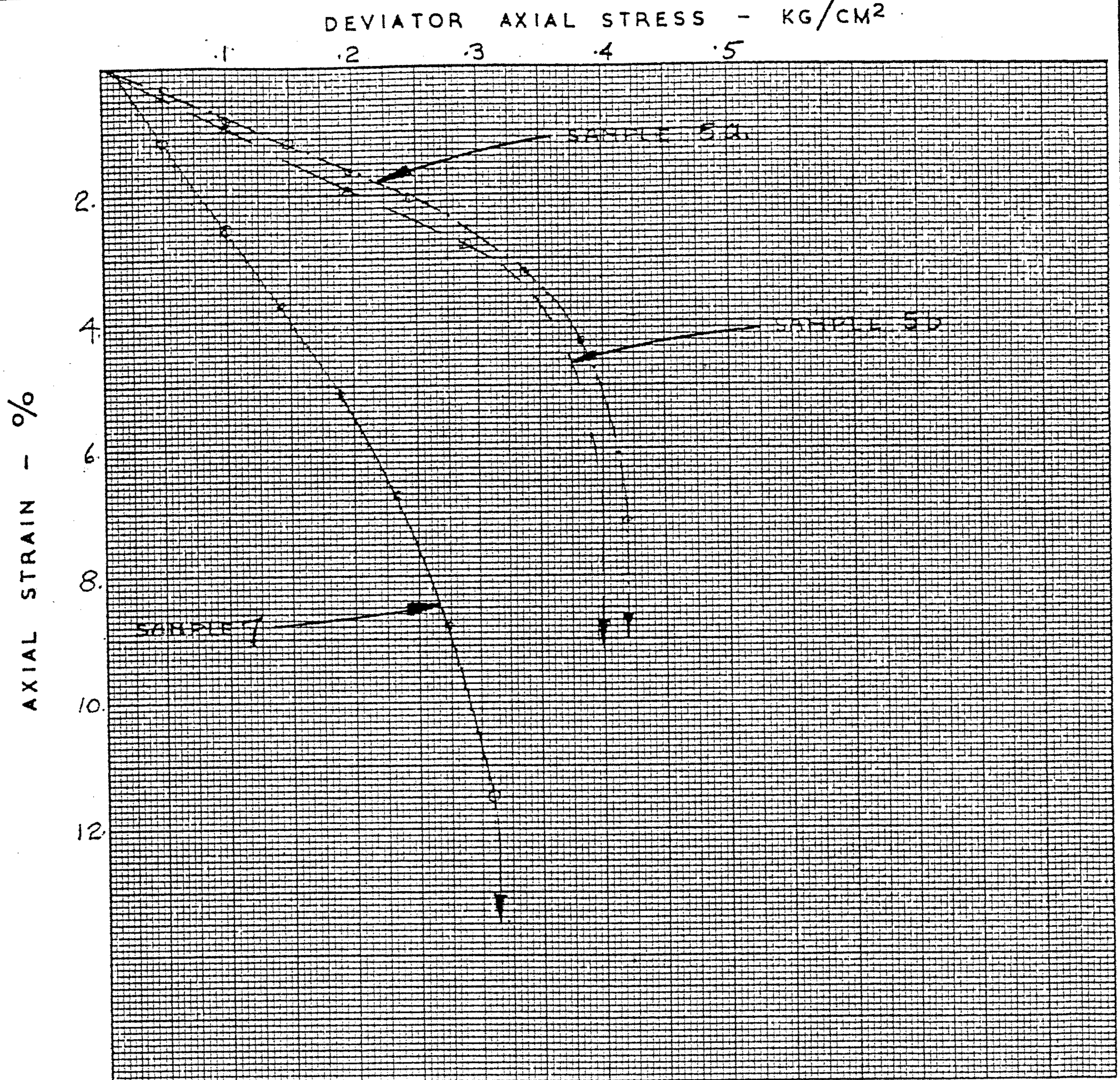
C.N.R. RELOCATION PORT MANN	CONSOLIDATION TEST	JOB NO: 144
R.A. SPENCE, P.ENG.	HOLE 2 SAMPLE 2	DATE: Mar 11/55



