UNITED NATIONS

COMMITTEE FOR COORDINATION OF INVESTIGATIONS
OF THE LOWER MEKONG BASIN

SECOND PHASE REPORT
ON

NONG KHAI / VIENTIANE BRIDGE PROJECT
LAOS AND THAILAND

APPENDICES

NOVEMBER 1968

OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO JAPAN

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PREFACE

Nong Khai/Vientiane Bridge Project was taken up as one of the first priority projects in the Ten-Year Development Program for the Lower Mekong Basin at the 29th Session of the Committee for Coordination of Investigations of the Lower Mekong River Basin.

The feasibility investigation on the Nong Khai/Vientiane Bridge Project was carried out in two phases, in accordance with the Plan of Operation signed in April 1967 between the Government of Japan and the Mekong Committee.

The first phase investigation was undertaken for about two months from August to October 1967 and the second phase investigation for about four months from February to June 1968.

The results of the field investigations and the subsequent studies such as topographic survey, soil survey, material survey, analysis of meteor- and hydrological data, economic survey and so forth, are compiled in Appendices.

The report therefore constitutes an integral part of the Second Phase Report of the Nong Khai/Vientiane Bridge Project.

NONG KHAI/VIENTIANE BRIDGE PROJECT

APPENDICES

TABLE OF CONTENTS

APPENDIX I

TOPOGRAPHIC SURVEY

CONTENTS

1.1 Survey Operations

Survey Operations carried out

in the First and the Second Phase Investigations

Items	Locations
1st phase investigations	
1. Spot leveling (Double-run leveling)	From Vientiane to each of the three bridge sites, Pa Mong, Vientiane and Nong Khai.
2. Echo-sounding (Accuracy of the machine: 1/100)	In the Mekong river channel based upon the bench-mark established at the three sites.
3. Simple triangulation to measure the width of the Mekong	Three bridge sites: Pa Mong, Vientiane and Nong Khai
2nd phase investigations	
1. Spot leveling to unify the elevation of the topography of the project area extending over both countries (Double-run leveling)	Bench-marks B.M.N-6 to B_T via the bench-mark established by N.E.A in the site of Hydrographic Office
2. Plane table survey including echo-sounding (Scale: 1/2,000, 1m contour)	Whole project area of the Nong Khai bridge site
3. Route survey (Transverse survey: 50 m long each on both sides of the route at intervals of 100 m along the route)	Routes for the access railway and the access highway on both the countries
4. Triangulation to measure the exact width of the Mekong	Nong Khai bridge site

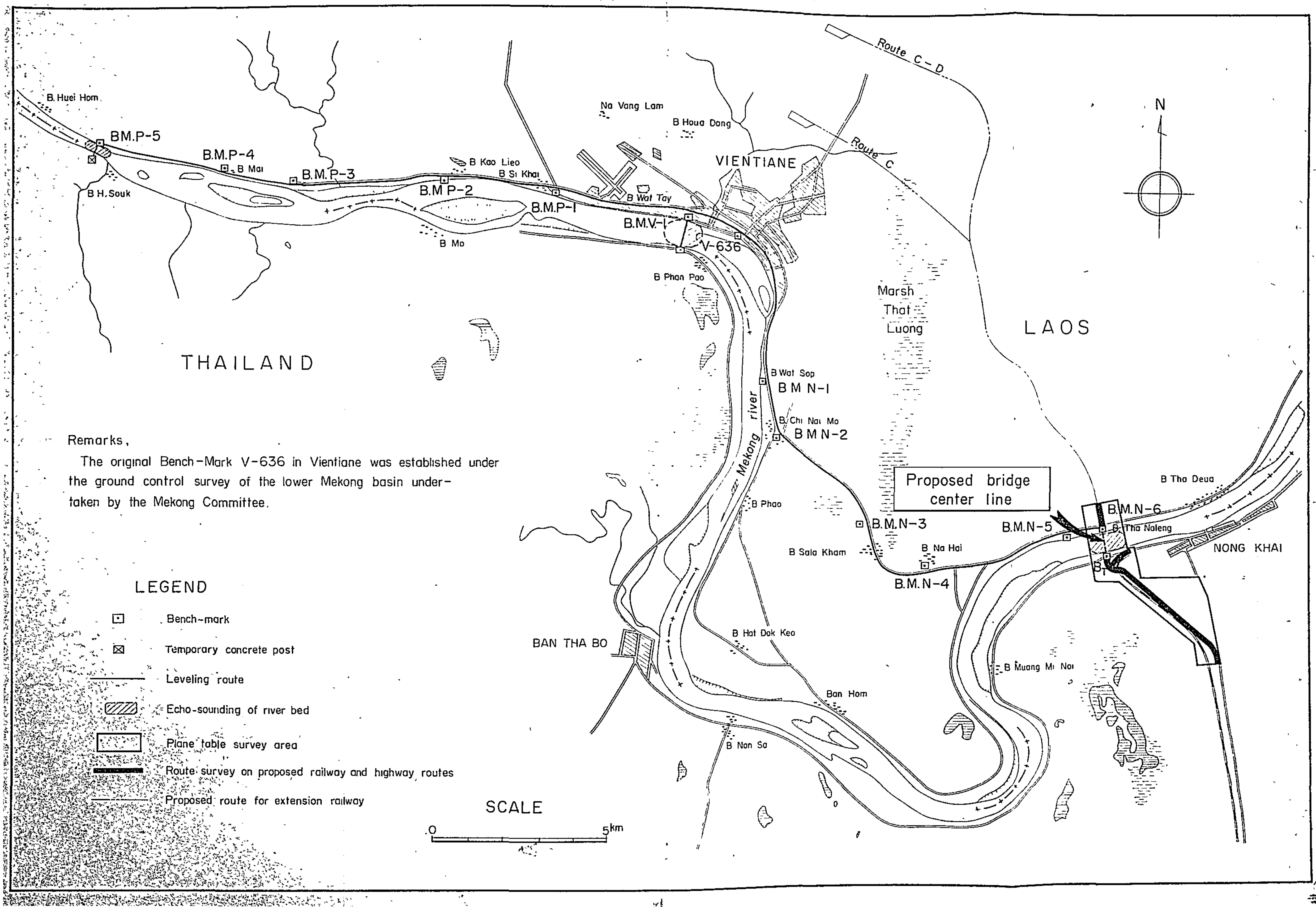
Remarks: -

1) The results of survey operations executed during the first phase investigation regarding Pa Mong and Vientiane bridge sites are not compiled in Appendices. As for Nong Khai bridge site, only the results of spot leveling are given in Appendices.

2) The map on a scale of 1/2,000 obtained from the plane table survey is not listed in Appendices. Reference, however, is made to PLATE 2 titled "GENERAL LAYOUT" scaled down to 1/10,000 from the above map.

3) The results of transverse survey operations in the route survey are not compiled in Appendices.

SURVEY OPERATIONS



1.2. Spot Leveling

1) The original bench-mark V636 is represented by a spike into a wall of the building of the Ministry of Foreign Affairs in Vientiane with the approval of the Mekong Committee.

2) Leveling between the bench-marks V636 and B.M.N-6 was carried out in the first phase investigation, and that between the bench-marks B.M.N-6 and B.M.N-7 was carried out in the second phase investigation via the bench-mark established by N.E.A. in the site of Hydrographic Office.

3) The bench-marks B.M.N-6 and B.M.N-7 were set on the bridge center line proposed in the First Phase Report. The mark B.M.N-7 is called the mark B_T in the Second Phase Report for the sake of convenience.

4) The elevation of the bench-mark in the site of Hydrographic Office is EL. 166.044 above the mean sea level at Ko Lak datum. On the other hand, according to the result of leveling made in the second phase investigation, the elevation of this bench-mark becomes EL. 165.861. The difference of the elevation between the two is 18.3 centimeters. Concerning this matter, please refer to the Second Phase Report, Chapter II.

RESULTS OF LEVELING

ROUTE: Vientiane to Nong Khai bridge site — Unit: m

T. P. No.	DISTANCE	DIFFERENCE OF ELEVATION 1	2	MEAN	ADJUST	ADJUSTED DIFFERENCE	ELEVATION	REMARKS
V.636							170.105	Authorized
TPN-1		+0.084	+0.087	+0.085			170.190	
N-2		+0.751	+0.755	+0.753			170.943	
N-3		+0.558	+0.556	+0.557			171.500	
N-4		-0.855	-0.862	-0.859			170.641	Wat Sop
N-5		+0.230	+0.240	+0.235			170.876	
N-6		+0.088	+0.105	+0.096			170.972	GOV. B.M.8-S40
N-7		+1.903	+1.902	+1.903			172.875	
N-8		+3.273	+3.272	+3.272			176.147	
N-9		-1.563	-1.565	-1.564			174,583	
N-10		-0.230	-0.235	-0.233			174.350	
N-11		-1.546	-1.549	-1.547			172.803	
N-12		-3.465	-3.464	-3.465			169.338	N.K.K B.M.43
N-13		-1.770	-1.760	-1.765			167.573	
N-14		+0.309	+0.309	+0.309			167.882	
N-15		-0.446	-0.450	-0.448			167.434	
N-16		-0.088	-0.097	-0.092			167.342	
N-17		+0.080	+0.081	+0.081			167.423	
N-18		+0.235	+0.229	+0.232			167.655	
N-19		+0.402	+0.409	+0.405			168.060	N.E.A. B.M.
BMN-6		+0.164	+0.164	+0.164			168.224	Laotian side
TPT-1		-12.172	-12.171	-12.171			156.053	
T-2		-0.653	-0.645	-0.649			155.404	
T-3		+0.277	+0.277	+0.277			155.681	
T-4		+10.180	+10.181	+10.180			165.861	N.E.A. B.M.
BMN-7		+0.713	+0.713	+0.713			166.574	Thai side

RESULTS OF LEVELING

Elevation of the bench-marks set on the leveling route

T. P. No.	DISTANCE	DIFFERENCE OF ELEVATION (m) 1	2	MEAN	ADJUST	ADJUSTED DIFFERENCE	ELEVATION (m)	REMARKS
TPN-3		-	-	-			171.500	
BMN-1		+2.878	+2.888	+2.883			174.383	
BMN-2		-	-	-			170.972	TPN-6
TPN-10		-	-	-			174.350	
BMN-3		+0.088	+0.087	+0.087			174.437	
TPN-13		-	-	-			167.573	
BMN-4		+0.218	+0.214	+0.216			167.789	
TPN-18		-	-	-			167.655	
BMN-5		-0.190	-0.191	-0.190			167.465	
Checking midway on the leveling								
TPN-4		-	-	-			170.641	
Zero point of staff gage in the Wat Sop G.S.		-12.643	-	-12.643			157.998	

Remarks:

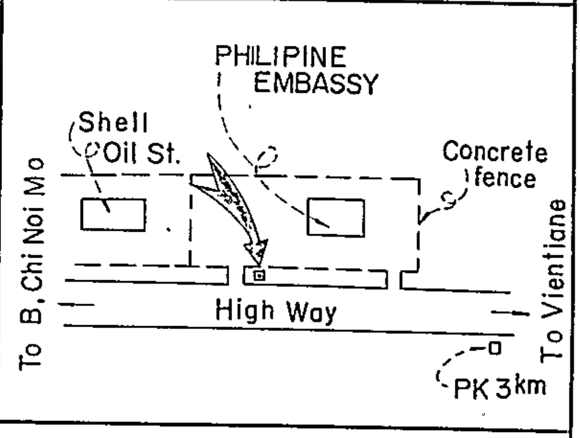
1) This leveling was of single-run.

2) Since the elevation of the zero point of staff gage in the Wat Sop gaging station is EL.158.040 above the mean sea level at Ko Lak datum, the difference of the elevations is 4.2 centimeters.

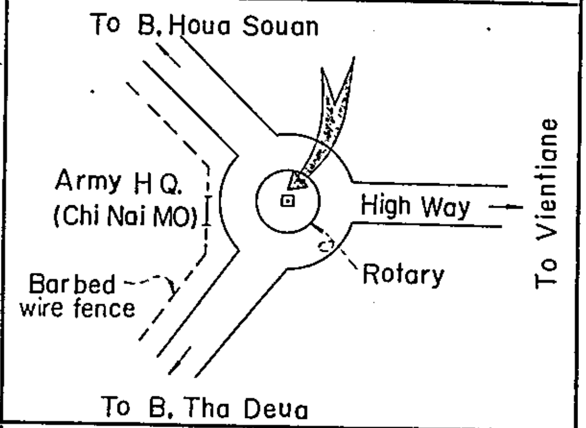
Location of Bench-Marks (1)

B. M. No.	DESCRIPTIONS	
N-1	ELEVATION	174.383
	LOCATION	Ban Wat Sop
	ESTABLISHED ON	26 Sep. 1967
	CARVED ELEVATION	
	Concrete precast post	

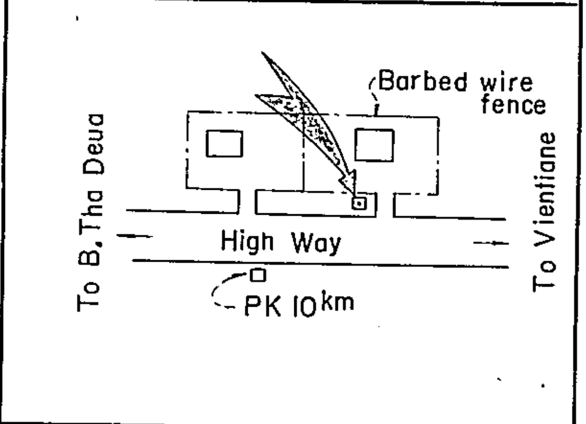
SKETCH



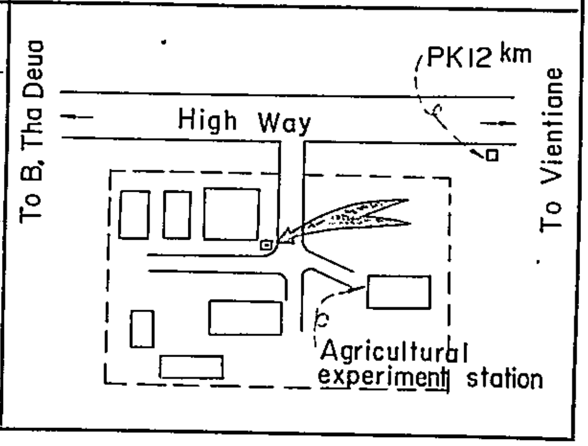
B. M. No.	DESCRIPTIONS	
N-2	ELEVATION	170.972
	LOCATION	Ban Chi Noi Mo
	ESTABLISHED ON	26 Sep. 1967
	CARVED ELEVATION	
	Concrete precast post	



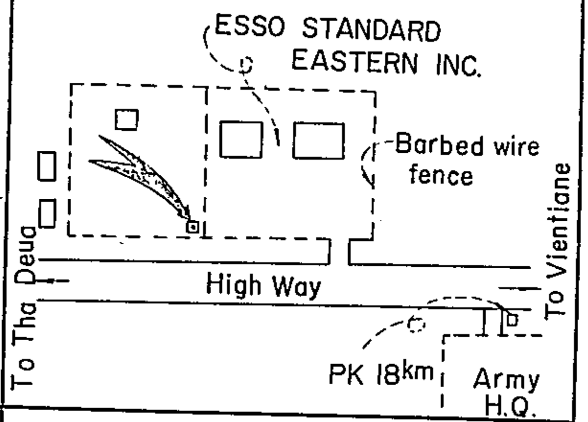
B. M. No.	DESCRIPTIONS	
N-3	ELEVATION	174.437
	LOCATION	Ban 10 Km
	ESTABLISHED ON	28 Sep. 1967
	CARVED ELEVATION	
	Concrete Precast post	



B. M. No.	DESCRIPTIONS	
N-4	ELEVATION	167.789
	LOCATION	Ban Na Hai
	ESTABLISHED ON	28 Sep. 1967
	CARVED ELEVATION	
	Concrete precast post	



Location of Bench-Marks (2)

<table>
<tr><th>B. M. No.</th><th colspan="2">DESCRIPTIONS</th><th>SKETCH</th></tr>
<tr><td rowspan="5">N-5</td><td>ELEVATION</td><td>167.465</td><td rowspan="5">
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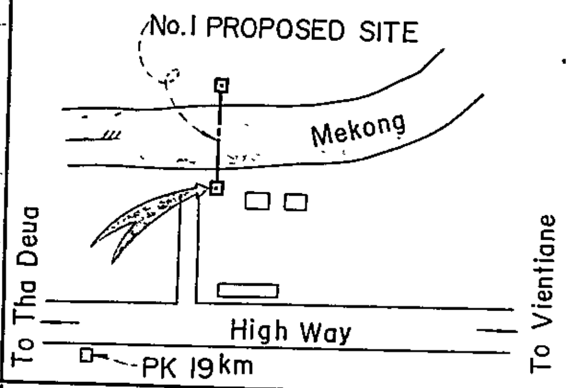
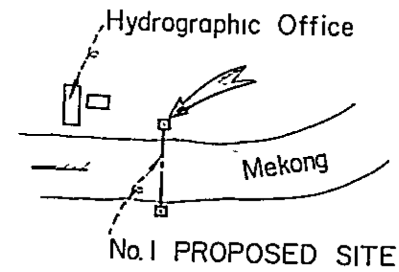
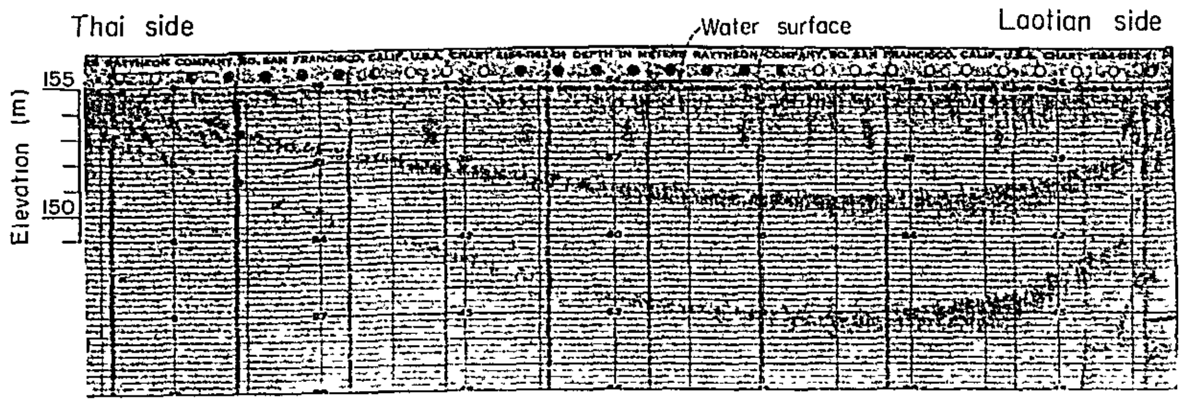
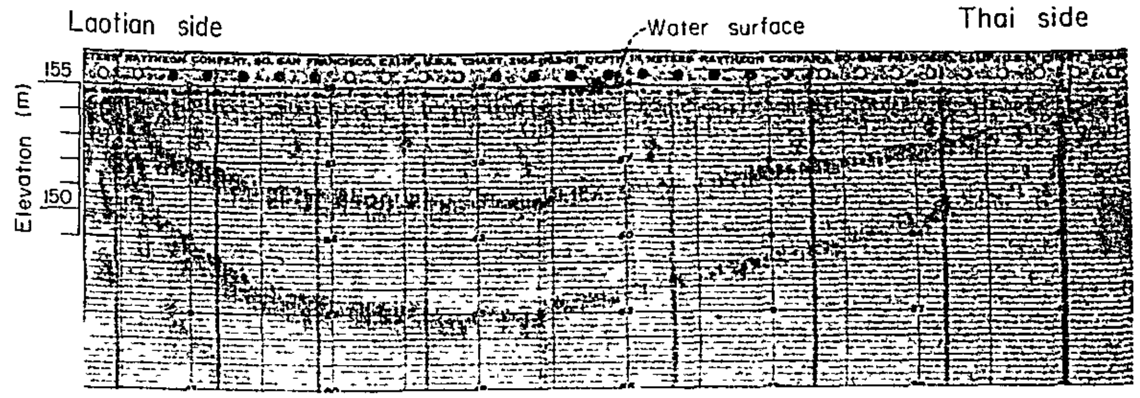
<tr><td>LOCATION</td><td>Ban Tha Naleng</td></tr>
<tr><td>ESTABLISHED ON</td><td>28 Sep. 1967</td></tr>
<tr><td>CARVED ELEVATION</td><td></td></tr>
<tr><td colspan="2">Concrete precast post</td></tr>
<tr><td rowspan="5">N-6</td><td>ELEVATION</td><td>168.224</td><td rowspan="5">
</td></tr>
<tr><td>LOCATION</td><td>Ban Tha Naleng
(No.1 proposed site)</td></tr>
<tr><td>ESTABLISHED ON</td><td>28 Sep. 1967</td></tr>
<tr><td>CARVED ELEVATION</td><td></td></tr>
<tr><td colspan="2">Concrete precast post</td></tr>
<tr><td rowspan="5">N-7</td><td>ELEVATION</td><td>166.574</td><td rowspan="5">
</td></tr>
<tr><td>LOCATION</td><td>Wat Chommane
(No.1 proposed site)</td></tr>
<tr><td>ESTABLISHED ON</td><td>9 Mar. 1968</td></tr>
<tr><td>CARVED ELEVATION</td><td></td></tr>
<tr><td colspan="2">Concrete precast post</td></tr>
<tr><td rowspan="5"></td><td>ELEVATION</td><td></td><td rowspan="5"></td></tr>
<tr><td>LOCATION</td><td></td></tr>
<tr><td>ESTABLISHED ON</td><td></td></tr>
<tr><td>CARVED ELEVATION</td><td></td></tr>
<tr><td colspan="2"></td></tr>
</table>

1.3 Echo - sounding

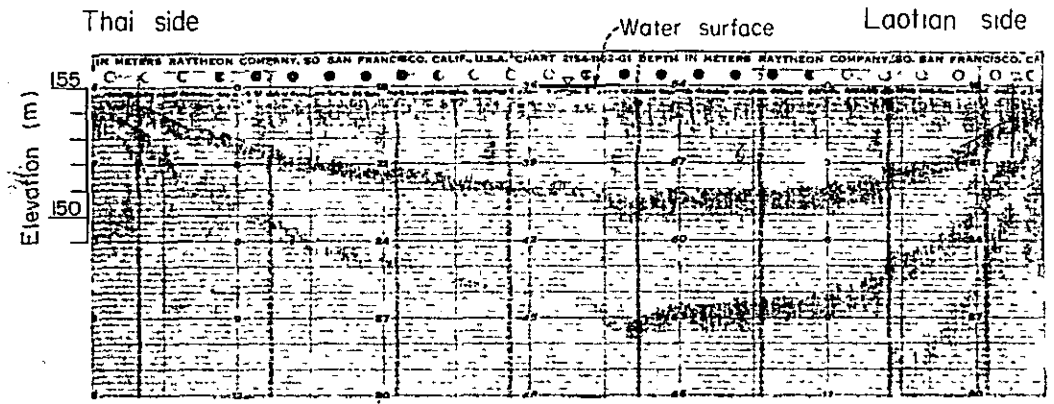
ECHO - SOUNDING RECORDS AT THE BRIDGE SITE



