BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR BRIDGE CONSTRUCTION
IN RURAL REGION
IN
GEOLOGICAL SURVEY

MAY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

SUBSURFACE INVESTIGATION REPORT FOR THE BASIC DESIGN STUDY ON THE PROJECT FOR BRIDGE CONSTRUCTION IN RURAL REGION IN NORTHEAST THAILAND

1. INTRODUCTION

This report presents a preliminary subsurface investigation data for foundation design of ten (10) proposed bridges in rural region in Northeast of Thailand as listed in Table 1 under the Japan International Cooperation Agency (JICA). Locations of each bridgesite are shown in Fig.1. Test results in the field and in laboratory are shown in Boring Logs and Summary of Test Results in Appendix B and Appendix C respectively. Recommendations for foundation type of each bridge are given herein the report.

2. INVESTIGATION METHOD

2.1 Boring

Boring of 10 cm diameter were made by three rotary and one motorized drilling machines. The boreholes were drilled by power augering and percussion wash boring depending subsoil condition encountered. Three borings were made on each bridgesite down to hard stratum having SPT N-value of over 50 blows/30 cm.

2.2 Standard Penetration Test (SPT)

The standard penetration test was performed conforming to ASTM D 1586-67 at an interval of 1.00 m. The test was performed by driving a split spoon barrel of 5 cm. outside diameter into the soil by a 63.6 kg drop hammer free falling through a distance of 76 cm. Number of blows were recorded at

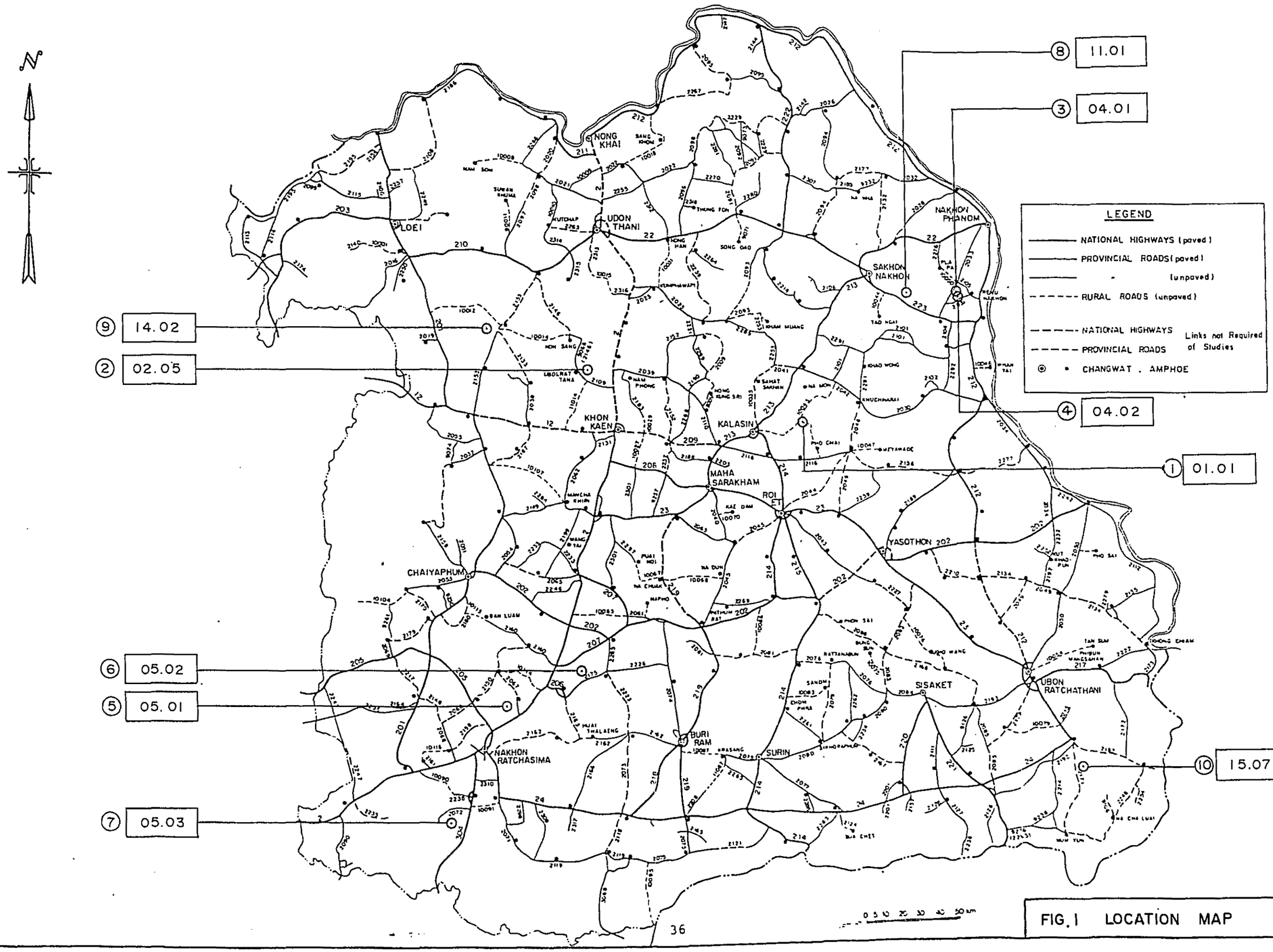


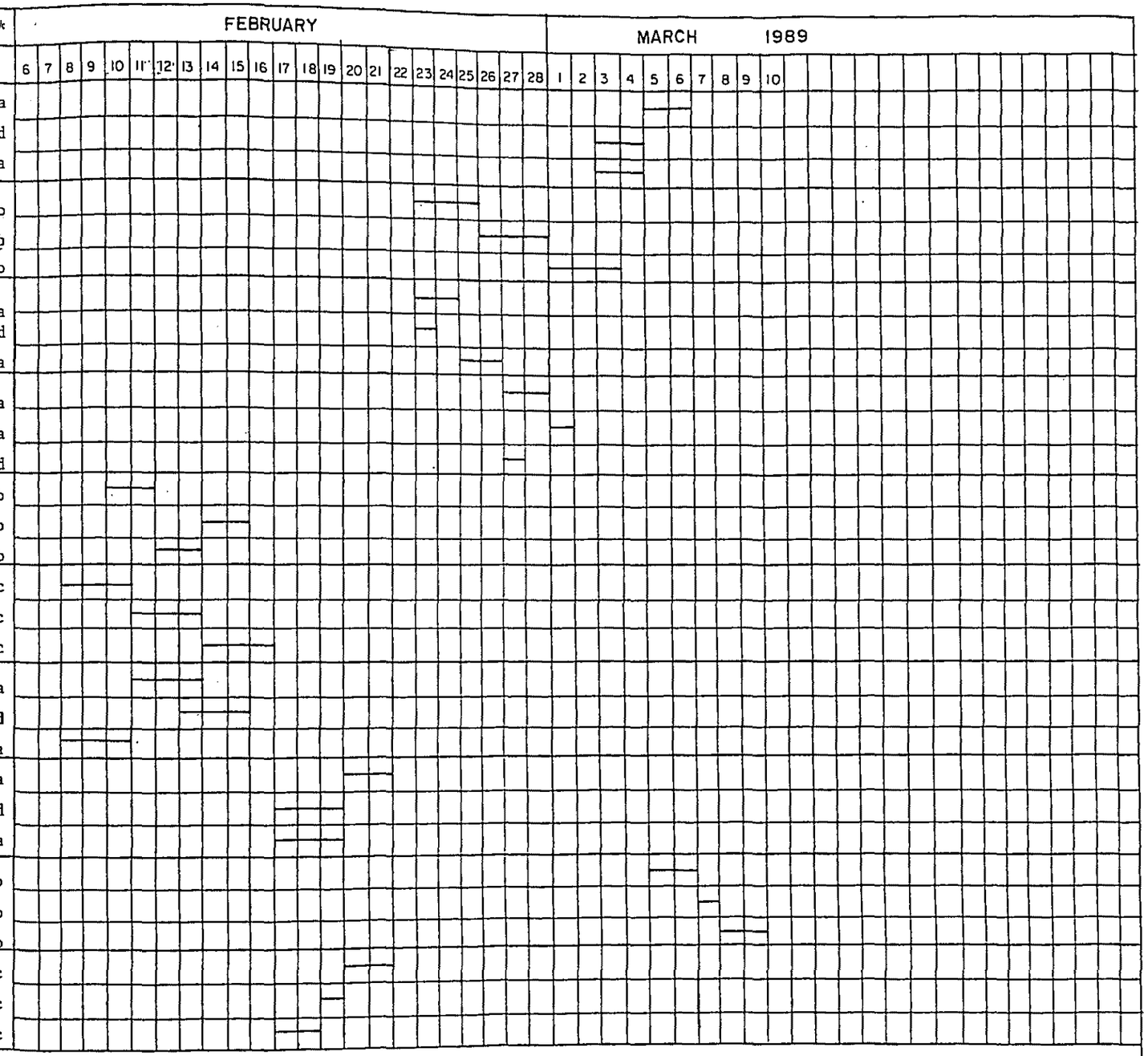
FIG. 1 LOCATION MAP

TABLE.1 BORING QUANTITY LIST.

NO.	BRIDGE NO.	BRIDGE NAME	LOCATION (CHANGWAT)	BORING NO.	BORING Depth (m.)	SPT.	LABORATORY TESTS Unit Weight	NMC.	LL.	PL.	Sieve	GS.	REMARKS
1.	01.01	HUAI KAE	Ban Kut Khlong-Ban Dan Tae Road (KALASIN)	1	11.03	11	3	5	1	1	3	4	SPT. : Standard Penetration Tests.
				2	9.05	9	2	4	-	-	4	2	NMC. : Natural Moisture Contents.
				3	10.40	10	5	5	-	-	5	4	LL. : Liquid Limit
2.	02.05	HUAI KHUM MUM	Km.6+250 Ban Huai Sai-Ban Kut Chiang Mee Road (KHON KAEN)	1	15.15	15	-	4	-	-	4	4	PL. : Plastic Limit
				2	20.35	20	-	4	-	-	4	4	GS. : Specific Gravity
				3	20.20	20	1	5	-	-	1	2	
3.	04.01	HUAI SOENG NO.1	Km.0+750 Rt. No.2031-Ban Bo Dok Son Road (NAKHON PHANOM)	1	10.05	10	1	4	1	1	2	2	
				2	4.15	4	1	2	1	1	1	1	
				3	10.03	10	2	3	2	2	1	2	
4.	04.02	HUAI SOENG NO.2	Km.1+150 Rt.No.2031-Ban Bo Dok Son Road (NAKHON PHANOM)	1	9.07	9	3	3	1	1	2	2	
				2	2.12	2	1	2	-	-	2	1	
				3	5.15	5	2	3	1	1	1	2	
5.	05.01	LAM KLANG	Ban Dan Khon Khob (NAKHON RATCHASIMA)	1	15.15	15	4	15	4	4	3	4	
				2	13.13	13	6	13	3	3	1	3	
				3	15.18	15	5	15	3	3	4	4	
6.	05.02	LAM NAM MUN	Ban Kham Klang (NAKHON RATCHASIMA)	1	20.45	20	9	9	1	1	5	5	
				2	27.45	27	11	11	4	4	5	7	
				3	20.45	20	9	11	1	1	5	5	
7.	05.03	LAM PHRA PHLOENG	Ban Phla Bung (NAKHON RATCHASIMA)	1	22.03	22	6	2	5	5	8	6	
				2	18.05	18	8	9	-	-	6	4	
				3	20.22	20	6	20	4	4	7	6	
8.	11.01	LAM NAM KAM	Km.3+200 Ban Khok Kong-Ban Phon Road (SAKHON NAKHON)	1	14.05	14	5	5	-	-	3	4	
				2	9.03	9	5	5	-	-	3	3	
				3	19.05	19	6	8	-	-	3	4	
9.	14.02	LAM NAM PHUAI	Km.5+650 A.Sibun Ruang-Ban Pa Kha Road (UDON THANI)	1	11.08	11	2	4	3	3	3	3	
				2	6.05	6	1	4	-	-	4	3	
				3	10.18	10	4	5	2	2	2	4	
10	15.07	LAM SOM NO.1	Km.1+225 Ban Nakae(Rt.No.2171)-Ban Sao Lao Road (UBON RATCHATHANI)	1	8.27	8	3	4	-	-	3	4	
				2	1.45	1	1	1	-	-	1	1	
				3	9.08	9	5	6	-	-	2	3	
		TOTAL		30	387.10	382	117	191	37	37	98	103	

TABLE. 2 WORK SCHEDULE

Bridge No.	Bridge Name	Location (Chang Wat)	Boring No.	Boring Depth (m.)	*
(1) 01.01	HUAI KAE	Ban Kut Khlong-Ban Dan Tae Road. (KALASIN)	1	11.03	a
			2	9.05	d
			3	10.40	a
(2) 02.05	HUAI KHUM MUM	KM.6+250 Ban Huai Sai-Ban Kut Chiang Mee Road (KHON KAEN)	1	15.15	b
			2	20.35	b
			3	20.20	b
(3) 04.01	HUAI SOENG NO.1	KM.0+750 Rt.No.2031-Ban Bo Dok Son Road. (NAKHON PHANOM)	1	10.03	a
			2	4.15	d
			3	10.03	a
(4) 04.02	HUAI SOENG NO.2	KM.1+150 Rt.No.2031-Ban Bo Dok Son Road. (NAKHON PHANOM)	1	9.07	a
			2	2.12	a
			3	5.15	d
(5) 05.01	LAM KLANG	Ban Dan Khon Khob (NAKHON RATCHASIMA)	1	15.15	b
			2	13.13	b
			3	15.18	b
(6) 05.02	LAM NAM MUN	Ban Kham Klang (NAKHON RATCHASIMA).	1	20.45	c
			2	27.45	c
			3	20.45	c
(7) 05.03	LAM PHRA PHLOENG	Ban Phla Bung (NAKHON RATCHASIMA).	1	22.03	a
			2	18.05	d
			3	20.22	a
(8) 11.01	LAM NAM KAM	KM.3+200 Ban Khok Kong-Ban Phon Road. (SAKHON NAKHON)	1	14.05	a
			2	9.03	d
			3	19.05	a
(9) 14.02	LAM NAM PHUAI	KM.5+650 A.Si Bun Ruang-Ban Pa Kha Road. (UDONTHANI)	1	11.08	b
			2	6.05	b
			3	10.18	b
(10) 15.07	LAM SOM NO.1	KM.1+225 Ban Na Kae(Rt.No.2171) Ban Sao Lao Road. (UBON RATCHATHANI)	1	8.27	c
			2	2.00	c
			3	9.08	c
	TOTAL		30	387.63	



* NOTE.-

TEAM a: LD-7 TEAM MEMBERS.-

TEAM b: LD-9 1-Operator

TEAM c: LD-8 2-Asst. Operator

TEAM d: M -1 1-Helper

1-Driver

APPENDIX A

SOIL PROFILE

- TABLE 3 -

DRILLING EQUIPMENT SPECIFICATIONS

1. Manufacturer's Designation : LD-7
   - No. of Units : 1
   - Make : ACKER DRILL CO., INC. USA.
   - Capacity : 150 M. with "AW" Rods and Standard Accesories.
   - Drilling Method : Rotary Drilling, Coring, Wash Boring

2. Manufacturer's Designation : LD-8
   - No. of Units : 1
   - Make : ACKER DRILL CO., INC. USA.
   - Capacity : 150 M. with "AW" Rods and Standard Accesories.
   - Drilling Method : Rotary Drilling, Coring, Wash Boring

3. Manufacturer's Designation : LD-9
   - No. of Units : 1
   - Make : ACKER DRILL CO., INC. USA.
   - Capacity : 200 M. with "AW" Rods and Standard Accesories.
   - Drilling Method : Rotary Drilling, Coring, Wash Boring

4. Manufacturer's Designation : M-1
   - No. of Units : 1
   - Make : ACKER DRILL CO., INC. USA.
   - Capacity : 30 M. with "AW" Rods.
   - Drilling Method : Wash Boring.

Note :

- Drilling Rods Size : AW
- Sampler Used : 50.0 Cm. O.D. Split Spoon
- Weight of Hammer : 63.6 Kg.
- Casing Size : NW.

every 15 cm. of penetration until either 45 cm. have been penetrated or 50 blows have been applied. The first 15 cm. of penetration is considered to be a seating and the sum of blow required for the second and third 15 cm. of penetration is termed the standard penetration resistance (SPT N-value). Disturbed soil samples from the standard penetration test were kept closely in plastic bags and glass bottles to prevent a loss of moisture content. Soil samples in glass bottles were kept in wooden boxes for each boring and sent to Public Work Department (PWD).

2.3 Groundwater Level Observation

Groundwater level of each boring was observed after the boring was finished about 24 hours or more. The depth of groundwater is referred to the existing ground serface at each boring and given in Boring Logs and in Summary of Test Results. The minus sign indicates that groundwater level is lower than the existing ground surface and the plus sign indicates that the groundwater level is above the existing ground surface.

2.4 Laboratory Tests

Representative soil samples of each layer are selected to be tested as follows.

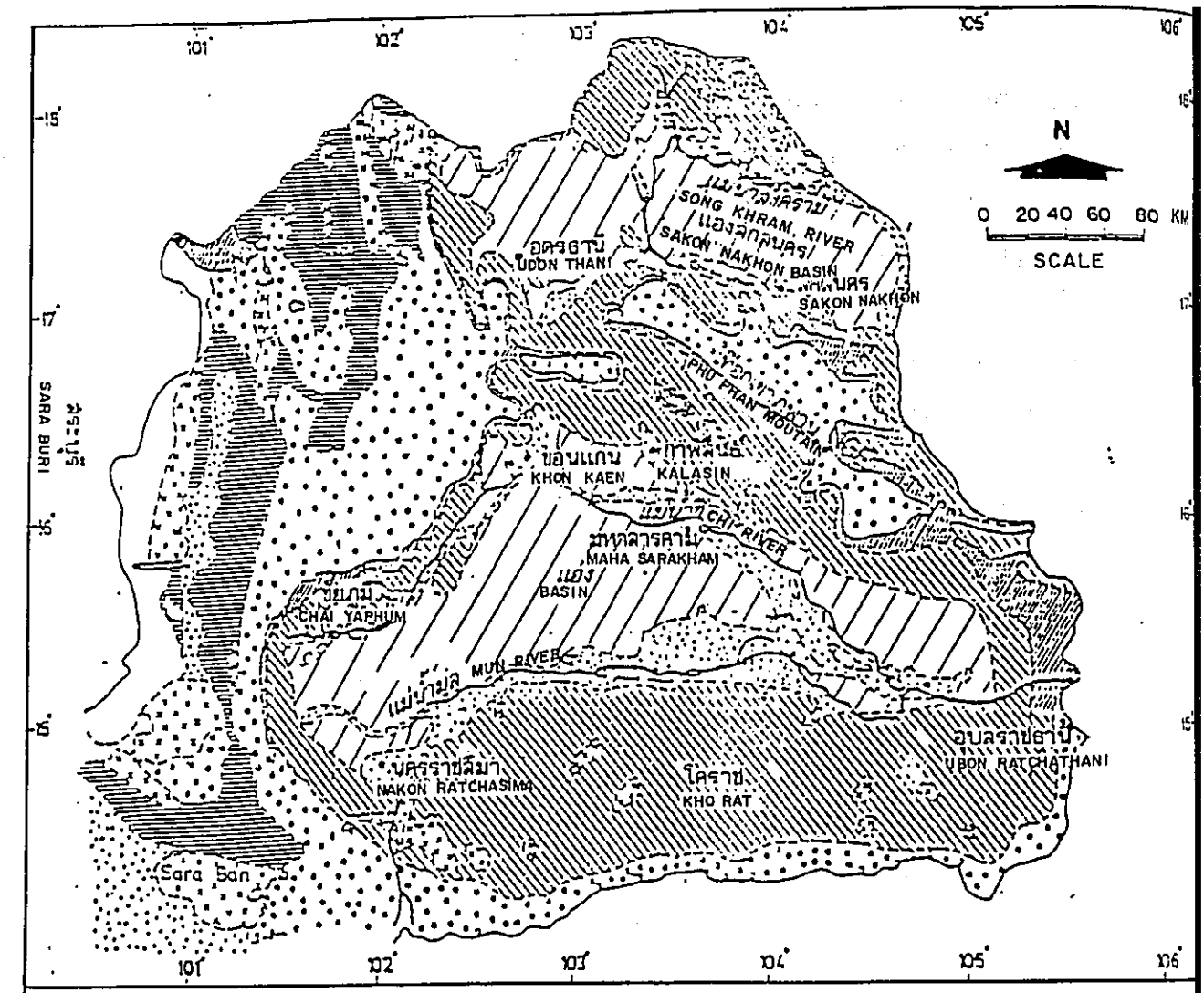
- Unit weight test
- Natural moisture content test
- Atterberg limits test (Liquid & Plastic Limit)
- Sieve analysis
- Specific gravity test

3. TOPOGRAPHY AND GEOLOGY IN NORTHEAST THAILAND

3.1 Topography

The northeast portion of Thailand is an elevated portion of the country, cover approximately 155,000 sq.km. It is bordered on the west and south by marginal escarpments which rise as high as 900 meters above sea level. The interior of the region is structurally divided into two large basins, namely the Sakhon Nakhon and Khorat Basin, by Phu Phan uplifted mountain range. The general surface of the region is slightly tilted from the western and northern boundaries to the southeast and, except the Phu Phan range, is characterized by a monotonous undulating to nearly flat plain dotted with monadnock, cuesta and swamps. The average height of the interior of the region is about 170 meters above sea level. The term "Plateau" is used for naming this region but technically the term has no meaning relevant to the structure of the region. It was apparently adopted because of the aforementioned western and southern escarpments that bordered the region which makes the region look resemble to plateau.

In general, the region is drained by three main rivers, one for Sakon Nakhon Basin in the north, and the other two for Khorat Basin in the south. For Sakon Nakhon Basin Mae Nam Songkhram and it's tributaries constitute a major drainage system whilst Mae Nam Chi and Mae Nam Mun are responsible for draining of the Khorat basin. Roughly most of the river flows across the region from the west marginal escarpment to the east and/or southeast and enters the Mae Khong River at the border of Thailand.



SYMBOLS

- QUATERNARY SEDIMENTS
- TERTIARY IGNEOUS ROCKS
- MAHA SARAKHAM FORMATION — TERTIARY / CRETACEOUS
- KHOK KHRUAT FORMATION — CRETACEOUS
- PHU PHAN FORMATION — CRETACEOUS
- JURASSIC AND SEDIMENTARY
- PALEOZOIC METAMORPHIC AND SEDIMENTARY ROCK , AND TRIASSIC IGNEOUS ROCK

KHORAT GROUP

MESOZOIC

FIG. 2 GEOLOGICAL MAP OF THE NORTHEAST_ THAILAND

3.2 Geology

Based on the geological map as shown in Figure 1, the Northeast Thailand lies on the continental Mesozoic sedimentary rocks, the Khorat Group, and the Quaternary deposits. The Khorat Group was uplifted and gently folded in late Tertiary to early Pleistodene time to form the broad syncline and a hill range on the south and the west.

The stratigraphy can be summarized from the older to the younger rock formations as follows :

(1) Huai Hin Lat Formation - This formation contains a basal polymictic conglomerate overlain by the sequence of gray to dark gray sandstone, siltstone, shale and limestone conglomerate.

(2) Nam Phong Formation - This formation consists of soft red to pale red siltstone and interbedded thick resistant beds of brownish red sandstone and conglomerate

(3) Phu Kradung Formation - The formation is characterized by predominantly soft, micaceous, reddish brown and grayish red siltstone; pale red, fine to very fine grained, well cemented calcareous sandstone; and interbedded and micaceous siltstone and sandstone.

(4) Phra Wihan Formation - This formation consists of massive, resistant, white to pink-coloured sandstone and some thin interbedded red siltstone and conglomerate.

(5) Sao Khua Formation - This formation is mainly the less resistant, reddish brown-coloured siltstone lying in between the more resistant, yellowish gray to brown or pale red sandstone.

(6) Phu Phan Formation - This formation is composed of massive beds of light-coloured, coarse to fine grained pebbly sandstone, and interbedded shale, siltstone and conglomerate.

(7) Khok Kruat Formation - This formation contains interbedded moderate consolidated red siltstone, moderately resistant white to red quartz sandstone and caliche conglomerate (buckshot conglomerate). In the upper part of the formation has thin layers and/or crystals of gypsum.

(8) Maha Sarakham Formation - This formation consists of distinguished three layers of rock salt: halite, carnellite and sylvite with subordinate anhydrite and gypsum, and two interbedded units of terrigenous red claystone, shale, siltstone, and fine-grained sandstone.

(9) Phu Pok Formation - This formation was believed to be eolian deposits and comprises very large-scaled cross bedding sandstone and small-scaled wavy bedding sandstone. Sandstone is red-coloured, fine grained, well sorted, and friable. The occurrence of the formation is only in the northern corner of the region.

(10) Quaternary Deposits - The Quaternary deposits are usually both fluviatile and eolian origins. The fluviatile deposit occurs in the vicinity of large rivers and of old river terraces and consists of gravel, sand, silt, and clay. The eolian deposit is generally yellow to red silty sand, loessial soil. Another Quaternary formation is laterite, loose form and continuous duricrust, which ofter occupy the topmost part of terraces and bedrocks.

(11) Volcalic Rocks - The volcanic rocks on the Khorat Plateau are the Tertiary basalts overlying the topmost part of the Khorat Group in the Southern part of the Plateau. The alkali basalt which is Hawaiite type extruded as lava flows and some places with minor eruptions throwing volcanic bomes which are fownd at Khao Kradung in Buri Ram province. The age of the basalt is in the range 0.92-3.8 million years.

4. SUBSOIL CONDITIONS AND FOUNDATION RECOMMENDATION

Subsoil conditions of each bridgesite are shown in Soil Profile (see Appendix A) and in Boring Logs (see Appendix B). Laboratory test results are summarized in tabular form in Appendix C. Explanation of subsoil conditions and foundation recommendation for preliminary design are described in the following pages.

BRIDGE NO.01.01

HUAI KAE BRIDGE

BAN KUTKLONG - BAN DAN TAE ROAD

A.MUANG, KALASIN

SUBSOIL CONDITIONS

The upper layers of soil are weak to medium strong which can be seen from SPT N-value varing from 3-30 blows/30 cm. These soil layers are loose to medium dense silty fine sand and very stiff fine sandy clay. Very strong layers of hard sandy clay and dense to very dense silty to clayey fine sand having SPT N-value of over 50 blows/ft. are encountered beneath the upper weak to medium strong soil starting from 8.00 m, 5.00 m. and 6.00 m. in BH-1, BH-2 and BH-3 repectively down to the bottom of boreholes.

FOUNDATION RECOMMENDATION

Pile foundation is recommended to be used at this site. Driven concrete with adequate steel reinforcement at tip is recommended to prevent damage of the tip during hard driving in very strong soil layer. Pile tip depth should be at 8.50 m., 5.00 m. and 6.00 m. depth from the existing ground serface in BH-1, BH-2 and BH-3 respectively.

BRIDGE NO. 02.05

HUAI KHUM MUN BRIDGE

KM.6+250 BAN HUAI SAI - BAN KUTCHIANG MEE ROAD

A. UBON RATTANA, KHON KAEN

SUBSOIL CONDITIONS

In BH-1, the subsoil is predominantly sand interbedded by soft fine sandy clay between 1.50-2.50 m. depth. From 0.00-8.00 m. depth the soil is weak and becoming to medium dense clayey fine sand between 8.00-10.00 m. depth. Strong layer of dense to very dense fine sand is encountered from 10.00 m. to the depth beyond the bottom of borehole of 15.15 m. depth.

In BH-2, the subsoil can be divided to 3 layers which are loose to medium dense silty fine sand in the uppermost from 0.00-6.00 m. depth, dense to very dense silty fine sand from 6.00-13.75 m. depth and hard clay from 13.75 m. depth to the depth beyond the bottom of borehole of 20.35 m. depth.

In BH-3, soft to medium and stiff sandy clay and medium dense to dense and very dense sand are encountered layers by layers. Weak soil is encountered between 2.00-4.00 m. depth and medium strong soil is encountered down to 12.00 m. depth. Beneath 12.00 m. depth, the soil is very strong except between 14.70-16.30 m. depth which is medium strong.

FOUNDATION RECOMMENDATION

Pile foundation is recommeded to be used at this site. Driven concrete pile with adequte steel reinforcement at tip is more preferable than steel pile because the major pile capacity is end bearing. The tip of pile is recommended to be at 10.00 m., 6.00 m. and 12.00 m. depth from the existing ground surface at BH-1, BH-2 and BH-3 respectively.

BRIDGE NO. 04.01

HUAI SOENG NO.1 BRIDGE

KM.0+750 RT. NO. 2031 - BAN BO DOK SON ROAD

A. NA KAE, NAKHON PHANOM

SUBSOIL CONDITIONS

Soft to medium clay layer having SPT N-value from 2-17 blows/30 cm. is encountered in the upper portion down to 5.00 m., 3.80 m. and 5.00 m. in BH-1, BH-2 and BH-3 respectively. Beneath this soft to medium clay layer, very strong soil of hard sandy-gravelly clay (laterite) having SPT N-value of over 50 blows/30 cm. is encountered in every borehole down to the depth beyond the bottom of borehole.

FOUNDATION RECOMMENDATION

Pile foundation is recommended to be used at this site. Driven concrete pile with proper tip reinforcement is recommended because it is end bearing pile. Pile tip depth at 5.00 m., 4.00 m. and 5.00 m. depth from the existing ground surface in BH-1, BH-2 and BH-3 respectively.

BRIDGE NO. 04.02

HUAI SOENG NO. 2 BRIDGE

KM.1+150 RT. NO. 2031-BAN BO DOK SON ROAD

A. NA KAE, NAKHON PHANOM

SUBSOIL CONDITION

Medium to stiff clay having SPT N-value from 5-16 blows/30 cm. is encountered in the upper portion down to 3.80 m., 1.50 m. and 4.50 m. depth in BH-1, BH-2 and BH-3 respectively. Beneath the medium to stiff clay, the soil is very strong strata of very dense laterite having SPT N-value of over 50 blows/ 30 cm. throughout the bottom of borehole.

FOUNDATION RECOMMENDATION

Spread footing is recommended to be used at this site. Depth of the spread footing is recommended at 4.00m., 2.00 m. and 5.00 m. depth from the existing ground surface at BH-1, BH-2 and BH-3 respectively. The allowable bearing capacity of spread footing of 50 t/sq.m. at the recommended depth can be used in design.

BRIDGE NO.05.01

LAM KLANG BRIDGE

BAN DON KHON KHOB

A. NON SOONG, NAKHON RATCHASIMA

SUBSOIL CONDITIONS

Loose to medium dense clayey and silty fine sand and sandy soil are encountered in the uppermost from 0.00-6.50 m. depth in BH-1 and BH-3. Very strong strata of clayey sand, sandy clay and clay with SPT N-value greater than 50 blows/30 cm. are found beneath 9.50 m. and 10.00 m. in BH-1 and BH-3 respectively. SPT N-value in BH-1 tends to increase with depth, but in BH-3 it varies considerably in the upper portion between 0.00-6.50 m. depth then it also increases with depth.

In BH-2, stiff to very stiff and hard fine sandy clay is encountered from 0.00-9.00 m. depth with SPT N-value varying from 13-56 blows/30 cm. Beneath 9 m. depth, the soil is hard clay of SPT N-value greater than 50 blows/30 cm.

FOUNDATION RECOMMENDATION

Spread footing is recommended to be used at this site. Depth of spread footing should be placed at 3.00 m., 2.00 m. and 4.00 m.depth at BH-1, BH-2 and BH-3 respectively. The allowable bearing capacity of 20 t/sq.m. is recommended at the recommended depth.

BRIDGE NO. 05.02

LAM NAM MUN BRIDGE

BAN KHAM KLANG

A. PHIMAI, NAKHON RATCHASIMA

SUBSOIL CONDITIONS

Loose to medium dense sand layers are encountered in the upper portion down to 13.50 m., 13.00 m. and 8.35 m. in BH-1, BH-2 and BH-3 respectively. In BH-1 and BH-2, stiff clay having SPT N-value between 7-12 blows/30 cm. lies beneath the loose to medium dense sand layers down to 17.25 m. in BH-1 and down to 17 m. in BH-2 but it is not encountered in BH-3. The very strong strata of dense to very dense sand and hard clay are encountered at 19.00 m., 17.00m. and 8.35 m.in BH-1, BH-2 and BH-3 down to the depth beyond the bottom of every borehole.

FOUNDATION RECOMMENDATION

Pile foundation is recommended to be used at this site. Either driven concrete or steel pile can be used because it acts as friction - end bearing pile. Pile tip depth is recommended at 8.50 m., 5.00 m.and 8.50 m. depth from the existing ground surface in BH-1, BH-2 and BH-3 respectively.

BRIDGE NO. 05.03

LAM PHRA PHLOENG BRIDGE

BAN PHLA BUNG

A. PAK THONG CHAI, NAKHON RATCHASIMA

SUBSOIL CONDITIONS

Weak soil of soft fine sandy clay and loose clayey fine sand are encountered between 4.00-7.00 m. in BH-1 and between 0.00-2.00 m. depth in BH-2. Generally, the subsoils at this site are sandy clay and clayey sand layers of medium to high and very high SPT N-value. SPT N-values in the most depths are quite constant with depth. Very strong strata of sandy clay, clayey sand and sandstone having SPT N-value greater than 50 blows/30 cm. are encountered at 20.00 m., 18.00 m. and 20.00 m. depth in BH-1, BH-2 and BH-3 respectively.

FOUNDATION RECOMMENDATION

Pile foundation is recommended to be used in this site. Either driven concrete or steel pile can be used because the pile is friction-end bearing pile. The recommended tip depth is at 8.00 m., 7.00 m. and 10.00 m. depth from the existing ground surface at BH-1, BH-2 and BH-3 respectively.

BRIDGE NO. 11.01

LAM NAM KAM BRIDGE

KM.3+200 BAN KHOK KONG - BAN PHON ROAD

A. MUNAG, SAKON NAKHON

SUBSOIL CONDITIONS

Weak to medium strong soil of silty to clayey fine sand and sandy clay are encountered from the existing ground surface down to 11.00 m.depth in BH-1, down to 6.00 m. in BH-2 and down to 8.00 m.in BH-3. Then the soil changes to hard clay having SPT N-value greater than 50 blows/30 cm. starting from 11.00 m., 6.00 m. and 15.50 m. depth down to the depth beyond the bottom of borehole. In BH-3, very stiff to hard sandy clay is encountered between the weak and very strong strata from 8.00-15.00 m. depth but it is not encountered in BH-1 and BH-2.

FOUNDATION RECOMMENDATION

Pile foundation is recommended to be used at this site. Driven concrete pile with proper steel reinforcement at the tip should be preferable than steel pile because it is end bearing pile. The recommended tip depth is at 11.00 m., 6.00 m. and 8.00 m. depth in BH-1, BH-2 and BH-3 respectively.

BRIDGE NO. 14.02

LAM NAM PHUAI BRIDGE

KM.5+650 A. SI BUN RUANG - BAN PA KHA ROAD

A. SI BUN RUANG, UDON THANI

SUBSOIL CONDITIONS

The upper portion soil is weak to medium strong soil of sandy caly and sand down to 8.25 m., 5.00 m. and 7.00 m. depth in BH-1, BH-2 and BH-3 respectively. Beneath these soil strata, hard clay of SPT N-value of over 50 blows/30 cm. is encountered through the bottom of borehole. The soil strata in BH-1 is vary considerably at about 5 m. depth where SPT N-value drops to 1 blows/30 cm. while the nearby depth has SPT N-value of 19-24 blows/30 cm.

FOUNDATION RECOMMENDATION

Pile foundation is recommendation to be used at this site. Driven concrete pile with proper steel reinforcement at the tip is recommended because it is end bearing pile. Pile tip depth at 8.50 m., 5.00 m. and 7.00 m. depth at BH-1, BH-2 and BH-3 is recommended.

BRIDGE NO. 15.07

LAM SOM NO.1 BRIDGE

KM.1+225 BAN NA KAE (RT.NO.2171) - BAN SAO LOA ROAD

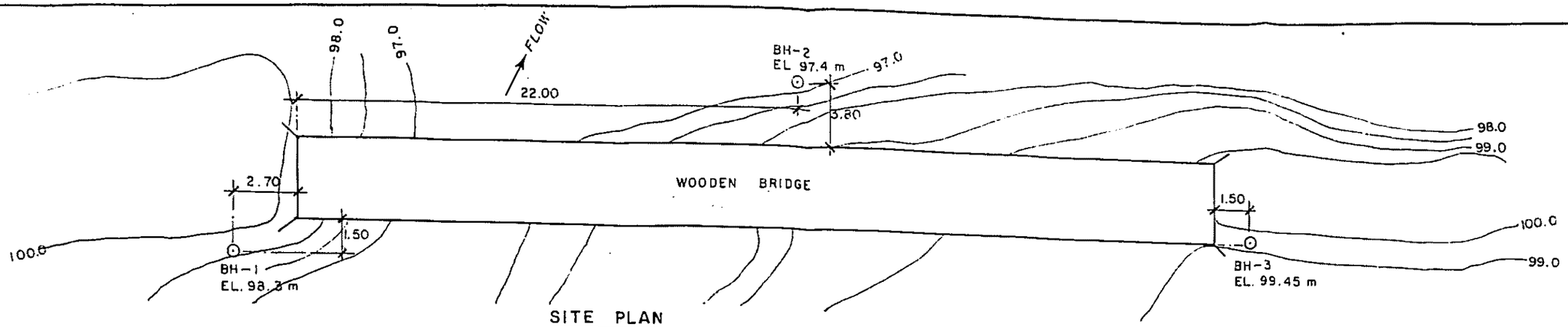
A. DET UDOM, UBON RATCHATHANI

SUBSOIL CONDITIONS

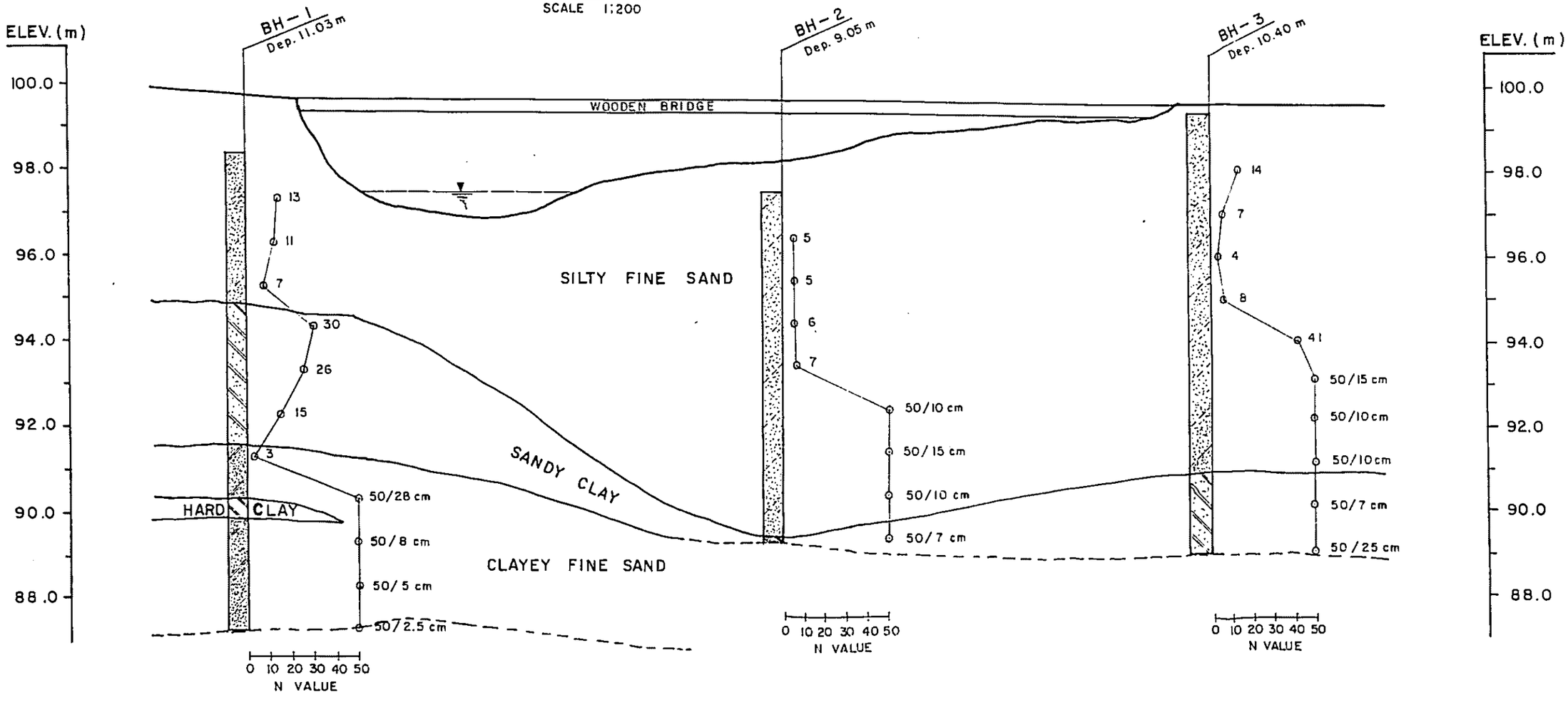
Laterite is encountered about 1 m. thick in BH-1 and BH-3 in the uppermost underlained by weak soil layers of sand and clay down to 7.50 m. and 8.20 m. depth in BH-1 and BH-3 respectively. Very dense siltstone of SPT N-value over 50 blows/30 cm. is encountered at 7.50 m., 1.35 m. and 8.20 m. depth in BH-1, BH-2 and BH-3 respectively.

FOUNDATION RECOMMENDATION

Both pile foundation and spread footing are recommended to be used at this site. For BH-1 and BH-3 pile foundation is to be used, but for BH-2 spread footing is to be used. Pile tip depth at 8.00 m. is recommended for both BH-1 and BH-3. At BH-2, depth of spread footing at 1.35 m. is recommended with the allowable bearing capacity of 50 t/sq.m.