C.N.R. RELOCATION PORT MANN	CONSOLIDATION TEST	JOB NO: 144
R. A. SPENCE, P. ENG.	HOLE 2 SAMPLE 2	DATE: Mar 11/5

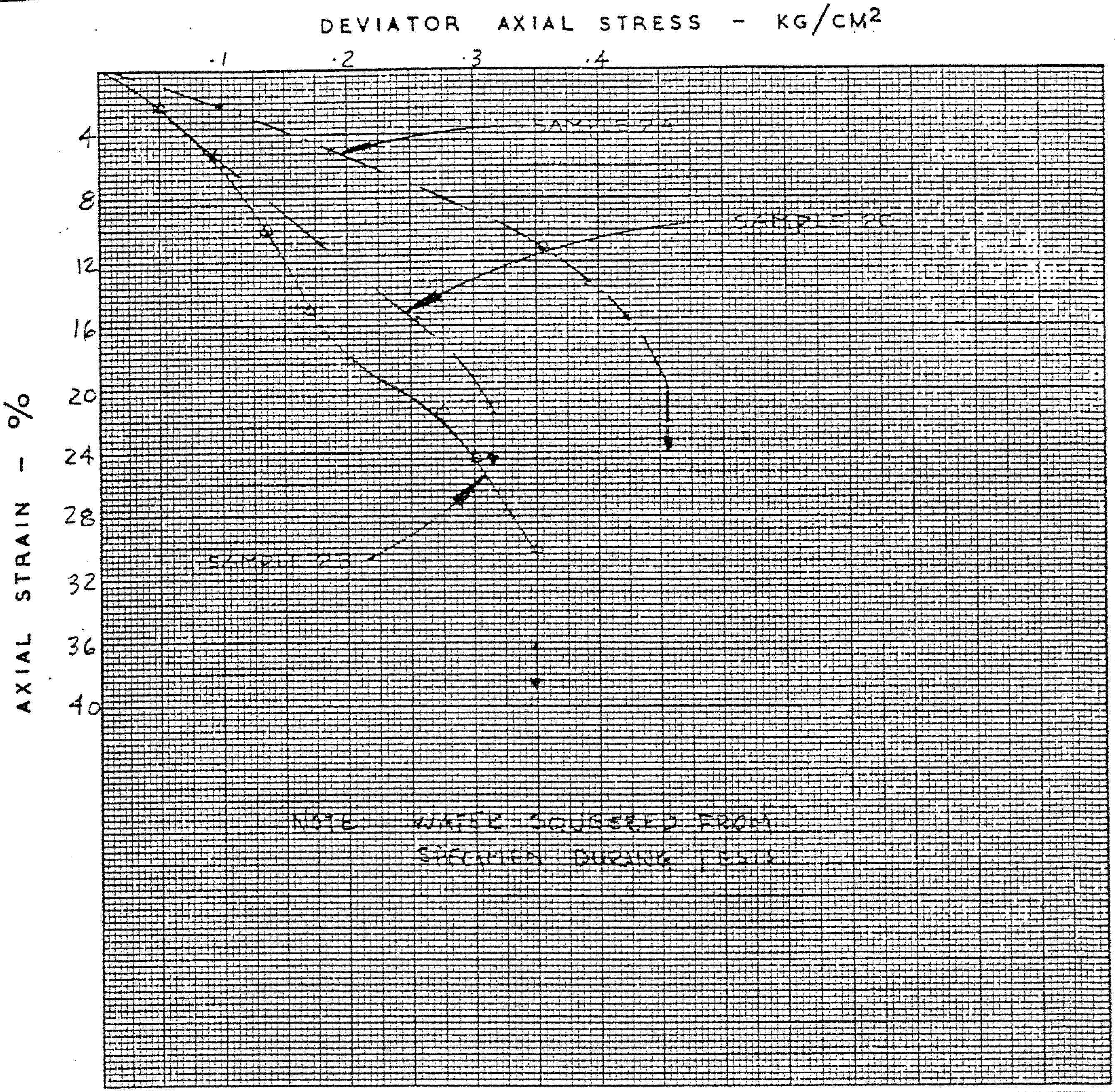


C.N.R. RELOCATION PORT MANN	CONSOLIDATION TEST	JOB NO: 144
R.A. SPENCE, P.ENG.	HOLE 6 SAMPLE 9	DATE: Apr.6/58



SPECIMEN HOLE	S'PLE	DEPTH	DESCRIPTION	INITIAL HT. CM	DIA. CM	STRENGTH P_c KG/CM²	σ_3	AXIAL STRAIN %	WATER CONT. INITIAL %	FINAL %