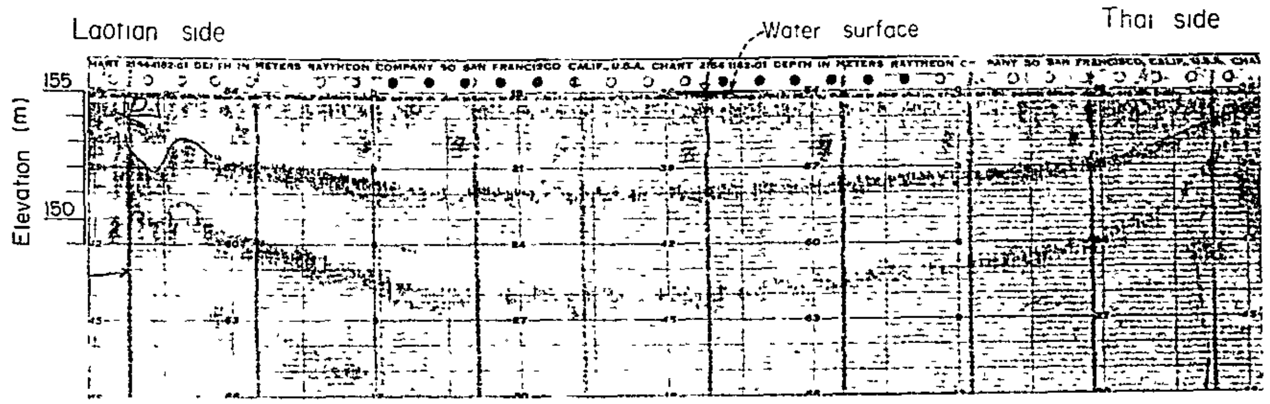
COURSE - A



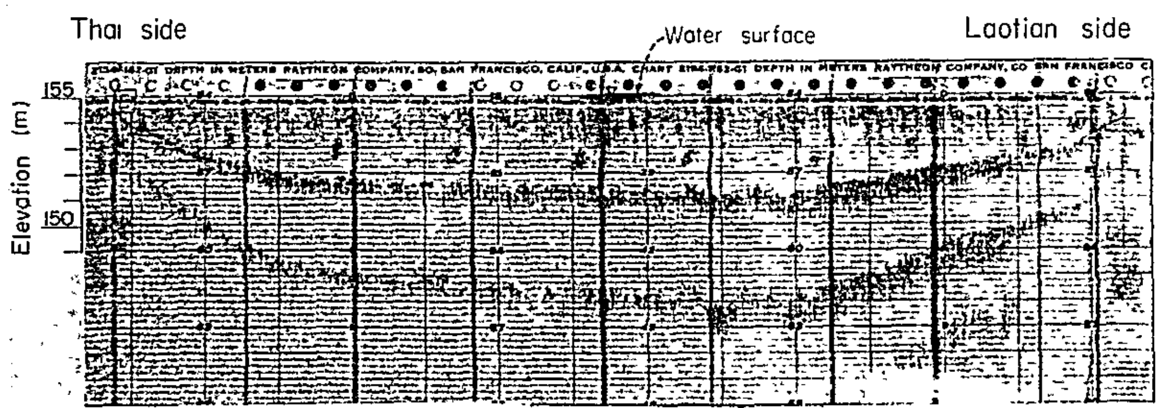
COURSE - B



COURSE - C



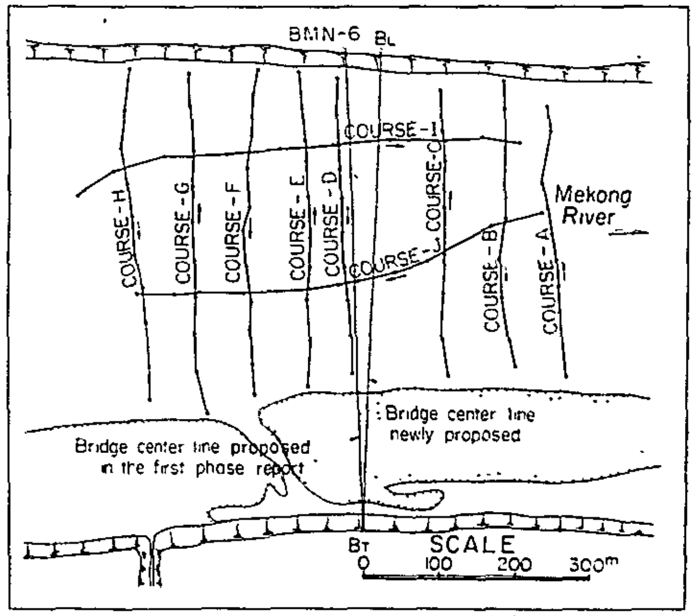
COURSE - D



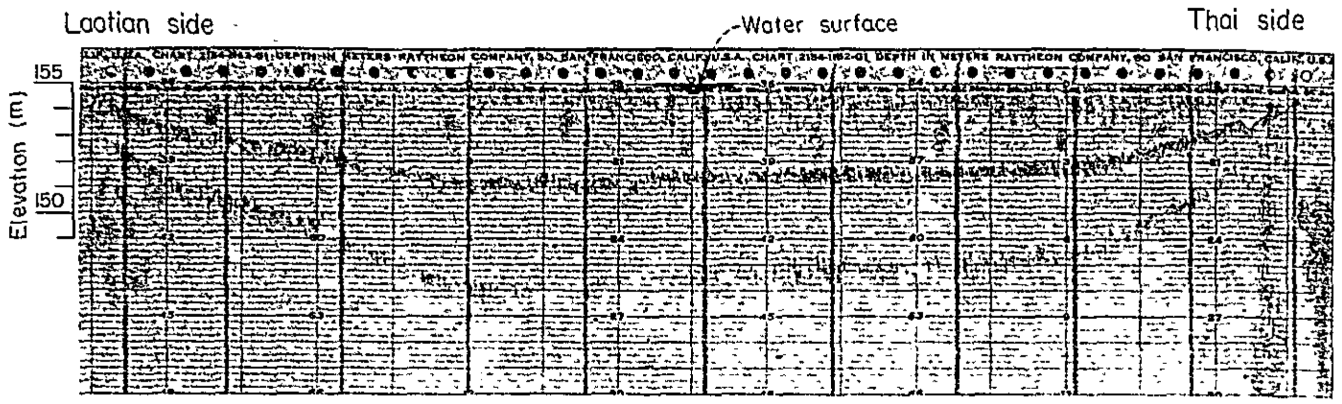
COURSE - E

Remarks :

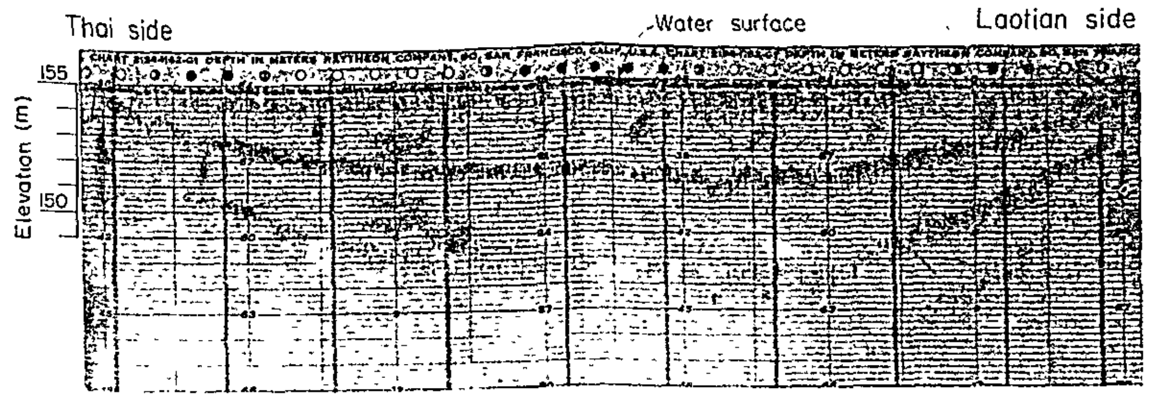
1) These records were taken on April 5 1968 in the second phase investigation
2) Water surface on April 5, 1968, EL. 155.0^{m}



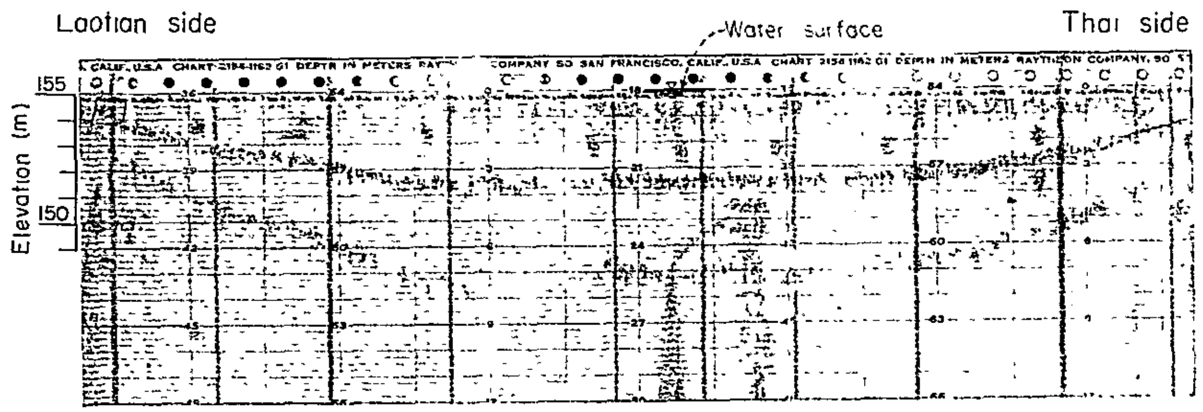
ECHO - SOUNDING RECORDS AT THE BRIDGE SITE - CONTINUED



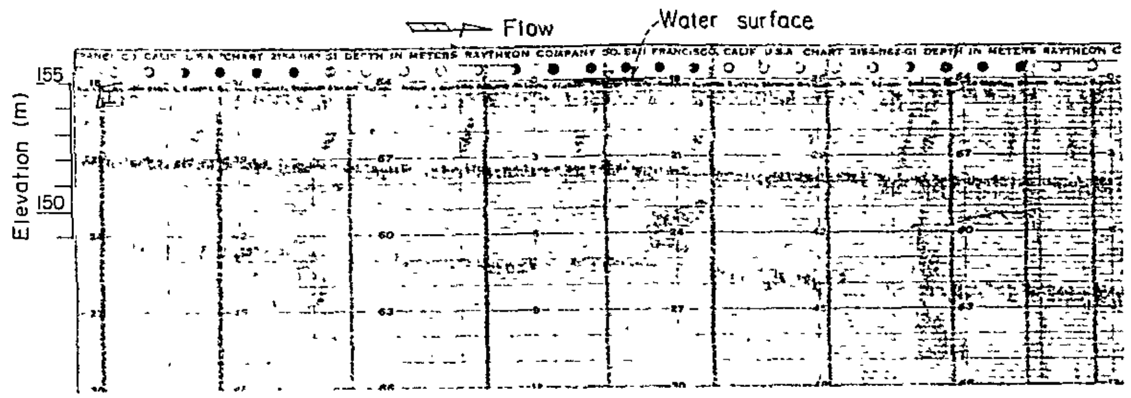
COURSE - F



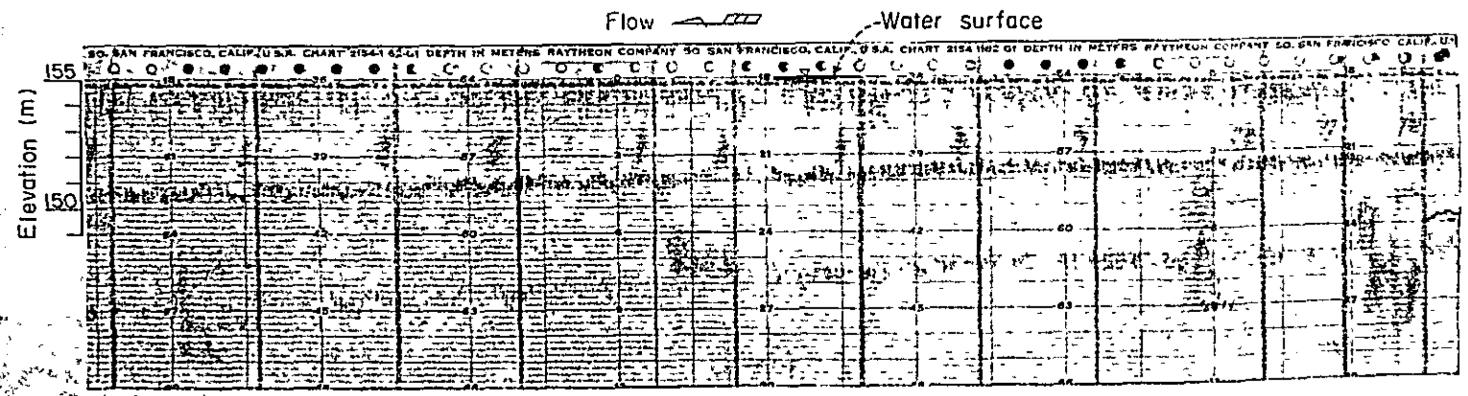
COURSE - G



COURSE - H



COURSE - I



COURSE - J

Remarks

1) These records were taken on April 5,1968 in the second phase investigation

2) Water surface on April 5.1968, EL.155.0^{m}

1.4 Triangulation

Triangulation Computation

1. General

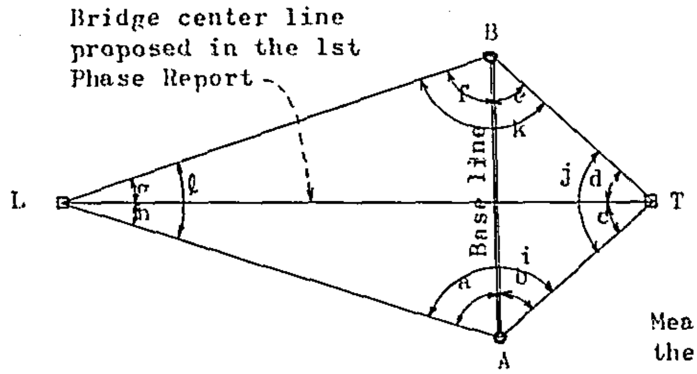
Triangulation was carried out in the second phase investigation as well as the first phase investigation to obtain the exact width of the Mekong along the proposed bridge center line that had been determined in the First Phase Report.

The base line for triangulation is desirable to be provided on either Laotian or Thai bank. But, it takes much time to do so because of jungle clearing. By this reason the base line was provided on the sandbar in the Mekong, and then measured and adjusted so that the errors resulting from high temperature and others could be minimized.

The exact length between the two temporary bench-marks established on both banks of the Mekong for triangulation was computed by means of the electronic computer on the basis of the results of the triangulation, as mentioned below.

2. Computation

The base line $\overline{AB}$ and the angles of the quadrilateral BLAT shown in the following Illust. 1. were observed.



Measured length of the base line:

$\overline{AB}$ = 200.000 m

Illust. 1

Each angle was observed as follows.

a. 75°43'15.0"	g. 11°14'47.5"
b. 54°19'10.0"	h. 10°42'00.0"
c. 39°15'55.0"	i. 130°02'00.0"
d. 37°15'05.0"	j. 76°31'10.0"
e. 49°10'00.0"	k. 131°30'05.0"
f. 82°19 50.0"	ℓ. 21°56'32.5"

2.1. Base Line Correction

The measured length of the base line was corrected in the three items expressed in the following equation. The slope and sea-level corrections were omitted because these are negligibly small.

$$D = D_N + C_t + C_s + C_p$$

where,
- D_N : measured length of the base line = 200.000 m
- D : corrected length
- C_t : temperature correction
- C_s : sag correction
- C_p : tension correction

(1) Temperature correction

$$C_t = D_N \cdot \alpha \, (T_m - T_o)$$

where,
- T_o : standard temperature = 15°C
- T_m : mean temperature = 29°C
- α : coefficient of expansion of steel tape = 0.0000117 m/°C

$$\therefore \quad C_t = 200 \times 0.0000117 \times (29 - 15) = 0.03276 \text{ m}$$

(2) Sag correction

$$C_s = -\frac{D_N}{24}\left(\frac{w \cdot d}{P}\right)^2$$

where, w : weight of steel tape per meter = 0.02158 kg/m

d : supported length = 10 m

P : mean tension = 10 kg

$$\therefore \quad C_s = -\frac{200}{24} \times \left(\frac{0.02158 \times 10}{10}\right)^2$$

$$= -0.00388 \text{ m}$$

(3) Tension correction

$$C_p = D_N \cdot \frac{(P - P_o)}{E \cdot S}$$

where, P : mean tension = 10 kg

P_o: standard tension = 7 kg

E : modulus of elasticity for steel = 2.1×10^6 kg/cm^2

S : cross sectional area of steel tape = 0.02749 cm^2

$$\therefore \quad C_p = 200 \times \frac{(10 - 7)}{2.1 \times 10^6 \times 0.02749}$$

$$= 0.01040 \text{ m}$$

As a result of the above calculation, the corrected length of the base line is obtained as follows.

$$D = 200 + 0.03276 - 0.00388 + 0.01040$$

$$= 200.03928 \text{ m}$$

Accordingly the base line is 200.0393 meters long.

2.2. Angle Adjustment

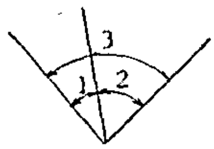
2.2.1. Condition

The quadrilateral BIAT in Illust. 1. has to be adjusted so as to satisfy the following three conditions.

i. The sum of Angles 1 and 2 shall be Angle 3. (see Illust. 2)

ii. The sum of the interior angles of a triangle shall be exactly 180°.

iii. The length of a side-line in a triangulation scheme is the same regardless of the conceivable courses of the computation.



Illust. 2

The above three conditions are expressed by the following eight equations.

Station equations

$a_o + b_o = i_o$ ...... (1)

$c_o + d_o = j_o$ ...... (2)

$e_o + f_o = k_o$ ...... (3)

$g_o + h_o = \ell_o$ ...... (4)

Angle equations

$a_o + b_o + c_o + d_o + e_o + f_o + g_o + h_o = 360^{\circ}$ .... (5)

$a_o + h_o = d_o + e_o$ .... (6)

$b_o + c_o = g_o + f_o$ .... (7)

Side equations

$$\frac{\overline{AB}}{\sin(c_o+d_o)} = \frac{\overline{TB}}{\sin b_o}, \quad \frac{\overline{TB}}{\sin g_o} = \frac{\overline{LT}}{\sin(e_o+f_o)}$$

$$\frac{\overline{AB}}{\sin(g_o+h_o)} = \frac{\overline{AL}}{\sin f_o}, \quad \frac{\overline{AL}}{\sin c_o} = \frac{\overline{LT}}{\sin(a_o+b_o)}$$

$$\therefore \frac{\sin(a_o+b_o)\cdot\sin(c_o+d_o)}{\sin(e_o+f_o)\cdot\sin(g_o+h_o)} \cdot \frac{\sin f_o\cdot\sin g_o}{\sin b_o\cdot\sin c_o} = 1 \quad \text{.........} \; (i)$$

Likewise

$$\frac{\overline{AB}}{\sin(c_o+d_o)} = \frac{\overline{AT}}{\sin e_o}, \quad \frac{\overline{AT}}{\sin h_o} = \frac{\overline{LT}}{\sin(a_o+b_o)}$$

$$\frac{\overline{AB}}{\sin(h_o+g_o)} = \frac{\overline{BL}}{\sin a_o}, \quad \frac{\overline{BL}}{\sin d_o} = \frac{\overline{LT}}{\sin(e_o+f_o)}$$

$$\therefore \frac{\sin(a_o+b_o).\sin(g_o+h_o)}{\sin(c_o+d_o).\sin(e_o+f_o)} \cdot \frac{\sin d_o\cdot\sin e_o}{\sin a_o\cdot\sin h_o} = 1 \quad \text{.........} \; (ii)$$

The following equation is derived from the above two equations (i) and (ii).

$$\frac{\sin^2 (g_0+h_0)\cdot \sin b_0 \cdot \sin c_0 \cdot \sin d_0 \cdot \sin e_0}{\sin^2 (c_0+d_0)\cdot \sin a_0 \cdot \sin f_0 \cdot \sin g_0 \cdot \sin h_0} = 1 \quad \ldots\ldots\ldots\ldots \quad (8)$$

2.2.2. Computation of Adjustment Value

Observation equations

$$\begin{array}{ll} a_0 = a_1 + v_a & g_0 = g_1 + v_b \\ b_0 = b_1 + v_b & h_0 = h_1 + v_h \\ c_0 = c_1 + v_c & i_0 = i_1 + v_i \\ d_0 = d_1 + v_d & j_0 = j_1 + v_j \\ e_0 = e_1 + v_e & k_0 = k_1 + v_k \\ f_0 = f_1 + v_f & \ell_0 = \ell_1 + v_\ell \end{array}$$

where $a_0, b_0, \ldots\ldots, \ell_0$ = Most probable values of angles
$a_1, b_1, \ldots\ldots, \ell_1$ = Observed angles
$v_a, v_b, \ldots\ldots, v_\ell$ = Probable errors (= adjustment values)

Condition equations

Equations (1) to (8) are rewritten from the above observation equations as follows.

1) $(a_1+v_a) + (b_1+v_e) = i_1 + v_i$

$\therefore \; v_a+v_e-v_i+w_1 = 0 \equiv \varphi_1$ (where $w_1 = a_1+b_1-i_1$) .... (9)

2) $(c_1+v_c) + (d_1+v_d) = j_1 + v_j$

$\therefore \; v_c+v_d-v_j+w_2 = 0 \equiv \varphi_2$ (where $w_2 = c_1+d_1-j_1$) .... (10)

3) $(e_1+v_e) + (f_1+v_f) = k_1 + v_k$

$\therefore \; v_e+v_f-v_k+w_3 = 0 \equiv \varphi_3$ (where $w_3 = e_1+f_1-k_1$) .... (11)

4) $(g_1+v_g) + (h_1+v_h) = \ell_1 + v_\ell$

$\therefore \; v_g+v_h-v_\ell+w_4 = 0 \equiv \varphi_4$ (where $w_4 = g_1+h_1-\ell_1$) .... (12)

5) $(a_1+v_a) + (b_1+v_b) + (c_1+v_c) + (d_1+v_d) + (e_1+v_e)$

$+ (f_1+v_f) + (g_1+v_g) + (h_1+v_h) - 360^o = 0$

$\therefore v_a+v_b+v_c+v_d+v_e+v_f+v_g+v_h+w_5 = 0 \equiv \varphi_5$ .... (13)

where $w_5 = a_1+b_1+c_1+d_1+e_1+f_1+g_1+h_1 - 360^o$

6) $(a_1+v_a) + (h_1+v_h) = (d_1+v_d) + (e_1+v_e)$

$\therefore v_b+v_h-v_d-v_e+w_6 = 0 \equiv \varphi_6$ (where $w_6 = a_1+h_1-d_1-e_1$) .... (14)

7) $(b_1+v_b) + (c_1+v_c) = (g_1+v_g) + (f_1+v_f)$

$\therefore v_e+v_c-v_g-v_f+w_7 = 0 \equiv \varphi_7$ (where $w_7 = b_1+c_1-g_1-f_1$) .... (15)

8) $2 \log \sin (g_o+h_o) - 2 \log \sin (c_o+d_o) + \log \sin b_o$

$+ \log \sin c_o + \log \sin d_o + \log \sin e_o - \log \sin a_o$

$- \log \sin f_o - \log \sin g_o - \log \sin h_o = 0$

The logarithmic sine can be expanded to the form of Taylor's series.

$$\log \sin (M + v) = \log \sin M + \mu \cot M \frac{v}{\rho} + \cdots\cdots$$

$$\fallingdotseq \log \sin M + d \cdot v$$

in which v is a very small angle as compared with M and d is tabular difference of 1" for log sin M.