SITE PLAN
SCALE 1:200



SCALE

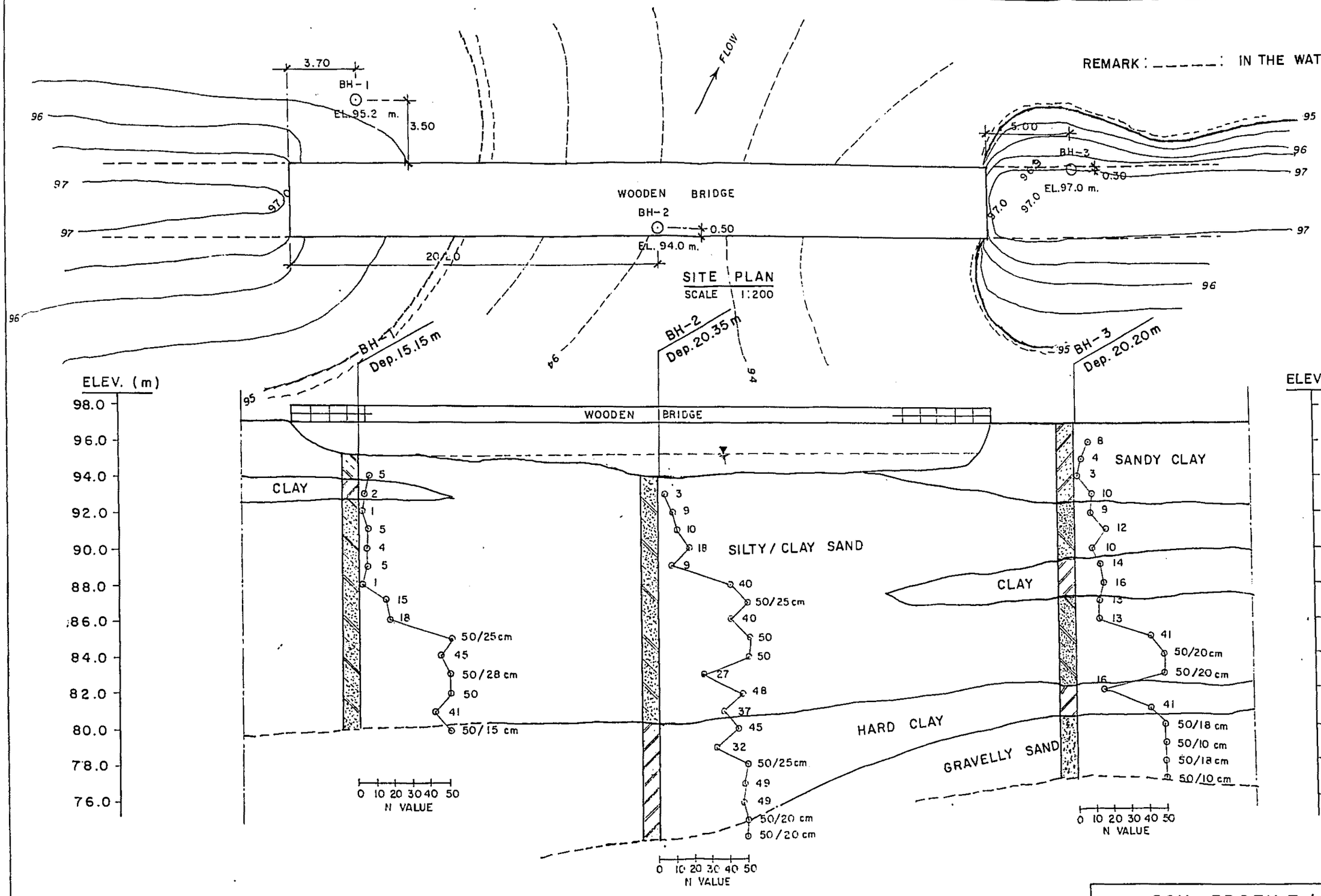
0 1 2 3 4 5 m
H = 1:200

0 1 2 3 4 m
V = 1:100

REMARK: ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

SOIL PROFILE (1/10)		
NO.	BRIDGE NO.	BRIDGE NAME
1	01.01	HUAI KAE

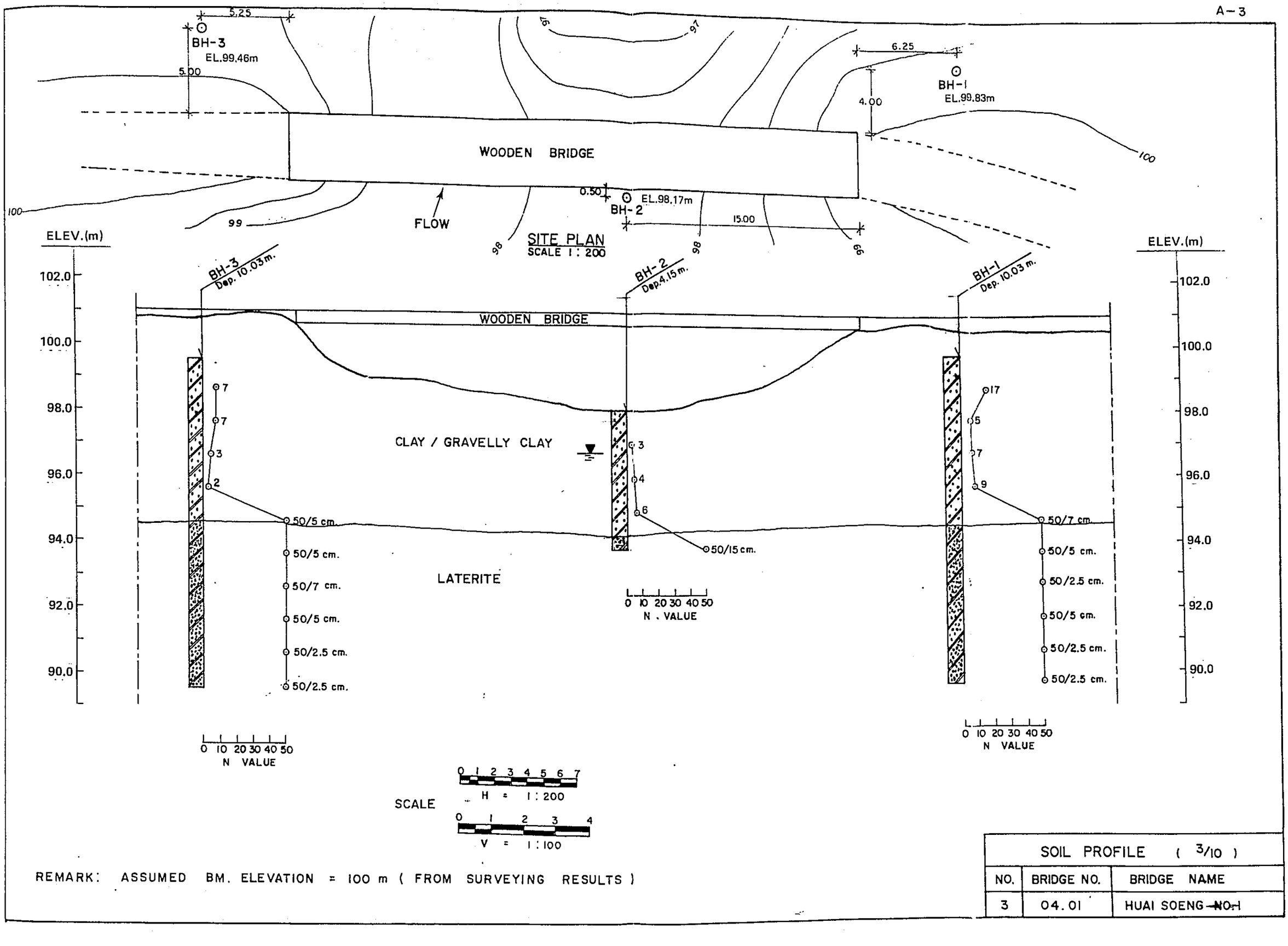
REMARK : _____ : IN THE WATER



SCALE
0 1 2 3 4 5 m
H = 1:200
V

REMARK: ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

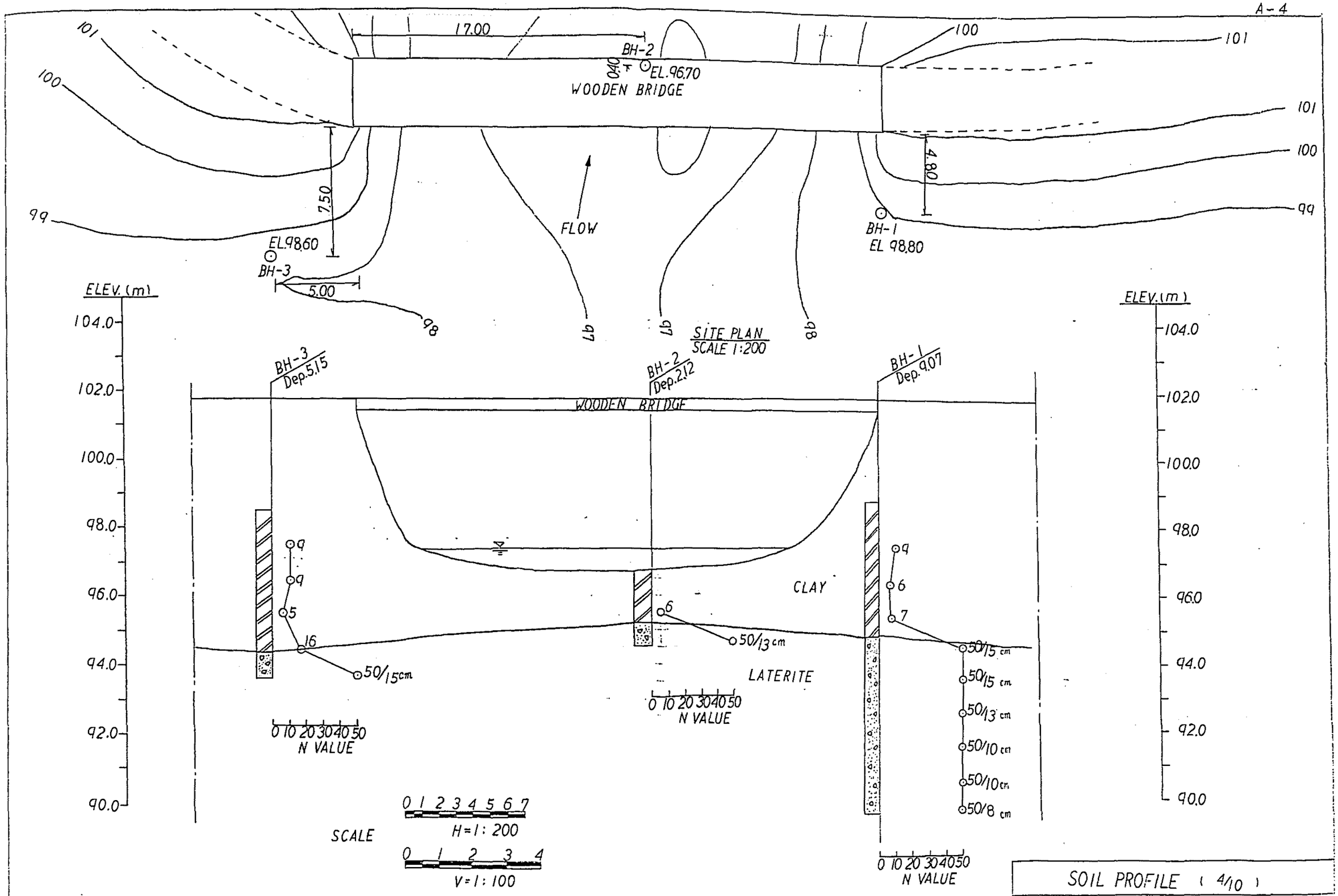
SOIL PROFILE (2/10)		
NO.	BRIDGE NO.	BRIDGE NAME
2	02.05.	HUAI KHUM MUN



REMARK: ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

SOIL PROFILE (3/10)

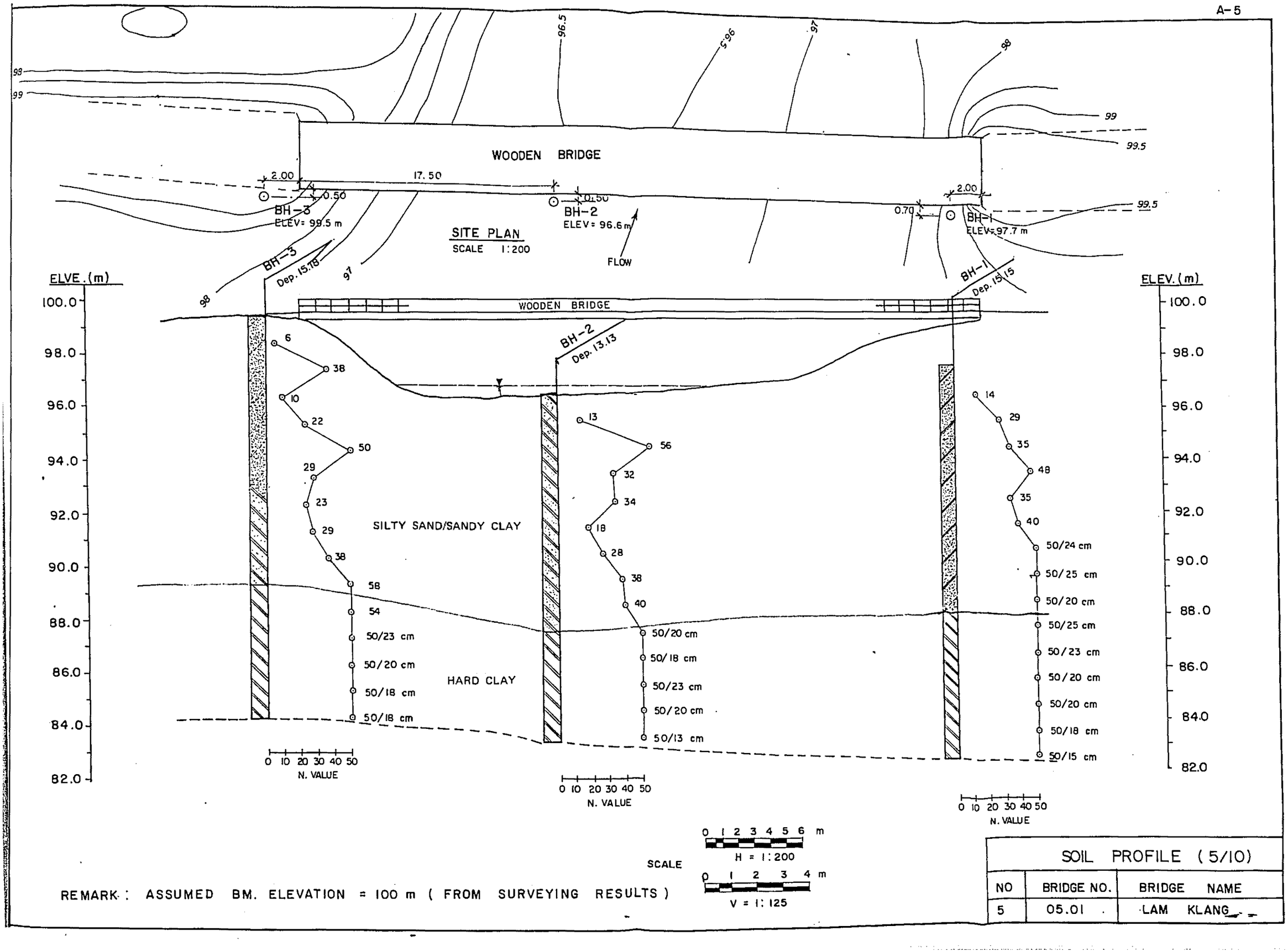
NO.	BRIDGE NO.	BRIDGE NAME
3	04.01	HUAI SOENG ~~NO.1~~



REMARK ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

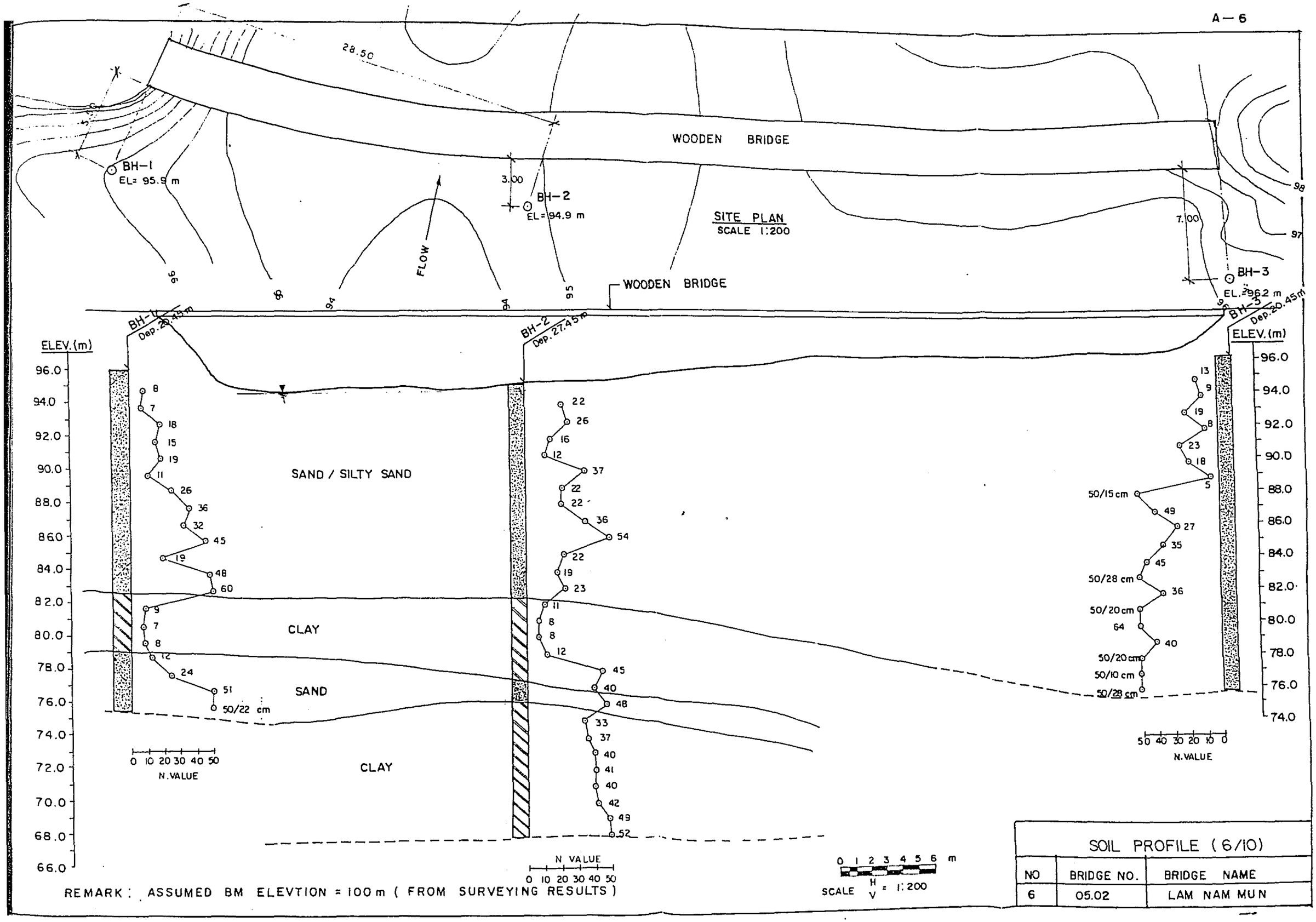
SOIL PROFILE (4/10)

NO	BRIDGE NO	BRIDGE NAME
4	04.02	HUAI SOENG NO.2



REMARK : ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

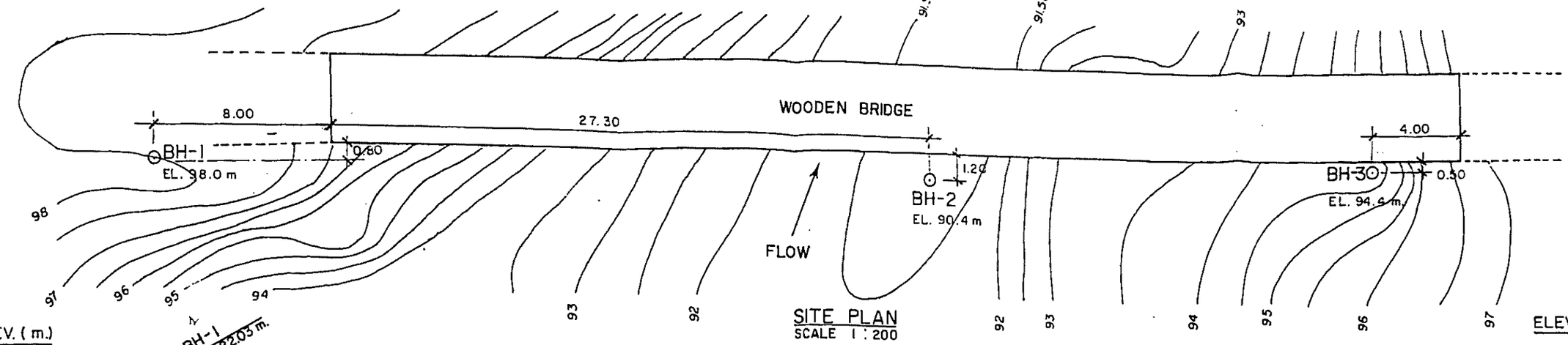
SOIL PROFILE (5/10)		
NO	BRIDGE NO.	BRIDGE NAME
5	05.01	LAM KLANG



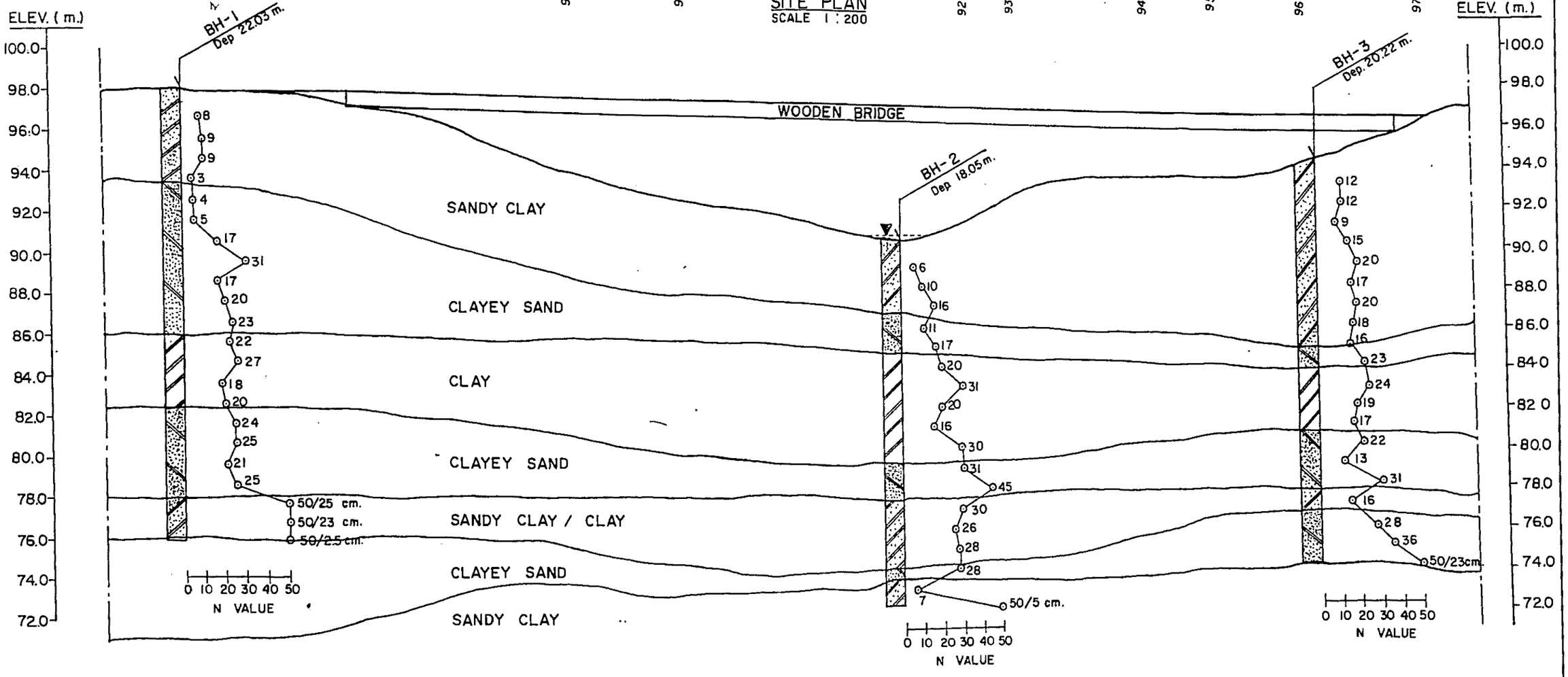
REMARK : ASSUMED BM ELEVTION = 100 m (FROM SURVEYING RESULTS)

SOIL PROFILE (6/10)

NO	BRIDGE NO.	BRIDGE NAME
6	05.02	LAM NAM MUN



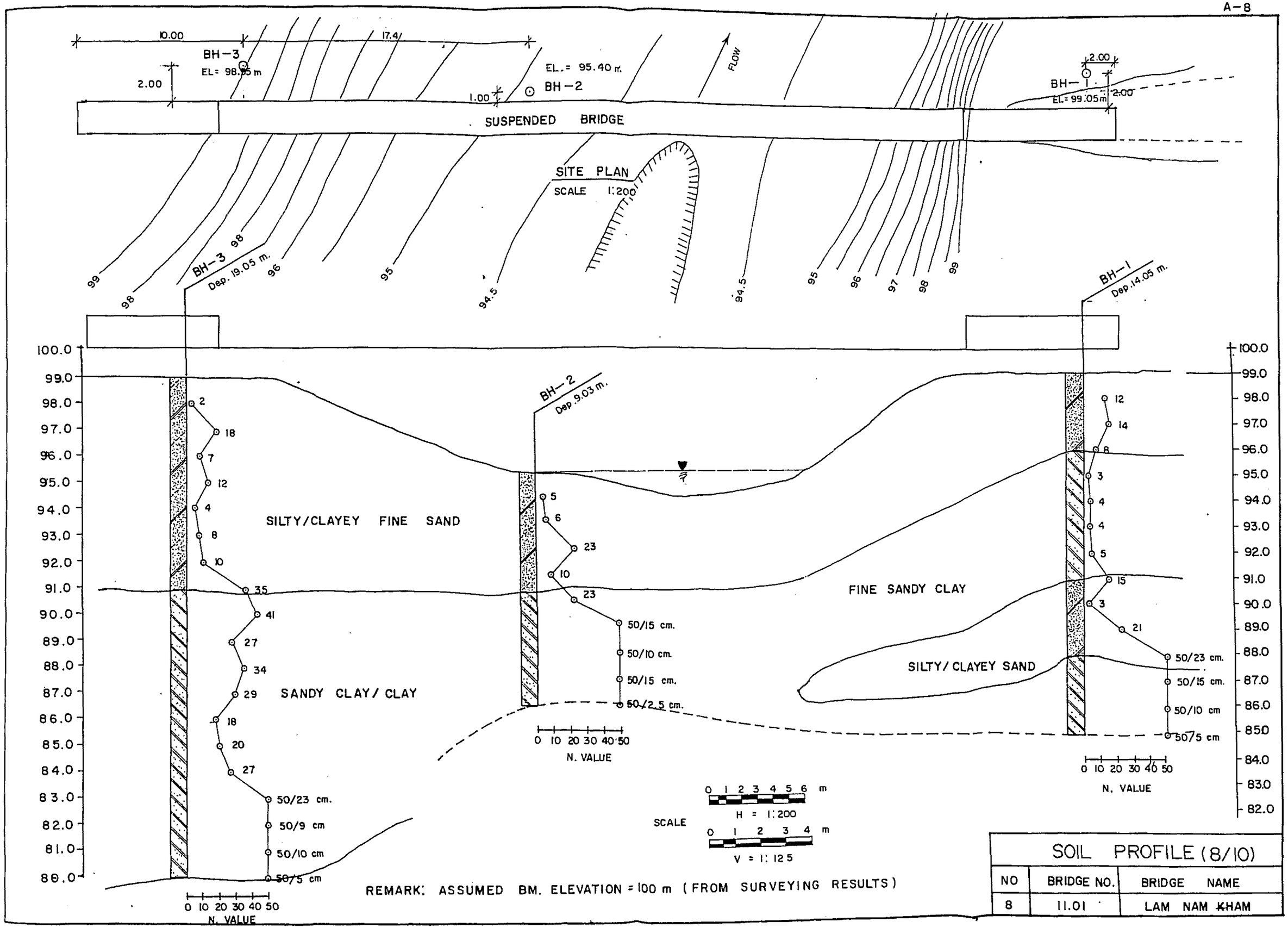
SITE PLAN
SCALE 1 : 200



SCALE
0 1 2 3 4 5 6 7
H
V = 1:200

REMARK: ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

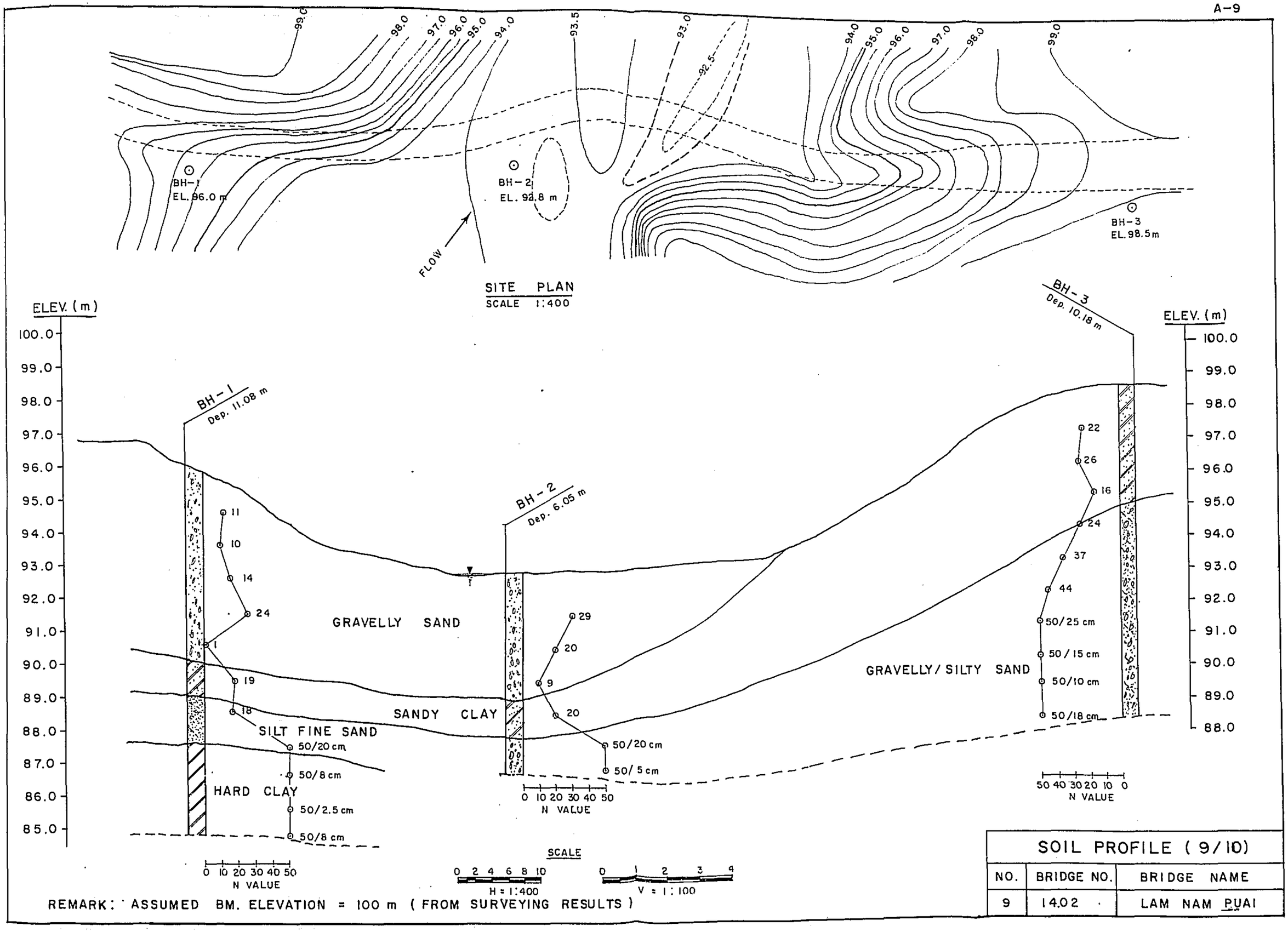
SOIL PROFILE (7/10)		
NO.	BRIDGE NO.	BRIDGE NAME
7	05.03	LAM PHRA PLOENG



REMARK: ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

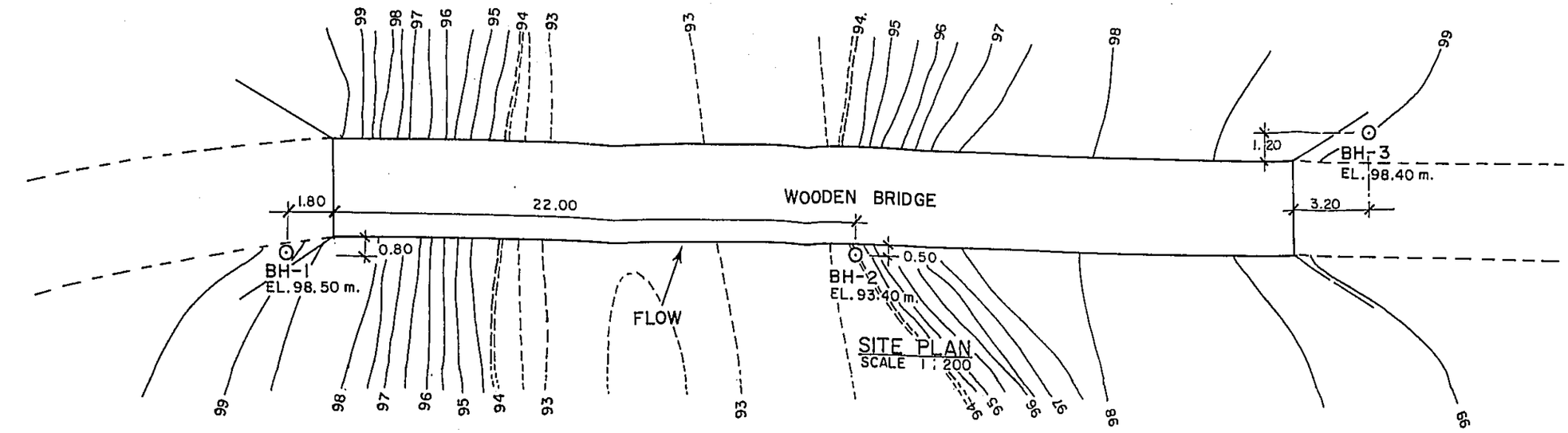
SOIL PROFILE (8/10)

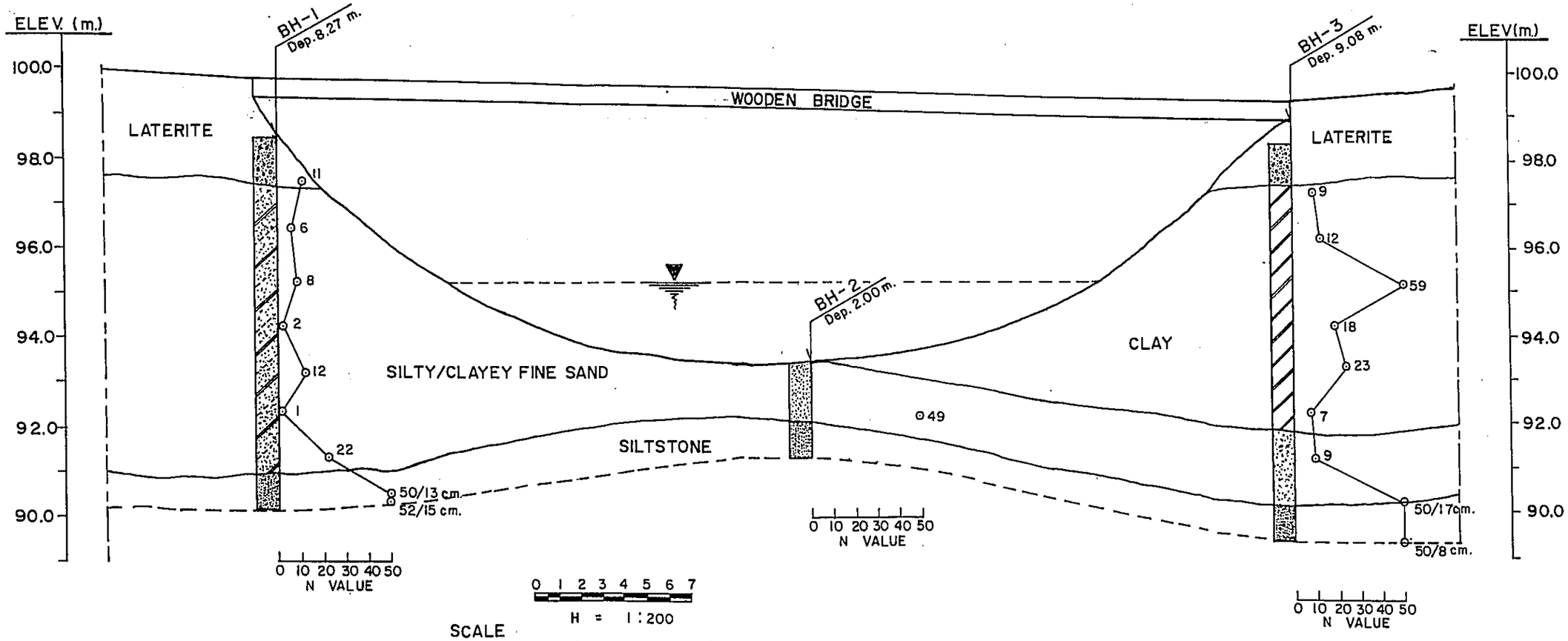
NO	BRIDGE NO.	BRIDGE NAME
8	11.01	LAM NAM KHAM



REMARK: ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

SOIL PROFILE (9/10)		
NO.	BRIDGE NO.	BRIDGE NAME
9	14.02	LAM NAM PUAI





REMARK: · ASSUMED BM. ELEVATION = 100 m (FROM SURVEYING RESULTS)

SOIL PROFILE (10/10)		
NO.	BRIDGE NO.	BRIDGE NAME
10	15.07 ·	LAM SOM NO.1

APPENDIX B

BORING LOGS

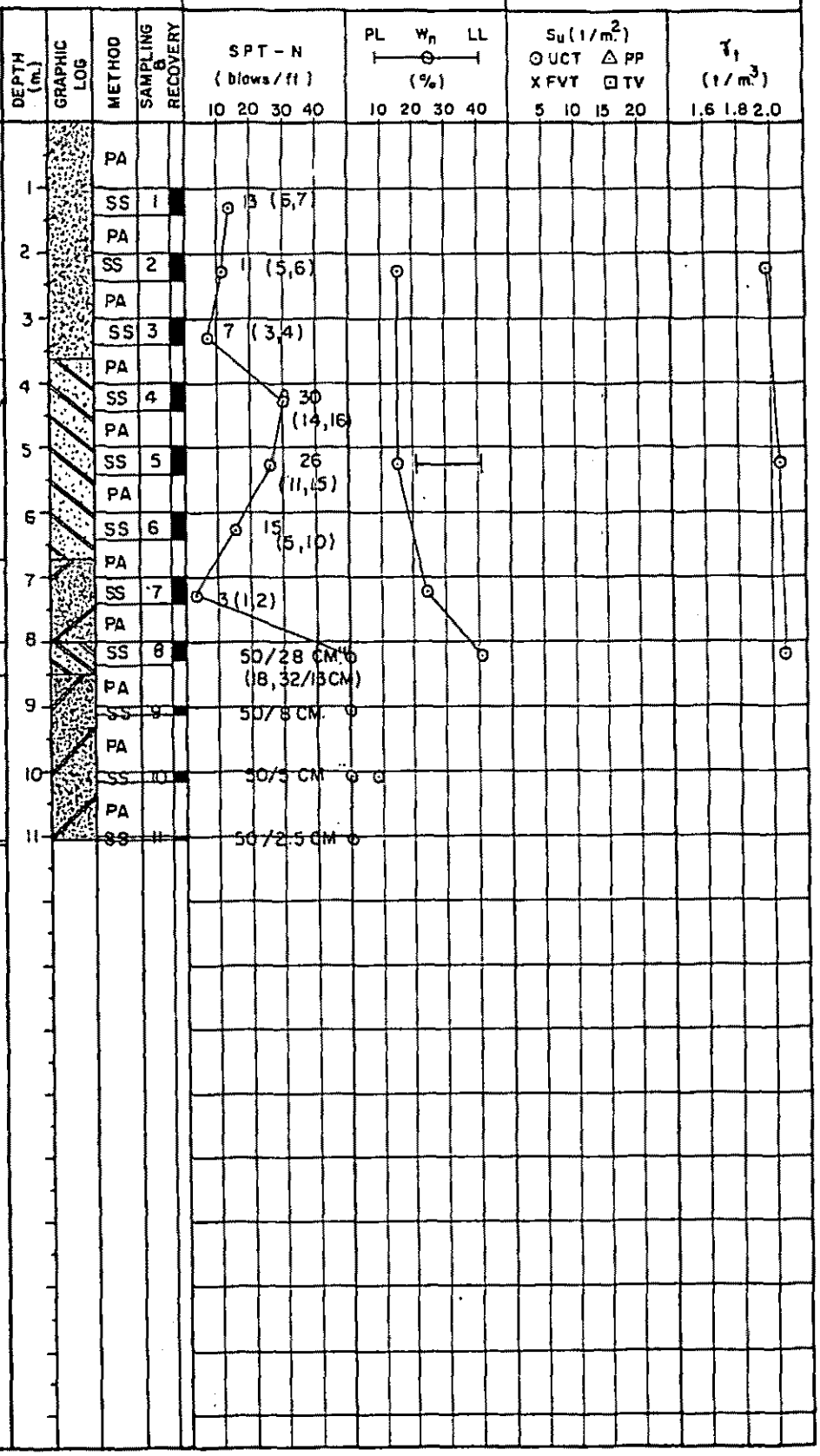
BORING LOG

PROJECT 01.01 HUAI KAE
LOCATION A. MUANG, KALASIN

BORING NO. BH-1
DEPTH (m.) 11.03
COORD. —

GROUND ELEV.(m.) 98.3
OBSERVED WL (m.) -2.00
DATE STARTED 5/3/89
DATE FINISHED 6/3/89

SOIL DESCRIPTION	DEPTH (m.)
LOOSE TO MEDIUM DENSE SILTY FINE SAND, LI-BROWN AND DARK BROWN (SM) (NO SALTY)	3.60
VERY STIFF FINE SANDY CLAY, GREYISH BROWN AND DARK BROWN (CL) (NO SALTY)	6.80
VERY LOOSE CLAYEY FINE SAND, DARK GREY (NO SALTY) (SC)	8.00
HARD SANDY CLAY, GREY AND DARK BROWN (CL) (NO SALTY)	8.50
VERY DENSE CLAYEY SAND, DARK BROWN AND REDDISH BROWN (NO SALTY) (SC)	11.03
END OF BORING	



