HARDY ASSOCIATES (1978) LTD.

N10-24

JSP

GEOTECHNICAL STUDY
NORTH SHORE
PORT MOODY, B. C.

Prepared For

CITY OF PORT MOODY

By

HARDY ASSOCIATES (1978) LTD.
BURNABY, B. C.

August 19, 1980.

Q-2270-001

OFFICE COPY

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

2.0 SITE LOCATION 3

3.0 FIELD PROCEDURES 4

4.0 LABORATORY TESTING 5

5.0 GEOTECHNICAL SUMMARY 6

- 5.1 Soil Conditions 6
- 5.2 Groundwater Conditions 7

6.0 EXISTING SLOPE STABILITY 9

7.0 STABILITY OF DEVELOPED SLOPES 11

- 7.1 Setback Distances 11
- 7.2 Noons Creek Slopes 14
- 7.3 Noons Creek Drive 15
- 7.4 Axford Bay to Campbell Road 16
- 7.5 April Road to Axford Bay 18
- 7.6 Secondary Creeks 19
- 7.7 Other Considerations 20

8.0 CONCLUSION 20

APPENDIX A - Geology Groundwater

APPENDIX B - Explanatory of Terms and Symbols
Test Hole Logs
Piezometer Installation Reports
Laboratory Tests

1.0 INTRODUCTION

On behalf of the City of Port Moody, Hardy Associates (1978) Ltd. has undertaken a geotechnical study of the North Shore of Port Moody. The primary purpose of the study is to assess the potential for the occurrence of a major deep seated landslide on the undeveloped lands within the limits of the city's North Shore. This study is also directed toward:

(i) Identifying areas of potential problems of stability associated with residential development.

(ii) Providing general guidelines for development.

(iii) Providing recommendations for any necessary future investigations.

The initial phase of this investigation consisted of a review of existing information and a study of geologic and geomorphic features from air photographs and from a field reconnaisance. A report on the results of this first phase of our investigation was submitted on April 3, 1980 to Aplin & Martin Engineering Ltd., consultants to the City of Port Moody. This report contained our preliminary opinions regarding the stability of the North Shore and presented preliminary guidelines for residential development. The first phase of the investigation is covered by the City of Port Moody Purchase Order Number 2424.

This report presents the results of our second phase of the investigation of the stability of the North Shore. This phase consisted of the drilling of 8 test holes to depths of up to 190 feet. The purpose of these test holes was to supplement the surface information collected in Phase I with information concerning soil properties, groundwater conditions and stratigraphic sequence. The results of this additional information has been used to confirm and expand upon the conclusions drawn and recommendations presented in our preliminary report.

In this second phase, because of the general nature of this investigation, our conclusions and recommendations are directed at identifying and solving potential regional problems rather than local site specific problems. It is envisaged that the results of this report would be used in the development of the overall neighbourhood concept. Site specific problems would be handled at the subdivision stage by separate geotechnical investigation directed toward the solution of the problems identified here in addition to the routine geotechnical investigation normally conducted at that stage.

The cost of this second phase of the investigation is covered by Purchase Order Number 2333 from the City of Port Moody.

2.0 SITE LOCATION

The area included in this investigation is located within the city limits of Port Moody on the northern side of Burrard Inlet. This investigation is directed specifically to the city owned and privately owned lands which are presently undeveloped within this area. The existing development is confined to a narrow strip of land along the north shore of Burrard Inlet and to the eastern margins of Noons and Mossom Creek.

The proposed north shore development is located on the southern slope of Eagle Mountain and lies on the physiographic boundary between the Coast Mountain range and the Fraser Lowlands.

Access to the site is restricted primarily to a number of roads located around the perimeter of the site. The upper slopes are heavily treed and access to the central areas can be gained only on foot.

3.0 FIELD PROCEDURES

A total of 8 test holes were drilled between June 2 and July 11, 1980, the locations of which are shown on Drawing Q-2270-001 A. The holes were drilled with a truck mounted Mayhew 1000 rotary drill rig using a bentonite-base drilling mud. A small bulldozer was needed to clear an access trail to the test hole 6 location and also to assist the drill rig up the rather steep grade to the hole site under adverse weather conditions.

The holes were drilled to depths ranging between 50 feet and 190 feet depending upon soil conditions and the position of the hole on the slope. The soils encountered were examined visually and classified by a geological engineer from our office. Representative soil samples were recovered using a 2 inch outside diameter split spoon sampler driven with a 140 pound hammer. These samples were stored in airtight containers and returned to our laboratory for testing. The test hole logs and laboratory test results are presented in Appendix B. A summary of the terms and symbols are used on the logs is also presented in Appendix B.

In order to evaluate regional groundwater conditions, pneumatic and standpipe type piezometers were placed in selected boreholes. Clean sand backfill was used as a filter material around the piezometer tips. Isolation of a particular stratigraphic unit was accomplished by placing at least 1 foot of bentonite sealant on either side of the zone. Piezometric readings taken immediately after drilling are meaningless because of the fluid introduced during drilling. Therefore, long term monitoring was necessary to evaluate the true groundwater regime.

Due to the very dense and bouldry nature of the soils encountered, the drilling progressed rather slowly and resulted in a total of 23 tricone bits to be worn out. Frequent equipment maintainance due to the difficult drilling and poor weather conditions further delayed completion of the investigation.

4.0 LABORATORY TESTING

Moisture content determinations were performed for all the samples. Generally, the moisture contents range between 10 and 20 percent. Gradation analyses were conducted on samples of sand from TH-1 and 4. The grain size distribution curves are presented in Appendix B. In addition, liquid and plastic limits were determined for the silt encountered in test hole 1.

5.0 GEOTECHNICAL SUMMARY

5.1 Soil Conditions

Four predominant soil groups occur within the area of investigation. The approximate distribution of these groups are shown on Drawing Q-2270-001 A, located in the pocket following the text of this report.

The western portion of the site is underlain by a deep deposit of dense sand, preglacial in age. The sand is generally fine to medium grained with occasional lenses of coarse sand or gravel. The undisturbed sand is capable of standing vertically in low slopes, suggesting a high relative density and possibly some degree of cementation or interpenetration of grains. However, the sand is easily eroded by surface or subsurface water. This material was encountered in TH-1 from the ground surface to a depth of 190 feet.

Glacial till overlies a portion of the preglacial sand in the western part of the site and occupies most of the area north and east of the crest of the slope above Ioco Road. This glacial till consists of sand and silt sized soil with gravel and frequent cobbles and boulders. This soil was subjected to high pressures during its deposition and is in a very dense condition. As a result of its high density the till has a relatively low permeability. However, occasional stratified sand layers were found to occur in most of the test holes and these are believed to be water bearing. The till was encountered in TH-2 and TH-5 through 8.

Glacio-marine sediments composed of stratified sand, silt and gravel and till-like mixtures occur between Ioco Road and the crest of the steep slope north of Ioco Road. These soils were encountered in test holes 3 and 4. They are generally compact to dense near the ground surface but rapidly increased in density with depth. Exposures of the soil near Barber Street and Walton Way indicate that the stratification within these deposits may be sub-parallel to the slope of the ground.

A more detailed description of the geology and the soil types may be found in Appendix A of this report. The test hole logs, containing a precise description of the soil type, standard penetration blow counts and moisture content, may be found in Appendix B.

5.2 Groundwater Conditions

The groundwater regimes which exist on the North Slope are intimately related to the major soil units recognized in the area. The groundwater associated with the glacial till unit is primarily confined to the more permeable thin mantle of sand and gravel above the till surface. The groundwater is the result of the infiltration of rainfall and consequently, the volume of seepage on the till surface will have peak flows that lag behind the peak precipitation. The groundwater table within the glacial till is difficult to measure due to the low permeability of the till. Where the till was found to contain stratified sand lenses, the sand was believed to be water bearing. These water bearing sand lenses could produce a significant volume of seepage into excavations or onto slopes.

In the glacio-marine sediments the groundwater table was found to be close to the ground surface resulting in significant seepage from sand layers in the sediments. Where a sand layer is confined between materials of low permeability such as the till, artesian pressures can result due to the inclined attitude of the sediments.

The preglacial sand has a relatively high groundwater table in the area along the upper end of April Road. In TH-1 the groundwater table was measured at a depth of 90 feet (27.4 m) which suggests that the groundwater table becomes deeper further to the north. The absence of any significant seepage on the upper portions of the east side of Mossom Creek, opposite April Road suggests that the groundwater table increases in depth in the vicinity of Mossom Creek.

A more detailed description of the groundwater conditions are reported in Appendix A to this report.

6.0 EXISTING SLOPE STABILITY

Where the slopes on the North Shore are formed of dense glacial till (Unit 3) and are not underlain by preglacial sand (Unit 3a) the slopes are considered exceptionally stable. The crest of the major east-west slope north of Ioco Road and east of April Road is thought to be formed of dense till. However, TH-5 was the only drill hole in glacial till which was close to this slope and the existence of till along the crest of this slope could not be confirmed in this investigation. Till slopes were also identified along the eastern and western sides of Noons Creek and in the northern portions of the site as indicated on Drawing Q-2270-001 A.

The slopes between Escola Bay and Crawford Bay in the western portion of the site are formed of preglacial sand overlain in part by glacial till which thickens toward the south. The slope angle increases from between 10 and 15 degrees near Escola Bay and increases to about 18 degrees near Crawford Bay. The groundwater table is close to the ground surface over most of this area and there is considerable seepage on the lower half of this slope. Assuming an effective angle of internal friction of 40 degrees, the factor of safety for the steepest section of this slope varies from about 1.2 to 1.6, depending upon the position of the groundwater table. This slope is considered stable but severe groundwater seepage can be anticipated, especially on the lower half of the slope.

The area between the existing developments above Ioco Road and the crest of the slope north of these developments is located in glacio-marine deposits consisting of interbedded till, sand and gravel. These slopes are all less than about 22 degrees and generally flatten out to less than 10 degrees near the existing developments. Groundwater seepage occurs within the existing developments and in the areas on the slope, north of the developments. The potential for the occurrence of low artesian pressures exists in some of the sand layers and artesian pressures were encountered in TH-4. The slope above the existing developments is considered stable against deep seated failure but severe groundwater conditions can be anticipated.

North of April Road and west to Mossom Creek, the slopes consist of preglacial sand which is overlain by a thin layer of glacial till, which thickens toward the north and east. A landslide along the eastern bank of Mossom Creek was recognized and reported in our preliminary investigation. The present lack of access for drilling equipment has excluded this area from the present investigation. It was recommended in our preliminary report that this area should be investigated separately when future development of adjacent lands improves access to the area.

7.0 STABILITY OF DEVELOPED SLOPES

All of the existing slopes, with the exception of the unstable area north and west of April Road, are at equilibrium with the conditions which presently exist on the slopes. To ensure that these slopes remain stable during construction and after development, guidelines are presented for the proposed developable areas.

7.1 Setback Distance

In our preliminary report on the stability of the North Shore slopes, setback distances from the crest of the slopes were presented for preliminary planning. The setback was specified as a theoretical line measured from the crest of the slope, within which, no permanent structures should be constructed. Defining the actual location of this theoretical line is sometimes difficult because of the vague definition of the 'crest of slope'. For the purposes of this report and our preliminary report, the crest of slope is intended to mean, that first sharp discontinuity of slope between the highland area and the creek or valley wall. It is precisely defined as the point of minimum radius of curvature of this discontinuity. Other possible definitions exist but this definition is generally the most precise from the view of slope stability.

Two surveyed lines have been defined along the top of the two major slopes within the area. On the west side of Noons Creek a surveyed line located 20 feet (6 m) back from the point where the slope steepens to 9 degrees or 20 percent grade has been laid out in the field. Along the steep central slope north of Ioco Road, a line defining the crest of bank was established as being that line where the slope angle is equal to 20 percent. This definition is different from the previous definition of the 'crest of slope'. It can be shown that the 20 percent definition of the crest of the slope is more conservative than the definition based upon minimum radius of curvature and it will always lie on the uphill side of the crest of slope as proposed by our definition. Where the crest of the slope is sharp, the difference between the two definitions is negligible, but where the crest of the slope is well rounded the difference between these definitions can be several tens of feet.

In order to utilize the existing survey information concerning the slope crests we have estimated the relative position of our recommended setback distances so that they can be measured with respect to the existing lines. The existing survey lines tend to average the local topography at the top of slopes, often crossing small depressions or gullies near the crest of the major slopes. Where the uniform crest of the slope is interrupted by a gully or depression less than about 10 feet (3 m) deep or 100 feet (30 m) wide, then the 'crest of slope' line can be assumed to be that smooth line joining the adjacent sides of the depression. For deeper or wider gullies, the setback distance should be adjusted to exclude from development, the areas within these gullies which are close to the crest of the slope.

7.2 Noons Creek Slopes

The slopes forming the valley walls of Noons Creek are composed of dense glacial till. In our preliminary report we estimated the factor of safety of the slopes to be close to unity based upon observations of soil creep and surficial movement on the slope. Based upon the result of this investigation we concluded that the slopes are at a factor of safety in excess of 1.5 (the factor of safety of course will vary with slope geometry and local groundwater conditions). No development should be permitted on the slopes within this creek valley and we recommend a reduced setback distance from our preliminary report to 30 feet (9 m) from the crest of the slope. We estimate that this setback would be equivalent to a line 10 feet (3 m) farther back from the slope than the existing surveyed line, which defines the locus of points 20 feet (6 m) uphill of a 20 percent grade. No permanent structures should be constructed within this setback distance. However, temporary structures, park areas or walkways may be established within 10 feet (3 m) of the crest of the slope or 10 feet (3 m) beyond the surveyed line.

7.3 Noons Creek Drive

The slope on the eastern side of Noons Creek Drive south of TH-8 varies in slope from about 12 to 17 degrees. Based upon the information collected in TH-8 the slope is composed of dense glacial till containing saturated sand and gravel lenses. Only one major sand and gravel layer was encountered in TH-8 but other sand layers can be anticipated on other parts of the slope and at other elevations. Despite the relatively low slope angle in this till, trees observed on the slope have curved lower trunks and some trees are leaning. We suspect that the 'drunken' trees are the result of seepage from sand layers located in the till.

This slope is stable against any deep seated movement and the occurrence of seepage on the slope can be controlled. If control measures are found to be required, they may be expected to escalate the cost of development.

We recommend that after clearing, but prior to the design of services for any development within this area, an attempt should be made to locate any concentrated zones of seepage. This would be done preferrably during the winter or spring when precipitation is heaviest and seepage is most severe. It would consist of an inspection of the slope for suspected zones of seepage and the subsequent excavation of test trenches to confirm the soil conditions and source of the seepage. Recommendations based upon this investigation at the subdivision stage would be directed at economically controlling any concentrated zones of seepage encountered, and other geotechnical factors related to the construction of a residential development on the slope.

7.4 Axford Bay to Campbell Road

ESCARPMENT

The steep central slope between these two streets above Ioco Road is believed to be composed of dense glacial till which is overlain by glacio-marine sediments. The glacio-marine sediments thicken from a thin veneer on the upper parts of the slope to over 30 m (100 feet) at the toe of the slope.

The crest of the slope is thought to be composed of dense glacial till which is exceptionally stable. We recommend that 2 test holes be drilled at the top of the slope above the locations of TH-3 and 4, to confirm the existence of glacial till. The test holes should be 12 to 15 m (40 to 50 feet) deep with the provision that the holes may be extended up to 30 m (100 feet) should unusual soil conditions be encountered. Should the crest of slope be confirmed to be glacial till, we would recommend a setback distrance of 50 feet (15 m) from the crest of the slope. We estimate that this would be equivalent to a setback beyond the existing surveyed line, which is the locus of points of 20 percent grade, of 12 m (40 feet). This setback distance would apply to the construction of any permanent structures including swimming pools. Temporary structures, walkways or parks are permitted within this setback distance but it is recommended that the area below the surveyed line be left undeveloped and the natural vegetation, if possible, left as a buffer between the residential development and the natural slope.

From the toe of the steep slope discussed above to the edge of the existing development above Ioco Road is at a slope angle of more than 10 degrees. This section of slope is presently stable but we understand that this area is not planned for development.

The section of the slope between the crest and toe resides generally at an angle of 17 to 22 degrees.

These slopes are stable under the present conditions of equilibrium but these slopes are not recommended for residential development. Drawing Q-2270-001 B shows the recommended limits of development on this slope. It should be noted that changes have been made to the eastern and western limits of development. The limit of development line along the top of the slope coincides with the surveyed line indicating the crest of slope. This line was plotted from information provided by Aplin & Martin Engineering Ltd. The eastern and western limits and the boundary at the toe of the slope were defined from the contours shown on the plan. They are only approximate and should be established in the field as those slopes between the crest and toe of the slope which exceed a slope angle of 17 degrees.

7.5 April Road to Axford Bay

As discussed previously this slope is presently in a stable state of equilibrium. It is composed of a thin layer of glacial till which thickens to over 25 m (80 feet) at TH-3 which overlies preglacial sand. Seepage is severe over parts of this slope especially on the lower portions where the slope steepens to about 16 degrees. Slope conditions could be improved with the installation of a system of subsurface drains which would be tied to the storm sewer system. The design of such a system would require the collection of further more closely spaced subsurface soil and groundwater information and ground controlled survey information. This information should be obtained at the subdivision stage and would best to be carried out during the winter or spring months in order to collect data during periods of heaviest precipitation.

7.6 Secondary Creeks

A number of secondary creeks occur between Noons and Mossom Creeks within the area of investigation. We understand that due to the hazard of windfalls associated with isolated stands of trees, it may not be possible to preserve these creeks in their natural state. The intention of preserving the natural environment of these creeks is to prevent the upset of the natural state of equilibrium at which the creek slopes and bottom now exist. During construction and after development, care should be taken to prevent bank erosion. With the exception of very small creeks which can be carried by or incorporated into the storm sewer system, no fill should be placed in the stream courses.

7.7 Other Considerations

(1) The placement of fill should not be permitted within the specified setback for any slope nor on any of the slopes considered unsuitable for development. Natural gullies at the crest of major slopes should not be filled within the specified setback of the major slope.

(2) Water from perimeter drains, roof gutters, storm sewers or intercepter trenches should not be discharged onto steep natural slopes but should discharge to the storm sewer system or controlled water courses.

(3) Swimming pools should be constructed with perimeter drains and should be founded on or in native undisturbed soil no closer to the slope than the specified setback distances.

(4) During construction, it is important that care be taken to prevent the uncontrolled runoff and consequent erosion of slopes.

8.0 CONCLUSION

As development of the North Shore proceeds and subdivisions are cleared for development, it is recommended that a third phase of geotechnical investigations should be carried out at the subdivision stage. These investigations would be directed toward solving the site specific problems which have been identified in a general way as a part of this investigation, and toward providing the routine geotechnical information normally required at this stage.

In addition, the area north of April Road and east to Mossom Creek, as recommended in our preliminary report, should be investigated in detail to determine the suitability of this area for development. Since access to this area is limited, it is suggested that investigation in this area be delayed until adjacent subdivisions are constructed, permitting less costly site access for drilling equipment.

We would be pleased to discuss or elaborate upon any of the conclusions or recommendations of this report and we look forward to assisting you further.

Respectfully submitted,

HARDY ASSOCIATES (1978) LTD.

Per: Jim Madsen

J. D. Madsen, M. Sc.,
Geotechnical Project Engineer.

Per: G.W. Slkington for AED

A. E. Dahlman, P. Eng.,
Manager - Geotechnical Division.

JM:AED:lt, cm.

4052 Graveley Street,
Burnaby, B. C. V3J 2S1

August 18, 1980.

Q-2270-001

Revised report
of Jan 20 1984

boundary line defining the toe of the escarpment. Some locally steeper slopes may exist east of this boundary and west of Turners Creek but it is felt that the slopes are not steep enough to justify including them in the Escarpment Area.

LIMITS OF DEVELOPMENT

Escarpment Area

For the steep area within the "Escarpment Area" (Drawing VG-03373-1) defined by the toe and crest of the escarpment lines discussed above, we feel that detailed geotechnical investigation, planning and engineering of the individual residences would be required in order to develop on these steep slopes. It may be geotechnically feasible to develop lots within this area, however, we feel that within the escarpment area detailed site specific geotechnical investigation and planning of each residence should be undertaken to mitigate any potential slope stability problems. Clearing of trees should not proceed without further consideration of any required drainage and erosion control measures.