$(d = \mu/\rho \cot M = 21.055 \times 10^{-7} \cot M)$

Thus,

$\{2 \log \sin (g_1+h_1) + d_{gh}(v_g+v_h)\} - \{2 \log \sin (c_1+d_1)+d_{cd}(v_c+v_d)\}$

$+ (\log \sin b_1+d_b v_b) + (\log \sin c_1+ d_c v_c) + (\log \sin d_1+d_d v_d)$

$+ (\log \sin e_1+d_e v_e) - (\log \sin a_1+ d_a v_a) - (\log \sin f_1+d_f v_f)$

$- (\log \sin g_1+d_g v_g) - (\log \sin h_1+ d_h v_h) = 0$

$\therefore d_{gh}(v_g+v_h) - d_{cd}(v_c+v_d) + d_b v_b+ d_c v_c + d_d v_d + d_e v_e$

$- d_a v_a - d_f v_f - d_g v_g - d_h v_h + w_8 = 0 \equiv \varphi_8$ .... (16)

where $w_8 = 2 \log \sin (g_1+h_1) - 2 \log \sin (c_1+d_1)+\log \sin b_1$

$+ \log \sin c_1 + \log \sin d_1 + \log \sin e_1 - \log \sin a_1$

$- \log \sin f_1 - \log \sin g_1 - \log \sin h_1$

Correlate equation

The most probable values of adjustment angles will be determined so that the following value Ω becomes mininum according to the least square method.

$$\Omega = [vv] - 2\lambda_1 \varphi_1 - 2\lambda_2 \varphi_2 - \cdots\cdots\cdots - 2\lambda_8 \varphi_8$$

where $[vv]$ = sum of squares of probable errors

λ = undetermined coefficient

The condition to satisfy the above equation is

$$\frac{\partial \Omega}{\partial v_\chi} = 0 \qquad (\chi = a, b, c \ldots\ldots, \ell) \qquad \ldots\ldots\ldots\ldots \quad (17)$$

By differentiating the above equation (17), the following equations are given.

$$v_a - \lambda_1 - \lambda_5 - \lambda_6 + \lambda_8 d_a = 0 \qquad \ldots\ldots\ldots \quad (18)$$

$$v_b - \lambda_1 - \lambda_5 - \lambda_7 - \lambda_8 d_b = 0 \qquad \ldots\ldots\ldots \quad (19)$$

$$v_c - \lambda_2 - \lambda_5 - \lambda_7 + \lambda_8 d_{cd} - \lambda_8 d_c = 0 \qquad \ldots\ldots\ldots \quad (20)$$

$$v_d - \lambda_2 - \lambda_5 + \lambda_6 + \lambda_8 d_{cd} - \lambda_8 d_d = 0 \qquad \ldots\ldots\ldots \quad (21)$$

$$v_e - \lambda_3 - \lambda_5 + \lambda_6 - \lambda_8 d_e = 0 \qquad \ldots\ldots\ldots \quad (22)$$

$$v_f - \lambda_3 - \lambda_5 + \lambda_7 + \lambda_8 d_f = 0 \qquad \ldots\ldots\ldots \quad (23)$$

$$v_g - \lambda_4 - \lambda_5 + \lambda_7 - \lambda_8 d_{gh} + \lambda_8 d_g = 0 \qquad \ldots\ldots\ldots \quad (24)$$

$$v_h - \lambda_4 - \lambda_5 - \lambda_6 - \lambda_8 d_{gh} + \lambda_8 d_h = 0 \qquad \ldots\ldots\ldots \quad (25)$$

$$v_i + \lambda_1 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (26)$$

$$v_j + \lambda_2 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (27)$$

$$v_k + \lambda_3 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (28)$$

$$v_\ell + \lambda_4 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (29)$$

From the equations (9) to (16) and (18) to (29), the following correlate equations are obtained.

1) $(\lambda_1 + \lambda_5 + \lambda_6 - \lambda_8 d_a) + (\lambda_1 + \lambda_5 + \lambda_7 + \lambda_8 d_b) + \lambda_1 + w_1$

$= 3\lambda_1 + 2\lambda_5 + \lambda_6 + \lambda_7 + (d_b - d_a)\lambda_8 + w_1 = 0$ .... (30)

2) $(\lambda_2 + \lambda_5 + \lambda_7 - \lambda_8 d_{cd} + d_c \lambda_8) + (\lambda_2 + \lambda_5 - \lambda_6$

$- \lambda_8 d_{cd} + \lambda_8 d_d) + \lambda_2 + w_2$

$= 3\lambda_2 + 2\lambda_5 - \lambda_6 + \lambda_7 + (d_c + d_d - 2d_{cd})\lambda_8 + w_2 = 0$ ...... (31)

3) $(\lambda_3 + \lambda_5 - \lambda_6 + \lambda_8 d_e) + (\lambda_3 + \lambda_5 - \lambda_7 - \lambda_8 d_f) + \lambda_3 + w_3$

$= 3\lambda_3 + 2\lambda_5 - \lambda_6 - \lambda_7 + (d_e - d_f)\lambda_8 + w_3 = 0$ .... (32)

4) $(\lambda_4 + \lambda_5 - \lambda_7 - \lambda_8 d_g + \lambda_8 d_{gh}) + (\lambda_4 + \lambda_5 + \lambda_6$

$+ \lambda_8 d_{gh} - \lambda_8 d_h) + \lambda_4 + w_4$

$= 3\lambda_4 + 2\lambda_5 + \lambda_6 - \lambda_7 + (2d_{gh} - d_g - d_h)\lambda_8 + w_4 = 0$ ...... (33)

5) $(\lambda_1 + \lambda_5 + \lambda_6 - \lambda_8 d_a) + (\lambda_1 + \lambda_5 + \lambda_7 + \lambda_8 d_b)$

$+ (\lambda_2 + \lambda_5 + \lambda_7 - \lambda_8 d_{cd} + \lambda_8 d_c) + (\lambda_2 + \lambda_5 - \lambda_6$

$- \lambda_8 d_{cd} + \lambda_8 d_d) + (\lambda_3 + \lambda_5 - \lambda_6 + \lambda_8 d_e)$

$+ (\lambda_3 + \lambda_5 - \lambda_7 - \lambda_8 d_f) + (\lambda_4 + \lambda_5 - \lambda_7 - \lambda_8 d_g$

$+ \lambda_8 d_{gh}) + (\lambda_4 + \lambda_5 + \lambda_6 + \lambda_8 d_{gh} - \lambda_8 d_h) + w_5$

$= 2\lambda_1 + 2\lambda_2 + 2\lambda_3 + 2\lambda_4 + 8\lambda_5 + (-d_a + d_b + d_c$

$+ d_d + d_e - d_f - d_g - d_h - 2d_{cd} + 2d_{gh})\lambda_8 + w_5 = 0$ .... (34)

6) $(\lambda_1 + \lambda_5 + \lambda_6 - \lambda_8 d_a) + (\lambda_4 + \lambda_5 + \lambda_6$

$+ \lambda_8 d_{gh} - \lambda_8 d_h) - (\lambda_2 + \lambda_5 - \lambda_6 - \lambda_8 d_{cd}$

$+ \lambda_8 d_d) - (\lambda_3 + \lambda_5 - \lambda_6 + \lambda_8 d_e) + w_6$

$= \lambda_1 - \lambda_2 - \lambda_3 + \lambda_4 + 4\lambda_6 - (d_a + d_d + d_e$

$- d_{gh} - d_{cd})\lambda_8 + w_6 = 0$ .... (35)

$$7)\ (\lambda_1 + \lambda_5 + \lambda_7 + \lambda_8 d_b) + (\lambda_2 + \lambda_5 + \lambda_7 - \lambda_8 d_{cd} + \lambda_8 d_c)$$

$$+ (-\lambda_4 - \lambda_5 + \lambda_7 + \lambda_8 d_g - \lambda_8 d_{gh}) + (-\lambda_3$$

$$- \lambda_5 - \lambda_7 + \lambda_8 d_f) + w_7 = \lambda_1 + \lambda_5 - \lambda_3 - \lambda_4 + 4\lambda_7$$

$$+ (d_b + d_c + d_f + d_g - d_{cd} - d_{gh})\lambda_8 + w_7 = 0 \quad \ldots\ldots\ldots\ldots \quad (36)$$

$$8)\ d_{gh}\ (\lambda_4 + \lambda_5 - \lambda_7 - \lambda_8 d_g + \lambda_8 d_{gh} + \lambda_4 + \lambda_5 + \lambda_6$$

$$+ \lambda_8 d_{gh} - \lambda_g d_h) - d_{cd}\ (\lambda_2 + \lambda_5 + \lambda_7 - \lambda_8 d_{cd} + \lambda_8 d_c$$

$$+ \lambda_2 + \lambda_5 - \lambda_6 - \lambda_8 d_{cd} + \lambda_8 d_d) + d_b\ (\lambda_1 + \lambda_5$$

$$+ \lambda_7 + \lambda_8 d_b) + d_c\ (\lambda_2 + \lambda_5 + \lambda_7 - \lambda_8 d_{cd} + \lambda_8 d_c)$$

$$+ d_d\ (\lambda_2 + \lambda_5 - \lambda_6 - \lambda_8 d_{cd} + \lambda_8 d_d) + d_e\ (\lambda_3 + \lambda_5$$

$$- \lambda_6 + \lambda_8 d_e) - d_a\ (\lambda_1 + \lambda_5 + \lambda_6 - \lambda_8 d_a) - d_f\ (\lambda_3$$

$$+ \lambda_5 - \lambda_7 - \lambda_8 d_f) - d_g\ (\lambda_4 + \lambda_5 - \lambda_7 - \lambda_8 d_g$$

$$+ \lambda_8 d_{gh}) - d_h\ (\lambda_4 + \lambda_5 + \lambda_6 + \lambda_8 d_{gh} - \lambda_8 d_h) + w_8$$

$$= (d_b - d_a)\lambda_1 + (d_d + d_e - 2d_{cd})\lambda_2 + (d_e - d_f)\lambda_3$$

$$+ (2d_{gh} - d_g - d_h)\lambda_4 + (-d_a + d_b + d_c + d_d + d_e$$

$$- d_f - d_g - d_h - 2d_{cd} + 2d_{gh})\lambda_5 - (d_a + d_d + d_e$$

$$- d_{gh} - d_{cd})\lambda_6 + (d_b + d_c + d_f + d_g - d_{cd} - d_{gh})\lambda_7$$

$$+ (d_a^2 + d_b^2 + d_c^2 + d_d^2 + d_e^2 + d_f^2 + d_g^2 + d_h^2$$

$$+ 2d_{cd}^2 + 2d_{gh}^2 - 2\,d_g d_{gh} - 2d_h d_{gh} - 2d_c d_{cd}$$

$$- 2d_d d_{cd})\lambda_8 + w_8 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (37)$$

The undetermined coefficients λ_1, λ_2 ...... λ_8 are the solutions which simultaneously satisfy the above correlate equations (30) to (37).

Consequently, the most probable values of the angles can easily be computed from both the equations (18) to (29) and the observation equations.

2.3. Computation of length $\overline{LT}$

The side equations can be arranged as follows.

$$\overline{LT} = \frac{\sin (a_o + b_o) \cdot \sin f_o}{\sin (g_o + h_o) \cdot \sin c_o} \; \overline{AB}$$

Therefore, from the above equation the length between the two bench-marks set on both banks is determined based on the length of the base line $\overline{AB}$ and the most probable values of angles obtained in the preceding paragraph.

These triangulation computations were made by a electronic computer requiring only a final result. As a result, the length $\overline{LT}$ was figured out at 641.722 meters.

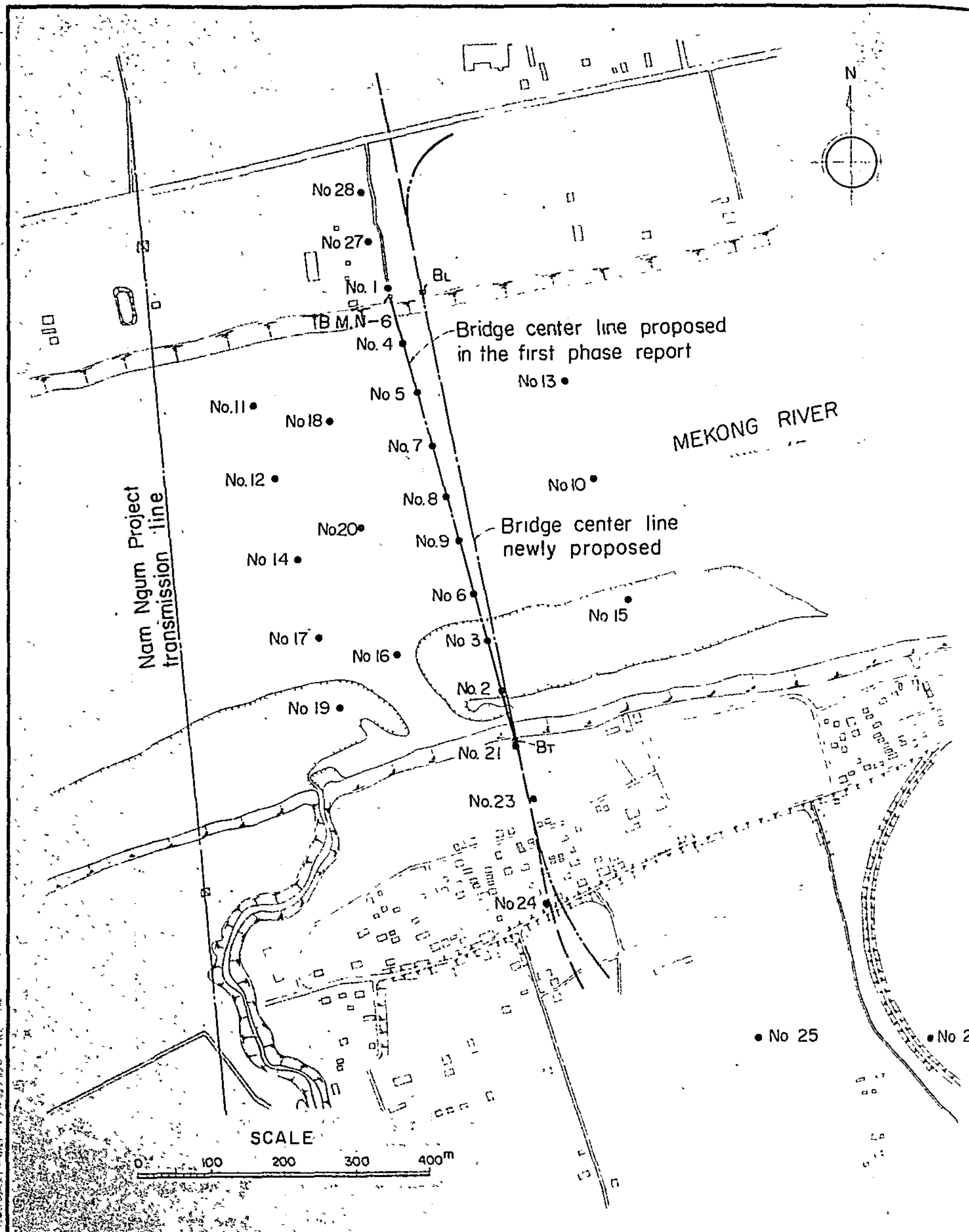
APPENDIX II

SOIL SURVEY

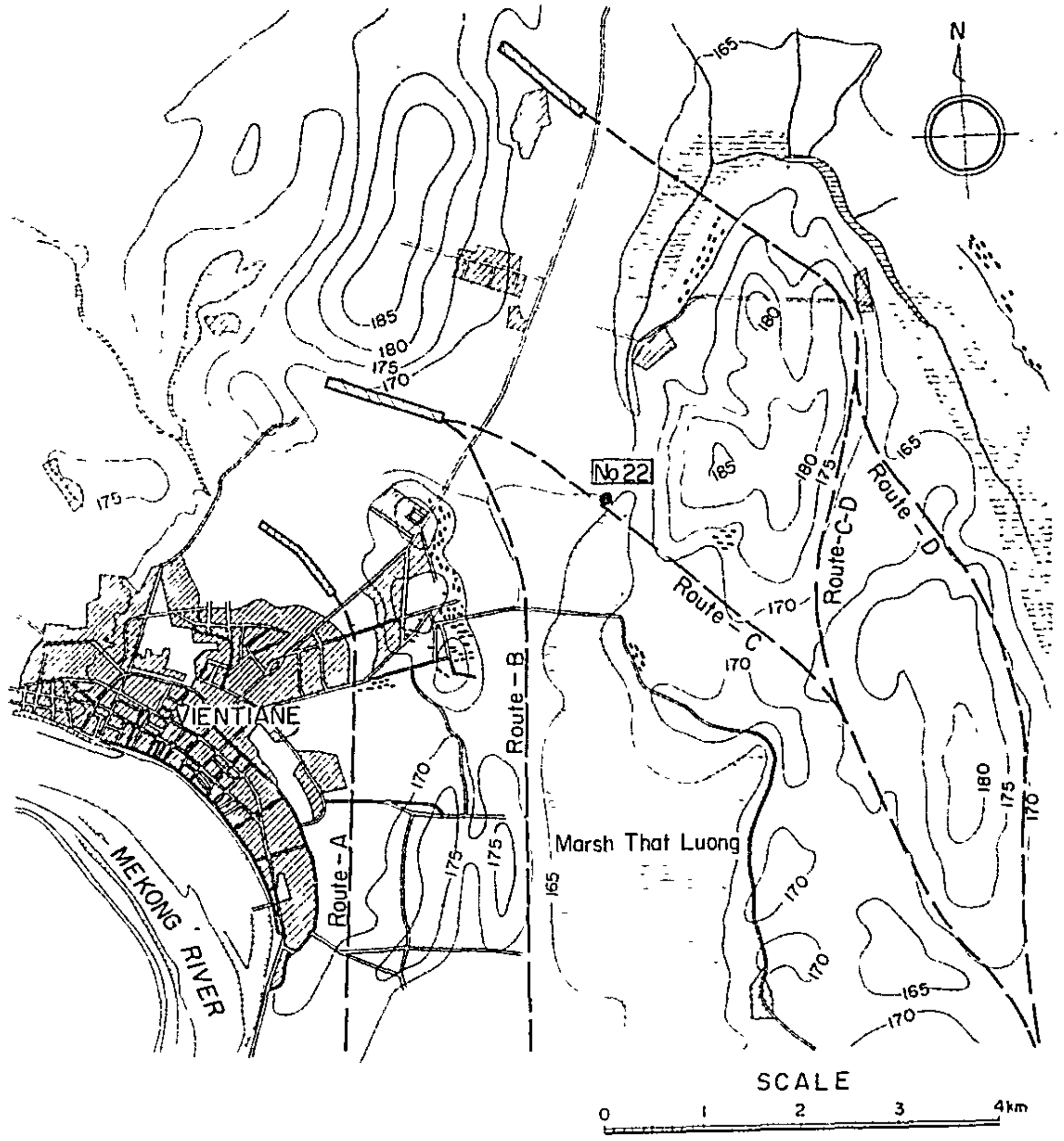
CONTENTS

2.1 Test Drilling

LOCATION OF THE TEST DRILLING HOLES



BRIDGE SITE



MARSH THAT LUONG

LEGEND

- ● Test drilling hole
- Proposed railway and station
- Proposed access highway

Summary of Test Drilling Holes

	Hole No.	Depth (m)	Elevation of ground surface(m)	Diameter of hole (mm)	Nos. of penetration test	Drilling expert	Operation period (year:1968)
Drilling of the nearby land	1	24.00	168.33	65 - 56	18	T.Onoue	Feb.23-Mar. 1
	21	22.00	166.59	65 - 56	13	K.Shirayama	Apr.29-May 5
	22	44.30	Unobserved	65 - 56	43	T.Onoue	Apr.27-May 28
	23	23.40	163.81	65 - 56	14	K.Shirayama	May 6-May 11
	24	26.00	165.80	65 - 56	13	"	May 12-May 16
	25	25.00	164.71	85 - 65	11	"	May 18-May 26
	26	35.00	165.41	85 - 65	23	"	May 27-Jun. 7
	27	23.00	168.17	65 - 56	15	T.Onoue	May 30-Jun. 4
	28	21.30	167.90	65 - 56	14	"	Jun. 5-Jun. 8
	Total	244.00			164		
Drilling of the Mekong river-bed	2	16.60	155.73	65 - 56	11	K.Shirayama	Feb.28-Mar. 2
	3	17.15	155.73	65 - 56	7	"	Mar. 5-Mar. 7
	4	13.00	151.92	65 - 56	3	T.Onoue	Mar. 2-Mar. 8
	5	13.00	150.96	65 - 56	4	"	Mar. 9-Mar.13
	6	13.60	153.58	65 - 56	6	K.Shirayama	Mar.11-Mar.16
	7	16.21	149.84	65 - 56	3	T.Onoue	Mar.14-Mar.18
	8	13.00	150.73	65 - 56	3	"	Mar.19-Mar.25
	9	12.80	151.61	65 - 56	4	K.Shirayama	Mar.21-Mar.23
	10	17.10	151.13	65 - 56	3	"	Mar.26-Mar.30
	11	12.50	152.16	65 - 56	1	T.Onoue	Mar.26-Mar.29
	12	12.00	150.95	65 - 56	1	"	Mar.30-Apr. 1
	13	7.20	149.82	65 - 56	1	K.Shirayama	Apr. 2-Apr. 3
	14	13.50	151.35	65 - 56	4	T.Onoue	Apr. 2-Apr.10
	15	16.30	156.11	65 - 56	5	K.Shirayama	Apr. 5-Apr. 9
	16	23.80	155.28	65 - 56	3	"	Apr.11-Apr.18
	17	15.00	152.36	65 - 56	6	T.Onoue	Apr.11-Apr.16
	18	16.00	151.20	65 - 56	1	"	Apr.16-Apr.23
	19	28.00	155.57	65 - 56	5	K.Shirayama	Apr.19-Apr.26
	20	13.00	150.93	65 - 56	4	T.Onoue	Apr.24-Apr.25
	Total	289.76			75		

Drilling machine: UD - 5

Inclination of hole: Vertical

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 1

LOCATION. Left Bank (Laos)
ELEVATION OF SURFACE. 168 M 33

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
	1	167.13	Surface soil	1.20	1.20		Light yellow, fine silt and clay
	10	158.33	Silt and clay	8.80	10.00		Silty clay, light brown N=39/30cm; N=35/30cm; N=34/30cm; Silty clay, N=30/30cm; Light grey N=32/30cm; Clayey silt N=25/30cm; N=15/30cm; Light brown silt N=17/30cm; Containing gravel ø 4cm
	16	151.93	Sand and gravel	6.40	16.40		N=20/30cm; Light brown, N=21/30cm; Earthy sand with pebble N=31/30cm; Sand with N=24/30cm pebble; N=23/30cm; N=19/30cm; N=16/30cm
	19	148.93	Weathered siltstone	3.00	19.40		N=16/30cm; Reddish brown fragments of N=33/30cm siltstone; Reddish siltstone N=50/23cm
	24	144.33	Fresh siltstone	4.60	24.00		Fresh reddish brown

N-VALUE: 20 40 60

HOLE NO 2

LOCATION. Riverbed
ELEVATION OF SURFACE. 155 M 73

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
	8	148.03	Fine sand and silty sand	7.70	7.70		Light brownish grey, Fine sand N=2/30cm; N=2/30cm Ditto; N=4/30cm; N=8/30cm; Grey silty Sand N=4/30cm; Ditto N=6/30cm; Ditto N=5/30cm
	11	144.03	Sand with pebble	4.00	11.70		N=17/30cm; Grey sand N=19/30cm with pebble; N=20/30cm; N=67/30cm
	12	143.53	Siltstone	4.50	12.20		Reddish brown siltstone
	16	139.13	Shale	4.40	15.60		Reddish brown shale cracked

N-VALUE: 20 40 60

HOLE NO 3

LOCATION. Riverbed
ELEVATION OF SURFACE. 155 M 73

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
	6	149.73	Sand	6.00	6.00		Grey, fine sand N=2/30cm; N=5/30cm Medium grained sand; Silty sand N=8/30cm; Fine sand
	8	147.73	Silt	7.00	8.00		N=5/30cm Silt
	11	144.33	Fine sand	3.40	11.40		N=16/30cm Fine sand; N=16/28cm Ditto; N=50/15cm; N=100
	12	143.68	Shale	0.65	12.05		Reddish brown shale
	14	141.48	Siltstone	2.20	14.25		Massive siltstone
	17	138.56	Shale	2.90	17.15		Silty shale cracked