1	5a	15'	gy. organic SILT, considerable organic mat'l. (sensitive)	8.5	3.58	0.37	0	4.0		92.5
1	5b	15'	" " "	9.1	3.58	0.36	0	4.0		81.5
1	7	25'	gy. peaty organic SILT, occ. pce wood, occ. pocket silt	8.0	3.58	0.31	0	12.0		157

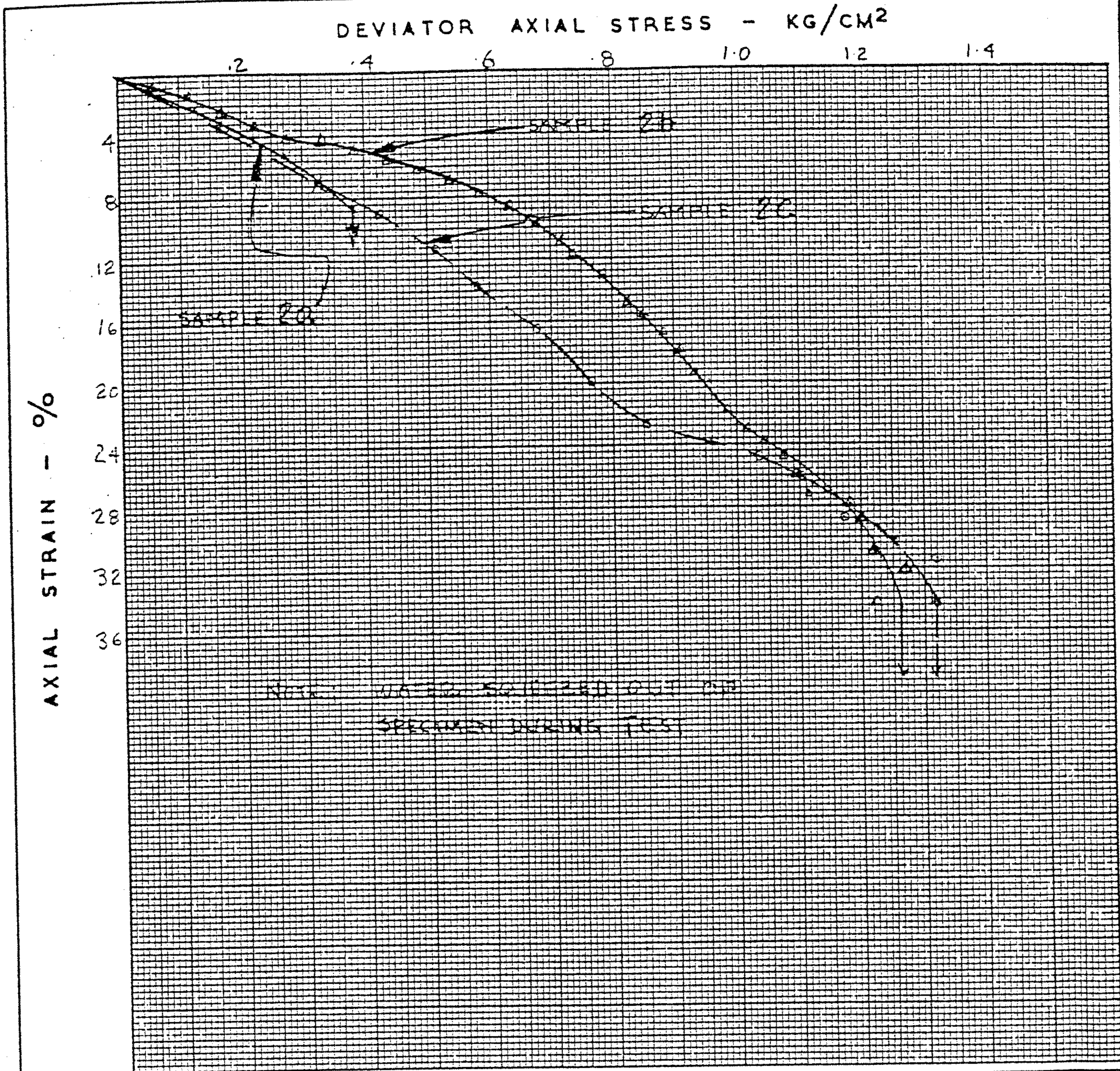
C.N.R. RELOCATION PORT MANN	UNCONFINED COMPRESSION TEST	JOB NO. 144
R. A. SPENCE, P.ENG.	HOLE 1 SAMPLE 5, 7	DATE: Apr. 13/59