Development Constraints : Turners Creek to Wilks Creek

In the area between Turners Creek and Wilks Creek and between the Aplin and Martin Escarpment Boundary and the Crest of Escarpment lines, the slopes vary from 11 to 17 degrees (20 to 30 percent). Generally, the slope increases gradually from 11 degrees (20 percent) at the Aplin and Martin Escarpment Boundary and increases downslope to about 17 degrees (30 percent). For conventional development within this area it would normally be necessary to construct open cuts, fills or retaining walls. Due to the relatively sensitive nature of all of these slopes and the promimity of existing or future developments at the toe of the slopes, we feel that any construction within this area should also require site specific geotechnical investigation and planning.

For permanent structures such as roads, utilities, houses or site fills situated behind (north of) the Aplin and Martin Escarpment line, we feel that development may proceed without site specific investigation.

For development below (south of) the Aplin and Martin Escarpment Boundary site specific investigation and planning should include:

1. Determination of the existing soil profile at the site and,

2. Recommendations for retaining walls, slopes for open cuts or fills, drainage measures or other parameters or constraints necessary to maintain long term stable slopes.

Clearing of the trees may be carried out below (south of) the Aplin and Martin Escarpment Boundary without further investigation, except in the Escarpment Area. As noted above clearing in the Escarpment Area should not occur without further consideration of drainage and erosion control.

Development Constraints : Turners Creek to Hutchison Creek

We understand that it is presently proposed to develop a single row of residential lots south of the Aplin & Martin Escarpment Boundary. Lots would be services from an easement located south of the lots. A 3 metre wide lane would be required in the easement.

Based upon the results of this investigation we believe that development below the Aplin & Martin Escarpment Boundary can proceed subject to the following recommended constraints:

1) Permanent excavated slopes should be limited to a total height of 4 metres at a maximum slope angle of 1.5 horizontal to 1 vertical except under the advisement of a geotechnical engineer. An interceptor ditch should be provided at the crest of the permanent slope to collect the perched groundwater on the till surface.

2) Permanent fills should be limited to 3 metres at a maximum slope angle of 2 horizontal to 1 vertical. Except under the advisement of a geotechnical engineer, all topsoil and weathered till should be excavated down to the dense till surface under the permanent fill. The fill should be compacted to a minimum of 95% of Standard Proctor maximum dry density. For structural fills supporting house foundations, or other settlement sensitive structures, the top 1.2 metres of fill should be compacted to a density of 100% of Standard Proctor maximum dry density over an area contained within a line located one metre beyond the perimeter of the structure.

3) Permanent cuts and fills should be revegetated.

4) Swimming pools should be provided with a perimeter drainage system, below the level of the pool bottom, which drains to the storm sewer system.

Development Constraints : Creek Valleys

For Hutchison, Turners and Wilks Creeks, we feel that the 6 metre setback adopted by the City of Port Moody is sufficiently safe from a geotechnical point of view for all permanent structures adjacent these creeks. The term 'permanent structures' includes all private residences, swimming pools, roads and services, and site fills.

ROADS AND SERVICES

The locations of the proposed subdivision roads have not as yet been determined. Based on the results of our hand auger holes (test holes 1 through 9), it will be necessary to excavate the saturated sandy silt which underlies the organic soil beneath all subdivision roads. The depth of excavation generally varies between .9 and 1.0 metre but has been found to extend to depths of up to 1.25 and 1.50 metres at test holes 7 and 6 respectively. The actual depth of excavation may vary and can be easily identified by the high contrast in strength between the overlying weaker, saturated silt and the very strong underlying glacial till.

For pavements constructed on dense glacial till as discussed above, the City of Port Moody minimum asphalt pavement struture may be used. This pavement structure consists of:

115 mm of asphaltic concrete,
75 mm of minus 19 mm crushed granular base,
150 mm of minus 75 mm crushed subbase.

For excavated slopes in glacial till up to heights of 10 metres, the slope grade should not exceed 1.5 horizontal to 1.0 vertical. For compacted glacial till fill placed directly on dense native undisturbed glacial till, slope grades should not exceed 2 horizontal to 1 vertical.

For excavated slopes in glacial till up to heights of 10 metres, the slope grade should not exceed 1.5 horizontal to 1.0 vertical. For compacted glacial till fill placed directly on dense native undisturbed glacial till, slope grades should not exceed 2 horizontal to 1 vertical.

Our experience with the re-use of native glacial till in the Port Moody area as backfill indicates that the material can only be used as compacted backfill under favourable weather conditions and favourable groundwater conditions. The glacial till soil is very susceptible to changes in moisture content and minor precipitation or seepage of groundwater from the till surface or from internal sand lenses can render the exposed soil surfaces unsuitable for compaction.

HOUSES

Houses should be founded on the dense glacial till and beneath the surficial layer of weathered till at a depth of between 0.9 and 1.5 metres. Footings should not be less than 450 mm for strip footings nor 600 mm for spread footings.

Water from perimeter drains, roof gutters, storm sewers or interceptor trenches should not be discharged onto steep natural slopes but should discharge to the storm sewer system or controlled water courses.

CONCLUSION

Should you have any questions concerning this report or require any further information, inspection or testing of compaction, please do not hesitate to contact us.

Yours truly,

HARDY ASSOCIATES (1978) LTD.

Per:

J.D. Madsen, M.Sc., P.Eng.,
Geotechnical Project Engineer.

JDM:cm,nmd

Enclosures

APPENDIX A

Geology Groundwater

GEOLOGY

The geology of the north shore of Port Moody was first mapped in 1953 by J. E. Armstrong of the Geological Survey of Canada. The geology was mapped at a scale of 1 inch to 1 mile and was part of a general study of the Vancouver area published in GSC Paper 57-5. According to the general geological map presented with this report, three basic geologic units occupy the area of the North Shore. The northern portion of the site above an elevation of about 600 feet was mapped as Surrey Till, a glacial ground moraine consisting of sand silt, clay and boulders. This glacial till is common throughout the Greater Vancouver District and was deposited under the weight of the last glacial advance. Mantling the southern slopes of the North Shore is an unit mapped as Newton Stony Clay and Surrey Till. The Newton Stony Clay is a glacio-marine deposit which was deposited in a marine environment at the margins or beneath the glacier. This deposit is the same age or younger than the Surrey Till and therefore is often mixed with Surrey Till or deposited on the till. The third geologed unit mapped by the GSC was Bose Gravel, a post glacial deposit of beach sand and gravel up to 25 feet thick. This deposit occupies a narrow portion of the area along the shore of Burrard Inlet.

The field work carried out in Phase I and the 8 test holes advanced as a part of this investigation allow a more detailed interpretation of the geology of the North Shore. Drawing Q-2770-001 A, located in the pocket following the test of this report, is a geological map showing the distribution of four major geologic units. Although the data has increased substantially, there are still large areas within the site in which there are no exposures to confirm our interpretations. Consequently, it was necessary to infer the boundaries between geologic units based upon topographic evidence and changes in vegetation cover. It is quite likely that the boundaries between the units will be altered as the data base grows. However, the present interpretation is based upon the best available information concerning the distribution of soil types geomorphology and geologic history in addition to more subtle detail such as soil fabric and orientation.

The three geologic units mapped by the Geological Survey were identified in the field and one additional unit not recognized was discovered. This additional unit is believed to be a preglacial outwash material possibly representing an ancient channel which existed prior to the last glaciation. This preglacial outwash consists primarily of brown, stratified sand, and appears to be restricted to the area between Mossom Creek and the eastern end of April Road. The character and distribution of this and the remaining will be described in detail below.

Pre-Glacial Sand

This material occurs between Mossom Creek and Barber Street in the western portion of the site. It is generally mantled by up to 10 feet of glacial till except in the upper portion of April Road and the steep slopes of Mossom Creek where it is exposed on the ground surface. The sand is a fine to medium grained, very dense, brown with subhorizontal stratification. It is occasionally coarse grained with occasional gravel layers typically 1 to 4 inches thick. The uniform gradation and horizontal stratification indicate that it was waterlain. Recently cut slopes stand nearly vertical for up to 6 or 8 feet indicating a relatively high friction angle and possible cementation or interpretation of grains. The absence of a cohesive binding material makes these sands extremely succepable to erosion by surface or seepage water.

The sand is over 100 feet thick in the banks of Mossom Creek and was found to be in excess of 190 feet thick in test hole one. It is found to be overlain by glacial till and therefore, is preglacial in relative age.

The valley which Mossom Creek occupies was formed by the erosion of the creek since the last glaciation. Where the creek has cut through easily erodable materials it is well incised and the slopes are relatively gentle. In less erodable materials the slopes tend to be steeper and the creek less incised. Unlike most of the other creeks on the North Shore, Mossom Creek is deeply incised into the topography between the bedrock upland region where it crosses the northern extension of Water Street to the mouth of the creek. This deep valley suggests that within this reach the creek is in preglacial sand. Exposures of glacial till on the west slope of the creek valley and the asymmetric cross section of the creek valley indicate that the western margin of the sand coincides with the location of the creek bottom.

The existence of this preglacial valley and its proximity to Buntzen Lake to the north suggests that the sand may have deposited in an ancient preglacial stream outlet to the lake. The advancing glacier may have eroded portions of the preglacial sand and deposited a layer of glacial till over the sand. Subsequent erosion by Mossom Creek has re-exposed the preglacial valley.

The overlying till cap which appears to thicken toward the east tends to obscure the eastern limit of the preglacial sand. Based upon drill hole information, surface exposures and topographic features the eastern limit of the sand has been inferred. On Drawing Q-2270-001 A where the preglacial sand is believe to occur and is covered by less than about 10 feet of till it has been mapped as unit four. Where the till is known to be relatively thick but is still underlain by preglacial sand it has been mapped with unit three.

Glacial Till

All of the upper slope areas and areas in the vicinity of Noons Creek are composed of a thick deposit of glacial till. Test holes 2 and 5 through 8 inclusive, encountered till to beyond the depth of investigation from 50 to 155 feet deep. The glacial till is the second oldest sedimentary deposit within the map area and was formed by the deposition of soil beneath the enormous weight of the glacier. This till is composed primarily of sand with silt, gravel, cobbles and boulders. It is recognized by the absence of sedimentary features such as stratification and by the wellgraded nature of its grey constituent minerals. The till occassionally contains some stratified sand layers.

Generally overlying the till is a layer of mottled grey and brown clayey silt up to 3 feet thick. The contact between the silt and the underlying till is generally parallel to the ground surface. A weathered sand and gravel from 3 to 5 feet in thickness generally covers the silt-till sequence and is relatively permeable compared to the underlying materials.

Where the glacial till is in excess of 10 feet thick it has been mapped as Unit 3. Where the till is believed to be underlain by preglacial sand it has been distinguished by the letter 'A' on Drawing Q-2270-001 A.

This material is classified as Surrey Till by the Geological Survey of Canada.

Glacio-Marine Deposits

Following the advance of the ice during the last glaciation, there was a subsidence of the land below existing sea level resulting from the enormous weight of the ice. Upon retreat of the glacier unsorted till and partly sorted materials were deposited in front of and beneath the ice, in a marine environment. These materials are believed to flank the slope from west of Barber Street to Cambell Road and were encountered in test holes 3 and 4. Exposures in excavations suggest that the materials are extremely variable in composition and fabric. Within a single exposure behind the elementary school on Barber Street, the soil changes from a dense unsorted till to a stratified gravel. Stratification was found frequently to be sub-parallel to the slope of the hill. Due to the similarity between the glacial till and some of the layers within the glacio-marine deposits, the boundaries between these two units was very difficult to determine. On Drawing Q-2270-001 A these materials have been mapped as Unit 2 and are similar to the unit described by the Geological Survey as Newton Stony Clay.

Post-Glacial Deposits

Sand and gravel alluvial and beach deposits laid down after the retreat of the glaciers occupy a narrow strip of land along the foreshore of the site. These deposits are generally confined to the areas which have already been developed and are of little importance to this investigation. They are generally underlain by glacio-marine or till materials. These materials have been mapped as Unit 1.

GROUNDWATER

The major factors which affect the existence and migration of groundwater are: soil type, geometry and groundwater recharge. The heavy rainfall experienced on the North Shore permits a great deal of water infiltration into the groundwater system in addition to the large volumes of surface runoff. The potential for problems associated with groundwater discharge onto slopes is intimately related to the slope geometry and the soil type. Three groundwater regimes are recognized on the North Shore and are associated with the three major soil units which underlie the site.

Glacial Till

In areas underlain primarily by glacial till a large volume of groundwater is found to be perched on the till surface beneath a thin mantle of sand and gravel. The till material is generally of very low permeability severly restricting the volume of groundwater which infiltrates into the till. Despite the low permeability of the till material the glacial till mass contains thin sand laminations and sand lenses which tend to increase the aggregate permeability of the mass where these lenses occur.

The actual groundwater level within the till mass is difficult to determine with confidence due to the slow changes in the levels of water in the test holes used for measuring the groundwater table levels. On TH-2 and 5 water levels were recorded over a period of 40 days and the level of the groundwater table appeared to be still dropping. However, in TH-7, the groundwater remained nearly constant even 25 days after the completion of drilling. This may be due to a high groundwater level or it is likely that it is due to the infiltration of surface water into the top of the sealed drill hole.

On TH-8 a lense of sand and gravel 4 feet (1.2 m) thick was encountered at a depth of 43 feet (13.1 m). The gravel layer was believed, at the time of drilling, to be water bearing. The water table indicated by the level of water in the hole after 23 day was at a depth of 10 feet (3.0 m). The existence of this water bearing sand and gravel layer and the possible existence of other layers at depth or elsewhere on the slope may account for the high observed seepage and slighly tilted or 'drunken' trees on the slope below TH-8.

Glacio-Marine Sediments

These deposits shown as Unit 2 on Drawing Q-2270-001 A are composed of interbedded sand and silt layers and till-like mixtures. The permeability of the sand lenses are much greater than the beds of till and will consequently produce a much higher volume of seepage. As mentioned previously, evidence suggests that these sediments dip parallel to the slope of the ground surface. Where this occurs there exists the potential for the development of artesian pressure in dipping sand layers which are confined between less permeable till.

Test holes 3 and 4 encountered glacio-marine sediments to in excess of 71.5 feet (21.8 m) in TH-3 and to 44 feet (13.4 m) in TH-4. The groundwater table in TH-3 was measured to be at a depth of 38 feet (11.6 m) in a sand layer. Test hole 4 was drilled at the edge of the road at Foresthill Place and the hole was backfilled. Water was found to be seeping from the top of the test hole for 24 days after completion of drilling suggesting that a slight artesian pressure exists in either the glacio-marine sediments or the underlying shale bedrock.

Pre-Glacial Sand

In TH-1 the groundwater table was observed at a depth of 90 feet (27.4 m). This level appears to correspond well with the seepage observed at the intersection of Escola Bay and April Road and also, where groundwater seepage emerges to form the stream located below the upper portion of April Road.

Where the sand is mantled by a layer of glacial till the discharge of groundwater onto the slope is inhibited. This can potentially produce artesian pressures in the underlying sand. Where tht till cap is breached by excavation or in areas of high groundwater erosion, serious seepage can be anticipated.

The groundwater table is expected to decrease rapidly in elevation close to Mossom Creek. Evidence for this lowering of the groundwater table is the lack of significant seepage on the upper portions of the slope bordering the creek in the vicinity of April Road.

APPENDIX B

Explanation of Terms and Symbols
Test Hole Logs
Piezometer Installation Reports
Laboratory Tests

EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of field investigation and subsequent laboratory testing are described in the following pages.

It should be noted that materials, boundaries, and conditions have been established only at the borehole locations, and are not necessarily representative of subsurface conditions elsewhere across the site.

TEST DATA

Data obtained from laboratory and field testing are shown on the grid at the appropriate depth interval.

The natural moisture (water) content of the soil at the time of drilling is plotted against depth, together with the plastic and liquid limits where determined.

Abbreviations, graphic symbols, and relevant test method designations are as follows:

⊙	w	natural moisture content (ASTM D 2216)
⊡	w_P	plastic limit (ASTM D 424)
△	w_L	liquid limit (ASTM D 423)
	NP	non plastic soil
⟶		seepage
▼		observed water level

Other abbreviations and symbols are as shown on the borehole log sheet.

DEPTH

The depth of borehole below existing ground surface is shown. Corresponding elevations sometimes are shown with respect to the datum given.

SOIL CLASSIFICATION AND DESCRIPTION

Soils are classified and described according to their engineering properties and behaviour.

The soil of each stratum is described using the Unified Soil Classification System[1] modified slightly so that an inorganic clay of "medium plasticity" is recognized.

The use of modifying adjectives may be employed to define the actual or estimated percentage range by weight of minor components. This is similar to a system developed by D.M. Burmister.[2]

The soil classification system is shown in greater detail on page 3.

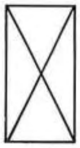
---

1. "Unified Soil Classification System", Technical Memorandum 3-357 prepared for Office, Chief of Engineering, by Waterways Experiment Station, Vicksburg, Mississippi, Corps. of Engineers, U.S. Army. Vol. 1, March 1953.

2. American Society for Testing and Materials. Procedures for Testing Soils, "Suggested Methods of Testing for Identification of Soils", 4th Ed; pp 221-233, Dec. 1964.

SOIL SAMPLES

CONDITION — This column graphically indicates the depth and condition of the sample:



TYPE — The type of sample is indicated in this column as follows:

A	auger sample
B	block sample
C	rock core, or frozen soil core
D	drive sample
P	Pitcher tube sample
U	tube sample (usually thin-walled)
W	wash or air return sample
O	other (see report text)

PENETRATION RESISTANCE — Unless otherwise noted this column refers to the number of blows (N) of a 140 pound (63.5 kg) hammer freely dropping 30 inches (0.76 m) required to drive a 2 inch (50.8 mm) O.D. open-end sampler 0.5 feet (0.15 m) to 1.5 feet (0.45 m) into the soil, or until 100 blows have been applied, in which case, the penetration is stated. This is the standard penetration test referred to in ASTM D 1586.

OTHER TESTS

In this column are tabulated results of other laboratory tests as indicated by the following symbols:

*C	Consolidation test
Fines	Percentage by weight smaller than #200 sieve
D_R	Relative density (formerly specific gravity)
k	Permeability coefficient
*MA	Mechanical grain size analysis and hydrometer test (if appropriate)
pp	Pocket penetrometer strength
*q	Triaxial compression test
q_u	Unconfined compressive strength
*SB	Shearbox test
SO_4	Concentration of water-soluble sulphate
*ST	Swelling test
TV	Torvane shear strength
VS	Vane shear strength (undisturbed-remolded)
ε_f	Unit strain at failure
γ	Unit weight of soil or rock
γ_d	Dry unit weight of soil or rock
ρ	Density of soil or rock
ρ_d	Dry density of soil or rock

* The results of these tests usually are reported separately.