N-VALUE: 20 40 60

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 4

LOCATION : Riverbed
ELEVATION OF SURFACE 151 M 92

DATE	DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N - VALUE (20 40 60)
	0–1.50	150.42	Sand and Pebble	1 50	1.50		Light yellow sand and pebble N = 9/30cm	
	1.50–2.00	149.92	Gravel	0 50	2.00		Gravel	
	2.00–4.30	147 62	Weathered and fragmental siltstone with gravel	2 30	4 30		N=25/30cm Weathered siltstone with N=32/30cm gravel	
	4.30–8.00		Fresh siltstone		8.00		Fresh shaly siltstone	
	8.00–9.00				9 00		Fine – grained siltstone	
	9.00–13.00	138 92		9 70	13 00		Fresh siltstone	

HOLE NO 5

LOCATION Riverbed
ELEVATION OF SURFACE 150 M 96

DATE	DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N - VALUE (20 40 60)
	0–1.50		Sand and gravel	1 50	1 50		Yellow brown sand and pebble N=16/30cm	
	1.50–2.00	148 96		0 50	2 00		Gravel and sand	
	2.00–3.90	147 06	Weathered siltstone with gravel	1 90	3 90		N =23/30cm Weathered siltstone and N =30/30cm gravel	
	3.90–4.50	146 46	Siltstone	0.60	4.50		N=50/11cm Siltstone	N= 136
	4.50–5.00	145 96	Shale	0 50	5 00		Shale, crushed	
	5.00–13.00	13‾96	Siltstone	8 00	13 00		Siltstone, sound Vertical joint at 7 5m	

HOLE NO 6

LOCATION Riverbed
ELEVATION OF SURFACE 153 M 58

DATE	DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N - VALUE (20 40 60)
	0–6.00	147 58	Grey fine sand	6 C0	6 00		Grey, fine sand N= 2/30cm N=2/30cm N= 7/30cm Ditto	
	6.00–7.00	146 58	Sand with pebble	1 00	7 00		N= 24/30cm Fine sand with pebble	
	7.00–8.60	144 98	Gravel with weathered siltstone	1 60	8 60		N=32/30cm Gravel N=50/25cm with fragmental siltstone	
	8.60–13.60	139 98	Siltstone	5 00	13 60		Siltstone with joints Massive siltstone	

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 7

LOCATION : Riverbed
ELEVATION OF SURFACE 149 M 84

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
		148 94	Gravel with rock fragments		0.90	0 90		Cherl gravel and fragments of siltstone	
	1–3	146 84	Gravel, sand and silt		2,10	3,00		N = 18/30 cm Gravel, sand and silt N=22/30 cm	N=136
	3–9				6 00	9,00		N=50/11 cm Redd'sh brown siltstone Partly shaly Vertical joint at 8 5m	
	9–16	133 63	Siltstone		7 21	16 21		Shaly siltstone Sound	

HOLE NO 8

LOCATION . Riverbed
ELEVATION OF SURFACE. 150 M 73

DATE	DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
	0–1.5	149 23	Mud and sand		1 50	1 50		Mud and grey sand N=27/30 cm	
	1.5–4	146 73	Sand and gravel		2 50	4 00		Mud, sand and gravel N=25/30cm Sand and gravel N=37/30cm	
	4–5	145,73	Gravel and rock fragments		1 00	5 00		Gravel and siltstone fragments	
	5–5.8				0 80	5,80		Shaly siltstone	
	5.8–13	137 73	Siltstone		7 20	13 00		Siltstone vertical joint between 7m and 8m	

HOLE NO 9

LOCATION . Riverbed
ELEVATION OF SURFACE 151 M 61

DATE	DEPTH (m)	ELEV TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION	N-VALUE
	0–4.3	147 31	Sand with pebble		4 30	4,30		N =4/30 cm Fine sand with pebbles N=18/30 cm N=19/30 cm	
		146 96	Gravel		0 35	4 65		N=70/30cm Gravel ø15cm	N=150
		146 56	Siltstone		0,30	4,95		Siltstone	
		146.06	Shale		0,60	5,55		Silty shale cracked	
	5.55–12.8	138 81	Siltstone		7 25	12 80		Siltstone	

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 10

LOCATION . Riverbed
ELEVATION OF SURFACE. 151 M.13

Date	Depth (m)	Elev. Top of Stratum (m)	Classification of Rocks	Columnar Section	Thickness of Stratum (m)	Accumulative Thickness of Strata (m)	Core Recovery	Description	N-Value
		150.13	Muddy sand		1.00	1.00		Muddy sand N=3/30cm	
		148.13	Sand and pebble		2.00	3.00		Fine sand N=18/30cm with pebble N=19/30cm	
		146.03	Gravel and sand		2.10	5.10		Gravel and N=26/30cm sand	
		145.03	Weathered siltstone		1.00	6.10		Fragmental siltstone	
			Siltstone		2.00	8.10		Reddish brown siltstone	
					1.00	9.10		Ditto, brittle	
		141.03			1.00	10.10		Siltstone	
		140.03	Sandstone		1.00	11.10		Fine grained sandstone	
			Siltstone		1.70	12.80		Shaly siltstone	
					0.30	13.10		Ditto, cracked	
		134.03			4.00	17.10		Massive siltstone	

HOLE NO 11

LOCATION . Riverbed
ELEVATION OF SURFACE. 152 M.16

Date	Depth (m)	Elev. Top of Stratum (m)	Classification of Rocks	Columnar Section	Thickness of Stratum (m)	Accumulative Thickness of Strata (m)	Core Recovery	Description	N-Value
		150.26	Sand and gravel		1.90	1.90		Brown gravel Contents 40~70%	
		148.66	Clay		1.60	3.50		Hard clay N=50/17cm	N=88
					0.60	4.10		Reddish brown siltstone	
		139.66	Siltstone		8.40	12.50		Reddish brown, clayey siltstone	

HOLE NO 12

LOCATION Riverbed
ELEVATION OF SURFACE 150 M.95

Date	Depth (m)	Elev. Top of Stratum (m)	Classification of Rocks	Columnar Section	Thickness of Stratum (m)	Accumulative Thickness of Strata (m)	Core Recovery	Description	N-Value
		150.55	Sand		0.40	0.40		Greymed sand	
		149.15	Sand and gravel		1.40	1.80		Sand, pebble and gravel with N = 30/30cm siltstone fragment	
		138.95	Siltstone and shale (alternated)		10.20	12.00		Fine-grained siltstone and shale (alternated)	

HOLE NO 13

LOCATION . Riverbed
ELEVATION OF SURFACE. 149 M.82

Date	Depth (m)	Elev. Top of Stratum (m)	Classification of Rocks	Columnar Section	Thickness of Stratum (m)	Accumulative Thickness of Strata (m)	Core Recovery	Description	N-Value
		148.57	Weathered shale		1.25	1.25		Weathered shale N = 50/25cm	
		148.02	Shale		0.65	1.80		Shale, cracked	
		142.62	Siltstone		5.40	7.20		Siltstone	

HOLE NO 14

LOCATION Riverbed
ELEVATION OF SURFACE. 151 M.35

Date	Depth (m)	Elev. Top of Stratum (m)	Classification of Rocks	Columnar Section	Thickness of Stratum (m)	Accumulative Thickness of Strata (m)	Core Recovery	Description	N-Value
		147.35	Sand and gravel		4.00	4.00		Grey sand N=24/30cm and gravel N=28/30cm Containing N=21/30cm siltstone fragments	
		146.85	Weathered siltstone		0.50	4.50		N=23/30cm Weathered siltstone	
		137.85	Siltstone		9.00	13.50		Shaly; Shaly	

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 15

LOCATION Riverbed
ELEVATION OF SURFACE 156.11 M

Depth (m)	Elev. top of stratum (m)	Classification of rocks	Thickness of stratum (m)	Accumulative thickness of strata (m)	Description	N-value
0 – 8.50	147.61	Fine sand	8.50	8.50	Grey, fine sand	N=2/32cm; N=5/30cm; N=6/30cm; N=12/30cm
8.50 – 11.30	144.81	Sand and pebble	2.80	11.30	Sand and pebble	N=58/30cm
11.30 – 16.30	139.81	Siltstone	5.00	16.30	Siltstone	

HOLE NO 16

LOCATION Riverbed
ELEVATION OF SURFACE 155.28 M

Depth (m)	Elev. top of stratum (m)	Classification of rocks	Thickness of stratum (m)	Accumulative thickness of strata (m)	Description	N-value
0 – 3.30	151.98	Sand	3.30	3.30	Grey, fine sand	N 4/30cm
3.30 – 6.00	149.28	Sand with pebble	2.70	6.00	Sand with subangular pebble	N 7/30cm
6.00 – 9.00	146.28	Sand	3.00	9.00	Fine sand	N 18/30cm
9.00 – 9.80	145.48	Weathered siltstone	0.80	9.80	Weathered siltstone	
9.80 – 11.80	143.48	Siltstone	2.00	11.80	Clayey siltstone	
11.80 – 12.10	143.18	Shale	0.30	12.10	Shale	
12.10 – 12.50	142.78	Siltstone	0.40	12.50	Clayey siltstone	
12.50 – 13.20	142.08	Shale	0.70	13.20	Shale	
13.20 – 13.80	141.48	Siltstone	0.60	13.80	Siltstone	
13.80 – 15.80	139.48	Shale	2.00	15.80	Shale	
15.80 – 17.90	137.38	Siltstone	2.10	17.90	Sound siltstone	
17.90 – 23.80	131.48	Shale	5.90	23.80	Shale	

HOLE NO 17

LOCATION Riverbed
ELEVATION OF SURFACE 152.36 M

Depth (m)	Elev. top of stratum (m)	Classification of rocks	Thickness of stratum (m)	Accumulative thickness of strata (m)	Description	N-value
0 – 6.20	146.16	Sand	6.20	6.20	Grey sand; Accompanied pebbles	N=13/30cm; N=15/30cm; N=18/30cm; N=22/30cm; N=15/30cm; N=25/30cm
6.20 – 7.00	145.36	Weathered siltstone	0.80	7.00	Weathered	
7.00 – 15.00	137.36	Siltstone	8.00	15.00	Siltstone partly shale; Siltstone	

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 18

LOCATION : Riverbed
ELEVATION OF SURFACE 151 M 20

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	DESCRIPTION	N-VALUE
	0–1.70	149.50	Gravel	1.70	1.70	Subangular or round N=50/13cm	N=115
	1.70–3.60	147.60	Shale	1.90	3.60	Reddish brown shale, cracky after drying	
	3.60–16.00	135.20	Siltstone	12.40	16.00	Siltstone; Shaly, fine-spotted; Siltstone	

HOLE NO 19

LOCATION . Riverbed
ELEVATION OF SURFACE 155 M 57

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	DESCRIPTION	N-VALUE
	0–6.50	149.07	Sand	6.50	6.50	Fine sand N=4/30cm N=5/30cm	
	6.50–7.00	148.57	Silt	0.50	7.00	Loamy silt N=21/30cm	
	7.00–10.00	145.57	Sand and pebble	3.00	10.00	Fine sand with pebble N=14/30cm	
	10.00–12.10	143.47	Gravel	2.10	12.10	Gravel ø = 5 ~ 6cm N=40/10cm	N=135
	12.10–28.00	127.57	Siltstone	15.90	28.00	→(Core lost) →(Core lost) Reddish-brown siltstone; Sound siltstone; →(Core lost); Reddish brown siltstone partly Conchoidal	

HOLE NO 20

LOCATION . Riverbed
ELEVATION OF SURFACE 150 M 93

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	DESCRIPTION	N-VALUE
	0–2.00	148.93	Sand	2.00	2.00	Grey med sand N=15/30cm	
	2.00–5.00	145.93	Sand and gravel	1.00	5.00	N=21/30cm Sand & gravel N=27/30cm N=50/25cm with weathered siltstone	
	5.00–13.00	137.93	Siltstone	8.00	13.00	Fine-grained siltstone	

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 21

LOCATION : Right Bank (Thai)
ELEVATION OF SURFACE 166.59 M

DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
0 – 4.00	162.59	Loam	4.00	4.00		Light brown loam; N=5/30cm; N=7/30cm; N=7/30cm
4.00 – 11.00	155.59	Silt	7.00	11.00		N=8/30cm; Light brown; N=12/30cm; 5.70 TWS 6.30; Clayey; N=11/30cm; 7.40 TWS 7.80; Dark brown; N=13/30cm; Gray brown; 10.30 TWS 10.85 TWS 11.25
11.00 – 19.00	147.59	Sand	8.00	19.00		Fine-grained; N=17/30cm; Medium-grained; N=23/30cm; N=36/30cm; Coarse-grained
19.00 – 21.55	145.04	Sand and pebbles	1.50	21.55		N=37/30cm; Sand and pebbles; N=29/30cm
21.55 – 22.00	144.59	Siltstone	0.45	22.00		N=45/15cm (N=90); Siltstone

N-VALUE scale: 20, 40, 60

HOLE NO 22

LOCATION That Luong
ELEVATION OF SURFACE Unobserved

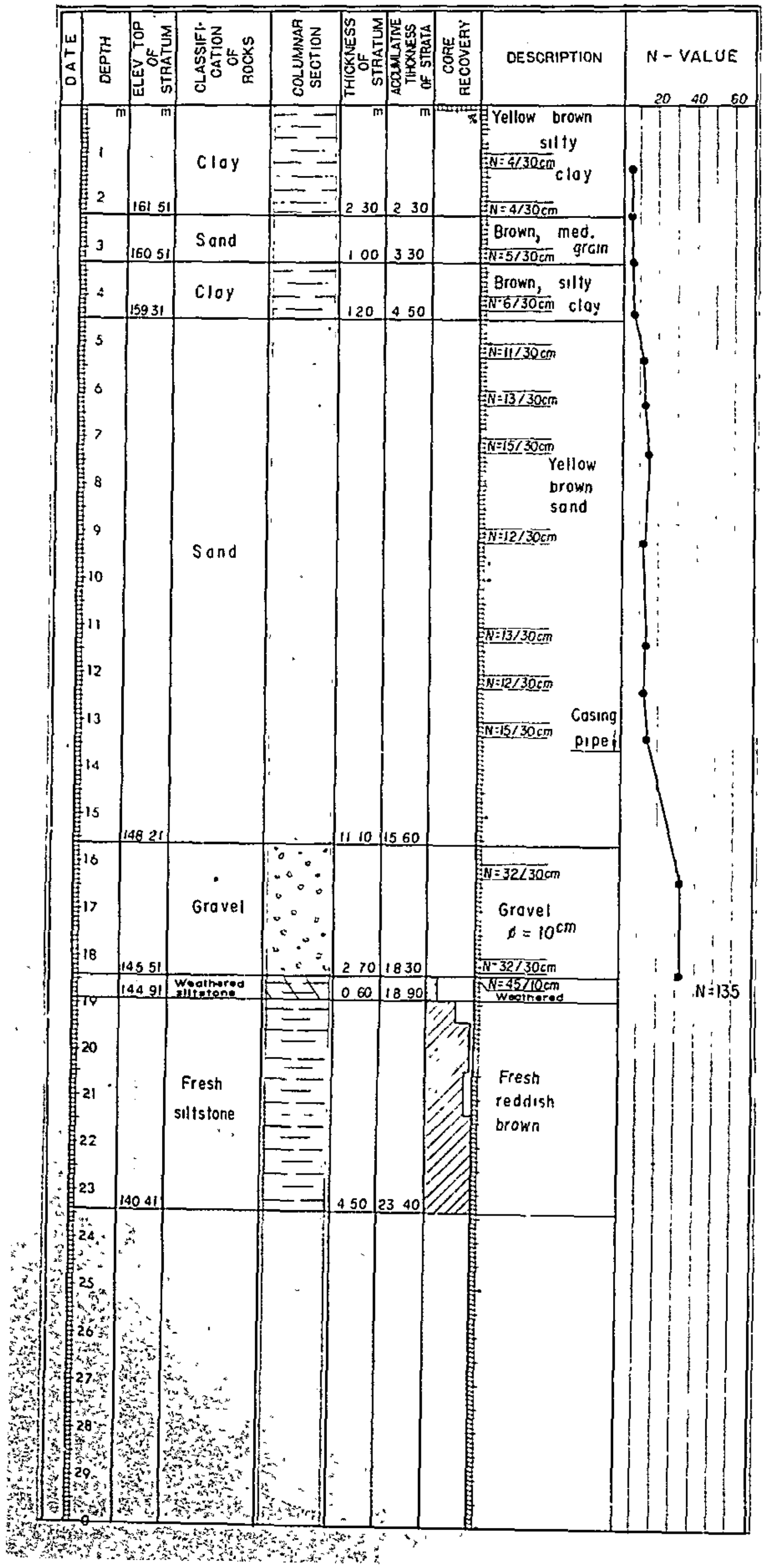
DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
0 – 0.40		Soil	0.40	0.40		Surface soil
0.40 – 1.60		Clay	1.20	1.60		Dark grey 0.70 TWS 1.35; N=6/30cm
1.60 – 2.90		Sand	1.30	2.90		Grey, brown, coarse; N=7/30cm
2.90 – 9.70		Clay	6.80	9.70		Grey, silty 3.00 TWS 3.40; N=6/30cm; Grey, sandy; N=9/30cm; Gray brown, sandy N=14/30cm; Light yellow N=15/30cm; Yellow brown N=12/30cm; Reddish brown N=9/30cm
9.70 – 12.80		Sand	3.10	12.80		N=10/30cm; Clayey; N=12/30cm; Grey brown; N=15/30cm
12.80 – 15.90		Clay	3.10	15.90		N=17/30cm; Sandy, N=23/30cm containing N=26/30cm pebbles
15.90 – 16.70		Sand	0.80	16.70		N=17/30cm Clayey
16.70 – 17.80		Clay	1.10	17.80		Sandy; N=13/30cm
17.80 – 25.80		Sand	8.00	25.80		N=17/30cm; Containing N=19/30cm gravel; N=19/30cm; Light grey, N=18/30cm clayey; N=28/30cm; Sometimes N=31/30cm with gravels; N=34/30cm; N=25/30cm
25.80 – 28.10		Clay	2.30	28.10		Yellow N=32/30cm brown; Sandy, sometimes N=39/30cm with gravel
28.10 – 44.30		Sand with gravel	16.20	44.30		N=31/30cm; Fine grained; N=34/30cm; N=35/30cm Containing gravel φ10-50 m/m; N=40/30cm; N=50/25cm; N=50/22cm; N=50/13cm (N=115); Grey, N=50/21cm (N=71); Containing gravel φ10-50 m/m N=50/27cm; N=50/26cm; N=50/21cm (N=71); N=50/25cm; With gravel N=50/23cm; N=50/21cm (N=71); Cave-in; N=50/21cm (N=71); N=50/18cm (N=83); N=50/17cm (N=88); Finish