BORING LOG

PROJECT 01.01 HUAI KAE
LOCATION A. MUANG, KALASIN

BORING NO. BH-2
DEPTH (m.) 9.05
COORD. —

GROUND ELEV.(m.) 97.4
OBSERVED WL (m.) 0.00
DATE STARTED 3/3/89
DATE FINISHED 4/3/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft)
LOOSE SILTY FINE SAND, BROWN AND GREYISH BROWN (SM) (NO SALTY)	0–4.50	WO / SS 1 / WO / SS 2 / WO / SS 3 / WO / SS 4		5 (2,3); 5 (2,3); 6 (3,3); 7 (3,4)
VERY DENSE SILTY FINE SAND, GREYISH BROWN AND BROWN (SM) (NO SALTY)	4.50–8.00	WO / SS 5 / WO / SS 6 / WO / SS 7 / WO / SS 8		50/10 CM; 50/15 CM; 50/10 CM.; 50/8 CM.
HARD FINE SAND CLAY, REDDISH BROWN (CL) (NO SALTY)	8.00–9.05	WO / SS 9		50/5 CM.
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ○ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m³) 1.6 1.8 2.0

BORING LOG

PROJECT 01.01 HUAI KAE
LOCATION A. MUANG, KALASIN

BORING NO. BH-3
DEPTH (m.) 10.40
COORD. -

GROUND ELEV.(m.) 99.45
OBSERVED WL (m.) -2.50
DATE STARTED 3/3/89
DATE FINISHED 4/3/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
LOOSE TO MEDIUM DENSE SILTY FINE SAND, DARK BROWN AND GREYISH BROWN (SM) (NO SALTY)	1	PA		
		SS	1	14 (7,7)
		PA		
	2	SS	2	7 (2,5)
		PA		
	3	SS	3	4 (2,2)
		PA		
	4	SS	4	8 (4,4)
5.00		PA		
DENSE TO VERY DENSE SILTY FINE SAND, DARK BROWN AND BROWNISH GREY (SM) (NO SALTY)	5	SS	5	(7,24) 41
		PA		
	6	SS	6	50/15 CM (24,50/15CM)
		PA		
	7	SS	7	50/10 CM (37,50/10CM)
		PA		
8.50	8	SS	8	50/10 CM (30,50/10 CM)
HARD SANDY CLAY, REDDISH BROWN (NO SALTY) (CL) 10.40		PA		
	9	SS	9	50/8 CM (28,50/8CM)
		PA		
	10	SS	10	50/25 CM (30,20/10CM)
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m^2) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m^3) 1.6 1.8 2.0

BORING LOG

PROJECT 02.05 HUAI KHUM MUN
LOCATION A. UBON RATTANA, KHON KAEN

BORING NO. BH-1
DEPTH (m.) 15.15
COORD. -

GROUND ELEV.(m.) 95.2
OBSERVED WL (m.) -0.10
DATE STARTED 23/2/89
DATE FINISHED 25/2/89

SOIL DESCRIPTION	DEPTH (m.)
LOOSE SILTY FINE SAND, BROWN (NO SALTY) (SM)	1.50
SOFT FINE SANDY CLAY, BROWN (CL/SC)	2.50
VERY LOOSE TO LOOSE SILTY AND CLAYEY FINE SAND, GREY (SM,SC) (NO SALTY)	8.00
MEDIUM DENSE CLAYEY FINE SAND, GREY (SC) (NO SALTY)	10.00
DENSE TO VERY DENSE FINE SAND, BROWN AND GREY (SP-SM) (NO SALTY)	15.15
END OF BORING	

METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
PA		
SS	1	5 (2,3)
PA		
SS	2	2 (1,1)
PA		
SS	3	1 (0,1)
PA		
SS	4	5 (3,2)
WO		
SS	5	4 (2,2)
WO		
SS	6	5 (3,2)
WO		
SS	7	1 (0,1)
WO		
SS	8	15 (9,6
WO		
SS	9	18 (4,14)
WO		
SS	10	50/25 CM
WO		(25,25/10CM)
SS	11	(20,25) 45
WO		
SS	12	50/27 CM
WO		(25,25/13 CM)
SS	13	(22,28) 50
WO		
SS	14	(16,25) 41
WO		
SS	15	50/15 CM

PL W_n LL (%) 10 20 30 40

S_u (t/m.^{2}) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m.^{3}) 1.6 1.8 2.0

BORING LOG

PROJECT 02.05 HUAI KHUM MUN

LOCATION A. UBON RATTANA, KHON KAEN

BORING NO. BH-2

DEPTH (m.) 20.35

COORD. —

GROUND ELEV.(m.) 94.0

OBSERVED WL (m.) +1.00

DATE STARTED 26/2/89

DATE FINISHED 28/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
LOOSE TO MEDIUM DENSE SILTY FINE SAND, BROWN (SM) (NO SALTY)	0	PA		
	1	SS	1	3 (2,1)
		PA		
	2	SS	2	9 (4,5)
		WO		
	3	SS	3	10 (4,6)
		WO		
	4	SS	4	18 (10,18)
		WO		
	5	SS	5	9 (5,4)
		WO		
6.00	6	SS	6	(20,20) 40
DENSE TO VERY DENSE SILTY FINE SAND, GREY AND BROWN (SM) (NO SALTY)		WO		
	7	SS	7	50/25 CM (30,20/10)
		WO		
	8	SS	8	(19,21) 40
		WO		
	9	SS	9	(25,25) 50
		WO		
	10	SS	10	(29,21) 50
		WO		
	11	SS	11	(15,12) 27
		WO		
	12	SS	12	(24,24) 48
		WO		
13.75	13	SS	13	(17,20) 37
HARD CLAY, BROWN (CL) (NO SALTY)		WO		
	14	SS	14	(18,27) 45
		WO		
	15	SS	15	(12,20) 32
		WO		
	16	SS	16	50/25 CM (36,14/0 CM)
		WO		
	17	SS	17	(20,29) 49
		WO		
	18	SS	18	(21,28) 49
		WO		
	19	SS	19	50/20 CM (25,25/5 CM)
		WO		
END OF BORING 20.35	20	SS	20	50/20 CM (35,15/5 CM)

PL W_n LL (%) — 10 20 30 40

S_u (t/m^2) ⊙ UCT △ PP X FVT ⊡ TV — 5 10 15 20

γ_t (t/m^3) — 1.6 1.8 2.0

BORING LOG

PROJECT 02.05 HUAI KHUM MUN

LOCATION A. UBON RATTANA, KHON KAEN

BORING NO. BH-3

DEPTH (m.) 20.20

COORD. —

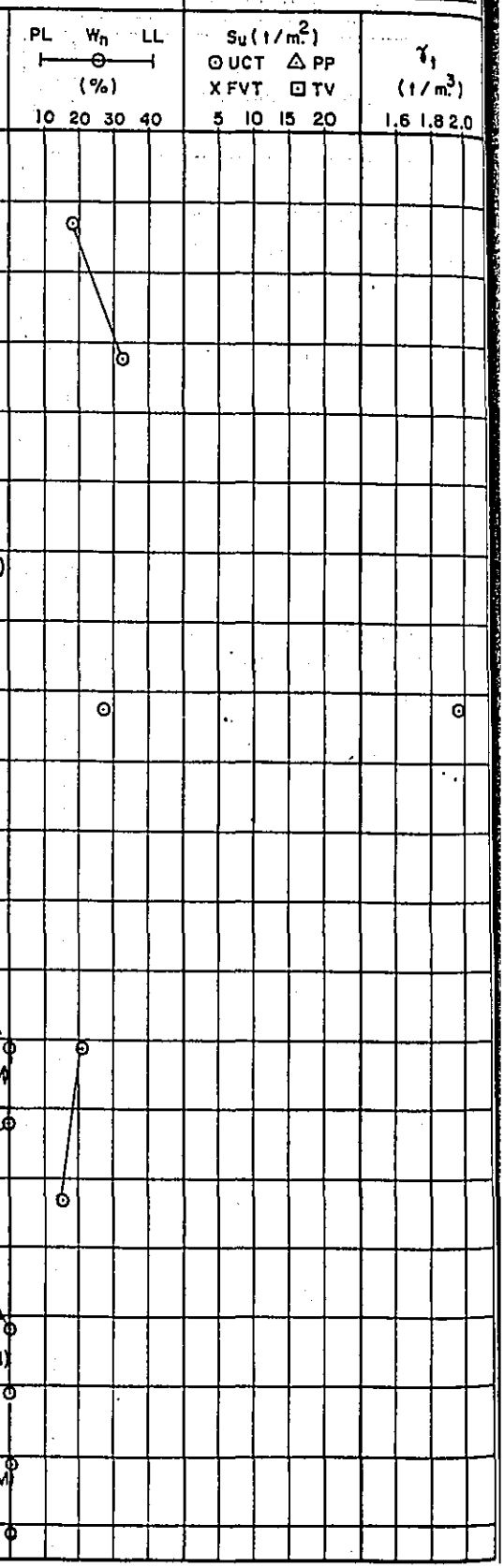
GROUND ELEV.(m.) 97.0

OBSERVED WL (m.) -1.90

DATE STARTED 1/3/89

DATE FINISHED 3/3/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft)
SOFT TO MEDIUM AND STIFF FINE SANDY CLAY, BROWN AND GREY (CL) (NO SALTY)	4.50	PA		
		SS	1	8 (4,4)
		PA		
		SS	2	4 (2,2)
		PA		
		SS	3	2 (1,1)
		PA		
		SS	4	10 (4,6)
MEDIUM DENSE SILTY SAND, BROWN (SM) (NO SALTY)	7.65	WO		
		SS	5	9 (4,5)
		WO		
		SS	6	18 (8,10)
		WO		
		SS	7	10 (2,8)
STIFF CLAY, DARK BROWN (CL) (NO SALTY)	9.70	WO		
		SS	8	14 (6,8)
		WO		
		SS	9	16 (6,10)
MEDIUM DENSE SILTY FINE SAND, BROWN (SM) (NO SALTY)	12.00	WO		
		SS	10	13 (8,5)
		WO		
		SS	11	13 (8,5)
DENSE TO VERY DENSE SILTY FINE SAND BROWN (SM) (NO SALTY)	14.70	WO		
		SS	12	(18,23)41
		WO		
		SS	13	50/20 CM
		WO		(40/0/5 CM)
		SS	14	50/20 CM
		WO		(30,20/5 CM)
VERY STIFF SANDY CLAY, DARK GREY (NO SALTY) (CL)	16.30	SS	15	16 (7,9)
		WO		
		SS	16	(9,32)41
VERY DENSE CLAYEY-GRAVELLY SAND, GREY (SC,SM) (NO SALTY)		WO		
		SS	17	50/18 CM
		WO		(34,16/2.5 CM)
		SS	18	50/10 CM
		WO		
		SS	19	50/18 CM
		WO		(39,11/2.5 CM)
END OF BORING	20.20	SS	20	50/5 CM



BORING LOG

PROJECT 04.01 HUAI SOENG NO.1
LOCATION A. NAKAE, NAKHON PHANOM

BORING NO. BH-1
DEPTH (m.) 10.03
COORD. -

GROUND ELEV.(m.) 99.83
OBSERVED WL (m.) -3.60
DATE STARTED 23/2/89
DATE FINISHED 24/2/89

SOIL DESCRIPTION	DEPTH (m.)	GRAPHIC LOG	METHOD	SAMPLING & RECOVERY	SPT - N (blows / ft) 10 20 30 40	PL W_n LL (%) 10 20 30 40	S_u (t/m²) ○ UCT △ PP X FVT ⊡ TV 5 10 15 20	γ_t (t/m³) 1.6 1.8 2.0
VERY STIFF CLAY, DARK BROWN AND GREY (NO SALTY) (CL) 1.50	1		PA					
			SS	1	17 (8,9)			
			PA					
MEDIUM CLAY, BROWN AND GREY (CL) (NO SALTY) 5.00	2		SS	2	5 (2,3)			
			PA					
	3		SS	3	7 (3,4)			
			PA					
	4		SS	4	9 (4,5)			
			PA					
HARD SANDY-GRAVELLY CLAY, (LATERITE), REDDISH BROWN (CL) (NO SALTY) 10.03	5		SS	5	50/8 CM			
			WO					
	6		SS	6	50/5 CM			
			WO					
	7		SS	7	50/2.5 CM			
			WO					
	8		SS	8	50/5 CM			
			WO					
	9		SS	9	50/2.5 CM			
			WO					
	10		SS	10	50/2.5 CM			
END OF BORING								

BORING LOG

PROJECT 04.01 HUAI SOENG NO.1

LOCATION A. NAKAE, NAKHON PHANOM

BORING NO. BH-2

DEPTH (m.) 4.15

COORD. —

GROUND ELEV.(m.) 98.17

OBSERVED WL (m.) -0.30

DATE STARTED 23/2/89

DATE FINISHED 23/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft) 10 20 30 40	PL Wn LL (%) 10 20 30 40	S_u (t/m²) ⊙UCT △PP XFVT ⊡TV 5 10 15 20	γ_t (t/m³) 1.6 1.8 2.0
SOFT TO MEDIUM CLAY, GREY AND BROWN (CL) (NO SALTY)	1	WO					
		SS	1	3 (1,2)			
	2	WO					
		SS	2	4 (2,2)			
	3	WO					
		SS	3	6 (3,3)			
3.80		WO					
VERY DENSE CLAYEY-GRAVELLY SAND (LATERITE), REDDISH BROWN (SC) (NO SALTY) 4.15	4	SS	4	50/15 CM			
END OF BORING							

BORING LOG

PROJECT 04.01 HUAI SOENG NO.1

LOCATION A. NAKAE, NAKHON PHANOM

BORING NO. BH-3

DEPTH (m.) 10.03

COORD. —

GROUND ELEV.(m.) 99.46

OBSERVED WL (m.) -3.00

DATE STARTED 25/2/89

DATE FINISHED 26/2/89

SOIL DESCRIPTION	DEPTH (m.)	GRAPHIC LOG	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft) 10 20 30 40	PL Wn LL (%) 10 20 30 40	S_u (t/m²) ⊙ UCT △ PP X FVT □ TV 5 10 15 20	γ_t (t/m³) 1.6 1.8 2.0
SOFT TO MEDIUM CLAY, BROWN AND GREY (CL) (NO SALTY)	5.00		PA / SS 1 / PA / SS 2 / PA / SS 3 / PA / SS 4 / PA / SS 5		7 (3,4); 7 (3,4); 3 (1,2); 2 (1,1); 50/5CM			
HARD SANDY-GRAVELLY CLAY (LATERITE), REDDISH BROWN (CL) (NO SALTY)	10.03		WO / SS 6 / WO / SS 7 / WO / SS 8 / WO / SS 9 / WO / SS 10		50/5 CM; 50/8 CM; 50/5 CM; 50/2.5 CM; 50/2.5 CM			
END OF BORING								

BORING LOG

PROJECT 04.02 HUAI SOENG NO.2
LOCATION A.NAKAE, NAKHON PHANOM

BORING NO. BH-1
DEPTH (m.) 9.07
COORD. —

GROUND ELEV.(m.) 98.80
OBSERVED WL (m.) -0.10
DATE STARTED 27/2/89
DATE FINISHED 28/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
MEDIUM TO STIFF CLAY, BROWN AND GREY (CH) (NO SALTY) 3.80	1–3	WO / SS 1 / WO / SS 2 / WO / SS 3		9 (4,5)
				6 (2,4)
				7 (3,4)
VERY DENSE CLAYEY-GRAVELLY SAND (LATERITE), REDDISH BROWN (SC/CL) (NO SALTY) 9.07	4–9	WO / SS 4 / WO / SS 5 / WO / SS 6 / WO / SS 7 / WO / SS 8 / WO / SS 9		50/15 CM 50/5 CM. 50/3 CM 50/10 CM 50/10 CM. 50/8 CM.
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m³) 1.6 1.8 2.0

BORING LOG

PROJECT 04.02 HUAI SOENG NO.2

LOCATION A.NAKAE, NAKHON PHANOM

BORING NO. BH-2

DEPTH (m.) 2.12

COORD. -

GROUND ELEV.(m.) 96.70

OBSERVED WL (m.) +1.50

DATE STARTED 1/3/89

DATE FINISHED 1/3/89

SOIL DESCRIPTION	DEPTH (m.)	GRAPHIC LOG	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft) 10 20 30 40	PL W_n LL (%) 10 20 30 40	S_u (t/m²) ○ UCT △ PP X FVT ⊡ TV 5 10 15 20	γ_t (t/m³) 1.6 1.8 2.0
MEDIUM CLAY, TRACE OF SAND, GREY (NO SALTY) (CL) 1.50	1		PA					
			SS	1	6 (3,3)			⊙
HARD SANDY CLAY (LATERITE) REDDISH BROWN (CL) (NO SALTY). 2.12	2		PA					
			SS	2	50/13 CM			
END OF BORING								

BORING LOG

PROJECT 04.02 HUAI SOENG NO.2

LOCATION A.NAKAE, NAKHON PHANOM

BORING NO. BH-3

DEPTH (m.) 5.15

COORD. -

GROUND ELEV.(m.) 98.60

OBSERVED WL (m.) -1.30

DATE STARTED 27/2/89

DATE FINISHED 27/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
MEDIUM TO STIFF CLAY, TRACE OF SAND, GREY AND BROWN (CL)	1	PA		
		SS	1	9 (4,5)
	2	PA		
		SS	2	9 (4,5)
	3	PA		
		SS	3	5 (2,3)
(NO SALTY) 4.50	4	PA		
		SS	4	16 (6,10)
VERY DENSE CLAYEY-GRAVELLY SAND(LATERITE), REDDISH BROWN (SC) 5.15	5	PA		
		SS	5	50/15 CM.
END OF BORING				

PL W_n LL (%) — 10 20 30 40

S_u (t/m^2) ⊙ UCT △ PP × FVT ⊡ TV — 5 10 15 20

γ_t (t/m^3) — 1.6 1.8 2.0

BORING LOG

PROJECT 05.01 : LAM KLANG

LOCATION A.NON SOONG, NAKHON RATCHASIMA

BORING NO. BH-1

DEPTH (m.) 15.15

COORD. -

GROUND ELEV.(m.) 97.7

OBSERVED WL (m.) -1.20

DATE STARTED 10/2/89

DATE FINISHED 11/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT - N (blows / ft)
MEDIUM DENSE CLAYEY FINE SAND, LI-GREY AND LI-BROWN (SC) (NO SALTY) 2.00	1	PA		
		SS	1	14 (6,8)
	2	PA		
		SS	2	29 (13,16)
DENSE CLAYEY FINE SAND, LI-GREY (SC) (NO SALTY) 5.00	3	PA		
		SS	3	(17,18) 35
	4	PA		
		SS	4	(23,28) 48
INTERMEDIATE SOIL (FINE SANDY CLAY OR CLAYEY FINE SAND), LI-BROWN AND LI-GREY (NO SALTY) (CL/SC) 6.50	5	PA		
		SS	5	(16,19) 35
	6	PA		
		SS	6	(13,27) 40
VERY DENSE CLAYEY SAND, LI-BROWN AND LI-GREY (SC) (NO SALTY) 9.50	7	WO		
		SS	7	50/24 CM (28,22/9 CM)
	8	WO		
		SS	8	50/25 CM (28,22/10 CM)
	9	WO		
		SS	9	50/20 CM (32,18/5 CM)
HARD CLAY, REDDISH BROWN (CL) (NO SALTY) 15.15	10	WO		
		SS	10	50/25 CM (26,24/10 CM)
	11	WO		
		SS	11	50/23 CM (30,20/8 CM)
	12	WO		
		SS	12	50/20 CM (32,18/5 CM)
	13	WO		
		SS	13	50/20 CM (25,25/5 CM)
	14	WO		
		SS	14	50/18 CM (38,12/2.5 CM)
	15	WO		
		SS	15	50/15 CM
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m^2) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m^3) 1.6 1.8 2.0

BORING LOG

PROJECT 05.01 · LAM KLANG

LOCATION A.NON SOONG, NAKHON RATCHASIMA

BORING NO. BH-2

DEPTH (m.) 13.13

COORD. -

GROUND ELEV.(m.) 96.6

OBSERVED WL (m.) +0.30(IN

DATE STARTED 14/2/89

DATE FINISHED 15/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft)
STIFF FINE SANDY CLAY, LI-GREY (CL) (NO SALTY) 2.00	1	PA		
		SS	1	13 (5,8)
	2	WO		
		SS	2	(26,30) 56
VERY STIFF TO HARD FINE SANDY CLAY, LI-BROWN AND LI-GREY (CL) (NO SALTY) 9.00	3	WO		
		SS	3	(14,18) 32
	4	WO		
		SS	4	(17,17) 34
	5	WO		
		SS	5	18 (8,10)
	6	WO		
		SS	6	28 (13,15)
	7	WO		
		SS	7	(18,20) 38
	8	WO		
		SS	8	(15,25) 40
HARD CLAY, REDDISH BROWN (CL) (NO SALTY) 13.13	9	WO		
		SS	9	50/20 CM (33,17/5CM)
	10	WO		
		SS	10	50/18CM (41,9/2.5CM)
	11	WO		
		SS	11	50/23CM (27,23/8CM)
	12	WO		
		SS	12	50/20CM (30,20/5CM)
	13	WO		
		SS	13	50/13 CM
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m³) 1.6 1.8 2.0

BORING LOG

PROJECT 05.01 LAM KLANG
LOCATION A.NON SOONG, NAKHON RATCHASIMA

BORING NO. BH-3
DEPTH (m.) 15.18
COORD. -

GROUND ELEV.(m.) 99.5
OBSERVED WL (m.) -3.00
DATE STARTED 12/2/89
DATE FINISHED 13/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT - N (blows / ft)
LOOSE TO MEDIUM DENSE AND DENSE SILTY FINE SAND, BROWN AND LI-GREY (SC) (NO SALTY)	1	PA		
		SS	1	6 (2,4)
	2	PA		
		SS	2	(13,25) 38
	3	PA		
		SS	3	10 (5,5)
	4	PA		
		SS	4	22 (9,13)
	5	WO		
		SS	5	(24/26) 50
6.50	6	WO		
		SS	6	(17,12) 29
VERY STIFF TO HARD FINE SANDY CLAY, LI-BROWN AND LI-GREY (CL) (NO SALTY)	7	WO		
		SS	7	23(10,13)
	8	WO		
		SS	8	(13,16) 29
	9	WO		
		SS	9	(18,20) 38
10.00	10	WO		
		SS	10	(26,32) 58
HARD FINE SANDY CLAY, LI-GREY AND REDDISH BROWN (CL) (NO SALTY)	11	WO		
		SS	11	(20,34) 54
	12	WO		
		SS	12	50/23 CM (29,21/8CM)
	13	WO		
		SS	13	50/20 CM (32,18/5CM)
	14	WO		
		SS	14	50/18 CM (40,10/2.5CM)
15.18	15	WO		
		SS	15	50/18 CM (35,15/2.5CM)
END OF BORING				

PL W_n LL (%) — 10 20 30 40

S_u (t/m^2) ⊙ UCT △ PP X FVT ⊡ TV — 5 10 15 20

γ_t (t/m^3) — 1.6 1.8 2.0

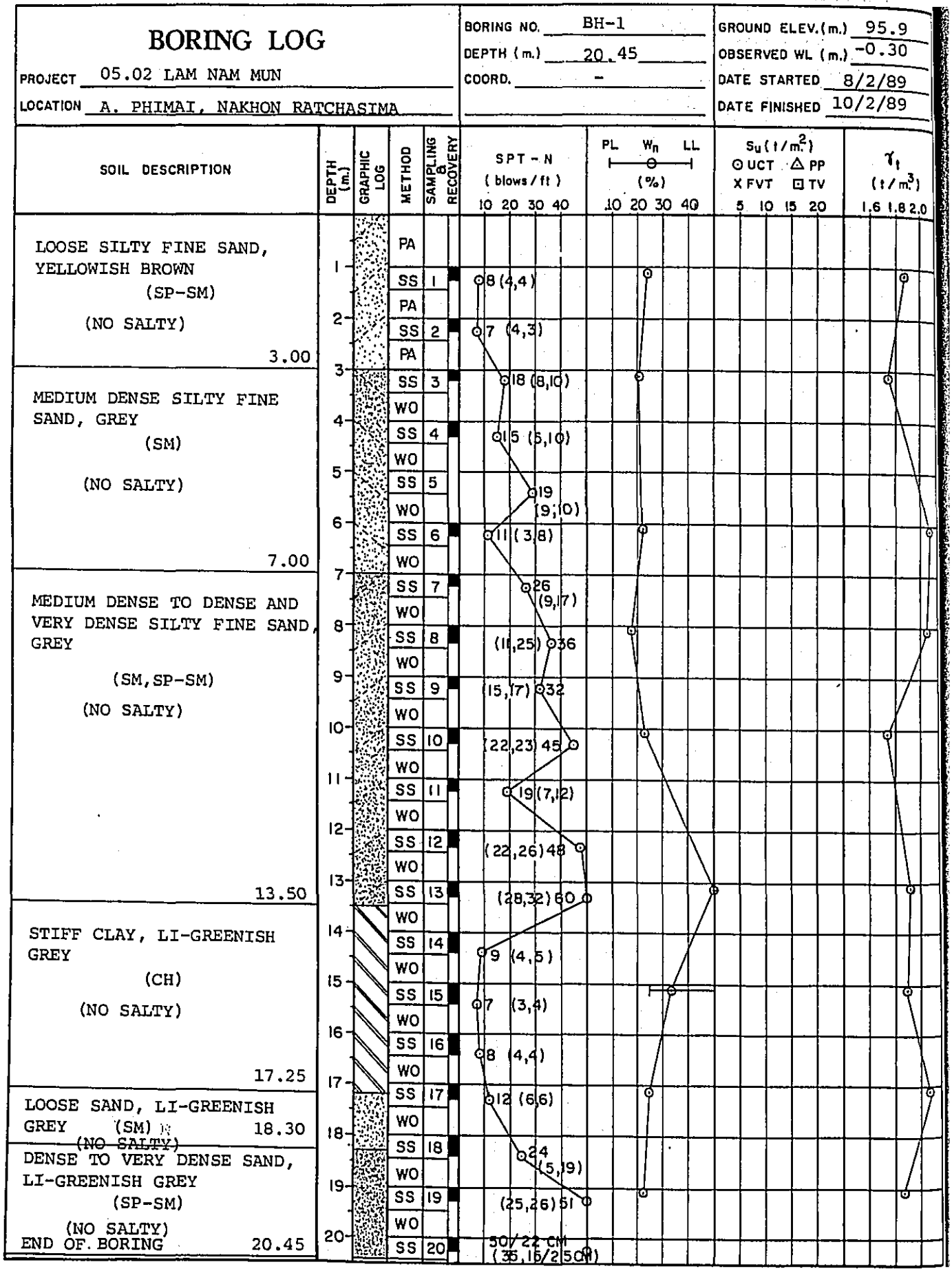
BORING LOG

PROJECT 05.02 LAM NAM MUN
LOCATION A. PHIMAI, NAKHON RATCHASIMA

BORING NO. BH-1
DEPTH (m.) 20.45
COORD. -

GROUND ELEV.(m.) 95.9
OBSERVED WL (m.) -0.30
DATE STARTED 8/2/89
DATE FINISHED 10/2/89

SOIL DESCRIPTION	DEPTH (m.)
LOOSE SILTY FINE SAND, YELLOWISH BROWN (SP-SM) (NO SALTY)	3.00
MEDIUM DENSE SILTY FINE SAND, GREY (SM) (NO SALTY)	7.00
MEDIUM DENSE TO DENSE AND VERY DENSE SILTY FINE SAND, GREY (SM,SP-SM) (NO SALTY)	13.50
STIFF CLAY, LI-GREENISH GREY (CH) (NO SALTY)	17.25
LOOSE SAND, LI-GREENISH GREY (SM) (NO SALTY)	18.30
DENSE TO VERY DENSE SAND, LI-GREENISH GREY (SP-SM) (NO SALTY) END OF BORING	20.45



BORING LOG

PROJECT 05.02 LAM NAM MUN

LOCATION A. PHIMAI, NAKHON RATCHASIMA

BORING NO. BH-2

DEPTH (m.) 27.45

COORD. ~

GROUND ELEV.(m.) 94.9

OBSERVED WL (m.) -0.30

DATE STARTED 11/2/89

DATE FINISHED 13/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
MEDIUM DENSE TO DENSE AND VERY DENSE SAND GREENISH GREY (SP-SM)	1	PA		
		SS	1	22 (9,13)
	2	PA		
		SS	2	26 (13,13)
	3	PA		
		SS	3	16 (9,7)
	4	WO		
		SS	4	12 (6,6)
	5	WO		
		SS	5	(18,19) 37
	6	WO		
		SS	6	22 (13,9)
	7	WO		
		SS	7	22 (11,11)
	8	WO		
		SS	8	(16,20) 36
	9	WO		
		SS	9	(25,29) 54
	10	WO		
		SS	10	22 (8,14)
	11	WO		
		SS	11	19 (7,12)
	12	WO		
13.00		SS	12	23 (11,12
STIFF CLAY, LI-GREENISH GREY (CL)	13	WO		
		SS	13	11 (5,6)
	14	WO		
		SS	14	8 (4,4)
	15	WO		
		SS	15	8 (4,4)
	16	WO		
17.00		SS	16	12 (6,6)
HARD CLAY, GREENISH GREY (CL) (NO SALTY) 18.00	17	WO		
		SS	17	(19,26) 45
DENSE SILTY FINE SAND, GREENISH GREY AND DARK BROWN (SP-SM) (SALTY) 19.50	18	WO		
		SS	18	(13,27) 40
HARD CLAY, REDDISH BROWN (CL) (SALTY)	19	WO		
		SS	19	22,26) 48
	20	WO		
		SS	20	(16,17) 33

PL W_n LL (%) 10 20 30 40

S_u (t/m^2) ○ UCT △ PP × FVT ☐ TV 5 10 15 20

γ_t (t/m^3) 1.6 1.8 2.0

BORING LOG

PROJECT 05.02 LAM NAM MUN
LOCATION A. PHIMAI, NAKHON RATCHASIMA

BORING NO. BH--2
DEPTH (m.) 27.45
COORD. -

GROUND ELEV.(m.) 94.9
OBSERVED WL (m.) -0.30
DATE STARTED 11/2/89
DATE FINISHED 13/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
HARD CLAY, REDDISH BROWN (CL) (SALTY)	21	WO		
		SS	21	(16,21) 37
	22	WO		
		SS	22	(16,24) 40
	23	WO		
		SS	23	(18,23) 41
	24	WO		
		SS	24	(18,22) 40
	25	WO		
		SS	25	(20,22) 42
	26	WO		
		SS	26	(23,26) 49
27.45	27	WO		
		SS	27	(23,29) 52
END OF BORING				

PL W_n LL (%): 20 40 60 80

S_u (t/m^2): ○ UCT △ PP × FVT ⊡ TV; 5 10 15 20

γ_t (t/m^3): 1.6 1.8 2.0

BORING LOG

PROJECT 05.02 LAM NAM MUN

LOCATION A. PHIMAI, NAKHON RATCHASIMA

BORING NO. BH-3

DEPTH (m.) 20.45

COORD. -

GROUND ELEV.(m.) 96.2

OBSERVED WL (m.) -1.35

DATE STARTED 14/2/89

DATE FINISHED 16/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
LOOSE TO MEDIUM DENSE SAND, LI-BROWN AND GREENISH GREY (SM) (NO SALTY)	1	PA		
		SS	1	13 (7,6)
	2	PA		
		SS	2	9 (3,6)
	3	PA		
		SS	3	19 (9,10)
	4	WO		
		SS	4	8 (4,4)
	5	WO		
		SS	5	23 (10,13)
	6	WO		
		SS	6	18 (8,10)
	7	WO		
		SS	7	5 (2,3)
8.35	8	WO		
PEAT TO LIGNITE, BLACK AND BROWN (PT)(SALTY) 8.50		SS	8	50/15 CM
	9	WO		
		SS	9	(17,32) 49
DENSE TO VERY DENSE SAND, LI-GREENISH GREY AND GREY, SOME PEAT BETWEEN 19.00-19.45 m DEPTH (SP-SM,SM) (SALTY)	10	WO		
		SS	10	27 (14,13)
	11	WO		
		SS	11	(16,19) 35
	12	WO		
		SS	12	(11,34) 45
	13	WO		
		SS	13	50/29 CM (26,24/13 CM)
	14	WO		
		SS	14	(16,20) 36
	15	WO		
		SS	15	50/20 CM (35,15/5 CM)
	16	WO		
		SS	16	(29,35) 64
	17	WO		
		SS	17	(14,26) 40
	18	WO		
		SS	18	50/20 CM (30,20/5 CM)
	19	WO		
		SS	19	50/10 CM (14,50/10 CM)
END OF BORING 20.45	20	WO		
		SS	20	50/28 CM (24,26/13 CM)

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m³) 1.6 1.8 2.0

BORING LOG

PROJECT 05.03 LAM PHRA PHLOENG

LOCATION A. PAK THONG CHAI, NAKHON RATCHASIMA

BORING NO. BH-1

DEPTH (m.) 22.03

COORD. -

GROUND ELEV.(m.) 98.0

OBSERVED WL (m.) -5.50

DATE STARTED 11/2/89

DATE FINISHED 13/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft)
SOFT TO STIFF FINE SANDY CLAY, DARK BROWN (CL) (NO SALTY)	4.50	PA / SS 1–4	1–4	8 (3,5); 9 (4,9); 9 (4,9); 3 (2,1)
LOOSE CLAYEY FINE SAND, DARK BROWN (SC) (NO SALTY)	7.00	PA / SS 5–6 / WO	5–6	4 (2,2); 5 (2,3)
MEDIUM DENSE CLAYEY AND SILTY SAND, DARK BROWN AND GREY (SC,SP-SM,SM) (NO SALTY)	12.00	WO / SS 7–11 / PA	7–11	17 (8,9); (3,18) 31; 17 (7,10); 20 (7,13); 23 (10,13)
VERY STIFF CLAY, TRACE OF SAND, DARK BROWN (CL) (NO SALTY)	15.50	PA / SS 12–15	12–15	22 (9,13); 27 (12,15)
DENSE CLAYEY FINE SAND (INTERMEDIATE SOIL), DARK BROWN (SC/CL) (NO SALTY)	20.00	PA / SS 16–19 / PA	16–19	18 (8,10); 20 (9,11); 24 (11,13); 25 (12,13); 21 (10,11); (12,13) 25
HARD SANDY CLAY (CL)		SS 20	20	50/25 CM (23,26/10 CM)

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ○ UCT △ PP × FVT ⊡ TV 5 10 15 20

γ_t (t/m³) 1.6 1.8 2.0

BORING LOG

PROJECT 05.03 LAM PHRA PHLOENG
LOCATION A. PAK THONG CHAI, NAKHON RATCHASIMA

BORING NO. BH-1
DEPTH (m.) 22.03
COORD. -

GROUND ELEV.(m.) 98.0
OBSERVED WL (m.) -5.50
DATE STARTED 11/2/89
DATE FINISHED 13/2/89

SOIL DESCRIPTION	DEPTH (m.)	GRAPHIC LOG	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft) 10 20 30 40	PL Wn LL (%) 20 40 60 80	S_u (t/m²) ○ UCT △ PP X FVT ⊡ TV 5 10 15 20	γ_t (t/m³) 1.6 1.8 2.0
HARD SANDY CLAY, LI-BROWN AND GREY (CL) (NO SALTY) 22.00			SS	20	50/25CM (23,26/10CM)			
	21		WO					
			SS	21	50/23CM (30, 20/8CM)			
			WO					
	22		SS	22	50/2.5CM			
VERY DENSE SANDSTONE, BROWNISH GREY (NO SALTY) (SM) 22.03								
END OF BORING								

BORING LOG

PROJECT 05.03 LAM PHRA PHLOENG

LOCATION A. PAK THONG CHAI, NAKHON RATCHASIMA

BORING NO. BH-2

DEPTH (m.) 18.05

COORD. -

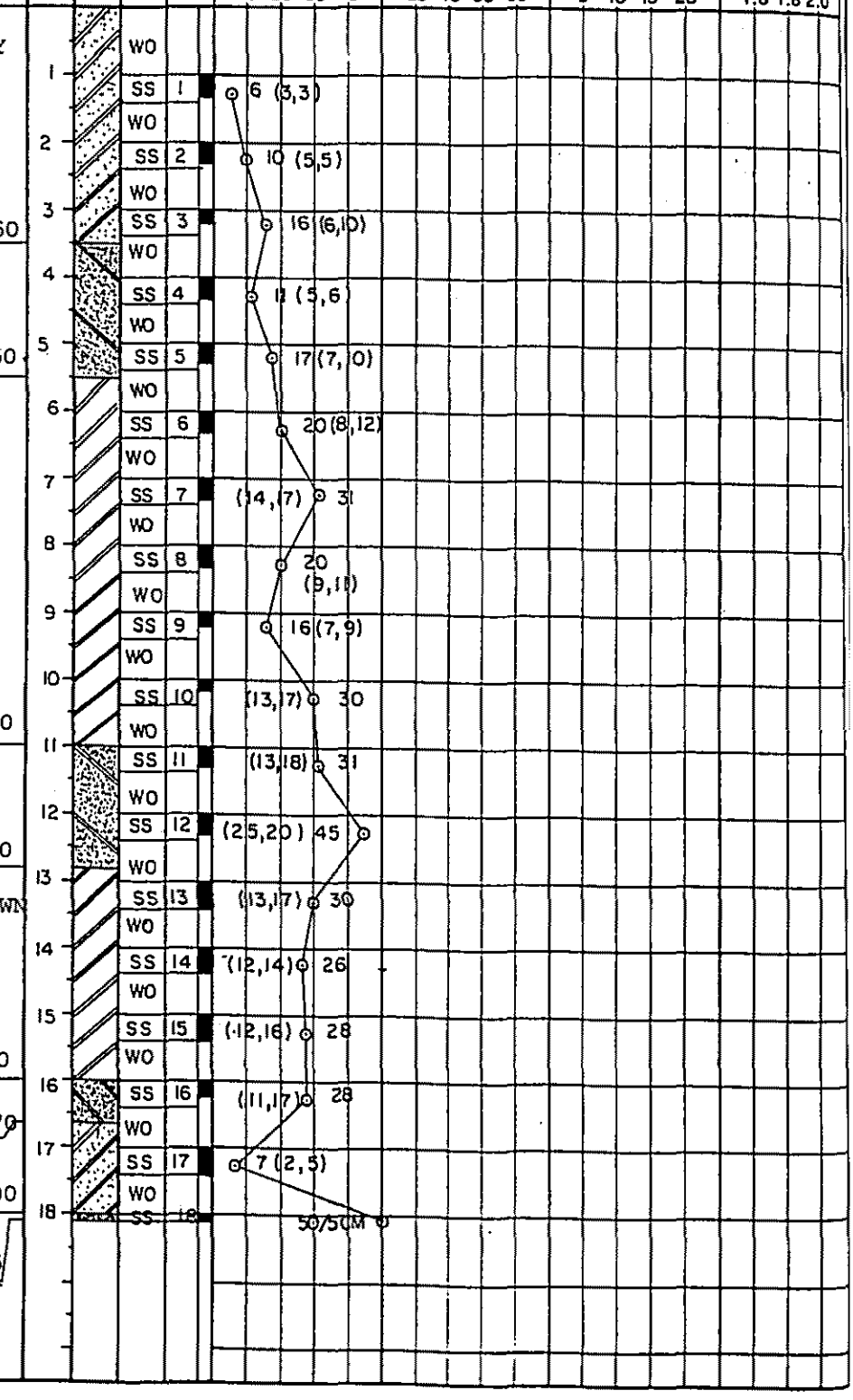
GROUND ELEV.(m.) 90.4

OBSERVED WL (m.) +0.20

DATE STARTED 13/2/89

DATE FINISHED 15/2/89

SOIL DESCRIPTION	DEPTH (m.)
STIFF TO VERY STIFF SANDY CLAY, GREYISH BROWN AND DARK BROWN (CL) (NO SALTY)	3.50
MEDIUM DENSE CLAYEY AND SILTY SAND, DARK BROWN AND GREY (NO SALTY) (SC,SM)	5.50
VERY STIFF TO HARD CLAY, DARK BROWN (CL) (NO SALTY)	11.00
DENSE CLAYEY FINE SAND, DARK BROWN (NO SALTY) (SC)	12.80
VERY STIFF CLAY, DARK BROWN (CL) (NO SALTY)	16.00
MEDIUM DENSE CLAYEY FINE SAND, DARK GREY (SC/CL)	16.70
MEDIUM SANDY CLAY, DARK GREY (NO SALTY) (CL)	18.00
VERY DENSE SANDSTONE, GREY (NO SALTY) (SM)	18.05
END OF BORING	