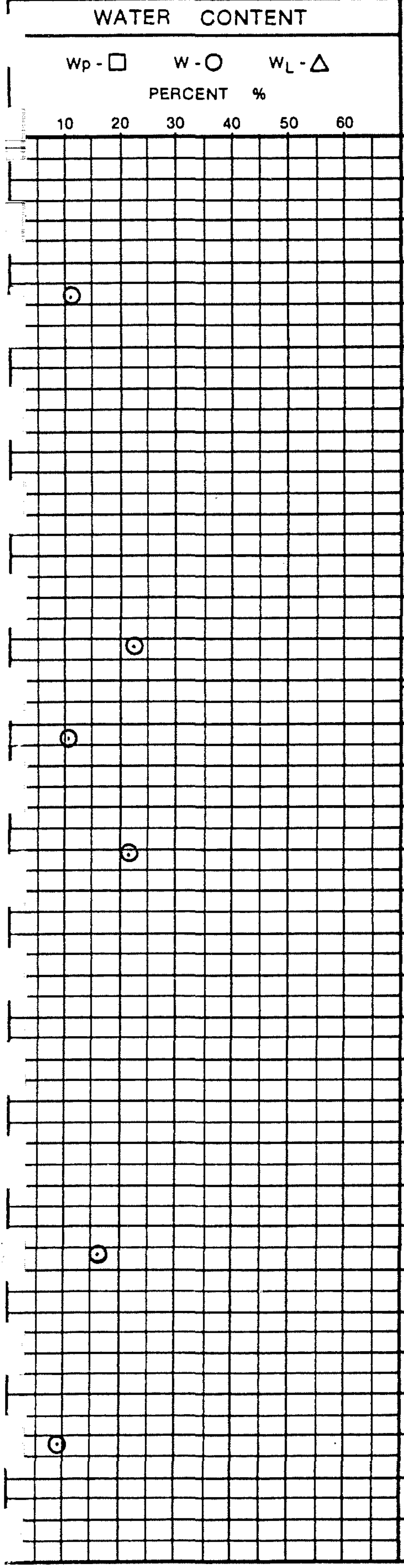
HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. H1
CKD.
DATE OF INVEST. 80/6/2
JOB NO. Q2270-001
HOLE NO. 1
DRILL TYPE ROTARY

DATUM GROUND SURFACE
SURFACE ELEVATION



DEPTH FEET	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
	TH 1				
	SAND - BROWN, OCCASIONAL GRAVEL SIZES, MEDIUM GRAINED, SOME SILT - VERY DENSE, LAYERS OF GRAVEL 1" TO 2" THICK	☒	▷	175 for 11"	
10	- COARSE SAND ⓦ FINE GRAVEL, TRACE SILT OCCAS. SMALL COBBLE SIZES				
20					
	- BROWN, OCCAS. GRAVEL SIZES, MED. GRAIN., SOME SILT, VERY DENSE, LAYERS OF GRAVEL	☒	▷		
	SMALL COBBLES FROM 29' TO 31.5'	☒	▷	188	MA plate 26
30					
	SAND - VERY FINE, VERY DENSE, BROWNISH-GREY	☒	▷	135	MA plate 27
	- STRATIFIED ⓦ LAYERS ½ TO 1mm THICK - SAND HEAVING UP THE RODS @ 35'	◸	NR		
40	SAND & GRAVEL - INTERLAYED SAND & SAND & GRAVEL LAYERS - GRAVEL LAYERS ONLY A FEW INCHES THICK, USUALLY SPACED FROM 1'-4'				
50	SAND LAYERS COMPRISED OF UNIFORM FINE TO MED. SAND, VERY DENSE, BROWN	☒	▷	164 for 10"	MA plate 28
60		☒	▷	200 for 5"	

HT08 - 79/05

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

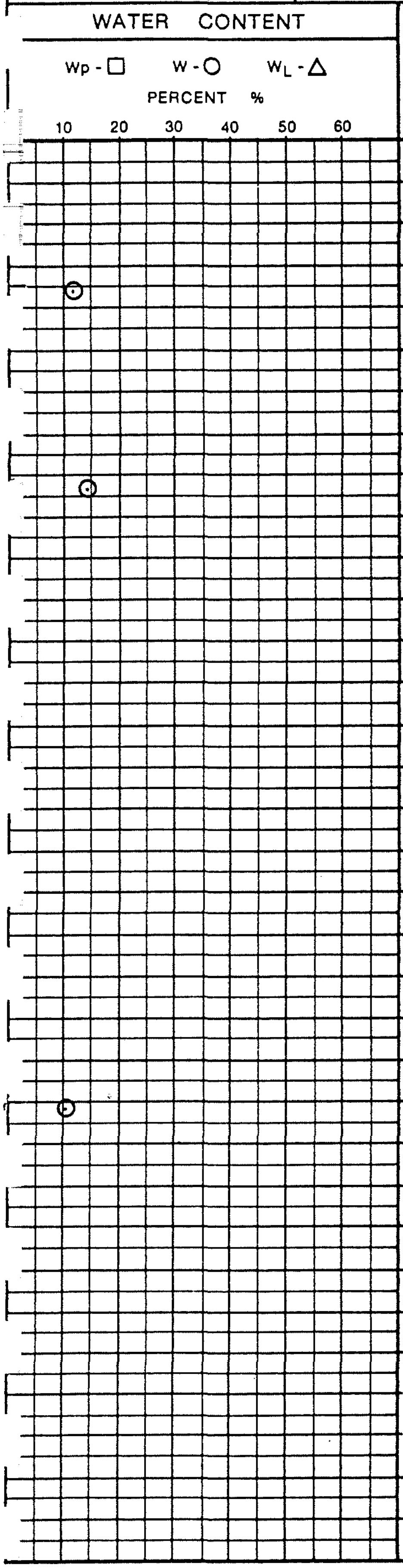
PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. H	CKD.	DATE OF INVEST. 80/6/2	JOB NO Q 2270-001
HOLE NO. 1			

DRILL TYPE ROTARY

DATUM GROUND SURFACE

SURFACE ELEVATION



TH 1

DEPTH FEET	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
70	SAND & GRAVEL (CONT.) - SAND & GRAVEL LAYERS WELL GRADED TO NO STRATIFICATION	☒	▷	200 for 10"	
80	SAND - UNIFORM, FINE TO MEDIUM GRAIN., VERY DENSE - BROWN	☒	▷	112	MA plate 29
90					▽ PIEZOMETRIC LEVEL RECORDED FROM DEEP PIEZ. ON 80/6/25
100	@ 110' SAND, BROWN - MED. TO COARSE GRAINED - FAINT STRATIFICATION; LAYER OF COARSE SAND TO ~ ¼" ABOUT ½" THICK NEAR MIDWAY IN SAMPLE - VERY DENSE, MOIST				
110	@ 119.5' ENCOUNTERED SOME COARSE SAND & FINE GRAVEL LAYERS A FEW INCHES THICK	☒	▷	181 for 6"	MA plate 30
120	@ ~ 127' - 130' SOME GRAVEL SIZES				
130	@ 130' - 135' BECOMING SLIGHTLY GRAVELLY				

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. H | CKD. | DATE OF INVEST. 80/6/2 | JOB NO Q2270-001 | HOLE NO. 1

WATER CONTENT: Wp - □ W - ○ WL - △ PERCENT %

DEPTH FEET

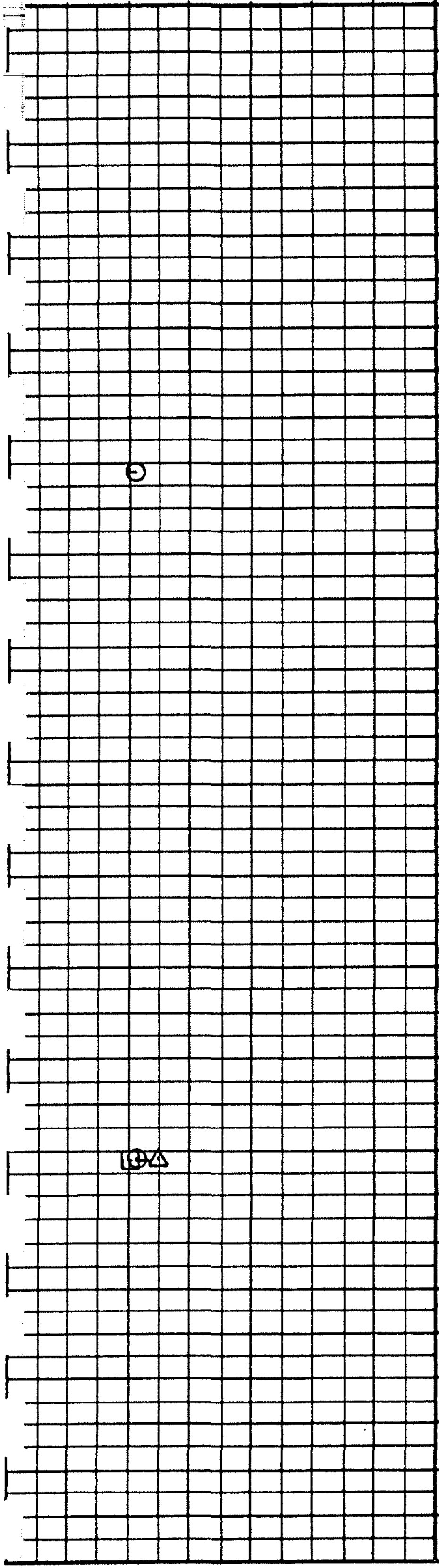
SOIL SYMBOL

SOIL DESCRIPTION
DATUM GROUND SURFACE
SURFACE ELEVATION

SOIL SAMPLE: CONDITION | TYPE | PENETRATION RESISTANCE

DRILL TYPE ROTARY

OTHER TESTS



TH 1

SAND (CONT.)

SAND (FROM 135' - 160')
- INTERLAYED VERY FINE SILTY SAND & UNIFORM FINE SAND
- VERY FINE SILTY SAND
- BROWN @ GREY INTERBEDS
- VERY FINE GRAIN @ SILT
- ~½ TO 1mm THICK LAMINATIONS, VERY DENSE
- FINE SAND, BROWN
- FAINTLY LAMINATED, FINE GRAIN., TRACE SILT
- VERY DENSE, MOIST

SILT - GREY, LAMINATED @ LAYERS OF VERY FINE SAND ~ 1/10 mm THICK
- LITTLE VERY FINE SAND
- LOW PLASTIC
- VERY DENSE
- MOIST

LITTLE CLAY

END OF HOLE @ 190.0'

Depth	Condition	Type	Penetration Resistance	Other Tests
150	☒	D	300 for 4"	MA plate 31
180	☒	D	528 for 8"	MA plate 32

Depth markings: 140, 150, 160, 170, 180, 190

6

HT08 - 79/05

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

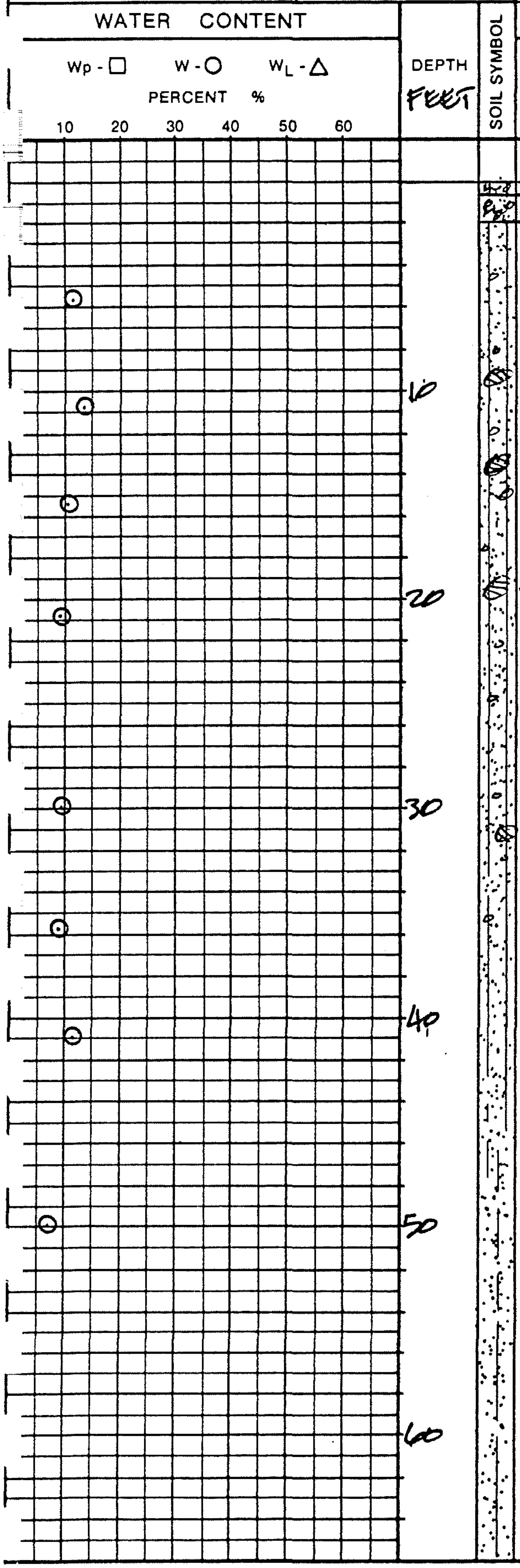
PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. H
CKD.
DATE OF INVEST. 80/6/5
JOB NO. Q2270-01
HOLE NO. 2

DRILL TYPE ROTARY

DATUM GROUND SURFACE
SURFACE ELEVATION

TH 2



SOIL DESCRIPTION

GRAVEL (FILL) - SOME SILTY SAND, ORGANICS

TOPSOIL - SAND & GRAVEL, ORG - BROWN

SAND & SILT - WELLGRADED
- FINE TO MED. SAND & SILT
- LITTLE COARSE SAND, TRACE GRAVEL, OCCAS. TO FREQUENT COBBLES
- VERY DENSE, GREY (TILL)

FAINT HORIZONTAL FISSILITY TO ~15'

SILT SEAMS ~½" THICK BY 1" TO 2" LONG @ 15'

LENSES & POCKETS OF UNIFORM MED. SAND TO 2" THICK @ 20'

@ 40.5' POCKET OF STRATIFIED SILT W VERY FINE SAND 2" THICK

FROM ~ 45' TO 75'
- PREDOMINANTLY FINE SAND W A DECREASE IN GRAVEL & COBBLE SIZES

SOIL SAMPLE

CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
☒	▷	175	
☒	▷	180 for 9"	
☒	▷	100 for 4"	
☒	▷	99	
☒	▷	120 for 5"	
☒	▷	90 for 1"	
☒	▷	130 for 6"	
☒	▷	100 for 5"	
☒	▷	200 for 5"	
			▼ 1 day after drilling
	NR	130 for 3"	NO RECOV.
			▼ 4 days after drilling

7

HT08 - 79/05

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. H
CKD.
DATE OF INVEST. 80/6/5
JOB NO Q 2270-001
HOLE NO. 2

DRILL TYPE ROTARY

DATUM GROUND SURFACE
SURFACE ELEVATION

WATER CONTENT Wp - ☐ W - ○ WL - △ PERCENT % (10 20 30 40 50 60)	DEPTH FEET	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
		TH 2				
		SAND & SILT (CONT.)				
○ 10	70		☒	D	250 for 5.5"	
			⧄	NR	215 for 6"	NO RECOV.
	80		⧄	NR	225 for 4"	NO RECOV.

END OF HOLE @ 82.5'

WATER LEVEL BELOW
PIEZ. TIP @ 63'
43 DAYS AFTER DRILLING

HOLE NO. 8

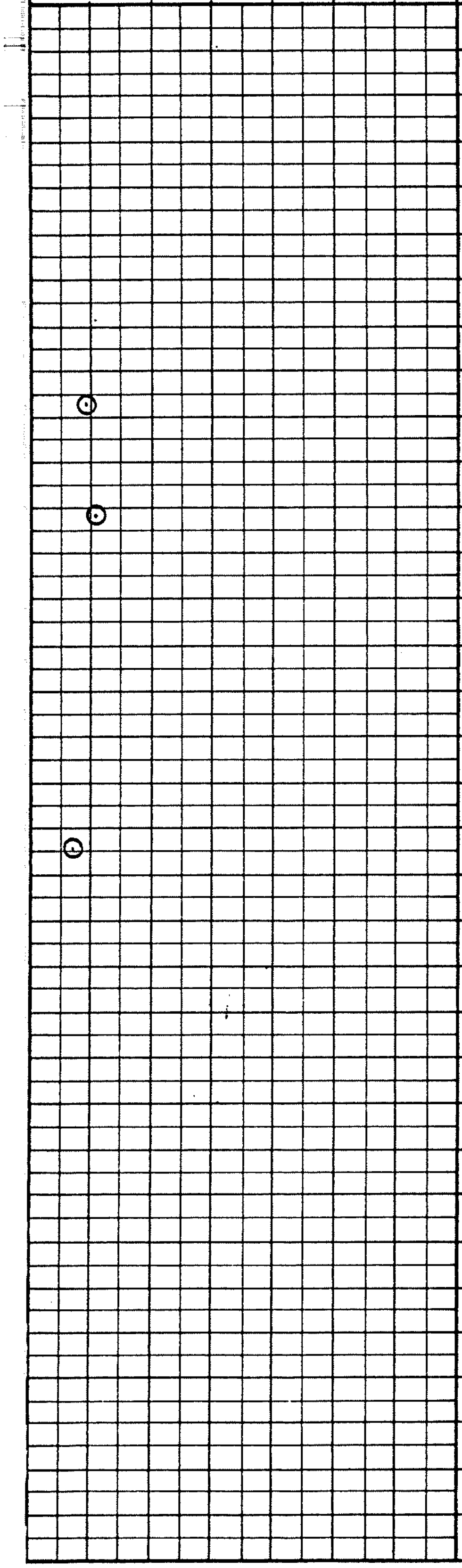
HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. H T
CKD.
DATE OF INVEST. 80/6/11
JOB NO Q2270-001
HOLE NO. 3

WATER CONTENT
Wp - ☐ W - ○ W_L - △
PERCENT %
10 20 30 40 50 60



DEPTH FEET
SOIL SYMBOL
SOIL DESCRIPTION
DATUM GROUND SURFACE
SURFACE ELEVATION
SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE
DRILL TYPE ROTARY
OTHER TESTS

TH 3

SAND & SILT (TILL)
- WELL GRADED

- SAND, MED. TO FINE GRAIN., SILTY, SOME FINE GRAVEL (OCCAS. TO 30mm) VERY DENSE, WELL GRADED OCCAS. COBBLE & BOULDER SIZES, GREY

THIN GRAVEL LAYERS FROM 24'-25' (SPACED 50-100mm APART & 100-200mm THICK)

END OF HOLE @ 35.0'
ROD LOST DOWN THE HOLE, COULD NOT BE RECOVERED.

CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
⧅	NR	40	
⧅	NR	55	
☒	D	120 for 6"	100% RECOV.
☒	D	361 for 11"	
☒	D		BOUNCING ON ROCK
☒	D	200 for 8"	

9

HT08 - 79/05

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

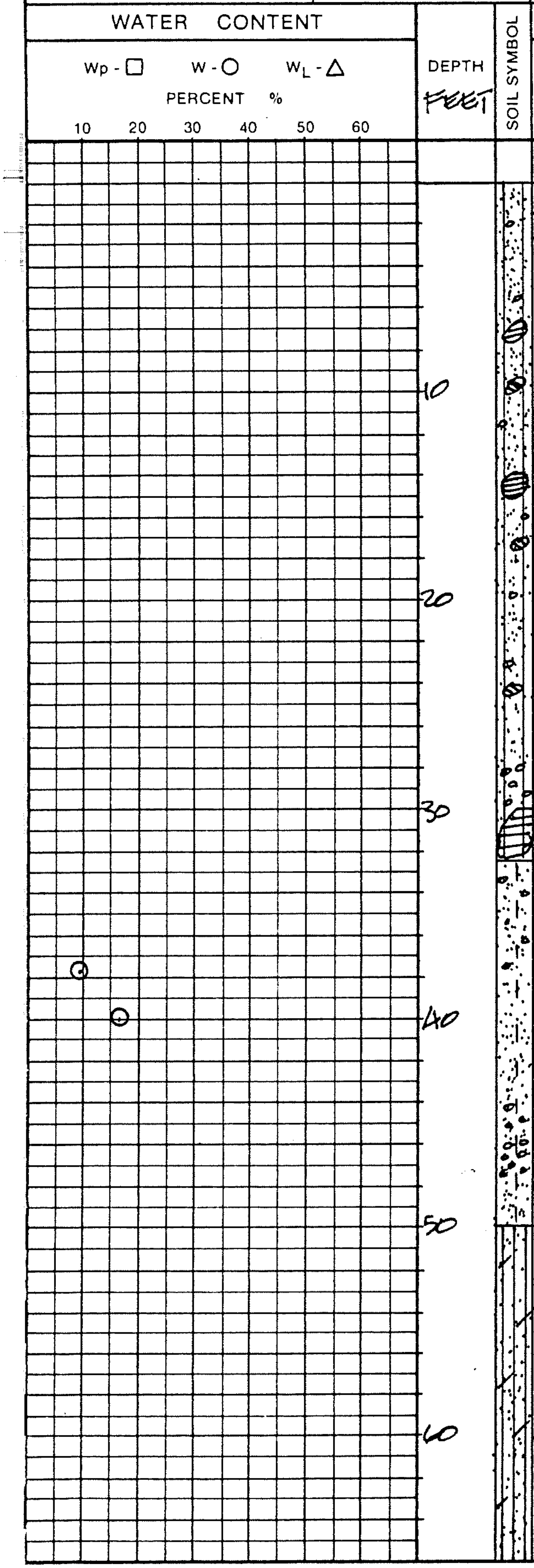
BOREHOLE LOG

PROJECT North Shore Development
Port Moody, B.C.

