D. OTHER SUPPLEMENTAL SURVEY REPORTS FOR DESIGN

ENVIRONMENTAL CONSIDERATION

Environmental Consideration

1. Methodology

'Environmental Consideration' has been done in the project is composed of the following examinations:

- analysing environmental impacts of development activities on the project site and its surrounding areas during the stages of both construction and operation,
- proposing necessary mitigation measures to avoid and/or alleviate significant adverse impacts on natural and human environment.

However, because of the project nature which environmental impacts of the development activities are minor, the environmental consideration did not include environmental impact assessment based upon simulation works to forecast and evaluate environmental impacts using simulation models. As shown in below it mainly examined the impacts caused by the development activities with qualitative expressions for the evaluation.

(1) pre-assessment

- Reviews of the previous environmental studies

(2) analysis of existing constraints and potential impacts

- Collection of further data and maps
- On-site survey by JICA Study Team
- Discussion with experts of JICA Study Team and the authorities concerned

(3) mitigation measures

- On-site survey
- Literatural survey
- Discussion with experts of JICA Study Team and the authorities concerned

As the Jordanian Government does not have its own guidelines on environmental assessment, basically taking into consideration of the Environmental Consideration Guidelines of JICA and OECF, the important environmental items were carefully assessed through the above process.

The environmental examination was undertaken in each work component of the project from the viewpoints of both natural and social environment, mainly focussing on unclear or significant environmental issues pointed out in the previous environmental studies. Based upon such comprehensive environmental examination, the possible negative and positive impacts at both construction and operational phases caused by the project implementation were identified. The impacts were classified according to the natures of the development activities such as site location and project scale. In addition, to reduce or avoid the negative impacts, mitigation measures were proposed.

2. Previous assessment

2.1. Initial Environmental Examination (IEE) by JICA:

The existing environmental issues identified by the IEE are as follows:

- traffic nuisance: air and noise pollution, traffic congestion on Ras al Ain which carries a daily flow of about 60,000 vehicles leading to pedestrian severance
- water: water supply irregularities and leakage, flooding and leakage of waste water during heavy rains
- waste: letter and waste accumulation
- amenity: the valley is considered to offer an exceptional visual landscape, but it suffers from a lack of integration of the green park of Ras al Ain with surrounding and poor pedestrian access
- landslide: the steep slopes are subject to landslide

Sensitive environmental problems arising from the proposed National Museum are limited to landscape and flooding. Due to these concerns the IEE concluded that an EIA was required.

2.2. Environmental consideration by SAPROF:

The flood risk is well within the scope of engineering design responses without necessitating disruption to the local area. SAPROF concludes that the proposed project is classed as a Category B and that an EIA is not necessary.

It also concludes that:

- there are no environmental regulations or conventions affected
- there are no environmental standards applicable to the project
- there are no important or designated sites of nature conservation
- there are no resettlement measures are needed
- the project will enhance local economic activities

3. Examination on potential environmental impacts and proposed mitigation measures

3.1. Potential environmental impacts

The project sites locates urban developed areas where residents and business building concentrate. Therefore, due to physical feature that there is little natural environment, it is considered that the effects arising from the project are limited to human environment.

However the project site is close to residential area, and adverse impacts such as noise and air pollution to human health would be possible especially during construction because of the operation of construction equipment and detonations. These environmental problems are not so serious and easy to be minimised or avoid by appropriate mitigation measures.

The key environmental impacts are shown in Table 1.

Table 1 Potential impacts

Factors	Actions	Impacts	Stage	Impact ranking	Type
Air Pollution	- construction work	- cause nuisance of the neighbouring residents	construction	△	direct
Water Pollution	- drain pipe clog by construction debris - wastewater from construction plants	- degrade water quality of groundwater	construction	△	direct
	- wastewater by washing of exhibition articles		operational	△	direct
Noise & Vibration Pollution	- construction work	- cause nuisance of the neighbouring residents	construction	△	direct
Waste Pollution	- construction work	- construction debris clog drain pipe - generate huge volume of construction wastes	construction	○	direct
	- increase of tourists	- increase tourist litters	operational	○	cumulative
Traffic& Safety	- construction work and transportation	- cause pedestrian disturbance	construction	△	direct
	- increase of vehicles and tourists	- increase traffic nuisance	operational	○	cumulative

○ major △ minor

Source: JICA Study Team

3.2. Proposed mitigation measures

The project helps to bring economic enhancement due to increase of tourists. On the other hand, cumulative negative impacts such as waste related problems and traffic congestion may occur due to increase of tourist cars and litters. The problems in concerned with waste management, traffic nuisance and insufficient parking space are raised and are required careful attention to the adequate management.

(1) Waste management

Municipal Waste management is important to Amman City where in future tourists will increase. The City has regular waste collection of the garbage by cars in the town. The garbage is usually disposed in the dumping sites, or in the five existing landfills: Marka/Amman, Enmlaih/Thaibech, Mubis, Al Humra/Salt, and Aquaba. Some of the disposal sites are for both solid waste and wastewater. The waste collection system in the Amman City and their surroundings are adequate. But, for increase of tourist litters further capacity building and betterment of the waste management system are required.

Construction waste management is also an important issue because the project will generate huge amount of construction wastes during construction stage. As the Jordan government does not have laws that require for control of solid waste and wastewater generated from construction work, appropriate disposal sites should be secured.

(2) Traffic problems

The project site locates in the public spaces and facilities including Amman Municipality where many peoples visit. To secure safety for the visitors and vehicles which come to the places during constrution works specific countermeasures should be taken.

As one of long term policies 'park and ride' enables to reduce the traffic volume of the city is effective. Short term policies in order to reduce car use, enhancement of environmental

education and betterment of public transpiration are important.

Proposed mitigation measures are different according to their nature, they are classified into those which should be described in tender documents and others as shown in Table 2.

Table 2 Proposed Mitigation Measures

	Impacts	Mitigation measures
mitigation measures should be clarified in the tender document	Air Pollution	**[construction stage]** - provide sheets for dust control - watering for dust control
	Water Pollution	**[construction stage]** - secure reliable and regular inspection - provide wastewater management facility
	Noise & Vibration Pollution	**[construction stage]** - provide noise protection sheets - restrict working hours
	Waste Pollution	**[construction stage]** - secure disposal sites - enhance recycling of the wastes
	Traffic & Safety	**[construction stage]** - conduct traffic control - secure detours (if necessary) - restrict working hours (avoid rash hours)
others	Water Pollution	**[operational stage]** - provide wastewater management facility
	Waste Pollution	**[operational stage]** - place litter box for increasing general wastes - improve capacity building and existing waste collection system
	Traffic & Safety	**[operational stage]** - improve the functions of the existing parking areas

Source: JICA Study Team

Environmental Checklist of National Museum

Construction stage

		Major	Minor	None	Not clear	Problems	Actions & Mitigation measures proposed	Remarks
Pollution	1. Air Pollution		—			• dust from construction work may effect the neighbouring residents	• provide sheets and watering for dust control	
	2. Water Pollution		—			• wastewater from construction plants may degrade water quality	• secure reliable and regular inspection • provide wastewater management facility	
	3. Soil contamination			*				
	4. Noise and vibration			*				
	5. Subsidence			*				
	6. Waste generation	—				• construction debris may clog drain pipe • generation of construction wastes	• secure waste disposal site • enhance recycling of construction wastes	
Natural Environment	1. Effect on ecology			*				
	2. Effect on landscape			*				
Human Environment	1. Historical and cultural heritage			*				
	2. Effect on existing infrastructure			*				
	3. Relocation			*				
	4. Traffic congestion and safety		—			• construction work may cause pedestrian disturbance	• conduct traffic control • secure detour (if necessary) • avoid rash hour	
	5. Socio-economic effects			*				
	6. Others			*				

Operational stage

		Major	Minor	None	Not clear	Problems	Actions & Mitigation measures proposed	Remarks
Pollution	1. Air Pollution			*				
	2. Water Pollution		—			• wastewater generated from washment of exhibition articles	• provide management facility for quality control of wastewater	wastewater by washing of exhibition articles may hazadous chemical substances.
	3. Soil contamination			*				
	4. Noise and vibration			*				
	5. Subsidence			*				
	6. Waste generation		—			• cumulative increase of tourist litters	•improve waste management system	GAM is in charge of waste management.
Natural Environment	1. Effect on ecology			*				
	2. Effect on landscape			*				
Human Environment	1. Historical and cultural heritage			*				
	2. Effect on existing infrastructure			*				
	3. Relocation			*				
	4. Traffic congestion and safety		—			• increase of tourist cars may cause traffic jam and lack of parking area	• improve the functions of the exsiting parking areas	
	5. Socio-economic effects	+				• enhance economic activities		
	6. Other		—			• land use of the surrounding area	• set land use planning including master plan by GAM	

+: positive impacts —: negative impacts

SOIL INVESTIGATION REPORT

TOUKAN AND SAKET Geo-Research

Foundation Engineering & Material Testing

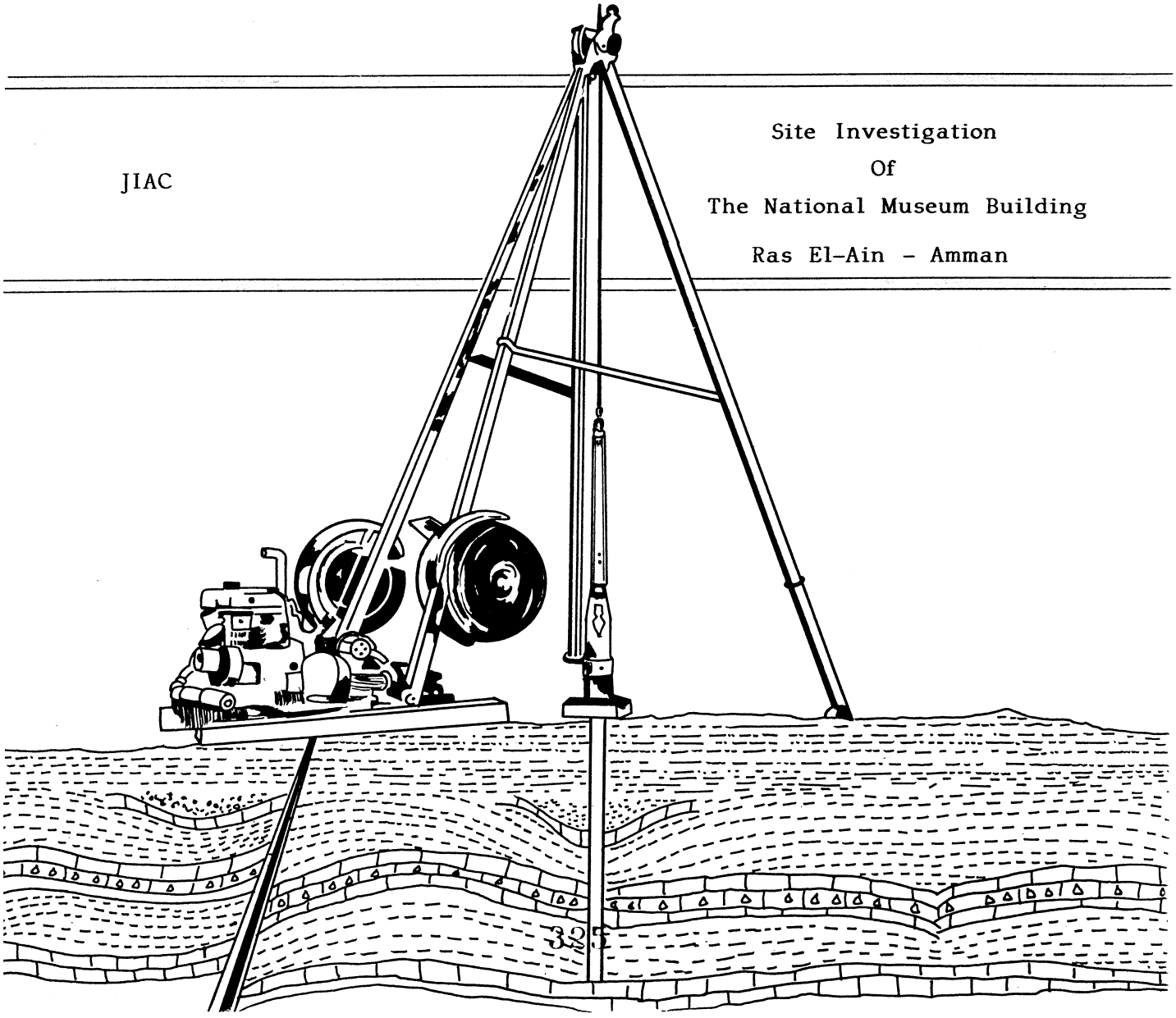
JIAC

Site Investigation

Of

The National Museum Building

Ras El-Ain - Amman



TOUKAN & SAKET
Geo - Research & Foundation
Engineering Office
Drilling , Sampling , Testing
Engineering Geology , Foundations,
Geomechanics,
& Material Testing

مكتب طوقان والساكت
للدراسات الهندسية الجيولوجية والأساسات
تثقيب ، اخذ عينات ، تحليل ،
مسح هندسي جيولوجي ، دراسة
اساسات وميكانيكا الصخور والتربة
وفحص المـــواد

Ref : R99/16/1999-06-02

Date : 1/6/1999

Messrs : JICA Study Team

Site Investigation
Of
The National Museum Building
Ras El Ain – Amman

Dear Sirs,

Upon your request, concerning the above mentioned project , we have the honour to submit for your consideration the attached report in which we summarized the results of the investigation undertaken by our firm.

We take the opportunity to express to you our highest consideration

Sincerely yours,
Toukan & Skaet

Dr.S.Saket

ص.ب ٩٢٦٨٩٧ – تلفون ٦٦٢٤٠٥ – فاكس ٦٦٤٤٨٣ – تلكس : ٢١٥٤٢ طوقان جو عمان – الأردن
P.O.Box 926897 - Telephone 662405 - Fax. 664483 Telex : 21542 Toukan Jo - Amman - Jordan

Site Investigation
Of
The National Museum Building
Ras El Ain - Amman

1.0 Introduction

Upon the request of Messrs. JICA Study Team , sub-soil investigation was carried out at the proposed site in accordance with the British Standards Specification, CP 2001 for site investigation and with the Jordanian Code .

The investigation was carried out by performing 9 boreholes, drilled at locations determined by the geotechnical Engineer to a depth ranging between 10 and 15 meters.

The proposed building is for the National Museum development .

The site is mainly recent fill and made flat ground .

The investigated site is bordered by two streets at the southern (Ras El –Ain street) and northern (Omar Matter street) boundary , and eastern side is the Municipality fountain and the western side is the mosque .

2.0 Scope of Work

The purpose of this study was to determine the ground conditions at the site , in order to provide full information about the ground conditions and geotechnical properties of foundation materials and all other information that would assists in the Engineer in the design of proper and safe foundation .

The works included the following

- Setting up locations of boreholes.
- Drilling 9 boreholes and carrying out the necessary field tests.
- Recovery of disturbed representative samples .
- Carrying out the required laboratory tests.

Analysis of the site investigation data, laboratory testing and geotechnical interpretation form the basis of this report.

3.0 General Geology

The natural material within the site is mainly Quaternary alluvial deposits covered by thick recent fill material . (see geologic map) .

The penetrated material within the site is heterogenous deposits (overburden) composed of brown clay , silt , fine to coarse sand , fine to coarse gravel , cobbles and boulders mixed with demolished buildings residue of concrete , wood , cloth etc .

All the material was dumped in a loose condition without any compaction . Therefore the density is not consistent . Non-uniform material in terms of lithology and density . No bed rock was encountered in any of the drilled boreholes .

4.0 Method of Investigation

All drilling, sampling and testing were performed in accordance with the British Standards, CP 2001.

The sub-surface was explored by using CME 75 type rig advance by rotary drilling allowing the performance of Standard and cone penetration tests and taking disturbed samples.

Dry drilling to refusal in boreholes was used to recover representative samples.
The boreholes were monitored for any ingress of water during dry drilling.

Representative soil samples were obtained during the drilling operation and were placed in tight plastic bags and wooden boxes for description.

Standard and cone penetration tests were carried out in accordance with the BS Standards 1377(Test 19) and the results were recorded on the boreholes logs at depths to which they refer.

The penetration tests were executed with 2 and 3 inch standard sampling spoon with catchers and driven by dropping a 140 Ibs. Weight hammer with a 30 inches fall height. The 2 inches diameter spoon was lowered to the bottom of the boreholes and penetrated about 6 inches in the materials, whereupon the penetration test was started.

The "N" value is the number of blows required to produce one foot of penetration.

In defining the density of the non-cohesive materials, very loose material was considered to have standard penetration values less than 4 blows per foot, loose, between 4 and 10 blows per foot, medium dense, between 10 and 30 blows per foot, dense, between 30 and 50 blows per foot , and very dense, more than 50 blows per foot .

In defining the relative density of the cohesive material , the following could be classified :

Soft	**Less than 4**	**blows per foot.**
Firm	**4-8**	**blows per foot.**
Stiff	**8-15**	**blows per foot**
Very stiff	**15-30**	**blows per foot**
Hard	**more than 30**	**blows per foot**

5.0 Field Works

5.1 Drilling

The locations of boreholes were chosen so as to represent the study area and provide as much information as possible.

A total of 9 boreholes were drilled . The locations of the drilled boreholes are shown on the attached plan .

The positioning and depth of the boreholes were determined by the geotechnical Engineer .

5.2 Sampling

Continuous samples of the drilled materials were collected at regular depth intervals of 1.0m and at each lithological change of the material . The samples were labeled, described and logged. Representative samples were also obtained for laboratory testing and classification .

5.3 Insitu Testing

In order to obtain an estimate of the density insitu, Standard and cone Penetration tests were performed on the foundation material .

The penetration tests results indicate that the penetrated material is loose to medium dense with the SPT, "N" value, ranging between 7 and more than 30 blows per foot . (see borehole logs).

Refusal results were obtain on cobbles and bouldery material .

The medium to high results are mainly coarse fill material and does not indicate high density .

5.4 Drilling Results

The drilled boreholes show that the penetrated materials are mainly heterogenous recent fill material , non-uniform in terms of lithology and density . In few boreholes it is silt , clay , sand , gravel and cobbles with wood fragments and bouldery in some other boreholes . (see boreholes logs) .

- No cavities or water table were detected in any of the drilled boreholes . Only cobbles and boulders in a loose condition were encountered where partial loss of drilling air circulation was observed .

6.0 Geomechanics

A laboratory testing program was devised and performed on representative samples obtained from the study area , to establish the engineering properties of the material involved. The only tests that could be performed on such material are :

- Grainsize analysis
- Atterberg limits
- Direct sheer test
- Compaction
- California Bearing Ratio

The results of the grainsize analysis of the tested samples are summarized in (Table 1). The material is composed of gravels, between 0.0% and 45.0 % , sand, between 19.2% and 73.6%, and silt, between 19.9% and 35.7% and clay between 00% and 41.2% .

The atterberg limits show that the liquid limit ranges between non-plastic and 61.7 with a plasticity index between non-plastic and 35.2 . Table (1).

The direct shear test performed on remoulded samples of brownish sandy , silty clayey material obtained from boreholes No BH3 and BH8 , depth (1.0-2.0) m, show that the cohesion is ranging between 0.20 kg/cm^2 and 0.17 kg/cm^2 with a peak friction angles between 14 and 17degrees . (Curves are attached) see table (2) .

The compaction tests performed on a two samples obtained from the excavated trial pits, shows that the maximum dry density is ranged between 1.85gr/cm^3 and 1.9gr/cm^3 with an optimum moisture content of 18.0 % to 19.5% . (curves are attached) see table (3)

The CBR values obtained from the same samples ranged between 17.3% and 18.5% .Curves are attached to this report.

7.0 Conclusions & Recommendation

As a result of this study and tests, the following conclusions could be summarized :

- The drilled boreholes show that the penetrated materials are :

- Overburden recent fill material composed of silt, sand and gravels with cobbles, and boulders , loose to medium dense .

- The material is heterogenous and non-uniform in terms of lithology and density .

- No bedrock was encountered in any of the drilled boreholes .

- No cavities or water table were encountered in the drilled boreholes . Partial loss of drilling air circulation was observed indicating the loose nature of the materials .

In order to have a safe and stable foundation, the following is recommended :

6.1 Foundation Type and Depth

In order to have safe structures , the foundation materials beneath the structures must have an adequate bearing capacity to support the design loads with an appropriate factor of safety and acceptable tolerable settlements.

Since the foundation will be laid on heterogenous, non-uniform material in terms of density and lithology , with different engineering properties , therefore excessive differential settlement will take place in the structure. Noting that the existing recent fill material is not capable to handle normal type of foundation .

To have safe foundation to support the structure, the following is suggested :

Alternative A

The safest type of foundation for the investigated site is pre – bored cast insitu pile type foundation .

The suggested diameter of piles is 80 cm . The depth of piles will be suggested when the loads are known . Additional recommendation , will be suggested when applying this type of foundation is decided .

Alternative B

As an alternative , the following could be suggested :

- Total excavation and removal of the overburden material down to a depth 3.0m below the proposed design foundation level .
- The ground at the excavated depth should be compacted by heavy vibratory roller (16 Tons) for at least one week repeatedly .
- Drilling a net of boreholes at 3.0m spacing between boreholes to a depth of 3.0m each .
- Filling the boreholes by pressure grouting to ensure that the voids are filled.
- Following the completion of grouting, backfill the site with about 3.0m thick selected coarse grained granular material in layers not exceeding 25cm and compacted to 95% of the maximum dry density (see attached sketches) . The selected material consists of crushed stone , gravels and cobbles with some fines. The fines (-No4) should not exceed 15% .

- These well compacted layers could support the proposed building by employing rigid strip foundation or raft . The suggested allowable bearing capacity to be used is 2.0 kg/cm2, assuming that the area is fully drained .

6.2 Excavation & Side Slopes

Any pneumatic excavation equipment could be used for excavation, such as dozers and loaders .

It is recommended to have a side slopes of 1H:2V for a short period, in a dry weathered condition .

The recent fill materials excavated during construction of the building is not suitable to be used as backfill material because it is unselected and of unengineered nature.

The materials to be used for backfilling purposes behind underground walls shall be a soil-rock mixture which is free from organic matter or other deleterious substances. It shall not contain rocks or lumps over 15cm in greatest dimension, and not more than 15 percent larger than 7cm. The plasticity index for the backfill material shall not be more than 15 percent . It shall be spread in layers not exceeding 25cm in uncompacted thickness, moisture conditioned to its optimum moisture content, and compacted to a dry density not less than 95 percent of the maximum dry density as obtained by standard proctor compaction test (ASTM D698).

- The study area is characterized by semi-arid climate, warm and dry in the summer with rainy winter . The rainfall is of medium to high intensity for a short period.
The average mean annual rainfall is about 500mm and this is limited to winter period.
The average maximum temperature is 40c and the lowest is 0c degree.

- As far as the seismic activity in the area, Jordan has not witnessed any serious earth quakes in the last 60 years . It is a general practice to consider the study area within zone I of the unified Building code. Research in Jordan concluded that one earth quake with magnitude 6½ every 100 years and one earth quake with magnitude 7½ every 500 years might take place.

The intensity factor is 0.75 for zone A and it is 0.5 for zone B.of Mercalli scale.

- A horizontal peak ground acceleration of at least 0.19g is suggested to be adopted in the design of the foundations .

The compaction should be under the supervision of our experienced geotechnical Engineers .

The recommendations given in this report are solely based on the results of the drilled boreholes at the time of investigation and our understanding, and concept of the project. Further check of the material at the foundation level by our geotechnical Engineer is very important . All of treatment , densification and grouting should be supervised by our geotechnical engineers .