BORING LOG

PROJECT 05.03 LAM PHRA PHLOENG
LOCATION A. PAK THONG CHAI, NAKHON RATCHASIMA

BORING NO. BH-3
DEPTH (m.) 20.22
COORD. -

GROUND ELEV.(m.) 94.4
OBSERVED WL (m.) -5.50
DATE STARTED 8/2/89
DATE FINISHED 10/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING NO.	SPT-N (blows/ft)	PL Wn LL (%)	Su (t/m²) UCT PP FVT TV	γt (t/m³)
STIFF TO VERY STIFF FINE SANDY CLAY, DARK BROWN (CL) (NO SALTY)	9.50	PA / SS	1	12 (6,6)			
		PA / SS	2	12 (6,6)			
		PA / SS	3	9 (4,5)			
		PA / SS	4	15 (6,9)			
		PA / SS	5	20 (9,11)			
		PA / SS	6	17 (7,10)			
		PA / SS	7	20 (9,11)			
		PA / SS	8	18 (8,10)			
MEDIUM DENSE CLAYEY SAND, DARK BROWN (NO SALTY) (SC)	10.50	PA / SS	9	16 (7,9)			
		PA / SS	10	23 (13,10)			
VERY STIFF SANDY CLAY, DARK BROWN (CL) (NO SALTY)	13.50	PA / SS	11	24 (12,12)			
		PA / SS	12	19 (8,11)			
		PA / SS	13	17 (8,9)			
MEDIUM DENSE TO DENSE CLAYEY FINE SAND, DARK BROWN AND GREY (SC) (NO SALTY)	16.50	PA / SS	14	22 (8,14)			
		PA / SS	15	13 (6,7)			
VERY STIFF FINE SANDY CLAY DARK BROWN (CL) (NO SALTY)	17.50	PA / SS	16	31 (15,16)			
		PA / SS	17	16 (8,8)			
MEDIUM DENSE TO DENSE AND VERY DENSE CLAYEY FINE SAND, DARK BROWN (SC) (NO SALTY)		PA / SS	18	28 (12,16)			
		PA / SS	19	(17,19) 36			
END OF BORING	20.22	PA / SS	20	50/23 CM (32,20/8 CM)			

BORING LOG

PROJECT 11.01 LAM NAM KAM

LOCATION A.MUANG, SAKON NAKHON

BORING NO. BH-1

DEPTH (m.) 14.05

COORD. –

GROUND ELEV.(m.) 99.05

OBSERVED WL (m.) -3.20

DATE STARTED 20/2/89

DATE FINISHED 21/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
MEDIUM DENSE SILTY FINE SAND, BROWN (SM) (NO SALTY)	3.00	PA / SS 1 / PA / SS 2 / PA	1 / 2	12 (5,7) / 14 (7,7)
SOFT TO MEDIUM FINE SANDY CLAY, (CL) (NO SALTY)	7.00	SS 3 / PA / SS 4 / WO / SS 5 / WO / SS 6 / WO	3 / 4 / 5 / 6	8 (4,4) / 3 (1,2) / 4 (2,2) / 4 (2,2)
LOOSE TO MEDIUM DENSE SILTY AND CLAYEY SAND, BROWN (SM,SC) (NO SALTY)	11.00	SS 7 / WO / SS 8 / WO / SS 9 / WO / SS 10 / WO	7 / 8 / 9 / 10	5 (2,3) / 15 (8,7) / 3 (1,2) / 21 (7,14)
HARD CLAY, DARK BROWN (CL) (NO SALTY)	14.05	SS 11 / WO / SS 12 / WO / SS 13 / WO / SS 14	11 / 12 / 13 / 14	50/23 CM (25,25/8CM) / 50/15 CM / 50/10 CM / 50/5 CM
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ○ UCT △ PP × FVT ⊡ TV 5 10 15 20

γ_t (t/m³) 1.6 1.8 2.0

K. ENGINEERING CONSULTANTS CO., LTD.

BORING LOG

PROJECT 11.01 LAM NAM KAM
LOCATION A. MUANG, SAKON NAKHON

BORING NO. BH-2
DEPTH (m.) 9.03
COORD. —

GROUND ELEV.(m.) 95.40
OBSERVED WL (m.) 0.00
DATE STARTED 17/2/89
DATE FINISHED 19/2/89

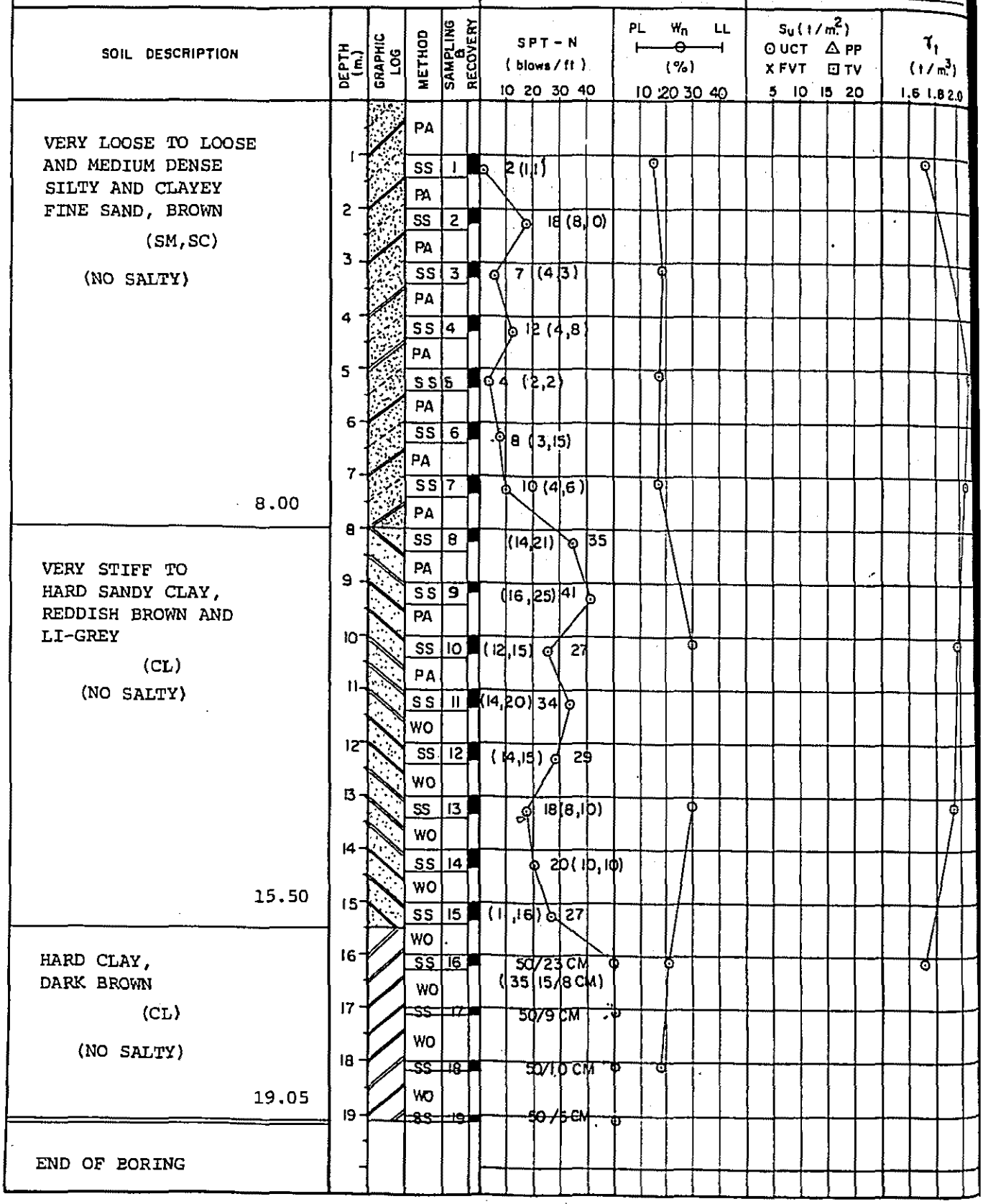
SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING NO.	SPT-N (blows/ft)	PL Wn LL (%)	Su (t/m²) UCT PP FVT TV	γt (t/m³)
LOOSE TO MEDIUM DENSE CLAYEY SAND, BROWN AND GREYISH BROWN (SC,SP-SM) (NO SALTY) 4.50	1	WO					
		SS	1	5 (2,3)			
	2	WO					
		SS	2	6 (4,2)			
	3	WO					
		SS	3	23 (10,13)			
	4	WO					
		SS	4	10 (5,5)			
VERY STIFF SANDY CLAY, REDDISH BROWN AND LI-GREY (CL) 6.00	5	WO					
		SS	5	23 (11,12)			
HARD CLAY, DARK BROWN (CL) (NO SALTY) 9.03	6	WO					
		SS	6	50/15 CM (25,50/15CM)			
	7	WO					
		SS	7	50/10 CM (26,50/10CM)			
	8	WO					
		SS	8	50/15 CM (40,10/2.5CM)			
	9	SS	9	50/2.5 CM			
END OF BORING							

BORING LOG

PROJECT 11.01 LAM NAM KAM
LOCATION A.MUANG, SAKON NAKHON

BORING NO. BH-3
DEPTH (m.) 19.05
COORD. –

GROUND ELEV.(m.) 98.95
OBSERVED WL (m.) -3.00
DATE STARTED 17/2/89
DATE FINISHED 19/2/89



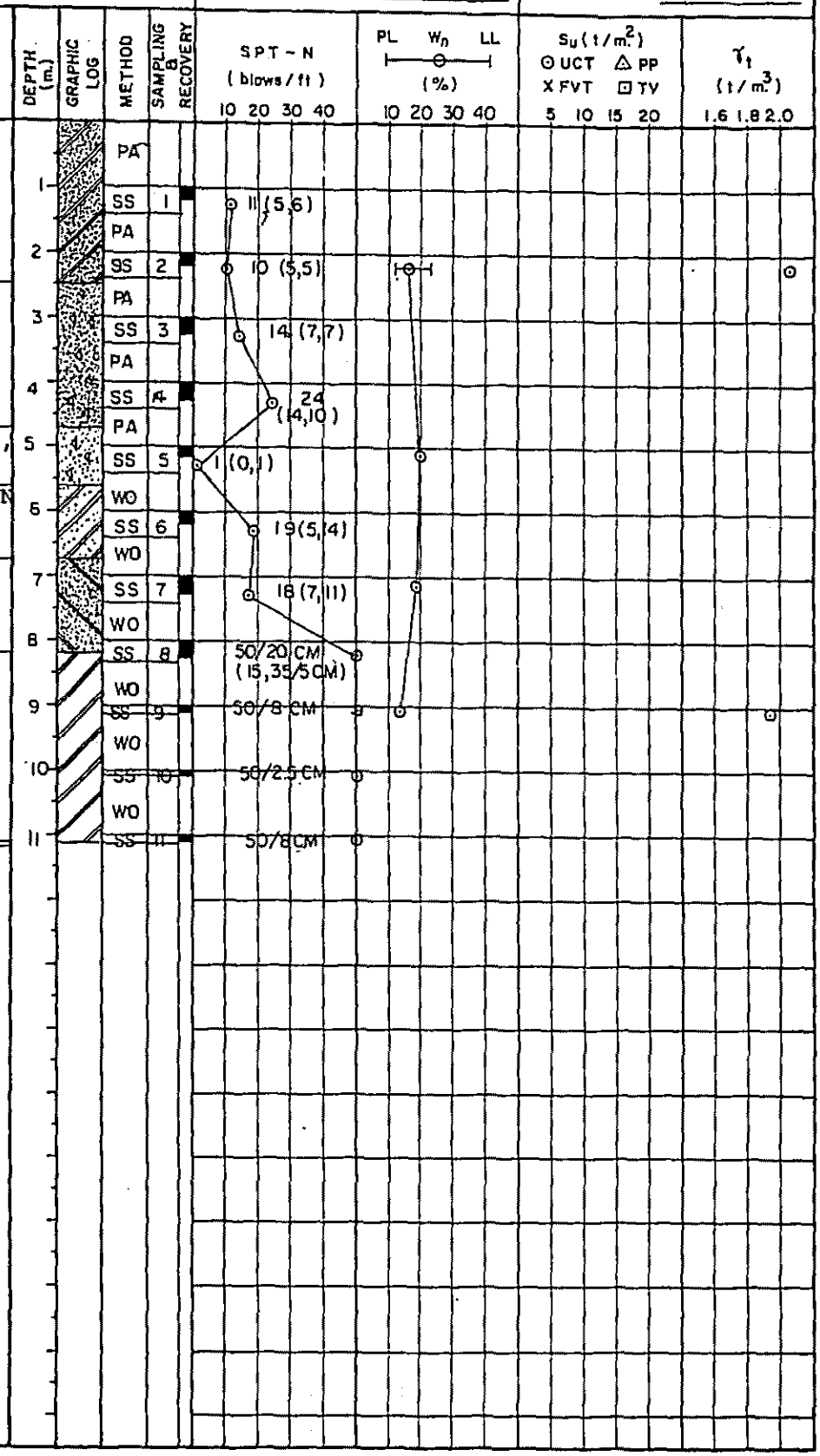
BORING LOG

PROJECT 14.02 LAM NAM PHUAI
LOCATION A. SI BUN RUANG, UDON THANI

BORING NO. BH-1
DEPTH (m.) 11.08
COORD. -

GROUND ELEV.(m.) 96.0
OBSERVED WL (m.) -2.95
DATE STARTED 5/3/89
DATE FINISHED 6/3/89

SOIL DESCRIPTION	DEPTH (m.)
STIFF SANDY CLAY TO CLAYEY SAND (INTERMEDIATE SOIL), BROWN (SC/CL) (NO SALTY)	2.50
MEDIUM DENSE SAND WITH GRAVEL AND CLAY, BROWN (SM) (NO SALTY)	4.80
VERY LOOSE SAND WITH GRAVEL, BROWN (SM) (NO SALTY)	5.65
VERY STIFF SANDY CLAY, BROWN (CL) (NO SALTY)	6.80
MEDIUM DENSE SILTY FINE SAND, GREY (NO SALTY) (SM)	8.25
HARD CLAY, DARK BROWN (CL) (NO SALTY)	11.08
END OF BORING	



BORING LOG

PROJECT 14.02 LAM NAM PHUAI
LOCATION A.SI BUN RUANG, UDON THANI

BORING NO. BH-2
DEPTH (m.) 6.05
COORD. –

GROUND ELEV.(m.) 92.80
OBSERVED WL (m.) -0.05
DATE STARTED 7/3/89
DATE FINISHED 7/3/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
MEDIUM DENSE GRAVELLY SAND BRONW (SP-SM) (NO SALTY) 2.50	1	PA		
		SS	1	29 (10,19)
	2	PA		
		SS	2	20 (9,11)
LOOSE SAND, WITH GRAVEL, BROWN (SM)(NO SALTY) 3.80	3	PA		
		SS	3	9 (4,5)
VERY STIFF SANDY CLAY,GREY (SC/CL)(NO SALTY) 5.00	4	WO		
		SS	4	20 (9,11)
VERY DENSE GRAVELLY SAND, GREY (SM) (NO SALTY) 6.05	5	WO		
		SS	5	50/20CM (27,23/5CM)
END OF BORING	6	WO		
		SS	6	50/5 CM

PL W_n LL (%) 10 20 30 40

S_u (t/m^2) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γ_t (t/m^3) 1.6 1.8 2.0

BORING LOG

PROJECT 14.02 LAM NAM PHUAI
LOCATION A.SI BUN RUANG, UDON THANI

BORING NO. BH-3
DEPTH (m.) 10.18
COORD. -

GROUND ELEV.(m.) 98.50
OBSERVED WL (m.) -3.10
DATE STARTED 8/3/89
DATE FINISHED 9/3/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
VERY STIFF SANDY CLAY, BROWN (CL) (NO SALTY)	3.70	PA / SS 1 / PA / SS 2 / PA / SS 3 / PA / SS 4 / PA / SS 5 / PA / SS 6 / PA / SS 7 / PA / SS 8 / PA / SS 9 / PA / SS 10		22 (11,11); 26 (12,14); 16 (7,9); 24 (12,12); (17,20) 37; (20,24) 44; 50/25 CM (26,24/10 CM); 50/15 CM (14,50/15 CM); 50/10 CM; 50/18 CM (40,10/2.5 CM)
MEDIUM DENSE CLAYEY SAND, WITH GRAVEL, BROWN (SM,SM-SC) (NO SALTY)	7.00			
VERY DENSE GRAVELLY SAND AND SILTY FINE SAND, BROWN AND GREY (SM) (NO SALTY)	10.18			
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

τ_f (t/m³) 1.6 1.8 2.0

BORING LOG

PROJECT 15.07 LAM SOM NO.1

LOCATION A. DET UDOM, UBON RATCHATHANI

BORING NO. BH-1

DEPTH (m.) 8.27

COORD. -

GROUND ELEV.(m.) 98.5

OBSERVED WL (m.) not found

DATE STARTED 20/2/89

DATE FINISHED 21/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING NO.	RECOVERY	SPT - N (blows/ft)
LATERITE, REDDISH BROWN (NO SALTY) 1.00	1	PA			
VERY LOOSE TO LOOSE AND MEDIUM DENSE SILTY AND CLAYEY FINE SAND, LI-BROWN AND YELLOWISH BROWN (SM,SC/CL)	2	SS	1		11 (5,6)
		PA			
	3	SS	2		6 (3,3)
		PA			
	4	SS	3		8 (4,4)
(NO SALTY)		PA			
	5	SS	4		2 (1,1)
		PA			
	6	SS	5		2 (5,7)
		PA			
	7	SS	6		1
7.50		PA			
VERY DENSE SILTSTONE, REDDISH VIOLET (SM) 8.27	8	SS	7		(9,13) 22
		SS	8		50/3 CM.
END OF BORING		SS	9		52/5 CM.

PL Wn LL (%) 10 20 30 40

Su (t/m²) ⊙ UCT △ PP X FVT ⊡ TV 5 10 15 20

γt (t/m³) 1.6 1.8 2.0

BORING LOG

PROJECT 15.07 LAM SOM NO.1

LOCATION A. DET UDOM, UBON RATCHATHANI

BORING NO. BH-2
DEPTH (m.) 2.00
COORD. -

GROUND ELEV.(m.) 93.4
OBSERVED WL (m.) +1.80
DATE STARTED 19/2/89
DATE FINISHED 19/2/89

SOIL DESCRIPTION	DEPTH (m.)	GRAPHIC LOG	METHOD	SAMPLING & RECOVERY	SPT - N (blows/ft) 10 20 30 40	PL Wn LL (%) 10 20 30 40	S_u (t/m²) ⊙UCT △PP ×FVT ⊡TV 5 10 15 20	γ_t (t/m³) 1.6 1.8 2.0
MEDIUM DENSE SAND, LI-BROWN (NO SALTY) (SM) 1.35	1		PA					
VERY DENSE SILTSTONE, REDDISH VIOLET (NO SALTY) (SM) 2.00			SS	1	(14,35) 49 ⊙	⊙		⊙
END OF BORING	2		PA					

BORING LOG

PROJECT 15.07 LAM SOM NO.1
LOCATION A. DET UDOM, UBON RATCHATHANI

BORING NO. BH-3
DEPTH (m.) 9.08
COORD. -

GROUND ELEV.(m.) 98.4
OBSERVED WL (m.) -3.90
DATE STARTED 17/2/89
DATE FINISHED 18/2/89

SOIL DESCRIPTION	DEPTH (m.)	METHOD	SAMPLING & RECOVERY	SPT-N (blows/ft)
LATERITE, REDDISH BROWN (NO SLATY) 1.00	1	PA		
STIFF TO VERY STIFF AND HARD CLAY, BROWN, LI-BROWN AND LI-GREY (CL) (SALTY)	2	SS	1	9
		PA		
	3	SS	2	12 (6,6)
		PA		
	4	SS	3	(3,56) 59
		PA		
	5	SS	4	18 (8,10)
		PA		
	6	SS	5	23 (11,12)
6.50		PA		
LOOSE TO MEDIUM DENSE FINE SAND, LI-GREY (SALTY) (SP-SM) 8.20	7	SS	6	7 (3,4)
		PA		
	8	SS	7	9 (3,6)
		PA		
VERY DENSE SILTSTONE, REDDISH VIOLET (SM) 9.08 (NO SALTY)	9	SS	8	50/17 CM (35,15)
		PA		
		SS	9	50/8 CM
END OF BORING				

PL W_n LL (%) 10 20 30 40

S_u (t/m²) ○ UCT △ PP × FVT ⊡ TV 5 10 15 20

γ_t (t/m³) 1.6 1.8 2.0

APPENDIX C

SUMMARY OF TEST RESULTS

SUMMARY OF TEST RESULTS

PROJECT : D1.01 HUAI KAE
LOCATION : A. HUANG, KALASIN

BORING NO. : BH-1
DEPTH (m) : 11.03
GROUND EL.(m): 98.3
GWL DEPTH (m): -2.00

MADE BY : NARONG P.
DATE : 10/3/89
CHECKED BY : WITOON S.
DATE : 10/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	-	-	-	-	-	-	-	-	-	-	-	13
SS-2	2.00	2.45	SM	100	100	98	21	16	-	-	-	-	2.678	1.97	11
SS-3	3.00	3.45	SM	-	-	-	-	-	-	-	-	-	-	-	7
SS-4	4.00	4.45	CL	-	-	-	-	-	-	-	-	-	-	-	30
SS-5	5.00	5.45	CL	100	99	97	73	15	41	21	20	-0.3	2.698	2.05	26
SS-6	6.00	6.45	CL	-	-	-	-	-	-	-	-	-	-	-	15
SS-7	7.00	7.45	SC	100	100	95	42	24	-	-	-	-	-	-	3
SS-8	8.00	8.40	CL	-	-	-	-	41	-	-	-	-	2.705	2.07	50/28cm
SS-9	9.00	9.07	SC	-	-	-	-	-	-	-	-	-	-	-	50/15cm
SS-10	10.00	10.05	SC	-	-	-	-	8	-	-	-	-	2.676	-	50/10cm
SS-11	11.00	11.03	SC	-	-	-	-	-	-	-	-	-	-	-	50/8cm

FILE : 0101-1

SUMMARY OF TEST RESULTS

PROJECT : 01.01 HUAI KAE
LOCATION : A. HUANG, KALASIN

BORING NO. : BH-2
DEPTH (m) : 9.05
GROUND EL.(m): 97.4
GWL DEPTH (m): 0.00

MADE BY : NARONG P.
DATE : 10/3/89
CHECKED BY : WITOON S.
DATE : 10/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	-	-	-	-	-	-	-	-	-	-	-	5
SS-2	2.00	2.45	SM	100	100	97	33	14	-	-	-	-	2.676	2.01	5
SS-3	3.00	3.45	SM	-	-	-	-	-	-	-	-	-	-	-	6
SS-4	4.00	4.45	SM	100	100	98	17	16	-	-	-	-	-	-	7
SS-5	5.00	5.10	SM	-	-	-	-	-	-	-	-	-	-	-	50/10cm
SS-6	6.00	6.15	SM	100	99	87	23	15	-	-	-	-	2.666	1.86	50/15cm
SS-7	7.00	7.10	SM	-	-	-	-	-	-	-	-	-	-	-	50/10cm
SS-8	8.00	8.07	CL	100	100	99	63	15	-	-	-	-	-	-	50/8cm

FILE : 0101-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3 | MADE BY : NARONG P.
DEPTH (m) : 10.40 | DATE : 10/3/89
PROJECT : 01.01 HUAI KAE | GROUND EL.(m): 99.45 | CHECKED BY : WITOON S.
LOCATION : A. MUANG, KALASIN | GWL DEPTH (m): -2.50 | DATE : 10/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	-	-	-	-	-	-	-	-	-	-	-	14
SS-2	2.00	2.45	SM	100	99	94	46	13	-	-	-	-	2.685	1.92	7
SS-3	3.00	3.45	SM	100	100	96	38	16	-	-	-	-	2.678	2.12	4
SS-4	4.00	4.45	SM	-	-	-	-	-	-	-	-	-	-	-	8
SS-5	5.00	5.45	SM	100	100	99	28	20	-	-	-	-	2.695	1.9	41
SS-6	6.00	6.30	SM	-	-	-	-	-	-	-	-	-	-	-	50/15cm
SS-7	7.00	7.25	SM	100	100	99	24	18	-	-	-	-	2.686	1.89	50/10cm
SS-8	8.00	8.30	SM	-	-	-	-	-	-	-	-	-	-	-	50/10cm
SS-9	9.00	9.22	CL	100	93	78	70	13	-	-	-	-	-	1.67	50/8cm
SS-10	10.00	10.40	CL	-	-	-	-	-	-	-	-	-	-	-	50/25cm

FILE : 0101-3

SUMMARY OF TEST RESULTS

PROJECT : 02.05 HUAI KHUN MUN
LOCATION : A.UBON RATTANA, KHON KAEN

BORING NO. : BH-1
DEPTH (m) : 15.15
GROUND EL.(m): 95.2
GWL DEPTH (m): -0.10

MADE BY : NARONG P.
DATE : 5/3/89
CHECKED BY : WITOON S.
DATE : 5/3/89

SAMPLE NO.	DEPTH (m)		USCS GROUP	GRADATION (% PASSING SIEVE)				NATURAL WATER CONTENT	ATTERBERG LIMITS (%) AND INDICIES				SP.GR	TOTAL UNIT WEIGHT	SPT-N
	FROM	TO		#4	#10	#40	#200	(%)	LL	PL	PI	LI	Gs	(t/cu.m)	
SS-1	1.00	1.45	SM	100	100	99	30	16	-	-	-	-	2.671	-	5
SS-2	2.00	2.45	CL/SC	100	100	99	53	17	-	-	-	-	2.685	1.25	2
SS-3	3.00	3.45	SM	-	-	-	-	-	-	-	-	-	-	-	1
SS-4	4.00	4.45	SM	-	-	-	-	-	-	-	-	-	-	-	5
SS-5	5.00	5.45	SC	-	-	-	-	-	-	-	-	-	-	-	4
SS-6	6.00	6.45	SC	-	-	-	-	-	-	-	-	-	-	-	5
SS-7	7.00	7.45	SM	100	100	99	34	26	-	-	-	-	2.688	-	1
SS-8	8.00	8.45	SC	-	-	-	-	-	-	-	-	-	-	-	15
SS-9	9.00	9.45	SC	-	-	-	-	-	-	-	-	-	-	-	18
SS-10	10.00	10.40	SP-SM	100	100	98	8	22	-	-	-	-	2.678	-	50/25cm
SS-11	11.00	11.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	45
SS-12	12.00	12.43	SP-SM	-	-	-	-	-	-	-	-	-	-	-	50/28cm
SS-13	13.00	13.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	50
SS-14	14.00	14.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	41
SS-15	15.00	15.15	SP-SM	-	-	-	-	-	NO RECOVERY		-	-	-	-	50/15cm

FILE : 0205-1

SUMMARY OF TEST RESULTS

BORING NO. : BH-2
DEPTH (m) : 20.35
GROUND EL.(m): 94.0
GWL DEPTH (m):+1.00

MADE BY : NARONG P.
DATE : 5/3/89
CHECKED BY : WITOON S.
DATE : 5/3/89

PROJECT : 02.05 HUAI KHUM MUN
LOCATION : A.UBON RATTANA, KHON KAEN

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	100	100	99	37	22	-	-	-	-	2.692	-	3
SS-2	2.00	2.45	SM	-	-	-	-	-	-	-	-	-	-	-	9
SS-3	3.00	3.45	SM	-	-	-	-	-	-	-	-	-	-	-	10
SS-4	4.00	4.45	SM	-	-	-	-	-	-	-	-	-	-	-	18
SS-5	5.00	5.45	SM	100	100	91	15	20	-	-	-	-	2.67	-	9
SS-6	6.00	6.45	SM	-	-	-	-	-	-	-	-	-	-	-	40
SS-7	7.00	7.40	SM	-	-	-	-	-	-	-	-	-	-	-	50/25cm
SS-8	8.00	8.45	SM	100	100	99	28	-	-	-	-	-	-	-	40
SS-9	9.00	9.45	SM	-	-	-	-	-	-	-	-	-	-	-	50
SS-10	10.00	10.45	SM	-	-	-	-	-	-	-	-	-	-	-	50
SS-11	11.00	11.45	SP-SM	100	100	68	11	21	-	-	-	-	2.677	-	27
SS-12	12.00	12.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	48
SS-13	13.00	13.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	37
SS-14	14.00	14.45	CL	-	-	-	-	-	-	-	-	-	-	-	45
SS-15	15.00	15.45	CL	-	-	-	-	32	-	-	-	-	2.708	1.88	32
SS-16	16.00	16.40	CL	-	-	-	-	-	-	-	-	-	-	-	50/25cm
SS-17	17.00	17.45	CL	-	-	-	-	-	-	-	-	-	-	-	49
SS-18	18.00	18.45	CL	-	-	-	-	-	-	-	-	-	-	-	49
SS-19	19.00	19.35	CL	-	-	-	-	-	-	-	-	-	-	-	50/20cm
SS-20	20.00	20.35	CL	-	-	-	-	-	-	-	-	-	-	-	50/20cm

FILE : 0205-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3
DEPTH (m) : 20.20
GROUND EL.(m): 97.0
GWL DEPTH (m): 0.00

MADE BY : NARONG P.
DATE : 5/3/89
CHECKED BY : WITOON S.
DATE : 5/3/89

PROJECT : 02.05 HUAI KHUM MUN
LOCATION : A.UBON RATTANA, KHON KAEN

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	100	99	99	85	18	-	-	-	-	2.689	-	8
SS-2	2.00	2.45	CL	-	-	-	-	-	-	-	-	-	-	-	4
SS-3	3.00	3.45	CL	-	-	-	-	33	-	-	-	-	2.713	-	2
SS-4	4.00	4.45	CL	-	-	-	-	-	-	-	-	-	-	-	10
SS-5	5.00	5.45	SM	-	-	-	-	-	-	-	-	-	-	-	9
SS-6	6.00	6.45	SM	-	-	-	-	-	-	-	-	-	-	-	18
SS-7	7.00	7.45	SM	-	-	-	-	-	-	-	-	-	-	-	10
SS-8	8.00	8.45	CL	-	-	-	-	27	-	-	-	-	-	1.97	14
SS-9	9.00	9.45	CL	-	-	-	-	-	-	-	-	-	-	-	16
SS-10	10.00	10.45	SM	-	-	-	-	-	-	-	-	-	-	-	13
SS-11	11.00	11.45	SM	-	-	-	-	-	-	-	-	-	-	-	13
SS-12	12.00	12.45	SM	-	-	-	-	-	-	-	-	-	-	-	41
SS-13	13.00	13.20	SM	-	-	-	-	21	-	-	-	-	-	-	50/20cm
SS-14	14.00	14.35	SM	-	-	-	-	-	-	-	-	-	-	-	50/20cm
SS-15	15.00	15.45	CL	-	-	-	-	25	-	-	-	-	2.74	-	16
SS-16	16.00	16.45	CL	-	-	-	-	-	-	-	-	-	-	-	41
SS-17	17.00	17.33	SC	-	-	-	-	-	-	-	-	-	-	-	50/18cm
SS-18	18.00	18.10	SM	-	-	-	-	-	-	-	-	-	-	-	50/10cm
SS-19	19.00	19.18	SM	-	-	-	-	-	-	-	-	-	-	-	50/18cm
SS-20	20.00	20.10	SM	-	-	-	-	-	-	-	-	-	-	-	50/10cm

FILE : 0205-3

SUMMARY OF TEST RESULTS

PROJECT : 04.01 HUAI SOENG NO.1
LOCATION : A. NAKAE, NAKHON PHANOM

BORING NO. : BH-1
DEPTH (m) : 10.03
GROUND EL.(m): 98.83
GWL DEPTH (m): -3.60

MADE BY : NARONG P.
DATE : 4/3/89
CHECKED BY : WITOON S.
DATE : 4/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	-	-	-	-	-	-	-	17
SS-2	2.00	2.45	CL	-	-	-	-	26	44	22	22	0.18	2.741	1.88	5
SS-3	3.00	3.45	CL	-	-	-	-	-	-	-	-	-	-	-	7
SS-4	4.00	4.45	CL	-	-	-	-	-	-	-	-	-	-	-	9
SS-5	5.00	5.07	CL	100	99	79	67	10	-	-	-	-	2.722	-	50/8cm
SS-6	6.00	6.05	CL	-	-	-	-	-	-	-	-	-	-	-	50/5cm
SS-7	7.00	7.03	CL	-	-	-	-	-	-	-	-	-	-	-	50/3cm
SS-8	8.00	8.05	CL	100	97	79	68	11	-	-	-	-	-	-	50/5cm
SS-9	9.00	9.03	CL	-	-	-	-	-	-	-	-	-	-	-	50/3cm
SS-10	10.00	10.03	CL	-	-	-	-	13	-	-	-	-	-	-	50/3cm

FILE : 0401-1

SUMMARY OF TEST RESULTS

PROJECT : 04.01 HUAI SOENG NO.1
LOCATION : A. NAKAE, NAKHON PHANOM

BORING NO. : BH-2
DEPTH (m) : 4.15
GROUND EL.(m): 97.17
GWL DEPTH (m): -0.30

MADE BY : NARONG P.
DATE : 4/3/89
CHECKED BY : WITOON S.
DATE : 4/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	-	-	-	-	-	-	-	3
SS-2	2.00	2.45	CL	-	-	-	-	28	31	18	13	0.77	2.738	2.05	4
SS-3	3.00	3.45	CL	-	-	-	-	-	-	-	-	-	-	-	6
SS-4	4.00	4.15	SC	74	51	38	34	14	-	-	-	-	-	-	50/15cm

FILE : 0401-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3 | MADE BY : HARONG P.
DEPTH (m) : 10.03 | DATE : 4/3/89
PROJECT : 04.01 HUAI SOENG NO.1 | GROUND EL.(m): 98.44 | CHECKED BY : WITOON S.
LOCATION : A. NAKAE, NAKHON PHANOM | GWL DEPTH (m): -3.00 | DATE : 4/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	-	-	-	-	-	-	-	7
SS-2	2.00	2.45	CL	-	-	-	-	20	29	15	14	0.36	2.710	2.04	7
SS-3	3.00	3.45	CL	-	-	-	-	-	-	-	-	-	-	-	3
SS-4	4.00	4.45	CL	-	-	-	-	18	20	11	9	0.78	-	2.10	2
SS-5	5.00	5.05	CL	100	98	79	68	9	-	-	-	-	2.695	-	50/5cm
SS-6	6.00	6.05	CL	-	-	-	-	-	-	-	-	-	-	-	50/5cm
SS-7	7.00	7.07	CL	-	-	-	-	-	-	-	-	-	-	-	50/8cm
SS-8	8.00	8.05	CL	-	-	-	-	-	-	-	-	-	-	-	50/5cm
SS-9	9.00	9.03	CL	-	-	-	-	-	-	-	-	-	-	-	50/3cm
SS-10	10.00	10.03	CL	-	-	-	-	-	-	-	-	-	-	-	50/3cm

FILE : 0401-3

SUMMARY OF TEST RESULTS

PROJECT : 04.02 HUAI SOENG NO.2
LOCATION : A. NAKAE, NAKHON PHANOM

BORING NO. : BH-1
DEPTH (m) : 9.07
GROUND EL.(m): 96.08
GWL DEPTH (m): -0.10

MADE BY : NARONG P.
DATE : 5/3/89
CHECKED BY : WITOON S.
DATE : 5/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CH	-	-	-	-	-	-	-	-	-	-	-	9
SS-2	2.00	2.45	CH	-	-	-	-	34	62	26	36	0.22	2.736	1.91	6
SS-3	3.00	3.45	CH	-	-	-	-	-	-	-	-	-	-	-	7
SS-4	4.00	4.15	SC/CL	-	-	-	-	-	-	-	-	-	-	-	50/15cm
SS-5	5.00	5.15	SC/CL	99	90	62	48	19	-	-	-	-	2.711	1.78	50/15cm
SS-6	6.00	6.12	SC/CL	-	-	-	-	-	-	-	-	-	-	-	50/13cm
SS-7	7.00	7.10	SC/CL	-	-	-	-	-	-	-	-	-	-	-	50/10cm
SS-8	8.00	8.10	SC/CL	100	90	64	49	15	-	-	-	-	-	1.64	50/10cm
SS-9	9.00	9.07	SC/CL	-	-	-	-	-	-	-	-	-	-	-	50/8cm

FILE : 0402-1

SUMMARY OF TEST RESULTS

PROJECT : 04.02 HUAI SOENG NO.2
LOCATION : A. NAKAE, NAKHON PHANOM

BORING NO. : BH-2
DEPTH (m) : 2.12
GROUND EL.(m): 92.4
GWL DEPTH (m): +1.50

MADE BY : NARONG P.
DATE : 5/3/89
CHECKED BY : WITOON S.
DATE : 5/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	100	99	95	89	23	-	-	-	-	2.684	1.94	6
SS-2	2.00	2.12	CL	94	81	64	59	10	-	-	-	-	2.707	-	50/13cm

FILE : 0402-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3 | MADE BY : NARONG P.
DEPTH (m) : 5.15 | DATE : 5/3/89
PROJECT : 04.02 NUAI SOENG NO.2 | GROUND EL.(m): 96.8 | CHECKED BY : WITOON S.
LOCATION : A. HAKAE, NAKHON PHANOM | GWL DEPTH (m): -1.30 | DATE : 5/3/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	-	-	-	-	-	-	-	9
SS-2	2.00	2.45	CL	-	-	-	-	26	30	19	11	0.64	2.746	1.89	9
SS-3	3.00	3.45	CL	-	-	-	-	-	-	-	-	-	-	-	5
SS-4	4.00	4.45	CL	-	-	-	-	26	-	-	-	-	-	2.02	16
SS-5	5.00	5.15	SC	97	69	50	44	13	-	-	-	-	2.723	-	50/15cm

FILE : 0402-3

SUMMARY OF TEST RESULTS

PROJECT : 05.01 LAM KLANG
LOCATION : A.NON SOONG, NAKHON RATCHASIMA

BORING NO. : BH-1
DEPTH (m) : 15.15
GROUND EL.(m): 97.7
GWL DEPTH (m): -1.20

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SC	-	-	-	-	15	-	-	-	-	-	-	14
SS-2	2.00	2.45	SC	91	90	85	21	13	33	13	20	0	2.715	2.14	29
SS-3	3.00	3.45	SC	-	-	-	-	14	-	-	-	-	-	-	35
SS-4	4.00	4.45	SC	-	-	-	-	12	-	-	-	-	-	-	48
SS-5	5.00	5.45	CL/SC	100	100	98	50	13	38	16	22	-0.13	2.711	2.18	35
SS-6	6.00	6.45	CL/SC	-	-	-	-	11	-	-	-	-	-	-	40
SS-7	7.00	7.39	SC	-	-	-	-	15	-	-	-	-	-	-	50/24 cm
SS-8	8.00	8.41	SC	100	100	85	32	13	22	10	12	0.25	2.693	-	50/25 cm
SS-9	9.00	9.36	SC	-	-	-	-	14	-	-	-	-	-	-	50/20 cm
SS-10	10.00	10.25	CL	-	-	-	-	17	-	-	-	-	-	-	50/25 cm
SS-11	11.00	11.38	CL	-	-	-	-	16	30	12	18	0.22	2.706	2.09	50/23 cm
SS-12	12.00	12.20	CL	-	-	-	-	15	-	-	-	-	-	-	50/20 cm
SS-13	13.00	13.20	CL	-	-	-	-	15	-	-	-	-	-	-	50/20 cm
SS-14	14.00	14.18	CL	-	-	-	-	15	-	-	-	-	-	-	50/18 cm
SS-15	15.00	15.15	CL	-	-	-	-	17	-	-	-	-	-	2.10	50/15 cm

FILE : 0501-1

SUMMARY OF TEST RESULTS

PROJECT : 05.01 LAM KLANG
LOCATION : A.NON SOONG, NAKHON RATCHASIMA

BORING NO. : BH-2
DEPTH (m) : 13.13
GROUND EL.(m): 96.6
GWL DEPTH (m):+0.30

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	17	-	-	-	-	-	1.99	13
SS-2	2.00	2.45	CL	-	-	-	-	12	31	13	18	0.06	2.718	2.19	56
SS-3	3.00	3.45	CL	-	-	-	-	12	-	-	-	-	-	-	32
SS-4	4.00	4.45	CL	-	-	-	-	14	-	-	-	-	-	2.15	34
SS-5	5.00	5.45	CL	-	-	-	-	20	-	-	-	-	-	-	18
SS-6	6.00	6.45	CL	100	99	92	64	15	37	16	21	-0.05	2.696	2.08	28
SS-7	7.00	7.45	CL	-	-	-	-	13	-	-	-	-	-	-	38
SS-8	8.00	8.45	CL	-	-	-	-	21	-	-	-	-	-	1.96	40
SS-9	9.00	9.36	CL	-	-	-	-	16	-	-	-	-	-	-	50/20 cm
SS-10	10.00	10.33	CL	-	-	-	-	16	30	13	17	0.18	2.681	1.84	50/18 cm
SS-11	11.00	11.23	CL	-	-	-	-	14	-	-	-	-	-	-	50/23 cm
SS-12	12.00	12.20	CL	-	-	-	-	17	-	-	-	-	-	-	50/20 cm
SS-13	13.00	13.13	CL	-	-	-	-	14	-	-	-	-	-	-	50/13 cm

FILE : 0501-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3
DEPTH (m) : 15.18
GROUND EL.(m): 99.5
GWL DEPTH (m): -1.60

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

PROJECT : 05.01 LAM KLANG
LOCATION : A.NON SOONG, NAKHON RATCHASIMA

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	-	-	-	-	7	-	-	-	-	-	-	6
SS-2	2.00	2.45	SM	99	96	76	16	11	-	-	-	-	2.691	1.81	38
SS-3	3.00	3.45	SM	-	-	-	-	13	-	-	-	-	-	-	10
SS-4	4.00	4.45	SC	100	100	98	41	14	31	12	19	0.11	-	2.13	22
SS-5	5.00	5.45	SC	-	-	-	-	13	-	-	-	-	-	-	50
SS-6	6.00	6.45	SC	100	100	97	32	14	-	-	-	-	2.696	2.11	29
SS-7	7.00	7.45	CL	-	-	-	-	19	-	-	-	-	-	-	23
SS-8	8.00	8.45	CL	-	-	-	-	14	35	14	21	0	-	2.13	29
SS-9	9.00	9.45	CL	-	-	-	-	16	-	-	-	-	-	-	38
SS-10	10.00	10.30	SC	100	100	98	32	13	-	-	-	-	2.712	-	58
SS-11	11.00	11.45	CL	-	-	-	-	18	-	-	-	-	-	-	54
SS-12	12.00	12.38	CL	-	-	-	-	17	-	-	-	-	-	-	50/23 cm
SS-13	13.00	13.36	CL	-	-	-	-	15	27	12	15	0.2	2.717	2.14	50/20 cm
SS-14	14.00	14.33	CL	-	-	-	-	13	-	-	-	-	-	-	50/18 cm
SS-15	15.00	15.18	CL	-	-	-	-	17	-	-	-	-	-	-	50/18 cm