N-VALUE scale: 20, 40, 60

GEOLOGICAL RECORDS OF TEST DRILLING HOLES

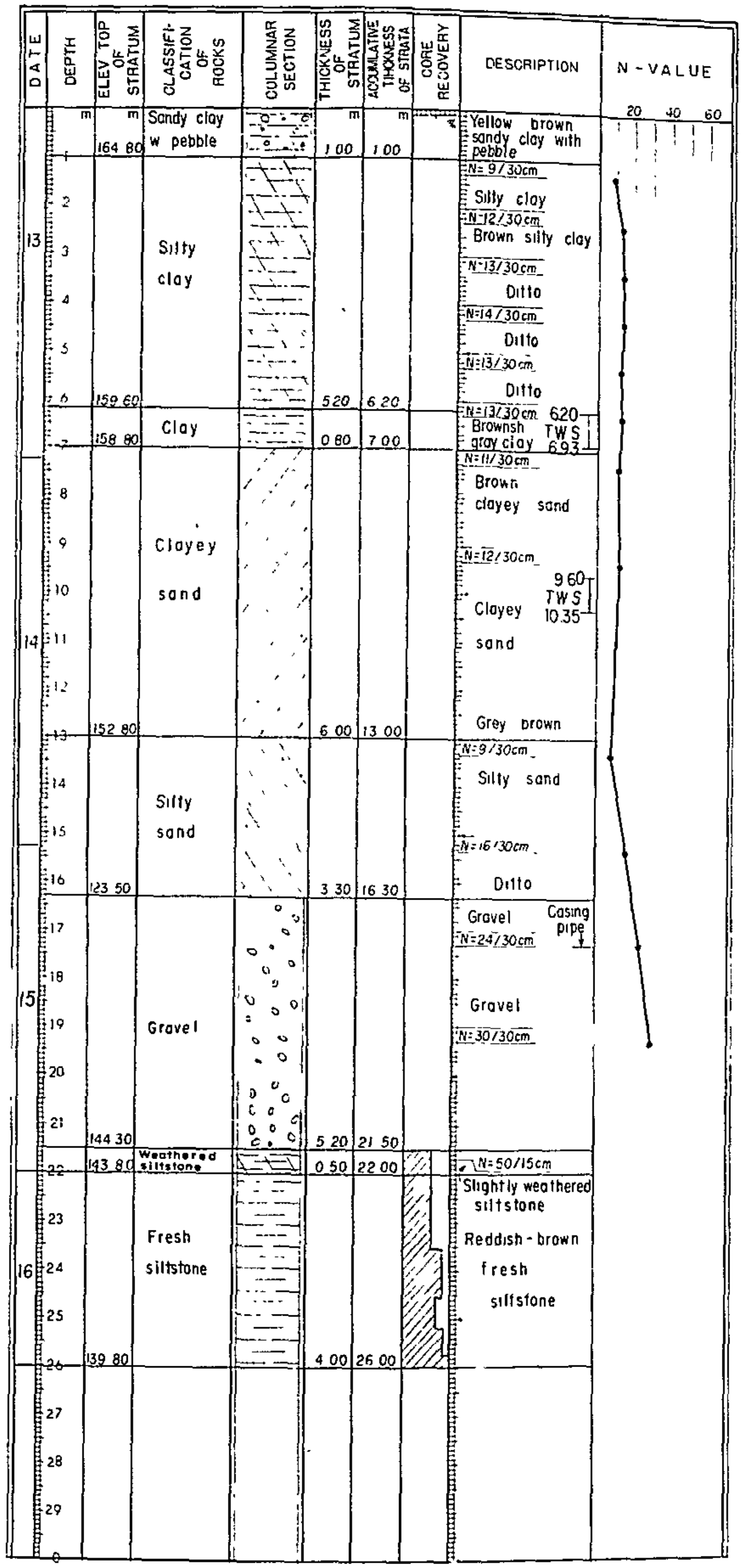
HOLE NO 23

LOCATION . Thai side
ELEVATION OF SURFACE. 163.81 M



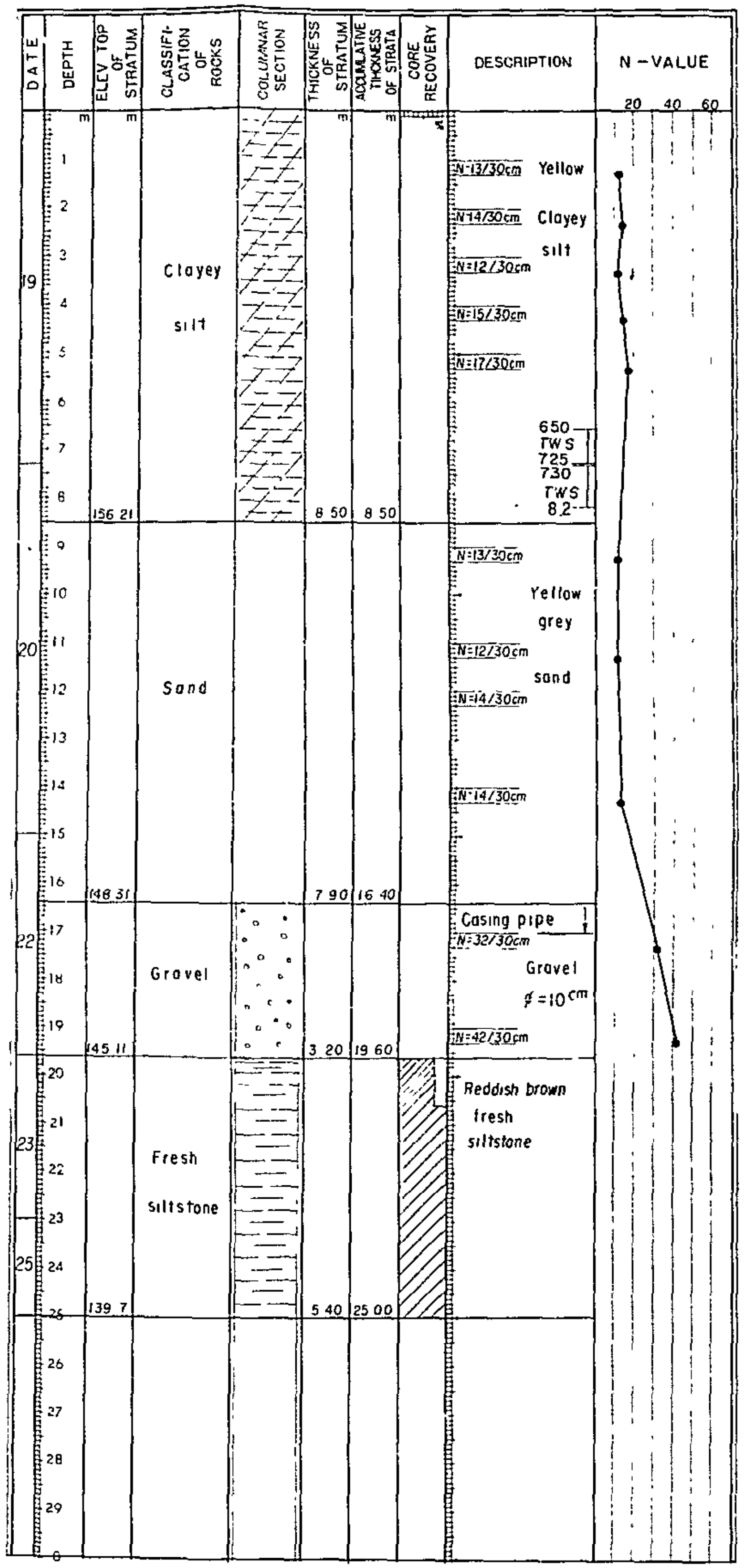
HOLE NO 24

LOCATION . Thai side
ELEVATION OF SURFACE. 165.80 M



HOLE NO 25

LOCATION . Thai side
ELEVATION OF SURFACE 164.71 M



GEOLOGICAL RECORDS OF TEST DRILLING HOLES

HOLE NO 26

LOCATION : Thai side
ELEVATION OF SURFACE 165.41 M

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
28	0 – 6.50	158.91	Sandy silt	6.50	6.50		Yellow-brown; N=19/30cm; N=16/30cm; Sandy silt; N=15/30cm; N=15/30cm; N=12/30cm
29	6.50 – 11.00	154.41	Silty sand	4.50	11.00		N=11/30cm; Silty sand; 80 TWS 875; 90 TWS 975; N=14/30cm; Sand
31	11.00 – 24.00	141.41	Sand and gravel	13.00	24.00		N=18/30cm; N=38/30cm; Sand and gravel; N=39/30cm; ø=5-10cm; N=39/30cm; N=39/30cm; N=40/30cm; N=41/30cm; Yellow-brown; N=40/30cm; N=41/30cm; Sand and gravel; N=42/30cm
	24.00 – 35.00	130.41	Gravel	11.00	35.00		N=41/30cm; Pebble; N=40/30cm; Pebble and gravel; N=43/30cm; Gravel; N=42/30cm; ø=10cm
3	30 – 35		Gravel				Gravel; N=41/30cm; ø=5-15cm; Ditto; N=43/30cm; ø=1-10cm
5							

N-VALUE scale: 20, 40, 60

HOLE NO 27

LOCATION : Laotian side
ELEVATION OF SURFACE 168.17 M

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY (%)	DESCRIPTION
	0 – 0.40	167.77	Soil	0.40	0.40		Soil
	0.40 – 4.80	163.37	Clayey loam	4.40	4.80		Dark grey Clayey loam 10 TWS 17; N=1/20cm; Containing humus; N=12/34cm; Containing light grey clay; N=17/30cm
	4.80 – 6.60	161.57	Clayey sand	1.80	6.60		N=13/30cm; Containing mica; N=12/30cm
	6.60 – 9.10	159.07	Sand	2.50	9.10		N=10/30cm; N=10/30cm
	9.10 – 15.90	152.27	Sand with gravel	6.80	15.90		N=22/30cm; N=23/30cm; Accompanying brown clay; N=31/30cm; N=25/30cm; N=38/30cm; Gravel ø10-30m/m; N=32/30cm; Sometimes ø=50m/m; N=30/30cm
	15.90 – 16.80	151.37	Weathered siltstone	0.90	16.80		N=50/22cm; Reddish brown decomposed
	16.80 – 23.00	145.17	Siltstone	6.20	23.00		Fresh, reddish brown siltstone

N-VALUE scale: 20, 40, 60

GEOLOGICAL RELORD OF TEST DRILLING HOLE

HOLE NO 28

LOCATION . Laos - side
ELEVATION OF SURFACE.167 M 90

DATE	DEPTH (m)	ELEV. TOP OF STRATUM (m)	CLASSIFICATION OF ROCKS	COLUMNAR SECTION	THICKNESS OF STRATUM (m)	ACCUMULATIVE THICKNESS OF STRATA (m)	CORE RECOVERY	DESCRIPTION	N - VALUE (20 40 60)
		167.10	Soil		0.80	0.80		Containing vegetable fiber	
	1–6	161.70	Loam		5.40	6.20		N=7/30cm Clayey N=11/30cm Accompanying a little humus N=15/30cm N=15/30cm Brown N=20/30cm Sandy	
	7	160.00	Sand with clay		1.70	7.90		N=11/30cm Containing N=9/30cm pebbles	
	8–11	156.30	Sand with gravel		3.70	11.60		N=25/30cm Grey brown N=22/30cm Gravel ø40 m/m 50m/m N=6/30cm N=12/30cm	
	12–14	153.00	Sand and gravel		3.30	14.90		Grey brown N=35/30cm Sand/Gravel = 1.1 N=50/21cm Accompanying little clay N=50/24cm	N=71
	15–21	146.60	Siltstone		6.40	21.30		Reddish-brown Slightly weathered	
	22–30								

2.2 Soil Test

Summary of soil test

Location: Nong Khai

Items	Unit	Characteristics											
Sample No.		1	2	3	4	5	6	7	8	9	10	11	12
Bore Hole No.		21	21	21	22	22	24	24	25	25	26	26	27
Sampling Depth	m	5.70-6.30	7.40-7.80	10.30-11.25	0.70-1.35	3.00-3.40	6.20-6.93	9.60-10.35	6.50-7.25	7.30-8.20	8.00-8.75	9.00-?.75	1.00-1.70
I. Observation		Reddish brown	Reddish brown	Reddish brown	Grey brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Yellow brown
II. Properties													
(1) Natural water content, w	%	20.11	21.23	24.04	26.25	36.70	22.04	28.42	25.41	25.75	25.72	25.40	16.45
(2) Specific gravity of soil, G		2.68	2.65	2.70	2.68	2.70	2.75	2.67	2.73	2.69	2.70	2.65	2.76
(3) Wet density, r_t	g/cm^3	1.875	1.940	1.893	2.044	1.789	2.009	1.792	1.899	1.891	1.948	1.992	2.067
(4) Dry density, r_d	g/cm^3	1.561	1.600	1.526	1.619	1.308	1.646	1.395	1.514	1.503	1.549	1.588	1.775
(5) Void ratio, e		0.717	0.656	0.769	0.655	1.064	0.671	0.914	0.803	0.790	0.743	0.669	0.555
(6) Degree of saturation, S	%	75.17	85.76	84.41	100	93.13	90.33	83.02	86.39	87.68	93.46	100	81.81
III. Grain Size													
(1) Constitution													
i) Gravel part	%	-	-	-	1.0	-	-	-	-	-	-	-	-
ii) Sand part	%	3.5	3.0	5.0	16.5	13.5	2.0	1.5	19.5	51.0	33.0	31.0	25.5
iii) Silt part	%	75.0	74.0	78.5	34.5	45.0	62.0	68.5	63.5	38.0	54.0	54.0	51.0
iv) Clay part	%	21.5	23.0	16.5	48.0	41.5	36.0	30.0	17.0	11.0	13.0	15.0	23.5
(2) Max. diameter	mm	0.105	0.105	0.105	4.8	2.0	0.105	0.105	0.42	0.84	0.42	0.42	2.0
(3) 60 % diameter, D_{60}	mm	0.035	0.033	0.0403	0.016	0.013	0.017	0.018	0.06	0.13	0.07	0.063	0.06
(4) 10 % diameter, D_{10}	mm	-	-	0.0018	-	0.0017	-	-	0.0018	0.004	0.0028	0.002	-
(5) Uniformity coefficient		-	-	22.4	-	7.65	-	-	33.3	32.5	25.0	31.5	-
(6) Grain size classification		Silty clay loam	Silty clay loam	Silty loam	Clay	Clay	Silty clay	Silty clay	Silty loam	Silty loam	Silty loam	Silty loam	Silty clay loam
(7) Unified classification		CL	CL	CL	CL or CH	CL or CH	CL	CL or CH	ML or CL	SC	ML or OL	CL	CL
IV. Consistency													
(1) Liquid limit, L.L.	%	33.25	39.80	35.20	49.80	52.00	37.10	53.10	28.20	24.10	26.40	26.85	36.50
(2) Plastic Limit, P.L.	%	20.45	21.70	22.05	17.37	20.47	20.64	24.33	22.15	18.66	22.49	18.43	11.68
(3) Plasticity index, P.I.		12.80	18.10	13.15	32.43	31.53	16.46	28.77	6.05	5.46	3.91	8.42	24.82
(4) Flow index, F.I.		6.30	8.48	8.25	10.10	10.10	10.00	12.80	5.10	5.95	5.10	5.05	15.70
V. Shearing Strength													
(1) Unconfined compression													
i) Compression strength	kg/cm^2	1.195	0.883	1.051	0.505	0.471	0.861	3.920	0.426	0.290	0.498	0.556	0.664
ii) Sensitivity ratio		2.36	1.56	4.08	1.18	1.64	1.38	5.16	N.G./1	4.08	N.G./1	N.G./1	1.06
(2) Direct compression													
i) Cohesion, c	kg/cm^2	-	-	-	-	-	0.60	-	0.30	-	0.70	0.28	0.60
ii) Internal friction angle, ϕ		-	-	-	-	-	40°02'	-	37°36'	-	15°39'	22°47'	30°58'
(3) Triaxial compression													
i) Cohesion, c	kg/cm^2	0.50	0.80	0.45	0.925	0.20	0.82	1.15	0.21	0.10	0.35	0.24	0.50
ii) Internal friction angle, ϕ		12°25'	19°18'	10°46'	5°43'	8°32'	11°52'	13°30'	15°39'	16°42'	6°17'	8°32'	15°07'
VI. Consolidation													
(1) Initial void ratio, e_o		0.610	0.672	0.670	0.642	1.360	0.689	0.876	0.769	0.657	0.616	0.680	0.682
(2) Preconsolidation load, p_o	kg/cm^2	3.50	4.50	3.20	1.22	1.17	3.00	4.90	3.00	2.63	3.90	2.48	0.56
(3) Compression index, C_c		0.198	0.186	0.147	0.161	0.361	0.235	0.308	0.251	0.201	0.137	0.146	0.158
(4) Coef. of consolidation, C_v	cm^2/sec	$2.8x10^{-2}$	$1.66x10^{-2}$	$2.1x10^{-3}$	$8.2x10^{-3}$	$8.1x10^{-3}$	$1.22x10^{-2}$	$2.0x10^{-2}$	$2.22x10^{-2}$	$3.1x10^{-2}$	$1.29x10^{-2}$	$1.15x10^{-2}$	$1.7x10^{-2}$
(5) Coef. of volume compressibility, M_v	cm^2/g	$1.3x10^{-5}$	$7.0x10^{-6}$	$8.1x10^{-6}$	$1.95x10^{-5}$	$4.7x10^{-5}$	$1.21x10^{-5}$	$8.6x10^{-6}$	$1.38x10^{-5}$	$1.28x10^{-5}$	$6.3x10^{-6}$	$1.03x10^{-5}$	$5.4x10^{-5}$
(6) Coef. of permeability, K	cm^2/sec	$3.6x10^{-7}$	$1.18x10^{-7}$	$1.74x10^{-8}$	$1.6x10^{-7}$	$3.8x10^{-7}$	$1.5x10^{-7}$	$1.75x10^{-7}$	$3.04x10^{-7}$	$4.0x10^{-7}$	$8.1x10^{-8}$	$1.2x10^{-7}$	$9.2x10^{-7}$

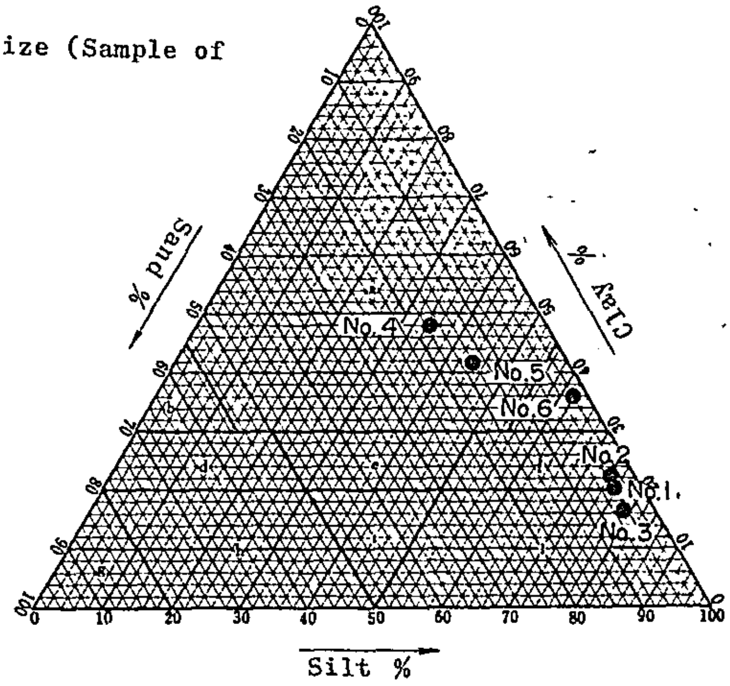
Remarks: /1 The remoulding was impossible for testing.

MECHANICAL ANALYSIS

Location Nong Khai

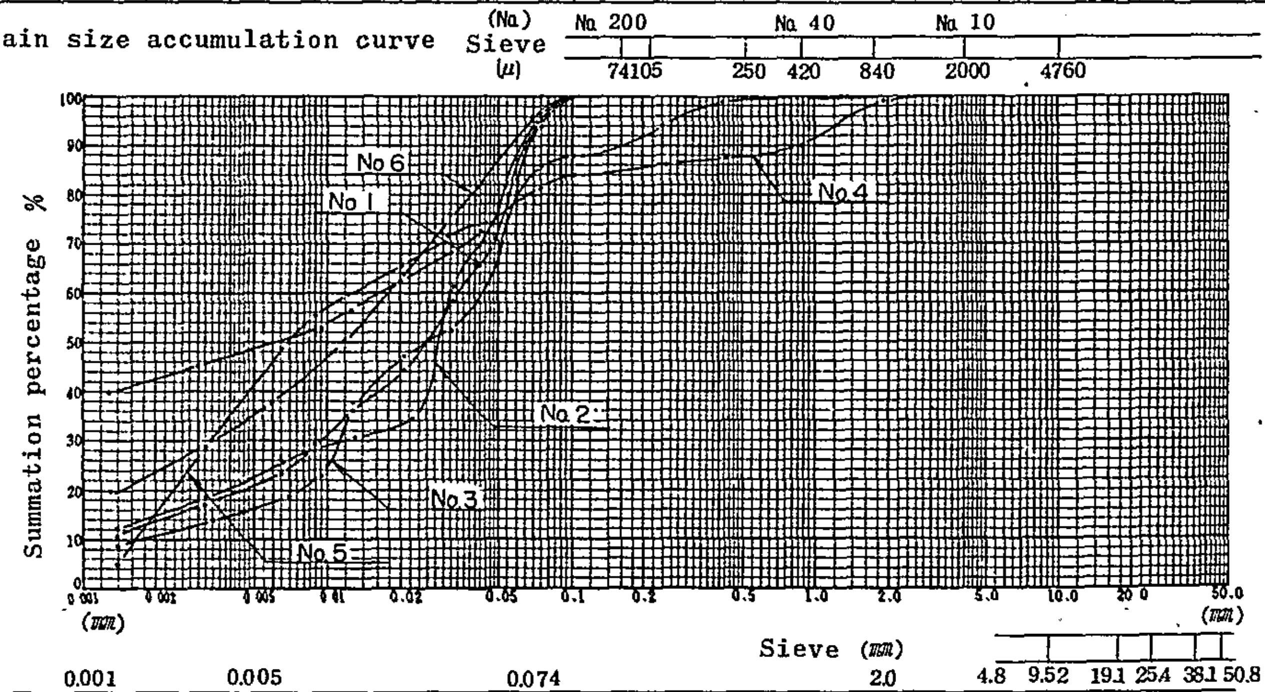
Soil classification of grain size (Sample of passed 2000 μ sieve)

- a CLAY
- b SANDY CLAY
- c SILTY CLAY
- d SANDY CLAY LOAM
- e CLAYEY LOAM
- f SILTY CLAY LOAM
- g SAND
- h SANDY LOAM
- i LOAM
- j SILTY LOAM



Sample No	Gravel %	Sand %	Silt %	Clay %	Max. size mm	D60 mm	D10 mm	Uniformity Coett	2000μ sieve	420μ sieve	74μ sieve	Sign of Plotted part on triangular diagram	Classification	Remarks
									Passed Percentage					
No. 1	—	3.5	75.0	21.5	0 105	0 035	—	—	100	100	96.0	f	SILTY CLAY LOAM	
No. 2	—	3.0	74.0	23 0	0 105	0 033	—	—	100	100	97.0	f	SILTY CLAY LOAM	
No. 3	—	5.0	78.5	16 5	0 105	0 0403	0 0018	22 4	100	100	95 5	j	SILTY LOAM	
No. 4	1 0	16.5	34.5	48 0	4 8	0 016	—	—	99.0	87 0	82.0	a	CLAY	
No. 5	—	13.5	45.0	41.5	2 0	0.013	0 0017	7.65	100	98 5	86.5	a	CLAY	
No 6	—	2.0	62.0	36.0	0.105	0.0107	—	—	100	100	98.5	c	SILTY CLAY	

Grain size accumulation curve



0.001	0.005	0.074	2.0	4.8 9.52 19.1 25.4 38.1 50.8

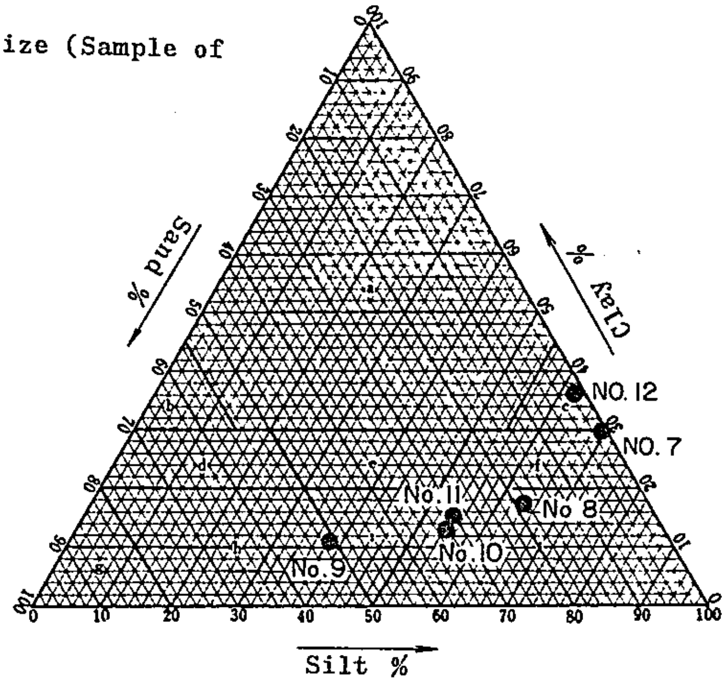
Colloid	Clay	Silt	Sand	Gravel

MECHANICAL ANALYSIS

Location Nong Khai

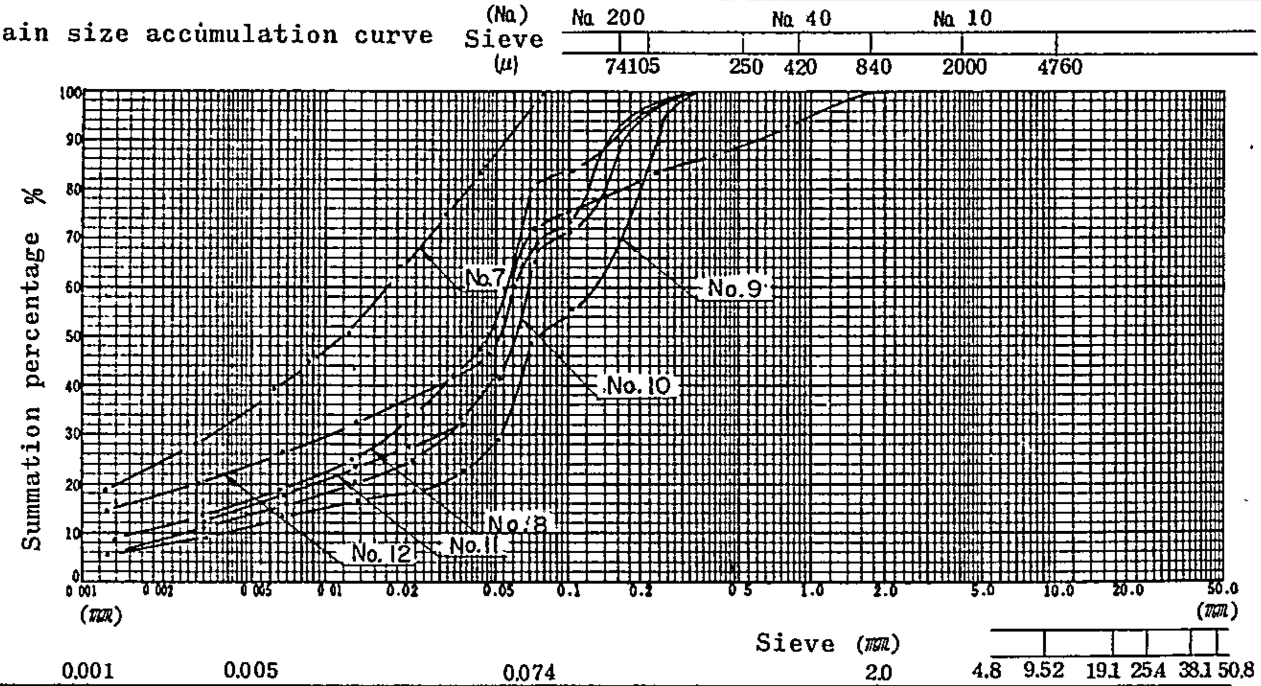
Soil classification of grain size (Sample of passed 2000 μ sieve)