Summary of Tests Results

Borehole No.	Depth (m)	Grain Size Analysis				Atterberg Limits		
		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)
BH .1	3.5-4.5	--	73.6	26.4	--	Np	Np	Np
	5.5-6.5	6.1	25.7	35.7	32.5	32.1	22.1	10.0
	6.5-7.5	4.1	61.8	19.9	14.2	31.6	22.1	9.5
	7.5-8.5	15.2	41.6	24.4	18.8	38.4	23.4	15.0
BH.2	5-6	--	53.9	25.3	20.8	30.2	21.9	8.3
	6-7	2.1	48.9	26.4	22.6	38.2	24.6	13.6
	9-10	6.2	70.7	19.9	3.2	24.3	18.1	6.2
BH .3	1-2	8.0	29.0	26.5	36.5	49.6	21.4	28.2
	3-4	7.2	61.5	22.5	8.8	33.1	21.5	11.6
	5-6	--	53.9	33.8	12.3	32.8	22.4	10.4
	9-10	4.2	43.8	35.0	17.0	42.1	25.6	16.5
BH.4	1.5-3	4.3	27.4	28.2	40.1	54.8	23.5	31.3
	4.5-5.5	--	41.8	29.4	28.8	45.2	22.4	22.8
	9.0-10.0	15.2	30.6	26.7	27.5	44.8	22.2	22.6
BH.5	0.00-1.0	13.2	30.5	25.3	31.0	47.5	24.3	23.2
	2.0-3.0	3.1	60.9	21.8	14.2	41.3	25.9	15.4
	4.0-5.0	2.5	65.5	22.0	10.0	39.1	25.5	13.6
	6.0-10.0	4.1	66.9	20.9	8.1	32.8	21.4	11.4
BH.6	0.00-1.5	8.2	37.7	26.3	27.8	42.8	22.2	20.6
	3.0-4.0	--	33.8	30.2	36.0	43.4	24.9	18.5
	5.0-6.0	2.1	67.9	23.9	6.1	23.2	19.2	4.0
	7.0-10.0	5.1	67.6	20.1	7.2	23.8	19.6	4.2
BH.7	0.00-3.0	9.8	19.2	29.8	41.2	46.7	23.5	23.2
	3.0-4.0	45.0	30	25	--	Np	Np	Np
BH.8	1.0-2.0	3.30	23.6	35.1	38.0	61.7	26.5	35.2
	2.0-3.0	10.0	50.0	27.2	12.80	29.5	21.3	8.2
	3.0-4.0	15.10	28.7	24.8	31.4	48.8	21.4	27.4
	4.0-5.0	7.20	46.5	29.3	17.0	32.1	22.6	9.5

Table (1)

Direct Shear Test Results

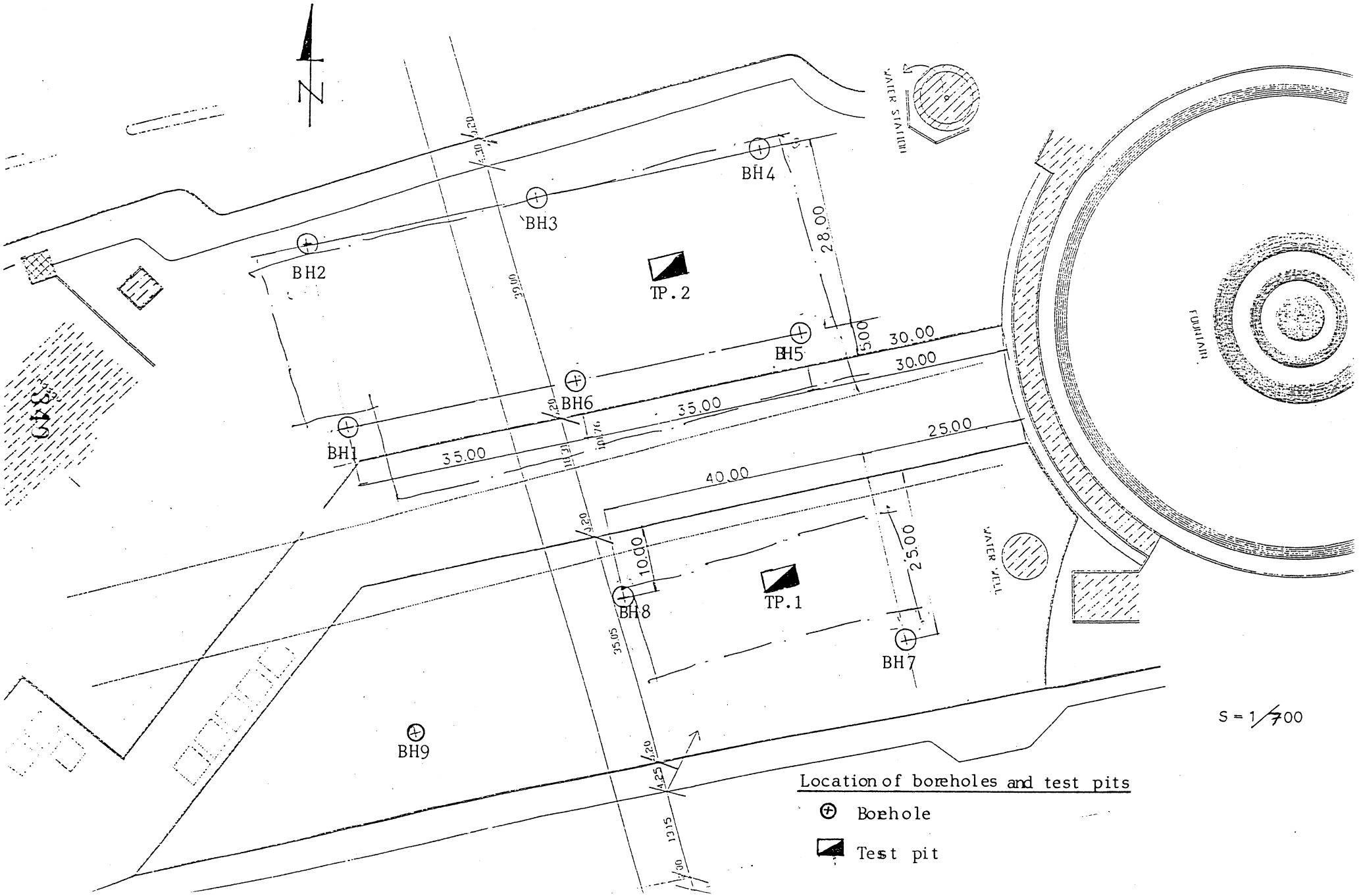
Borehole No. & Depth(m)	Cohesion (Kg/cm^2)		Friction Angle (Degree)	
	Cp	Cr	Øp	Ør
BH3 (1.0–2.0)	0.17	0.0	17.0	14.0
BH8 (1.0–2.0)	0.20	0.0	14.0	11.0

Table(2)

Compaction and CBR

Sample No.	Depth (m)	Max.Dry Density (Gr/cm^3)	Optimum Moisture Content (%)	CBR at o.m.c (%)
Tp1	0.00-1.0	1.90	18.0	18.5
Tp2	1.0-2.0	1.85	19.5	17.3

Table (3)


N
BH1
BH2
BH3
BH4
BH5
BH6
BH7
BH8
BH9
TP.1
TP.2
28.00
5.00
30.00
30.00
35.00
35.00
25.00
40.00
10.00
25.00
WATER STATION
WATER TANK
FOUNTAIN
S = 1/700
Location of boreholes and test pits
Borehole
Test pit

TOUKAN & SAKET
Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : National Museum				**TYPE & SIZE OF DRILLING:**							**Rotary 4½"**
BOREHOLE NO : BH.1				**Date:**		**Started :**					**24./5/99**
						Finished:					**24/5/99**
Depth (M)	**L O G**	**DESCRIPTION ELEVATION : Flat**		**REC (%)**	**RQD. (%)**	**SPT. "N"**	**MC. (%)**	**LL**	**PI**	**(gr/cm³)**	**sample No.**
1		Recent fill material composed of cobbles , gravels , sand , clay , wood and cloth .				9					
2						13					
3						17					
4						12					
5		Brown sandy silty clay and gravels fine to medium , mixed with recent fill .				3					
6						8					
7						6					
8						8					
9						7					
10						32					
11		Final depth (10.0)m									
12		**Remark**									
13		Partial loss of drilling air circulation, very loose material between 4.5 m and 10.0m .									
14											

TOUKAN & SAKET
Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : National Museum			TYPE & SIZE OF DRILLING: Rotary 4½"							
BOREHOLE NO : BH.2			Started : 24/5/99 Date: Finished: 25/5/99							
Depth (M)	L O G	DESCRIPTION ELEVATION : Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	(gr/cm³)	Sample No.
1		Recent fill material composed of cobbles, gravels, sand , clay , wood and cloth , with boulders .			11					
2					16					
3					12					
4					21					
5		Brown sandy silty clay and gravels fine to medium , mixed with recent fill .			11					
6					9					
7					13					
8					13					
9					18					
10					19					
11		Final depth (10.0) m								
12		**Remark**								
13		Partial loss of drilling air circulation loose material at depth 6.5m .								
14										

TOUKAN & SAKET
Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : National Museum			TYPE & SIZE OF DRILLING: Rotary 4½"							
BOREHOLE NO : BH.3			Date: Started : 26./5/99 Finished: 26/5/99							
Depth (M)	L O G	DESCRIPTION ELEVATION : Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	(gr/cm³)	Sample No.
1		Recent deposits composed of brown sandy silty clay with Gravels .			11					
2					15					
		Recent fill material composed of cobbles ,gravels, sand, clay , silt and some boulders .			20					
4					10					
5					16					
6		Brown sandy silty clay and gravels, fine to medium , mixed with recent fill .			25					
7					11					
8					17					
9					35					
10					37					
-		Final Depth (10.0)m								
12		**Remark**								
13		Partial loss of drilling air circulation at depth 7.0 and 4.0m .								
14										

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BOREHOLE LOG DATA SHEET

PROJECT : National Museum			TYPE & SIZE OF DRILLING: Rotary 4½"							
BOREHOLE NO : BH.4			Date: Started : 26./5/99 Finished: 26/5/99							
Depth (M)	L O G	DESCRIPTION ELEVATION : Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	(gr/cm³)	Sample No.
1		Recent fill material composed of brown sandy silty clay With gravels and cobbles .			12					
2					16					
					18					
4					13					
5					15					
6		Recent fill material composed of cobbles ,gravels, sand , clay and silt .			7					
7					14					
8		Brown sandy silty clay and gravels, fine to medium , mixed with recent fill material .			12					
9					9					
10					30					
		Final Depth (10.0)m								
12		**Remark**								
13		Partial loss of drilling air circulation very loose material at depth 6.0m and 9.0 meters .								
14										

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Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : National Museum			TYPE & SIZE OF DRILLING: Rotary 4½"							
BOREHOLE NO : BH.5			Started : 27./5/99 Date: Finished: 27/5/99							
Depth (M)	L O G	DESCRIPTION ELEVATION : Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	(gr/cm³)	Sample No.
1		Brown sandy silty clay and gravels (Recent Fill) .			18					
2					22					
					21					
		Brown sandy silty clay mixed with recent fill material								
4		Composed of cobbles , gravels and sand and boulders .			7					
5					11					
6					17					
7					36					
8					13					
9					21					
10					12					
		Final Depth (10.0)m								
12		**Remark**								
13		Partial loss of drilling air circulation loose material At depth 4.0m .								
14										

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BOREHOLE LOG DATA SHEET

PROJECT : National Museum						TYPE & SIZE OF DRILLING: Rotary 4½"						
BOREHOLE NO : BH.6						Started : 27./5/99 Date: Finished: 28/5/99						
Depth (M)	L O G	DESCRIPTION ELEVATION : Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	(gr/cm³)	Sample No.
1		Brown sandy silty clay and gravel (Recent Fill) .			6					
2					17					
					9					
4		Fill material composed of cobbles , gravels , sand , Silt , brown clay and asphalt cuttings .			11					
5					22					
6		Fill material composed of crushed boulders of limestone , chert and marlstone with some brown clay .			50/3					
7					15					
8					21					
9					50/Ref					
10					21					
--		Final Depth (10.0)m								
12		**Remark**								
13		Partial loss of drilling air circulation loose material At depth 3.0 .								
14		Refusal blows indicates presence of boulders Not relative density .								

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BOREHOLE LOG DATA SHEET

PROJECT : National Museum			TYPE & SIZE OF DRILLING: Rotary 4½"							
BOREHOLE NO : BH.7			Started : 29./5/99 Date: Finished: 29/5/99							
Depth (M)	L O G	DESCRIPTION ELEVATION : Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	(gr/cm³)	Sample No.
1		Brown sandy silty clay and gravel (Recent Fill) .			7					
2					21					
-					9					
4					50/17					
5		Fill material composed of crushed boulders of limestone , Chert and marlstone with some brown clay .			26					
6					50/Ref					
7					50/7cm					
8					11					
9					Ref					
10					32					
-		Final Depth (10.0)m								
12		**Remark**								
13		Partial loss of drilling air circulation loose material At depth 3.0m .								
14		Refusal penetration indicates presence of large boulders Not relative density .								

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BOREHOLE LOG DATA SHEET

PROJECT : National Museum			TYPE & SIZE OF DRILLING : Rotary 4 ½"							
BOREHOLE NO : BH.8			DATE : Started: 30/5/99 Finished: 30/5/99							
Depth (M)	L O G	DESCRIPTION ELEVATION: Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	Gr/cm³	Sample
1-		Fill material composed cobbles , gravels , sand And silt .			15					
2-		Brown sandy silty clay with gravels fine to Coarse .			19					
3-		Brown sandy silty clay mixed with recent fill material .			22					
4-					9					
5-					18					
6-					50/2cm					
7-		Fill material composed of crushed boulders of limestone , chert and marlstone ,			50/11cm					
8-					12					
9-					16					
10-					50/3cm					
11-		Final depth (10.0m)								
12-										
13-										
14-										
15-										
16-		Remark								
17-		* Partial loss of drilling air circulation , loose Material at depth 4.0m .								
18-		* Refusal penetration indicates presence of Boulders not relative density .								

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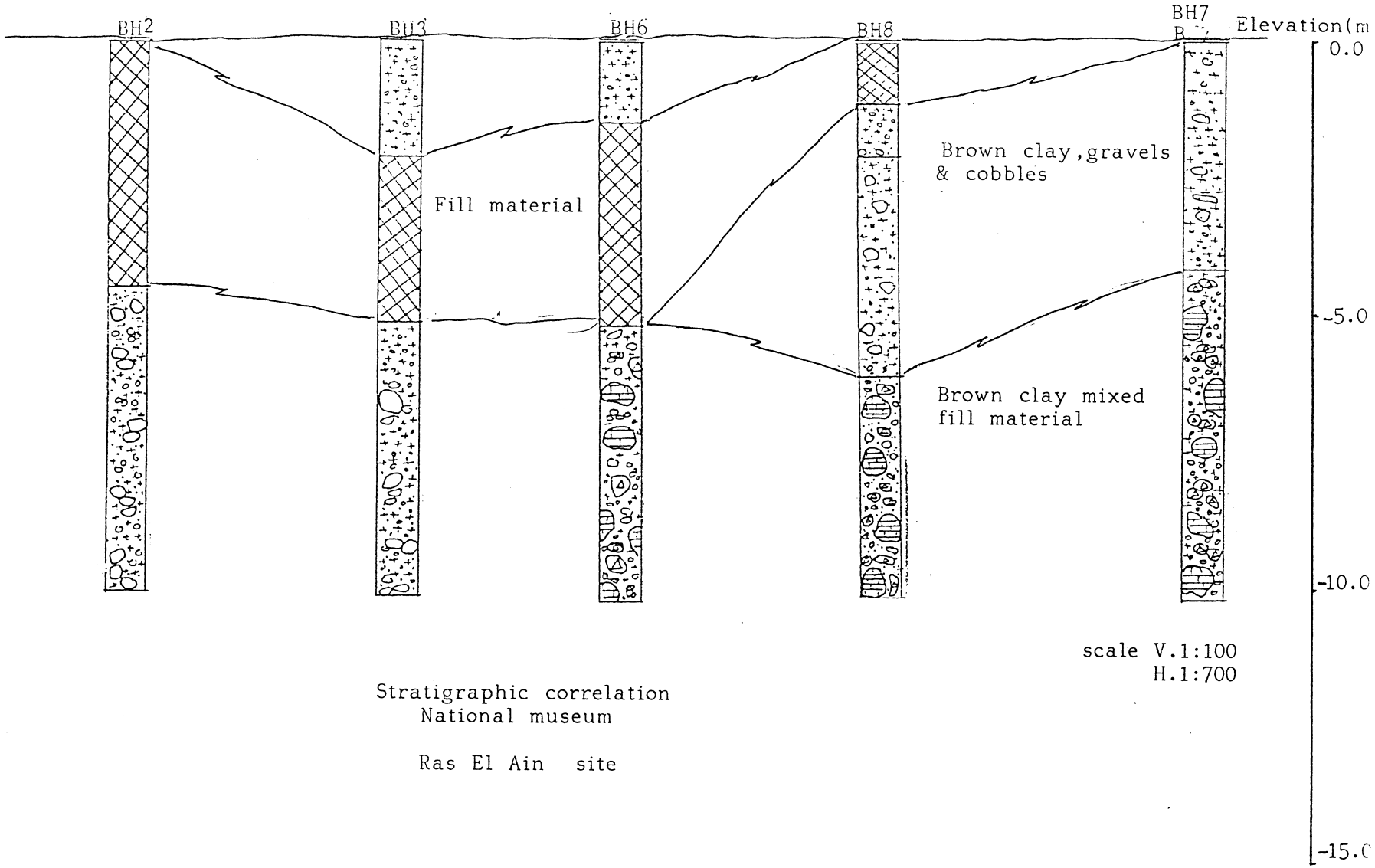
BOREHOLE LOG DATA SHEET

PROJECT : National Museum			TYPE & SIZE OF DRILLING : Rotary 4 ½"							
BOREHOLE NO : BH.9			DATE : Started: 30/5/99 Finished: 31/5/99							
Depth (M)	L O G	DESCRIPTION ELEVATION: Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI		Sample
1-		Brown sandy silty with gravels and cobbles , trace boulders (Recent Fill) .			12					
2-					17					
3-					13					
4-					22					
5-		Fill material composed of cobbles , gravels , sand , silt , and brown clay .			11					
6-					8					
7-		Fill material composed of crushed boulders of of limestone , chert and marlstone , with gravels and trace clay .			24					
8-					50/13cm					
9-					15					
10-					23					
11-					50/Ref					
12-		Mixture of brown sandy , silty , clay with gravels and cobbles .			31					
13-					35					
14-					42					
15-		Final depth (15.0m)			50/25cm					
16-		Remark * Partial loss of drilling air circulation , loose Material at depth 6.0m .								
17-		* Refusal penetration indicates presence of Boulders not relative density .								
18-		* Water table was observed at depth 13.0m .								



Stratigraphic correlation
National museum

Ras El Ain site

Elevation(
0.0
-5.0
-10.0
-15.0
BH4
BH5
BH6
BH1
BH9
Brown clay & gravel
Brown clay mixed with fill material
Fill material
scale: v.1:100
H.1:700
Stratigraphic correlation
National museum
Ras El Ain site

TOUKAN & SAKET

Geo. Research

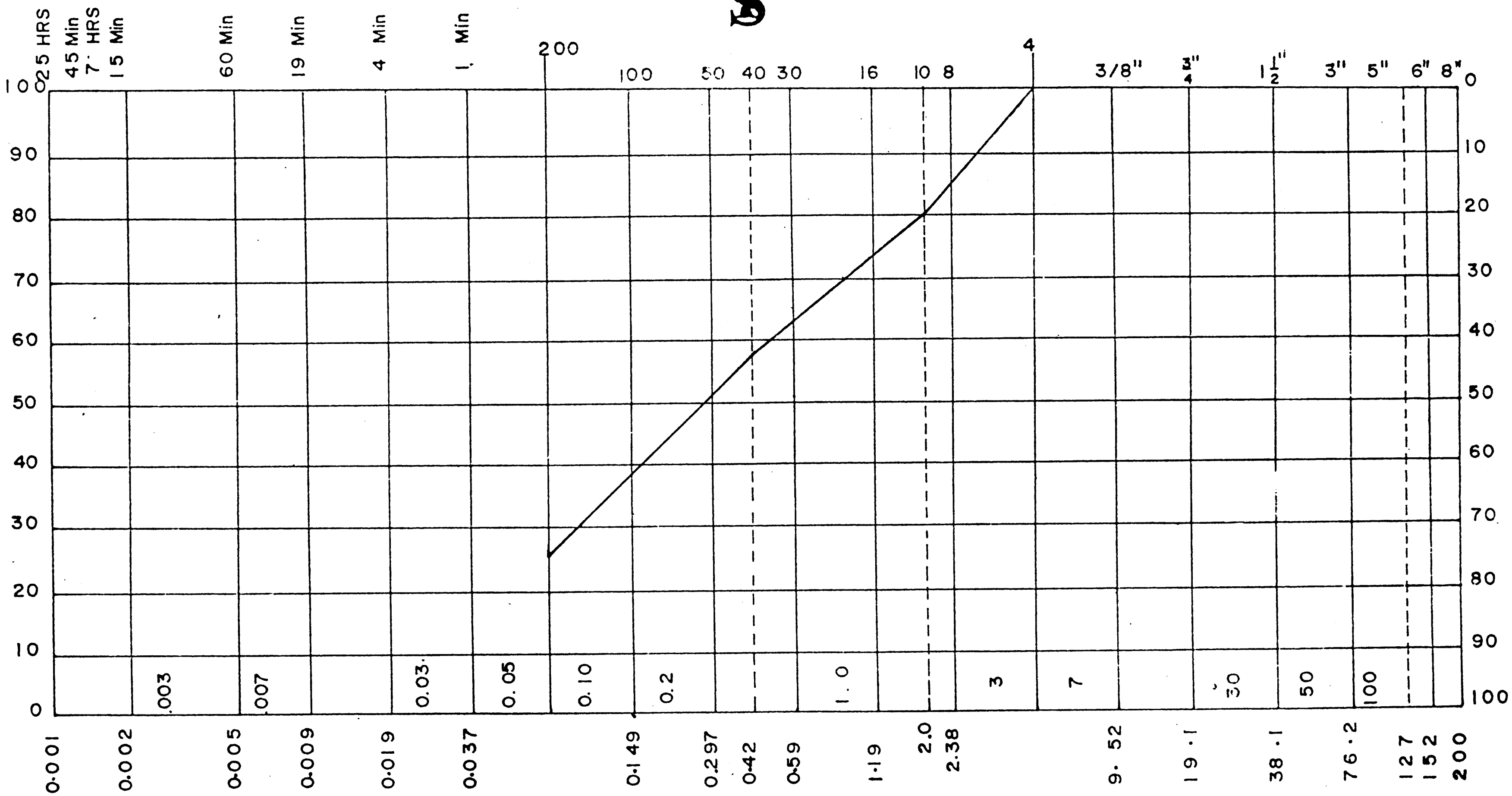
PROJECT__

DATE __________

SAMPLE No ______

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND%	SILT %	CLAY %
BH1				
3.5 – 4.5m	–	73.6	26.4	