LOGGED/DWN. H
CKD.
DATE OF INVEST. 80/6/12
JOB NO. Q 2270-001
HOLE NO. 3A
DRILL TYPE ROTARY

DATUM GROUND SURFACE
SURFACE ELEVATION

TH 3A



DEPTH (FEET)	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
0	SAND & SILT - WELL GRADED - MED. TO FINE, SAND @ SILT - SOME GRAVEL, OCCAS. COBBLES & BOULDERS, VERY DENSE - GREY (TILL)				▼ 1 day after drilling
17–22	FROM 29' TO 30' - WATER BEARING GRAVEL HOLE CAVING BADLY MUD THINNING				
28	BOULDER @ 30'-32.5'				
32.5	SAND - FINE TO MEDIUM GRAIN - TRACE SILT, DENSE, GREY - TRACE COARSE SAND & OCCAS. GRAVEL SIZES FROM 32.5' TO 37' @ 44'-45' ~1"-2" THICK GRAVEL LAYERS @ 45'-47' GRAVEL LAYER	☒	D	85	▼ 13 days after drilling
40		☒	D	43	MA plate 33
50	SILT - SOME FINE SAND - TRACE CLAY, LOW PLASTIC - MED. DENSE @ 55' SILT BECOMING SANDIER	☒	D	200 for 6"	
55–62		☒	D		LARGE SAMPLES FROM CUTTINGS (TYPICAL)
62–66		☒	D		

16

HT08 - 79/05

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. HT	CKD.	DATE OF INVEST. 80/6/12	JOB NO Q2270-001	HOLE NO. 3A

WATER CONTENT Wp - ☐ W - ○ W_L - △ PERCENT % 10 20 30 40 50 60	DEPTH FEET	SOIL SYMBOL	SOIL DESCRIPTION DATUM GROUND SURFACE SURFACE ELEVATION	SOIL SAMPLE CONDITION	SOIL SAMPLE TYPE	SOIL SAMPLE PENETRATION RESISTANCE	DRILL TYPE ROTARY OTHER TESTS
			TH 3A				
	70		SILT - (CONT.) HAD TO DISCONTINUE HOLE @ 71.5' DUE TO STEEL FROM BROKEN SPLIT SPOON @ THE BOTTOM	☒	▷		
			END OF TEST HOLE @ 71.5'				

11

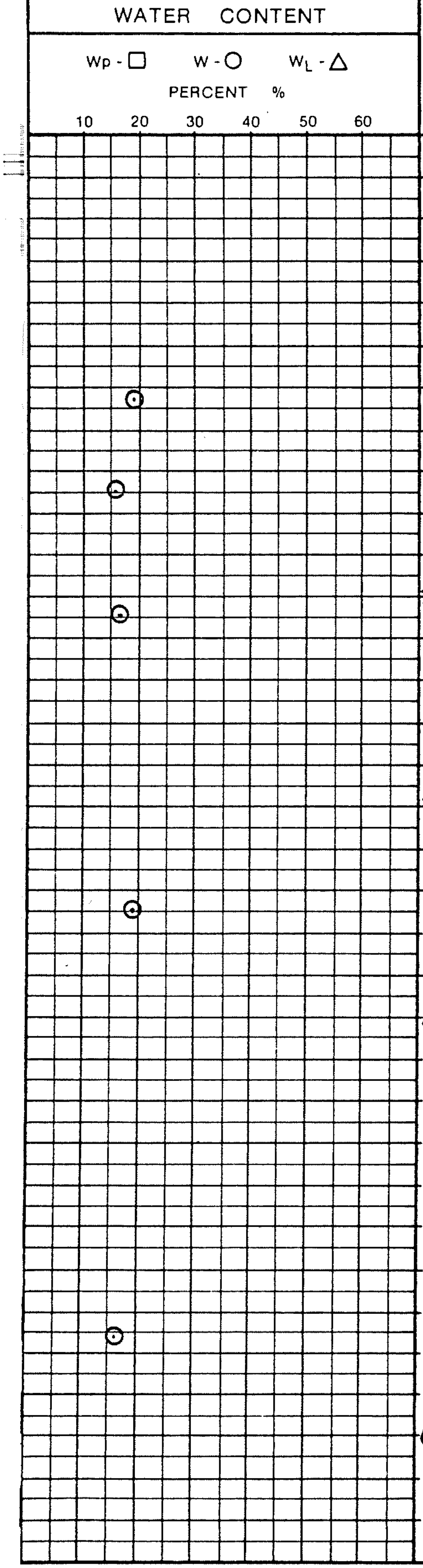
HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. HT
CKD.
DATE OF INVEST. 80/6/24
JOB NO. Q2270-001
HOLE NO. 4
DRILL TYPE ROTARY
DATUM GROUND SURFACE
SURFACE ELEVATION
OTHER TESTS

TH 4



DEPTH FEET
10
20
30
40
50
60

SOIL DESCRIPTION

SAND & GRAVEL
- MEDIUM DENSE

SAND & SILT
- INTERLAYERED SILTY FINE SAND, SILT & SILTY CLAY
- LAYERS 2 TO 5 mm THK, SOME ORG. INTERLAYERS, FEW CLAY LAYERS, MED. DENSE, MED. PLASTIC SILT, GREY
- MED. GRAIN SAND, SILT LAYERS W FINE SAND TO 1cm THICK
- SOME WELL GRADED PORTIONS W COARSE GRAIN SAND & GRAVEL SIZES, DENSE TO VERY DENSE, BR. TO BROWNISH GREY

SILT & SAND (TILL) - FINE SAND
- WELL GRADED, GREY, TRACE GRAVEL, LITTLE CLAY, SLIGHTLY PLASTIC, VERY DENSE, OCCAS. COBBLES

SAND - SILTY, FINE, GREY
- MODERATELY UNIFORM, VERY DENSE, MOIST, GRAVELLY FROM 42-44', OCCAS. GRAVEL SIZES THROUGHOUT

SHALE - SILTY
- HORIZONTALLY TO SUBHORIZONTALLY FISSURED
- HARD (BRITTLE)
- GREY TO BLACK
- DRY

SOIL SAMPLE

CONDITION	TYPE	PENETRATION RESISTANCE
☒	D	27
☒	D	38
	D	
☒	D	56 for 6"
	NE	
	NE	
	D	
	NE	
	NE	200 for 4"
	NE	100 for 3"
☒	D	
	D	140 for 4"

12

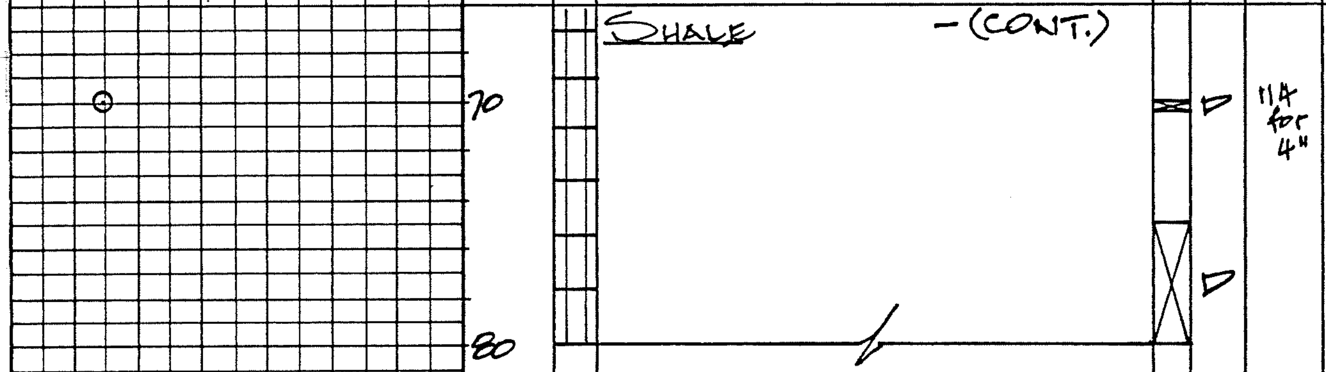
HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT North Shore Development
Port Moody, B.C.

LOGGED/DWN. HT
CKD.
DATE OF INVEST. 80/6/24
JOB NO. Q2270-001
HOLE NO. 4

WATER CONTENT Wp - ☐ W - ○ W_L - △ PERCENT % 10 20 30 40 50 60	DEPTH FEET	SOIL SYMBOL	SOIL DESCRIPTION DATUM Ground Surface SURFACE ELEVATION	SOIL SAMPLE: CONDITION	TYPE	PENETRATION RESISTANCE	DRILL TYPE Rotary OTHER TESTS
			TH 4				



END OF TEST HOLE
@ 80.0'

NOTE: WATER WAS NOTED TO BE FLOWING FROM THE HOLE @ A RATE OF ~0.1 gal/min. ON 80/7/18

13

HT08 - 79/05

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

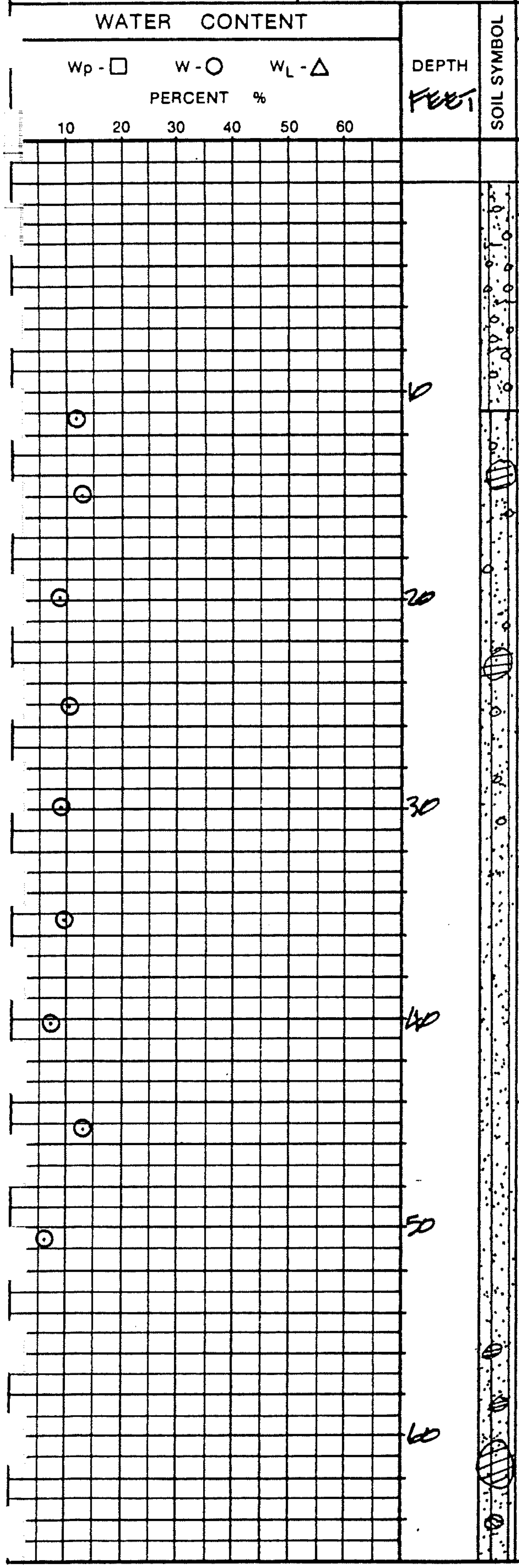
PROJECT: NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. H
CKD.
DATE OF INVEST. 80/6/2
JOB NO. Q2270-001
HOLE NO. 5

DRILL TYPE: ROTARY

DATUM: GROUND SURFACE
SURFACE ELEVATION

TH 5



SOIL DESCRIPTION

FILL - DARK BROWN, SILTY,
- SAND & GRAVEL, LOOSE
- BECOMING DENSE @ 9'
- ORGANICS, WOOD FIBRES & ROOTS, COARSE SAND & GRAVEL

SAND & SILT (TILL)
- WELLGRADED
- TRACE FINE GRAVEL
- OCCAS. BOULDERS
- VERY DENSE, GREY

BECOMING SANDIER 15' TO 20'
@ 20' FAINT HORIZONTAL STRATIFICATION

@ 45' INTERLAYERED UNIFORM MED. SAND & VERY FINE GRAIN. SILTY SAND
LAYERS 1"-2" THICK

@ 57'-67' FREQUENT BOULDERS & COBBLES

CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
⧄	NR	6	NO RECOVERY
☒	D	61	
☒	D	130 for 5"	
☒	D	100 for 5"	
☒	D	100 for 5.5"	
☒	D	100 for 6"	
☒	D	100 for 4"	
☒	D	100 for 2"	
☒	D	110 for 5"	
☒	D	135 for 5"	
			@ 65' NO RECOV.
⧄	NR	30	

14

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

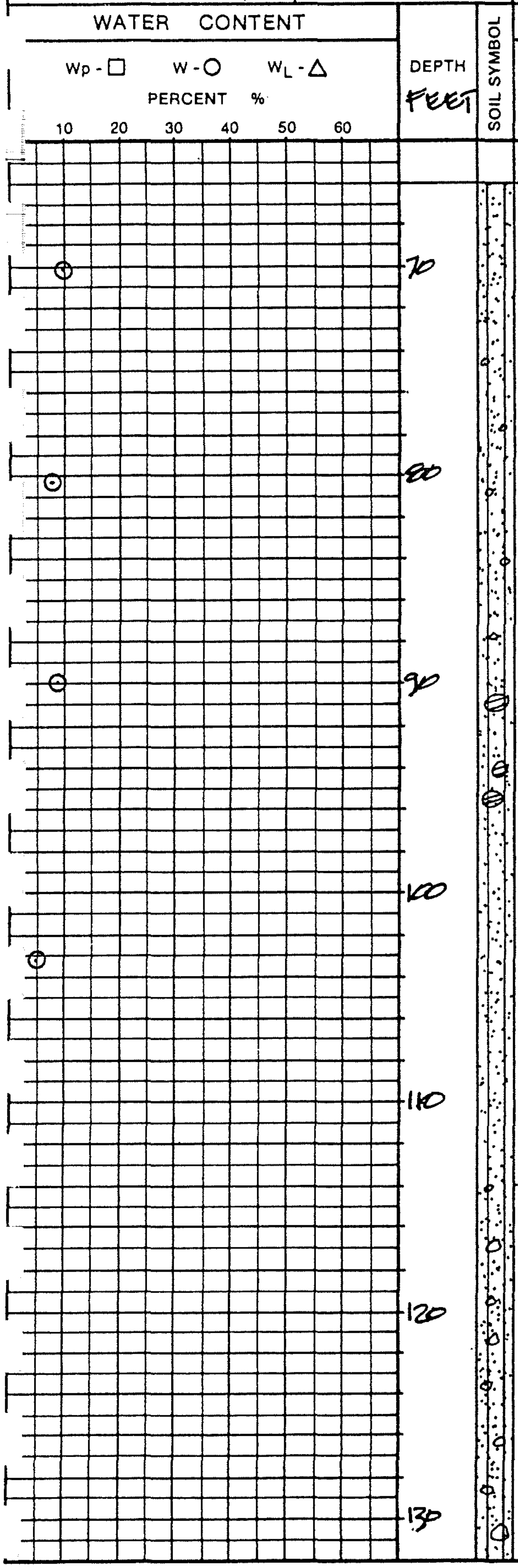
BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. HT
CKD.
DATE OF INVEST. 80/6/2
JOB NO. Q 2270-001
HOLE NO. 5
DRILL TYPE ROTARY

DATUM GROUND SURFACE
SURFACE ELEVATION

TH 5



SAND & SILT (TILL) - CONT.

@ 75'-90' TILL, GREY
- FINE TO MED. SAND, LITTLE SILT
- TRACE FINE GRAVEL
- ANGULAR PARTICLES
- NON - PLASTIC
- VERY DENSE

FROM 90'-95' FREQUENT SMALL COBBLES

BELOW ~116' LESS LARGE GRAVEL & COBBLE SIZES TILL IS SILTIER

Depth (ft)	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
70	☒	▷	115 for 6" 36 for 2"	
75	☒	NR	40 for 3"	NO RECOV.
80	☒	▷	150 for 5"	
90	☒	▷	175 for 4"	
103	☒	▷	225 for 5"	
117				▽ 22 days after drilling

15

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. HT
CKD.
DATE OF INVEST. 80/6/2
JOB NO. Q2270-001
HOLE NO. 5

WATER CONTENT Wp - ☐ W - ○ W$_L$ - △ PERCENT % 10 20 30 40 50 60	DEPTH FEET	SOIL SYMBOL	SOIL DESCRIPTION DATUM GROUND SURFACE SURFACE ELEVATION	SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE	DRILL TYPE ROTARY OTHER TESTS
			TH 5				
			SAND & SILT (TILL) - CONT.				24 days after drilling
	100						
	150		LOSS OF CIRCULATION IN HOLE @ 155'				
			END OF HOLE @ 155.0'				

16

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. HT
CKD.
DATE OF INVEST. 80/7/11
JOB NO. Q 2270-001
HOLE NO. 6

WATER CONTENT
Wp - ☐ W - ○ W_L - △
PERCENT %
10 20 30 40 50 60

DATUM GROUND SURFACE
SURFACE ELEVATION

DRILL TYPE ROTARY

TH 6

DEPTH FEET	SOIL DESCRIPTION	SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
	SAND & GRAVEL - COMPACT				▼ @ end of drilling
	SILT- FINE, SANDY - NON. PLASTIC, TRACE FINE GRAVEL, WELLGRADED - HARD	☒	D	53	▼ 7 days after drilling
10	SAND & SILT - SOME GRAVEL	☒	D		
	- WELLGRADED, VERY DENSE - PEBBLES, WEATHERED COBBLES @ 12.5' TO 4" (TILL)	☒	D		
	@ 15' SILT & COARSE SAND WELLGRADED, SOME FINE GRAVEL				
20	OCCAS. MED. GRAVEL, VERY DENSE NON-PLASTIC / @ 18' MORE COARSE OCCAS. COBBLES	☒	D	75 for 5"	
	GRAVEL & SAND - WELLGRADED - SILTY, GRAVEL TO ½"; VERY DENSE / @ 22' COBBLES (TILL)	☒	D	100 for 6"	
30	SAND & (TILL) GRAVEL - SILTY - WELLGRADED, V. VERY DENSE	☒	D		
	SAND & SILT - @ SOME FINE GRAVEL, WELLGRADED, V. VERY DENSE, NON-PLASTIC @ 34' SMALL COBBLES, COARSE GRAVEL	☒	D	85 for 6"	
40	(TILL)	☒	D	110 for 5"	
	BECOMING VERY COARSE GRAVEL & COBBLES BELOW 50'				
50	BOULDER FROM 54' TO 56'	☒	D	100 for 5½"	
60					
	END OF HOLE @ 60.5'				

17

HT08 - 79/05

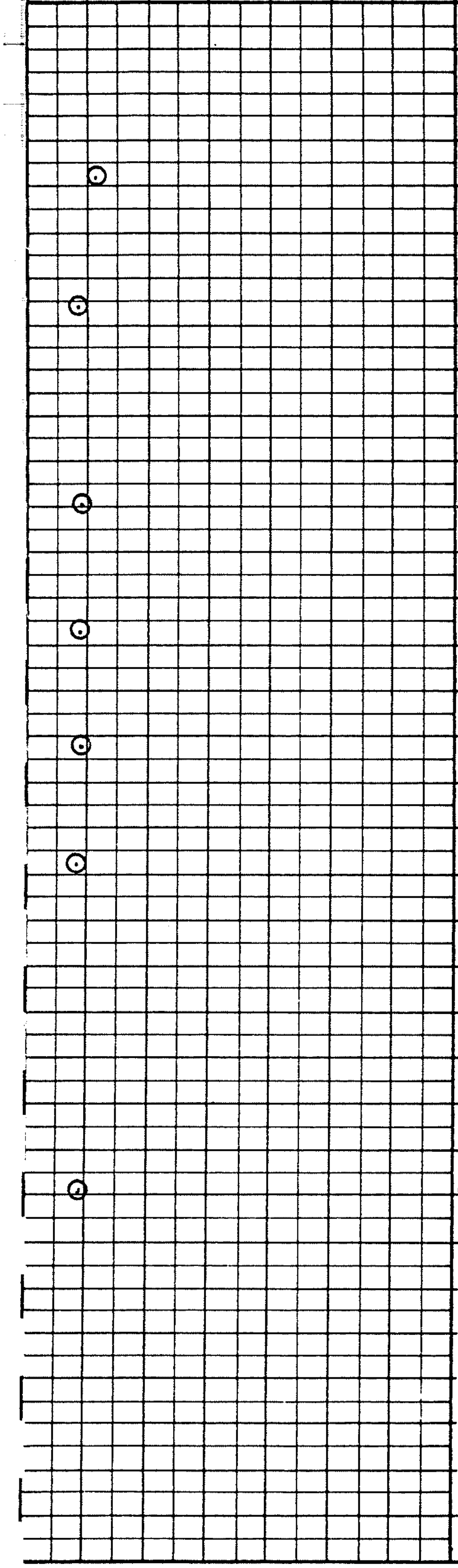
HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

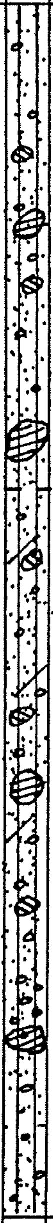
BOREHOLE LOG

PROJECT North Shore Development
Port Moody, B.C.