FILE : 0501-3

SUMMARY OF TEST RESULTS

BORING NO. : BH-1
DEPTH (m) : 20.45
GROUND EL.(m): 95.9
GWL DEPTH (m): -0.30

MADE BY : NARONG P.
DATE : 20/2/89
CHECKED BY : WITOON S.
DATE : 20/2/89

PROJECT : 05.02 : LAM NAM MUN
LOCATION : A.PHIMAI, NAKHON RATCHASIMA

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SP-SM	100	100	98	9	23	-	-	-	-	2.691	1.87	8
SS-2	2.00	2.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	7
SS-3	3.00	3.45	SM	-	-	-	-	20	-	-	-	-	-	1.75	18
SS-4	4.00	4.45	SM	-	-	-	-	-	-	-	-	-	-	-	15
SS-5	5.00	5.45	SM	-	-	-	-	-	-	-	-	-	-	-	19
SS-6	6.00	6.45	SM	100	95	77	43	21	-	-	-	-	2.683	2.08	11
SS-7	7.00	7.45	SM	-	-	-	-	-	-	-	-	-	-	-	26
SS-8	8.00	8.45	SM	-	-	-	-	18	-	-	-	-	-	2.06	36
SS-9	9.00	9.45	SM	-	-	-	-	-	-	-	-	-	-	-	32
SS-10	10.00	10.45	SP-SM	100	100	99	8	22	-	-	-	-	2.692	1.75	45
SS-11	11.00	11.45	SM	-	-	-	-	-	-	-	-	-	-	-	19
SS-12	12.00	12.45	SM	-	-	-	-	-	-	-	-	-	-	-	48
SS-13	13.00	13.45	SM	99	96	72	41	78	-	-	-	-	-	1.92	60
SS-14	14.00	14.45	CH	-	-	-	-	-	-	-	-	-	-	-	9
SS-15	15.00	15.45	CH	-	-	-	-	33	62	27	35	0.17	2.722	1.88	7
SS-16	16.00	16.45	CH	-	-	-	-	-	-	-	-	-	-	-	6
SS-17	17.00	17.45	CH,SM	-	-	-	-	26	-	-	-	-	-	2.04	12
SS-18	18.00	18.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	24
SS-19	19.00	19.45	SP-SM	100	100	95	9	22	-	-	-	-	2.699	1.83	51
SS-20	20.00	20.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	50/22cm

FILE : 0502-1

SUMMARY OF TEST RESULTS

BORING NO. : BH-2
DEPTH (m) : 27.45
GROUND EL.(m): 94.9
GWL DEPTH (m): -0.30

MADE BY : HARONG P.
DATE : 20/2/89
CHECKED BY : WITOON S.
DATE : 20/2/89

PROJECT : 05.02 : LAM NAM MUN
LOCATION : A.PHIMAI, NAKHON RATCHASIMA

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SP-SM	100	99	67	5	19	-	-	-	-	2.697	1.65	22
SS-2	2.00	2.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	26
SS-3	3.00	3.45	SP-SM	-	-	-	-	15	-	-	-	-	-	1.94	16
SS-4	4.00	4.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	12
SS-5	5.00	5.45	SP-SM	100	100	97	10	22	-	-	-	-	2.689	1.79	37
SS-6	6.00	6.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	22
SS-7	7.00	7.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	22
SS-8	8.00	8.45	SP-SM	99	99	60	4	21	-	-	-	-	-	1.92	36
SS-9	9.00	9.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	54
SS-10	10.00	10.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	22
SS-11	11.00	11.45	SM	99	79	33	16	16	-	-	-	-	2.698	2.05	19
SS-12	12.00	12.45	SM	-	-	-	-	-	-	-	-	-	-	-	23
SS-13	13.00	13.45	CL	-	-	-	-	33	-	-	-	-	-	1.89	11
SS-14	14.00	14.45	CL	-	-	-	-	-	-	-	-	-	-	-	8
SS-15	15.00	15.45	CL	-	-	-	-	33	48	21	27	0.44	2.712	1.89	8
SS-16	16.00	16.45	CL	-	-	-	-	-	-	-	-	-	-	-	12
SS-17	17.00	17.45	CL	-	-	-	-	23	27	11	16	0.75	2.717	2.11	14
SS-18	18.00	18.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	40
SS-19	19.00	19.45	SP-SM	100	100	94	9	22	-	-	-	-	2.697	1.84	48
SS-20	20.00	20.45	CL	-	-	-	-	-	-	-	-	-	-	-	33
SS-21	21.00	21.45	CL	-	-	-	-	-	-	-	-	-	-	-	37
SS-22	22.00	22.45	CL	-	-	-	-	28	47	20	27	0.3	-	1.88	40
SS-23	23.00	23.45	CL	-	-	-	-	-	-	-	-	-	-	-	41
SS-24	24.00	24.45	CL	-	-	-	-	-	-	-	-	-	-	-	40
SS-25	25.00	25.45	CH	-	-	-	-	27	53	23	30	0.13	2.730	2.02	42
SS-26	26.00	26.45	CH	-	-	-	-	-	-	-	-	-	-	-	49
SS-27	27.00	27.45	CH	-	-	-	-	-	-	-	-	-	-	-	52

FILE : 0502-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3 | MADE BY : NARONG P.
DEPTH (m) : 20.45 | DATE : 20/2/89
PROJECT : 05.02 : LAM NAM MUN | GROUND EL.(m): 96.2 | CHECKED BY : WITOON S.
LOCATION : A.PHIMAI, NAKHON RATCHASIMA | GWL DEPTH (m): -1.35 | DATE : 20/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	-	-	-	-	20	-	-	-	-	-	1.84	13
SS-2	2.00	2.45	SM	-	-	-	-	-	-	-	-	-	-	-	9
SS-3	3.00	3.45	SM	100	100	61	29	21	-	-	-	-	2.696	1.78	19
SS-4	4.00	4.45	-	-	-	-	-	- NO RECOVERY			-	-	-	-	8
SS-5	5.00	5.45	SM	-	-	-	-	21	-	-	-	-	-	1.84	23
SS-6	6.00	6.45	SC	-	-	-	-	-	-	-	-	-	-	-	18
SS-7	7.00	7.45	SM-SC	91	71	27	17	15	17	11	6	0.67	2.698	2.02	5
SS-8	8.00	8.45	PT	-	-	-	-	22	-	-	-	-	-	-	50/15cm
SS-9	9.00	9.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	49
SS-10	10.00	10.45	SP-SM	100	100	94	8	25	-	-	-	-	2.692	1.94	27
SS-11	11.00	11.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	35
SS-12	12.00	12.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	45
SS-13	13.00	13.45	SP-SM	-	-	-	-	23	-	-	-	-	-	1.71	50/28cm
SS-14	14.00	14.45	SP-SM	-	-	-	-	- NO RECOVERY			-	-	-	-	36
SS-15	15.00	15.45	SP-SM	100	98	62	7	20	-	-	-	-	2.708	1.81	50/20
SS-16	16.00	16.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	64
SS-17	17.00	17.45	SC	-	-	-	-	-	-	-	-	-	-	-	40
SS-18	18.00	18.45	SM	100	99	38	24	16	-	-	-	-	2.695	2.09	50/20cm
SS-19	19.00	19.45	PT	-	-	-	-	30	-	-	-	-	-	-	50/10cm
SS-20	20.00	20.45	SM	-	-	-	-	17	-	-	-	-	-	2.12	50/28cm

FILE : 0502-3

SUMMARY OF TEST RESULTS

BORING NO. : BH-1
DEPTH (m) : 22.03
GROUND EL.(m): 98.0
GWL DEPTH (m): -5.50

MADE BY : NARONG P.
DATE : 20/2/89
CHECKED BY : WITOON S.
DATE : 20/2/89

PROJECT : 05.03 : LAM PHRA PHLOENG
LOCATION : A.PAK THONG CHAI, NAKHON RATCHASIMA

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	12	-	-	-	-	-	-	8
SS-2	2.00	2.45	CL	100	100	100	62	12	-	-	-	-	-	-	9
SS-3	3.00	3.45	CL	100	100	100	67	15	25	11	14	0.29	2.721	2.07	9
SS-4	4.00	4.45	CL	-	-	-	-	19	-	-	-	-	-	-	3
SS-5	5.00	5.45	SC	-	-	-	-	18	-	-	-	-	-	-	4
SS-6	6.00	6.45	SC	100	100	96	40	18	25	10	15	0.53	2.711	2.04	5
SS-7	7.00	7.45	SM	-	-	-	-	19	-	-	-	-	-	-	17
SS-8	8.00	8.45	SC	-	-	-	-	25	-	-	-	-	-	-	31
SS-9	9.00	9.45	SP-SM	96	62	17	3	15	-	-	-	-	2.687	1.85	17
SS-10	10.00	10.45	SC	-	-	-	-	17	-	-	-	-	-	-	20
SS-11	11.00	11.45	SM	100	98	82	24	18	-	-	-	-	-	-	23
SS-12	12.00	12.45	CL	-	-	-	-	32	-	-	-	-	-	-	22
SS-13	13.00	13.45	CL	100	100	99	94	20	37	15	22	0.23	2.731	2.05	27
SS-14	14.00	14.45	CL	-	-	-	-	16	-	-	-	-	-	-	18
SS-15	15.00	15.45	CL	-	-	-	-	17	-	-	-	-	-	-	20
SS-16	16.00	16.45	SC/CL	-	-	-	-	16	-	-	-	-	-	-	24
SS-17	17.00	17.45	SC/CL	-	-	-	-	12	-	-	-	-	-	-	25
SS-18	18.00	18.45	SC/CL	99	98	90	46	16	25	15	10	0.1	2.696	2.04	21
SS-19	19.00	19.45	SC/CL	-	-	-	-	15	-	-	-	-	-	-	25
SS-20	20.00	20.40	CL	96	89	81	62	13	40	17	23	-0.17	2.701	2.21	50/25cm
SS-21	21.00	21.22	CL	-	-	-	-	14	-	-	-	-	-	-	50/23cm
SS-22	22.00	22.03	SM	-	-	-	-	- NO RECOVERY			-	-	-	-	50/3cm

FILE : 0503-1

SUMMARY OF TEST RESULTS

BORING NO. : BH-2
DEPTH (m) : 18.05
GROUND EL.(m): 90.4
GWL DEPTH (m): 0.02

MADE BY : NARONG P.
DATE : 20/2/89
CHECKED BY : WITOON S.
DATE : 20/2/89

PROJECT : 05.03 : LAM PHRA PHLOENG
LOCATION : A.PAK THONG CHAI, NAKHON RATCHASIMA

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	100	99	97	61	30	-	-	-	-	-	-	6
SS-2	2.00	2.45	CL	100	99	78	63	25	-	-	-	-	2.712	2.05	10
SS-3	3.00	3.45	CL	-	-	-	-	-	-	-	-	-	-	-	16
SS-4	4.00	4.45	SC	100	100	86	40	20	-	-	-	-	2.705	2.15	11
SS-5	5.00	5.45	SM	-	-	-	-	-	-	-	-	-	-	-	17
SS-6	6.00	6.45	CL	100	100	99	86	23	-	-	-	-	-	2.02	20
SS-7	7.00	7.45	CL	-	-	-	-	-	-	-	-	-	-	-	31
SS-8	8.00	8.45	CL	-	-	-	-	-	-	-	-	-	-	-	20
SS-9	9.00	9.45	CL	-	-	-	-	21	-	-	-	-	2.722	2.11	16
SS-10	10.00	10.45	CL	-	-	-	-	-	-	-	-	-	-	-	30
SS-11	11.00	11.45	SC	-	-	-	-	-	-	-	-	-	-	-	31
SS-12	12.00	12.45	SC	100	99	92	43	17	-	-	-	-	-	2.09	45
SS-13	13.00	13.45	CL	-	-	-	-	-	-	-	-	-	-	-	30
SS-14	14.00	14.45	CL	-	-	-	-	19	-	-	-	-	2.699	2.08	26
SS-15	15.00	15.45	CL	-	-	-	-	-	-	-	-	-	-	-	28
SS-16	16.00	16.45	SC/CL	99	98	94	47	22	-	-	-	-	-	1.99	28
SS-17	17.00	17.45	CL	-	-	-	-	28	-	-	-	-	-	1.99	7
SS-18	18.00	18.05	SM	-	-	-	-	-	-	-	-	-	-	-	50/5cm

FILE : 0503-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3
DEPTH (m) : 20.22
GROUND EL.(m): 94.4
GWL DEPTH (m): -5.50

MADE BY : NARONG P.
DATE : 20/2/89
CHECKED BY : WITOON S.
DATE : 20/2/89

PROJECT : 05.03 : LAM PHRA PHLOENG
LOCATION : A.PAK THONG CHAI, NAKHON RATCHASIMA

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	17	-	-	-	-	-	-	8
SS-2	2.00	2.45	CL	100	99	98	87	17	44	21	23	-0.17	2.712	1.69	9
SS-3	3.00	3.45	CL	100	100	92	59	15	-	-	-	-	-	-	9
SS-4	4.00	4.45	CL	-	-	-	-	26	-	-	-	-	-	-	3
SS-5	5.00	5.45	CL	-	-	-	-	19	49	21	28	-0.07	2.694	2.02	4
SS-6	6.00	6.45	CL	-	-	-	-	18	-	-	-	-	-	-	5
SS-7	7.00	7.45	CL	-	-	-	-	22	-	-	-	-	-	-	17
SS-8	8.00	8.45	CL	100	97	77	62	23	49	20	29	0.1	2.696	1.92	31
SS-9	9.00	9.45	CL	-	-	-	-	28	-	-	-	-	-	-	17
SS-10	10.00	10.45	SC	99	92	48	23	13	-	-	-	-	2.686	-	20
SS-11	11.00	11.45	CL	-	-	-	-	20	-	-	-	-	-	-	23
SS-12	12.00	12.45	CL	-	-	-	-	19	26	14	12	0.42	-	2.14	22
SS-13	13.00	13.45	CL	-	-	-	-	20	-	-	-	-	-	-	27
SS-14	14.00	14.45	SC	-	-	-	-	15	-	-	-	-	-	-	18
SS-15	15.00	15.45	SC	100	99	92	18	16	-	-	-	-	2.71	2.11	20
SS-16	16.00	16.45	SC	-	-	-	-	19	-	-	-	-	-	-	24
SS-17	17.00	17.45	CL	100	100	99	59	19	-	-	-	-	-	2.01	25
SS-18	18.00	18.45	SC	-	-	-	-	16	-	-	-	-	-	-	21
SS-19	19.00	19.45	SC	100	100	97	41	16	-	-	-	-	2.721	-	25
SS-20	20.00	20.22	SC	-	-	-	-	17	-	-	-	-	-	-	50/23cm

FILE : 0503-3

SUMMARY OF TEST RESULTS

BORING NO. : BH-1
DEPTH (m) : 14.05
GROUND EL.(m): 99.5
GWL DEPTH (m): -3.20

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

PROJECT : 11.01 LAM NAM KAM
LOCATION : A. MUANG, SAKON NAKHON

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	-	-	-	-	-	-	-	-	-	-	-	12
SS-2	2.00	2.45	SM	100	100	99	46	14	-	-	-	-	2.672	1.86	14
SS-3	3.00	3.45	CL	-	-	-	-	-	-	-	-	-	-	-	8
SS-4	4.00	4.45	CL	100	100	98	55	19	-	-	-	-	2.683	2.17	5
SS-5	5.00	5.45	CL	-	-	-	-	-	-	-	-	-	-	-	6
SS-6	6.00	6.45	CL	-	-	-	-	23	-	-	-	-	-	2.03	4
SS-7	7.00	7.45	SM	-	-	-	-	-	-	-	-	-	-	-	5
SS-8	8.00	8.45	SM	-	-	-	-	-	-	-	-	-	-	-	15
SS-9	9.00	9.45	SM	99	96	87	29	18	-	-	-	-	2.694	2.05	1
SS-10	10.00	10.45	SC	-	-	-	-	-	-	-	-	-	-	-	21
SS-11	11.00	11.37	CL	-	-	-	-	-	-	-	-	-	-	-	50/23cm
SS-12	12.00	12.15	CL	-	-	-	-	17	-	-	-	-	2.710	1.75	50/15cm
SS-13	13.00	13.10	CL	-	-	-	-	-	-	-	-	-	-	-	50/10cm
SS-14	14.00	14.05	CL	-	-	-	-	-	-	-	-	-	-	-	50/5cm

FILE : 1101-1

SUMMARY OF TEST RESULTS

BORING NO. : BH-2
DEPTH (m) : 9.03
GROUND EL.(m): 95.0
GWL DEPTH (m): 0.00

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

PROJECT : 11.01 LAM NAM KAM
LOCATION : A. MUANG, SAKON NAKHON

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SC	-	-	-	-	-	-	-	-	-	-	-	5
SS-2	2.00	2.45	SP-SM	98	95	67	7	21	-	-	-	-	2.691	1.83	9
SS-3	3.00	3.45	SC	95	90	83	33	24	-	-	-	-	2.694	2.05	23
SS-4	4.00	4.45	SC	84	58	42	33	22	-	-	-	-	2.679	2.05	11
SS-5	5.00	5.45	CL	-	-	-	-	-	-	-	-	-	-	-	21
SS-6	6.00	6.30	CL	-	-	-	-	23	-	-	-	-	-	1.76	50/15cm
SS-7	7.00	7.25	CL	-	-	-	-	-	-	-	-	-	-	-	50/10cm
SS-8	8.00	8.35	CL	-	-	-	-	19	-	-	-	-	-	1.78	50/15cm
SS-9	9.00	9.03	CL	-	-	-	-	-	-	-	-	-	-	-	50/3cm

FILE : 1101-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3
DEPTH (m) : 19.05
GROUND EL.(m): 99.6
GWL DEPTH (m): -3.00

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

PROJECT : 11.01 LAM NAM KAM
LOCATION : A. MUANG, SAKON NAKHON

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	100	99	98	44	15	-	-	-	-	2.663	1.74	2
SS-2	2.00	2.45	SM	-	-	-	-	-	-	-	-	-	-	-	18
SS-3	3.00	3.45	SM	-	-	-	-	19	-	-	-	-	-	-	7
SS-4	4.00	4.45	SM	-	-	-	-	-	-	-	-	-	-	-	12
SS-5	5.00	5.45	SC	99	98	90	36	18	-	-	-	-	2.681	2.14	4
SS-6	6.00	6.45	SC	-	-	-	-	-	-	-	-	-	-	-	8
SS-7	7.00	7.45	SC	100	100	97	32	18	-	-	-	-	2.669	2.07	10
SS-8	8.00	8.45	CL	-	-	-	-	-	-	-	-	-	-	-	35
SS-9	9.00	9.45	CL	-	-	-	-	-	-	-	-	-	-	-	41
SS-10	10.00	10.45	CL	-	-	-	-	30	-	-	-	-	-	1.99	27
SS-11	11.00	11.45	CL	-	-	-	-	-	-	-	-	-	-	-	34
SS-12	12.00	12.45	CL	-	-	-	-	-	-	-	-	-	-	-	29
SS-13	13.00	13.45	CL	-	-	-	-	30	-	-	-	-	2.692	1.95	18
SS-14	14.00	14.45	CL	-	-	-	-	-	-	-	-	-	-	-	20
SS-15	15.00	15.45	CL	-	-	-	-	-	-	-	-	-	-	-	27
SS-16	16.00	16.32	CL	-	-	-	-	21	-	-	-	-	-	1.71	50/29cm
SS-17	17.00	17.07	CL	-	-	-	-	-	-	-	-	-	-	-	50/9cm
SS-18	18.00	18.10	CL	-	-	-	-	18	-	-	-	-	-	-	50/10cm
SS-19	19.00	19.05	CL	-	-	-	-	-	-	-	-	-	-	-	50/5cm

FILE : 1101-3

SUMMARY OF TEST RESULTS

PROJECT : 14.02 LAM NAM PHUAI
LOCATION : A. SI BUN RUANG, UDON THANI

BORING NO. : BH-1
DEPTH (m) : 11.08
GROUND EL.(m): 96.0
GWL DEPTH (m): -2.95

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SC/CL	-	-	-	-	-	-	-	-	-	-	-	11
SS-2	2.00	2.45	SC/CL	100	100	99	49	17	23	14	9	0.33	2.967	2.06	10
SS-3	3.00	3.45	SM	-	-	-	-	-	-	-	-	-	-	-	14
SS-4	4.00	4.45	SM	-	-	-	-	-	-	-	-	-	-	-	24
SS-5	5.00	5.45	SM	96	88	70	18	20	-	-	-	-	2.681	-	1
SS-6	6.00	6.45	CL	-	-	-	-	-	-	-	-	-	-	-	19
SS-7	7.00	7.45	SM	100	100	97	18	19	-	-	-	-	2.682	-	18
SS-8	8.00	8.35	SM	-	-	-	-	-	-	-	-	-	-	-	50/20 cm
SS-9	9.00	9.08	CL	-	-	-	-	13	-	-	-	-	-	1.95	50/8 cm
SS-10	10.00	10.03	CL	-	-	-	-	-	-	-	-	-	-	-	50/3 cm
SS-11	11.00	11.08	CL	-	-	-	-	-	-	-	-	-	-	-	50/8 cm

FILE : 1402-1

SUMMARY OF TEST RESULTS

PROJECT : 14.02 LAM NAM PHUAI
LOCATION : A. SI BUN RUANG, UDON THANI

BORING NO. : BH-2
DEPTH (m) : 6.05
GROUND EL.(m): 92.85
GWL DEPTH (m): -0.05

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTEHT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SP-SM	66	42	20	8	10	-	-	-	-	2.671	-	29
SS-2	2.00	2.45	SP-SM	-	-	-	-	-	-	-	-	-	-	-	20
SS-3	3.00	3.45	SM	82	66	39	12	15	-	-	-	-	2.679	-	9
SS-4	4.00	4.45	SC/CL	100	100	99	48	17	-	-	-	-	2.707	2.09	20
SS-5	5.00	5.20	SM	63	48	26	14	12	-	-	-	-	-	-	50/20cm
SS-6	6.00	6.05	SM	-	-	-	-	-	NO RECOVERY		-	-	-	-	50/5cm

FILE : 1402-2

SUMMARY OF TEST RESULTS

PROJECT : 14.02 LAM NAM PHUAI
LOCATION : A. SI BUN RUANG, UDON THANI

BORING NO. : BH-3
DEPTH (m) : 10.18
GROUND EL.(m): 93.48
GWL DEPTH (m): -3.10

MADE BY : NARONG P.
DATE : 23/2/89
CHECKED BY : WITOON S.
DATE : 23/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	100	100	99	70	11	25	16	9	-0.56	2.709	2.08	22
SS-2	2.00	2.45	CL	-	-	-	-	-	-	-	-	-	-	-	26
SS-3	3.00	3.45	CL	100	100	99	80	17	-	-	-	-	2.692	2.05	16
SS-4	4.00	4.45	SM	-	-	-	-	-	-	-	-	-	-	-	24
SS-5	5.00	5.45	SM-SC	95	80	52	32	8	19	12	7	-0.57	2.662	1.85	37
SS-6	6.00	6.45	SM-SC	-	-	-	-	-	-	-	-	-	-	-	44
SS-7	7.00	7.40	SM	68	54	34	15	11	-	-	-	-	-	-	50/25 cm
SS-8	8.00	8.45	SM	-	-	-	-	-	-	-	-	-	-	-	50/15 cm
SS-9	9.00	9.10	SM	-	-	-	-	12	-	-	-	-	2.686	1.9	50/10 cm
SS-10	10.00	10.18	SM	-	-	-	-	-	-	-	-	-	-	-	50/18 cm

FILE : 1402-3

SUMMARY OF TEST RESULTS

PROJECT : 15.07 LAM SOM
LOCATION : A. DET UDOM, UBON RATCHATHANI

BORING NO. : BH-1
DEPTH (m) : 8.27
GROUND EL.(m): 98.5
GWL DEPTH (m): not found

MADE BY : NARONG P.
DATE : 25/2/89
CHECKED BY : WITOON S.
DATE : 25/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	100	100	99	28	9	-	-	-	-	2.687	1.64	11
SS-2	2.00	2.45	SM	-	-	-	-	-	-	-	-	-	-	-	6
SS-3	3.00	3.45	SM	100	99	96	41	13	-	-	-	-	2.696	1.79	8
SS-4	4.00	4.45	SM	-	-	-	-	-	NO RECOVERY		-	-	-	-	7
SS-5	5.00	5.45	SM	-	-	-	-	-	NO RECOVERY		-	-	-	-	12
SS-6	6.00	6.45	SC/CL	100	100	99	49	23	-	-	-	-	2.708	2.07	1
SS-7	7.00	7.45	SM	-	-	-	-	-	-	-	-	-	-	-	22
SS-8	8.00	8.12	SM	-	-	-	-	14	-	-	-	-	2.723	-	50/13cm
SS-9	8.12	8.27	SM	-	-	-	-	-	-	-	-	-	-	-	50/15cm

FILE : 1507-1

SUMMARY OF TEST RESULTS

PROJECT : 15.07 LAM SOM
LOCATION : A. DET UDOM, UBON RATCHATHANI

BORING NO. : BH-2
DEPTH (m) : 1.45
GROUND EL.(m): 93.4
GWL DEPTH (m): +1.80

MADE BY : NARONG P.
DATE : 25/2/89
CHECKED BY : WITOON S.
DATE : 25/2/89

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	SM	98	95	66	21	22	-	-	-	-	2.697	1.80	49

FILE : 1507-2

SUMMARY OF TEST RESULTS

BORING NO. : BH-3
DEPTH (m) : 9.08
GROUND EL.(m): 98.4
GWL DEPTH (m): -3.90

MADE BY : NARONG P.
DATE : 25/2/89
CHECKED BY : WITOON S.
DATE : 25/2/89

PROJECT : 15.07 LAM SOM
LOCATION : A. DET UDOM, UBON RATCHATHANI

SAMPLE NO.	DEPTH (m) FROM	DEPTH (m) TO	USCS GROUP	GRADATION (% PASSING SIEVE) #4	#10	#40	#200	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%) AND INDICIES LL	PL	PI	LI	SP.GR Gs	TOTAL UNIT WEIGHT (t/cu.m)	SPT-N
SS-1	1.00	1.45	CL	-	-	-	-	15	-	-	-	-	2.736	2.00	9
SS-2	2.00	2.45	CL	-	-	-	-	-	-	-	-	-	-	-	12
SS-3	3.00	3.45	CL	-	-	-	-	19	-	-	-	-	-	1.94	59
SS-4	4.00	4.45	CL	-	-	-	-	-	-	-	-	-	-	-	18
SS-5	5.00	5.45	CL	-	-	-	-	13	-	-	-	-	2.712	2.12	23
SS-6	6.00	6.45	CL	-	-	-	-	-	-	-	-	-	-	-	7
SS-7	7.00	7.45	SP-SM	100	98	98	9	22	-	-	-	-	2.693	1.75	9
SS-8	8.00	8.31	SP-SM	100	100	97	10	19	-	-	-	-	-	1.63	50/17cm
SS-9	9.00	9.08	SM	-	-	-	-	16	-	-	-	-	-	-	50/8cm