REMARKS ____________

TOUKAN & SAKET

Geo. Research

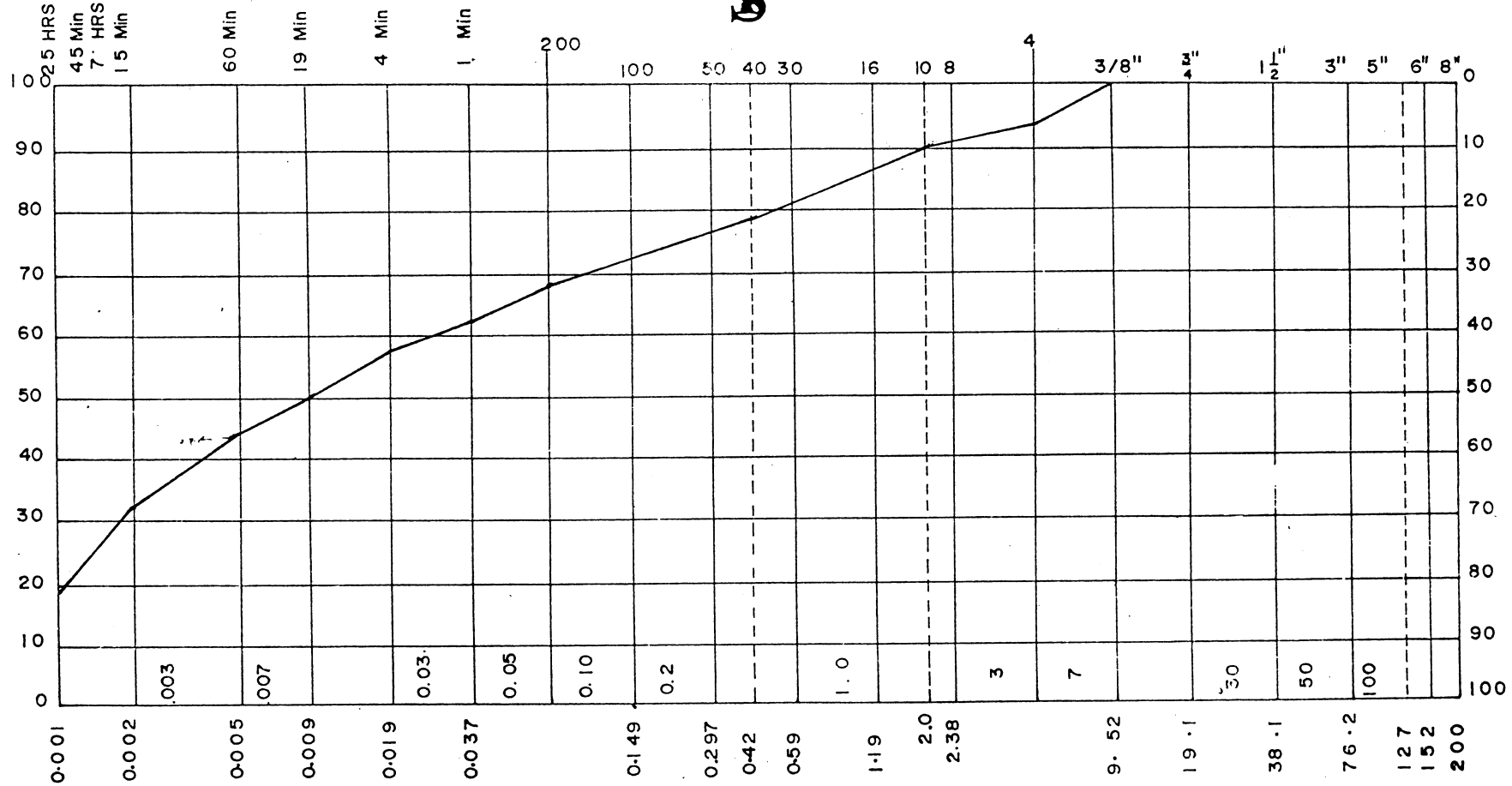
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH1				
5.5–6.5m	6.1	25.7	35.7	32.5

REMARKS _____

TOUKAN & SAKET

Geo. Research

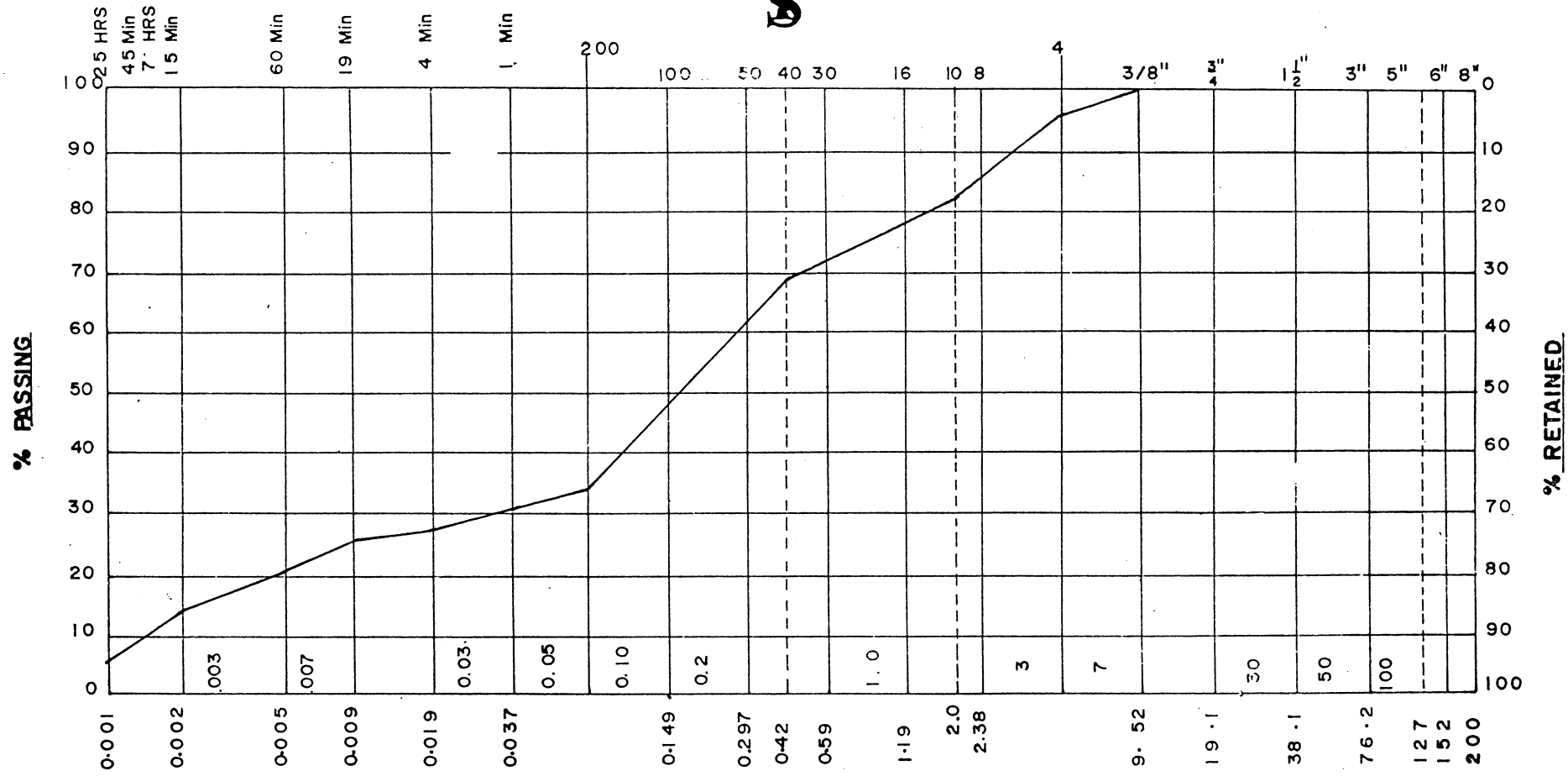
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH1				
6.5 - 7.5	4.1	61.8	19.9	14.2

REMARKS _____

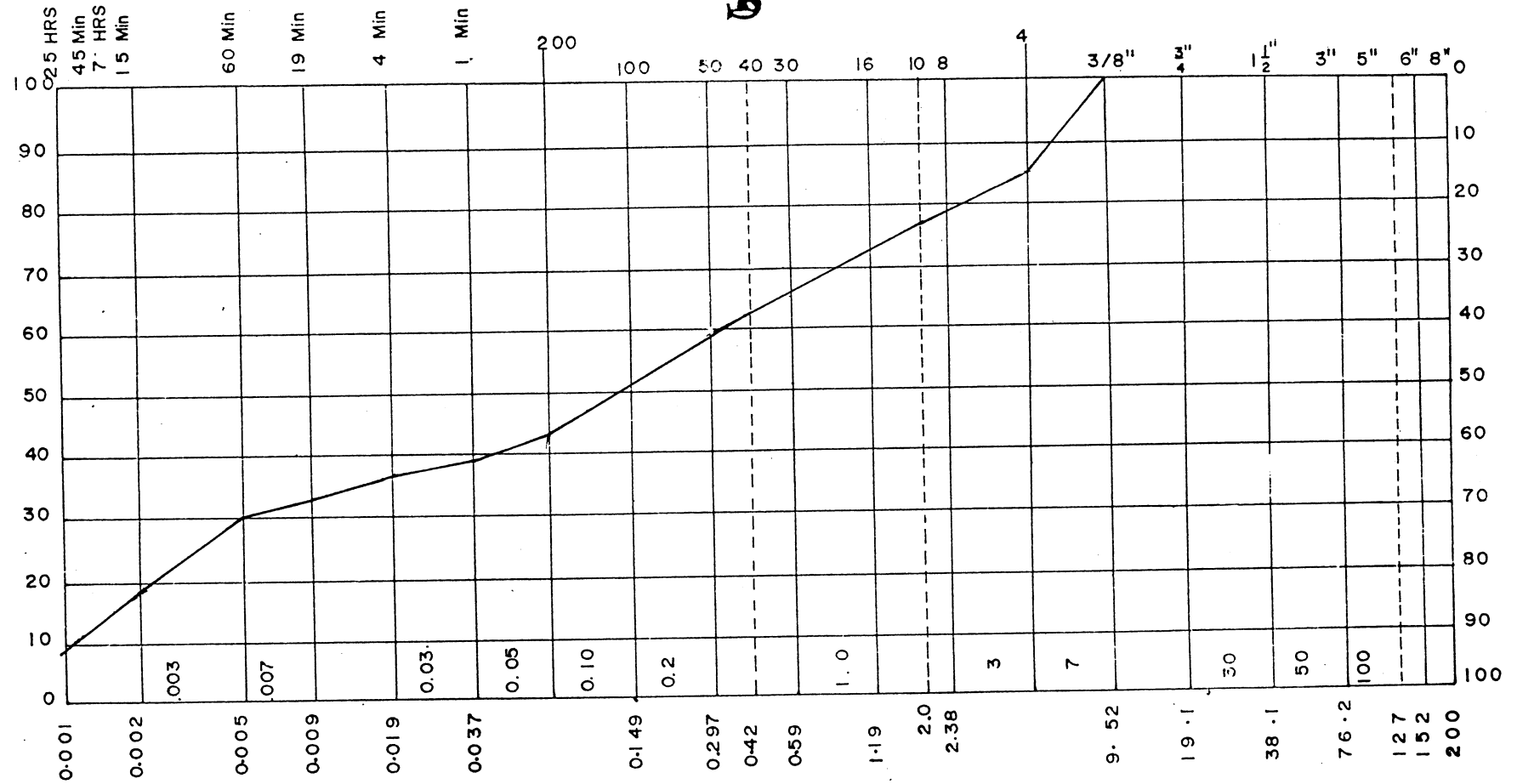
TOUKAN & SAKET

Geo. Research

DATE _____

PROJECT _____ SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-1				
7.5 – 8.5	15.2	41.6	24.4	18.8

REMARKS _____

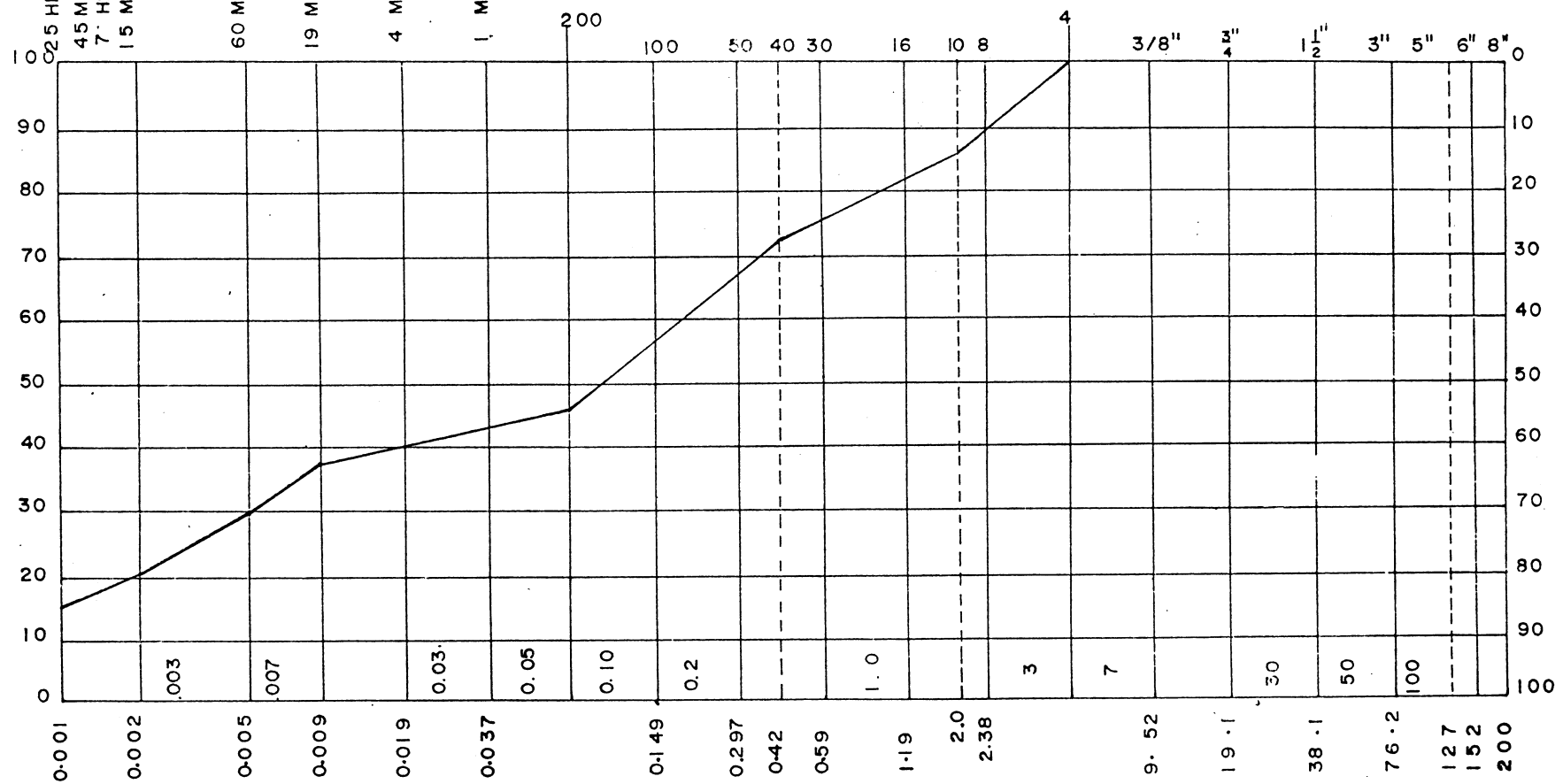
TOUKAN & SAKET

Geo. Research

PROJECT _____ DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH2				
5.0–6.0	–	53.9	25.3	20.8

REMARKS _____

TOUKAN & SAKET

Geo. Research

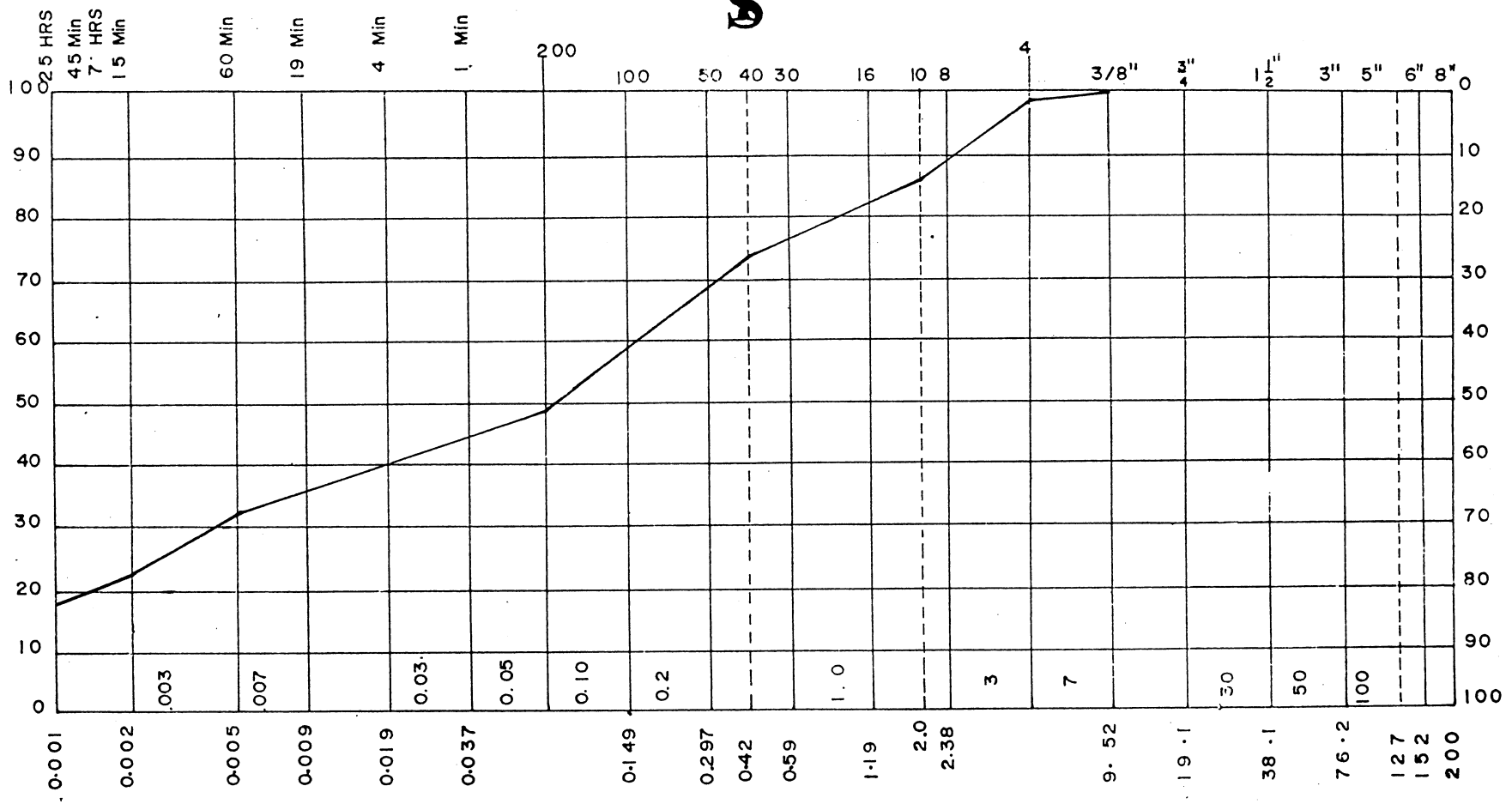
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH2				
6.0 – 7.0	2.1	48.9	26.4	22.6

REMARKS _____

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Geo. Research

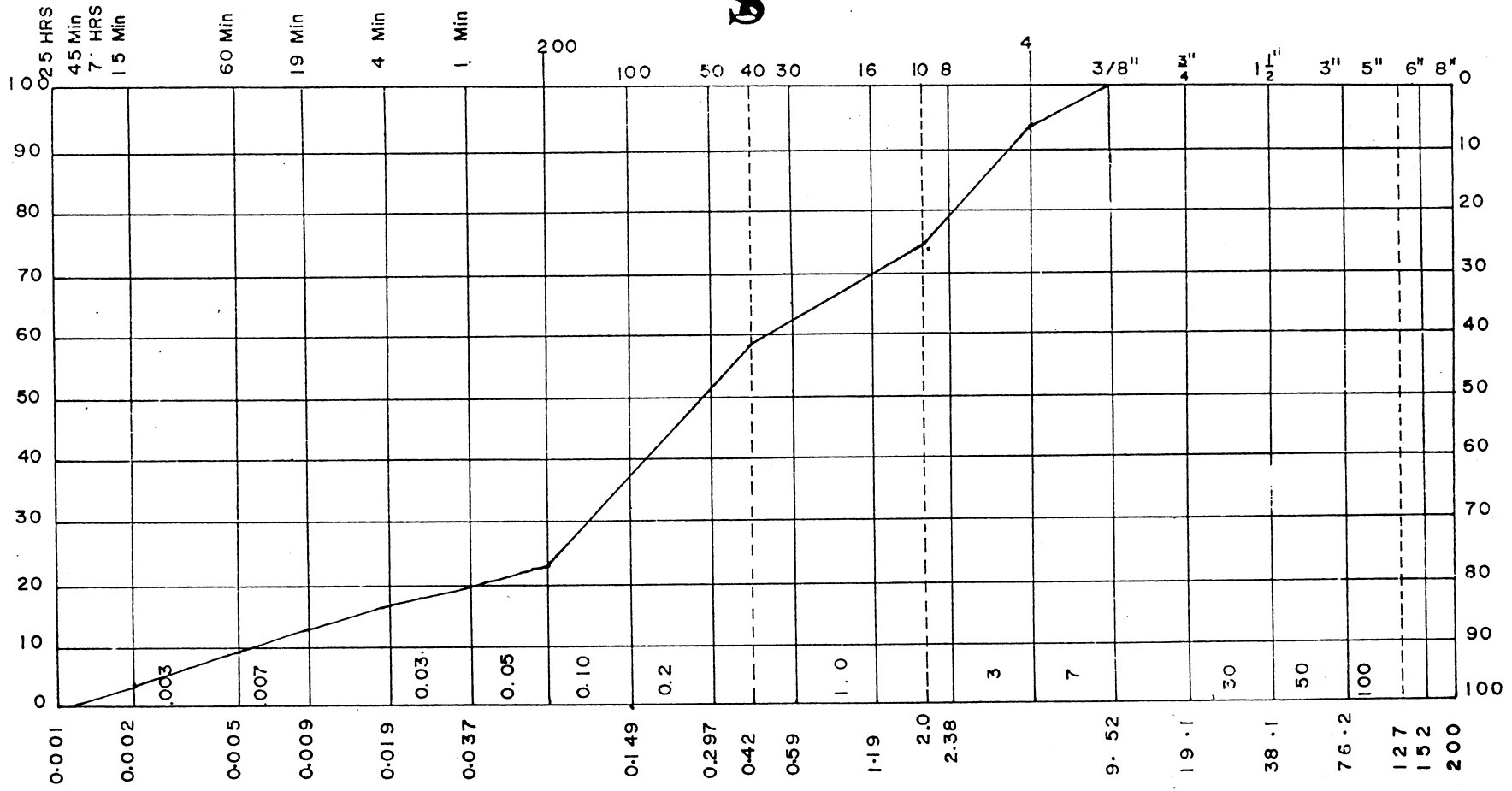
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH2				
9.0 – 10.0	6.2	70.7	23.1	