LOGGED/DWN. HT
CKD.
DATE OF INVEST. 80/6/23
JOB NO Q2270-001
HOLE NO. 7
DRILL TYPE ROTARY
DATUM GROUND SURFACE
SURFACE ELEVATION

TH 7





SOIL DESCRIPTION

SILT & SAND - WELLGRADED
- FINE TO MED. SAND
- TRACE COARSE SAND & GRAVEL
- OCCAS. COBBLES & BOULDERS
- DENSE TO VERY DENSE
- BROWNISH GREY
- MOIST (TILL)

@ 17.5' TO 19.5' BOULDER

- FINE SAND, WELLGRADED
- LITTLE CLAY, TRACE MED. GRAIN & COARSE GRAIN SAND
- GRAVEL, MED. TO LOW PLASTIC, VERY DENSE
- OCCAS. COBBLE & BOULDER SIZES
- MOIST, GREY

@ 40'-42' FREQUENT COARSE GRAVEL SIZES
ON A BOULDER @ 42' - THRU IT @ 43'

@ 45' HOLE SLOUGHING

END OF HOLE @ 50.0'

SOIL SAMPLE

CONDITION	TYPE	PENETRATION RESISTANCE
☒	D	49
☒	D	66
☒	D	
☒	D	29 for 2"
☒	D	26 for 4"
☒	D	109 for 4"
☒	D	100 for 4"

OTHER TESTS

▼ 25 days after drilling

18

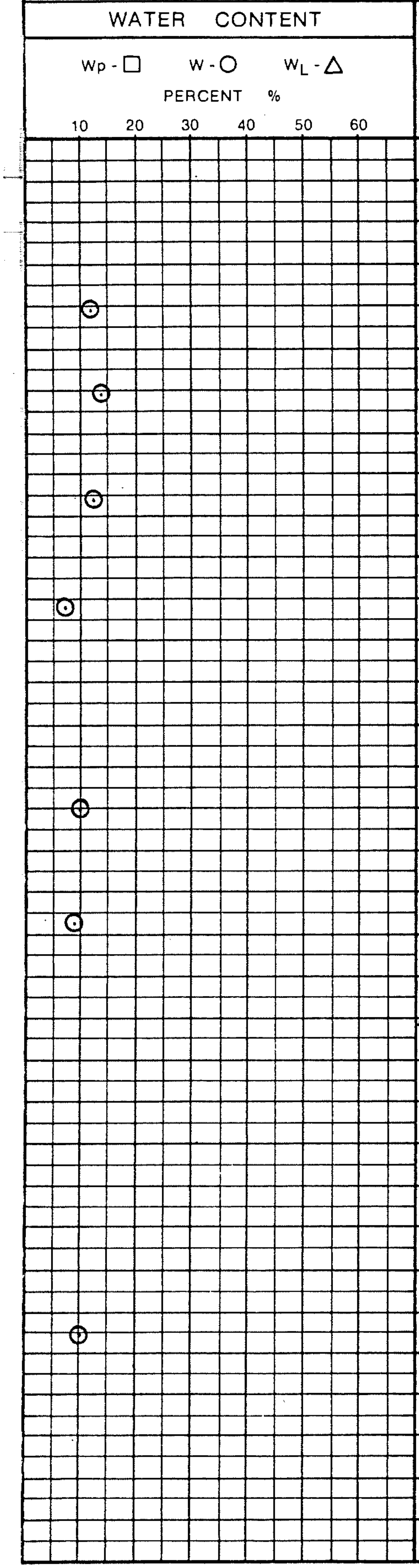
HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

LOGGED/DWN. HT
CKD.
DATE OF INVEST. 80/6/25
JOB NO. Q 2270-001
HOLE NO. 8
DRILL TYPE ROTARY

WATER CONTENT Wp - ☐ W - ○ WL - △ PERCENT %



DEPTH FEET
DATUM GROUND SURFACE
SURFACE ELEVATION

DEPTH	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
	TH 8				
	SAND & SILT - FINE SAND - WELLGRADED, TRACE COARSE SAND & GRAVEL, DENSE - BECOMING VERY DENSE @ DEPTH, BROWN, MOIST (TILL)	☒	D	42	
10	TRACE CLAY, FAINTLY STRATIFIED @ 6' @ SILT POCKETS & LAYERS TO ABOUT 1mm THICK OCCASIONAL COBBLES	☒	D	100 for 3"	▼ 23 days after drilling
		☒	D	100 for 6"	
20	SILT & SAND - WELLGRADED - FINE TO MED. SAND, TRACE COARSE SAND & FINE GRAVEL SIZES, VERY DENSE - OCCAS. COBBLES & BOULDERS - GREY, MOIST (TILL)	☒	D	60 for 5"	
		☒	NR	60 for 5"	
30	@ 35' BECOMING SILTIER MORE GRAVELLY FROM 33'-34'	■	D	37 for 4"	
		☒	D	75 for 4"	
40					
	SAND & GRAVEL - CAVING IN, WATER BEARING				
	SILT & SAND (TILL)				
50					
	HAVING TROUBLE GETTING RODS DOWN HOLE @ 60' MUD SEEMS TO BE THINNING	☒	D	100 for 5"	
60	END OF HOLE @ 60.0' CANNOT CONTINUE DUE TO CAVING				

HOLE NUMBER 1

JOB NUMBER Q 2270-001

DATE 80/6/9

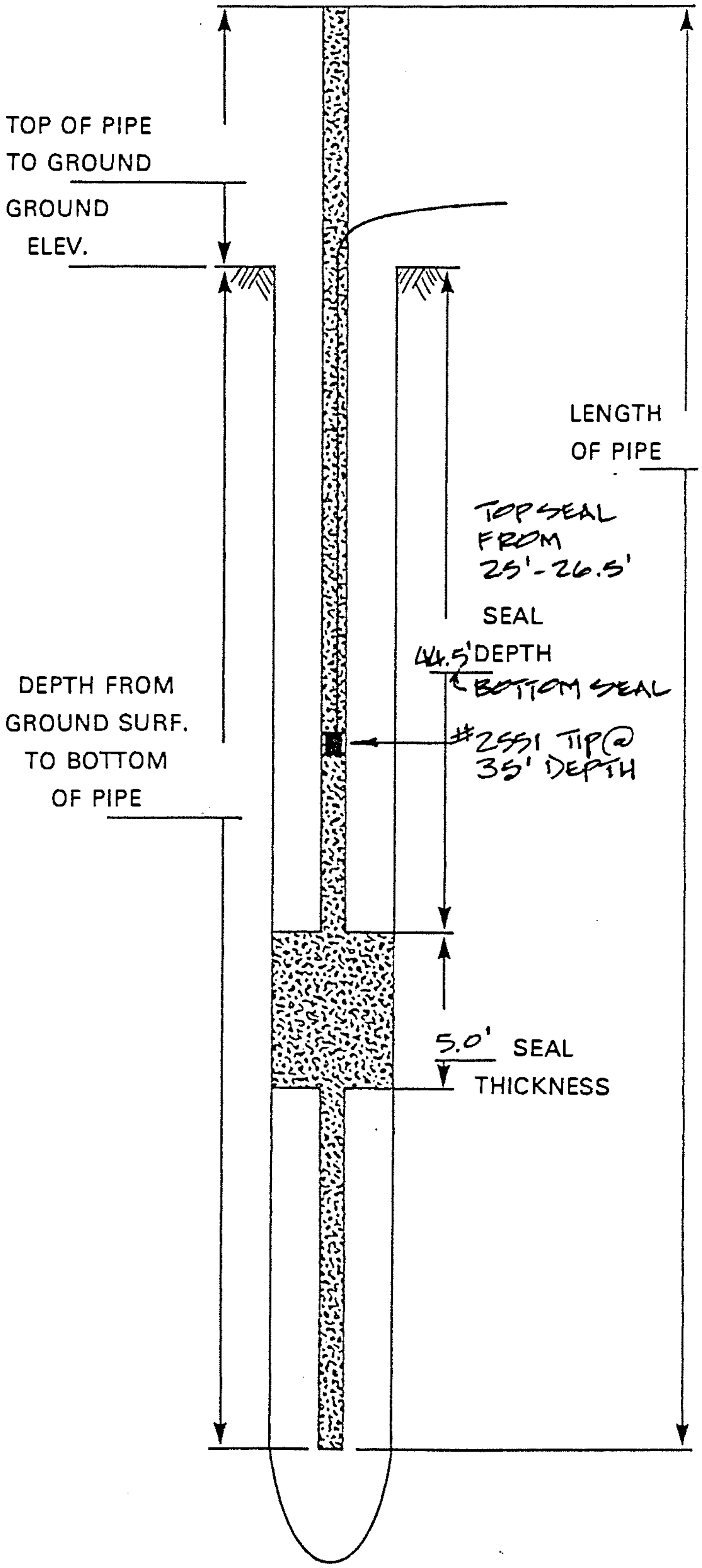
TYPE Pneumatic Piezometer

DIAMETER P-100 # 2551

TECHNICIAN

INITIAL WATER LEVEL
(RELATIVE TO TOP OF PIPE)

REMARKS:



HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

PIEZOMETER OR STANDPIPE INSTALLATION REPORT

SCALE AS NOTED	DATE 80/7/17	MADE H T	CHKD.	JOB Q2270-001	PLATE 20

TA 464 12/77

HOLE NUMBER 1

JOB NUMBER Q 2270-001

DATE 80/6/9

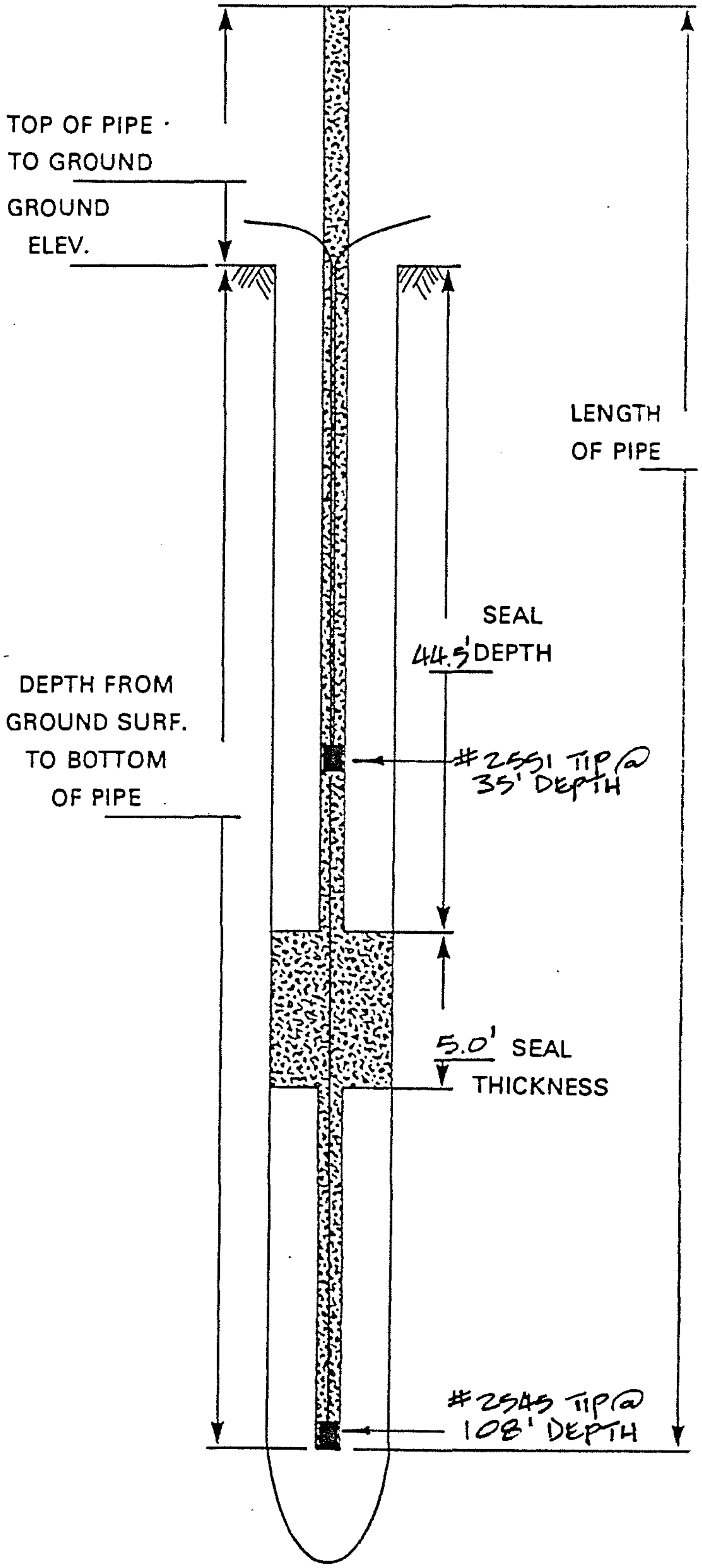
TYPE Pneumatic Piezometer

DIAMETER P-100 #2545

TECHNICIAN

INITIAL WATER LEVEL
(RELATIVE TO TOP OF PIPE)

REMARKS:



HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

PIEZOMETER OR STANDPIPE INSTALLATION REPORT

SCALE AS NOTED	DATE 80/7/17	MADE # 1	CHKD.	JOB Q2270-001	PLATE 21

TA 464 12 77

HOLE NUMBER 2

JOB NUMBER Q 2270-001

DATE 80/6/6

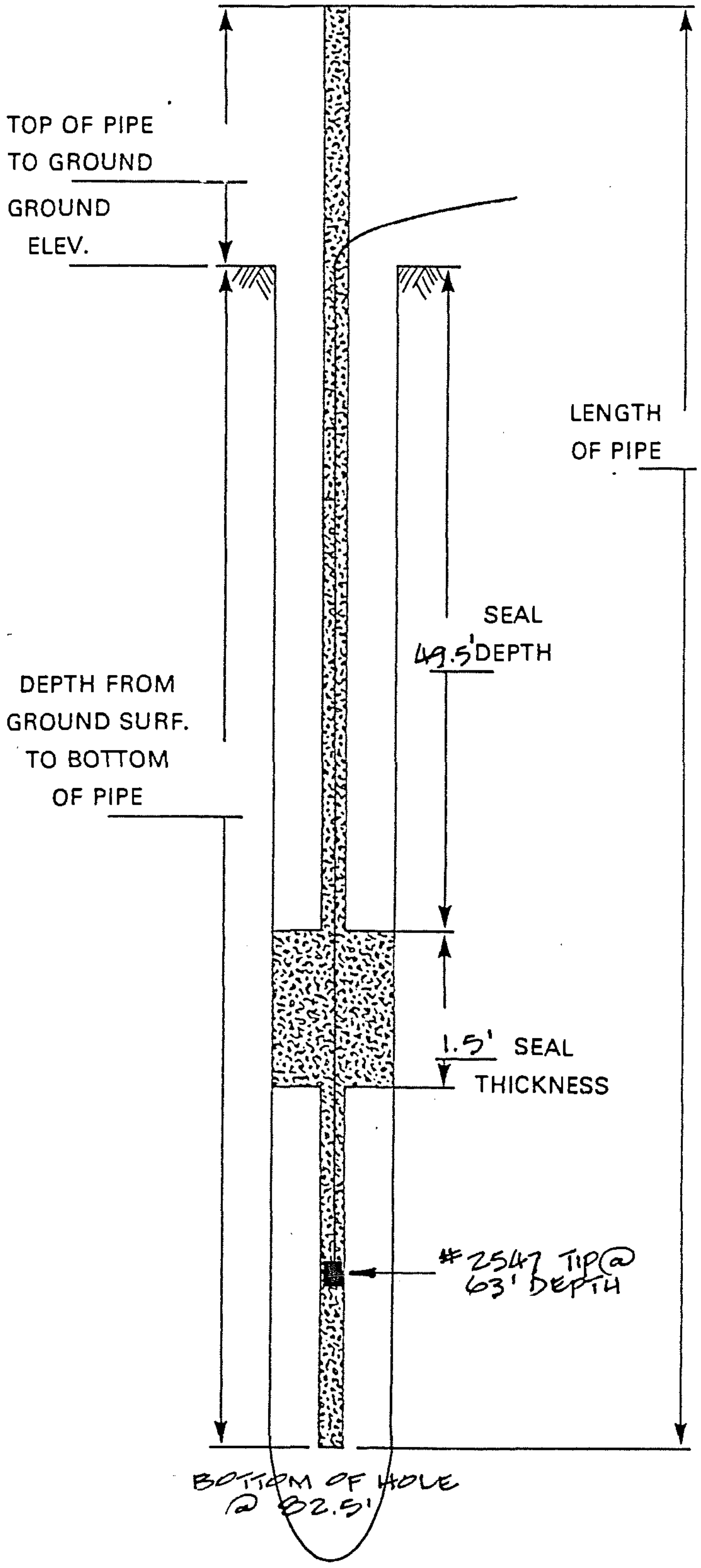
TYPE Pneumatic Piezometer

DIAMETER P-100 #2547

TECHNICIAN

INITIAL WATER LEVEL
(RELATIVE TO TOP OF PIPE)

REMARKS:



HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

PIEZOMETER OR STANDPIPE INSTALLATION REPORT

SCALE AS NOTED
DATE 80/7/17
MADE HT
CHKD.
JOB: Q2270-001
PLATE 22

TA 464 12/77

HOLE NUMBER 3A

JOB NUMBER Q2270-001

DATE 80/6/13

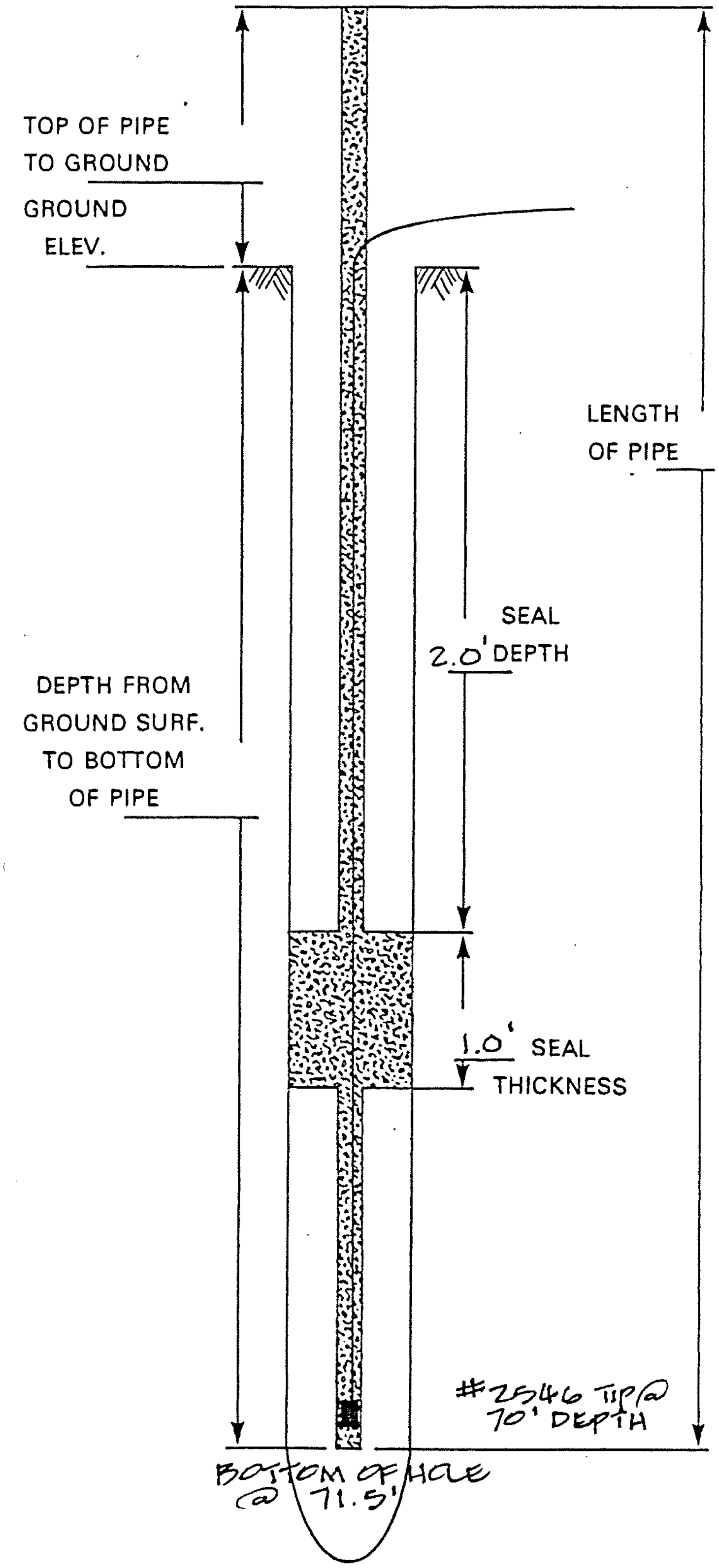
TYPE Pneumatic Piezometer

DIAMETER P-100 #2546

TECHNICIAN

INITIAL WATER LEVEL
(RELATIVE TO TOP OF PIPE)

REMARKS:



HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

PIEZOMETER OR STANDPIPE INSTALLATION REPORT

SCALE AS NOTED | DATE 80/7/18 | MADE H | CHKD. | JOB Q2270-001 | PLATE 23

TA 464 12/77

HOLE NUMBER 7

JOB NUMBER Q2270-001

DATE 80/6/23

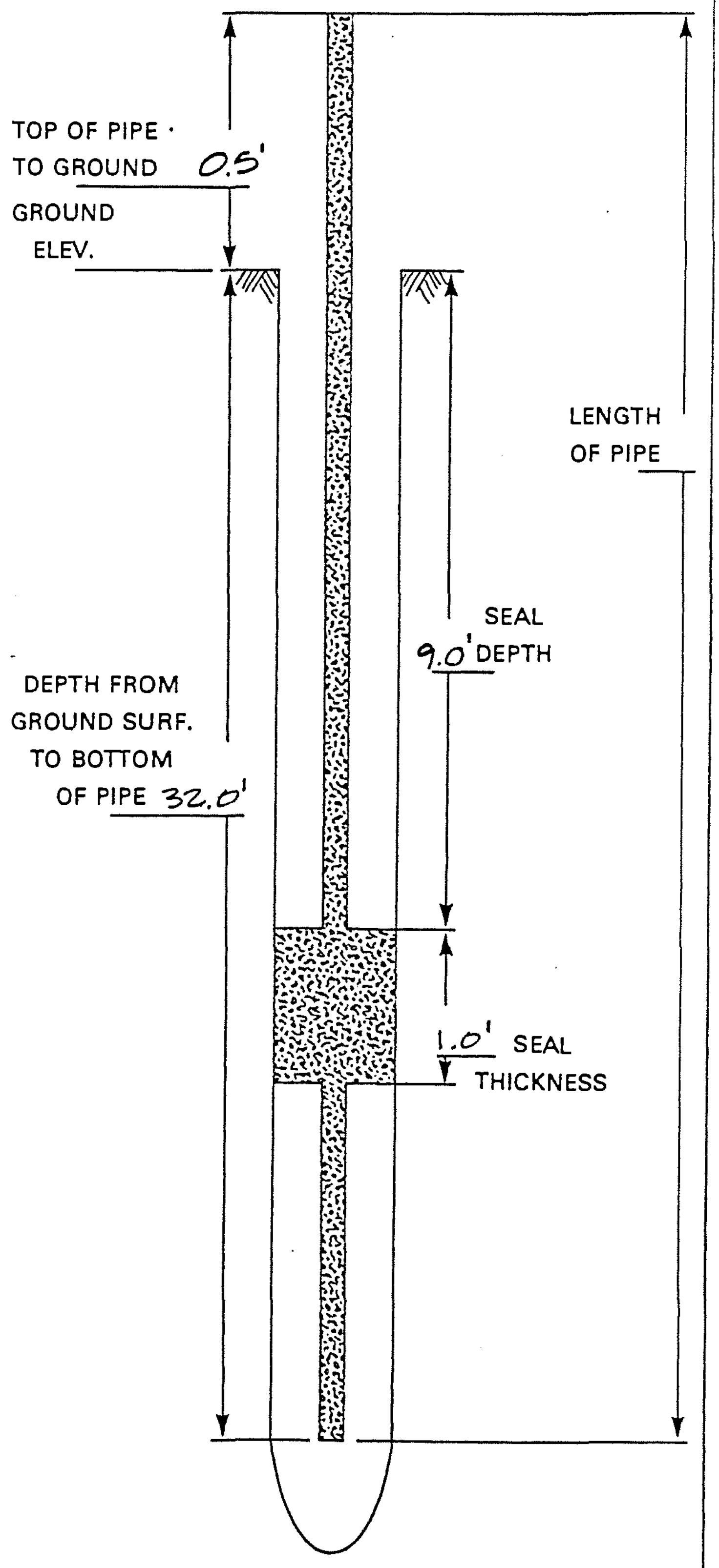
TYPE Standpipe

DIAMETER

TECHNICIAN

INITIAL WATER LEVEL
(RELATIVE TO TOP OF PIPE)

REMARKS:



HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

PIEZOMETER OR STANDPIPE INSTALLATION REPORT

SCALE AS NOTED
DATE 80/7/18
MADE HT
CHKD.
JOB Q2270-001
PLATE 24

TA 464 12/77

HOLE NUMBER 8

JOB NUMBER Q2270-001

DATE 80/6/25

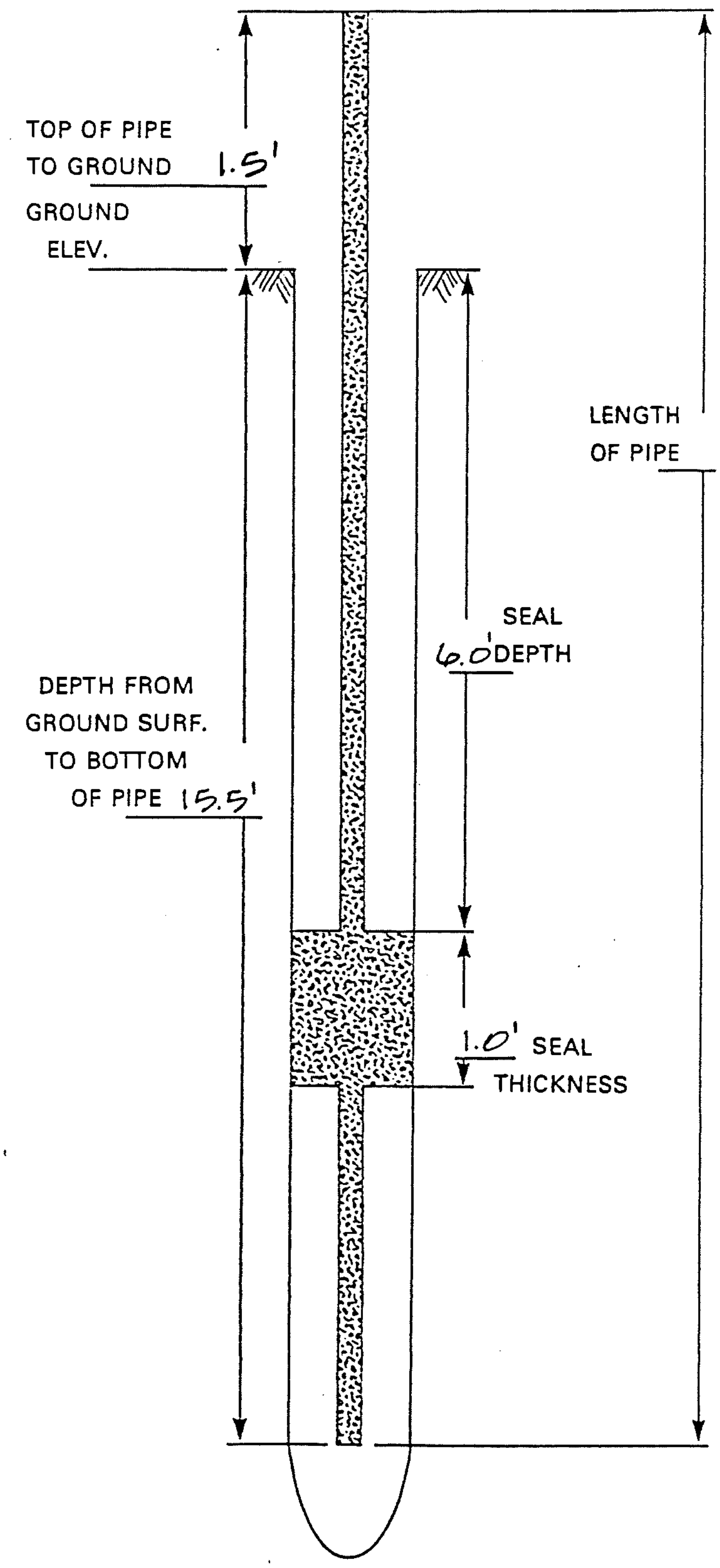
TYPE Standpipe

DIAMETER

TECHNICIAN

INITIAL WATER LEVEL
(RELATIVE TO TOP OF PIPE)

REMARKS:



HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

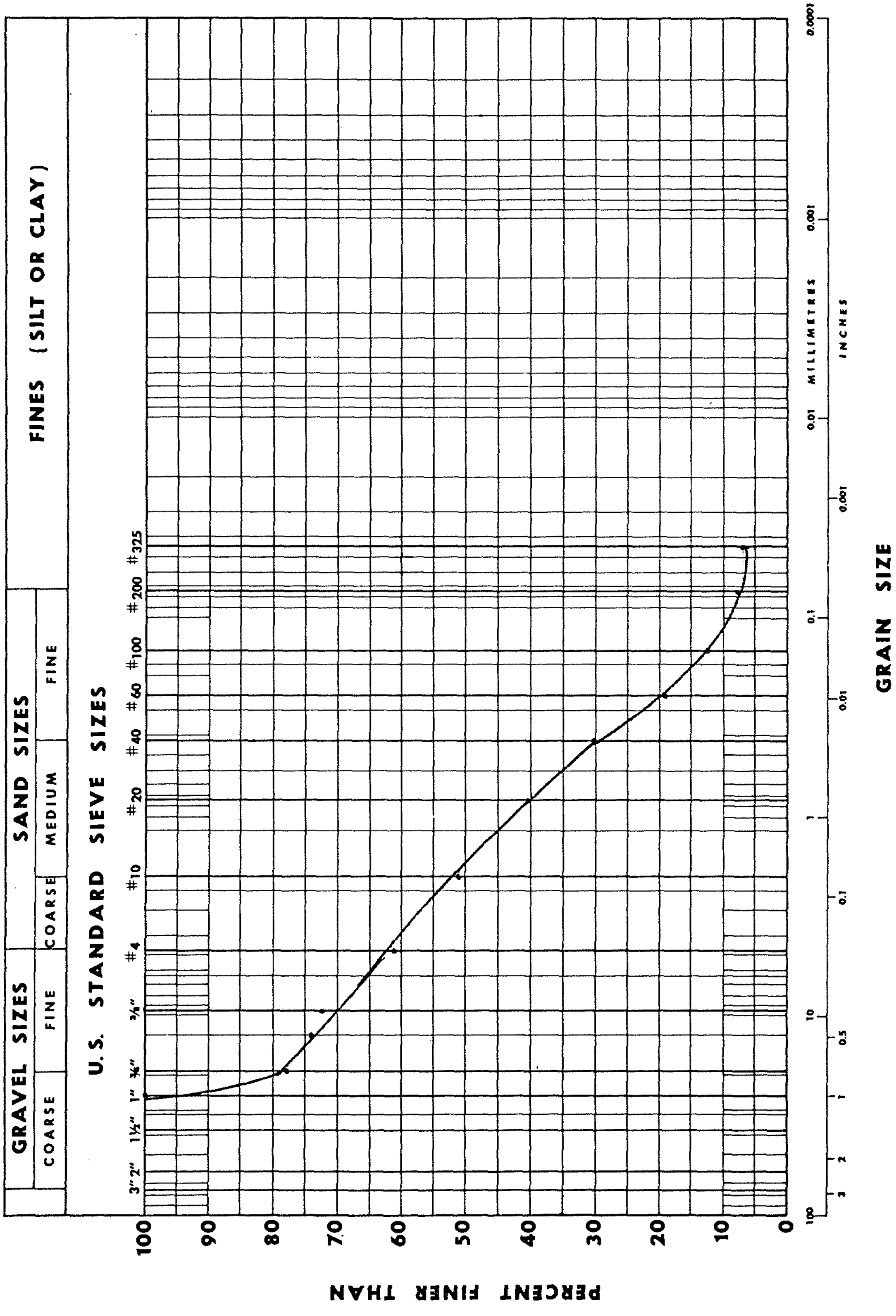
PIEZOMETER OR STANDPIPE INSTALLATION REPORT

SCALE AS NOTED
DATE 80/7/18
MADE H
CHKD.
JOB Q2270-001
PLATE 25

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001
CLIENT CITY OF PORT MOODY
SAMPLE
SOURCE
HOLE 1 DEPTH 26'-27.5' DATE REC'D.
TECHNICIAN DATE TESTED



D$_{10}$ = 0.11 MM
D$_{30}$ = 0.40 MM
D$_{60}$ = 3.9 MM
C$_U$ 35.5
C$_C$ 0.37

REMARKS: SP-SM - CLEAN SAND, POORLY GRADED, TRACE OF SILT

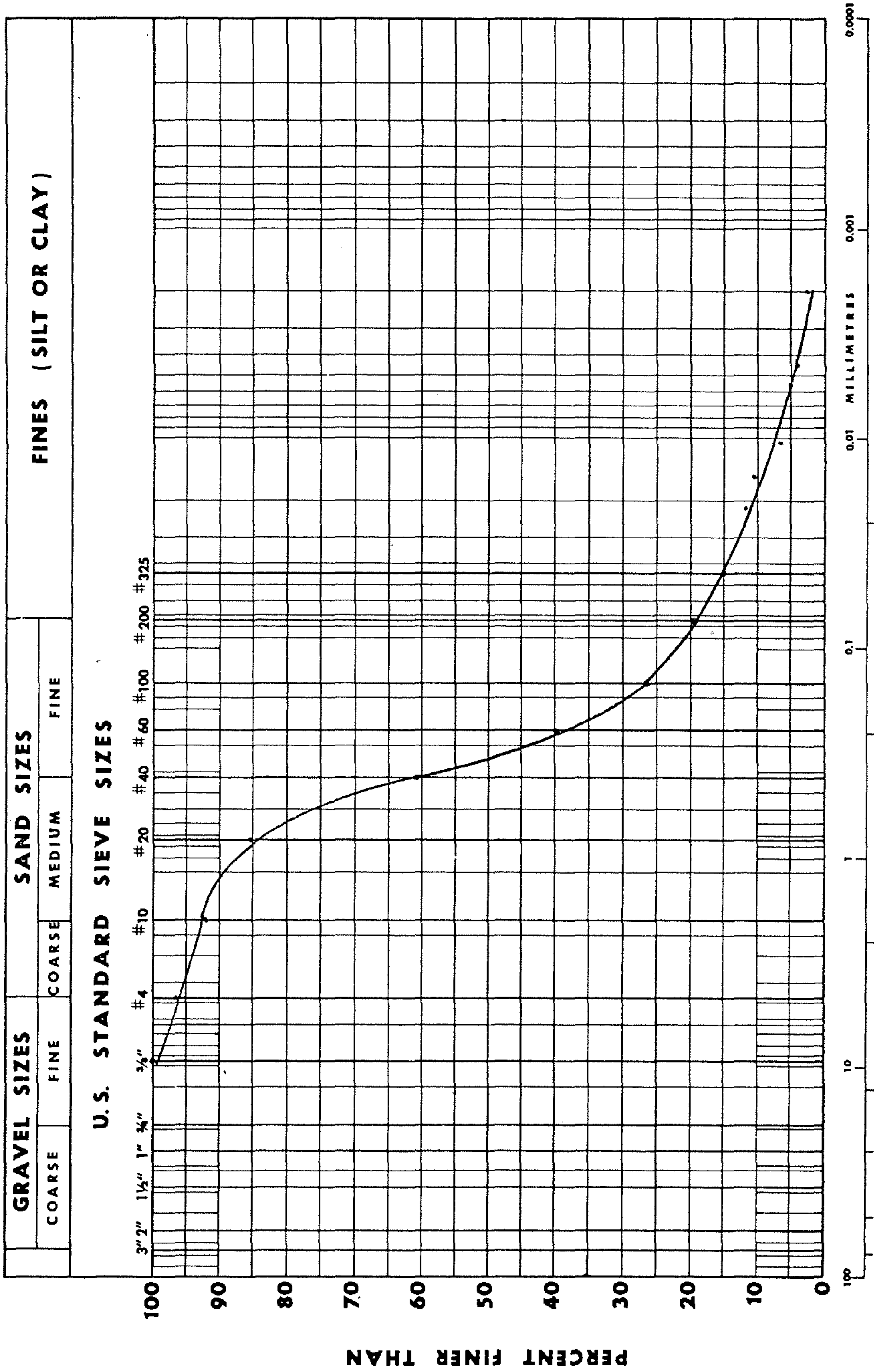
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 26

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001
CLIENT CITY OF PORT MOODY
SAMPLE
SOURCE
HOLE 1 DEPTH 31.5'-33.0' DATE REC'D.
TECHNICIAN DATE TESTED