FILE : 1507-3

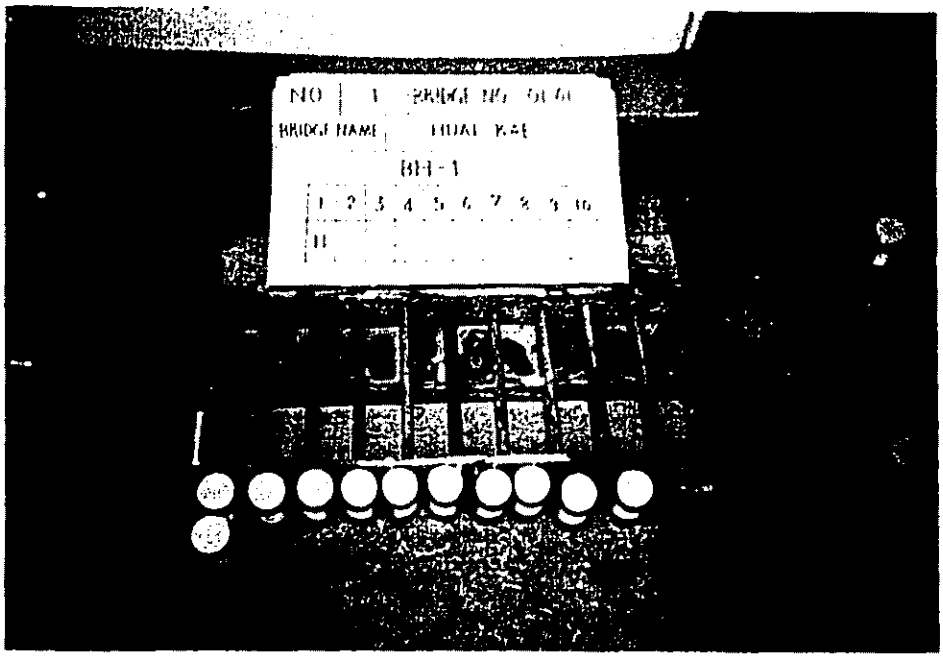
APPENDIX D

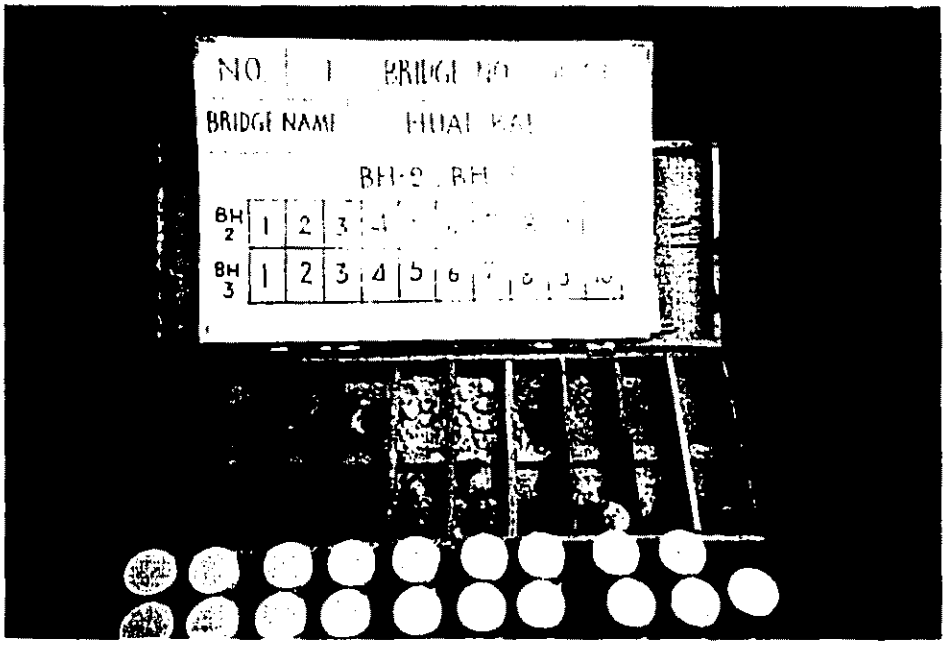
PHOTOGRAPHS OF COREBOX SAMPLES

(1) Bridge No.01.01

Bridge Name HUAI KAE

BH-1,2,3

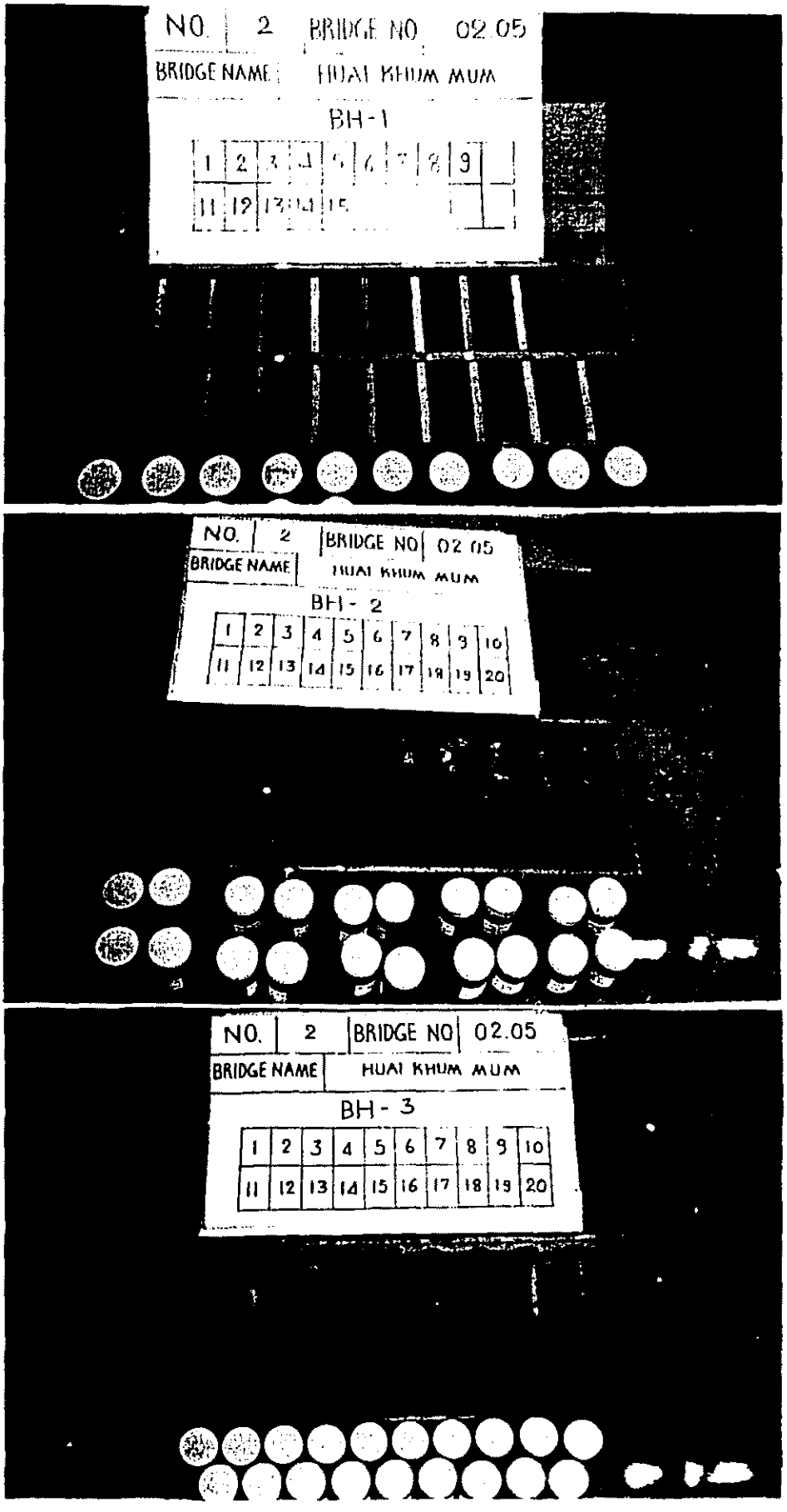




(2) Bridge No.02.05

Bridge Name HUAI KHUM MUM

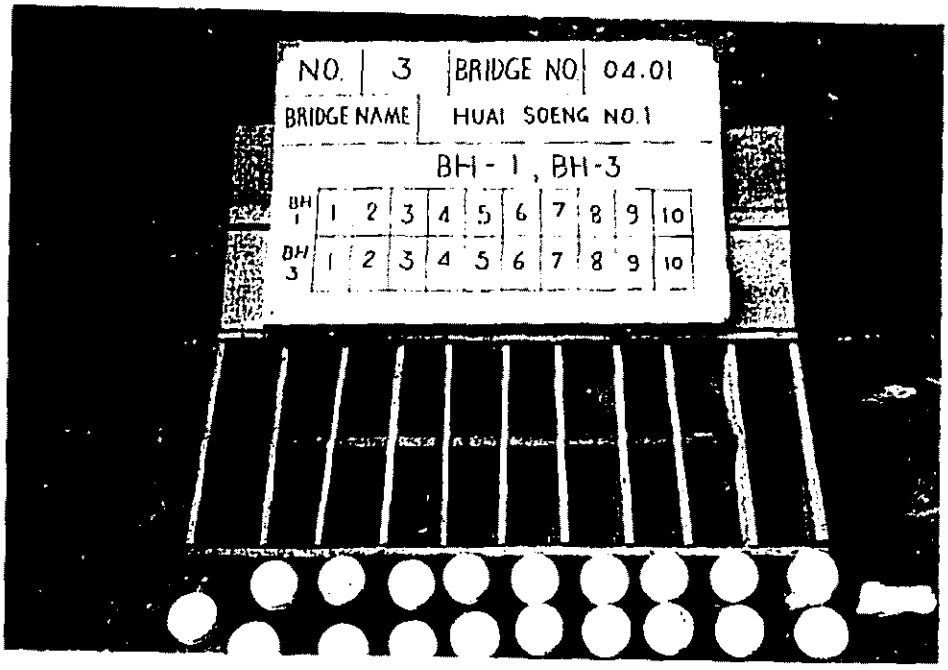
BH-1,2,3

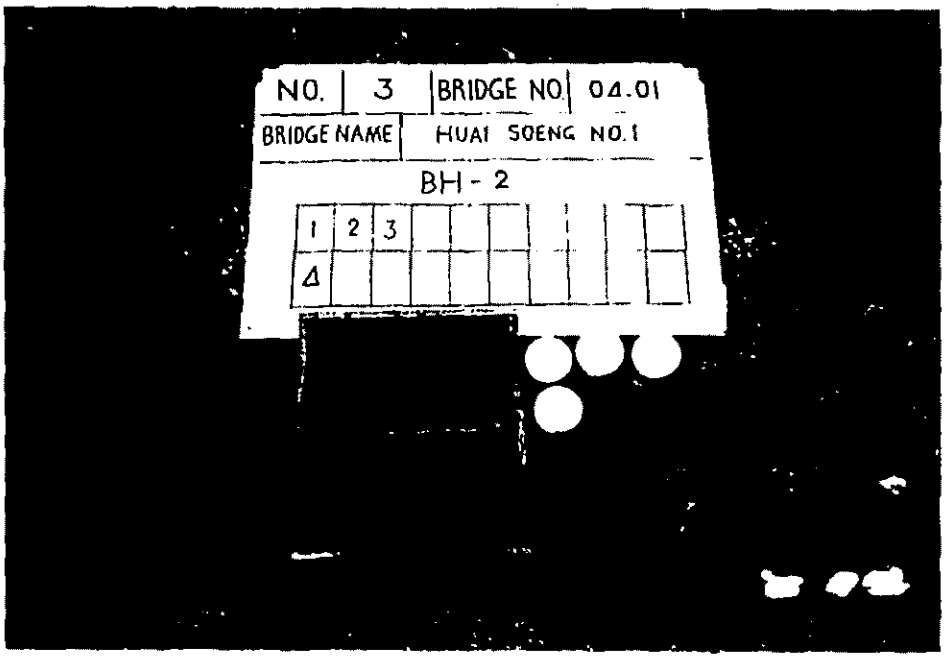


(3) Bridge No.04.01

Bridge Name HUAI SOENG NO.1

BH-1,2,3

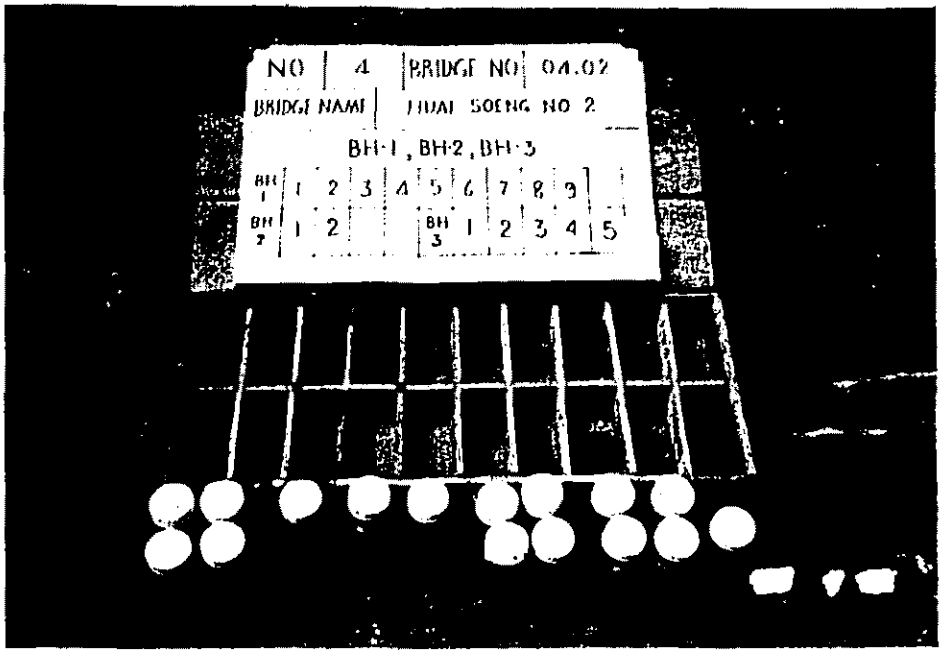




(4) Bridge No.04.02

Bridge Name HUAI SOENG NO.2

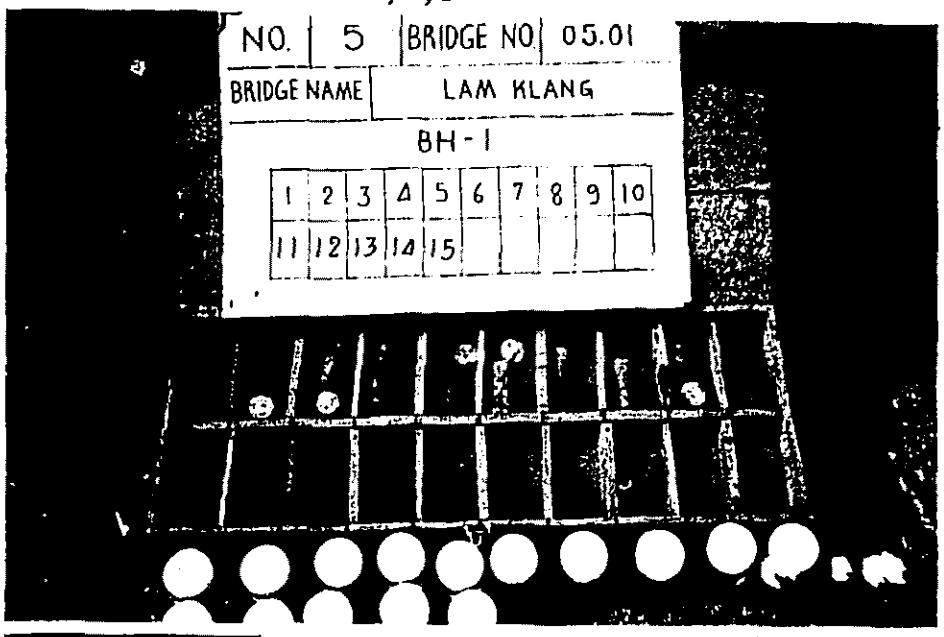
BH-1,2,3

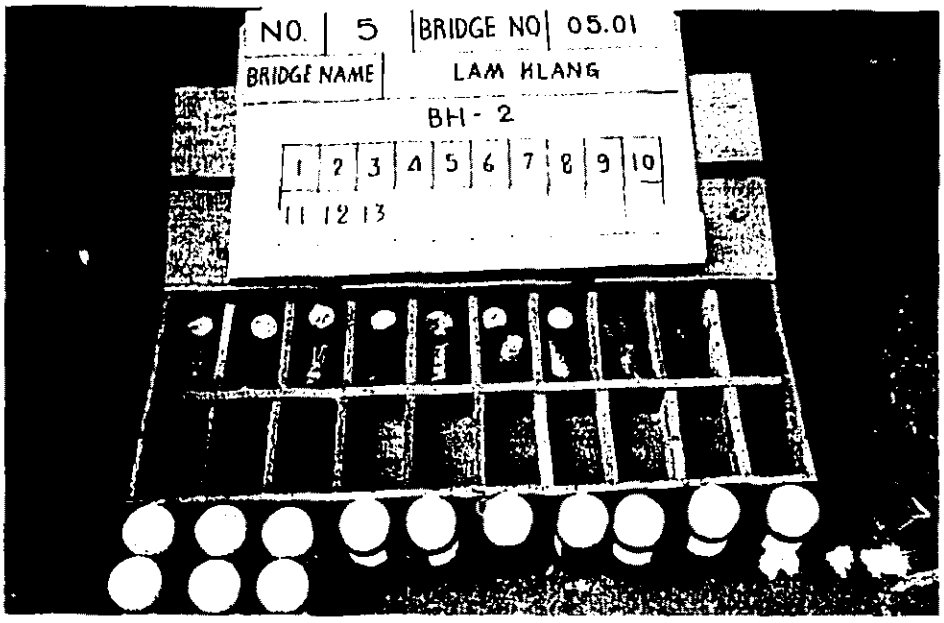


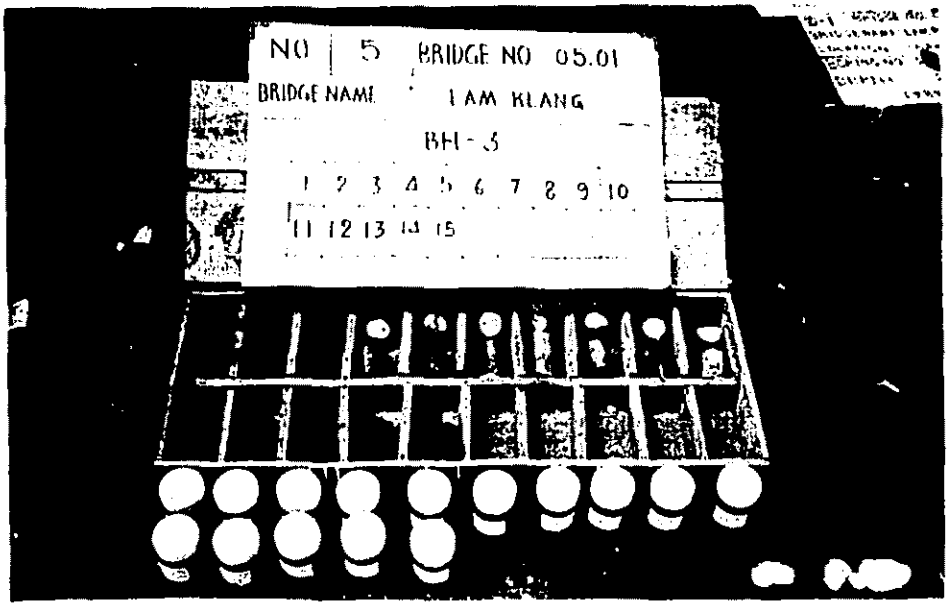
(5) Bridge No.05.01

Bridge Name LAM KLANG

BH-1,2,3



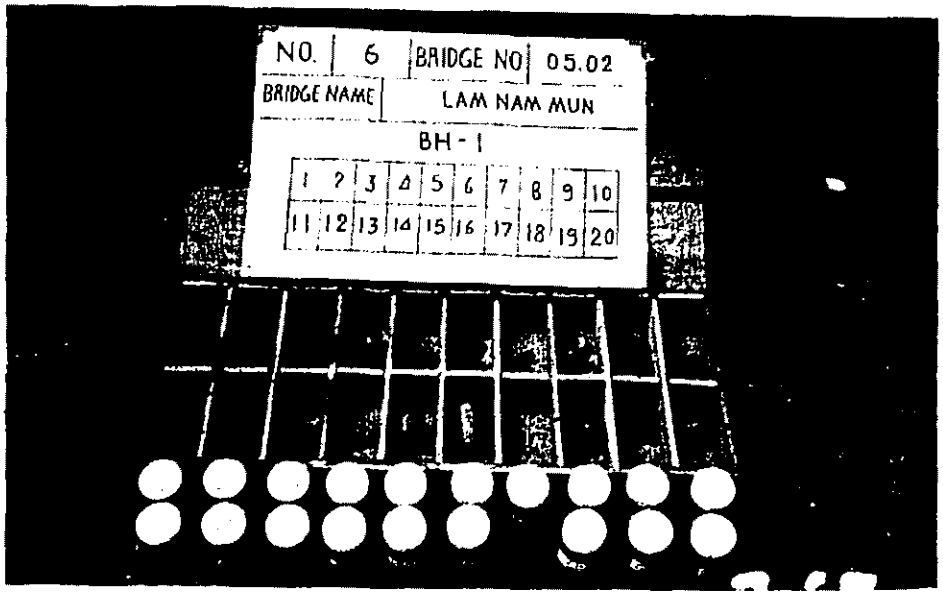


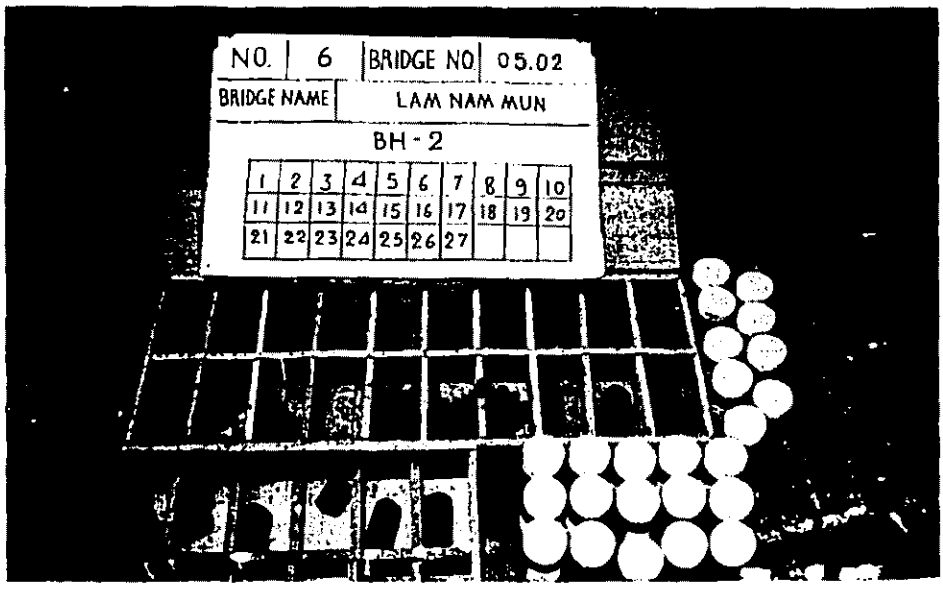


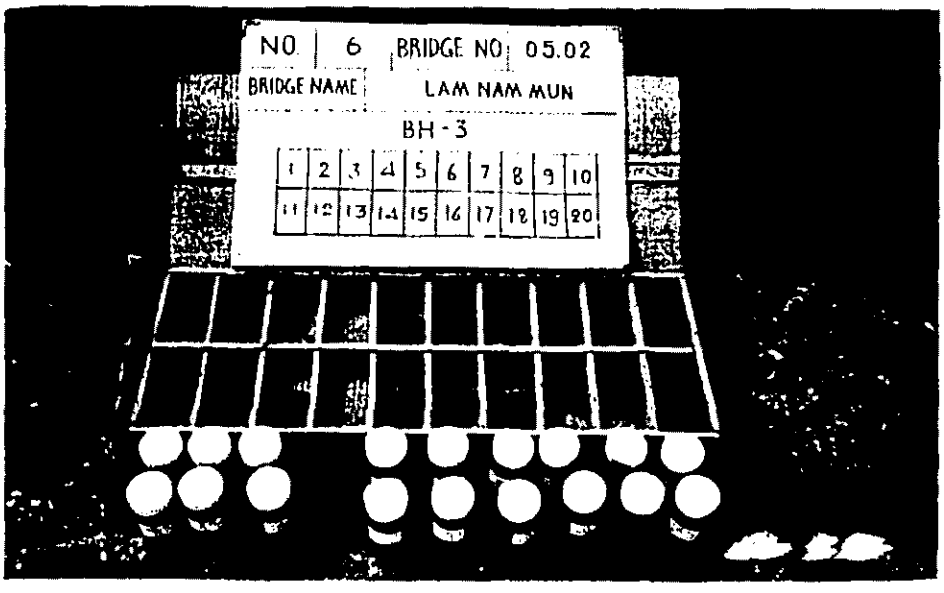
(6) Bridge No.05.02

Bridge Name LAM NAM MUN

BH-1,2,3



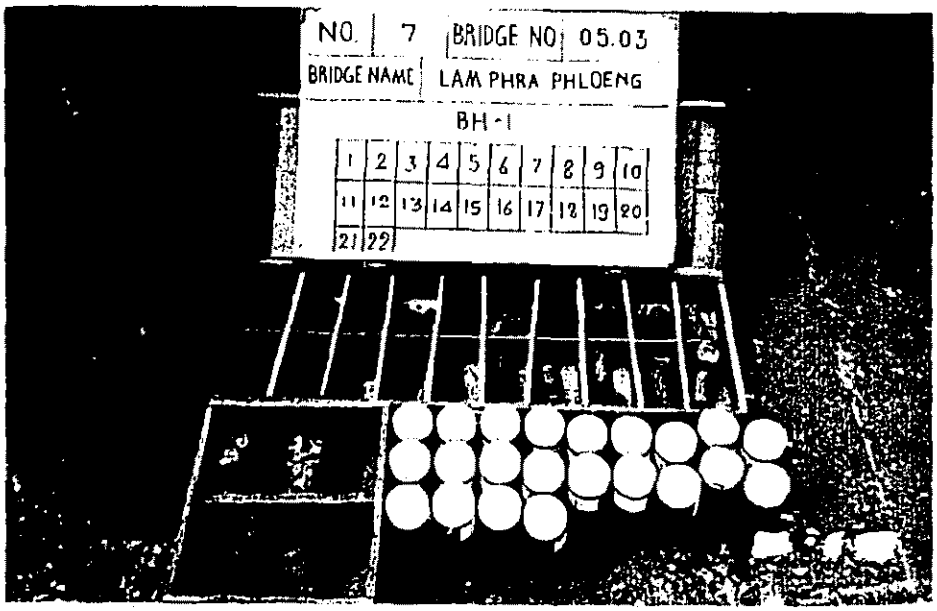


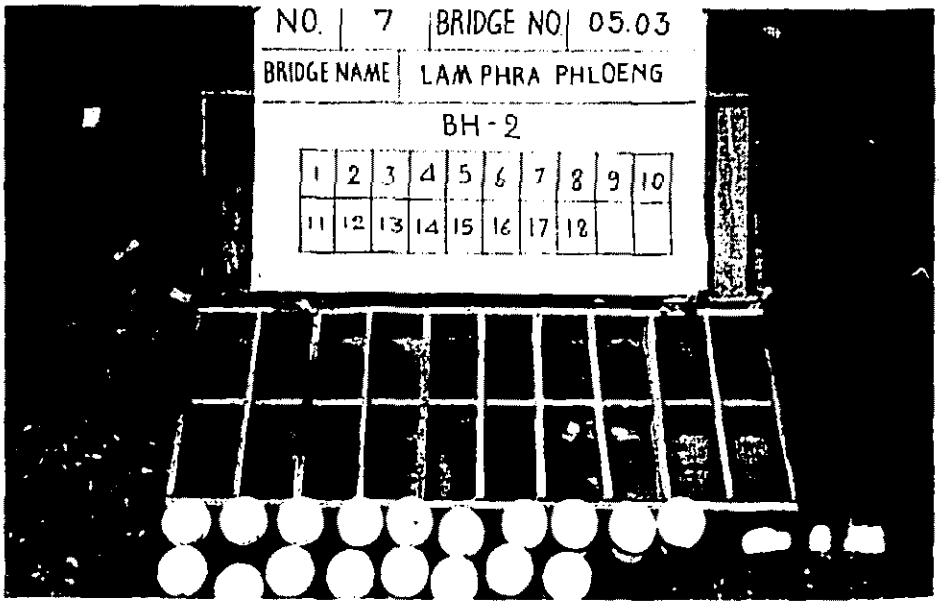


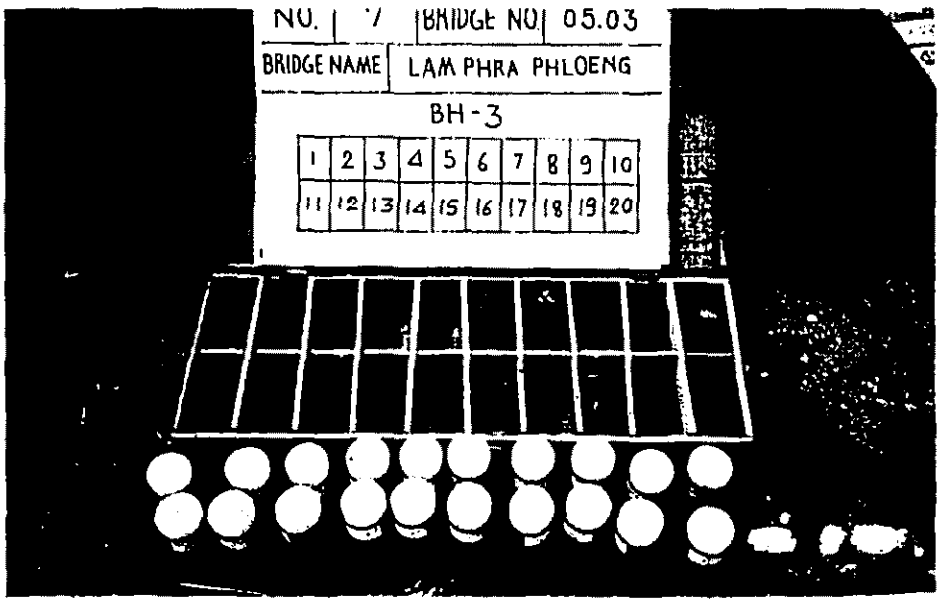
(7) Bridge No.05.03

Bridge Name LAM PHRA PHLOENG

BH-1,2,3



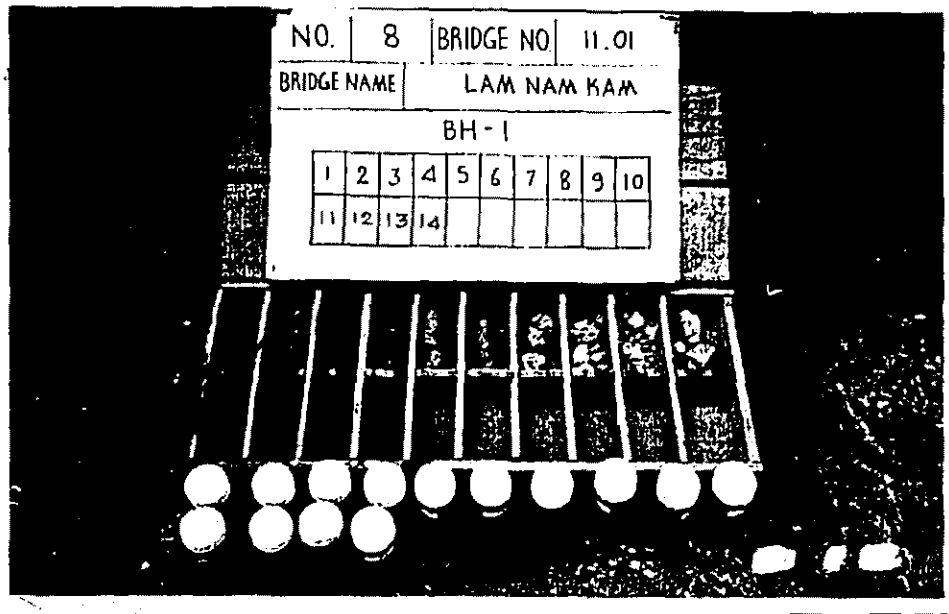


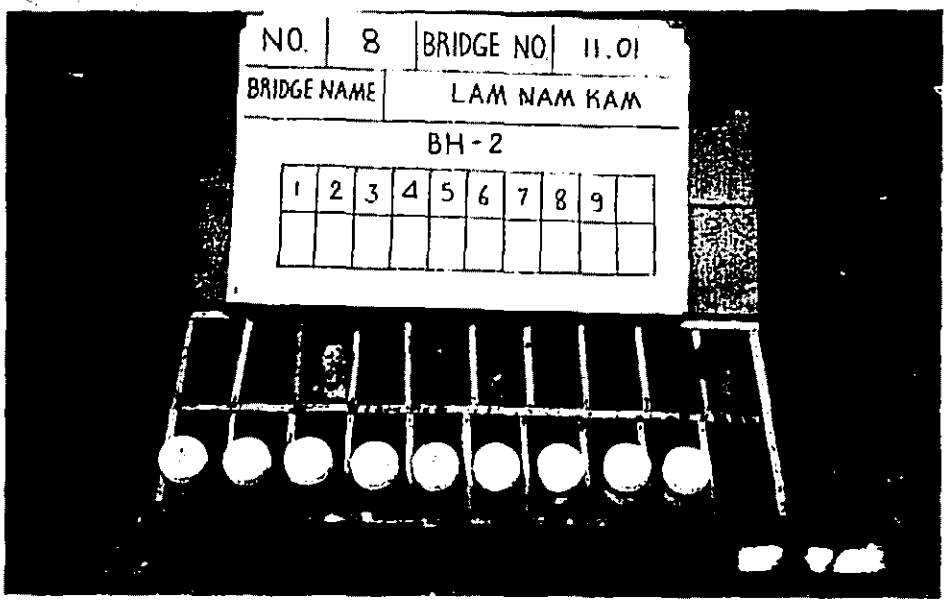


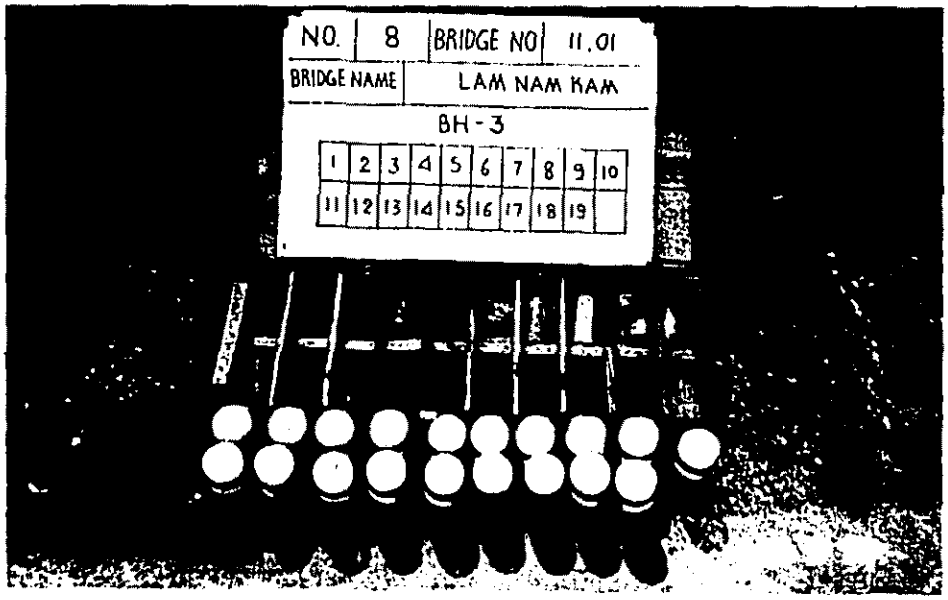
(8) Bridge No.11.01

Bridge Name LAM NAM KAM

BH-1,2,3



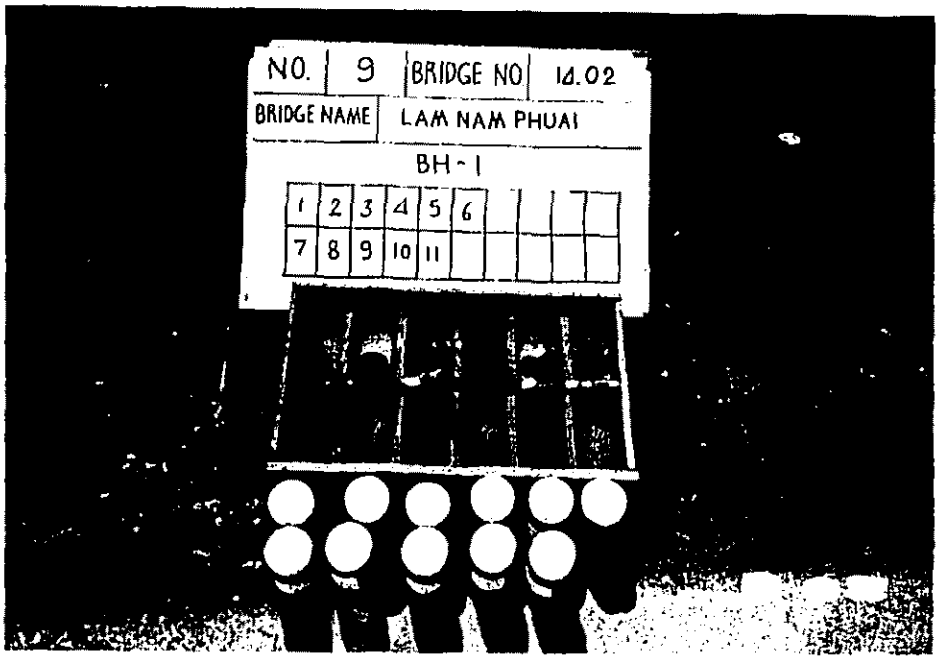


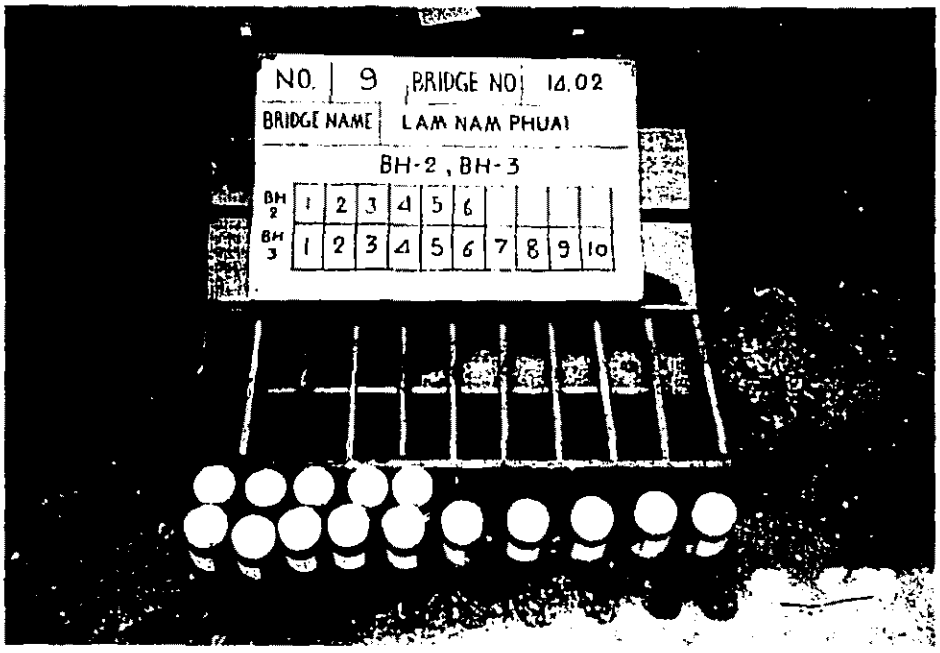


(9) Bridge No.14.02

Bridge Name LAM NAM PHUAI

BH-1,2,3

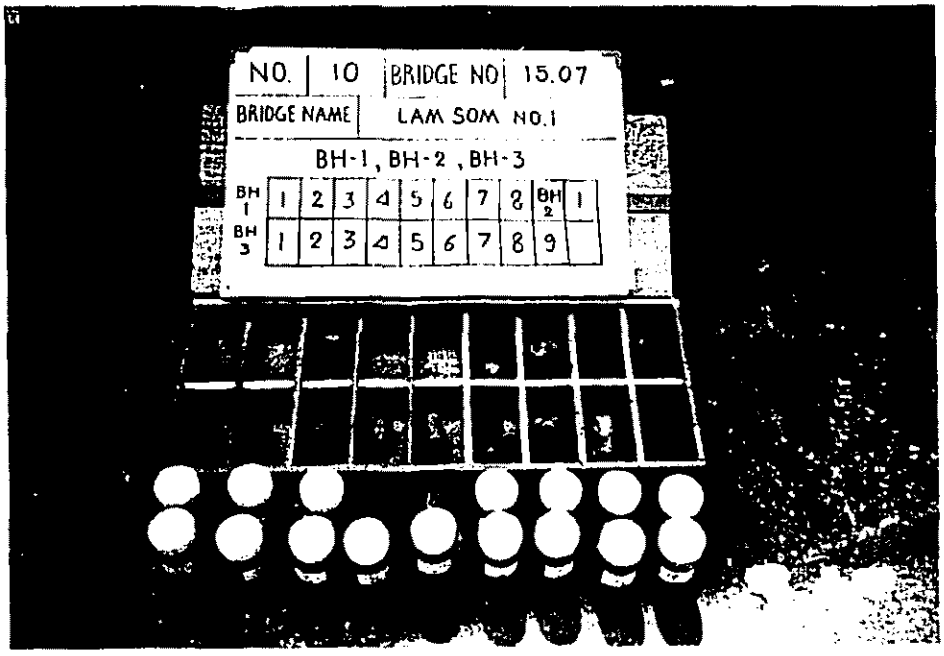




(10) Bridge No.15.07

Bridge Name LAM SOM NO.1

BH-1,2,3



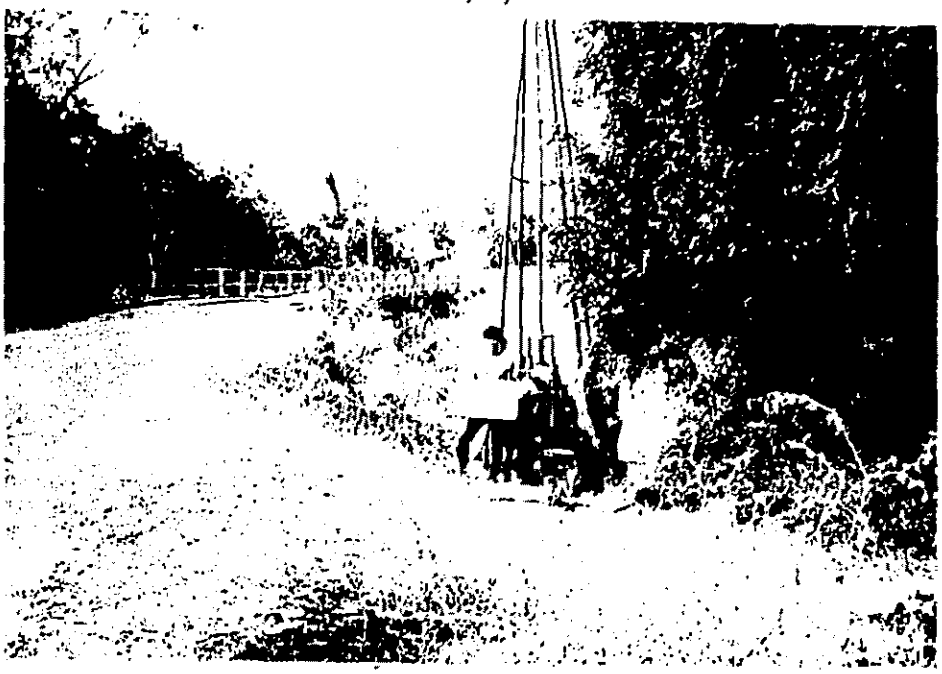
APPENDIX E

PHOTOGRAPHS OF DRILLING OPERATIONS

(1) Bridge No.01.01

Bridge Name HUAI KAE

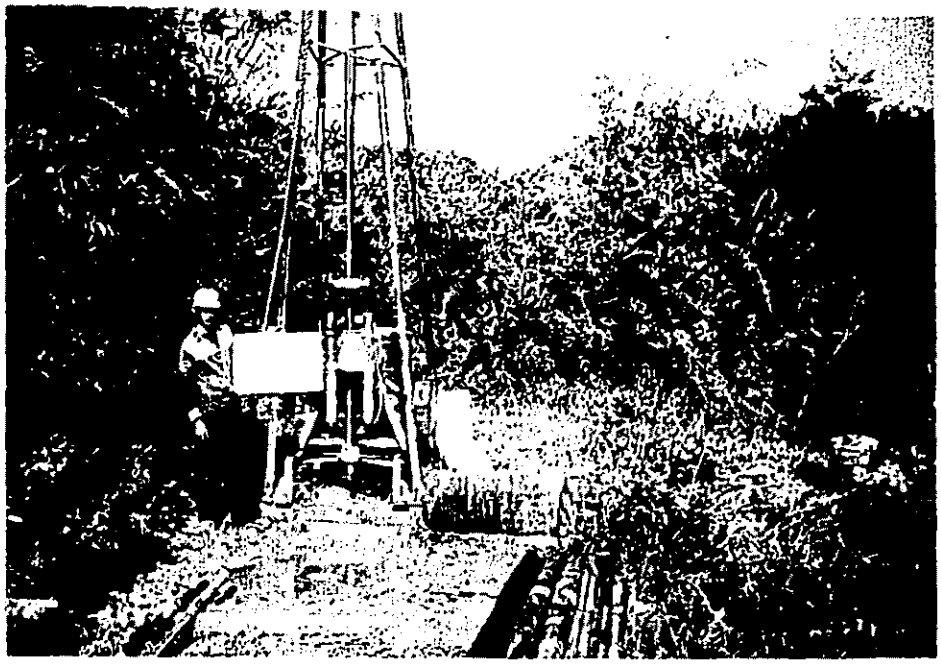
BH-1,2,3

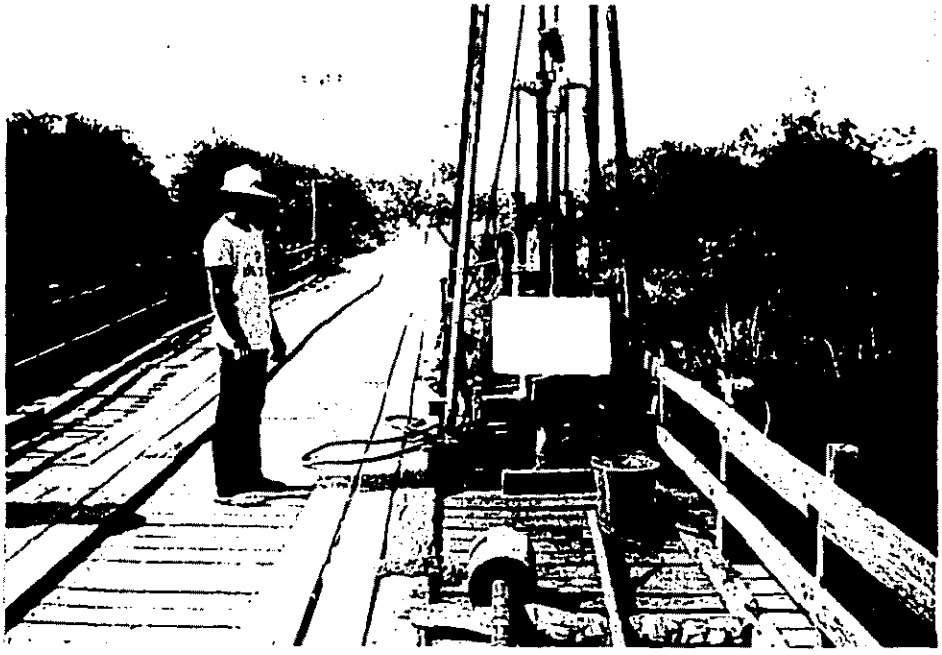


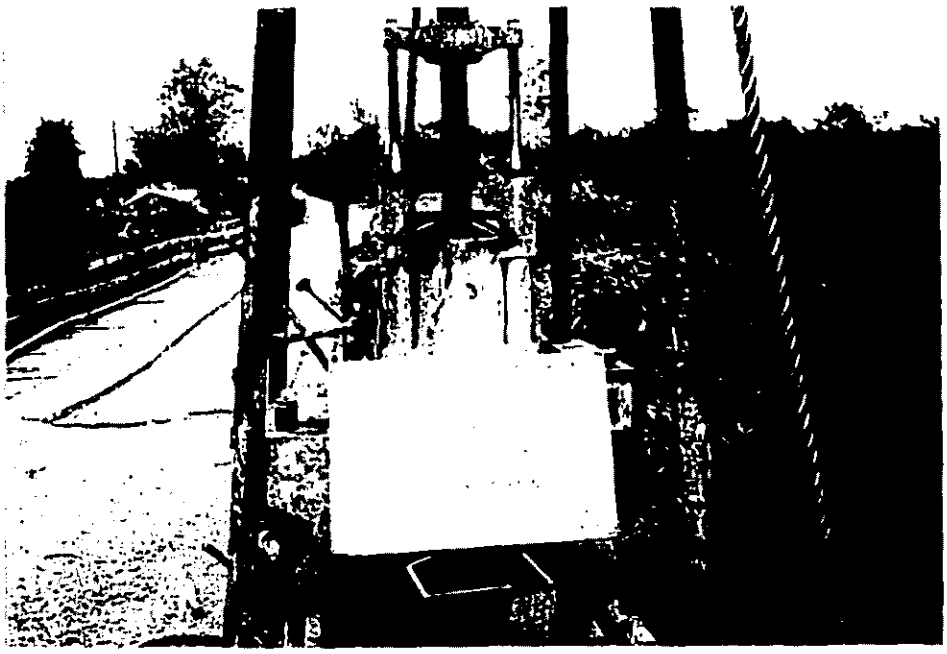
(2) Bridge No.02.05

Bridge Name HUAI KHUM MUM

BH-1,2,3



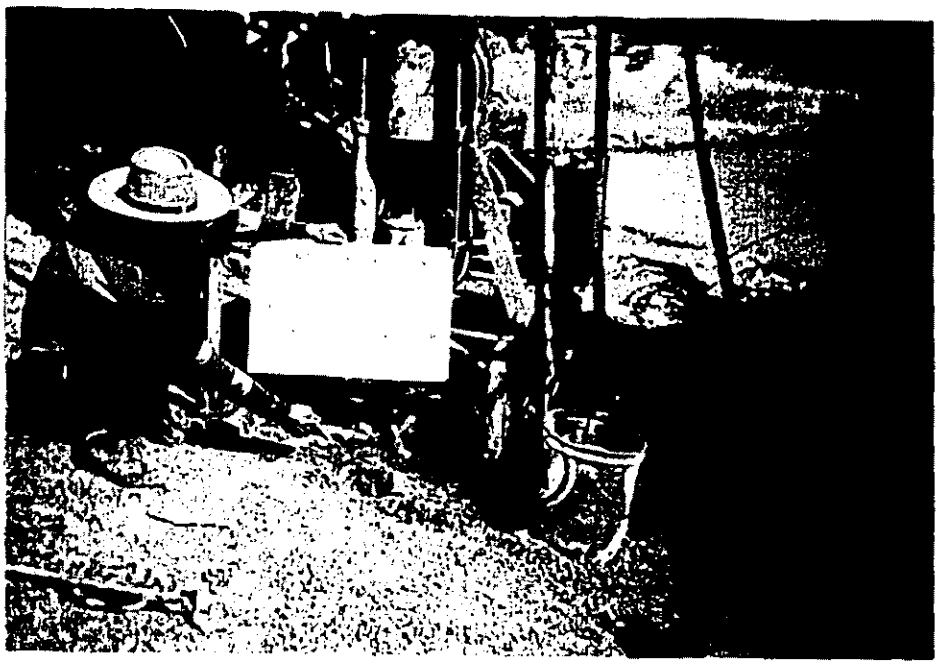


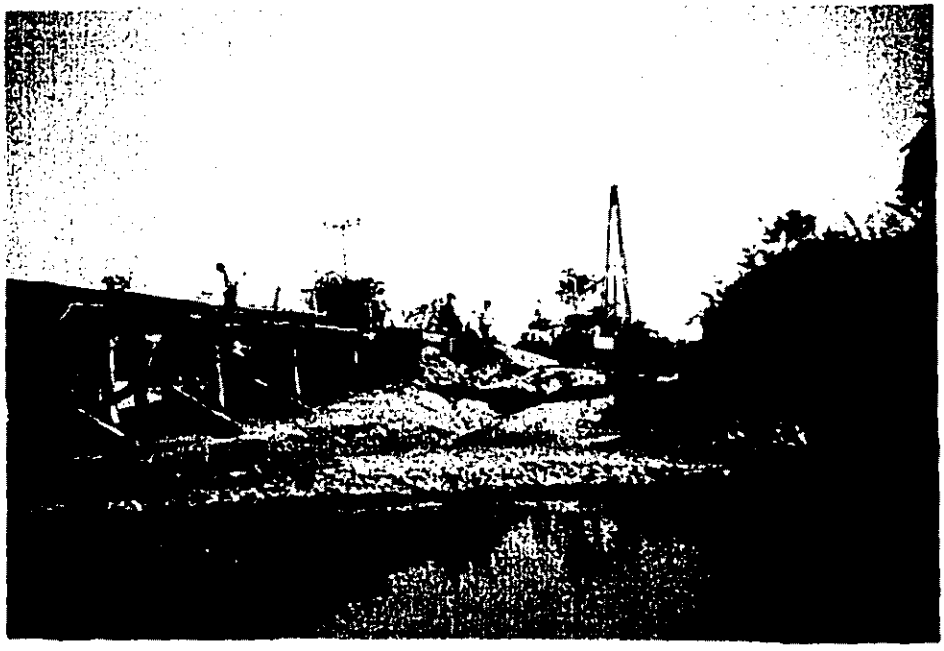


(3) Bridge No.04.01

Bridge Name HUAI SOENG NO.1

BH-1,2,3





(4) Bridge No.04.02

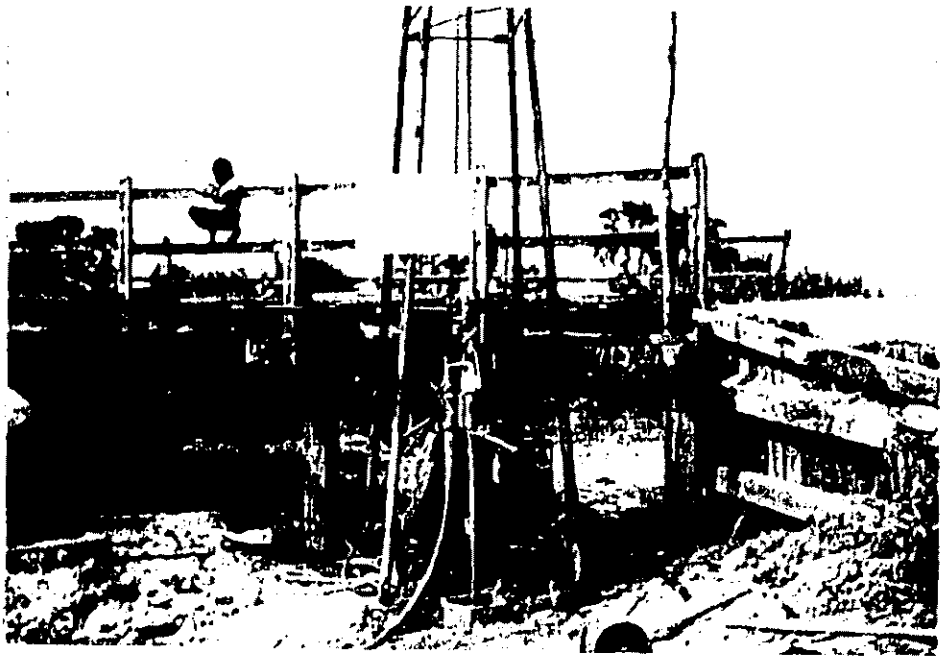
Bridge Name HUAI SOENG NO.2

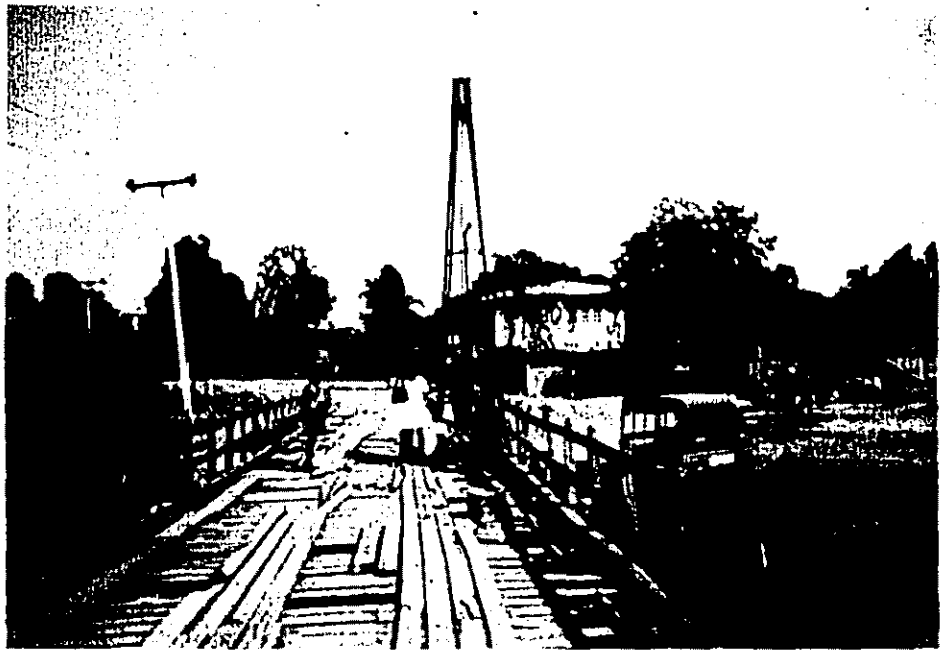
BH-1,2,3

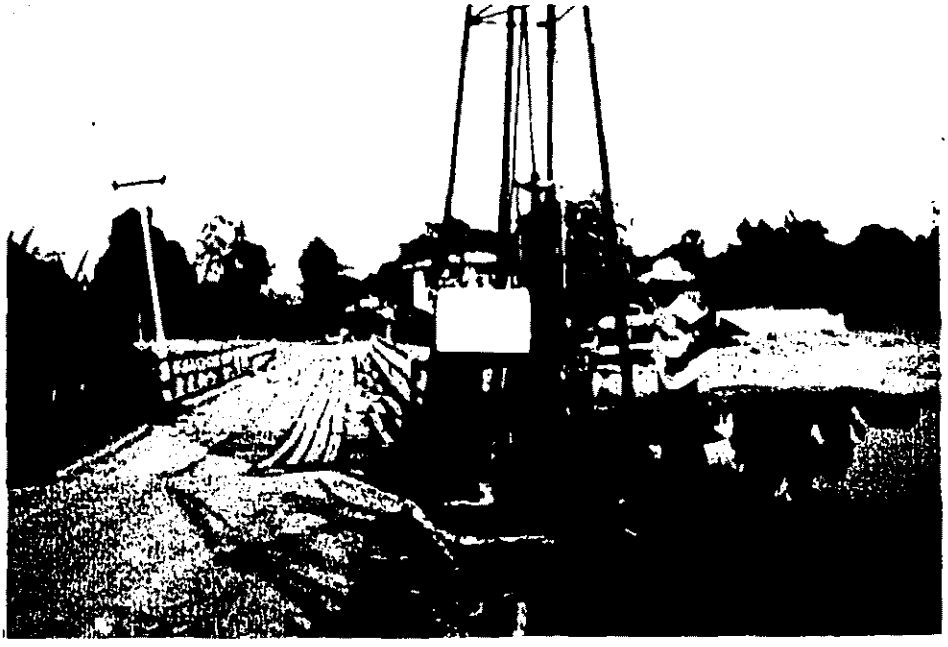
(5) Bridge No.05.01

Bridge Name LAM KLANG

BH-1,2,3



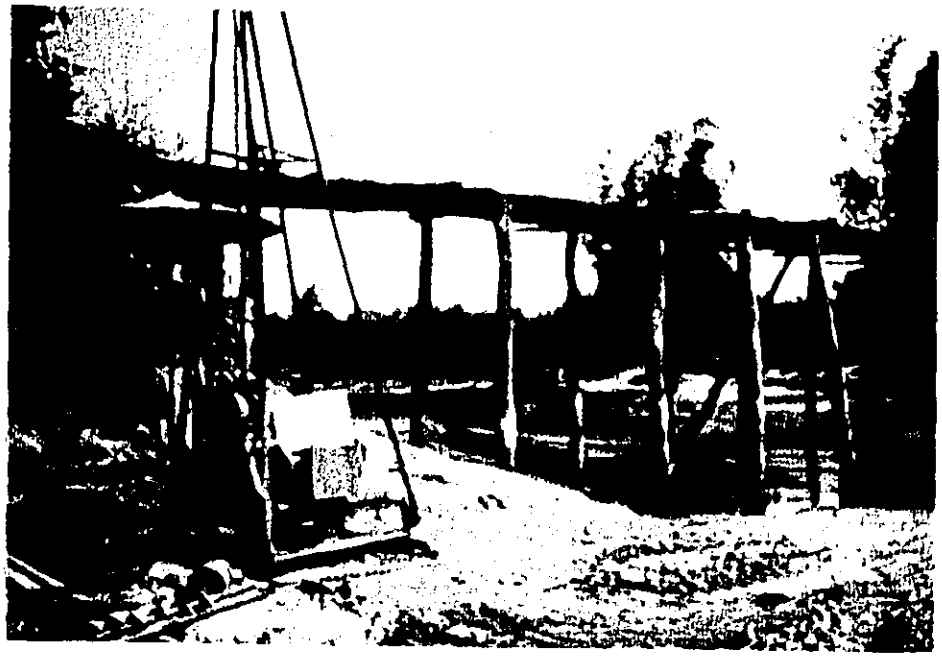


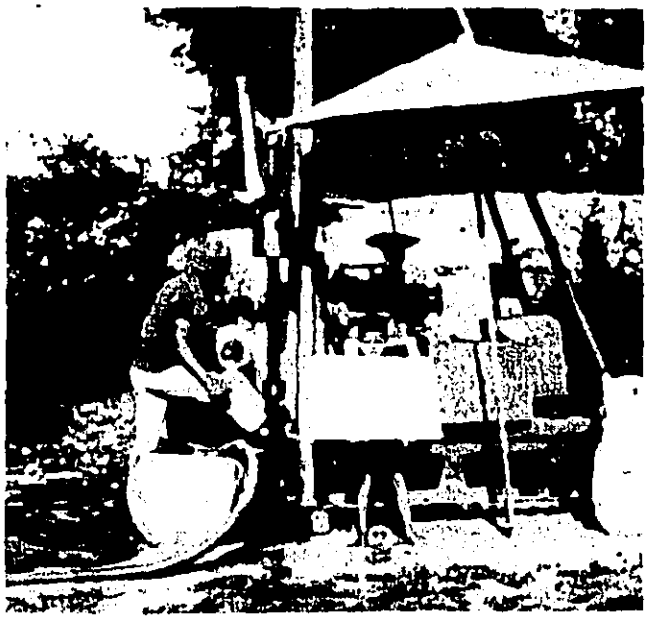


(6) Bridge No.05.02

Bridge Name LAM NAM MUN

BH-1,2,3

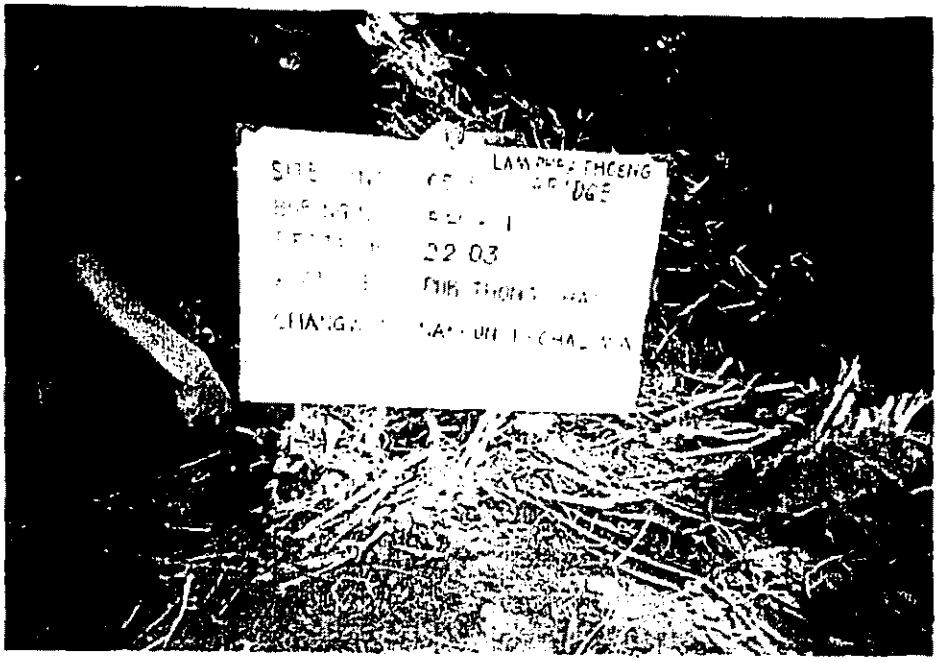


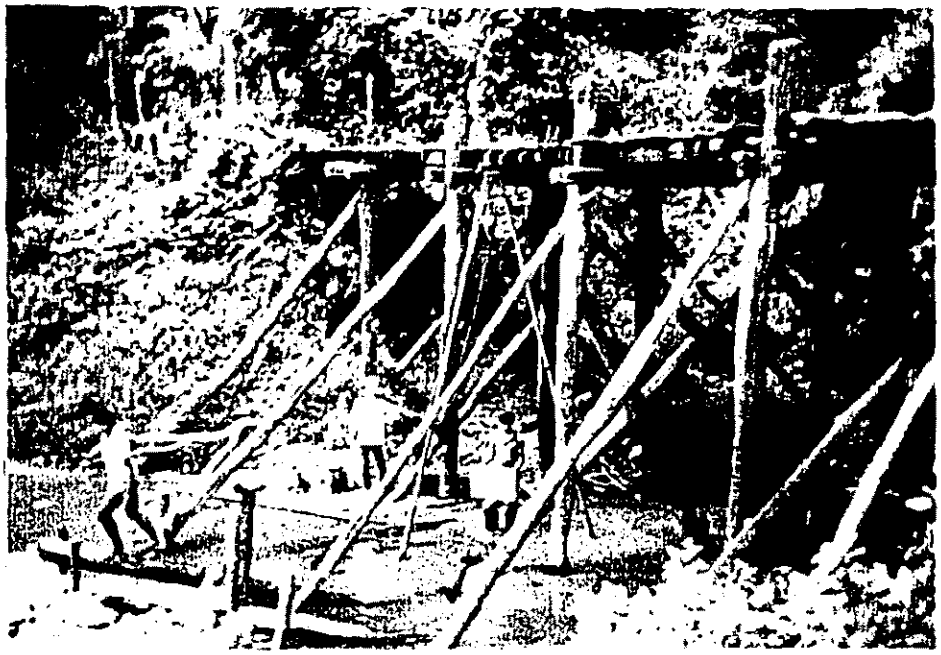


(7) Bridge No.05.03

Bridge Name LAM PHRA PHLOENG

BH-1,2,3

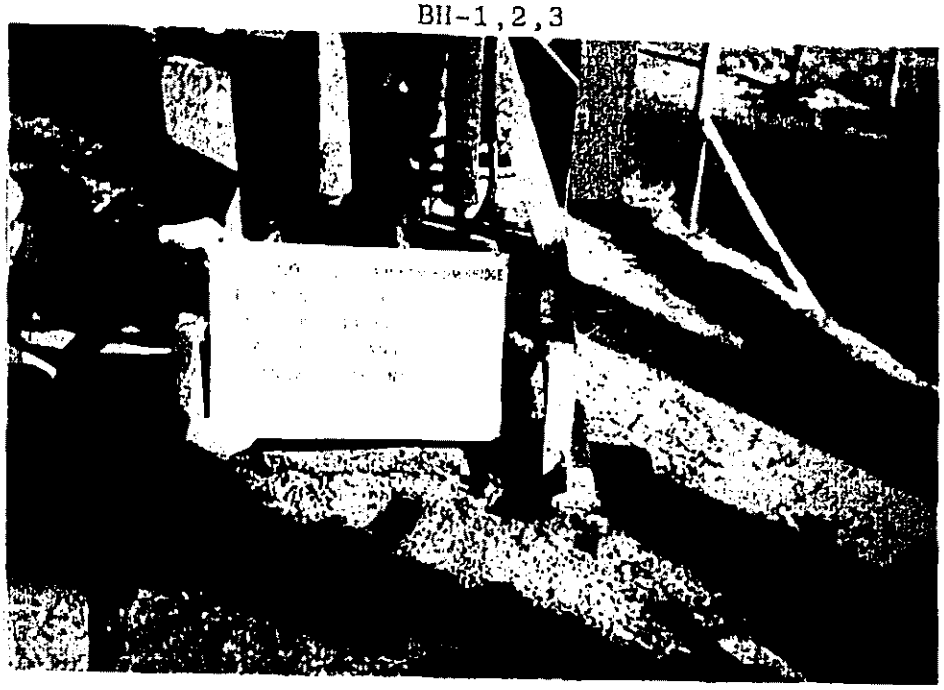


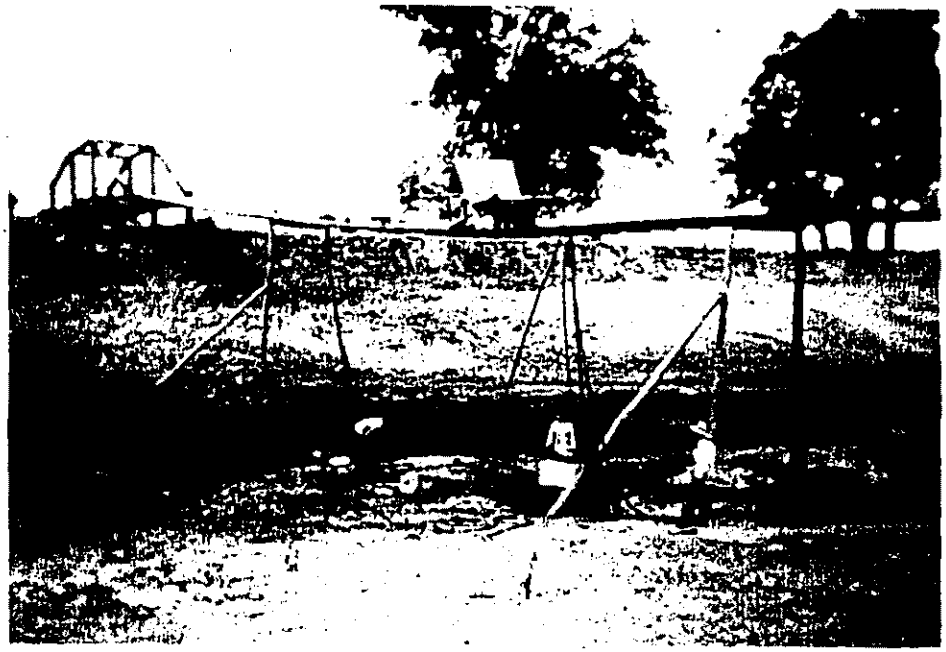


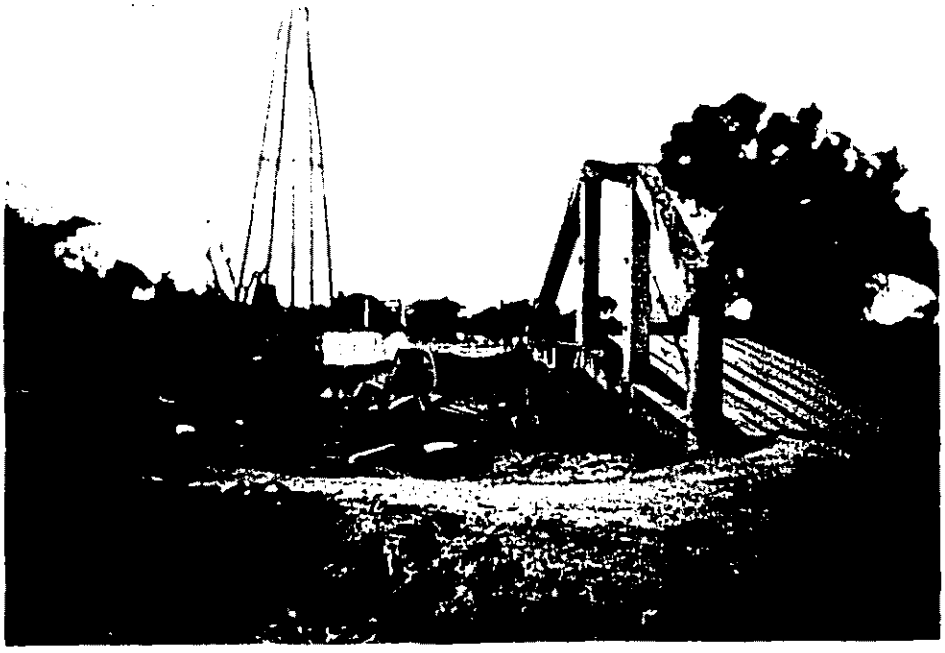
(8) Bridge No.11.01

Bridge Name LAM NAM KAM

BH-1,2,3



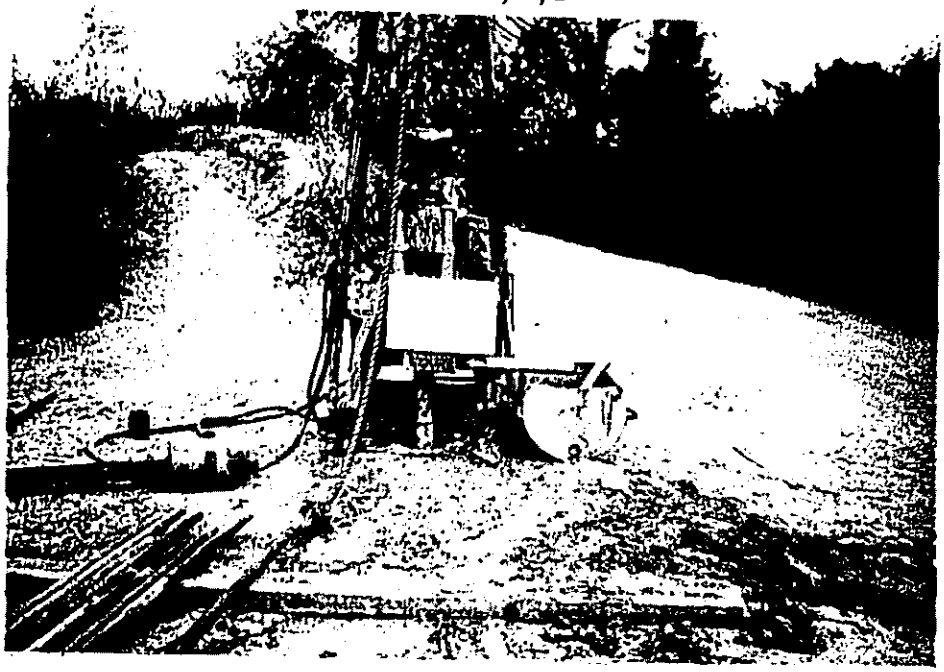


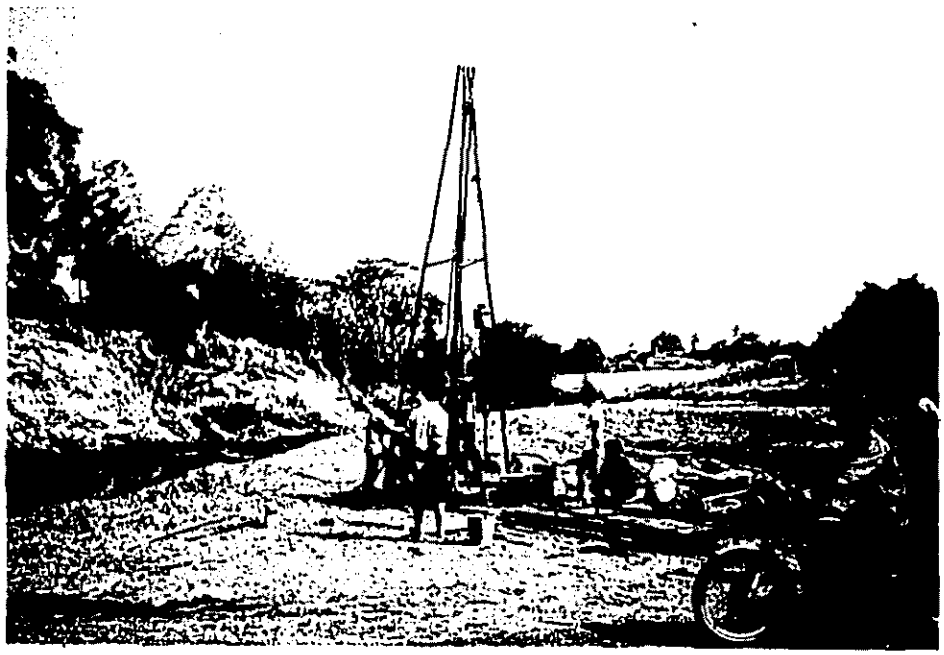


(9) Bridge No.14.02

Bridge Name LAM NAM PHUAI

BH-1,2,3





(10) Bridge No.15.07

Bridge Name LAM SOM NO.1

BH-1,2,3

APPENDIX F

REVIEW OF THE CONTINENTAL MESOZOIC STRATIGRAPHY OF THAILAND

WORKSHOP ON STRATIGRAPHIC CORRELATION OF
THAILAND AND MALAYSIA

Haad Yai, Thailand
8-10 September, 1983

REVIEW OF THE CONTINENTAL MESOZOIC STRATIGRAPHY OF THAILAND

Nares Sattayarak
Mineral Fuels Division
Department of Mineral Resources
Bangkok 10400, Thailand

INTRODUCTION

The continental Mesozoic redbeds are widely distributed throughout the country, especially in the Khorat Plateau, from which the group's name was obtained. The rocks are predominantly red clastic, i.e., sandstone, siltstone, claystone, shale and conglomerate. The Khorat Group rests unconformably on older rocks, generally of Paleozoic age, but occasionally it overlies the Permo-Triassic igneous rocks and/or Lower to Middle Triassic sedimentary rocks.

The Khorat Group was previously reviewed in Thai by Nakornsri (1975) and in English by Kulasing (1975) and Ramingwong (1978). This paper is an attempt to update the knowledge so far reported about the Khorat rocks and their equivalents.

REVIEW OF PREVIOUS WORKS

Lee (1923) was the first geologist who noted the non-marine Mesozoic rocks in the Khorat Plateau and divided them into Upper and Lower Group, the Triassic age was given.

Brown et al. (1953) named **the Khorat Series** to represent the continental redbeds and the marine Triassic limestone of northern Thailand. The sequence consists of interbedded sandstone, conglomerate, shale and marly limestone. No fossil was found except some petrified wood.

La Moreaux et al. (1956) divided the Khorat Series, following Chaliphan and Bunnag (1954), into three members and assigned the age of this sequence to the Triassic period. Their subdivision are as follows:

Phu Kradung Member is the oldest member it lies unconformably on Paleozoic rocks. The lowest part began with the basal conglomerate and was subsequently overlain by massive purple shale with minor sandstone.

From the Phu Kradung Formation: the lower jaw of the new crocodile species, *Sunosuchus thailandicus* (Buffetaut and Ingavat, 1980).

From the Huai Hin Lat Formation: *Cyclotosaurus* cf. *posthumus* Fraas (Ingavat and Janvier, 1981), *Ceratodus* cf. *szechuanensis* (Dipnoi) (Martin and Ingavat, 1982), aquatic *chelonian* gen. et sp. indet. (Broin et al.), *Phytosaur* (Buffetaut and Ingavat, 1982).

SUMMARY

The continental Mesozoic rocks in Thailand can be divided provincially into the Khorat-Phayao basin and other small separated basins (Bunopas, 1978, Pitakpaivan and Chonglukmani, 1978). The Khorat-Phayao basin is part of the huge basin, so-called "Indochina basin". It is believed that this basin covered the areas of the eastern part of northern Thailand, the eastern Thailand, the northern part of Campuchea, the northeastern Thailand and can be traced across the border to Laos and probably to southern China. The basin is roughly trending NW-SE direction. Thus, the source rocks are the Chieng Saen massif, the Khun Tan granite, the concealed igneous rocks in the central plain, the Chon Buri massif, the Pailin massif in Campuchea, the Kontum, Rao Co and Song Ma massif in Viet Nam. The basin is probably connected to the Lampang sea by the NW end and/or probably to another sea in Campuchea. The thickness variation of the Nam Phong and Phu Kradung Formation shows that the basin center is more or less parallel to the line between Khon Kaen and Maha Sarakham. Lower to Middle Triassic Sediments.

Lower to Middle Triassic Sediments

The Indosinian orogeny uplifted the Permian basin. Compressional forces caused the Permian series to be folded and faulted. The continental Mesozoic sediments started to accumulate since the Scythian in some area in the north, contemporaneously with the beginning of the Marine Triassic Lampang Group (Hahn and Sieberhuner, 1982).

From the field observation in the northeastern and north-central Thailand, e.g. at Phu Hin Kong, Chum Phae, just west of the Huai Hin Lat type locality, the redbeds start with basal conglomerate containing pebbles of limestone. Overlying the redbeds is the interbedded sequence of reddish brown conglomerate and sandstone with an intercalation of volcanic rocks at the upper part. Subsequently, conglomerate beds with pebbles of volcanic rocks are encountered again. The sequence is followed by the black shale of the Huai Hin Lat Formation.

The section along the Pitsanulok-Lom Sak Highway and its vicinity starts with the basal conglomerate that rests unconformably on the Permain limestone. The sequence is followed by predominant gray beds, but redbeds wer observed locally. After that the pyroclastic rocks appear. Redbeds are found again in the upper part showing an intercalation with the volcanic rocks. The true redbeds belonging to the Khorat Group overlies this sequence with an inferred contact. The correlation between these two strata above both conglomerate beds is inferred, but, possibly they are equivalent.

The difference in natures of folding was found in these two sequences, together with the presence of igneous dikes in the lower unit, and, in addition, the Permian limestone was found as a thrusted sheet above the volcanic rocks. The latter two criteria are not seen in the nearby Khorat Group. The data suggest possibly an unconformity. The environment of deposition is considered to be a fluvio-lacustrine type. Unidentified bone fragments and fossil plants are found. The age of the unit is Middle Triassic (Maranate, in print) and probably a continuation from the Lower Triassic. These continental sediments occurred in the north-central and northeastern part of the country while in the western and northern part marine deposits were found. By the reasons already mentioned, the new rock unit is suggested.

The Huai Hin Lat Formation

After the late stage of the Indonisian orogeny, probably in Carnian, the Huai Hin Lat sediments were deposited in the separated paleo-basins. The contacts with the older Triassic rocks were more or less unconformable. The depositional environment was considered to be a fluvio-lacustrine type. Restricted basins were typical, and the limestone is believed to be a lacustrine deposit (Broin et al. 1982). According to the paleogeography it can be noted that, in some areas, the Huai Hin Lat Formation comprises only redbeds, while in other areas it may contain a minor gray beds. Since the positions of the Norian beds are located in the middle part of the sequence, the base of the Huai Hin Lat Formation are considered to be Carnian (Chonglakmani and Sattayrak, 1978).

The Nam Phong Formation

Just before or when all small-separated basins were filled with the Huai Hin Lat sediments, the Nam Phong Formation started its accumulation. The deposits were transitionally changed into redbeds from the gray beds below. As the matter of fact, the Nam Phong Formation is the lowest formation of the Khorat Group where the Huai Hin Lat is absent, e.g. in the high lands and the basin flanks. It is predominantly reddish brown and resistant sandstone, siltstone and conglomerate. No fossil was found but the age is considered to be between those of the Huai Hin Lat and of the Phu Kradung Formation, i.e., Rhaetian. The fluvio-lacustrine environment was its depositional environment.

The Phu Kradung Formation

Deposition of the Phu Kradung Formation took place when the Indochina basin was a huge basin. This unit rests unconformably on the Pre-Khorat rocks at the basin flanks. Ward and Bunnag (1964) noted the contact between the Nam Phong and Phu Kradung Formation at the limestone alternating zone. The formation is characterized by predominantly claystone in the lower part, and with some massive sandstone intercalation in the middle part, while the upper part consists of massive sandstone interbedded with claystone. The interpreted marine ingression based on the presence of a Plesiosaur tooth at Nong Bua Lam Phu (Ward and Bunnag, 1964) was doubtful due to a recent discovery of the fresh water crocodile bones (Buffetaut and

Ingavat, 1980) probably at the same locality. The fluvio-lacustrine depositional environment is again assigned to the Phu Kradung sediments (Hahn, 1982 a). The claystone represented the flood plain deposits, while sandstone was the channal sand of the meandering streams. The upper sequence characterized a gradually change to the Phra Wihan rocks's environment. The age of this formation is Lower Jurassic (Hayami, 1968, Hahn, 1982 a).

The Phra Wihan Formation

The formation comprises massive, resistant, light-coloured sandstone with some interbedded siltstone and comglomerate. Pebbly sandstone usually are encountered in the upper part of the section. The sequence reveals a deposition of braided streams. In some areas, it resembles the fluvio-lacustrine deposits (Hahn, 1982 a). The fossils indicated the Upper Triassic to Lower Jurassic age. The age of the formation is considered to be the Middle Jurassic.

The Sao Khua Formation

This formation is known as the less-resistant, reddish brown-coloured siltstone lying in between the more resistant sandstone. Aside from the marine pelecypods (Ward and Bunnag, 1964, Huhn, 1982 a), Plesiosaur tooth (Hahn, 1982 a) and Icthyosaur tooth (Takai, 1963), other types of fossils and the rock characteristics suggest the continental depositional environment. The age of the Sao Khua Formation is Upper Jurassic.

The Phu Phan Formation

This formation is characterized by massive beds of light-coloured, pebbly sandstone and conglomerate. The average thickness is about 80 meters, but at Nam Phung Dam site, it is about 400 meters thick. The middle part of the Nam Phung section comprises the redbeds containing Lower Cretaceous pelecypods (Kobayashi, 1968). Paleocurrent measurements in the northern part of the Khorat Plateau was studied by the author. The result suggests the S-SW and/or W current direction which is similar to that of the Phra Wihan Formation. Hahn (1982 a) considered the Phu Phan Formation as a typical fluviatile sediments.