REMARKS _____

TOUKAN & SAKET

Geo. Research

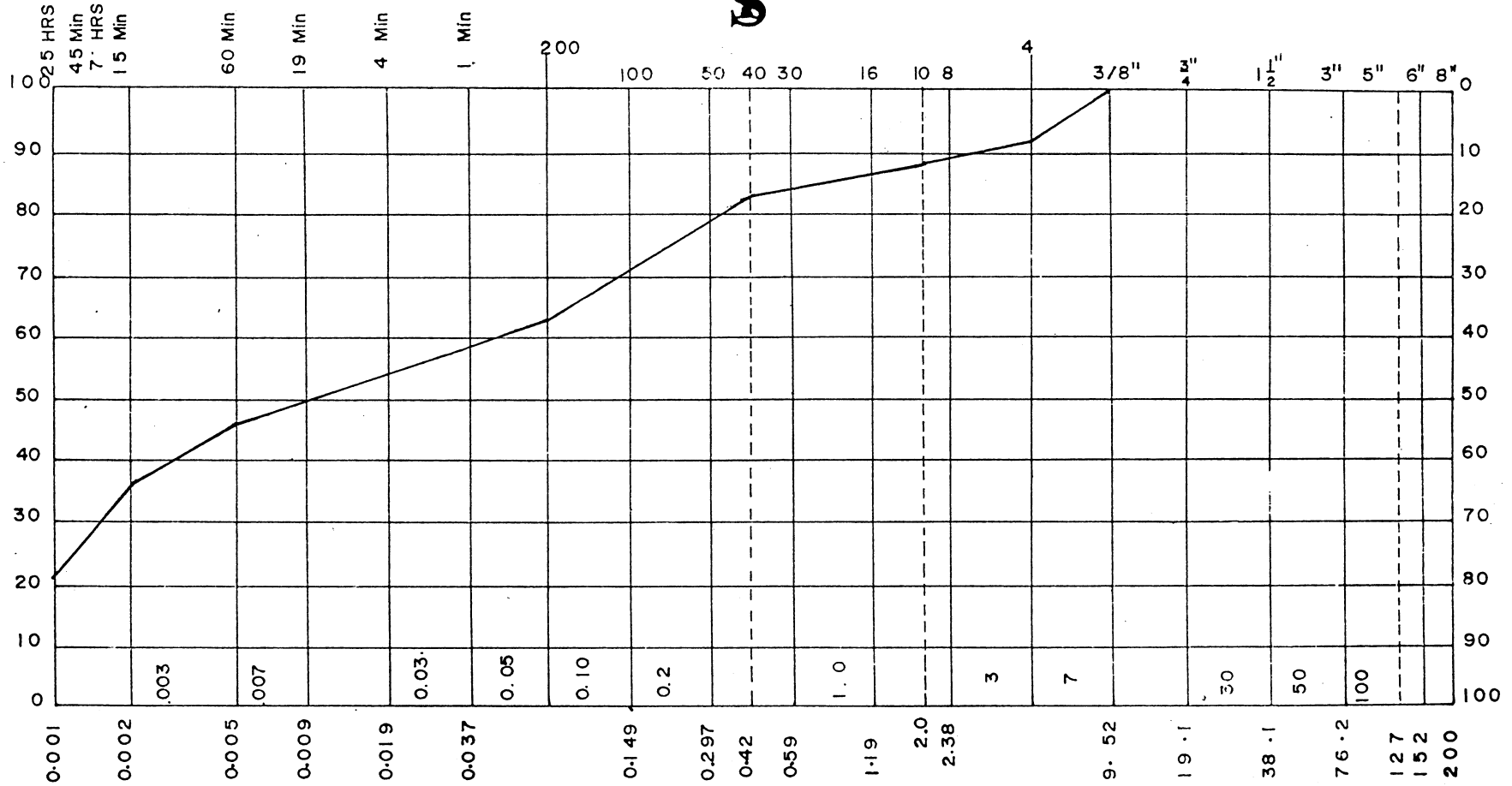
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-3				
1.0–2.0	8.0	29.0	26.5	36.5

REMARKS _____

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TOUKAN & SAKET

Geo. Research

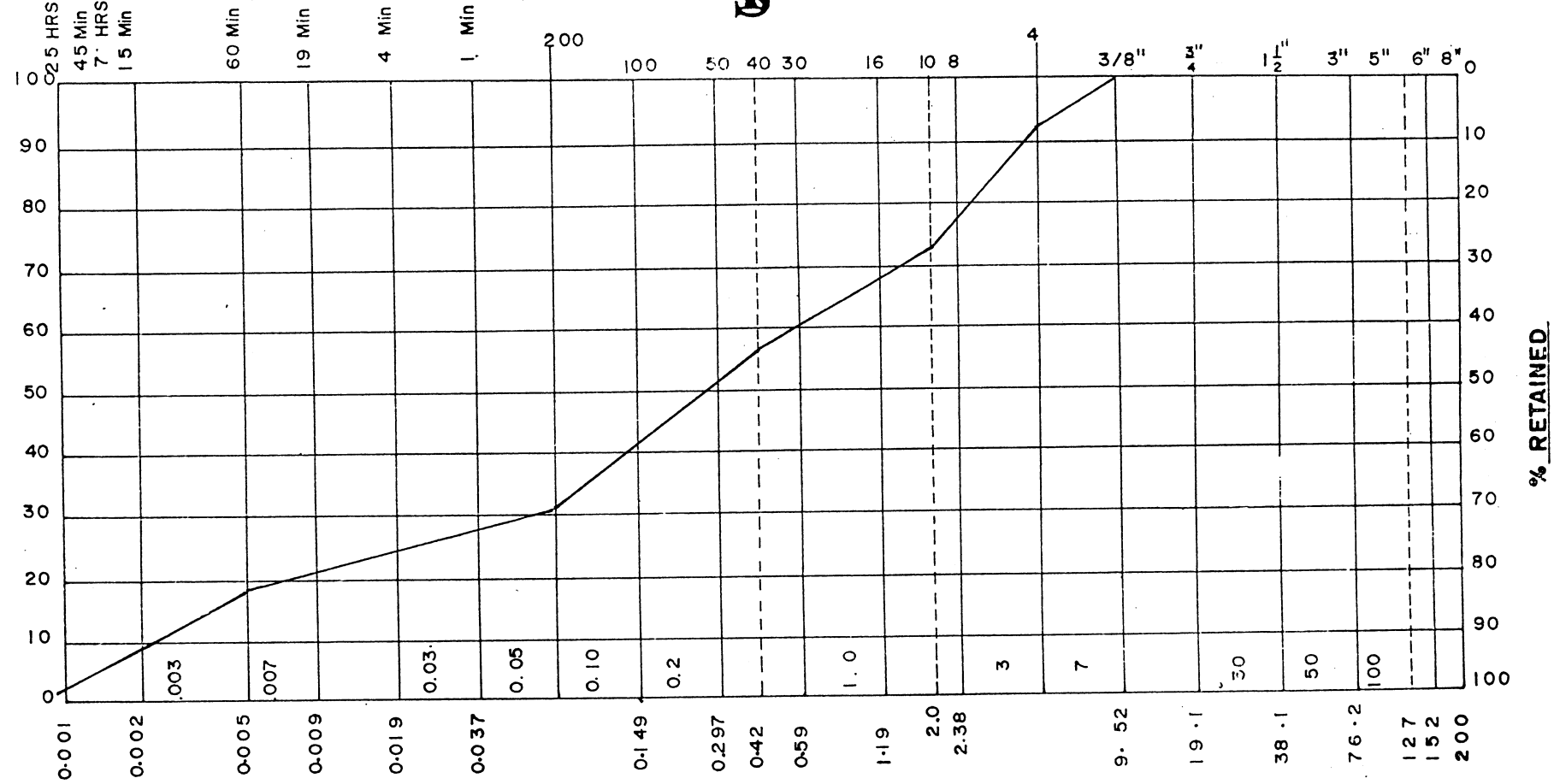
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-3				
3.0–4.0	7.2	61.5	22.5	8.8

REMARKS _____

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Geo. Research

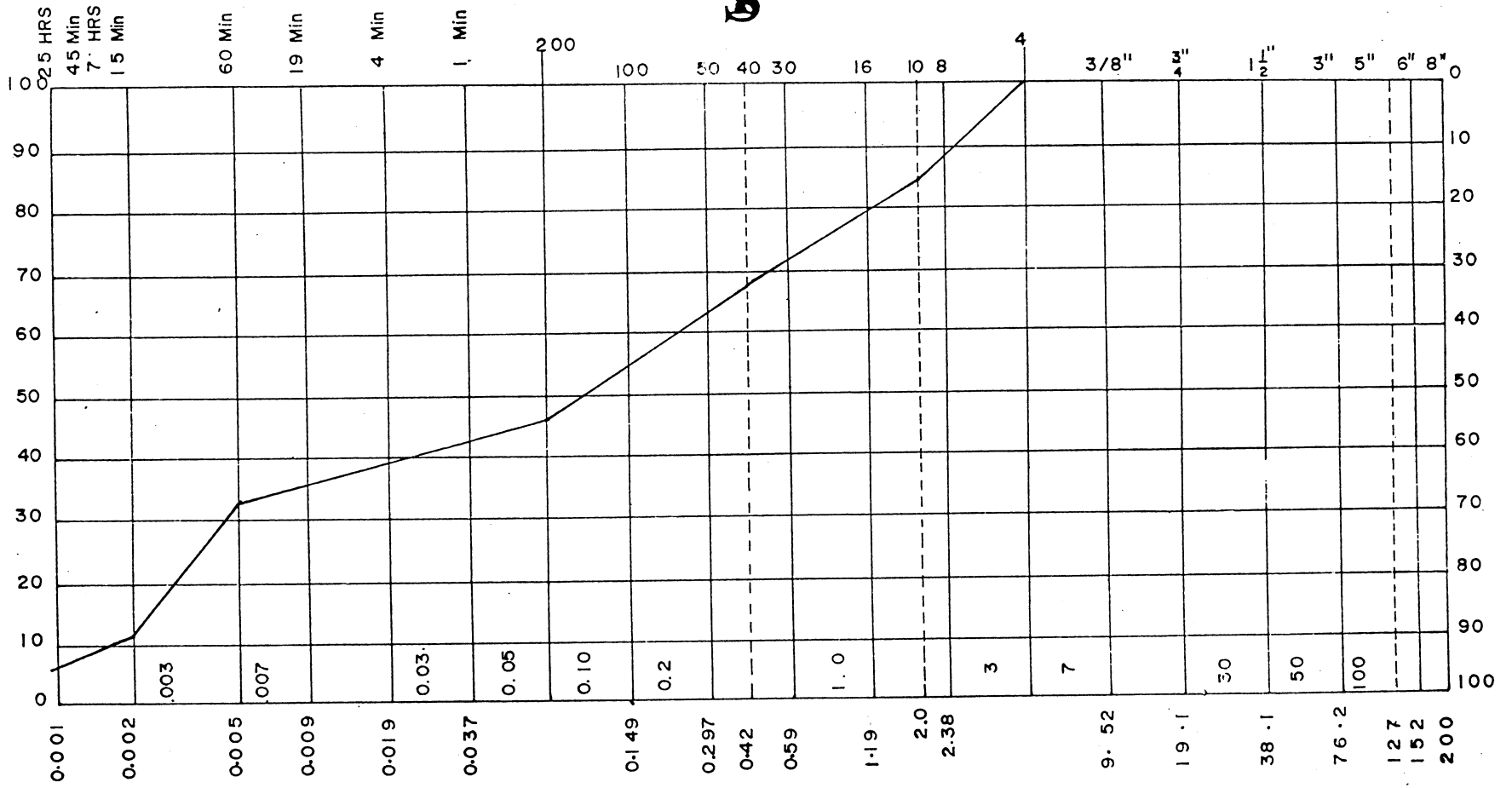
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-3	—			
5.0–6.0	—	58.9	33.8	12.3

REMARKS _____

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Geo. Research

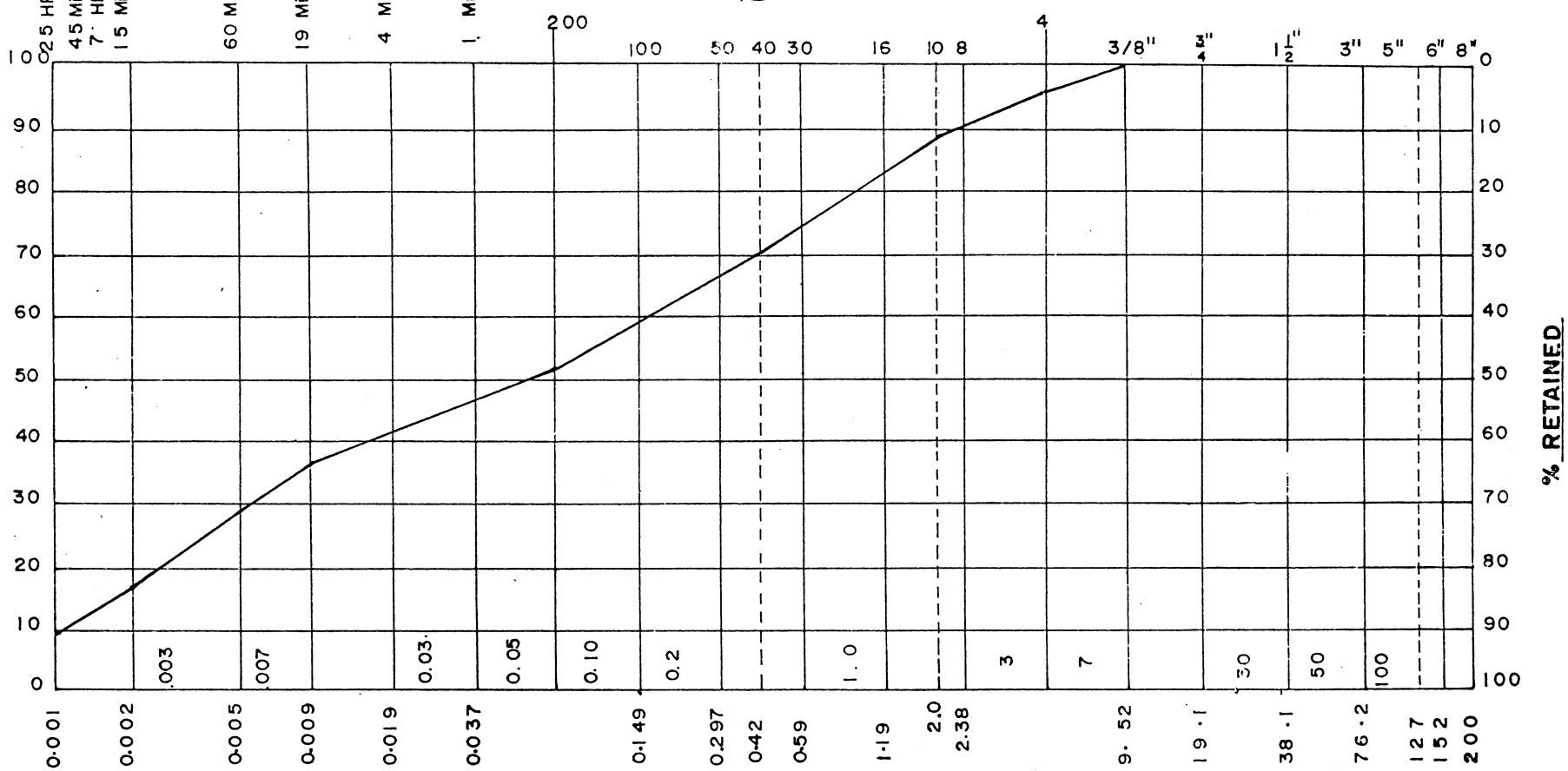
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-3				
9.0–10.0	4.2	43.8	35.0	17.0

REMARKS _____

TOUKAN & SAKET

Geo. Research

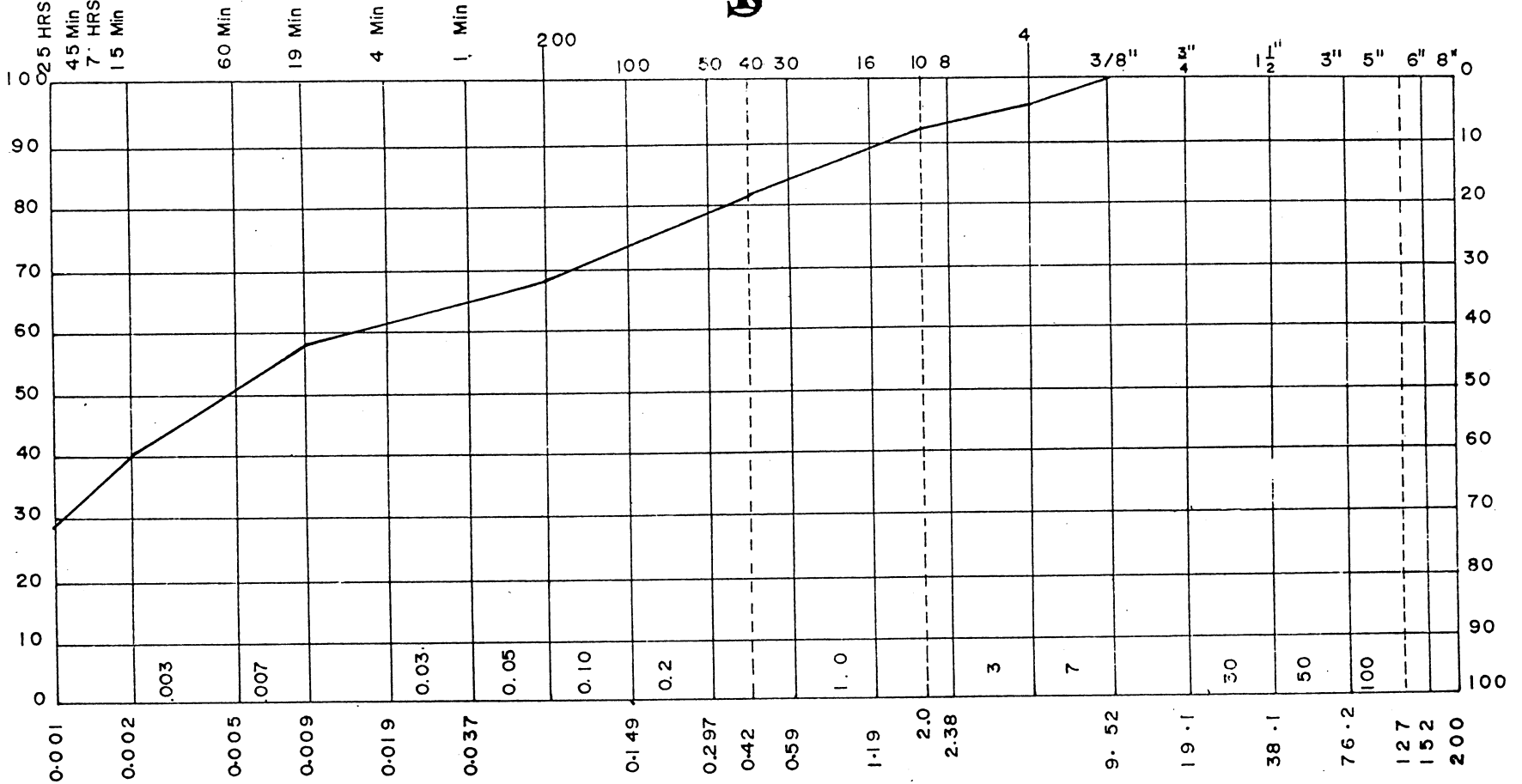
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH4				
1.5-3.0	4.3	27.4	28.2	40.1

REMARKS _____

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Geo. Research

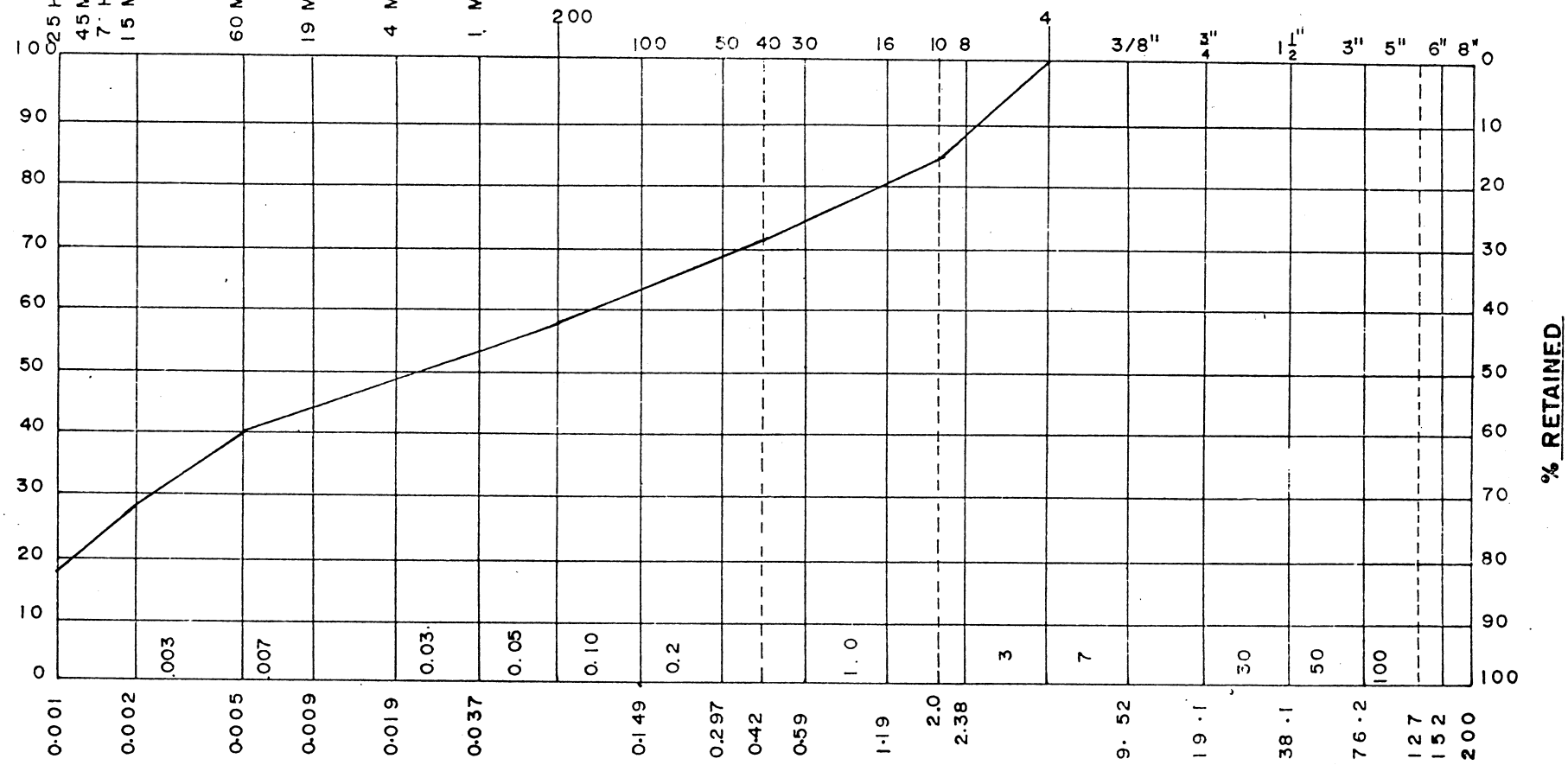
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-4				
4.5-5.5	-	41.8	29.4	28.8