D_{10} = 0.09 MM.
D_{30} = 0.18 MM.
D_{60} = 0.40 MM.
C_U 4.4
C_C 0.9

REMARKS: SW - CLEAN SAND, WELL GRADED, MEDIUM TO FINE GRAINED, TRACE OF SILT

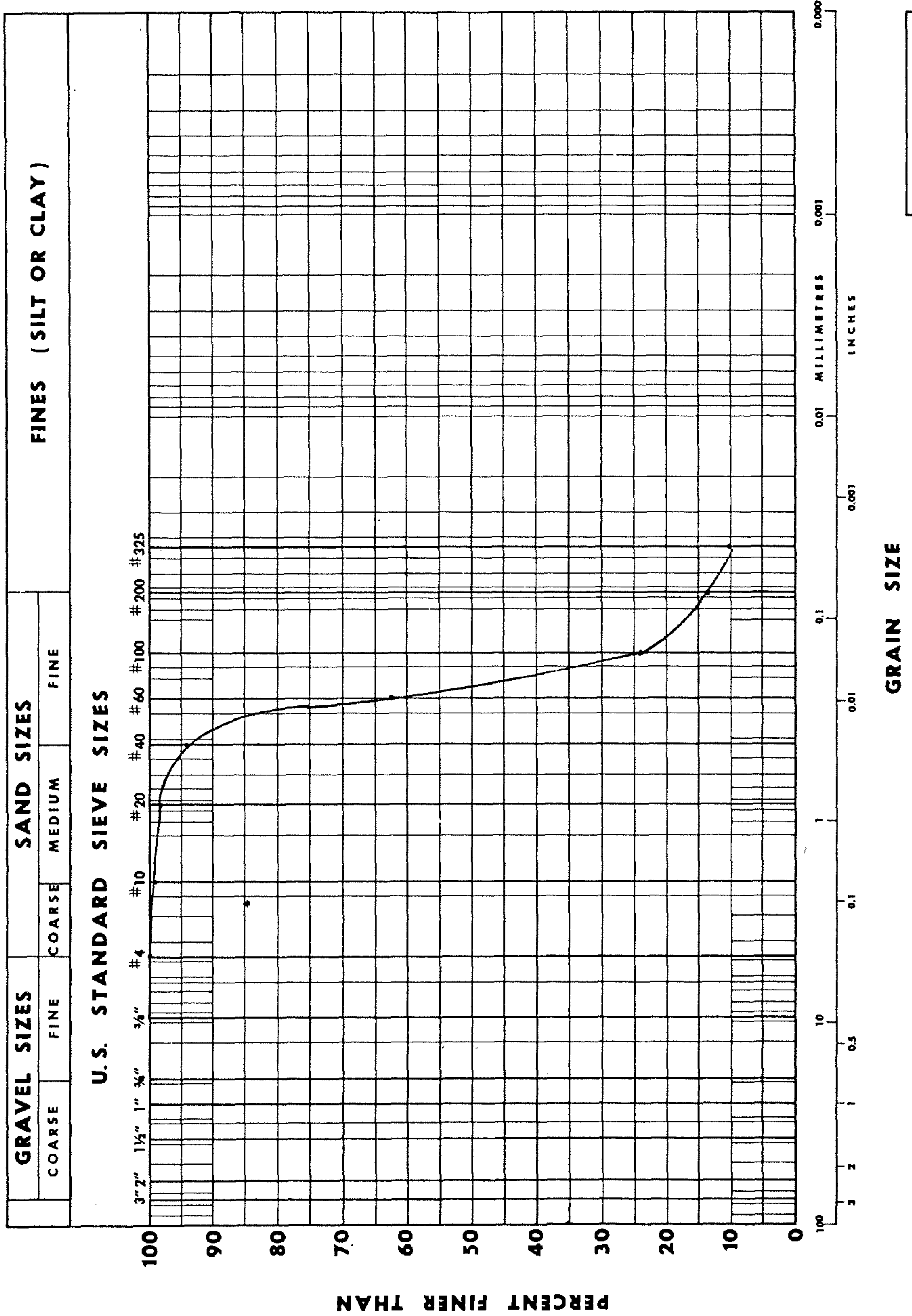
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 27

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001
CLIENT CITY OF PORT MOODY
SAMPLE
SOURCE
HOLE 1 DEPTH 50.5'-52.0' DATE REC'D.
TECHNICIAN DATE TESTED



D_{10} = 0.046 MM.
D_{30} = 0.16 MM.
D_{60} = 0.24 MM.
C_U = 5.2
C_C = 2.3

REMARKS: SM - FINE SILTY SAND, POORLY GRADED

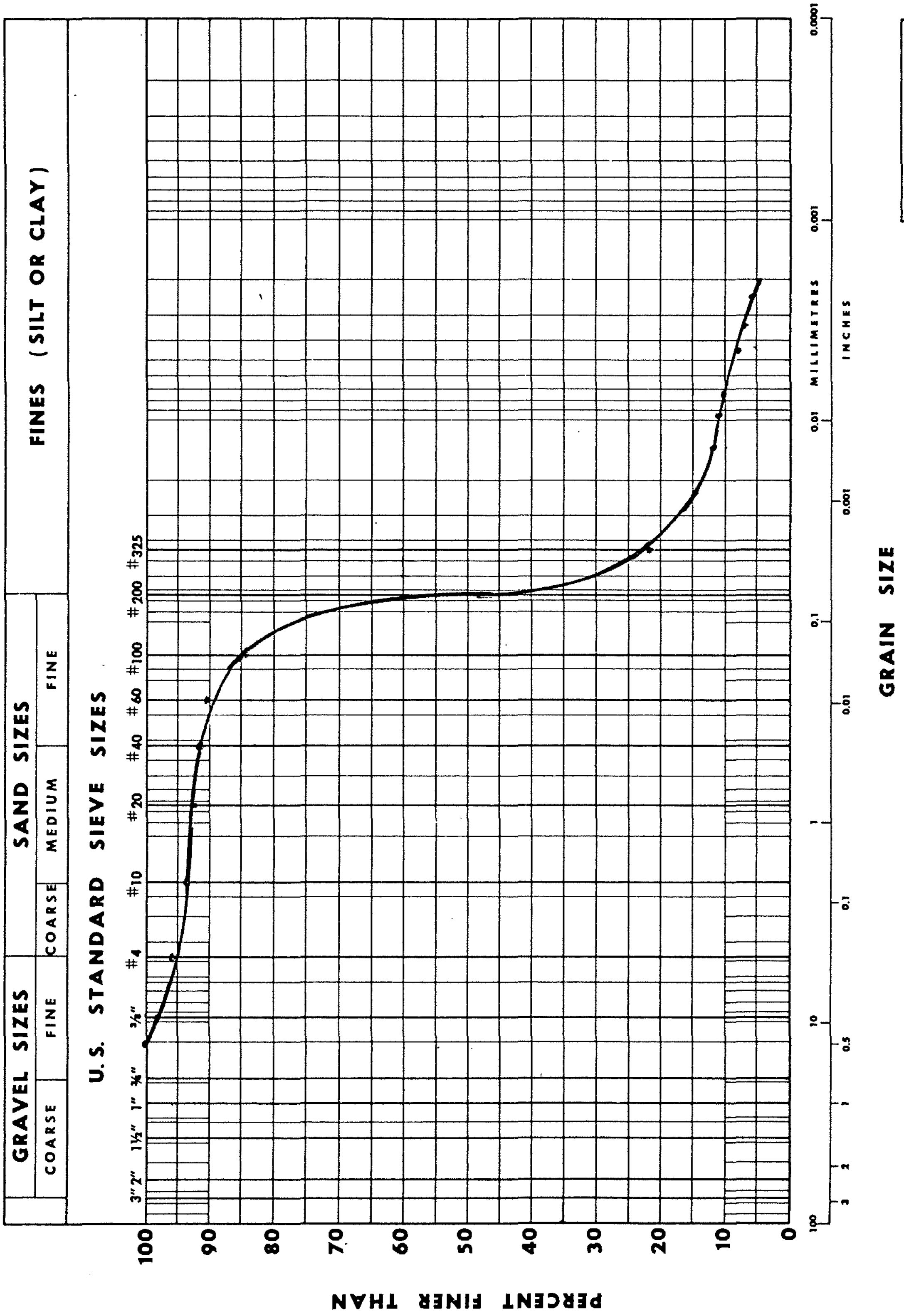
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 28

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001
CLIENT CITY OF PORT MOODY
SAMPLE
SOURCE
HOLE 1 DEPTH 80.0'-81.5' DATE REC'D.
TECHNICIAN DATE TESTED



D_{10} = 0.007 MM.
D_{30} = 0.06 MM.
D_{60} = 0.078 MM.
C_U 11.1
C_C 6.6

REMARKS: SM-ML - FINE SAND AND SILT, POORLY GRADED

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

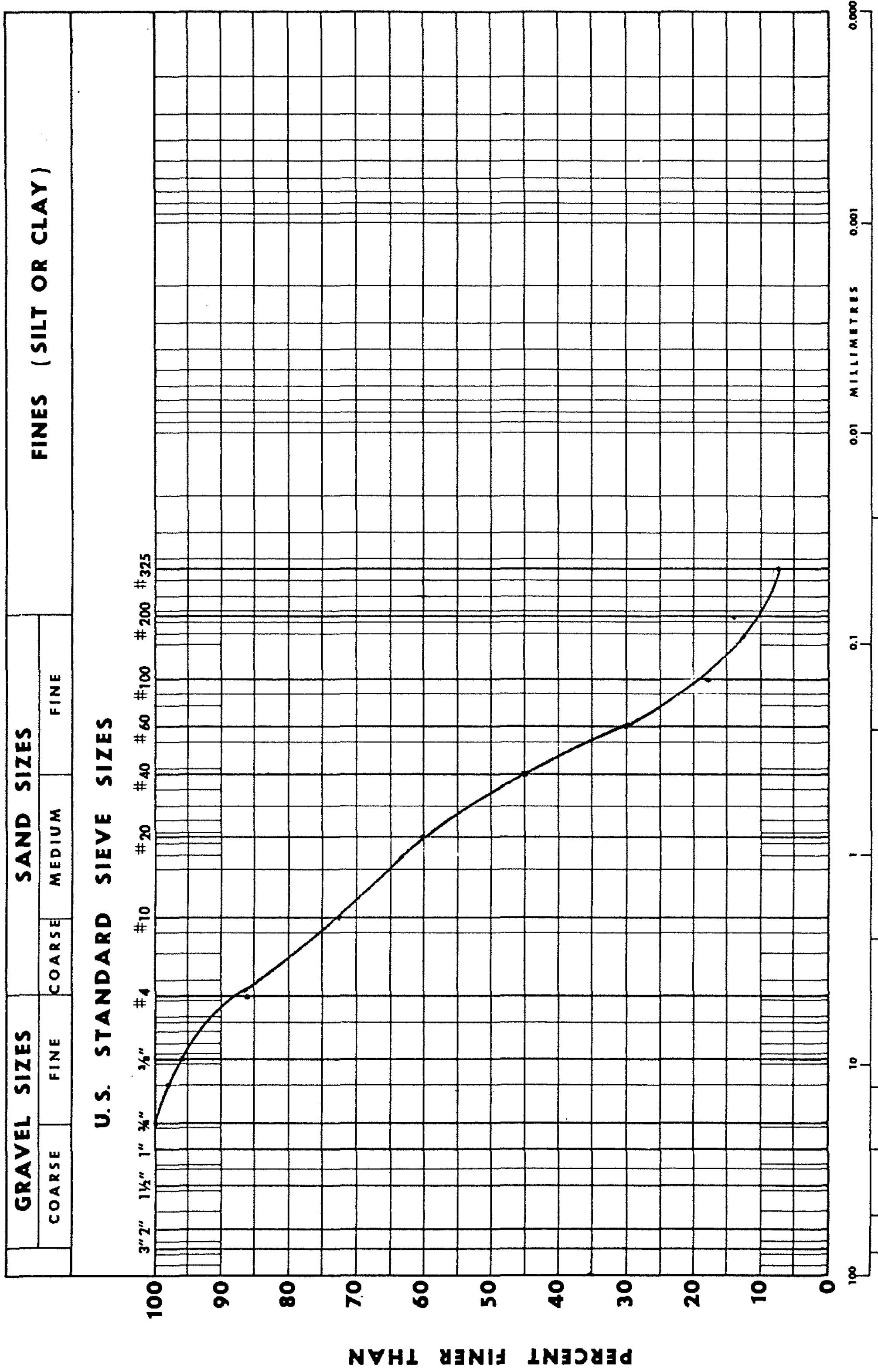
PLATE 29

GU202-0373

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001
CLIENT CITY OF PORT MOODY
SAMPLE
SOURCE
HOLE 1 DEPTH 110.5' DATE REC'D.
TECHNICIAN DATE TESTED



D_{10} = 0.074 MM.
D_{30} = 0.23 MM.
D_{60} = 0.8 MM.
C_U 10.8
C_C 0.89

REMARKS: SW-SM SAND, MEDIUM GRAINED, WELL GRADED, TRACE SILT

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

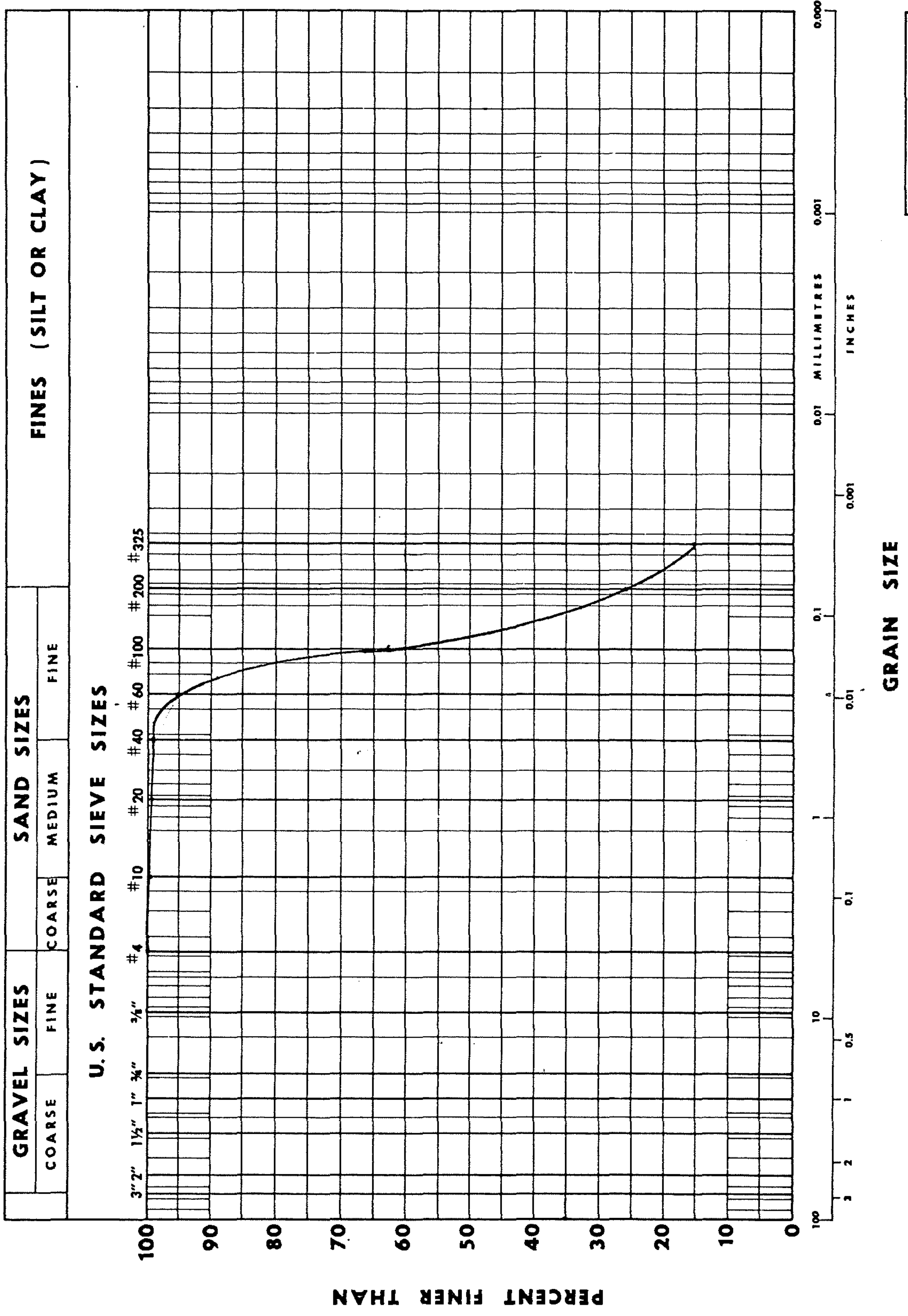
PLATE 30

GU202-0373

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001
CLIENT CITY OF PORT MOODY
SAMPLE
SOURCE
HOLE 1 DEPTH 150.5' DATE REC'D.
TECHNICIAN DATE TESTED



D_{10} = ______ MM.
D_{30} = ______ MM.
D_{60} = ______ MM.
C_U ______
C_C ______

REMARKS: SM - SAND, POORLY GRADED, FINE GRAINED, SOME SILT

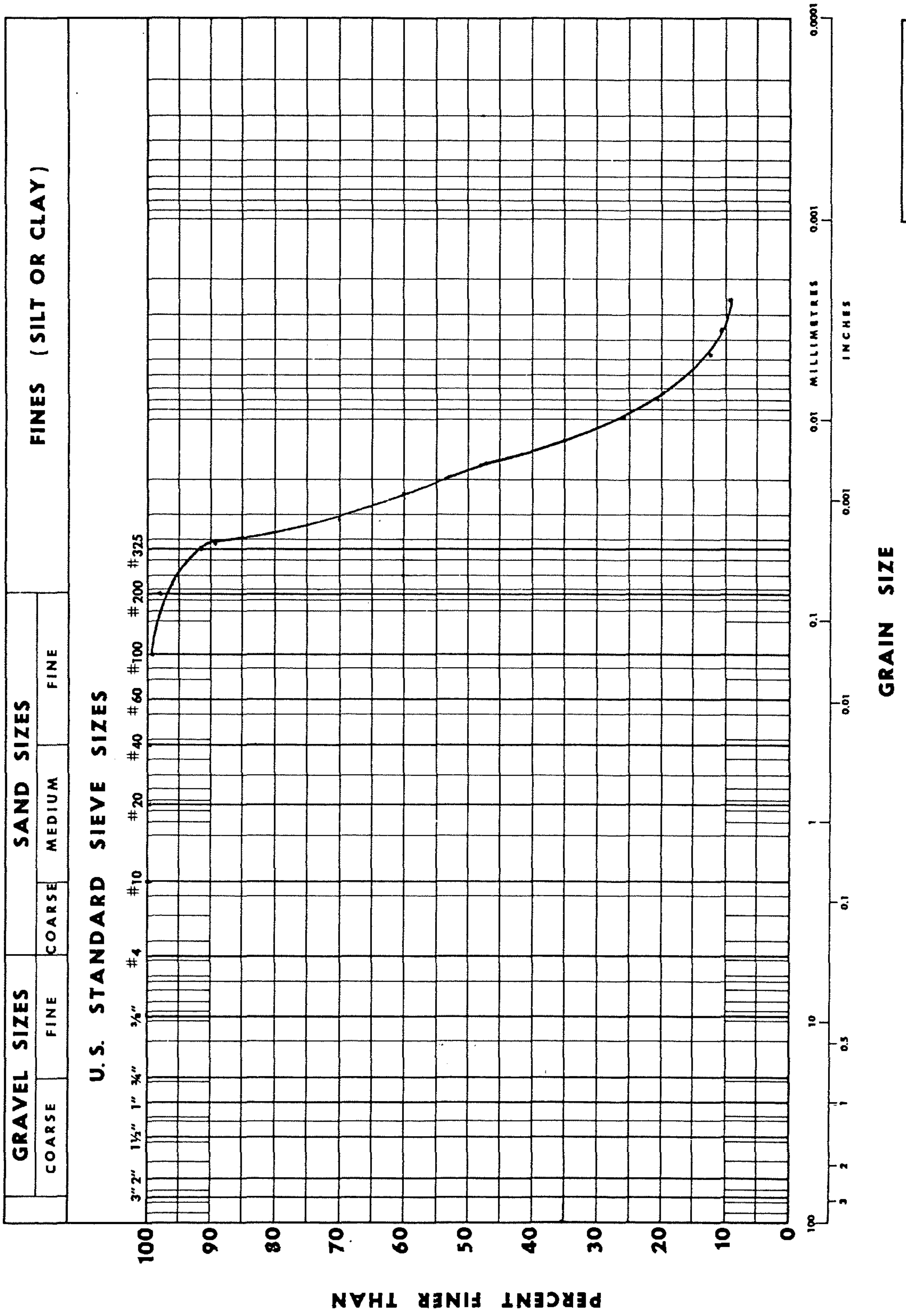
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 31

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001
CLIENT CITY OF PORT MOODY
SAMPLE
SOURCE
HOLE | DEPTH 180.5' DATE REC'D.
TECHNICIAN DATE TESTED



D_{10} = .0032 MM.
D_{30} = .011 MM.
D_{60} = .024 MM.
C_U
C_C

REMARKS: ML SILT, TRACE OF FINE SAND, LOW PLASTIC

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 32

U202-0373

R.M.HARDY & ASSOCIATES LTD.

CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. Q2270-001

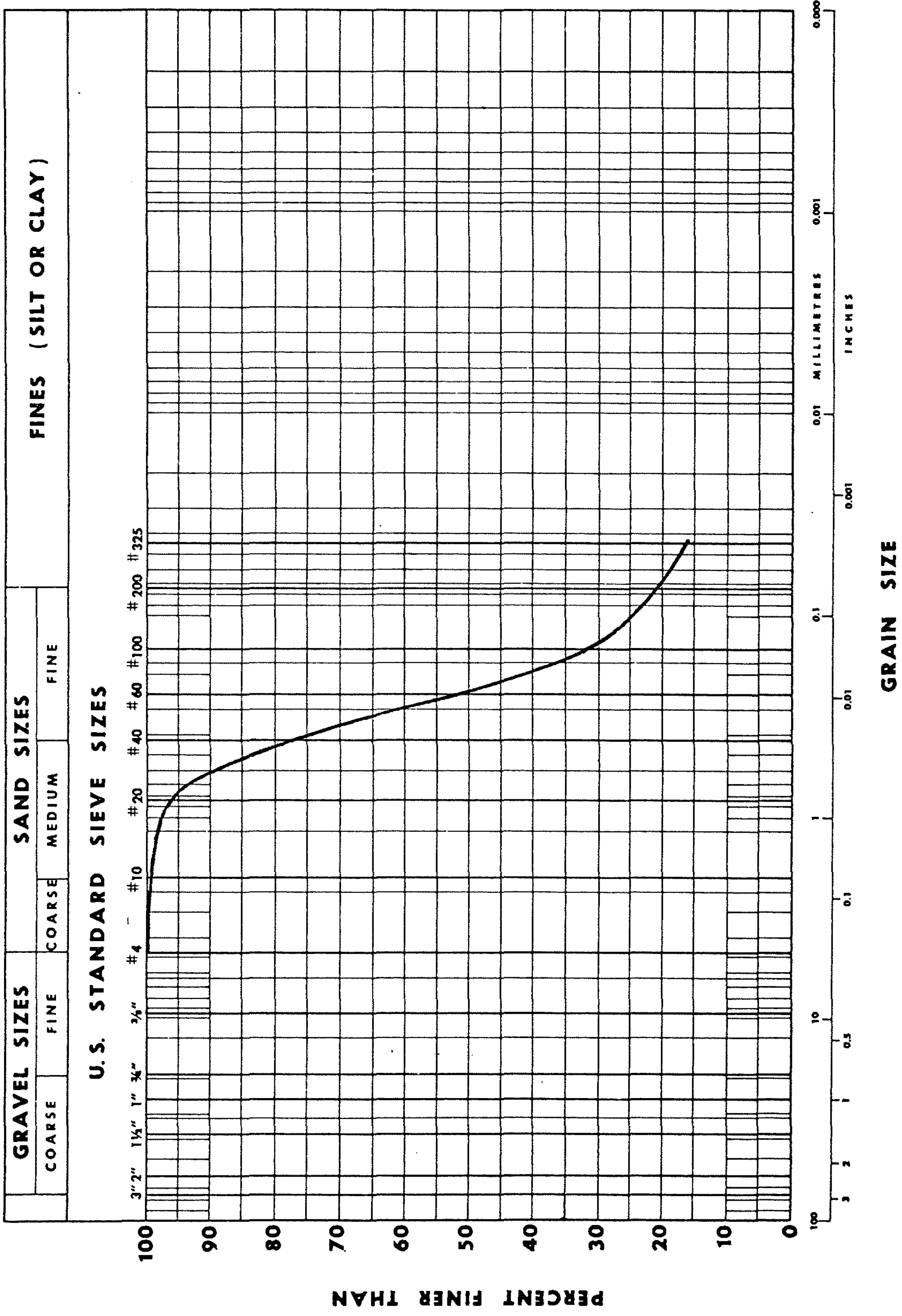
CLIENT CITY OF PORT MOODY

SAMPLE

SOURCE

HOLE 3A DEPTH 40'-40.5' DATE REC'D.

TECHNICIAN DATE TESTED



D_{10} = ______ MM.

D_{30} = ______ MM.

D_{60} = ______ MM.

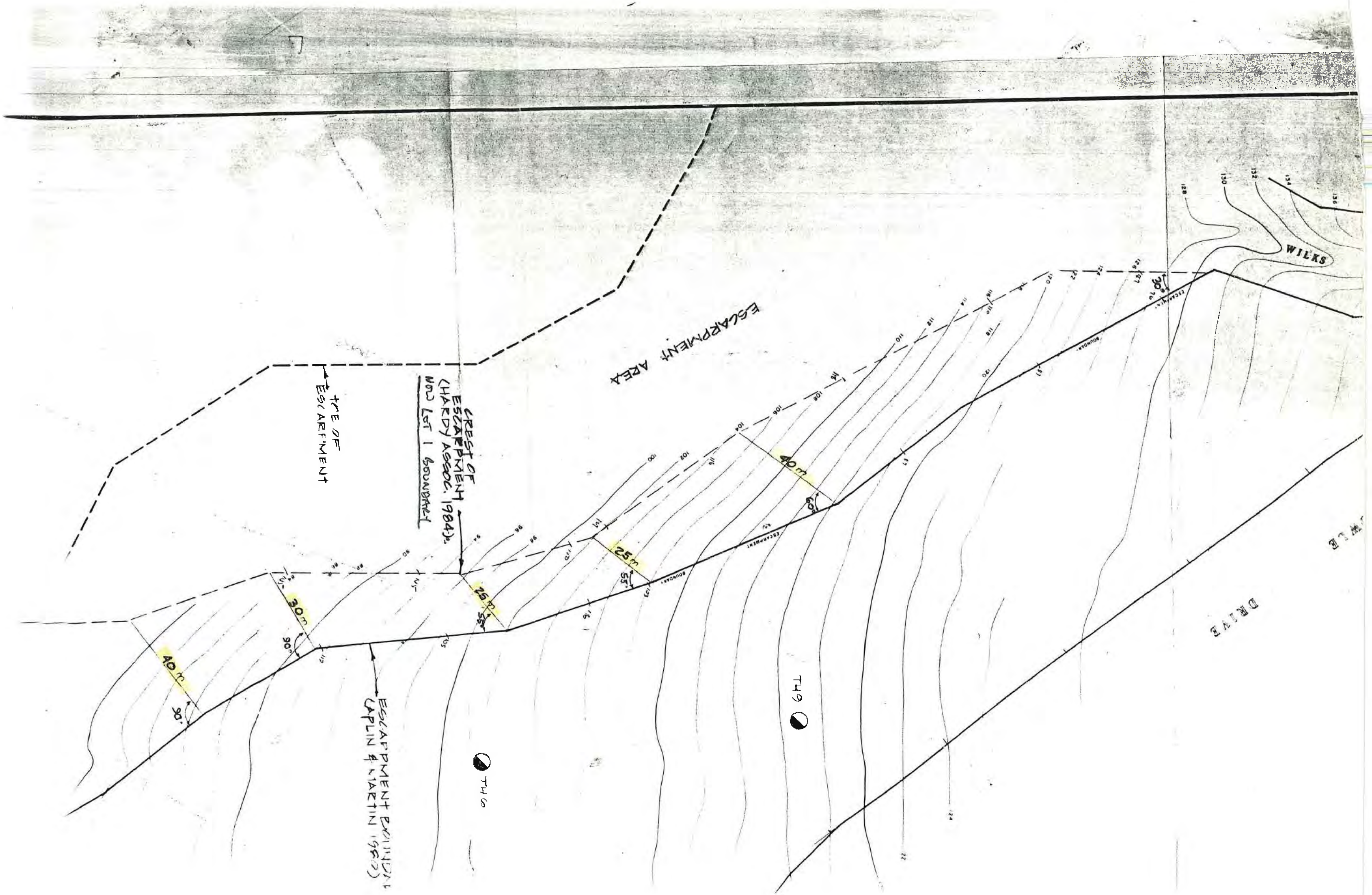
C_U ______

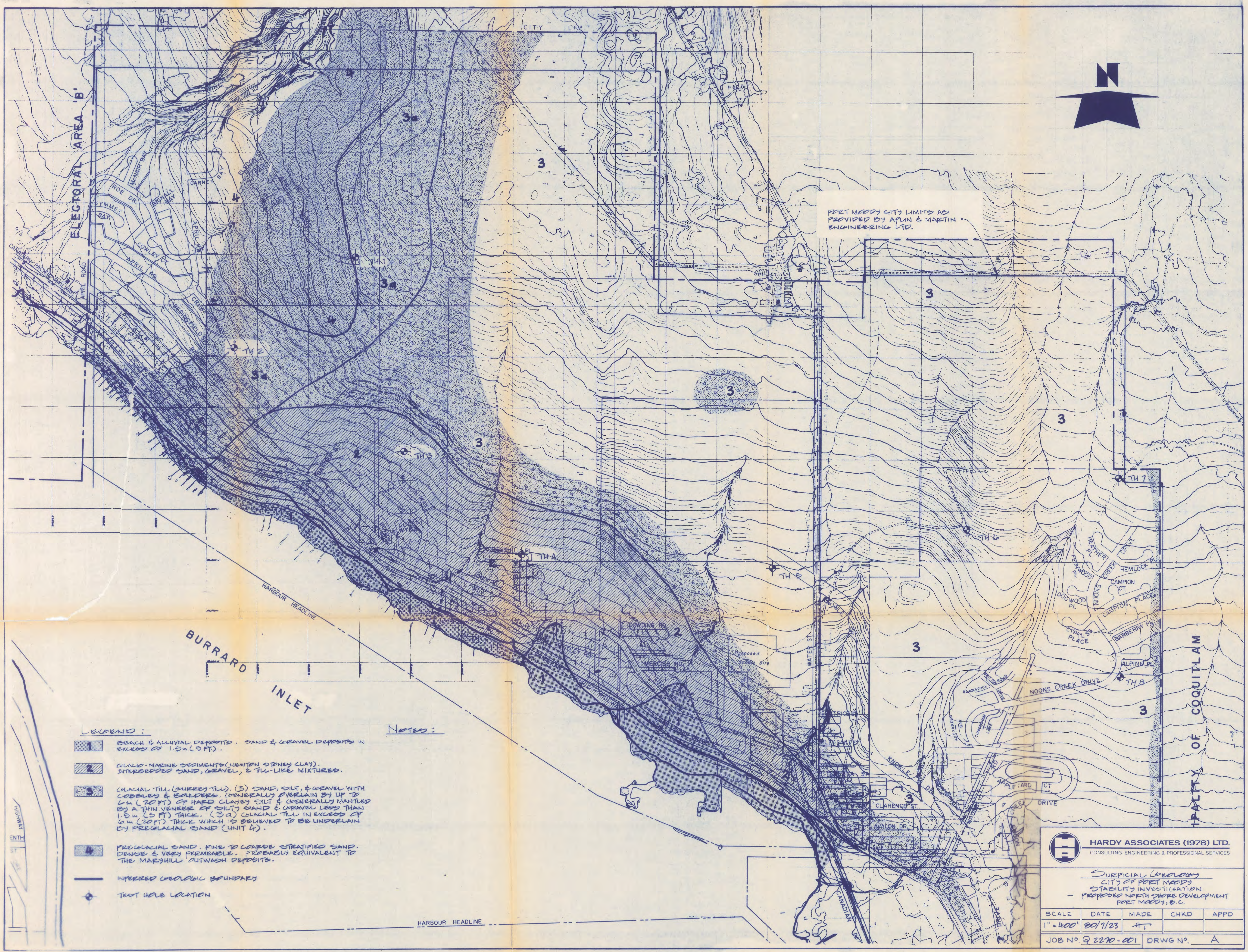
C_C ______

REMARKS: SM SAND, FINE GRAINED, POORLY GRADED, SOME SILT

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 33


ESCARPMENT AREA
TOE OF ESCARPMENT
CREST OF ESCARPMENT (HARDY ASSOC. 1984).
NOW LOT 1 BOUNDARY
ESCARPMENT BOUNDARY
(APLIN & MARTIN 1983)
40 m
90°
30 m
90°
25 m
55°
25 m
55°
40 m
60°
30
WILKS
DRIVE
TH9
TH6



LEGEND:

1	BEACH & ALLUVIAL DEPOSITS. SAND & GRAVEL DEPOSITS IN EXCESS OF 1.5m (5 FT).
2	GLACIO-MARINE SEDIMENTS (NEWTON STONEY CLAY). INTERBEDDED SAND, GRAVEL, & TILL-LIKE MIXTURES.
3	GLACIAL TILL (SURREY TILL). (3) SAND, SILT, & GRAVEL WITH COBBLES & BOULDERS. GENERALLY OVERLAIN BY UP TO 6m (20 FT) OF HARD CLAYEY SILT & GENERALLY MANTLED BY A THIN VENEER OF SILTY SAND & GRAVEL LESS THAN 1.5m (5 FT) THICK. (3a) GLACIAL TILL IN EXCESS OF 6m (20 FT) THICK WHICH IS BELIEVED TO BE UNDERLAIN BY PREGLACIAL SAND (UNIT 4).
4	PREGLACIAL SAND. FINE TO COARSE STRATIFIED SAND. DENSE & VERY PERMEABLE. PROBABLY EQUIVALENT TO THE MARYHILL OUTWASH DEPOSITS.
—	INFERRED GEOLOGIC BOUNDARY
⌖	TEST HOLE LOCATION

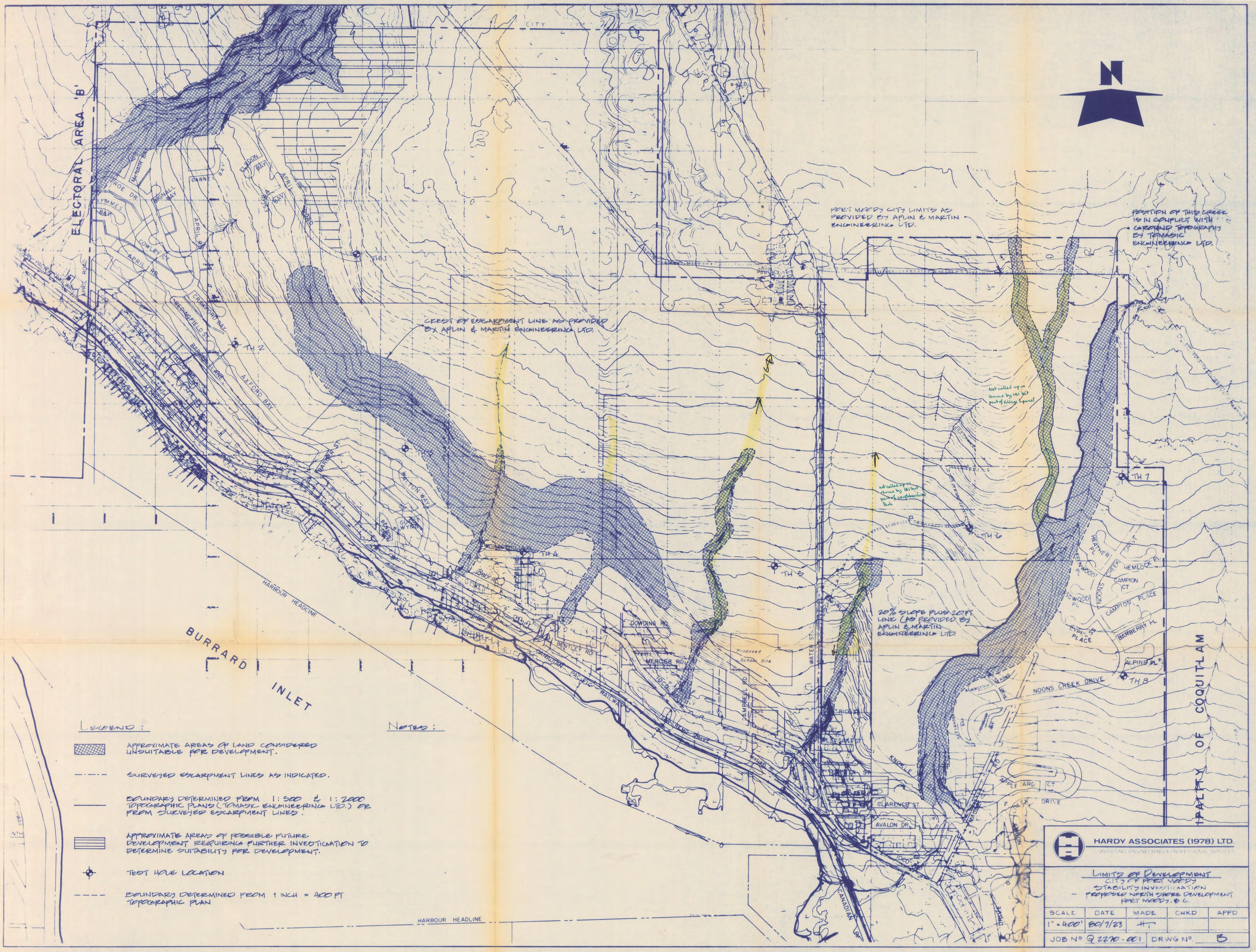
NOTES:

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

SURFICIAL GEOLOGY
CITY OF PORT MOODY
STABILITY INVESTIGATION
– PROPOSED NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

SCALE	DATE	MADE	CHKD	APPD
1" = 400'	80/7/23	HT		

JOB No. Q 2270 - 001
DRWG No. A



PORT MOODY CITY LIMITS AS PROVIDED BY APLIN & MARTIN ENGINEERING LTD.

POSITION OF THIS CREEK IS IN CONFLICT WITH GROUND TOPOGRAPHY BY TOMASIC ENGINEERING LTD.

CREST OF ESCARPMENT LINE AS PROVIDED BY APLIN & MARTIN ENGINEERING LTD.

Not called up as ravine by IBI but part of Village I panel

not called up as ravine by IBI but part of neighbourhood Park

20% SLOPE PLUS 20 FT LINE (AS PROVIDED BY APLIN & MARTIN ENGINEERING LTD.

LEGEND:

▨	APPROXIMATE AREAS OF LAND CONSIDERED UNSUITABLE FOR DEVELOPMENT.
—·—·—	SURVEYED ESCARPMENT LINES AS INDICATED.
———	BOUNDARY DETERMINED FROM 1:500 & 1:2000 TOPOGRAPHIC PLANS (TOMASIC ENGINEERING LTD.) OR FROM SURVEYED ESCARPMENT LINES.
▤	APPROXIMATE AREAS OF POSSIBLE FUTURE DEVELOPMENT REQUIRING FURTHER INVESTIGATION TO DETERMINE SUITABILITY FOR DEVELOPMENT.
⊕	TEST HOLE LOCATION
- - - -	BOUNDARY DETERMINED FROM 1 INCH = 400 FT TOPOGRAPHIC PLAN

NOTES:

HARDY ASSOCIATES (1978) LTD.

CONSULTING ENGINEERING & PROFESSIONAL SERVICES

LIMITS OF DEVELOPMENT
CITY OF PORT MOODY
STABILITY INVESTIGATION
– PROPOSED NORTH SHORE DEVELOPMENT
PORT MOODY, B.C.

SCALE	DATE	MADE	CHKD	APPD
1" = 400'	80/7/23	H		

JOB Nº Q 2270-001
DRWG Nº. B