The Khok Kruat Formation

The redbeds overlying the Phu Phan Formation represent the Khok Kruat Formation. It consists predominantly of sandstone with some siltstone and claystone. The fluviatile environment is suggested and the deposition took place in an arid climate. Gypsum nodules and lenses were observed. The fossil found in its equivalent beds, the Ban Na Yo Formation, points to the Upper Cretaceous age (Kobayashi, 1968).

The Maha Sarakham Formation

This formation is thought to rest unconformably on the underlying Khorat strata (Japakasetr and Workman, in print) thus, raising the problem about its status. This rock unit consists of the Lower, Middle and Upper

Rock Salt with 2 units of claystone in between. The unconformity does not show a strong discordance, thus a disconformity is suggested (Japakasetr and Workman, in print). The depositional basin, is quite similar in shape to that of the older Khorat sediments. The Khorat and Sakon Nakorn basins were the same basin at that time. The age of this formation is inferred as the Upper most Cretaceous.

The Phu Tok Formation

This informal formation was mapped by Sattayarak and Sutheetorn (1979). It consists of two sandstone types, one with very large-scaled crossbedding and the other with small wavy structures. The sandstone was described as a red-coloured, fine-grained, well sorted and friable rock. The gross characteristics of this formation resembled an eolian deposits. The strata are found above the Khok Kruat Formation, but, correlation with the Maha Sarakham Formation is not conclusive. It was probably deposited contemporaneously, but in different environment, with the rock salt. This formation, on the other hand, is possibly younger than the Maha Sarakham Formation as it lies unconformably on the latter.

The Upper Claystone

The sequence consists typically of brick red-coloured claystone, siltstone and sandstone with gypsum and anhydrite lenses and/or nodules. This unit rests unconformably on the Maha Sarakham Formation (Japakasetr and Workman, in print). Its age is likely to be Tertiary more than Mesozoic. Furthermore, the sandstone resembled that of the Phu Tok Formation. If this is true, the two units would be of the same age but with a slightly different environment of deposition. This unit cropped out in the central part of the Plateau. It was probably accumulated in two separated basins, the Khorat and Sakon Nakorn basins, after the Himalayan orogeny built up the Phu Phan anticlinorium.

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APPENDIX G

STANDARD PENETRATION TEST
UNIFIED SOIL CLASSIFICATION SYSTEM
LIST OF TERMS USED AND SYMBOLS
REFERENCES

Designation: D 1586 – 67 (Reapproved 1974)

Standard Method for PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]

This Standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This method describes a procedure for using a split-barrel sampler to obtain representative samples of soil for identification purposes and other laboratory tests, and to obtain a measure of the resistance of the soil to penetration of the sampler.

2. Apparatus

2.1 *Drilling Equipment*—Any drilling equipment shall be acceptable that provides a reasonably clean hold before insertion of the sampler to ensure that the penetration test is performed on undisturbed soil, and that will permit the driving of the sampler to obtain the sample and penetration record in accordance with the procedure described in Section 3. To avoid "whips" under the blows of the hammer, it is recommended that the drill rod have a stiffness equal to or greater than the A-rod. An "A" rod is a hollow drill rod or "steel" having an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm), through which the rotary motion of drilling is transferred from the drilling motor to the cutting bit. A stiffer drill rod is suggested for holes deeper than 50 ft (15 m). The hole shall be limited in diameter to between 2¼ and 6 in. (57.2 and 152 mm).[2]

2.2 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 1. The drive shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The coupling head shall have four ½-in. (12.7-mm) (minimum diameter) vent ports and shall contain a ball check valve. If sizes other than the 2-in. (50.8-mm) sampler are permitted, the size shall be conspicuously noted on all penetration records.

2.3 *Drive Weight Assembly*—The assembly shall consist of a 140-lb (63.5-kg) weight, a driving head, and a guide permitting a free fall of 30 in. (0.76 m). Special precautions shall be taken to ensure that the energy of the falling weight is not reduced by friction between the drive weight and the guides.

2.4 *Accessory Equipment*—Labels, data sheets, sample jars, paraffin, and other necessary supplies should accompany the sampling equipment.

3. Procedure

3.1 Clear out the hole to sampling elevation using equipment that will ensure that the material to be sampled is not disturbed by the operation. In saturated sands and silts withdraw the drill bit slowly to prevent loosening of the soil around the hole. Maintain the water level in the hole at or above ground water level.

3.2 In no case shall a bottom-discharge bit be permitted. (Side-discharge bits are permissible.) The process of jetting through an open-tube sampler and then sampling when the

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[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock for Engineering Purposes.

Current edition approved Oct. 20, 1967. Originally issued 1958. Replaces D 1586 – 64 T.

[2] Hvorslev, M. J., *Surface Exploration and Sampling of Soils for Civil Engineering Purposes*, The Engineering Foundation, 345 East 47th St, New York, N. Y. 10017.

desired depth is reached shall not be permitted. Where casing is used, it may not be driven below sampling elevation. Record any loss of circulation or excess pressure in drilling fluid during advancing of holes.

3.3 With the sampler resting on the bottom of the hole, drive the sampler with blows from the 140-lb (63.5-kg) hammer falling 30 in. (0.76 m) until either 18 in. (0.45 m) have been penetrated or 100 blows have been applied.

3.4 Repeat this operation at intervals not longer than 5 ft (1.5 m) in homogeneous strata and at every change of strata.

3.5 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fractions thereof. The first 6 in. (0.15 m) is considered to be a seating drive. The number of blows required for the second and third 6 in. (0.15 m) of penetration added is termed the penetration resistance, *N*. If the sampler is driven less than 18 in. (0.45 m), the penetration resistance is that for the last 1 ft (0.30 m) of penetration (if less than 1 ft (0.30 m) is penetrated, the logs shall state the number of blows and the fraction of 1 ft (0.30 m) penetrated).

3.6 Bring the sampler to the surface and open. Describe carefully typical samples of soils recovered as to composition, structure, consistency, color, and condition; then put into jars without ramming. Seal them with wax or hermetically seal to prevent evaporation of the soil moisture. Affix labels to the jar or make notations on the covers (or both) bearing job designation, boring number, sample number, depth penetration record, and length of recovery. Protect samples against extreme temperature changes.

4. Report

4.1 Data obtained in borings shall be recorded in the field and shall include the following:

4.1.1 Name and location of job,

4.1.2 Date of boring—start, finish,

4.1.3 Boring number and coordinate, if available,

4.1.4 Surface elevation, if available,

4.1.5 Sample number and depth,

4.1.6 Method of advancing sampler, penetration and recovery lengths,

4.1.7 Type and size of sampler,

4.1.8 Description of soil,

4.1.9 Thickness of layer,

4.1.10 Depth to water surface; to loss of water; to artesian head; time at which reading was made,

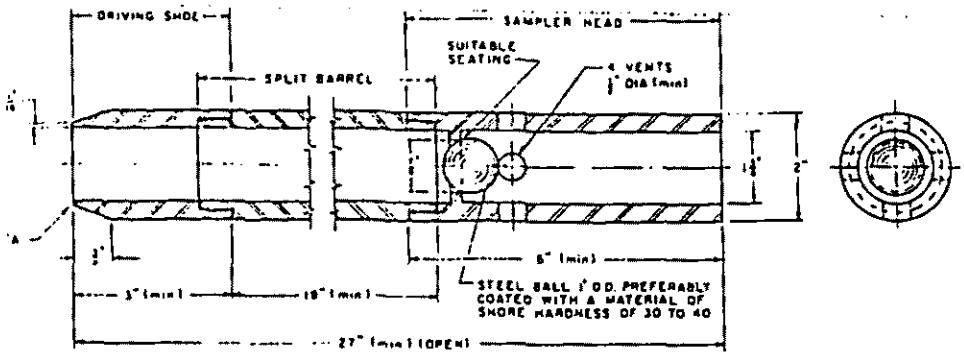
4.1.11 Type and make of machine,

4.1.12 Size of casing, depth of cased hole,

4.1.13 Number of blows per 6 in. (0.15 m),

4.1.14 Names of crewmen, and

4.1.15 Weather, remarks.



NOTE 1—Split barrel may be 1½ in. inside diameter provided it contains a liner of 16-gage wall thickness.
NOTE 2—Core retainers in the driving shoe to prevent loss of sample are permitted.
NOTE 3—The corners at *A* may be slightly rounded.

Metric Equivalents

in.	mm	in.	mm
0.049 (16 gage)	1.5*	2	50.8
½	12.7	3	76.2
¾	19.0	6	152.4
⅞	22.2	18	457.2
1⅜	34.9	27	685.8
1½	38.1		

FIG. 1 Standard Split Barrel Sampler Assembly.

Designation: D 2487 – 83

Standard Test Method for
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES[1]

This standard is issued under the fixed designation D 2487; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes a system for classifying mineral and organo-mineral soils for engineering purposes based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index and shall be used when precise classification is required.

NOTE 1—Use of this standard will result in a single classification group symbol and group name except when a soil contains 5 to 12 % fines or when the plot of the liquid limit and plasticity index values falls into the crosshatched area of the plasticity chart. In these two cases, a dual symbol is used, for example, GP-GM, CL-ML. When the laboratory test results indicate that the soil is close to another soil classification group, the borderline condition can be indicated with two symbols separated by a slash. The first symbol should be the one based on this standard, for example, CL/CH, GM/SM, SC/CL. Borderline symbols are particularly useful when the liquid limit value of clayey soils is close to 50. These soils can have expansive characteristics and the use of a borderline symbol (CL/CH, CH/CL) will alert the user of the assigned classifications of expansive potential.

1.2 The group symbol portion of this sytem is based on laboratory tests performed on the portion of a soil sample passing the 3-in. (75-mm) sieve (see Specification E 11).

1.3 As a classification system, this test method is limited to naturally occurring soils.

NOTE 2—The group names and symbols used in this test method may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. See Appendix X2.

1.4 This test method is for qualitative application only.

NOTE 3—When quantitative information is required for detailed designs of important structures, this test method must be supplemented by laboratory tests or other quantitative data to determine performance characteristics under expected field conditions.

1.5 The system is based on the widely recognized Unified Soil Classification System which was adopted by several U.S. Government agencies in 1952 as an outgrowth of the Airfield Classification System developed by A. Casagrande.[2]

1.6 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Applicable Documents

2.1 *ASTM Standards:*

C 117 Test Method for Material Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing[3]

C 136 Method for Sieve Analysis of Fine and Coarse Aggregates[3]

C 702 Methods for Reducing Field Samples of Aggregate to Testing Size[3]

D 420 Recommended Practice for Investigation and Sampling Soil and Rock for Engineering Purposes[4]

D 421 Method for Dry Preparation of Soil

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[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Aug. 17, 1983. Published October 1983. Originally published as D 2487 – 66 T. Last previous edition D 2487 – 69 (1975).

[2] Casagrande, A., "Classification and Identification of Soils," *Transactions*, ASCE, 1948, p. 901.

[3] *Annual Book of ASTM Standards*, Vol 04.02.

[4] *Annual Book of ASTM Standards*, Vol 04.08.

Samples for Particle-Size Analysis and Determination of Soil Constants[4]
D 422 Method of Particle-Size Analysis of Soils[4]
D 423 Test Method for *Liquid Limit of Soils*[4]
D 424 Test Method for Plastic Limit and Plasticity Index of Soils[4]
D 653 Terms and Symbols Relating to Soil and Rock[4]
D 1140 Test Method for Amount of Material in Soils Finer than the No. 200 (75-μm) Sieve[4]
D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures[4]
D 2217 Method for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[4]
D 2488 Recommended Practice for Description of Soils (Visual-Manual Procedures)[4]
E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

3. Summary of Method

3.1 As illustrated in Table 1, this classification system identifies three major soil divisions: coarse-grained soils, fine-grained soils, and highly organic soils. These three divisions are further subdivided into a total of 15 basic soil groups.

3.2 Based on the results of visual observations and prescribed laboratory tests, a soil is catalogued according to the basic soil groups, assigned a group symbol(s) and name, and thereby classified. The flow charts, Fig. 1 for fine-grained soils, and Fig. 2 for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name.