REMARKS _____

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Geo. Research

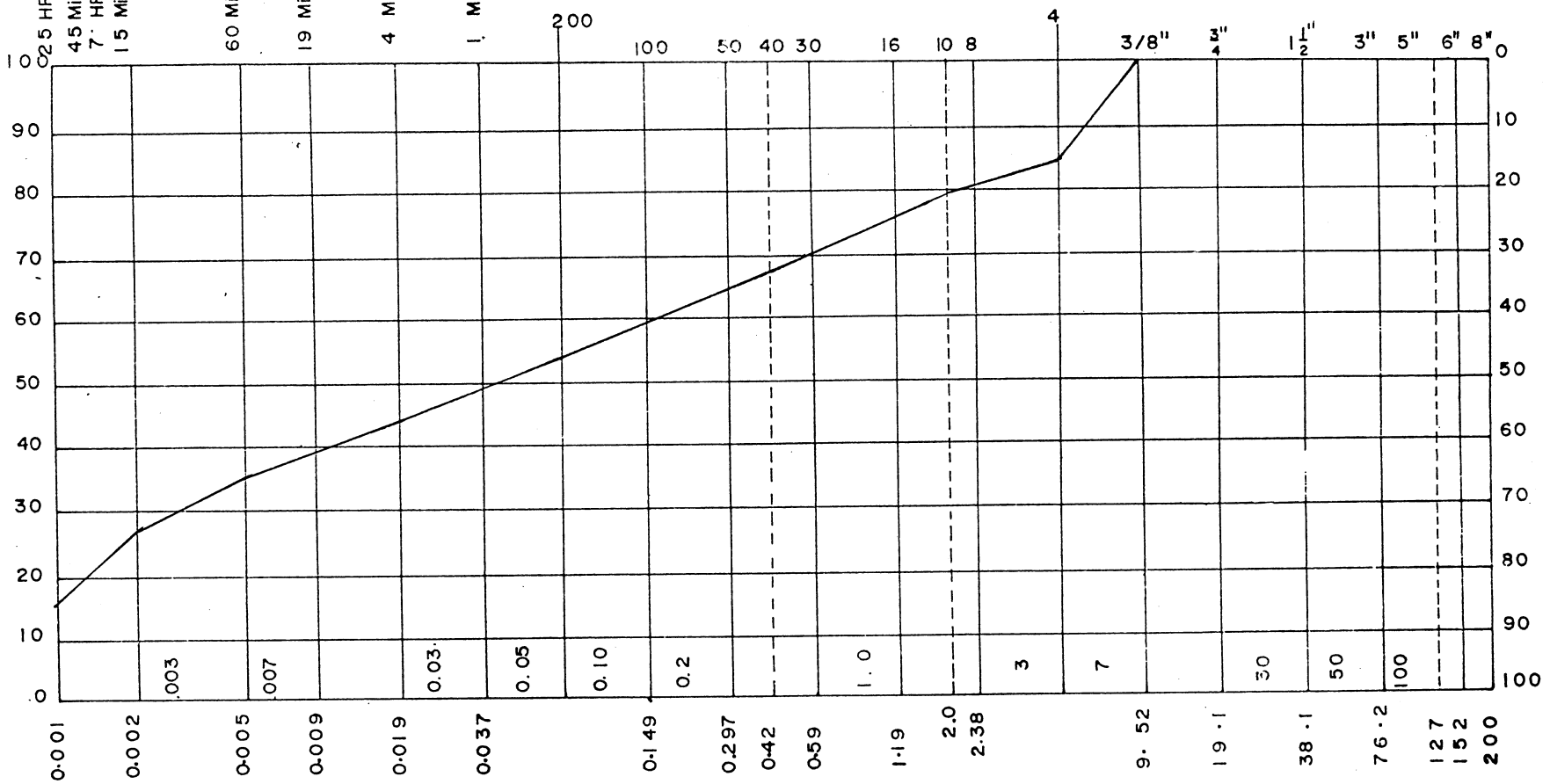
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-4				
9.0 - 10.0	15.2	30.6	26.7	27.5

REMARKS _____

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Geo. Research

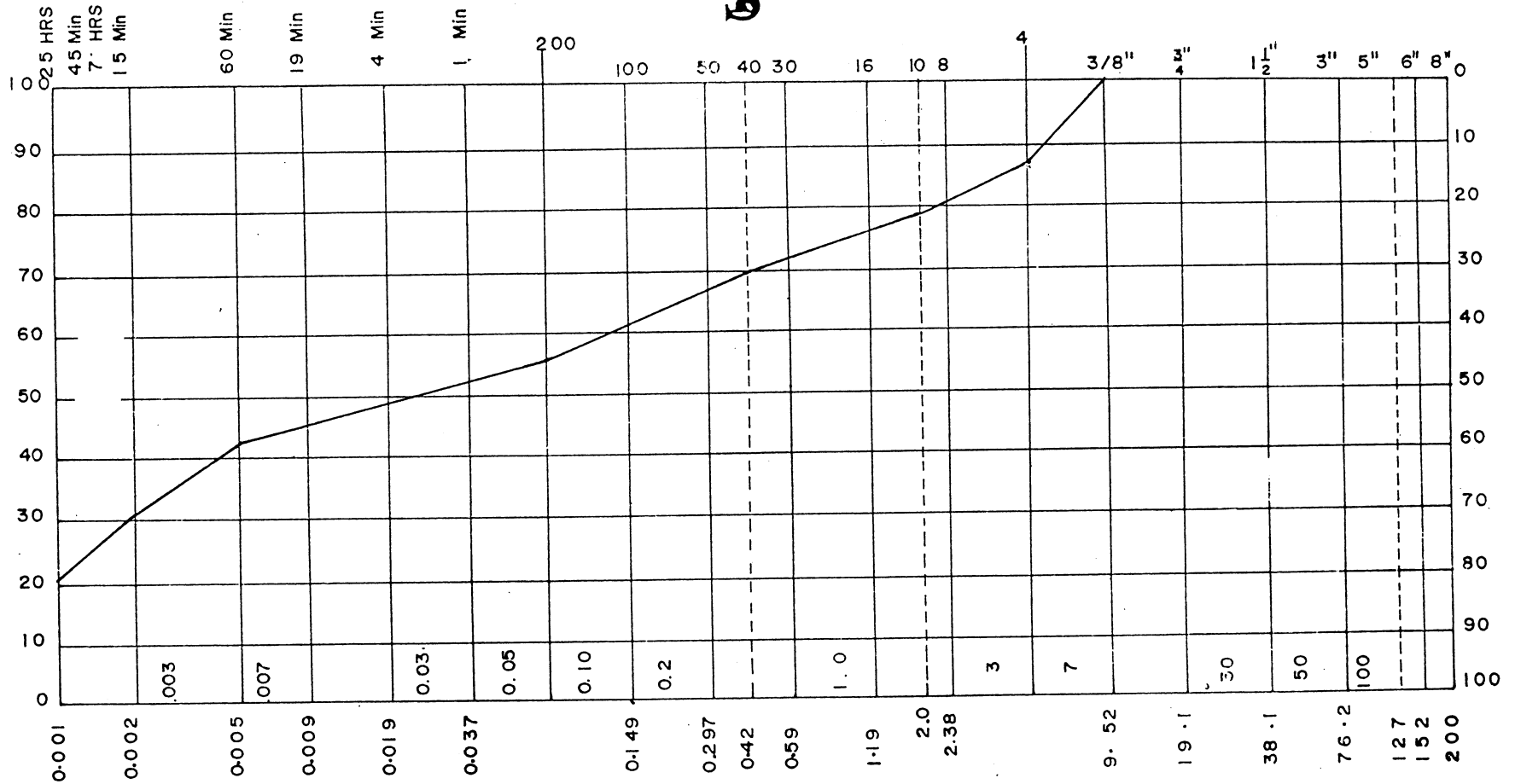
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH5				
0.0 – 1.0	13.2	30.5	25.3	31.0

REMARKS _____

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Geo. Research

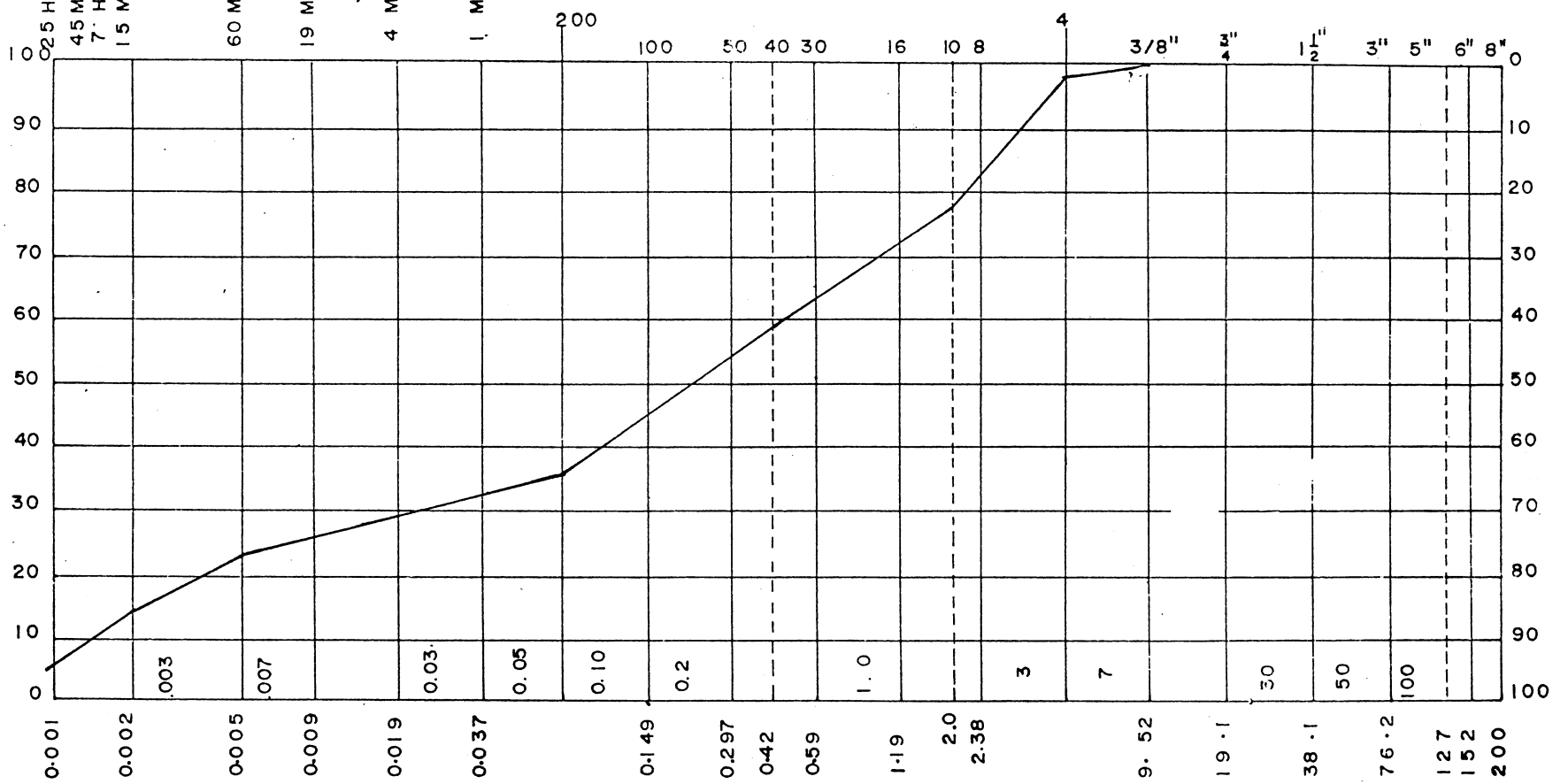
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH-5				
2.0-3.0m	3.1	60.9	21.8	14.2

REMARKS _____

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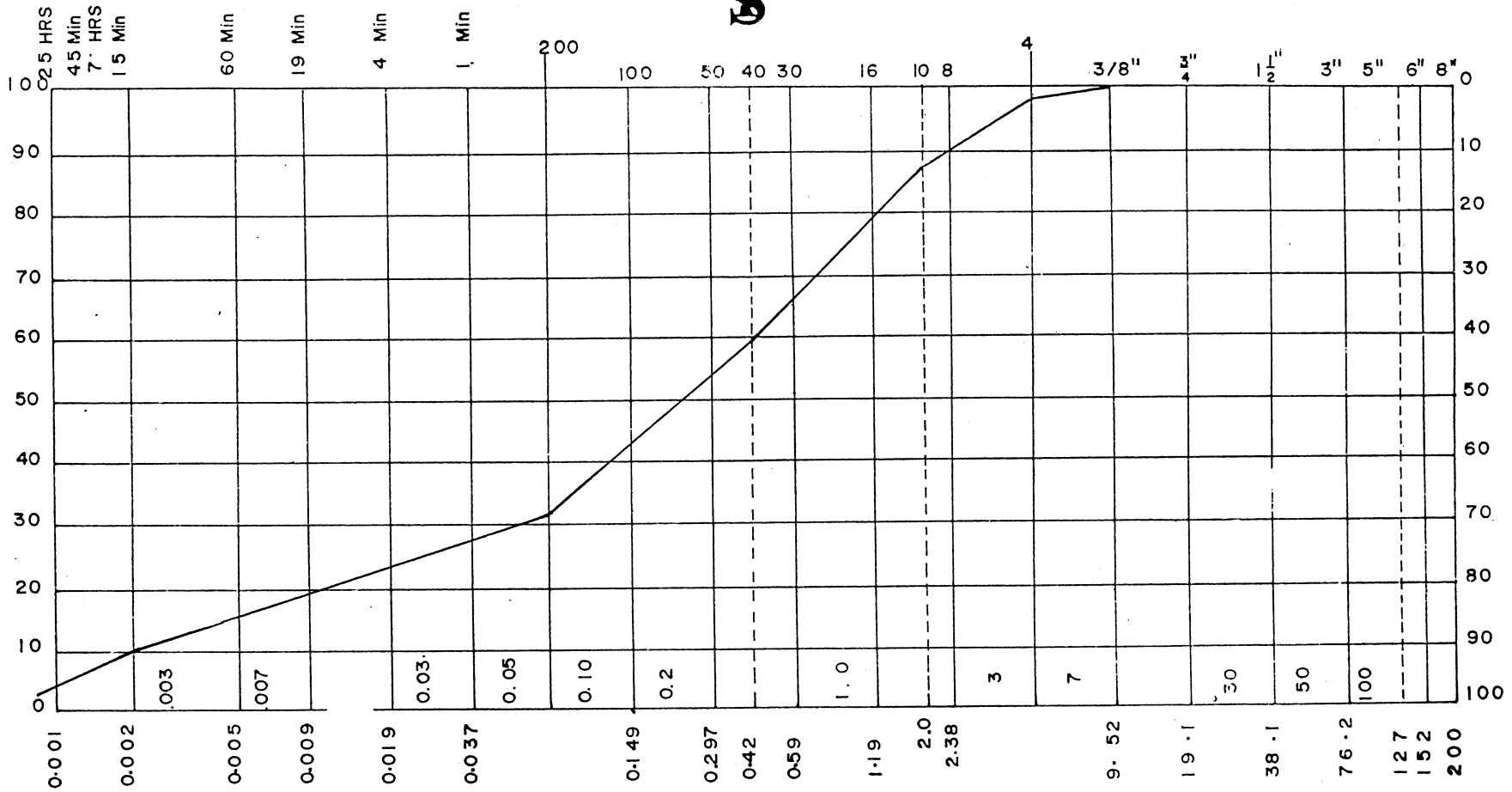
Geo. Research

PROJECT _____ DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH5				
4.0–5.0	2.5	65.5	22.0	10.0

REMARKS _____

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Geo. Research

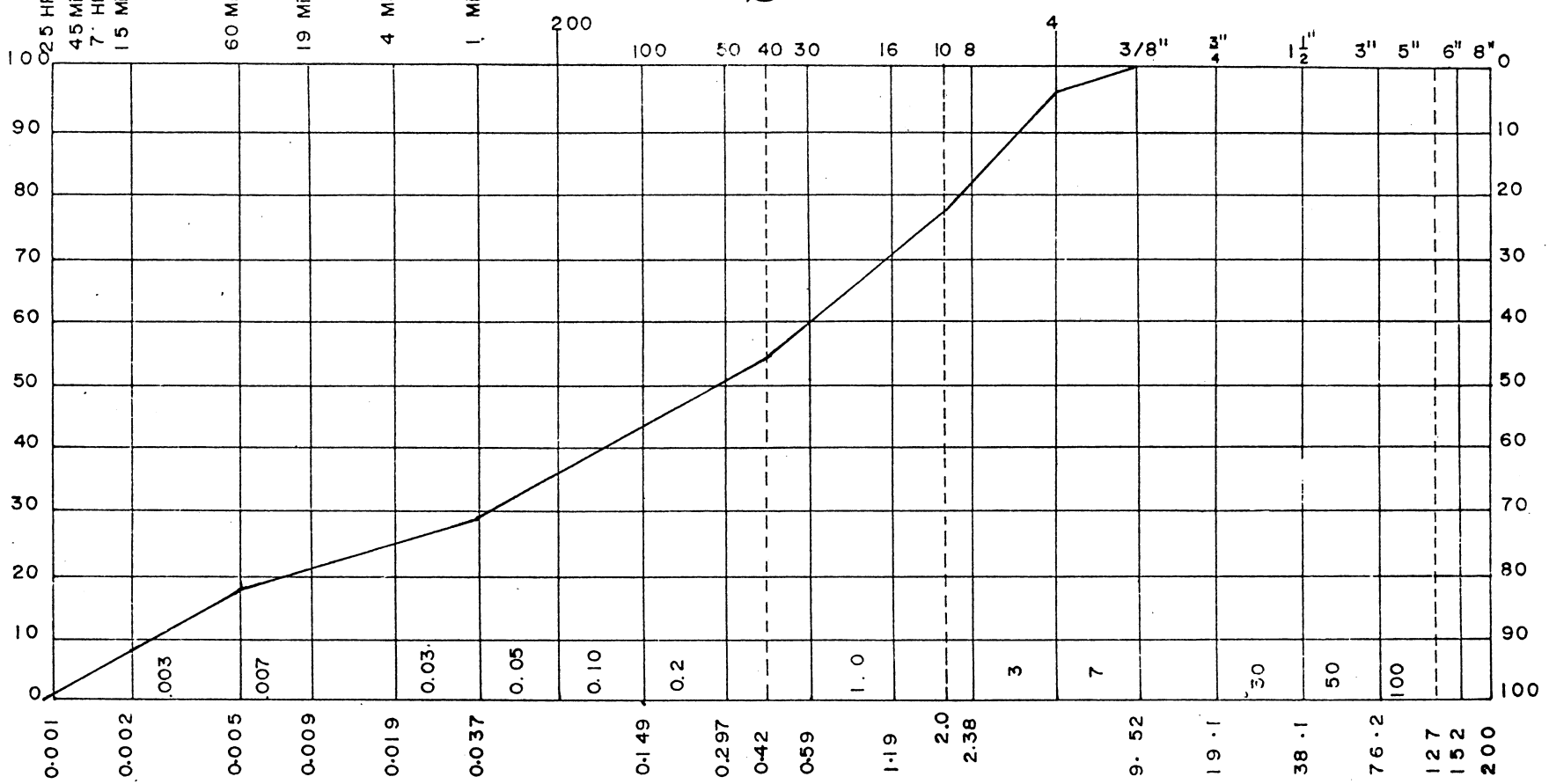
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH5				
6.0 – 10.0	4.1	66.9	20.9	8.1

REMARKS _____

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Geo. Research

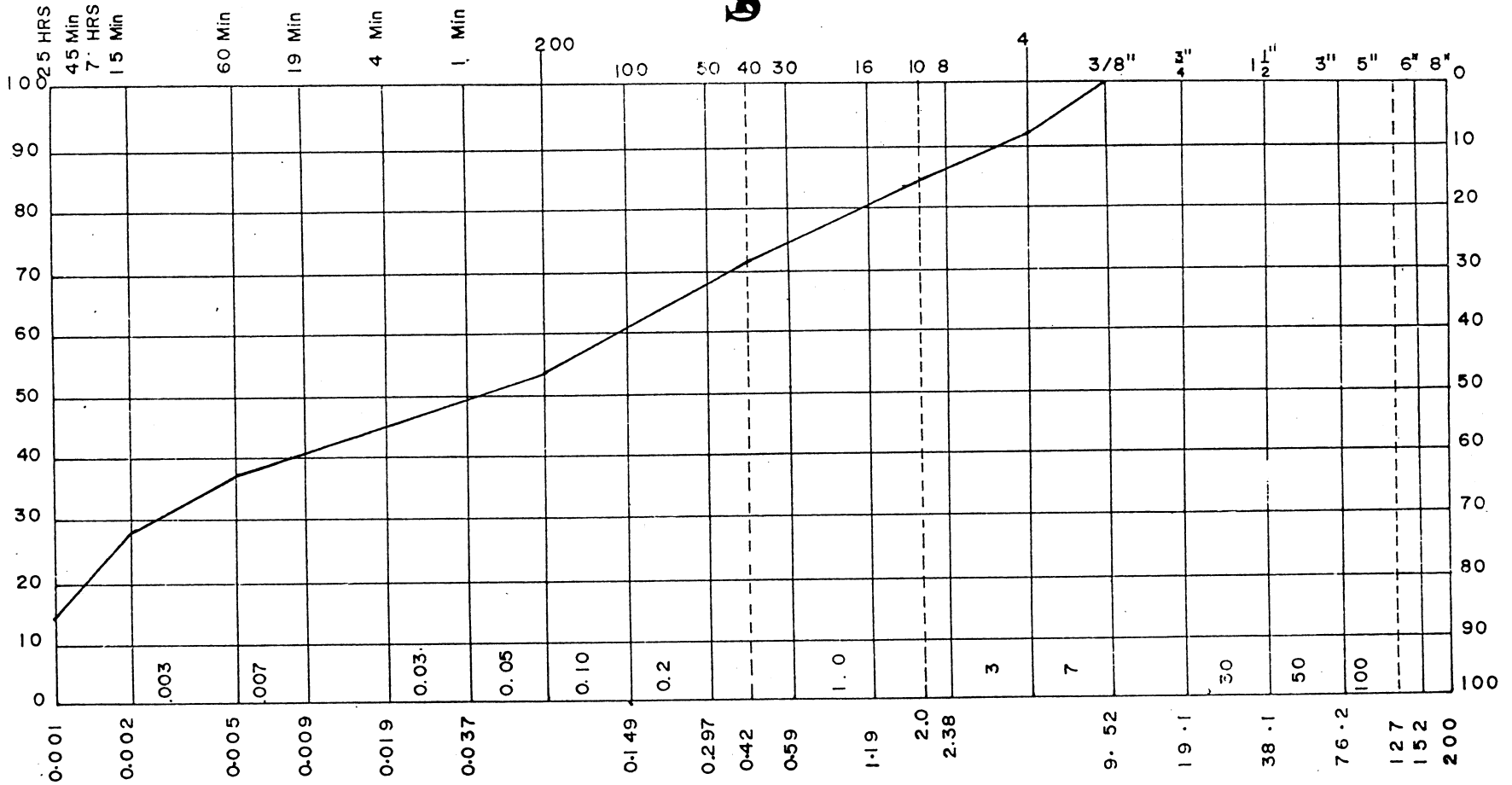
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND (0.074)			GRAVEL (4.76)		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH6				
0.0–1.5	8.2	37.7	26.3	27.8