- a CLAY
- b SANDY CLAY
- c SILTY CLAY
- d SANDY CLAY LOAM
- e CLAYEY LOAM
- f SILTY CLAY LOAM
- g SAND
- h SANDY LOAM
- i LOAM
- j SILTY LOAM



Sample No	Gravel %	Sand %	Silt %	Clay %	Max. size mm	D60 mm	D10 mm	Uniformity Coett	2000μ sieve	420μ sieve	74μ sieve	Sign of Plotted part on triangular diagram	Classification	Remarks
									Passed Percentage					
No. 7		1.5	68 5	30 0	0.105	0018	—	—	100	100	98.5	c	SILTY CLAY	
No.8		19.5	63.5	17.0	0.420	0006	00018	33 3	100	100	80 5	j	SILTY LOAM	
No. 9		51 0	38 0	11.0	0 84	0 13	0.004	32.5	100	995	49.0	h	SANDY LOAM	
No 10		33.0	54 0	13 0	0 42	0.007	0.0028	25.0	100	100	67 0	j	SILTY LOAM	
No.11		31.0	54.0	15.0	0.42	0.063	0.002	31.5	100	100	69.0	j	SILTY LOAM	
No 12		25.5	51.0	23.5	2.0	0 06	—	—	100	90.5	74.5	c	SILTY CLAY LOAM	

Grain size accumulation curve

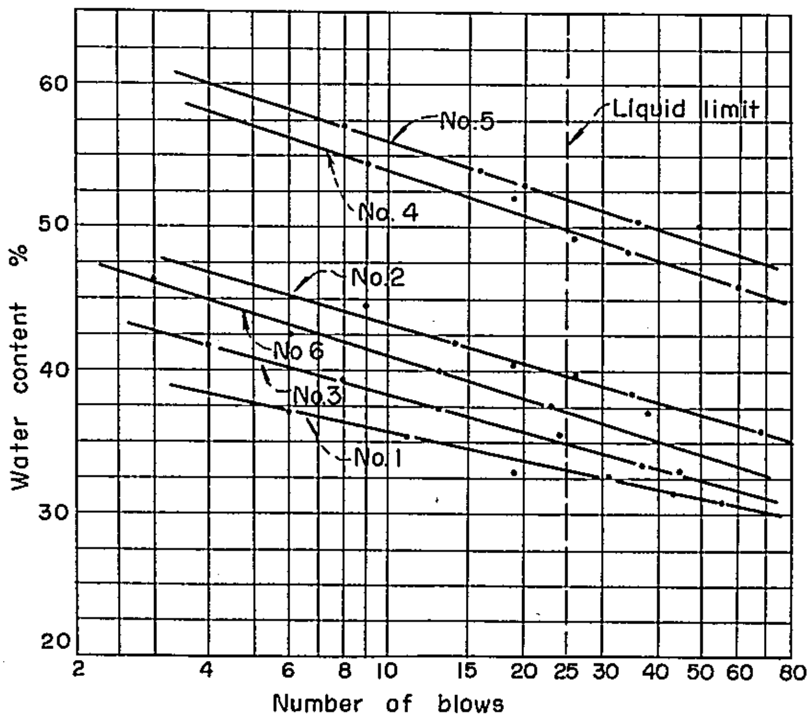


0.001	0.005	0.074	2.0	
Colloid	Clay	Silt	Sand	Gravel

Liquid Limit and Plastic Limit Tests - 1

Result of Test

Sample No.	Liquid limit	Plastic limit			Plasticity index	Flow index
		(1)	(2)	Mean		
1	33.25	20.76	20.14	20.45	12.80	6.30
2	39.80	21.67	21.72	21.70	18.10	8.48
3	35.20	22.17	21.92	22.05	13.15	8.25
4	49.80	17.49	17.24	17.37	32.43	10.10
5	52.00	20.62	20.32	20.47	31.53	10.10
6	37.10	20.66	20.62	20.64	16.46	10.00

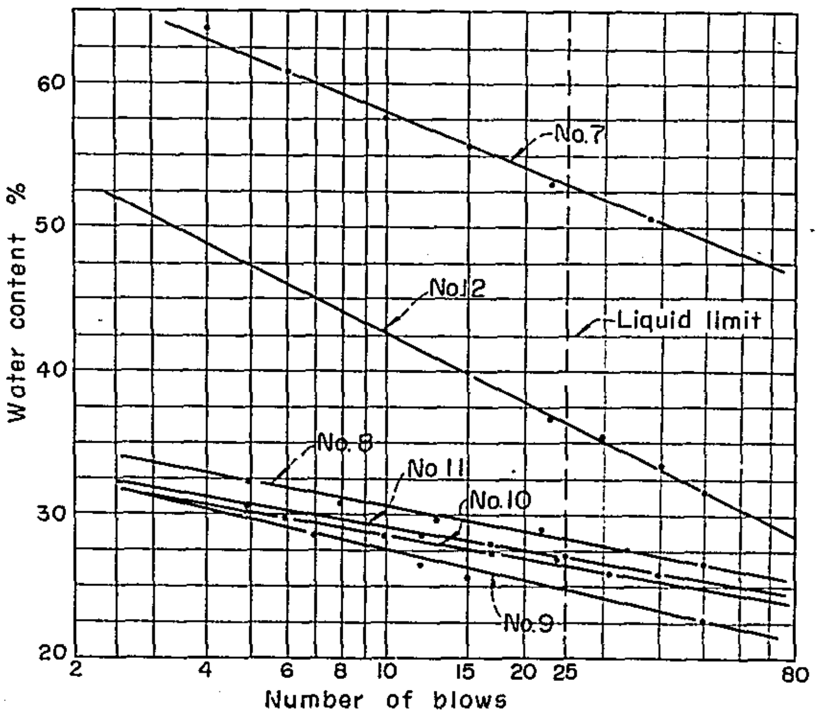


Remarks: The soil passing 0.4 mm sieve was used for the test to decide the liquid and plastic limits.

Liquid Limit and Plastic Limit Test - 2

Result of Test

Sample No.	Liquid limit	Plastic limit			Plasticity index	Flow index
		(1)	(2)	Mean		
7	53.10	24.75	23.91	24.33	28.77	12.80
8	28.20	22.27	22.02	22.15	6.05	5.10
9	24.10	18.46	18.85	18.66	5.46	5.95
10	26.40	22.54	22.43	22.49	3.91	5.10
11	26.85	18.50	18.36	18.43	8.42	5.05
12	36.50	11.85	11.50	11.68	24.82	15.70



Remarks: The soil passing 0.4 mm sieve was used for the test to decide the liquid and plastic limits.

Direct Shear Test

Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ
6	1.650	0.6	1.118	0.60	40°02'
	1.618	1.1	1.511		
	1.649	1.6	1.739		
	1.630	2.1	2.400		
8	1.491	0.6	0.758	0.30	37°36'
	1.496	1.1	1.190		
	1.498	1.6	1.373		
	1.501	2.1	1.914		
10	1.480	0.6	0.874	0.70	15°39'
	1.507	1.1	0.963		
	1.499	1.6	1.137		
	1.501	2.1	1.309		
11	1.542	0.6	0.531	0.28	22°47'
	1.520	1.1	0.766		
	1.536	1.6	0.937		
	1.510	2.1	1.163		
12	1.754	0.6	0.973	0.60	30°58'
	1.770	1.1	1.237		
	1.781	1.6	1.560		
	1.783	2.1	1.654		

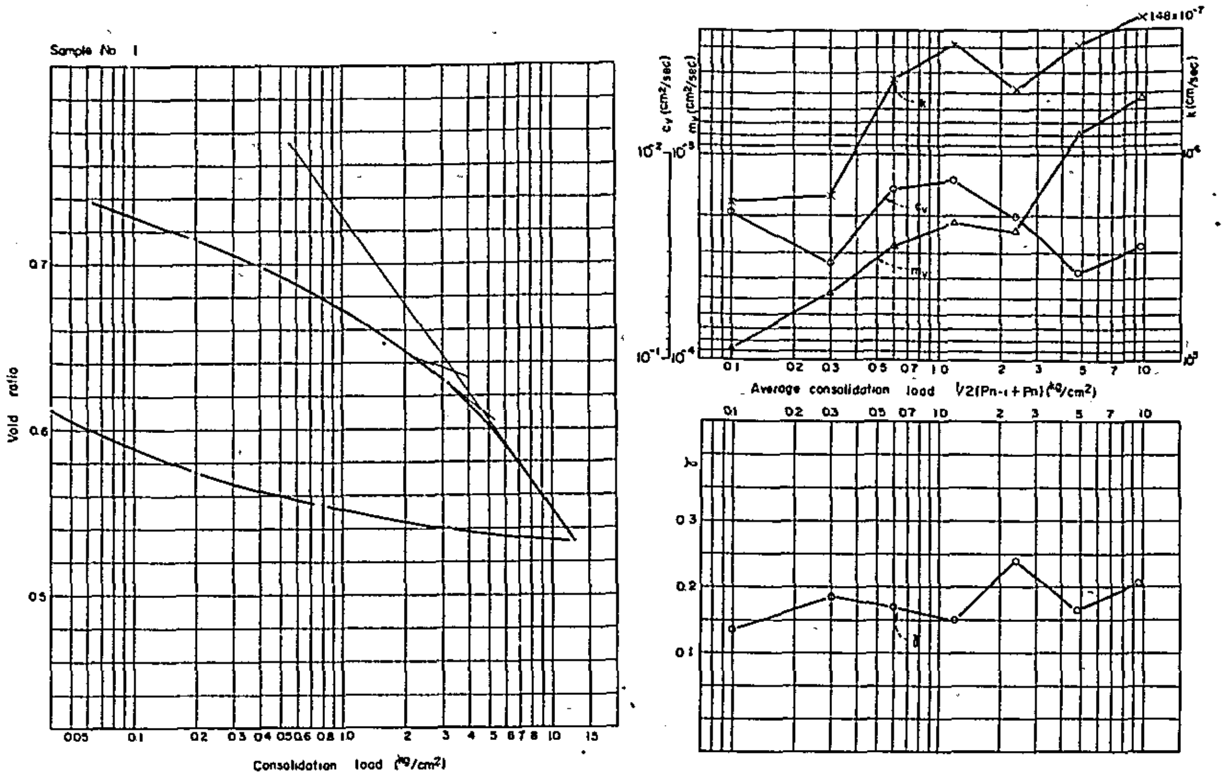
Triaxial Compression Test

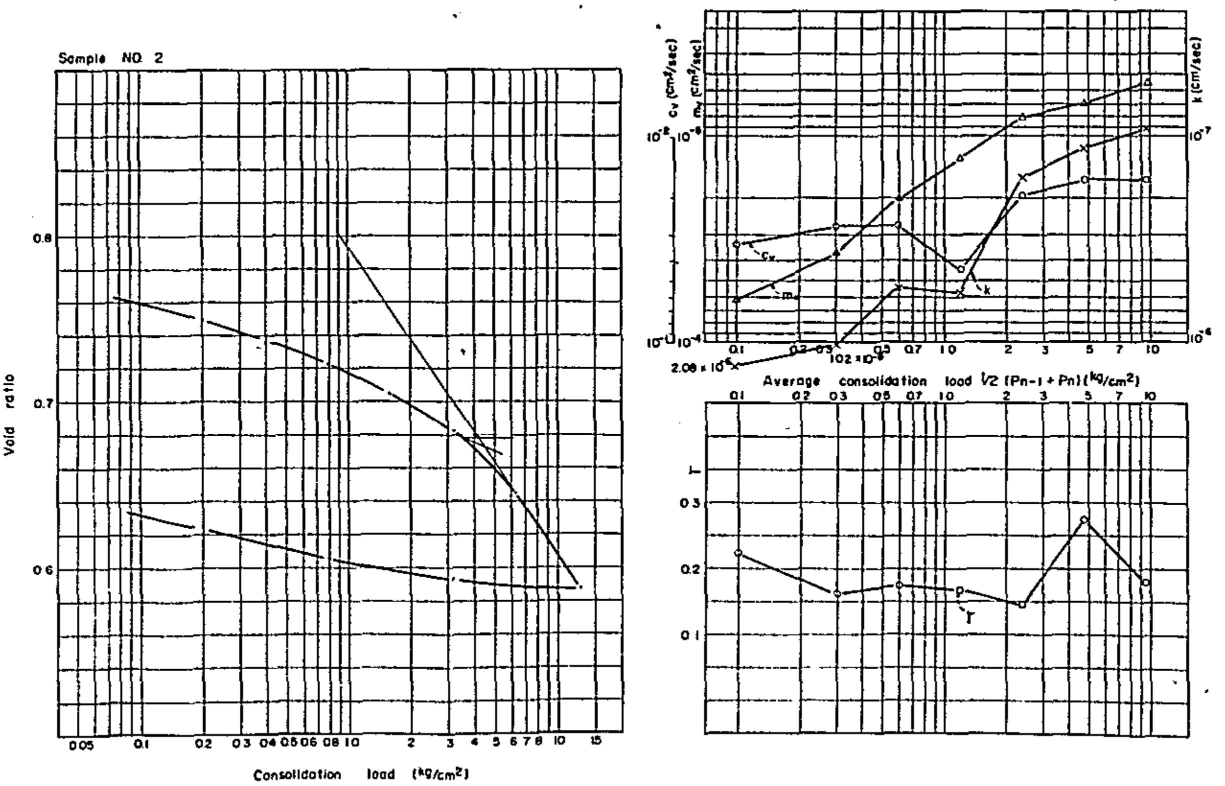
Sample No.	Dry density γ_d (g/cm^3)	Lateral pressure σ_3 (kg/cm^2)	Max. compression stress σ_1 (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ
1	1.600 1.561 1.562	1 2 3	1.803 2.431 2.776	0.50	12°25'
2	1.600 1.615	1 2	3.238 4.250	0.80	19°18'
3	1.543 1.526 1.509	1 2 3	1.569 2.038 2.747	0.45	10°46'
4	1.619 1.605 1.619	1 2 3	0.725 0.921 1.198	0.925	5°43'
5	1.273 1.308 1.329	1 2 3	0.828 1.161 1.804	0.20	8°32'
6	1.622 1.619 1.646	1 2 3	2.547 3.100 3.651	0.82	11°52'
7	1.406 1.400 1.395	1 2 3	3.602 4.182 4.691	1.15	13°30'
8	1.461 1.514 1.551	1 2 3	1.160 1.985 2.583	0.21	15°39'
9	1.503 1.481	1 2	1.031 1.896	0.10	16°42'
10	1.611 1.549 1.549	1 2 3	1.046 1.358 2.100	0.35	6°17'
11	1.595 1.588 1.580	1 2 3	0.961 1.231 1.709	0.24	8°32'
12	1.668 1.742 1.775	1 2 3	2.10 2.78 3.31	0.50	15°07'

<u>Unconfined Compression Test</u>

Sample No.	Mean water content (%)	Unit weight (g/cm^3)	Unconfined compression strength (kg/cm^2)		Sensitivity ratio
			undisturbed sample	disturbed sample	
1	19.06	1.878	1.195	0.508	2.36
2	27.41	1.878	0.883	0.564	1.56
3	22.89	1.858	1.051	0.258	4.08
4	26.77	2.030	0.505	0.427	1.18
5	38.27	1.803	0.471	0.287	1.64
6	24.86	1.965	0.861	0.626	1.38
7	28.70	1.797	3.920	0.760	5.16
8	27.18	1.848	0.426	-	-
9	21.17	1.838	0.290	0.071	4.08
10	25.76	1.934	0.498	-	-
11	25.85	1.950	0.556	-	-
12	16.51	1.992	0.664	0.627	1.06

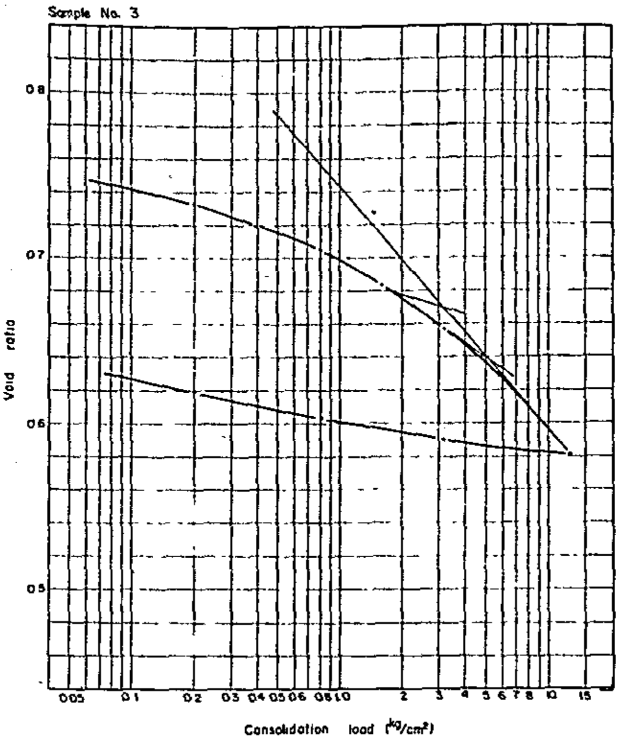
CONSOLIDATION TEST — I

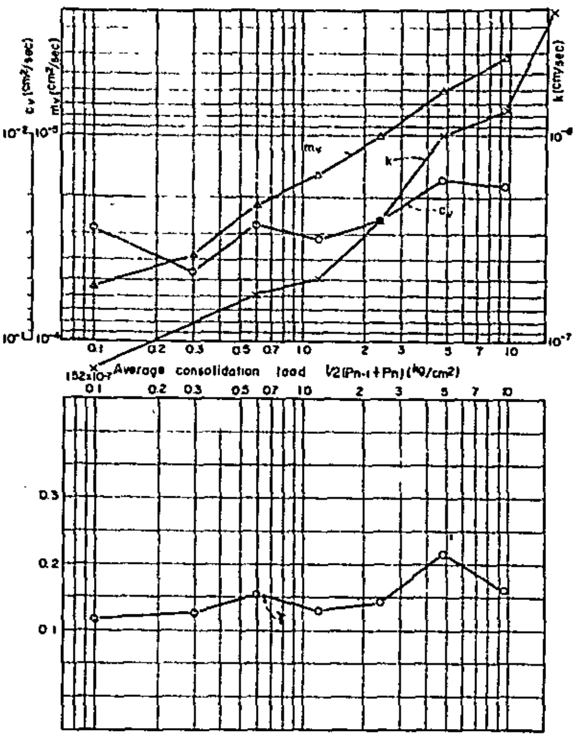


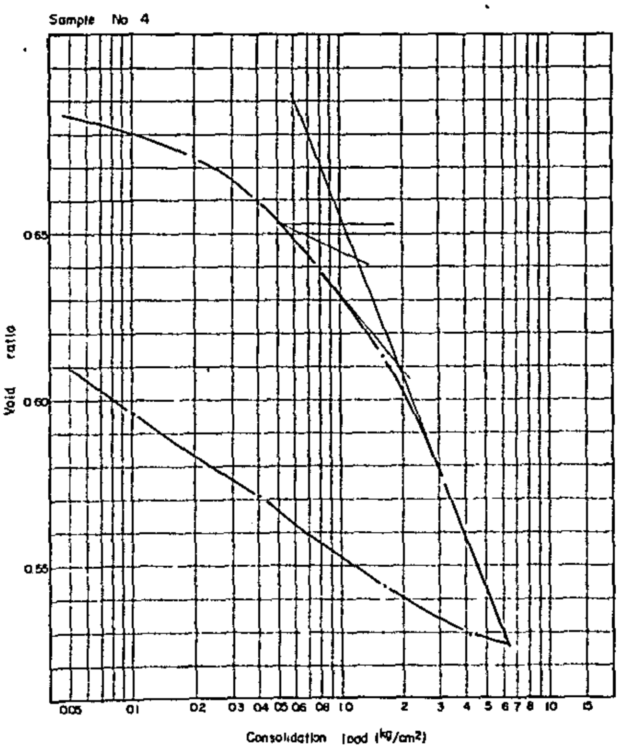


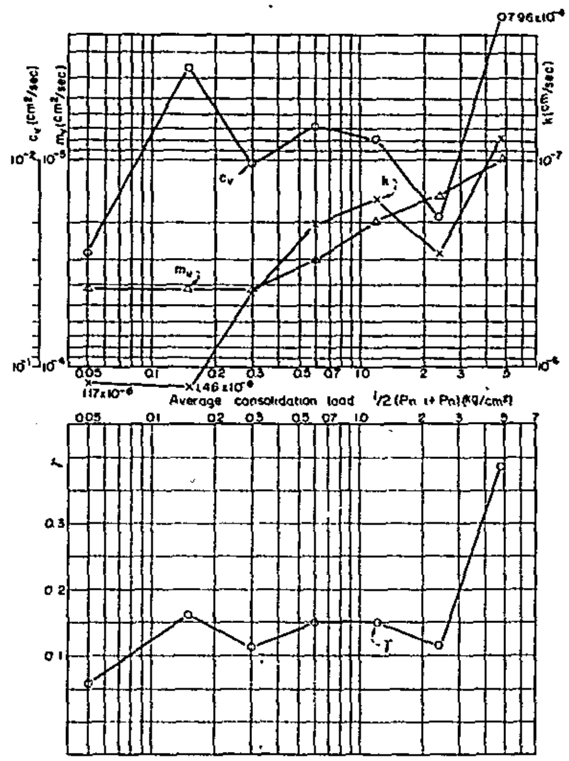
Remarks: c_v Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
r Primary compression ratio

CONSOLIDATION TEST — 2





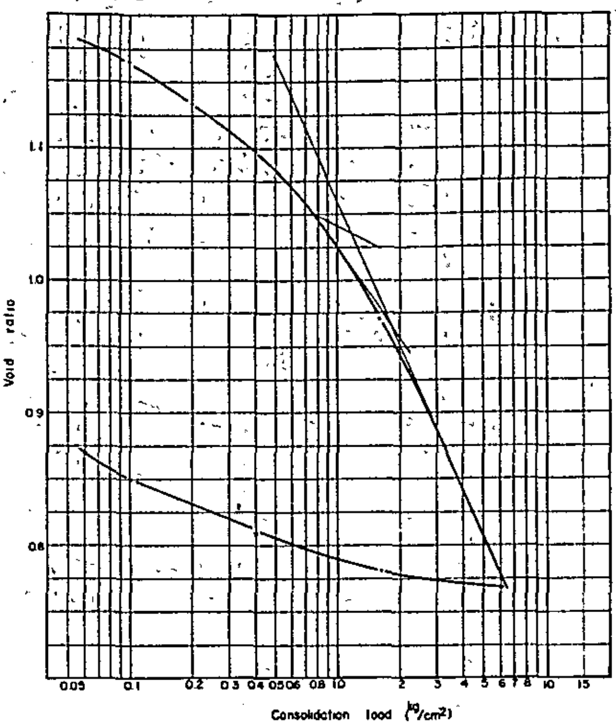


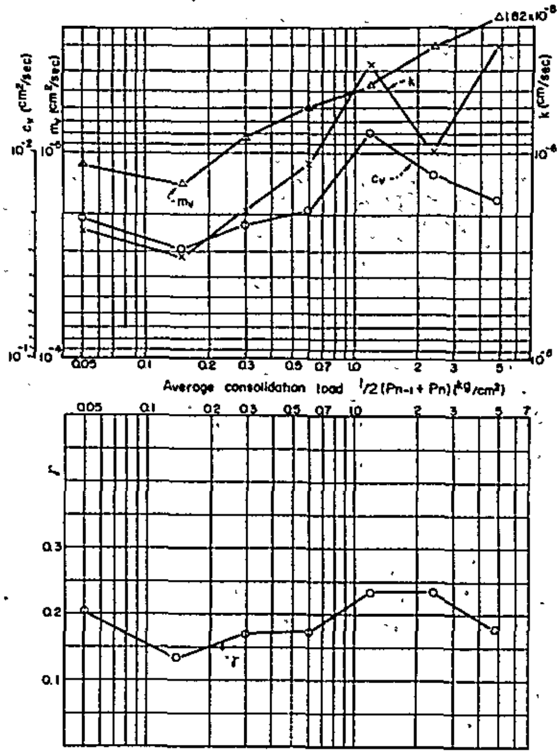


Remarks c_v . Coefficient of consolidation
m_v . Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