SPECIMEN			DESCRIPTION	INITIAL		STRENGTH		AXIAL	WATER CONT.	
HOLE	S'PLE	DEPTH		HT. CM	DIA. CM	P_c KG/CM²	σ_3	STRAIN %	INITIAL %	FINAL %
3	2A	5'	br. fibrous PEAT, occ. pce decayed wood	8.8	3.58	.42	0	16	703	652
3	2B	5'6"	" " "	7.0	3.58	.18	0	16	783	647
3	2C	6'0"	br. fibrous PEAT, occ. thin parting gy. clayey silt	9.7	3.58	.30	0	20	340	314

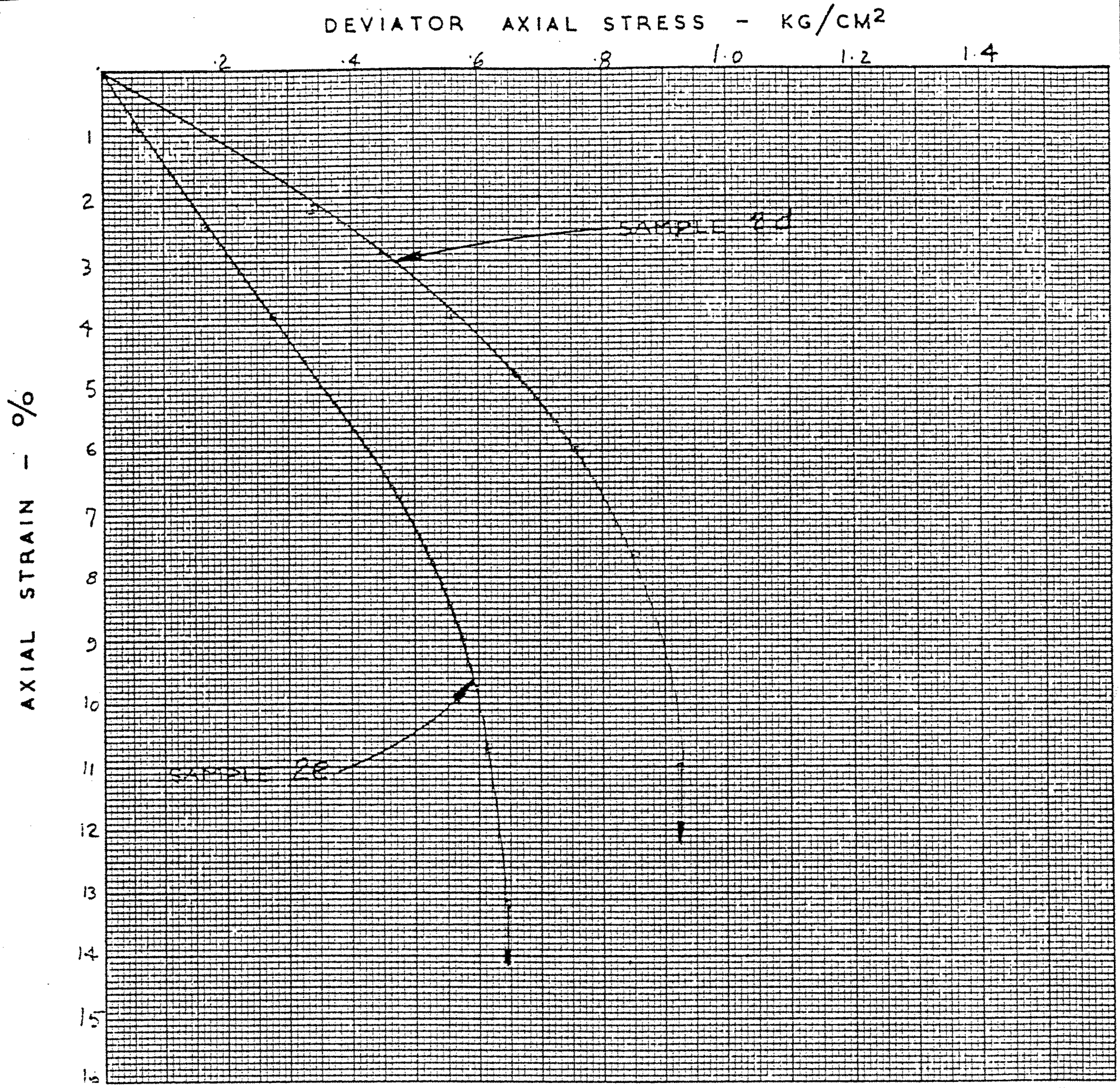
C.N.R. RELOCATION PORT MANN	UNCONFINED COMPRESSION TEST	JOB NO. 144
R. A. SPENCE, P.ENG.	HOLE 3 SAMPLE 2	DATE: MAY 6/59