REMARKS _____

370

TOUKAN & SAKET

Geo. Research

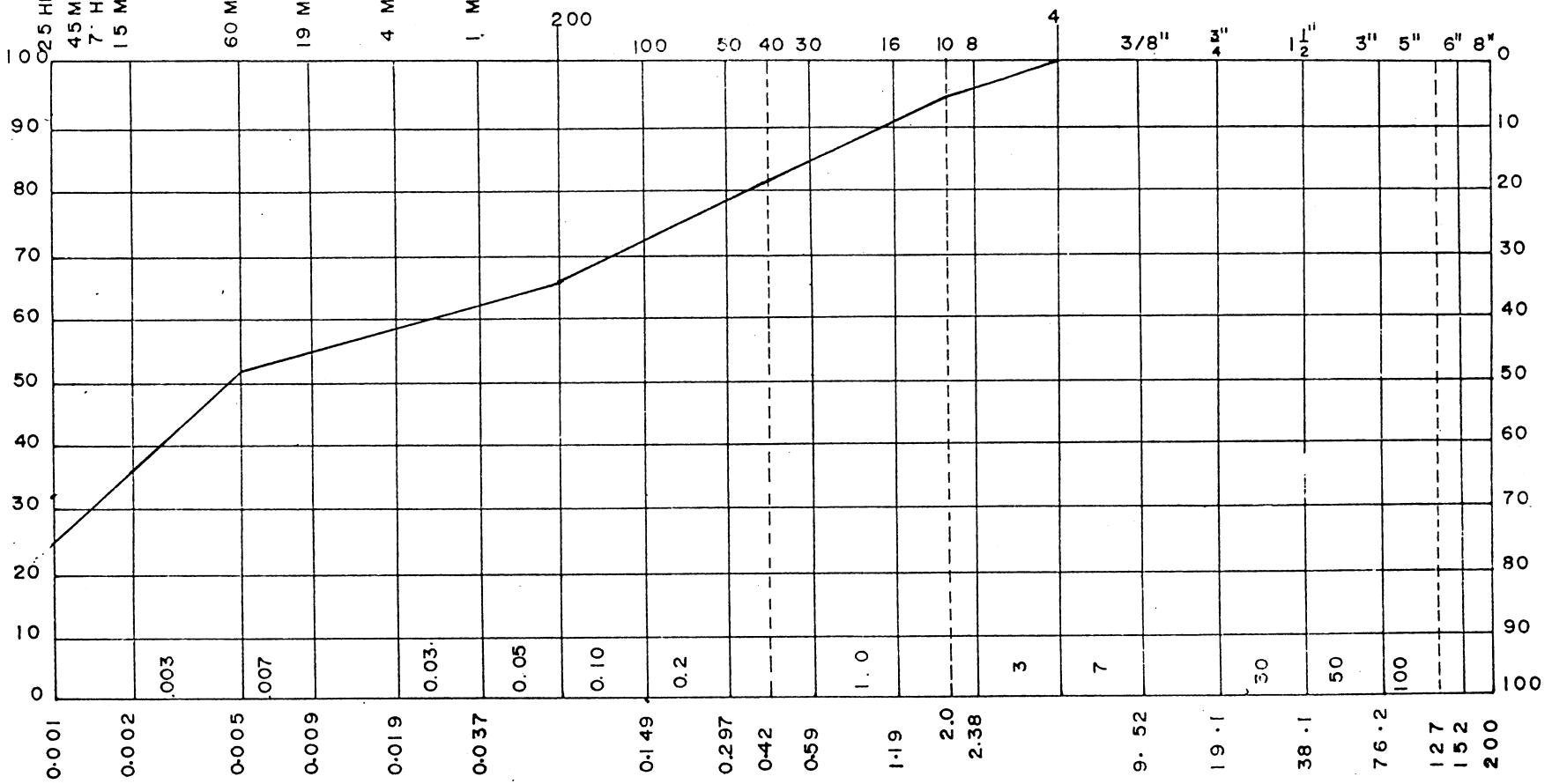
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH6				
3.0 – 4.0	–	33.8	30.2	36.0

REMARKS _____

371

TOUKAN & SAKET

Geo. Research

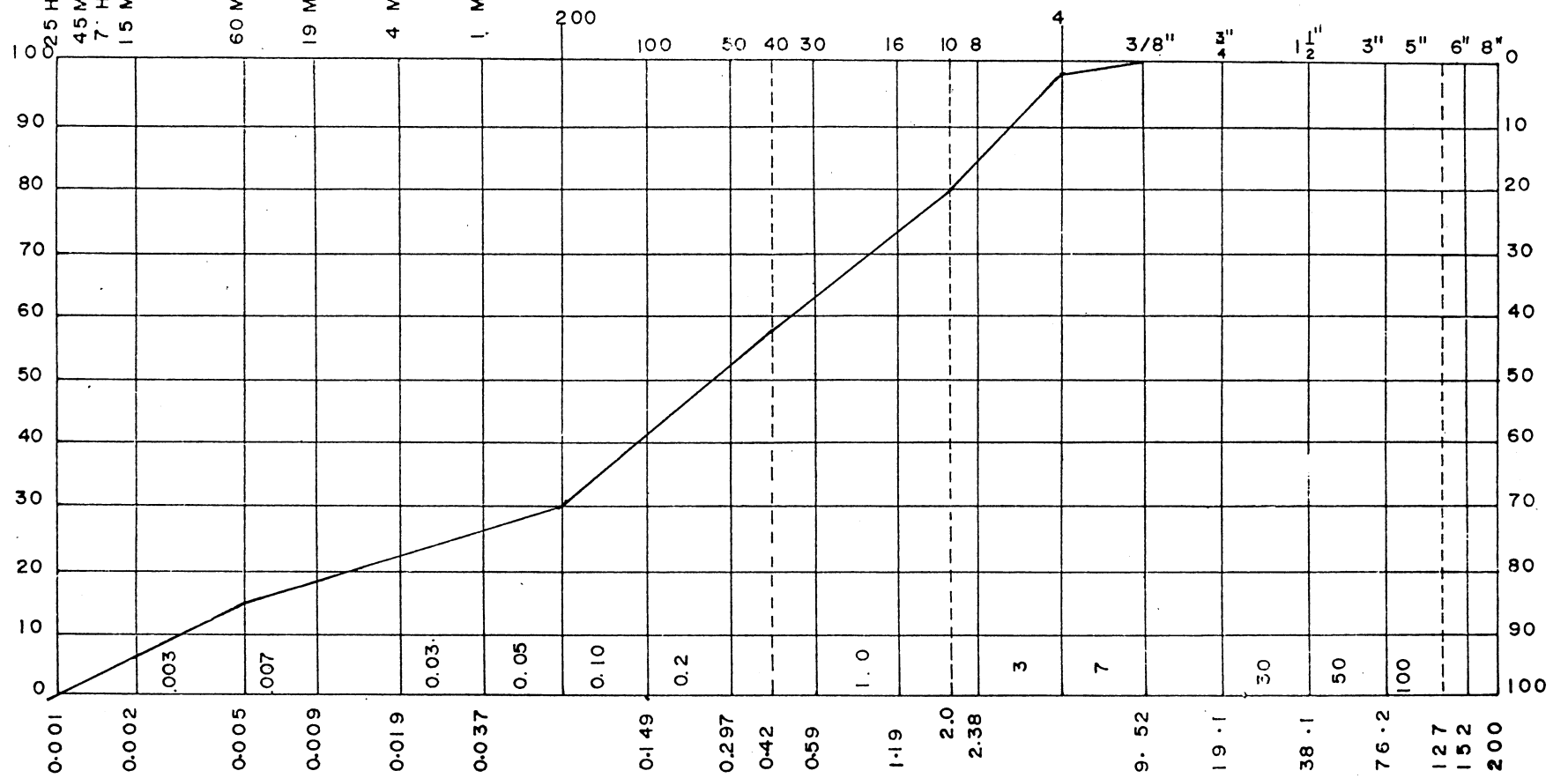
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH6				
5.0–6.0 m	2.1	67.9	23.9	6.1

REMARKS _____

3272

TOUKAN & SAKET

Geo. Research

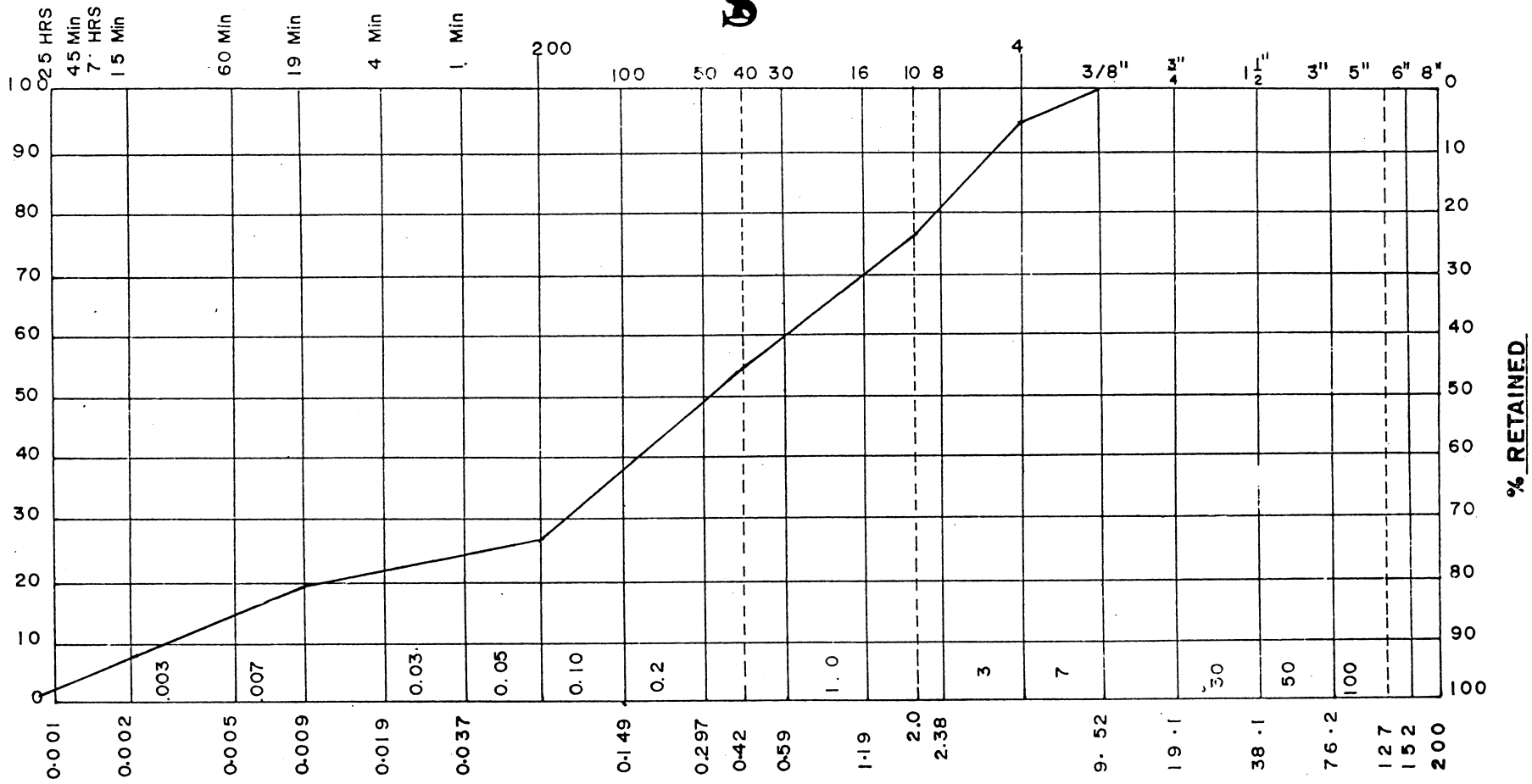
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH6				
7.0–10.0	5.1	67.6	20.1	7.2

REMARKS _____

373

TOUKAN & SAKET

Geo. Research

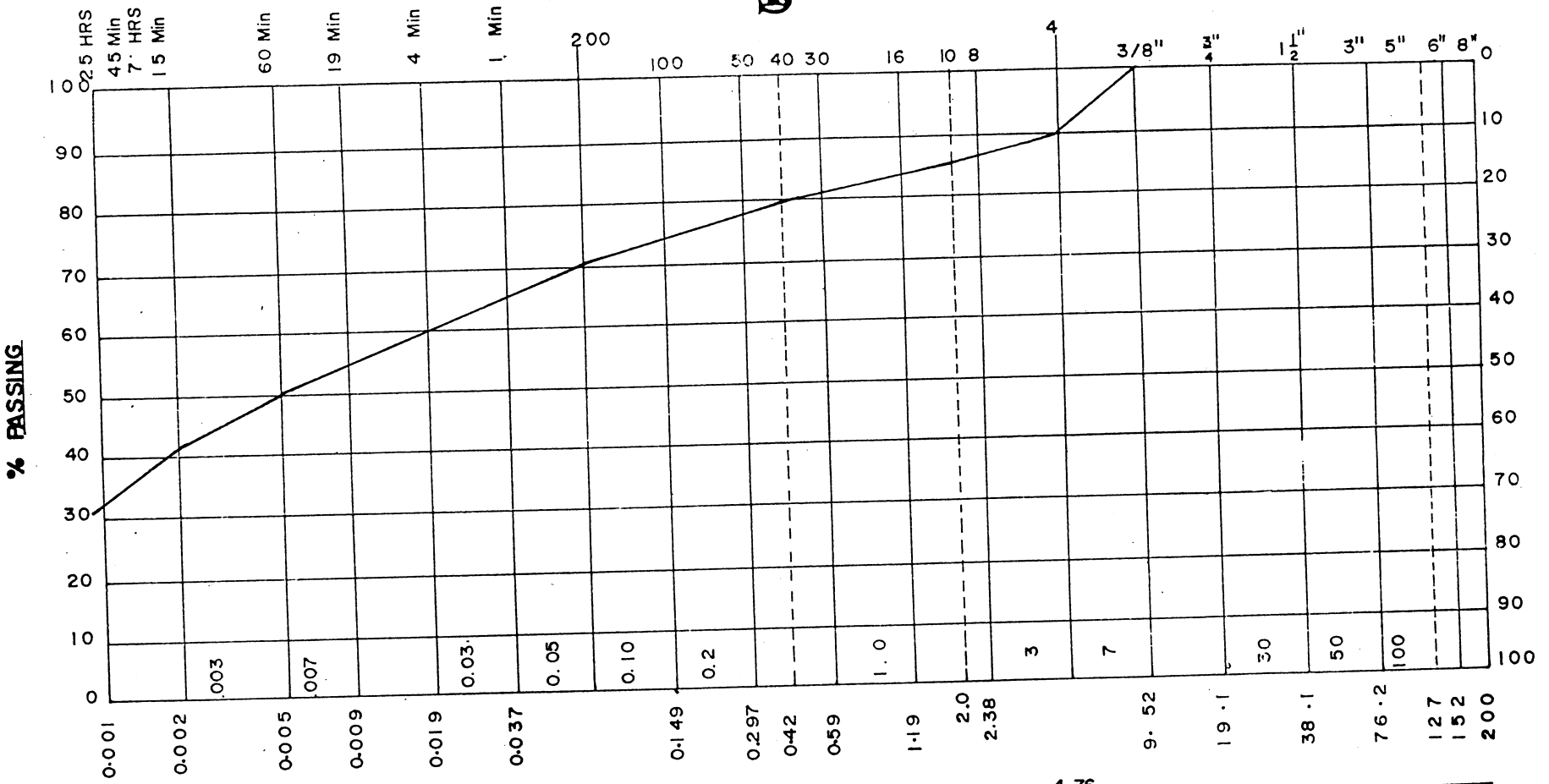
DATE _____

SAMPLE No _____

PROJECT _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH7				
0.0 – 3.0m	9.8	19.2	29.8	41.2

REMARKS _____

TOUKAN & SAKET

Geo. Research

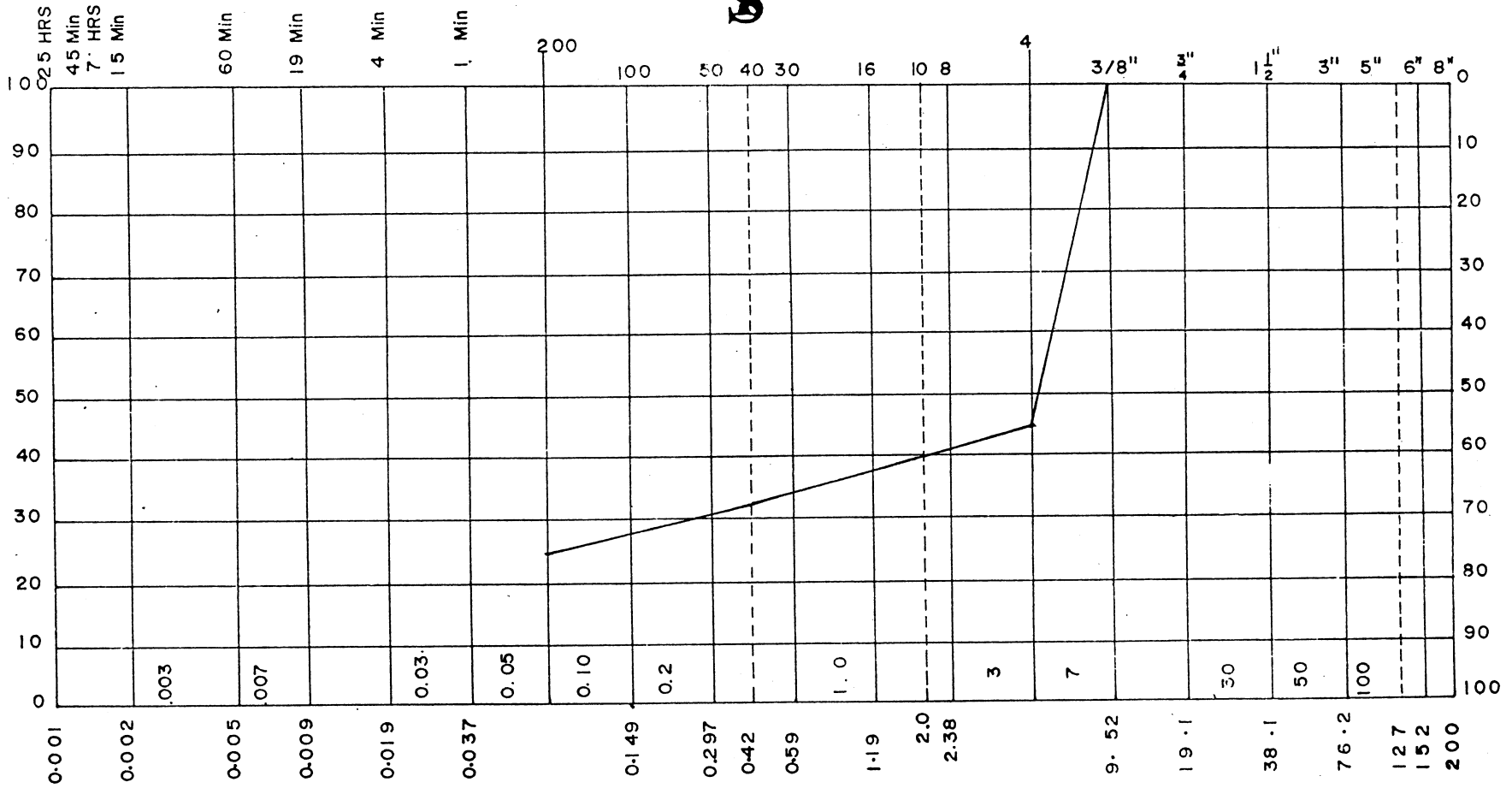
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH7				
3.0 – 4.0	45.0	30.0	25.0	–

REMARKS _____

375

TOUKAN & SAKET

Geo. Research

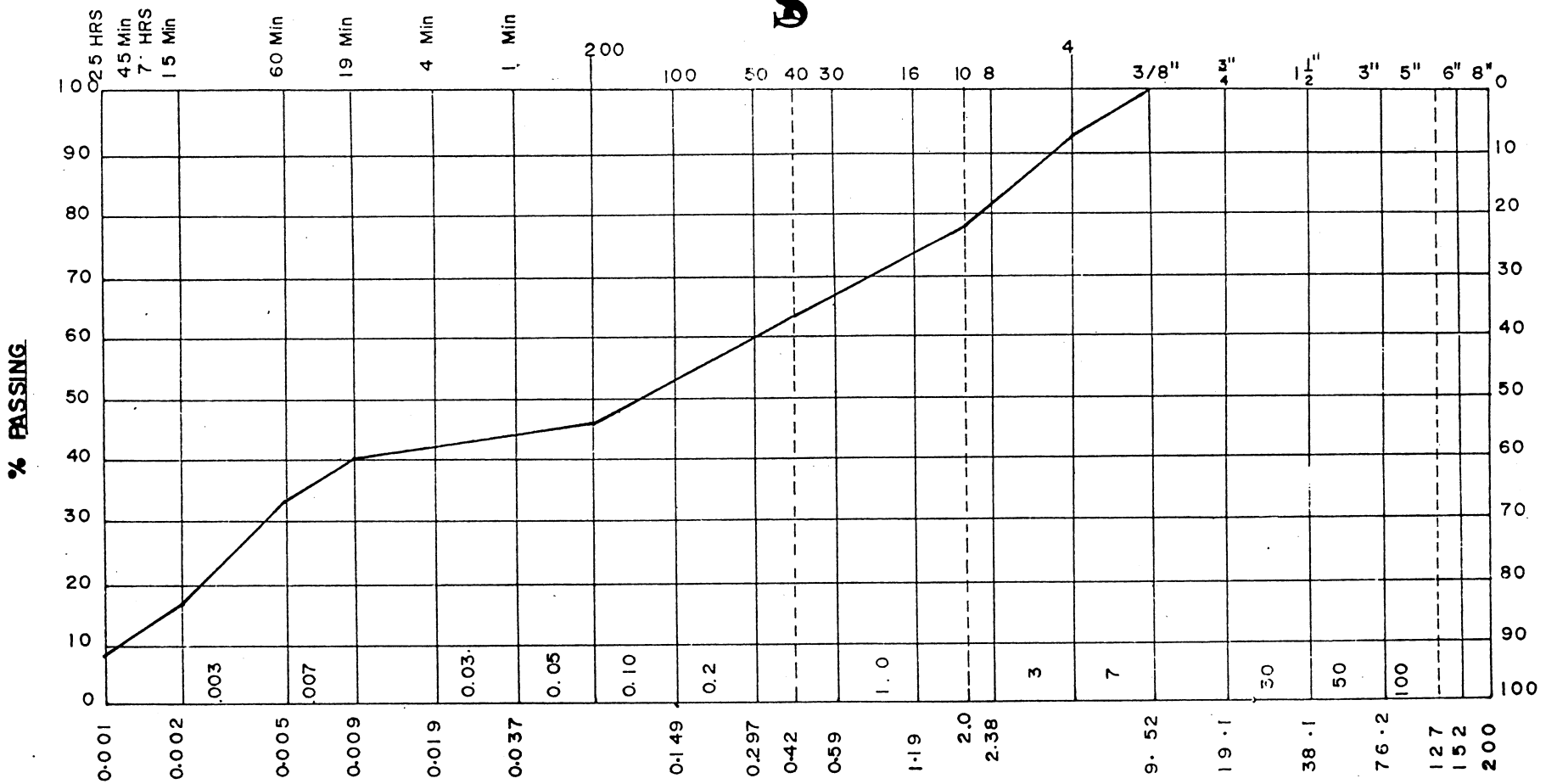
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH8				
4.0–5.0 m	7.2	46.5	29.3	17.0