4. Significance and Use

4.1 This test method classifies soils from any geographic location into categories representing the results of prescribed laboratory tests to determine the particle-size characteristics, the liquid limit, and the plasticity index.

4.2 The assigning of a group name and symbol(s) along with the descriptive information required in Recommended Practice D 2488 can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

4.3 The various groupings of this classification system have been devised to correlate in a general way with the engineering behavior of soils. This test method provides a useful first step in any field or laboratory investigation for geotechnical engineering purposes.

4.4 This test method may also be used as an aid in training personnel in the use of Recommended Practice D 2488.

5. Terminology

5.1 *Definitions*—Except as listed below, all definitions are in accordance with Definitions D 653.

NOTE 4—For particles retained on a 3-in. (75-mm) U.S. standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) U.S. standard sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening

5.1.1 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) U.S. standard sieve with the following subdivisions:

Coarse—passes 3-in. (75-mm) sieve and retained on ¾-in. (19-mm) sieve, and

Fine—passes ¾-in. (19-mm) sieve and retained on No. 4 (4.75-mm) sieve.

5.1.2 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) U.S. standard sieve with the following subdivisions:

Coarse—passes No. 4 (4.75-mm) sieve and retained on No. 10 (2.00-mm) sieve,

Medium—passes No. 10 (2.00-mm) sieve and retained on No. 40 (425-μm) sieve, and

Fine—passes No. 40 (425-μm) sieve and retained on No. 200 (75-μm) sieve.

5.1.3 *clay*—soil passing a No. 200 (75-μm) U.S. standard sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents and that exhibits considerable strength when air dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line.

5.1.4 *silt*—soil passing a No. 200 (75-μm) U.S. standard sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4 or if the plot of plasticity index versus liquid limit falls below the "A" line.

5.1.5 *organic clay*—a clay with sufficient or-

ganic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

5.1.6 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

5.1.7 *peat*—a soil composed of vegetable tissue in various stages of decomposition usually with an organic odor, a dark-brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

5.2 *Descriptions of Terms Specific to This Standard:*

5.2.1 *coefficient of curvature*, Cc—the ratio $(D_{30})^2/(D_{10} \times D_{60})$, where D_{60}, D_{30}, and D_{10} are the particle diameters corresponding to 60, 30, and 10 % finer on the cumulative particle-size distribution curve, respectively.

5.2.2 *coefficient of uniformity*, Cu—the ratio D_{60}/D_{10}, where D_{60} and D_{10} are the particle diameters corresponding to 60 and 10 % finer on the cumulative particle-size distribution curve, respectively.

6. Apparatus

6.1 In addition to the apparatus that may be required for obtaining and preparing the samples and conducting the prescribed laboratory tests, a plasticity chart, similar to Fig. 3, and a cumulative particle-size distribution curve, similar to Fig. 4, are required.

NOTE 5—The "U" line shown on Fig. 3 has been empirically determined to be the approximate "upper limit" for natural soils. It is a good check against erroneous data, and any test results that plot above or to the left of it should be verified.

7. Sampling

7.1 Samples shall be obtained and identified in accordance with a method or methods, recommended in Recommended Practice D 420 or by other accepted procedures.

7.2 For accurate identification, the minimum amount of test sample required for this test method will depend on which of the laboratory tests need to be performed. Where only the particle-size analysis of the sample is required, specimens having the following minimum dry weights are required:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

Whenever possible, the field samples should have weights two to four times larger than shown.

7.3 When the liquid and plastic limit tests must also be performed, additional material will be required sufficient to provide 150 g to 200 g of soil finer than the No. 40 (425-μm) sieve.

7.4 If the field sample or test specimen is smaller than the minimum recommended amount, the report shall include an appropriate remark.

8. Classification of Peat

8.1 A sample composed primarily of vegetable tissue in various stages of decomposition and has a fibrous to amorphous texture, a dark-brown to black color, and an organic odor should be designated as a highly organic soil and shall be classified as peat, PT, and not subjected to the classification procedures described hereafter.

9. Preparation for Classification

9.1 Before a soil can be classified according to this test method, generally the particle-size distribution and the plasticity characteristics of the minus 3-in. (75-mm) material must be determined. See 9.8 for the specific required tests.

9.2 The preparation of the soil specimen(s) and the testing for particle-size distribution and liquid limit and plasticity index shall be in accordance with accepted standard procedures. Two procedures for preparation of the soil specimens for testing for soil classification purposes are given in Appendixes X3 and X4. Appendix X3 describes the wet preparation method and is the preferred method for cohesive soils that have never dried out and for organic soils.

9.3 When reporting soil classifications determined by this test method, the preparation and test procedures used shall be reported or referenced.

9.4 Although the test procedure used in determining the particle-size distribution or other considerations may require a hydrometer analysis of the material, a hydrometer analysis is not necessary for soil classification.

9.5 The percentage (by dry weight) of any plus 3-in. (75-mm) material must be determined and

reported as auxiliary information.

9.6 The maximum particle size shall be determined (measured or estimated) and reported as auxiliary information.

9.7 When the cumulative particle-size distribution is required, a set of sieves shall be used which include the following sizes (with the largest size commensurate with the maximum particle size) with other sieve sizes as needed or required to define the particle-size distribution:

3-in. (75-mm)
¾-in. (19.0-mm)
No. 4 (4.75-mm)
No. 10 (2.00-mm)
No. 40 (425-μm)
No. 200 (75-μm)

9.8 The tests required to be performed in preparation for classification are as follows:

9.8.1 For soils estimated to contain less than 5 % fines, a plot of the cumulative particle-size distribution curve of the fraction coarser than the No. 200 (75-μm) sieve is required. The cumulative particle-size distribution curve may be plotted on a graph similar to that shown in Fig. 4.

9.8.2 For soils estimated to contain 5 to 15 % fines, a cumulative particle-size distribution curve, as described in 9.8.1, is required, and the liquid limit and plasticity index are required.

9.8.2.1 If sufficient material is not available to determine the liquid limit and plasticity index, the fines should be estimated to be either silty or clayey using the procedures described in Recommended Practice D 2488 and so noted in the report.

9.8.3 For soils estimated to contain 15 % or more fines, a determination of the percent fines, percent sand, and percent gravel is required, and the liquid limit and plasticity index are required. For soils estimated to contain 90 % fines or more, the percent fines, percent sand, and percent gravel may be estimated using the procedures described in Recommended Practice D 2488 and so noted in the report.

10. Preliminary Classification Procedure

10.1 Class the soil as fine-grained if 50 % or more by dry weight of the test specimen passes the No. 200 (75-μm) sieve and follow Section 11.

10.2 Class the soil as coarse-grained if more than 50 % by dry weight of the test specimen is retained on the No. 200 (75-μm) sieve and follow Section 12.

11. Procedure for Classification of Fine-Grained Soils (50 % or more by dry weight passing the No. 200 (75-μm) sieve)

11.1 The soil is an inorganic clay if the position of the plasticity index versus liquid limit plot, Fig. 3, falls on or above the "A" line, the plasticity index is greater than 4, and the presence of organic matter does not influence the liquid limit as determined in 11.3.2.

11.1.1 Classify the soil as a *lean clay*, CL, if the liquid limit is less than 50. See area identified as CL on Fig. 3.

11.1.2 Classify the soil as a *fat clay*, CH, if the liquid limit is 50 or greater. See area identified as CH on Fig. 3.

NOTE 6—In cases where the liquid limit exceeds 110 or the plasticity index exceeds 60, the plasticity chart may be expanded by maintaining the same scale on both axes and extending the "A" line at the indicated slope.

11.1.3 Classify the soil as a *silty clay*, CL-ML, if the position of the plasticity index versus liquid limit plot falls on or above the "A" line and the plasticity index is in the range of 4 to 7. See area identified as CL-ML on Fig. 3.

11.2 The soil is an inorganic silt if the position of the plasticity index versus liquid limit plot, Fig. 3, falls below the "A" line or the plasticity index is less than 4, and presence of organic matter does not influence the liquid limit as determined in 11.3.2.

11.2.1 Classify the soil as a *silt*, ML, if the liquid limit is less than 50. See area identified as ML on Fig. 3.

11.2.2 Classify the soil as an *elastic silt*, MH, if the liquid limit is 50 or greater. See area identified as MH on Fig. 3.

11.3 The soil is an organic silt or clay if organic matter is present in sufficient amounts to influence the liquid limit as determined in 11.3.2.

11.3.1 If the soil has a dark color and an organic odor when moist and warm, a second liquid limit test shall be performed on a test specimen which has been oven dried at 110 ±5°C to a constant weight, typically over night.

11.3.2 The soil is an organic silt or organic clay if the liquid limit after oven drying is less than 75 % of the liquid limit of the original specimen determined before oven drying (see Procedure B of Method D 2217).

11.3.3 Classify the soil as an *organic silt* or *organic clay*, OL, if the liquid limit (not oven dried) is less than 50 %. Classify the soil as an

organic silt, OL, if the plasticity index is less than 4, or the position of the plasticity index versus liquid limit plot falls below the "A" line. Classify the soil as an *organic clay*, OL, if the plasticity index is 4 or greater and the position of the plasticity index versus liquid limit plot falls on or above the "A" line. See area identified as OL (or CL-ML) on Fig. 3.

11.3.4 Classify the soil as an *organic clay* or *organic silt*, OH, if the liquid limit (not oven dried) is 50 or greater. Classify the soil as an *organic silt*, OH, if the position of the plasticity index versus liquid limit plot falls below the "A" line. Classify the soil as an *organic clay*, OH, if the position of the plasticity index versus liquid-limit plot falls on or above the "A" line. See area identified as OH on Fig. 3.

11.4 If less than 30 % but 15 % or more of the test specimen is retained on the No. 200 (75-μm) sieve, the words "with sand and/or gravel" shall be added to the group name. For example, lean clay with sand, CL; silt with sand and gravel, ML.

11.5 If 30 % or more of the test specimen is retained on the No. 200 (75-μm) sieve, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if 30 % or more of the test specimen is retained on the No. 200 (75-μm) sieve and the coarse-grained portion is predominantly sand. Add the word "gravelly" if 30 % or more of the test specimen is retained on the No. 200 (75-μm) sieve and the coarse-grained portion is predominantly gravel. For example, sandy lean clay, CL; gravelly fat clay, CH; sandy silt, ML.

12. Procedure for Classification of Coarse-Grained Soils (more than 50 % retained on the No. 200 (75-μm) sieve)

12.1 Class the soil as gravel if more than 50 % of the coarse fraction [plus No. 200 (75-μm) sieve] is retained on the No. 4 (4.75-mm) sieve.

12.2 Class the soil as sand if 50 % or more of the coarse fraction [plus No. 200 (75-μm) sieve] passes the No. 4 (4.75-mm) sieve.

12.3 If 12 % or less of the test specimen passes the No. 200 (75-μm) sieve, plot the cumulative particle-size distribution, Fig. 4, and compute the coefficient of uniformity, Cu, and coefficient of curvature, Cc, as given in Eqs 1 and 2.

$$Cu = D_{60}/D_{10} \quad (1)$$

$$Cc = (D_{30})^2/(D_{10} \times D_{60}) \quad (2)$$

where:

D_{10}, D_{30}, and D_{60} = the particle-size diameters corresponding to 10, 30, and 60 %, respectively, passing on the cumulative particle-size distribution curve, Fig. 4.

NOTE 7—It may be necessary to extrapolate the curve to obtain the D_{10} diameter.

12.3.1 If less than 5 % of the test specimen passes the No. 200 (75-μm) sieve, classify the soil as a *well-graded gravel*, GW, or *well-graded sand*, SW, if Cu is greater than 4.0 for gravel or greater than 6.0 for sand, and Cc is at least 1.0 but not more than 3.0.

12.3.2 If less than 5 % of the test specimen passes the No. 200 (75-μm) sieve, classify the soil as *poorly graded gravel*, GP, or *poorly graded sand*, SP, if either the Cu or the Cc criteria for well-graded soils are not satisfied.

12.4 If more than 12 % of the test specimen passes the No. 200 (75-μm) sieve, the soil shall be considered a coarse-grained soil with fines. The fines are determined to be either clayey or silty based on the plasticity index versus liquid limit plot on Fig. 3. (See 9.8.2.1 if insufficient material available for testing).

12.4.1 Classify the soil as a *clayey gravel*, GC, or *clayey sand*, SC, if the fines are clayey, that is, the position of the plasticity index versus liquid limit plot, Fig. 3, falls on or above the "A" line and the plasticity index is greater than 7.

12.4.2 Classify the soil as a *silty gravel*, GM, or *silty sand*, SM, if the fines are silty, that is, the position of the plasticity index versus liquid limit plot, Fig. 3, falls below the "A" line or the plasticity index is less than 4.

12.4.3 If the fines plot as a silty clay, CL-ML, classify the soil as a *silty, clayey gravel*, GC-GM, if it is a gravel or a *silty, clayey sand*, SC-SM, if it is a sand.

12.5 If 5 to 12 % of the test specimen passes the No. 200 (75-μm) sieve, give the soil a dual classification using two group symbols.

12.5.1 The first group symbol shall correspond to that for a gravel or sand having less than 5 % fines (GW, GP, SW, SP), and the second symbol shall correspond to a gravel or sand having more than 12 % fines (GC, GM, SC, SM).

12.5.2 The group name shall correspond to the first group symbol plus "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example, well-graded gravel with

clay, GW-GC; poorly graded sand with silt, SP-SM (See 9.8.2.1 if insufficient material available for testing).

NOTE 8—If the fines plot as a *silty clay*, CL-ML, the second group symbol should be either GC or SC. For example, a poorly graded sand with 10 % fines, a liquid limit of 20, and a plasticity index of 6 would be classified as a poorly graded sand with silty clay, SP-SC.

12.6 If the specimen is predominantly sand or gravel but contains 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example, poorly graded gravel with sand, clayey sand with gravel.

12.7 If the field sample contained any cobbles or boulders or both, the words "with cobbles," or "with cobbles and boulders" shall be added to the group name. For example, silty gravel with cobbles, GM.

13. Report

13.1 The report should include the group name, group symbol, and the results of the laboratory tests. The particle-size distribution shall be given in terms of percent of gravel, sand, and fines. The plot of the cumulative particle-size distribution curve shall be reported if used in classifying the soil. Report appropriate descriptive information according to the procedures in Recommended Practice D 2488. A local or commercial name or geologic interpretation for the material may be added at the end of the descriptive information if identified as such. The test procedures used shall be referenced.

NOTE 9—*Example: Clayey Gravel with Sand and Cobbles* (GC)—46 % fine to coarse, hard, subrounded gravel; 30 % fine to coarse, hard, subrounded sand 24 % clayey fines, LL = 38, PI = 19; weak reaction with HCl; original field sample had 4 % hard, subrounded cobbles; maximum size 150 mm.

In-Place Conditions—firm, homogeneous, dry brown.

Geologic Interpretation—alluvial fan.

NOTE 10—Other examples of soil descriptions are given in Appendix X1.

14. Precision and Bias

14.1 This test method provides qualitative data only; therefore, a precision and bias statement is nonapplicable.

TABLE 1 Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50 % retained on No. 200 sieve	Gravels More than 50 % of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5 % fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3^E$	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12 % fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50 % or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5 % fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3^E$	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3^E$	SP	Poorly graded sand[I]
		Sands with Fines More than 12 % fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15 % sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15 % gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

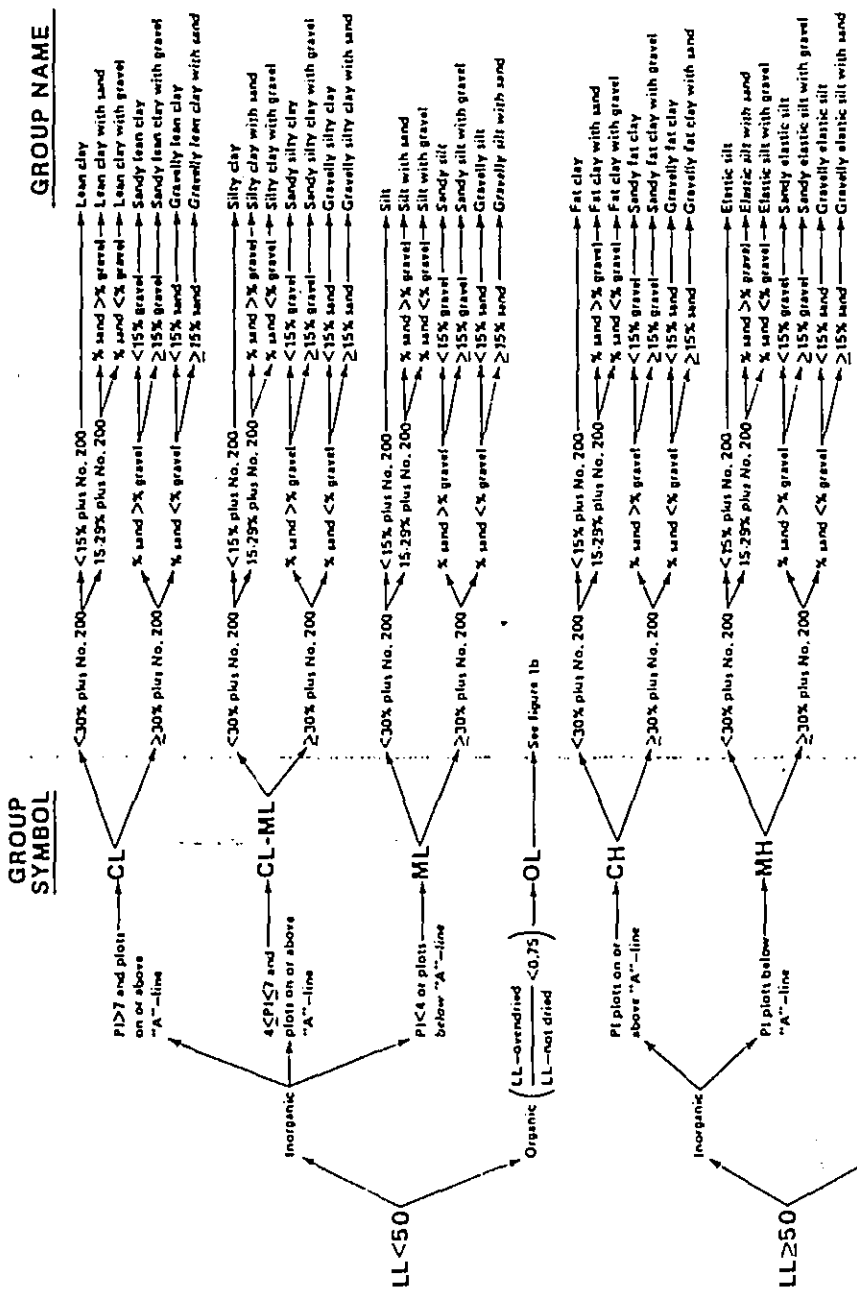

FIG. 1a Flow Chart for Classifying Fine-Grained Soil (50 % or More Passes No. 200 Sieve)

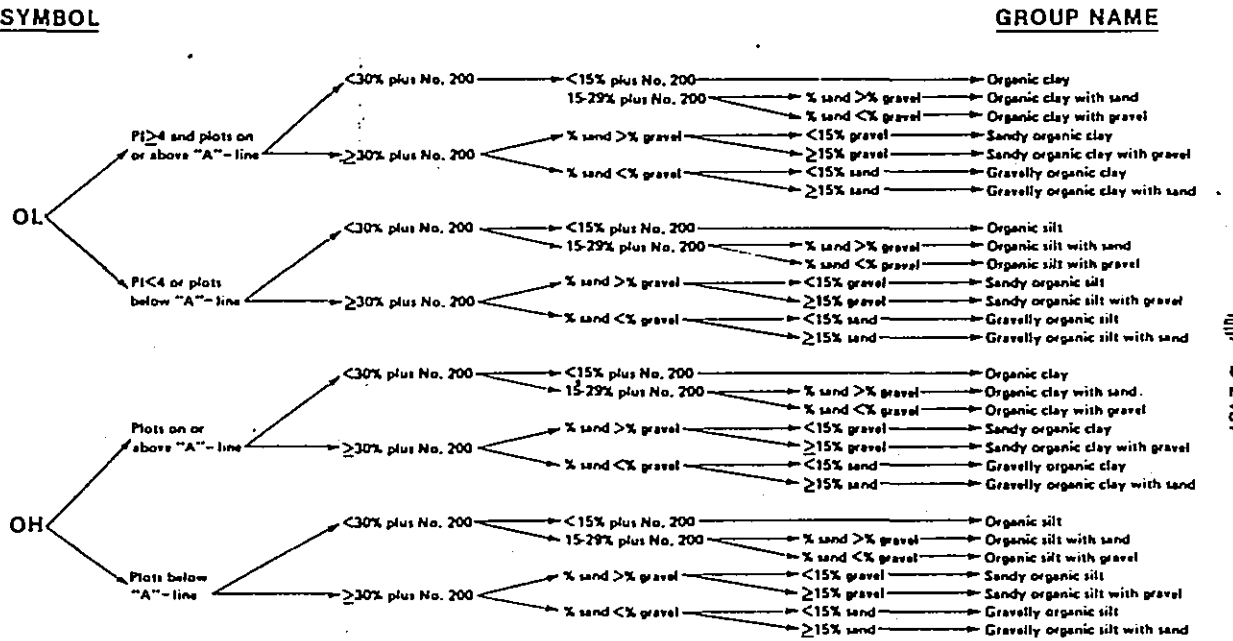

FIG. 1b Flow Chart for Classifying Organic Fine-Grained Soil (50 % or More Passes No. 200 Sieve)

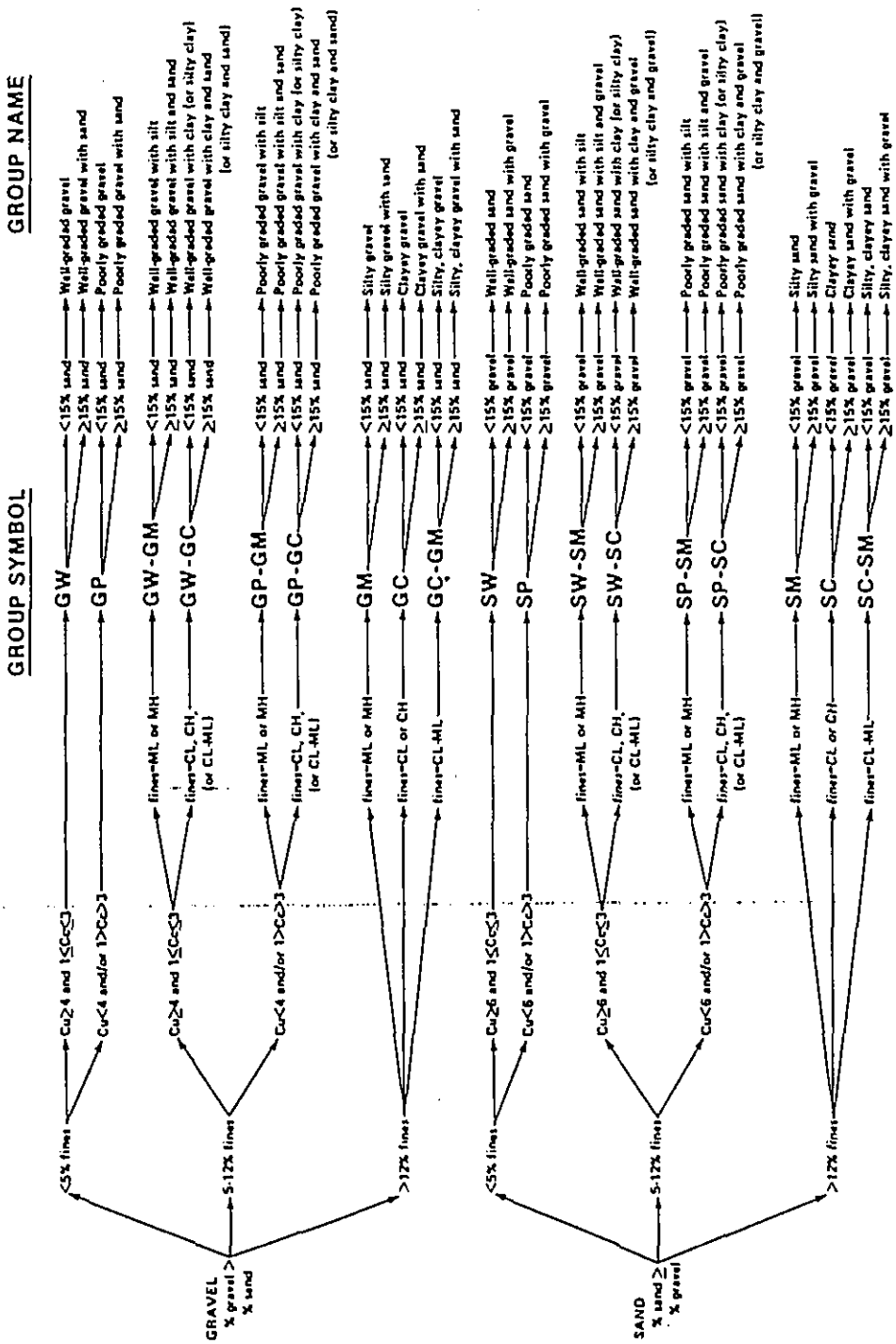

FIG. 2 Flow Chart for Classifying Coarse-Grained Soils (More Than 50 % Retained on No. 200 Sieve)

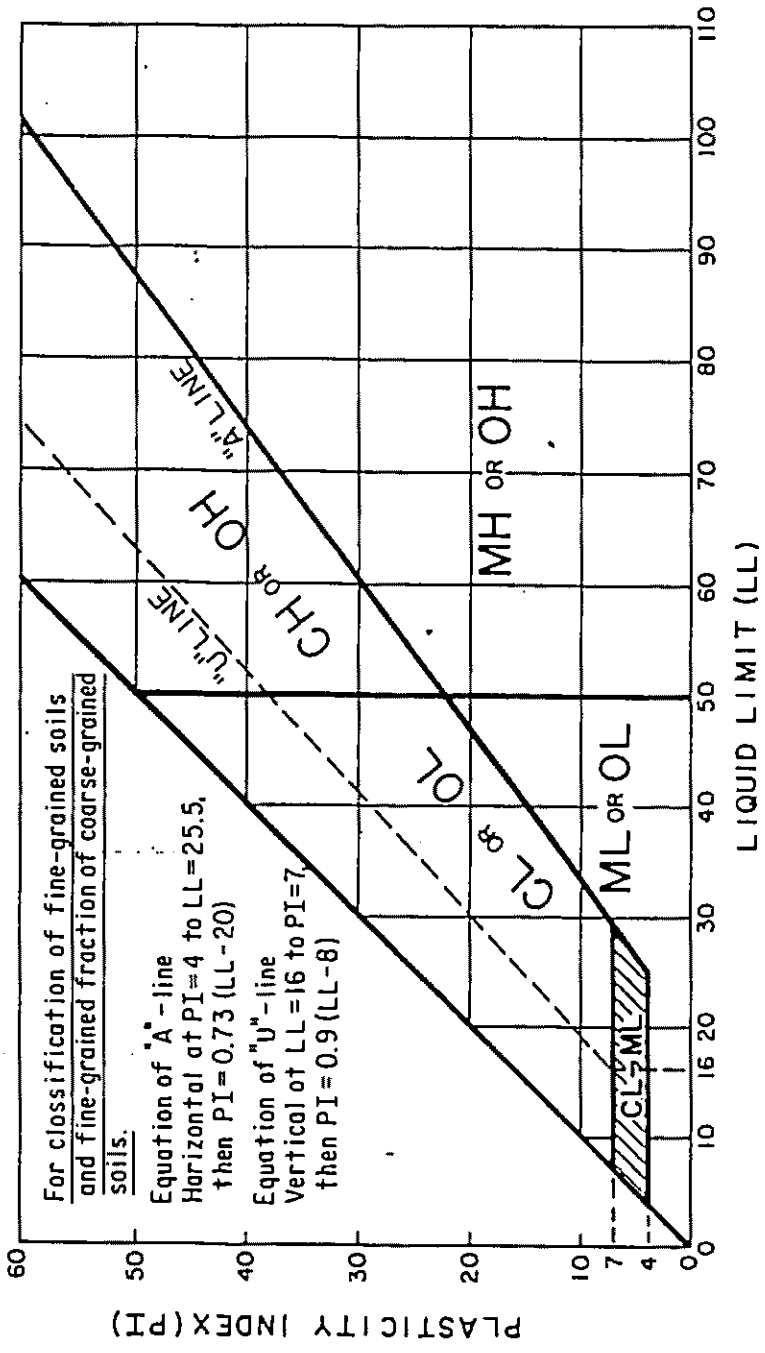

FIG. 3 Plasticity Chart

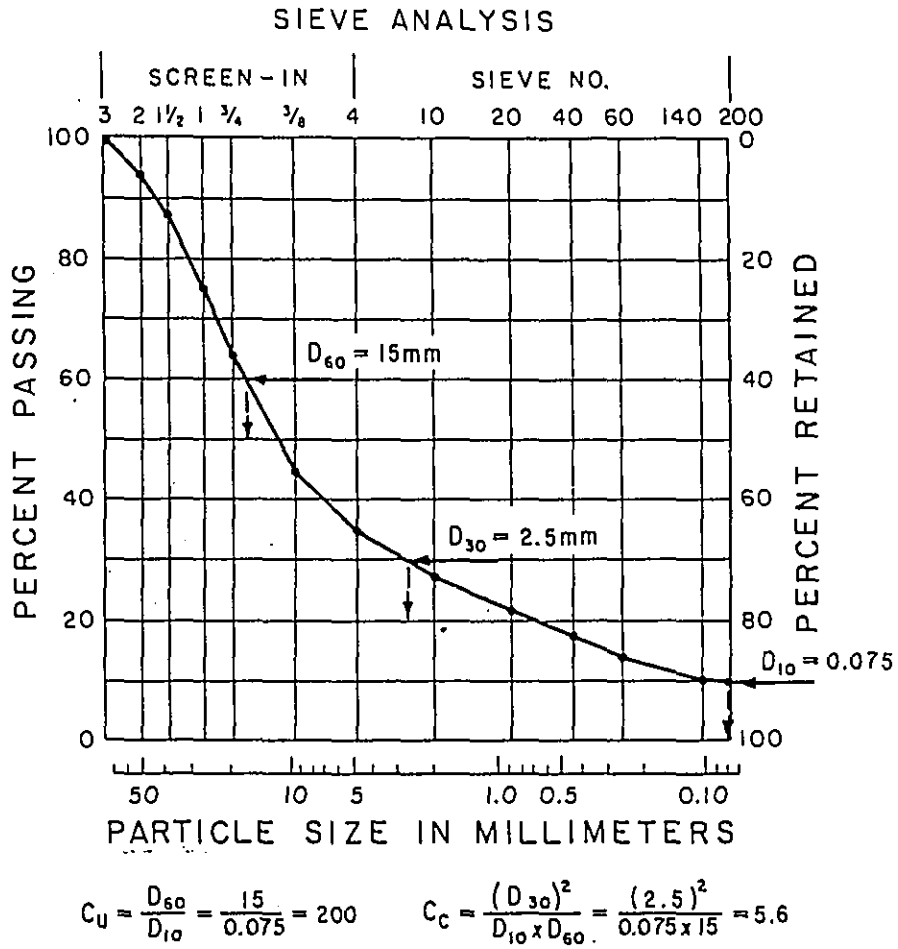

FIG. 4 Cumulative Particle-Size Plot

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF DESCRIPTIONS USING SOIL CLASSIFICATION

X1.1 The following examples show how the information required in 13.1 can be reported. The appropriate descriptive information from Recommended Practice D 2488 is included for illustrative purposes. The additional descriptive terms that would accompany the soil classification should be based on the intended use of the classification and the individual circumstances.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—73 % fine to coarse, hard, subangular gravel; 23 % fine to coarse, hard, subangular sand; 4 % fines; Cc = 2.7, Cu = 12.4.

X1.1.2 *Silty Sand with Gravel (SM)*—61 % predominantly fine sand; 23 % silty fines, LL = 33, PI = 6; 16 % fine, hard, subrounded gravel; no reaction with HCl; (field sample smaller than recommended). *In-Place Conditions*—Firm, stratified and contains lenses of silt 1 to 2 in. thick, moist, brown to gray; in-place density = 106 lb/ft³ and in-place moisture = 9 %.

X1.1.3 *Organic Clay (OL)*—100 % fines, LL (not

rial, take extreme care in obtaining a representative portion of the No. 40 (425-μm) fraction. Typically, a larger portion than normal has to be selected, such as the minimum weights required in 7.2.

X3.7.1.2 To obtain a representative specimen of a basically cohesive soil, it may be advantageous to pass the soil through a ¾-in. (19-mm) sieve or other convenient size so the material can be more easily mixed and then quartered or split to obtain the representative specimen.

X3.7.2 Process the representative specimen in accordance with Procedure B of Method D 2217.

X3.7.3 Perform the liquid-limit test in accordance with Method D 423, except the soil shall not be air dried prior to the test.

X3.7.4 Perform the plastic-limit test in accordance with Test Method D 424, except the soil shall not be air dried prior to the test, and calculate the plasticity index.

X3.8 Determine the particle-size distribution as follows:

X3.8.1 If the water content of the fraction passing the 3-in. (75-mm) sieve was required (X3.6.3), use the water-content specimen for determining the particle-size distribution. Otherwise, select a representative specimen in accordance with Methods C 702 with a minimum dry weight as required in 7.2.

X3.8.2 If the cumulative particle-size distribution including a hydrometer analysis is required, determine the particle-size distribution in accordance with Method D 422. See 9.7 for the set of required sieves.

X3.8.3 If the cumulative particle-size distribution without a hydrometer analysis is required, determine the particle-size distribution in accordance with Method C 136. See 9.7 for the set of required sieves. The specimen should be soaked until all clayey aggregations have softened and then washed in accordance with Test Method C 117 prior to performing the particle-size distribution.

X3.8.4 If the cumulative particle-size distribution is not required, determine the percent fines, percent sand, and percent gravel in the specimen in accordance with Test Method C 117, being sure to soak the specimen long enough to soften all clayey aggregations, followed by Method C 136 using a nest of sieves which shall include a No. 4 (4.75-mm) sieve and a No. 200 (75-μm) sieve.

X3.8.5 Calculate the percent fines, percent sand, and percent gravel in the minus 3-in. (75-mm) fraction for classification purposes.

X4. AIR-DRIED METHOD OF PREPARATION OF SOILS FOR TESTING FOR CLASSIFICATION PURPOSES

X4.1 This appendix describes the steps in preparing a soil sample for testing for purposes of soil classification when air-drying the soil before testing is specified or desired or when the natural moisture content is near that of an air-dried state.

X4.2 If the soil contains organic matter or mineral colloids that are irreversibly affected by air drying, the wet-preparation method as described in Appendix X3 should be used.

X4.3 Since this classification system is limited to the portion of a sample passing the 3-in. (75-mm) sieve, the plus 3-in. (75-mm) material shall be removed prior to the determination of the particle-size characteristics and the liquid limit and plasticity index.

X4.4 The portion of the field sample finer than the 3-in. (75-mm) sieve shall be obtained as follows:

X4.4.1 Air dry and weigh the field sample.

X4.4.2 Separate the field sample into two fractions on a 3-in. (75-mm) sieve.

X4.4.3 Weigh the two fractions and compute the percentage of the plus 3-in. (75-mm) material in the field sample.

X4.5 Determine the particle-size distribution and liquid limit and plasticity index as follows (see 9.8 for when these tests are required):

X4.5.1 Thoroughly mix the fraction passing the 3-in. (75-mm) sieve.

X4.5.2 If the cumulative particle-size distribution including a hydrometer analysis is required, determine the particle-size distribution in accordance with Method D 422. See 9.7 for the set of sieves that is required.

X4.5.3 If the cumulative particle-size distribution without a hydrometer analysis is required, determine the particle-size distribution in accordance with Test Method D 1140 followed by Method C 136. See 9.7 for the set of sieves that is required.

X4.5.4 If the cumulative particle-size distribution is not required, determine the percent fines, percent sand, and percent gravel in the specimen in accordance with Test Method D 1140 followed by Method C 136 using a nest of sieves which shall include a No. 4 (4.75-mm) sieve and a No. 200 (75-μm) sieve.

X4.5.5 If required, determine the liquid limit and the plasticity index of the test specimen in accordance with Test Methods D 423 and D 424.

dried) = 32, LL (oven dried) = 21, PI (not dried) = 10; wet, dark brown, organic odor, weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—74 % fine to coarse, hard, subangular reddish sand; 26 % organic and silty dark-brown fines, LL (not dried) = 37, LL (oven dried) = 26, PI (not dried) = 6, wet, weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—78 % fine to coarse, hard, subrounded to subangular gravel; 16 % fine to coarse, hard, subrounded to subangular sand; 6 % silty (estimated) fines; moist, brown; no reaction with HCl; original field sample had 7 % hard, subrounded cobbles and 2 % hard, subrounded boulders with a maximum size of 18 in.

X2. USING SOIL CLASSIFICATION AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, ETC.

X2.1 The group names and symbols used in this test method may be used as a descriptive system applied to materials that exist in situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, etc.).

X2.2 Materials such as shells, crushed rock, slag, etc., should be identified as such. However, the procedures used in this method for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, a classification in accordance with this test method may be assigned to aid in describing the material.

X2.3 If a classification is used, the group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how soil classifications could be incorporated into a description system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. pieces of shale from power auger hole, dry, brown, no reaction with HCl. After laboratory processing by slaking in water for 24 h, material classified as "Sandy Lean Clay (CL)"—61 % clayey fines, LL = 37, PI = 16; 33 % fine to medium sand; 6 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"—91 % fine to medium sand; 9 % silty (estimated) fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—62 % gravel-size broken shells; 31 % sand and sand-size shell pieces; 7 % fines; would be classified as "Poorly Graded Gravel with Sand (GP)".

X2.4.4 *Crushed Rock*—Processed gravel and cobbles from Pit No. 7; "Poorly Graded Gravel (GP)"—89 % fine, hard, angular gravel-size particles; 11 % coarse, hard, angular sand-size particles, dry, tan; no reaction with HCl; Cc = 2.4, Cu = 0.9.

X3. PREPARATION AND TESTING FOR CLASSIFICATION PURPOSES BY THE WET METHOD

X3.1 This appendix describes the steps in preparing a soil sample for testing for purposes of soil classification using a wet-preparation procedure.

X3.2 Samples prepared in accordance with this procedure should contain as much of their natural water content as possible and every effort should be made during obtaining, preparing, and transportating the samples to maintain the natural moisture.

X3.3 The procedures to be followed in this test method assume that the field sample contains fines, sand, gravel, and plus 3-in. (75-mm) particles and the cumulative particle-size distribution plus the liquid limit and plasticity index values are required (see 9.8). Some of the following steps may be omitted when they are not applicable to the soil being tested.

X3.4 If the soil contains plus No. 200 (75-μm) particles that would degrade during dry sieving, use a test procedure for determining the particle-size characteristics that prevents this degradation.

X3.5 Since this classification system is limited to the portion of a sample passing the 3-in. (75-mm) sieve, the plus 3-in. (75-mm) material shall be removed prior to the determination of the particle-size characteristics and the liquid limit and plasticity index.

X3.6 The portion of the field sample finer than the 3-in. (75-mm) sieve shall be obtained as follows:

X3.6.1 Separate the field sample into two fractions on a 3-in. (75-mm) sieve, being careful to maintain the natural water content in the minus 3-in. (75-mm) fraction. Any particles adhering to the plus 3-in. (75-mm) particles shall be brushed or wiped off and placed in the fraction passing the 3-in. (75-mm) sieve.

X3.6.2 Determine the air-dry or oven-dry weight of the fraction retained on the 3-in. (75-mm) sieve. Determine the total (wet) weight of the fraction passing the 3-in. (75-mm) sieve.

X3.6.3 Thoroughly mix the fraction passing the 3-in. (75-mm) sieve. Determine the water content, in accordance with Method D 2216, of a representative specimen with a minimum dry weight as required in 7.2. Save the water-content specimen for determination of the particle-size analysis in accordance with X3.8.

X3.6.4 Compute the dry weight of the fraction passing the 3-in. (75-mm) sieve based on the water content and total (wet) weight. Compute the total dry weight of the sample and calculate the percentage of material retained on the 3-in. (75-mm) sieve.

X3.7 Determine the liquid limit and plasticity index as follows:

X3.7.1 If the soil disaggregates readily, mix on a clean, hard surface and select a representative sample by quartering in accordance with Method C 702.

X3.7.1.1 If the soil contains coarse-grained particles coated with and bound together by tough clayey mate-

LIST OF TERMS USED AND SYMBOLS

1) DRILLING & SAMPLING

ACR	= After Casing Removed	HA	= Hand Augering
AD	= After Drilling	PA	= Power Augering
BCR	= Before Casing Removed	PP	= Pocket Penetrometer
BS	= Bentonite Slurry	SPT	= Standard Penetration Test
CA	= Casing Advanced	SS	= Split - Spoon
CR	= Casing Removed	ST	= Shelby Tube
FVT	= Field Vane Shear Test	TB	= Thin-Walled Bit
GWL	= Ground Water Level	WO	= Wash Out

2) SOIL PROPERTIES

W_n	= Natural Water Content	G_s	= Specific Gravity
LL	= Liquid Limit	γ_t	= Total Unit Weight
PL	= Plastic Limit	S_u	= Undrained Shear Strength
PI	= Plasticity Index	S_t	= Sensitivity
LI	= Liquidity Index	SPT-N	= Standard Penetration Resistance

3) SOIL CONSISTENCY AND COMPACTNESS

COHESIVE SOILS		
Consistency	SPT-N (Blows/Ft.)	Unconfined Shear Strength (t/m^2)
Very Soft	0 - 2	< 1.25
Soft	2 - 4	1.25 - 2.50
Medium	4 - 8	2.50 - 5.00
Stiff	8 - 15	5.00 - 10.00
Very Stiff	15 - 30	10.00 - 20.00
Hard	> 30	> 20.00

COHESIONLESS SOILS		
Compactness	SPT - N (Blows/Ft.)	Relative Density %
Very Loose	0 - 4	0 - 15
Loose	4 - 10	15 - 35
Medium	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very Dense	> 50	85 - 100

4) TERMS USED FOR IDENTIFYING MINOR COMPONENT OF SOIL

Term	% of Sample
Trace	< 10
Trace to some	10 - 20
Some	20 - 35
And	35 - 50

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