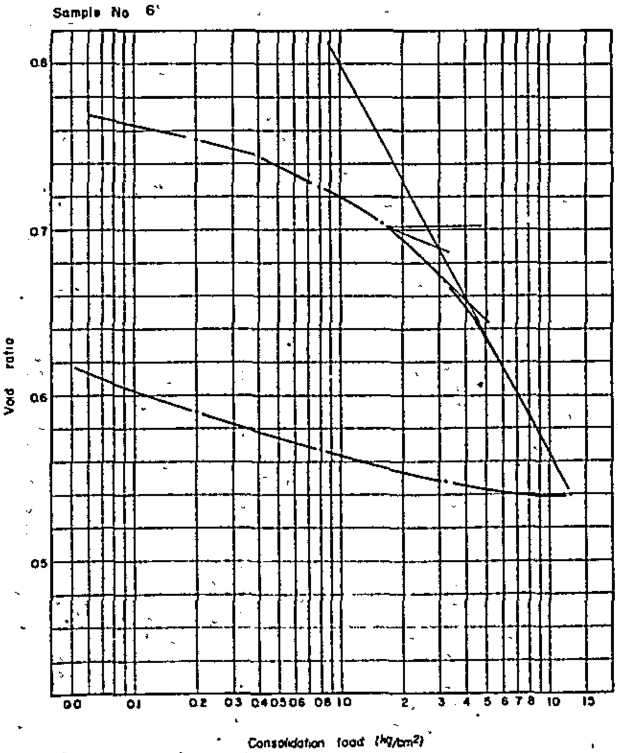
CONSOLIDATION TEST — 3

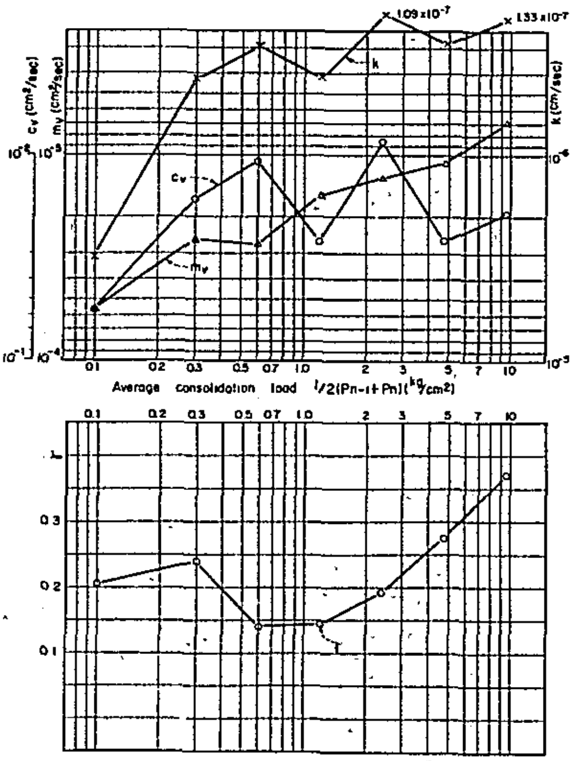
Sample No 5





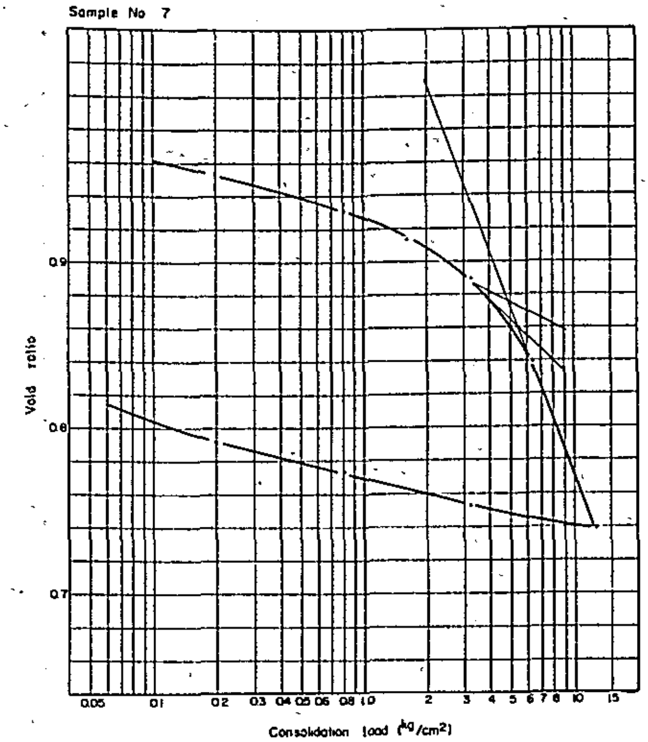
Sample No 6

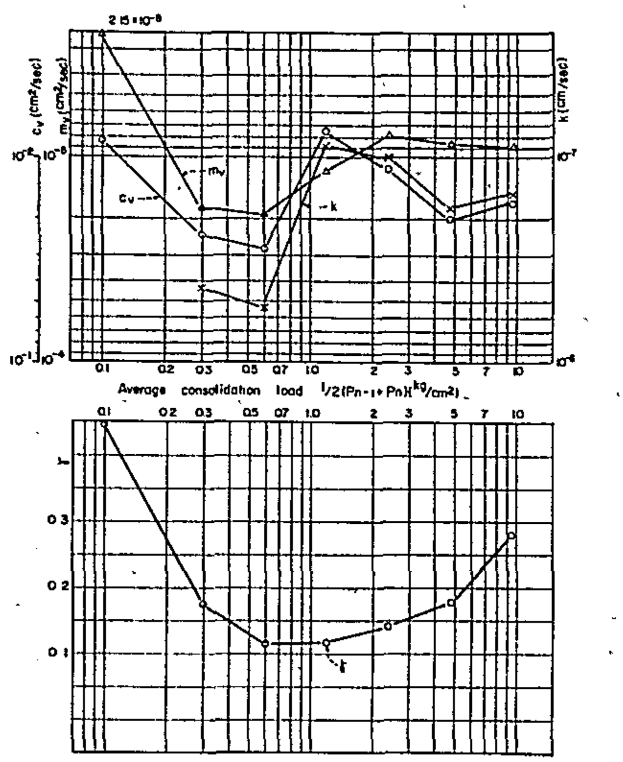


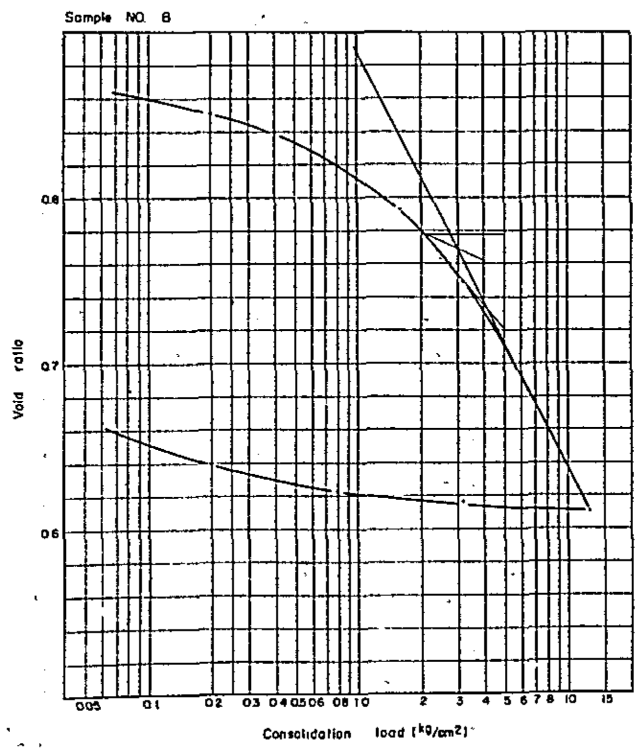


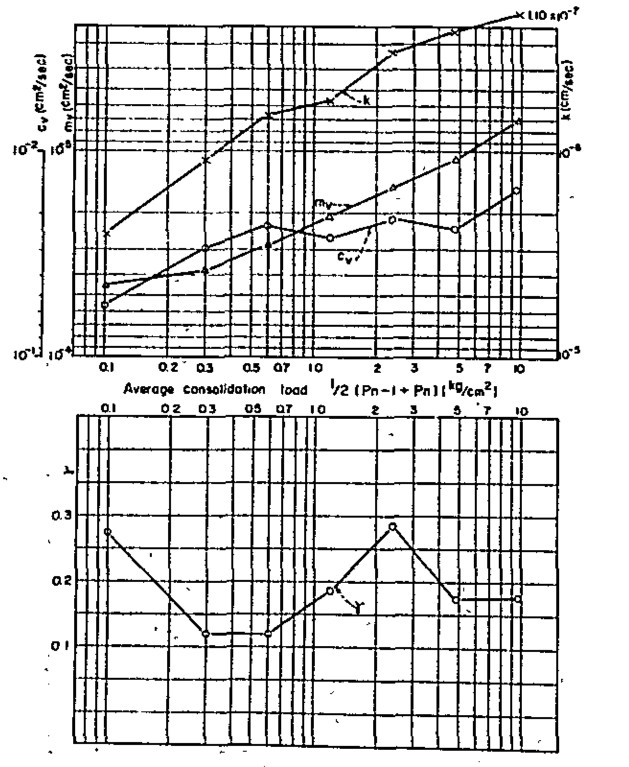
Remarks c_v : Coefficient of consolidation
m_v : Coefficient of volume compressibility
k : Coefficient of permeability
r : Primary compression ratio

CONSOLIDATION TEST — 4



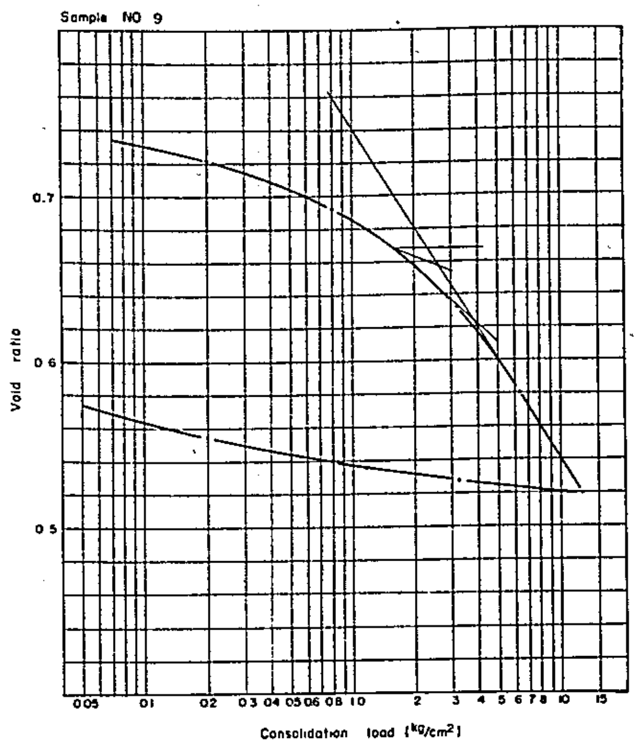


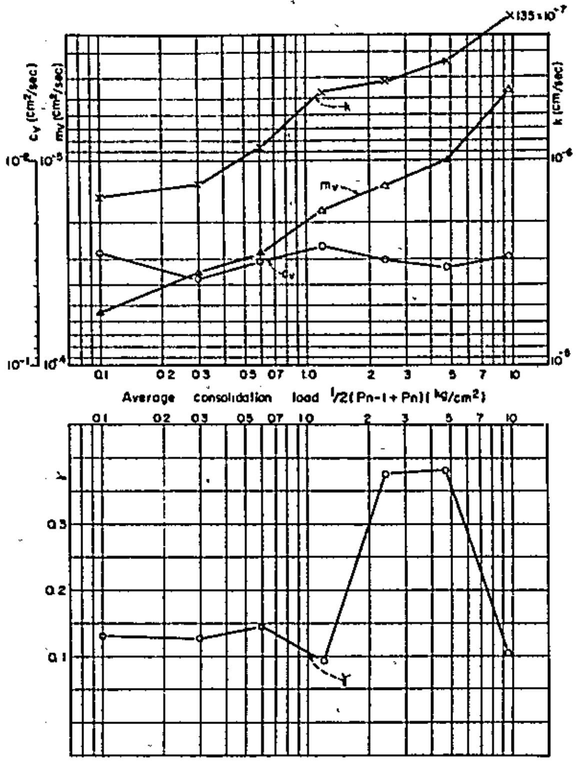


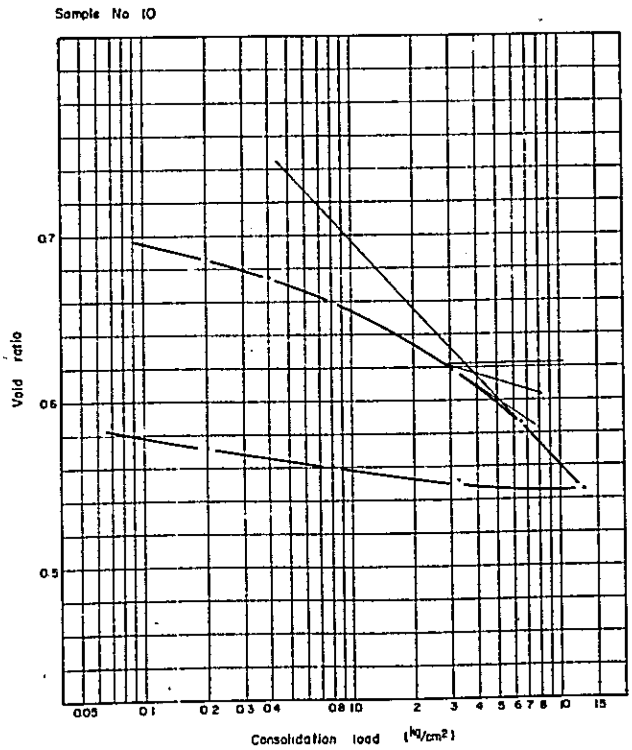


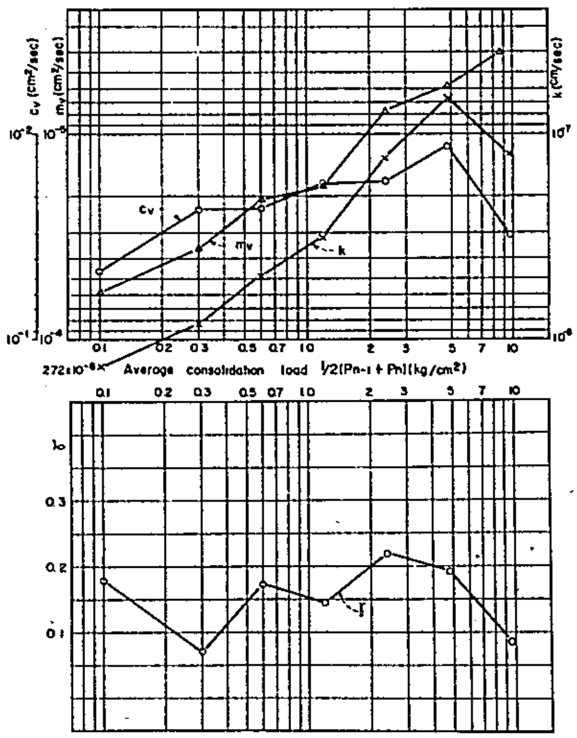
Remarks. c_v Coefficient of consolidation
m_v: Coefficient of volume compressibility
k : Coefficient of permeability
γ : Primary compression ratio

CONSOLIDATION TEST — 5





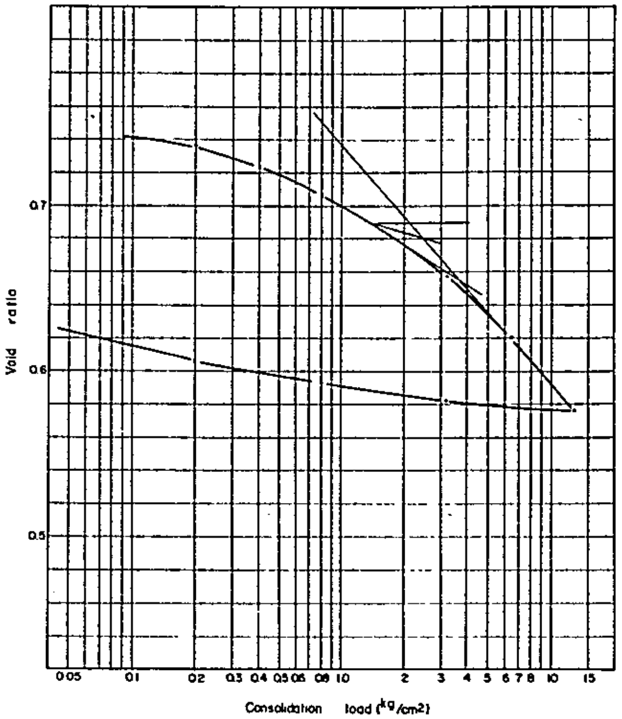


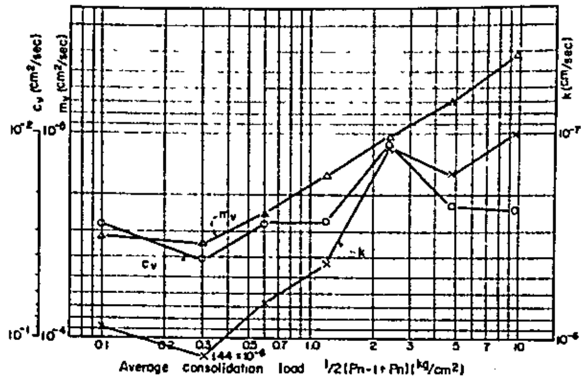


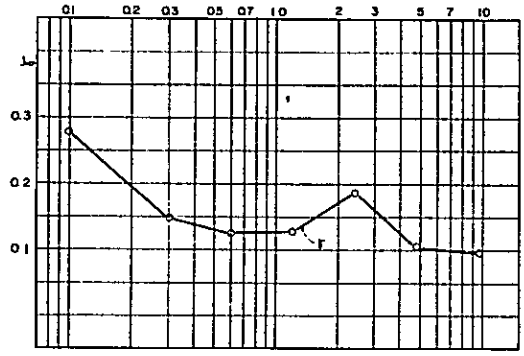
Remarks. c_v . Coefficient of consolidation
m_v . Coefficient of volume compressibility
k Coefficient of permeability
γ Primary compression ratio

CONSOLIDATION TEST — 6

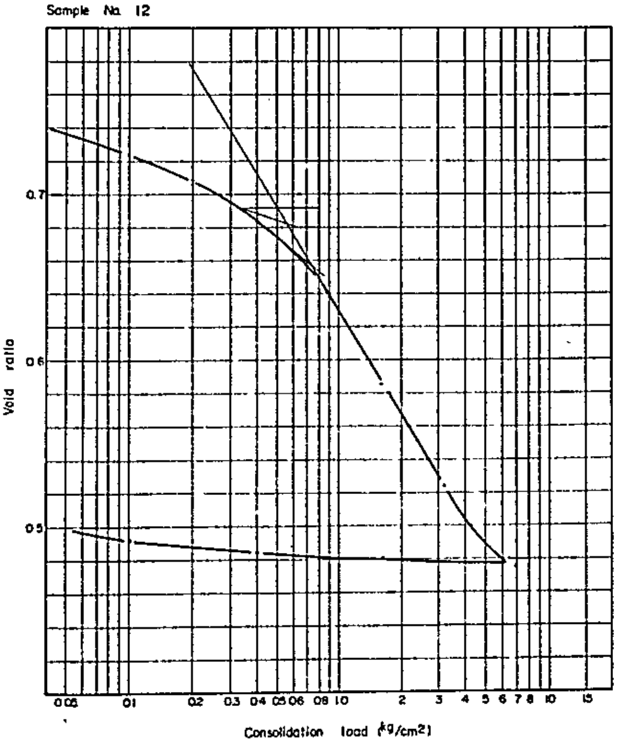
Sample No 11

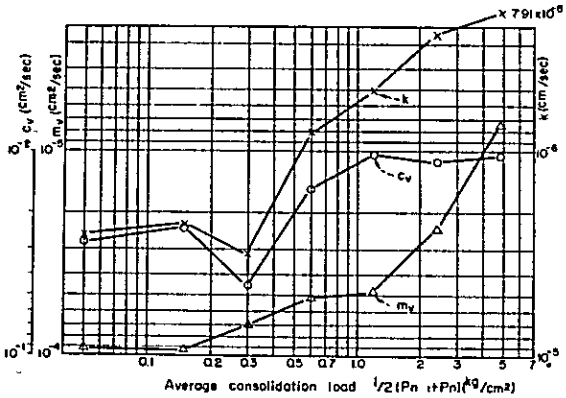


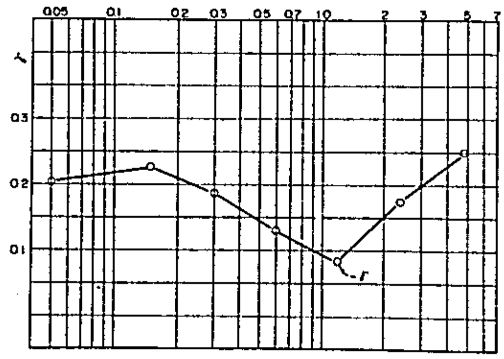




Sample No. 12







Remarks c_v · Coefficient of consolidation
m_v Coefficient of volume compressibility
k Coefficient of permeability
r Primary compression ratio

Compressive Strength Test of Core Samples (Siltstone)

Sample No.	Bore hole No.	Sampling depth (m)	Compressive strength (kg/cm^2)
1	5	7.5 - 7.7	173
2	6	10.45 - 10.60	170
3	9	7.3 - 7.4	165
Mean			169

Remarks

(1) The test was made with the dry condition at the laboratory of Chuo Univ. in Tokyo on Aug. 17, 1968.