REMARKS _____

TOUKAN & SAKET

Geo. Research

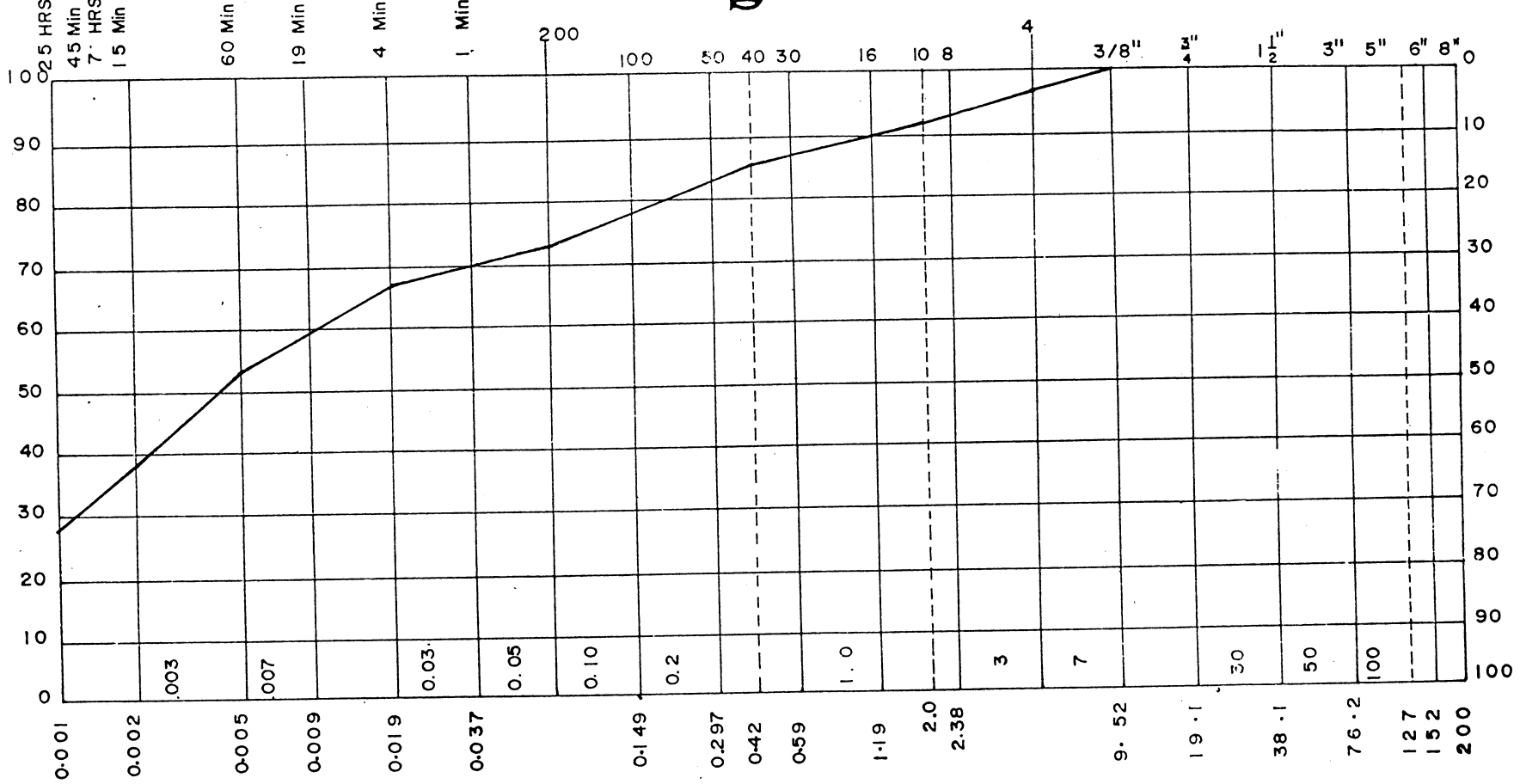
DATE _____

PROJECT _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH8				
1.0–2.0 m	3.3	23.6	35.1	38.0

REMARKS _____

TOUKAN & SAKET

Geo. Research

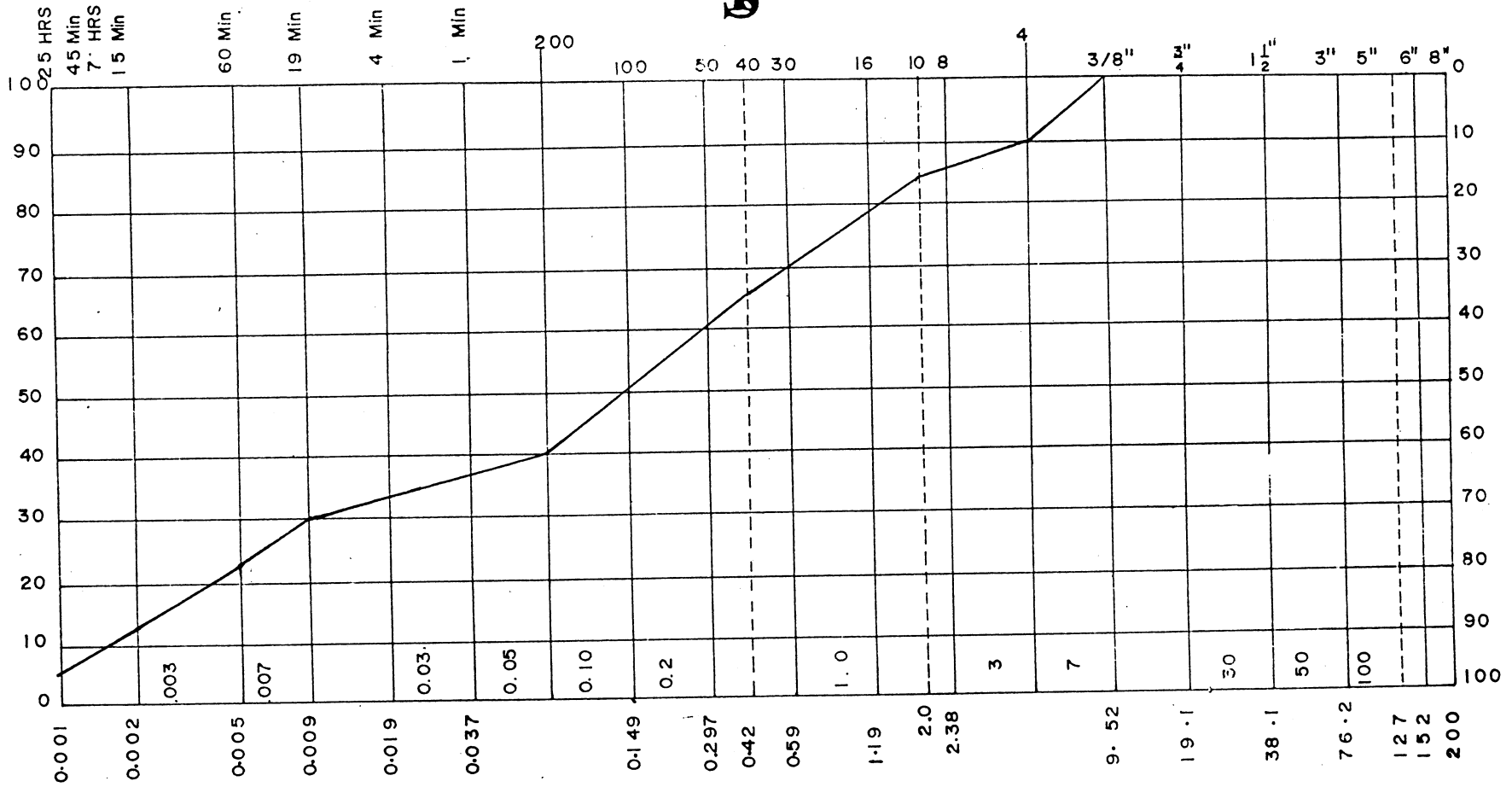
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	0.074 SAND			4.76 GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH8				
2.0–3.0 m	10.0	50.0	27.2	12.8

REMARKS _____

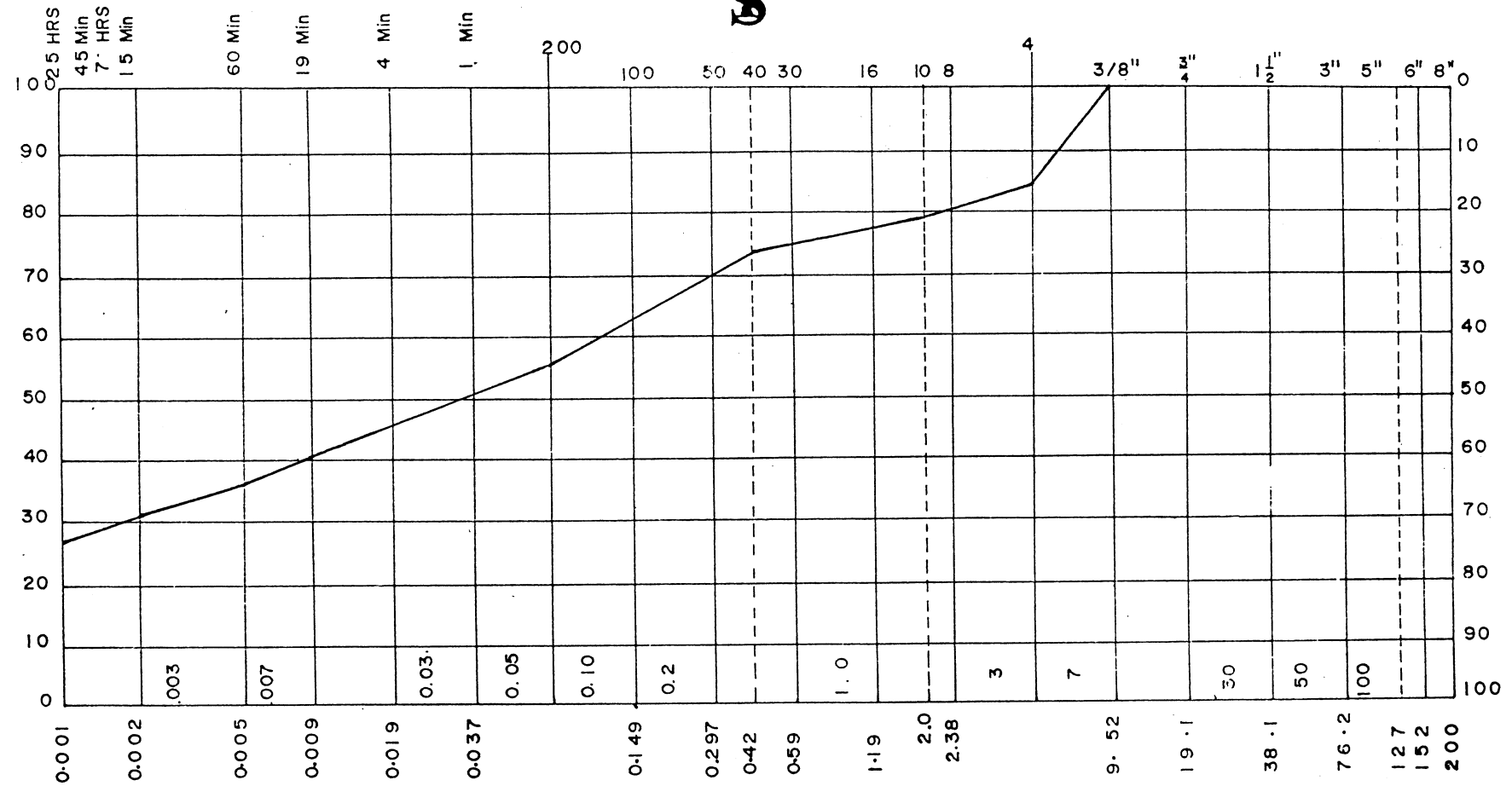
TOUKAN & SAKET

Geo. Research

PROJECT _____ DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH8 3.0–4.0	15.1	28.7	24.8	31.4

REMARKS _____

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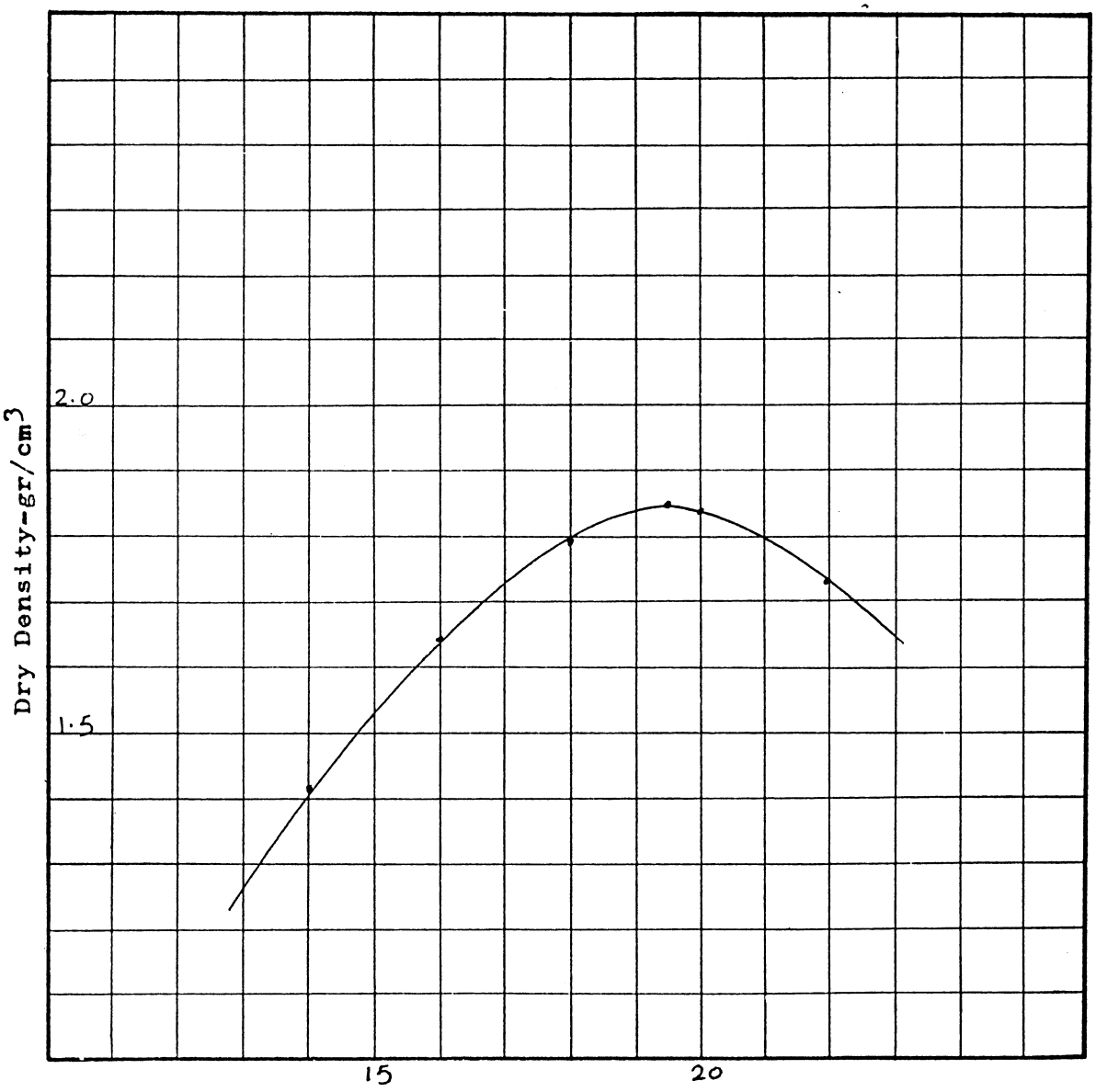
Geo-Research

Proctor Compaction Test

Sample No.: T.P.2 (1.0 – 2.0) m Project:



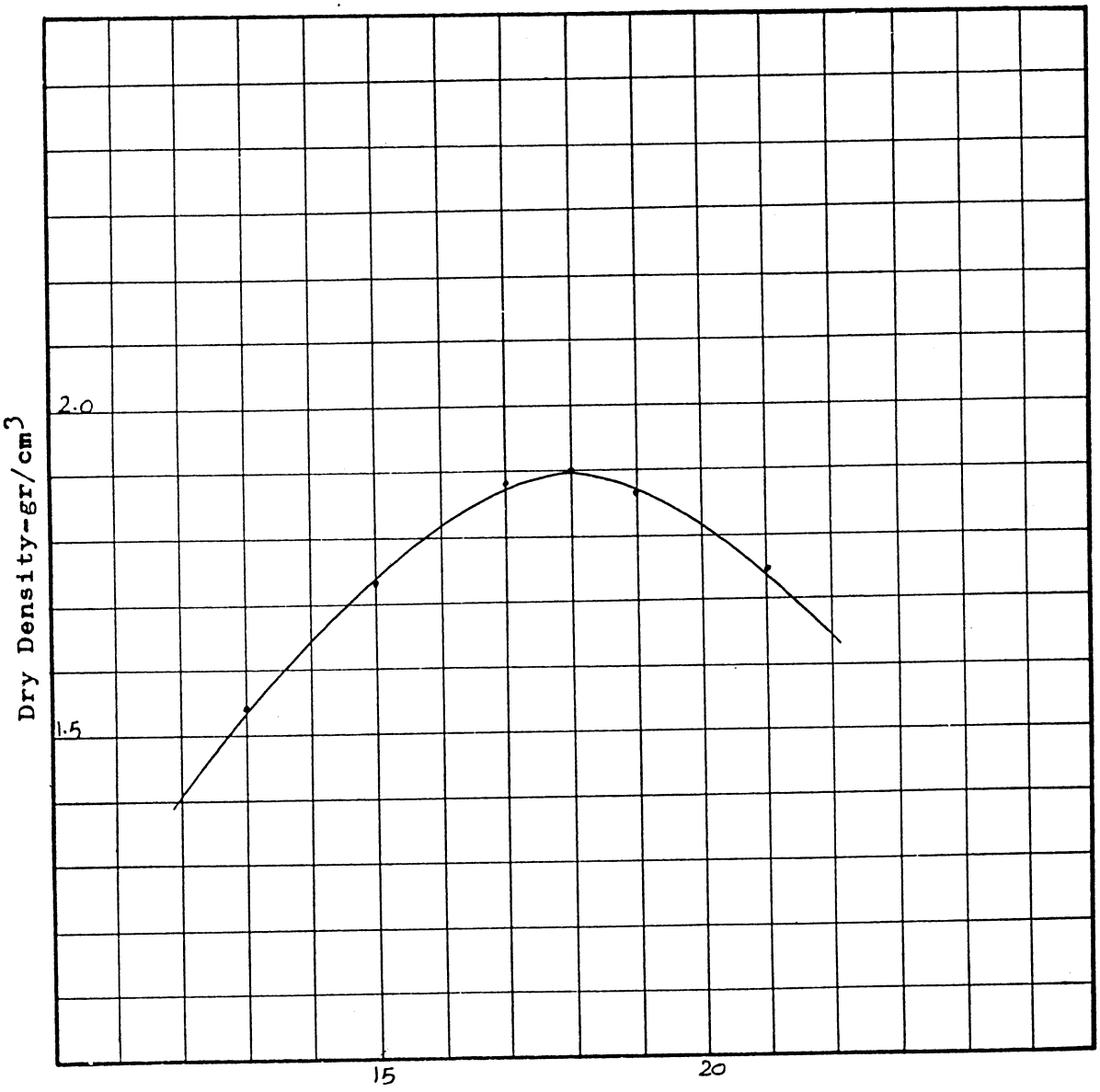
Max. Dry Density = 1.85 gr/cm^3

Optimum Moisture Content = 19.5 %

Geo-Research

Proctor Compaction Test

Sample No.: T.P.1 (0.0 – 1.0)m Project:



Max. Dry Density = 1.9 gr/cm³ Moisture Content(%)