Form S2-58



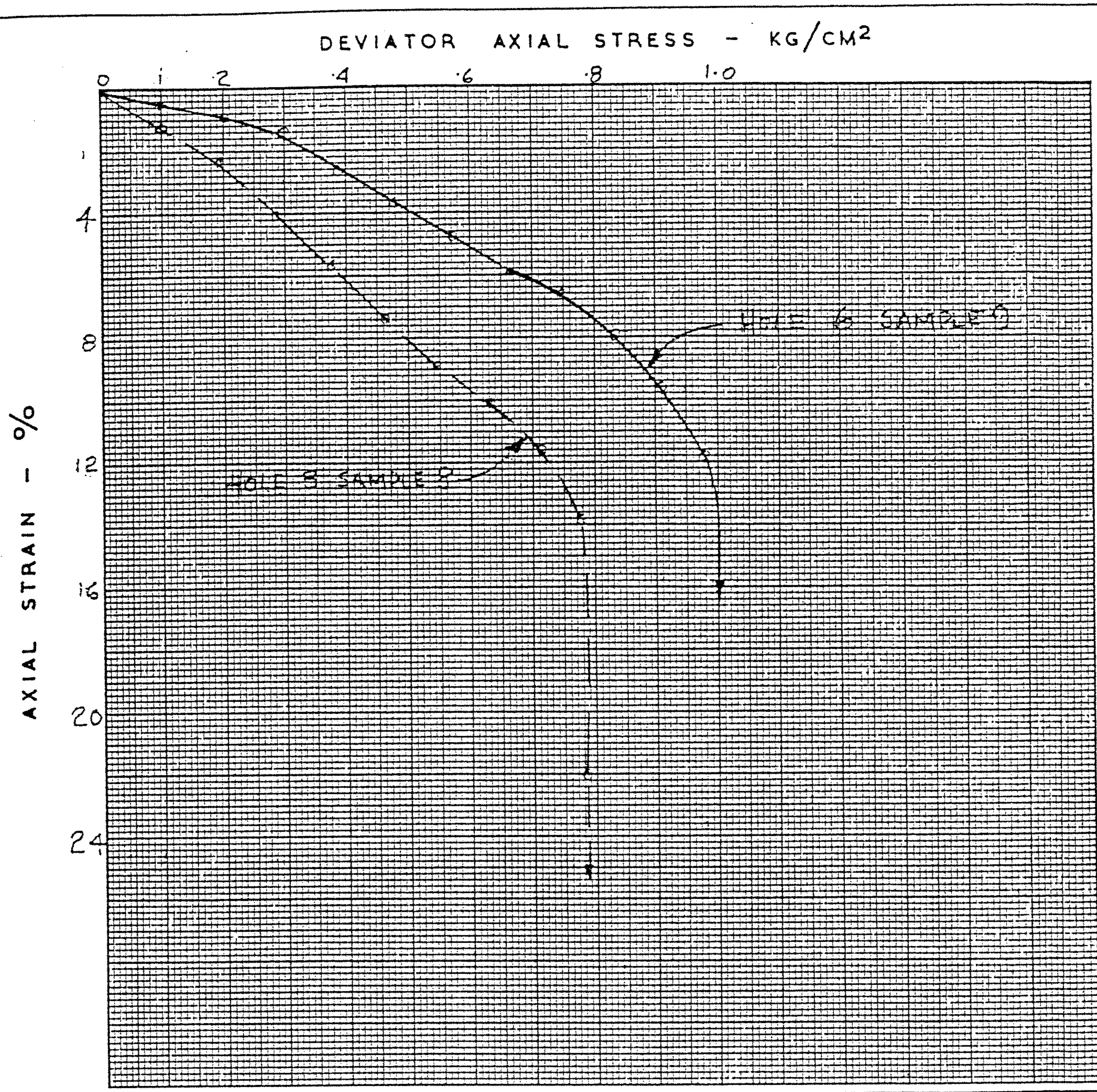
SPECIMEN HOLE	S'PLE	DEPTH	DESCRIPTION	INITIAL HT. CM	INITIAL DIA. CM	STRENGTH P_c KG/CM²	σ_3	AXIAL STRAIN %	WATER CONT. INITIAL %	WATER CONT. FINAL %
5	2a	11'8"	gy. br. peaty SILT (compact)	8.42	4.71	0.38	0	8.6		156
5	2b	11'2"	br. fibrous PEAT, some silt	9.10	4.71	0.98	0	22.		249
5	2c	10'8"	br. fibrous PEAT, tr. silt	7.5	4.71	0.76	0	20.	481	379

C.N.R. RELOCATION PORT MANN	UNCONFINED COMPRESSION TEST	JOB NO. 144
R. A. SPENCE, P.ENG.	HOLE 5 SAMPLE 2	DATE: APR. 24/59



SPECIMEN HOLE	S'PLE	DEPTH	DESCRIPTION	INITIAL HT. CM	DIA. CM	STRENGTH P_c KG/CM²	σ_3	AXIAL STRAIN %	WATER CONT. INITIAL %	FINAL %
5	2d	10'4	br. PEAT, tr. silt (compact)	8.8	4.71	·76	0	6		242
5	2e	10'	gy. organic SILT, some organic mat'l.	8.4	4.71	·54	0	8		63.5

C.N.R. RELOCATION PORT MANN	UNCONFINED COMPRESSION TEST	JOB NO. 144
R. A. SPENCE, P. ENG.	HOLE 5 SAMPLE 2	DATE: MAY 4/59



SPECIMEN HOLE	S'PLE	DEPTH	DESCRIPTION	INITIAL HT. CM	DIA. CM	STRENGTH P_c KG/CM²	σ_3	AXIAL STRAIN %	WATER CONT. INITIAL %	FINAL %
3	8	30'	gy. org. SILT, thin lenses f. sand occ. pce. wood and peat	7.6	3.58	0.78	0	14		46.3
6	9	45'	gy. clayey SILT, f. sand partings tr. organic mat'l.	7.9	3.58	0.98	0	12		40.0

CNR. RELOCATION PORT MANN	UNCONFINED COMPRESSION TEST	JOB NO. 144
R. A. SPENCE, P. ENG.	HOLE 3 / 6 SAMPLE 8 / 9	DATE: Apr 12/59