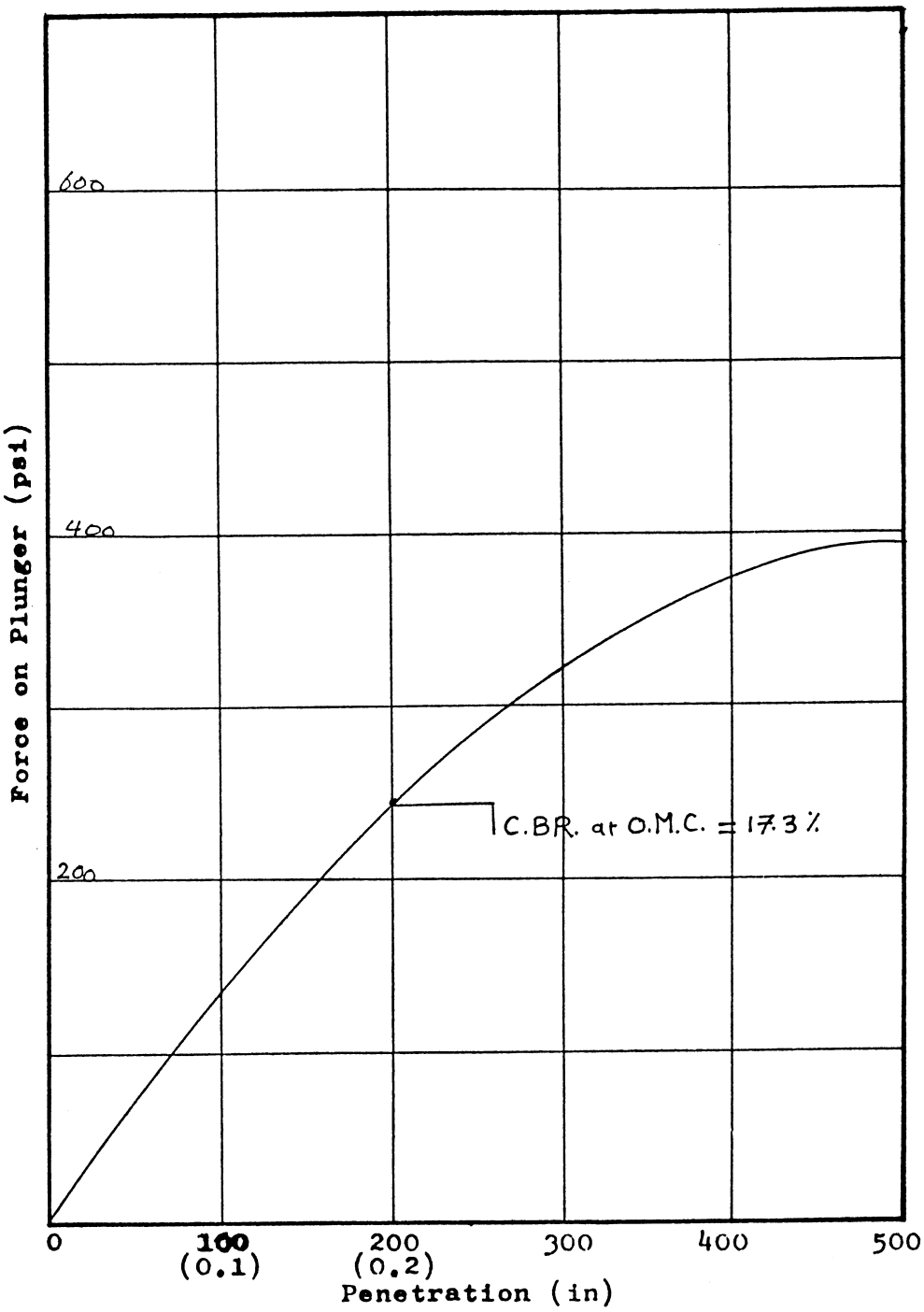
Optimum Moisture Content = 18.0%

T

Geo-Research

California Bearing Ratio

Project: **Sample No.:** T.P.2 (1.0–2.0)m

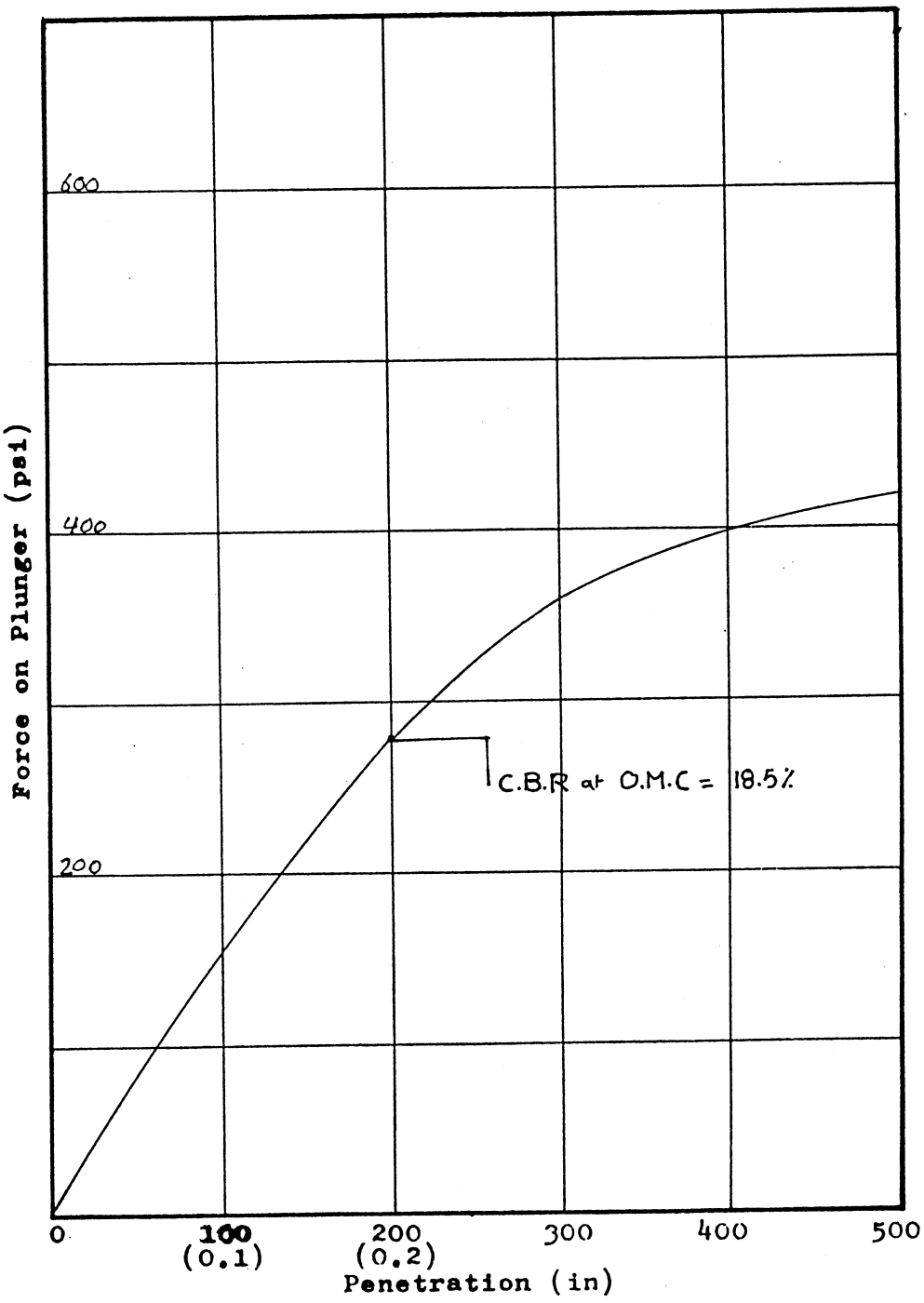


Remarks:

Geo-Research

California Bearing Ratio

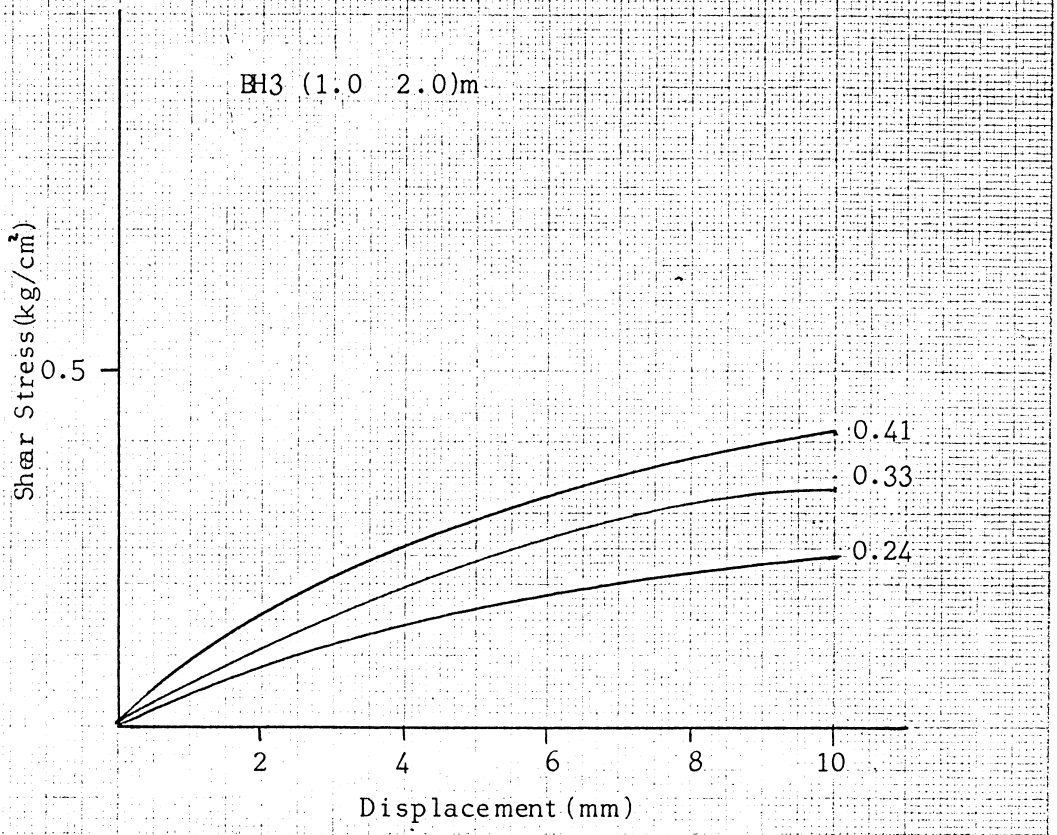
Project: **Sample No.:** T.P.1 (0.0 – 1.0)

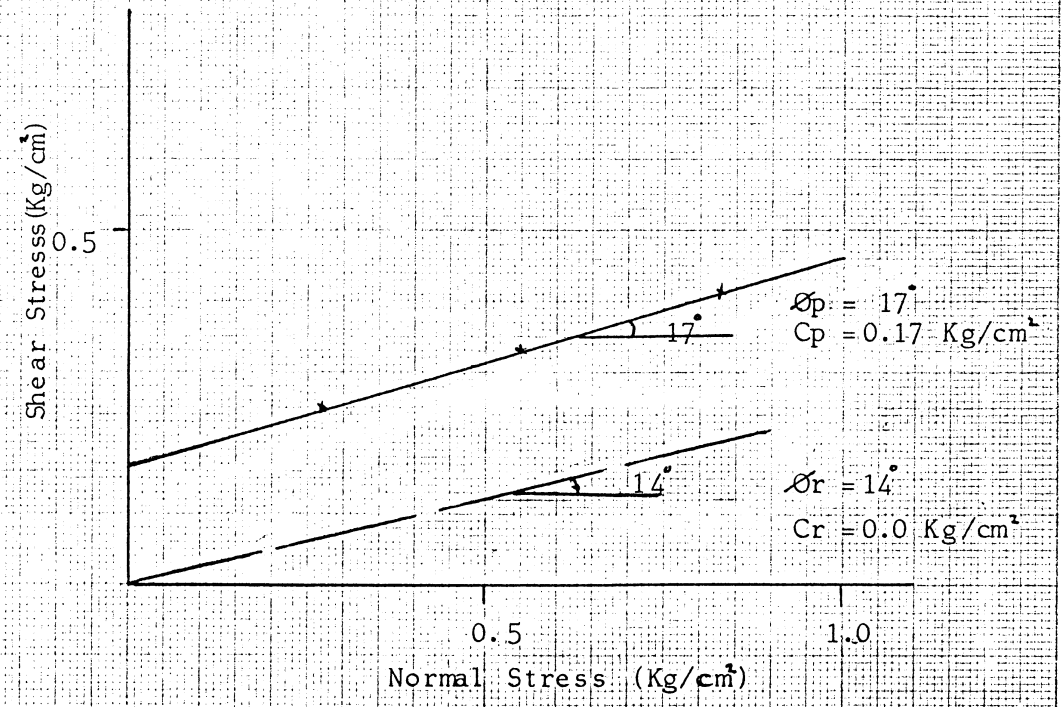


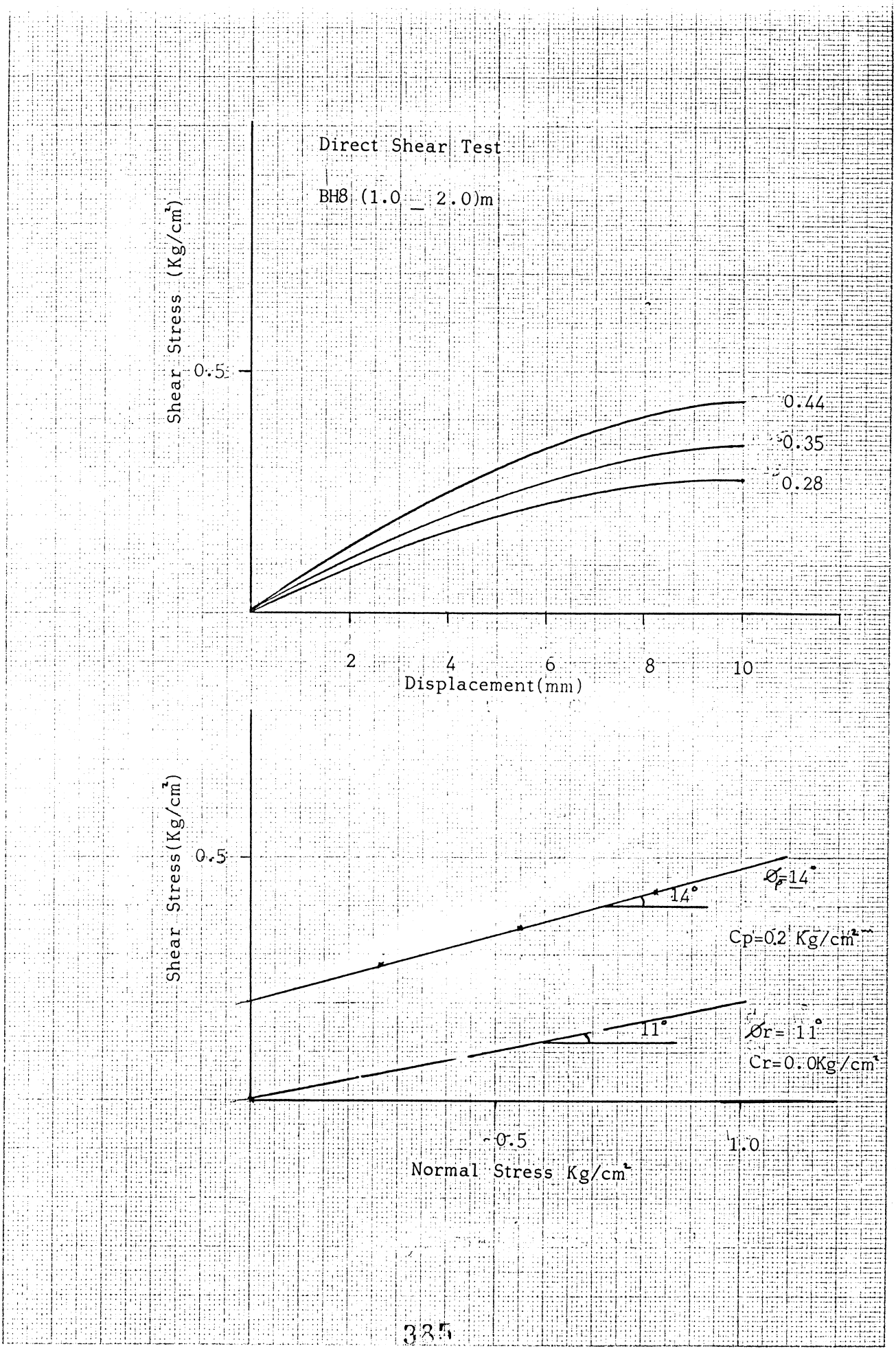
Remarks:

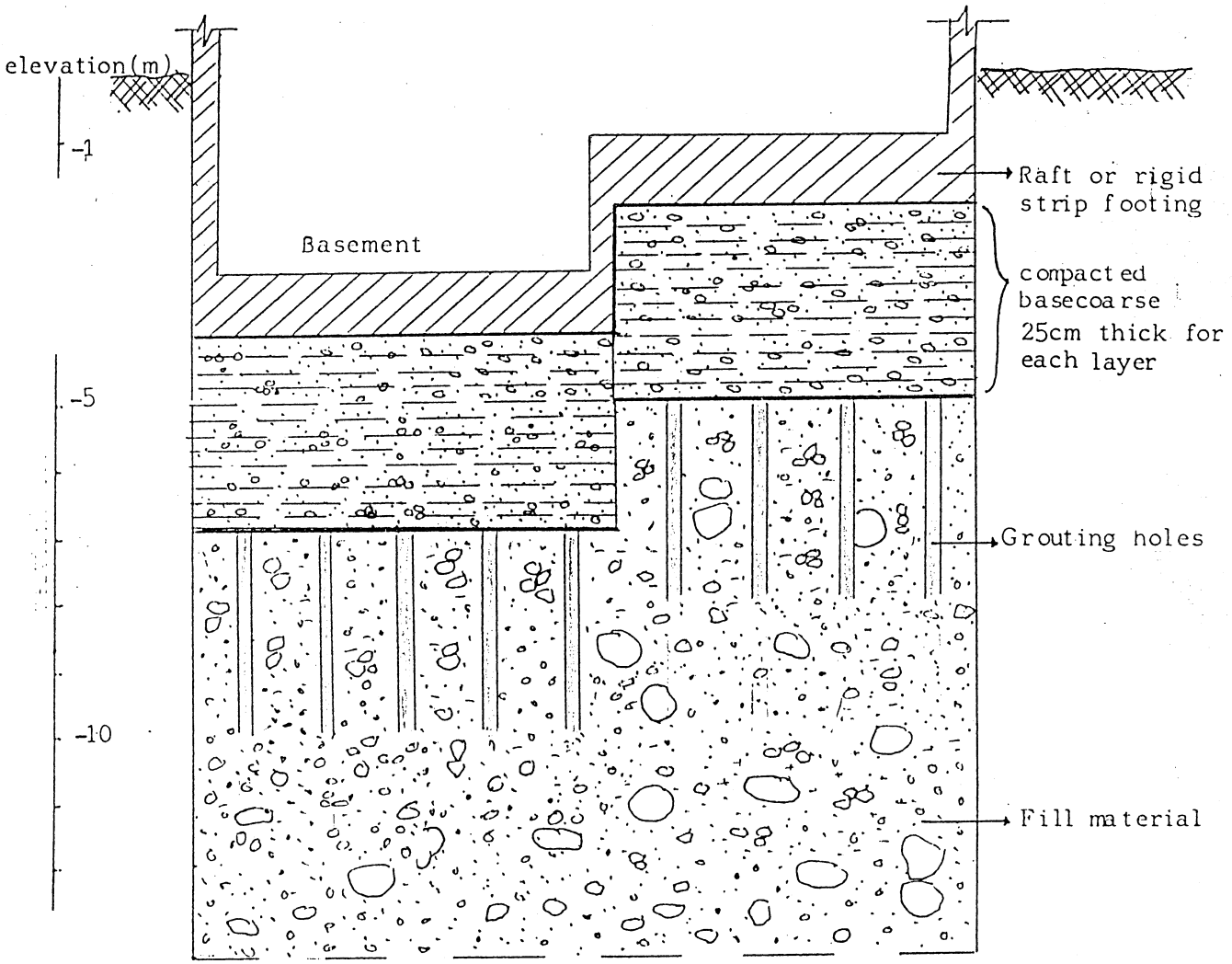
Direct Shear Test

BH3 (1.0 2.0)m

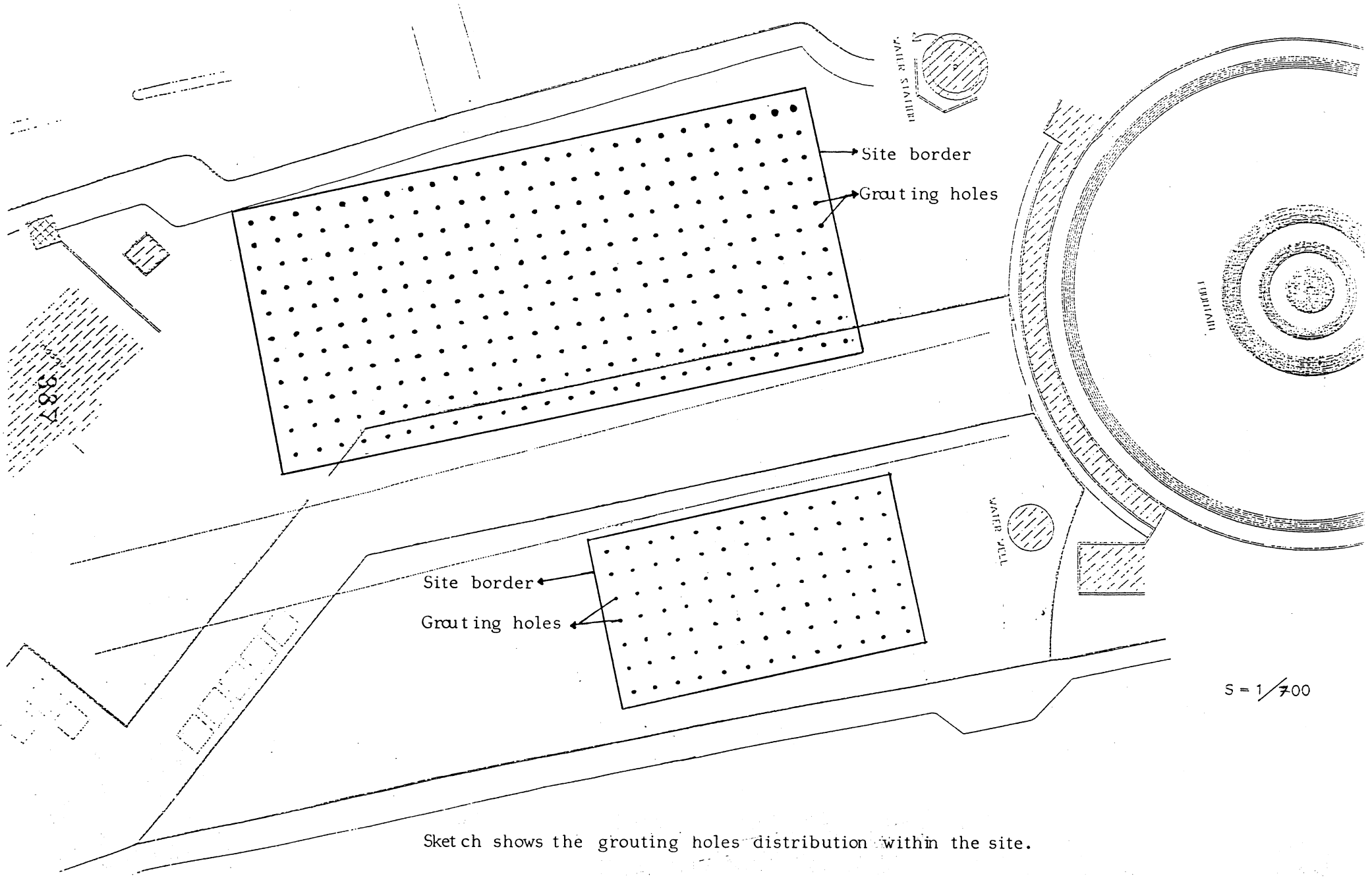





Direct Shear Test
BH8 (1.0 _ 2.0)m
Shear Stress (Kg/cm²)
0.5
0.44
0.35
0.28
2
4
6
8
10
Displacement(mm)
Shear Stress(Kg/cm²)
0.5
14°
Øp=14°
Cp=0.2 Kg/cm²
11°
Ør= 11°
Cr=0.0Kg/cm²
0.5
1.0
Normal Stress Kg/cm²



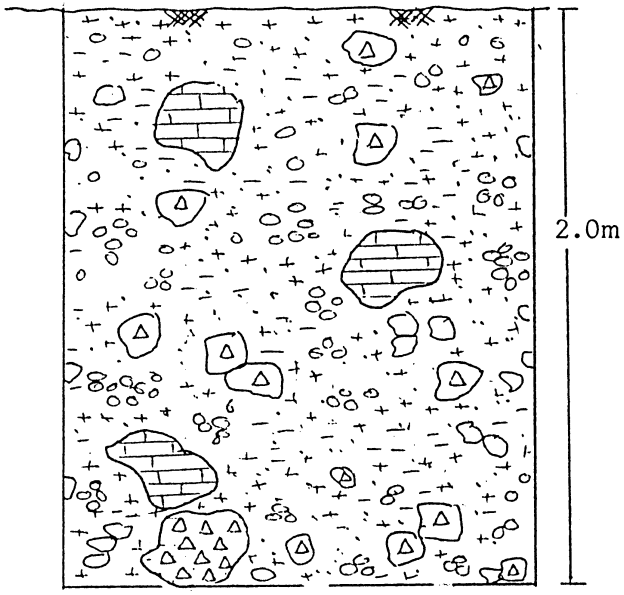
Sketch Shows the treatment stages of alternative (B) for the ground.



Sketch shows the grouting holes distribution within the site.

Material discreption

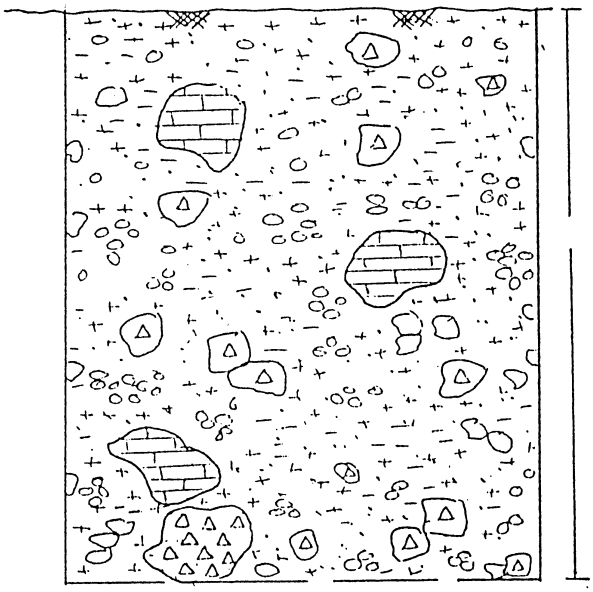
Brown sandy silty clay with gravels, cobbles and some boulders of chert and limestone.



Cross section in test pit No.1

Material discreption

Brown sandy silty clay with gravels, cobbles and some boulders of chert and limestone.



Cross section in test pit No. TP2