(2) Furthermore, two more samples were tested in the laboratory of N.E.A. in Bangkok on Apr. 1, 1968. The results were as follows:

Bore hole No.	Sampling depth (m)	Compressive strength (kg/cm^2)
1	20	115.3
3	12	126.9

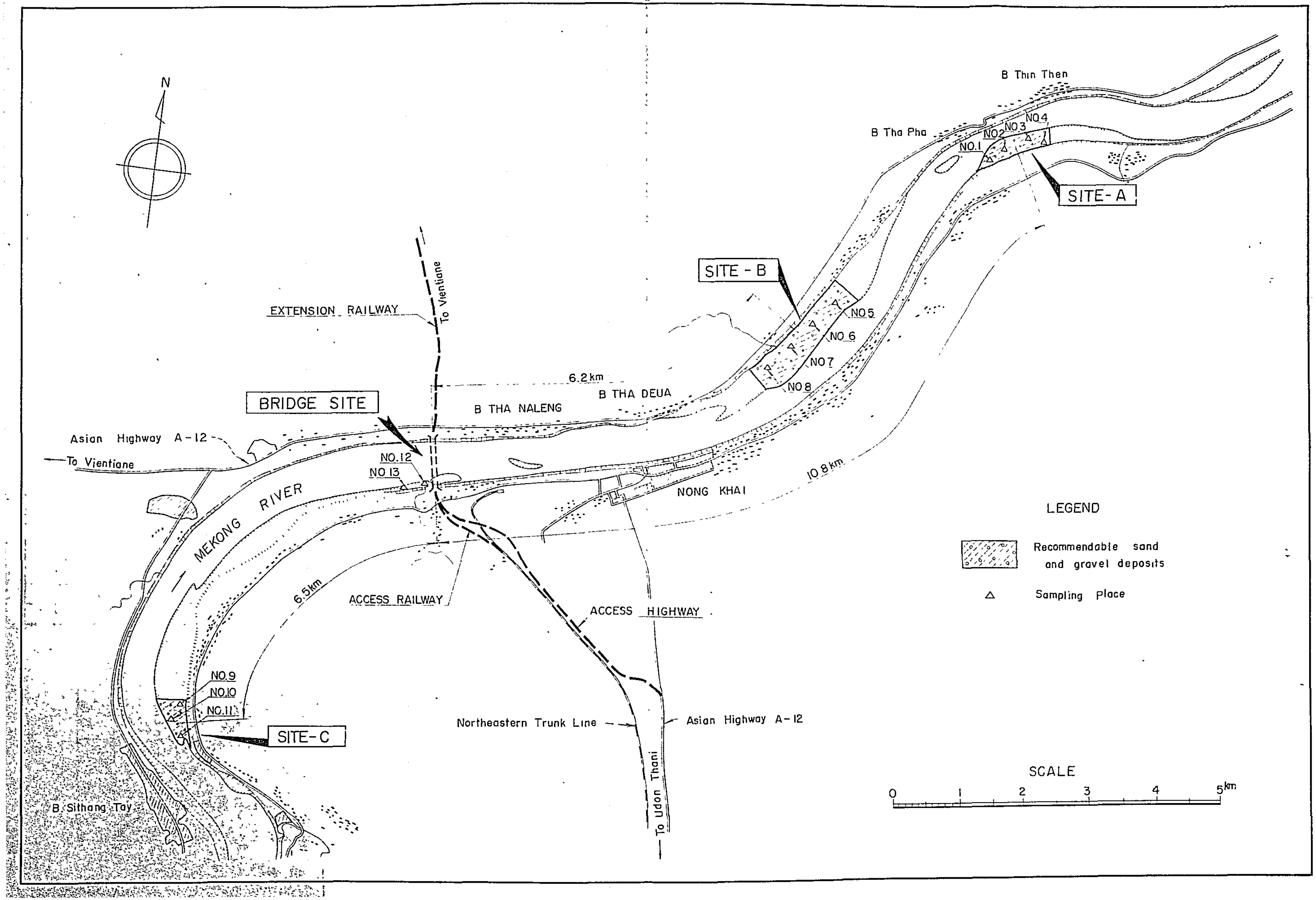
APPENDIX III

MATERIAL SURVEY

CONTENTS

3.1 Concrete Aggregate

RECOMMENDABLE SAND AND GRAVEL DEPOSITS



SAND TEST

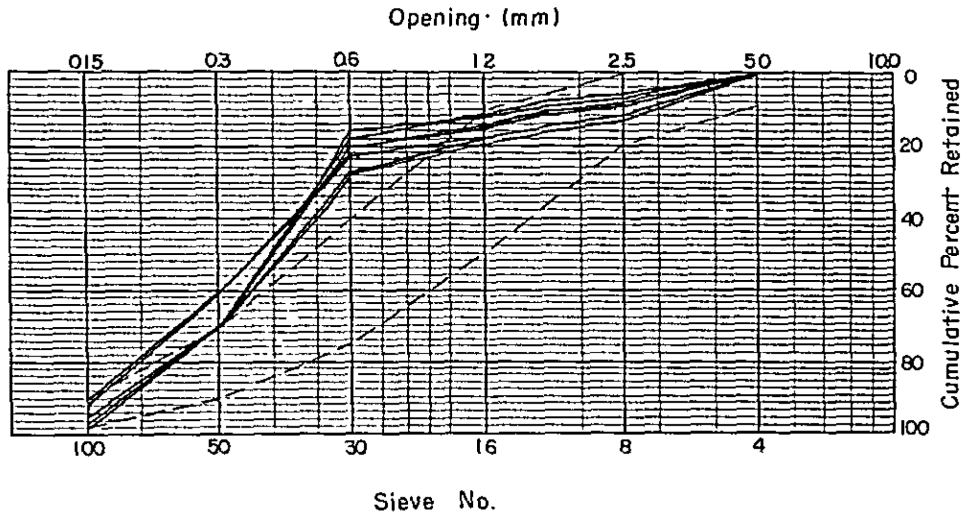
1) SIEVE ANALYSIS

SITE: A

W: Cumulative weight retained (grm)   F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	1				2			
Weight of sample	516 grms		541.7 grms		516 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	0	0	0	0	0	0
8	71	13.4	63.2	11.7	37	7.2	27	5.4
12	84	15.9	76.4	14.1	43	8.3	34	6.8
16		(19.0)		(18.0)		(11.0)		(10.0)
30	146	27.6	165.2	26.8	79	15.3	86	17.2
50	371	70.1	384.2	71.0	360	69.8	402	80.4
100	499	94.4	513.2	94.9	487	94.5	490	98.0
Passing	529	100.0	541.7	100.0	516	100.0	500	100.0
Max. size	2.7 mm		3.0 mm		1.3 mm		1.3 mm	
F.M.	2.25		2.22		1.98		2.11	

Sample No.	3				4			
Weight of sample	504 grms		505 grms		503 grms		495 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	1	0.2	0	0	0	0	0	0
8	42	8.3	44	8.7	66	13.1	67	13.5
12	50	9.9	53	10.5	76	15.1	76	15.4
16		(13.0)		(13.0)		(18.5)		(18.5)
30	98	19.4	96	19.0	110	21.9	113	22.8
50	355	70.5	355	70.4	302	60.0	300	60.6
100	487	96.6	489	96.8	450	89.3	447	90.4
Passing	504	100.0	505	100.0	503	100.0	495	100.0
Max. size	1.8 mm		1.8 mm		2.9 mm		2.9 mm	
F.M.	2.08		2.08		2.03		2.06	



SAND TEST

SITE: A

2) UNIT WEIGHT

Sample No.		2		3	
Weight of sample	(grm)	3,212	3,226.5	3,319	3,331
Volume of sample	(cm^3)	2,000	2,000	2,000	2,000
Unit weight	(kg/m^3)	1,610	1,610	1,660	1,670

3) SPECIFIC GRAVITY

Sample No.			2			
Weight of sample	(grm)	A =	500	500		
Capacity of flask	(cm^3)	B =	500	500		
Water added to flask	(cm^3)	C =	311	309		
Specific gravity	A/(B - C)		2.64	2.62		

4) ABSORPTION

Sample No.	2			
Weight, surface dry condition (grm) A =	500.0	500.0		
Weight, oven dry condition (grm) B =	494.2	493.8		
Absorption (A - B)/B x 100 (%)	1.17	1.25		

5) MATERIAL PASSING NO.200 SIEVE

Sample No.		1		4	
Weight of sample before washing	(grm)	500.0	500.0	500.0	500.0
Weight of sample after washing	(grm)	495.2	496.1	494.3	496.1
Decreased amount	(grm)	4.8	3.9	5.7	3.9
Percentage		0.96	0.78	1.14	0.78

SAND TEST

1) SIEVE ANALYSIS

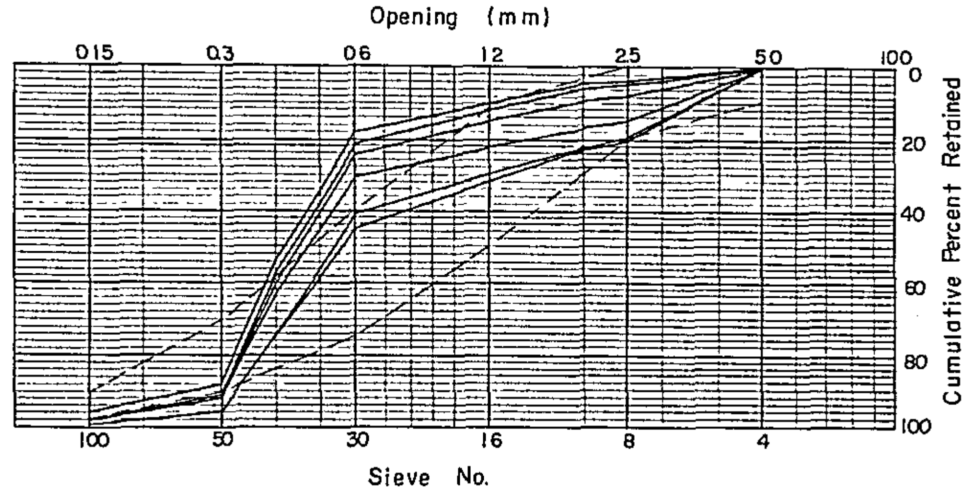
SITE: B

W: Cumulative weight retained (grm)   F.M.: Fineness modulus

%: Cumulative percent retained

Sample No.	5				6			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	3	0.6	4	0.8	4	0.8	0.5	0.1
8	98	19.6	101	20.2	76	15.2	39.5	7.9
10	112	22.4	113	22.6	84	16.8	46.5	9.3
16		(32.5)		(30.0)		(23.0)		(15.0)
30	226	45.2	203	40.6	152	30.4	117.5	23.5
40	371	74.2	375	75.0	307	61.5	293.5	58.7
50	483	96.6	477	95.5	461	92.2	457.5	91.5
100	499	99.8	495	99.0	491	98.2	487.5	97.5
Passing	500	100.0	500	100.0	500	100.0	500.0	100.0
Max. size	3.5 mm		3.5 mm		1.9 mm		3.2 mm	
F.M.	2.94		2.86		2.60		2.36	

Sample No.	7				8			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	1	0.2	0.8	0.2	0	0
8	19	3.8	25	5.0	14.3	2.9	18	3.6
10	22	4.4	30	6.0	109.6	21.9	22	4.4
16		(11.0)		(12.5)		(23.5)		(13.5)
30	91	18.2	105	21.0	127.8	25.6	138	27.6
40	267	53.4	283	56.6	420.8	84.2	437	87.5
50	441	88.2	455	91.0	484.8	97.0	491	98.2
100	479	95.8	492	98.4	488.8	97.8	495	99.0
Passing	500	100.0	500	100.0	500.0	100.0	500	100.0
Max. size	1.2 mm		1.5 mm		2.2 mm		1.5 mm	
F.M.	2.17		2.28		2.47		2.42	



SAND TEST

SITE: B

2) UNIT WEIGHT

Sample No.		6		7	
Weight of sample	(grm)	3,317.2	3,322.2	3,327.2	3,322.2
Volume of sample	(cm^3)	2,000	2,000	2,000	2,000
Unit weight	(kg/m^3)	1,560	1,560	1,660	1,660

3) SPECIFIC GRAVITY

Sample No.			6			
Weight of sample	(grm)	A =	500	500		
Capacity of flask	(cm^3)	B =	500	500		
Water added to flask	(cm^3)	C =	306	307		
Specific gravity	A/(B - C)		2.58	2.59		

4) ABSORPTION

Sample No.	6			
Weight, surface dry condition (grm) A =	500.0	500.0		
Weight, oven dry condition (grm) B =	495.2	494.7		
Absorption (A - B)/B x 100 (%)	0.97	1.07		

5) MATERIAL PASSING NO.200 SIEVE

Sample No.		5		8	
Weight of sample before washing	(grm)	641.8	570.0	522.6	500.0
Weight of sample after washing	(grm)	634.9	563.0	517.2	497.7
Decreased amount	(grm)	6.9	7.0	5.4	2.3
Percentage		1.1	1.2	1.0	0.5

6) ORGANIC IMPURITIES

Sample No. 5

Result Trace

SAND TEST

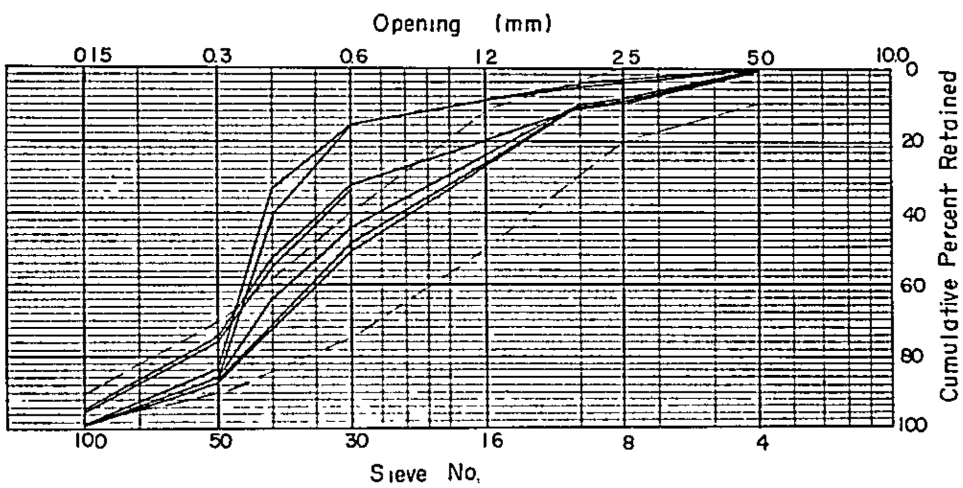
1) SIEVE ANALYSIS

SITE : C

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	9				10			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	0	0	0	0	0	0
8	19	3.8	15	3.0	47	9.4	49	9.8
10	23	4.6	20	4.0	55	11.0	58	11.6
16		(9.0)		(9.0)		(20.0)		(20.0)
30	79	15.8	79	15.8	165	33.0	163	32.6
40	164	32.8	200	40.0	272	54.4	263	52.5
50	418.9	83.8	434	86.8	380	76.0	371	74.2
100	498.0	99.6	498	99.6	475	95.0	472	94.4
Passing	500	100.0	500	100.0	500	100.0	500	100.0
Max. size	1.1 mm		1.1 mm		2.3 mm		2.3 mm	
F.M.	2.12		2.14		2.33		2.31	

Sample No.	11 - 1				11 - 2			
Weight of sample	500 grms		500 grms		500 grms		500 grms	
Sieve No.	W	%	W	%	W	%	W	%
4	0	0	0	0	0	0	0	0
8	43	8.6	42.4	8.5	43	8.6	47	9.4
10	51	10.2	50.0	10.0	50	10.0	53	10.6
16		(24.0)		(24.0)		(26.0)		(27.0)
30	217	43.5	217.0	43.4	242	48.4	251	50.2
40	323	64.6	319.0	63.8	354	70.8	356	71.2
50	430	86.0	431.0	86.2	433	86.6	437	87.4
100	490	98.0	489.0	97.8	492	98.4	492	98.4
Passing	500	100.0	500	100.0	500	100.0	500	100.0
Max. size	2.0 mm		2.0 mm		2.0 mm		2.2 mm	
F.M.	2.60		2.60		2.68		2.72	



SAND TEST

SITE: C

2) UNIT WEIGHT

Sample No.	10		11-1		11-2	
Weight of sample (grm)	3,408.2	3,427.3	3,438.2	3,446.2	3,404.2	3,410.2
Volume of sample (cm^3)	2,000	2,000	2,000	2,000	2,000	2,000
Unit weight (kg/m^3)	1,700	1,710	1,720	1,720	1,700	1,710

3) SPECIFIC GRAVITY

Sample No.			11-1		11-2	
Weight of sample	(grm)	A =	500.0	500.0	500.0	500.0
Capacity of flask	(cm^3)	B =	500.0	500.0	500.0	500.0
Water added to flask	(cm^3)	C =	307.5	307.5	308.3	308.3
Specific gravity	A/(B - C)		2.60	2.60	2.60	2.60

4) ABSORPTION

Sample No.	11-1		11-2	
Weight, surface dry condition (grm) A =	500.0	500.0	500.0	500.0
Weight, oven dry condition (grm) B =	496.3	495.7	494.9	494.5
Absorption (A - B)/B x 100 (%)	0.75	0.87	1.03	1.11

5) MATERIAL PASSING NO.200 SIEVE

Sample No.		9 and 10			
Weight of sample before washing	(grm)	502.0	500.7		
Weight of sample after washing	(grm)	499.1	497.8		
Decreased amount	(grm)	2.9	2.9		
Percentage		0.58	0.58		

6) ORGANIC IMPURITIES

Sample No. 9

Result Trace

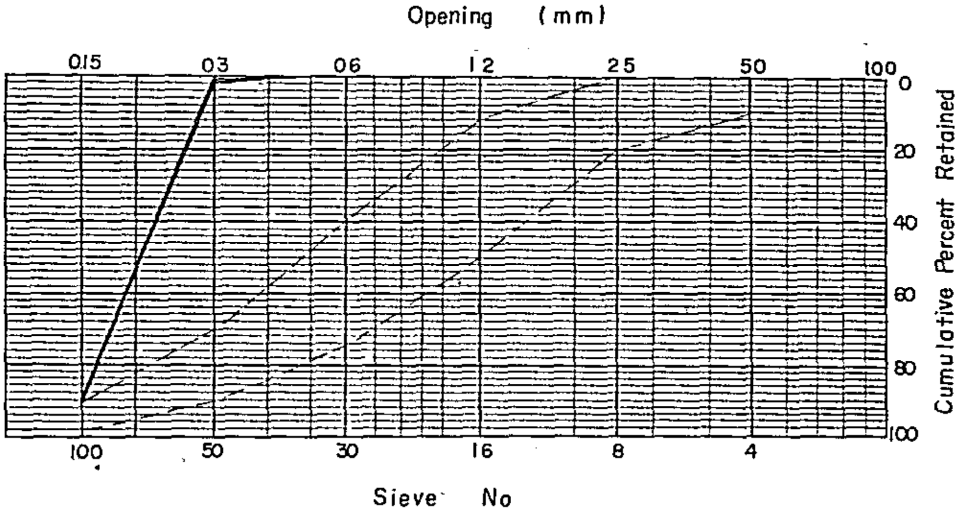
SAND TEST

1) SIEVE ANALYSIS

SITE: Bridge Site

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	12				13			
Weight of sample	494.2 grms		490.5 grms		500.4 grms		500.9 grms	
Sieve No.	W	%	W	%	W	%	W	%
4								
8								
12								
16		(0)		(0)		(0)		
30	0	0	1.7	0.3	0.2	0	0	0
50	2.0	0.4	5.2	1.1	5.7	1.1	5.7	1.1
100	444.4	88.9	439.2	89.6	447.7	89.5	453.7	90.6
Passing	494.2	100.0	490.5	100.0	500.4	100.0	500.9	100.0
Max. size	0.3 mm		0.3 mm		0.3 mm		0.3 mm	
F.M.	0.89		0.91		0.91		0.92	



SAND TEST

SITE: Bridge site

2) UNIT WEIGHT

Sample No.		12		13	
Weight of sample	(grm)	2,903	2,903	2,925	2,927
Volume of sample	(cm^3)	2,000	2,000	2,000	2,000
Unit weight	(kg/m^3)	1,450	1,450	1,460	1,460

3) SPECIFIC GRAVITY

Sample No.			13			
Weight of sample	(grm)	A =	500.0	500.0		
Capacity of flask	(cm^3)	B =	500.0	500.0		
Water added to flask	(cm^3)	C =	303.2	302.5		
Specific gravity	A/(B - C)		2.54	2.53		

4) ABSORPTION

Sample No.			13			
Weight, surface dry condition	(grm)	A =	500.0	500.0		
Weight, oven dry condition	(grm)	B =	491.9	492.1		
Absorption (A - B)/B	(%)		1.65	1.61		

5) MATERIAL PASSING NO.200 SIEVE

Sample No.		13			
Weight of sample before washing	(grm)	500.0	500.0		
Weight of sample after washing	(grm)	491.3	487.7		
Decreased amount	(grm)	8.7	12.3		
Percentage		1.74	2.46		

GRAVEL TEST

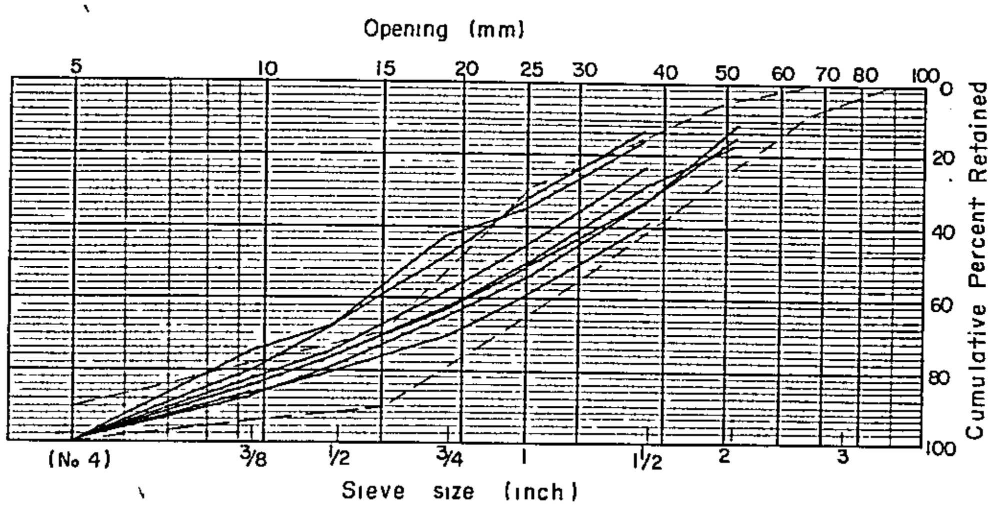
1) SIEVE ANALYSIS

SITE: A

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	1				2			
Weight of sample	21,515 grms		21,464 grms		4,855 grms		6,302 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2	3,680	17.1	3,675	17.1				
1½	6,008	27.9	5,999	27.9	1,114	23.0	2,433	38.6
1	11,150	51.8	11,090	51.6	2,238	46.1	3,762	59.7
3/4	13,437	62.5	13,337	62.1	2,808	57.9	4,449	70.6
1/2			16,067	74.8	3,553	73.2	5,076	80.5
3/8	17,887	83.0	17,874	83.3	3,981	82.1	5,457	86.6
No.4	21,515	100.0	21,464	100.0	4,855	100.0	6,302	100.0
Max. size	(60 mm)		(60 mm)		(55 mm)		(70 mm)	
F.M.	7.73		7.73		7.63		7.96	

Sample No.	3				4			
Weight of sample	4,125 grms		5,131 grms		11,831 grms		13,884 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2					1,747	14.8	1,566	11.3
1½	542	13.1	820	16.0	3,835	32.4	4,521	32.5
1	1,298	31.5	1,800	35.1	5,940	50.2	7,630	55.0
3/4	1,994	48.4	2,194	42.8	7,370	62.3	9,027	65.0
1/2	2,804	68.0	3,498	68.2	9,080	76.8	11,015	79.3
3/8	3,082	74.8	4,088	79.7	10,052	85.0	12,053	86.7
No.4	4,125	100.0	5,131	100.0	11,831	100.0	13,884	100.0
Max. size	(45 mm)		(50 mm)		(55 mm)		(50 mm)	
F.M.	7.36		7.38		7,80		7.84	



GRAVEL TEST

SITE: A

2) UNIT WEIGHT

Sample No.		2		3	
Weight of sample	(grm)	18,596	18,585	19,944	19,956
Volume of sample	(cm^3)	10,776	10,776	10,776	10,776
Unit weight	(kg/m^3)	1,730	1,720	1,850	1,850

3) SPECIFIC GRAVITY and ABSORPTION

Sample No.		2		3	
Surface dry condition	Weight in air (grm) A =	2,000.0	2,000.0	2,000.0	2,000.0
	Weight in water(grm) B =	1,237.5	1,235.0	1,233.0	1,242.5
Weight, oven dry condition	(grm) C =	1,991.0	1,990.0	1,984.0	1,983.2
Specific gravity	A/(A - B)	2.62	2.61	2.61	2.64
Absorption	(A - C)/C x 100 (%)	0.45	0.50	0.86	0.85

GRAVEL TEST

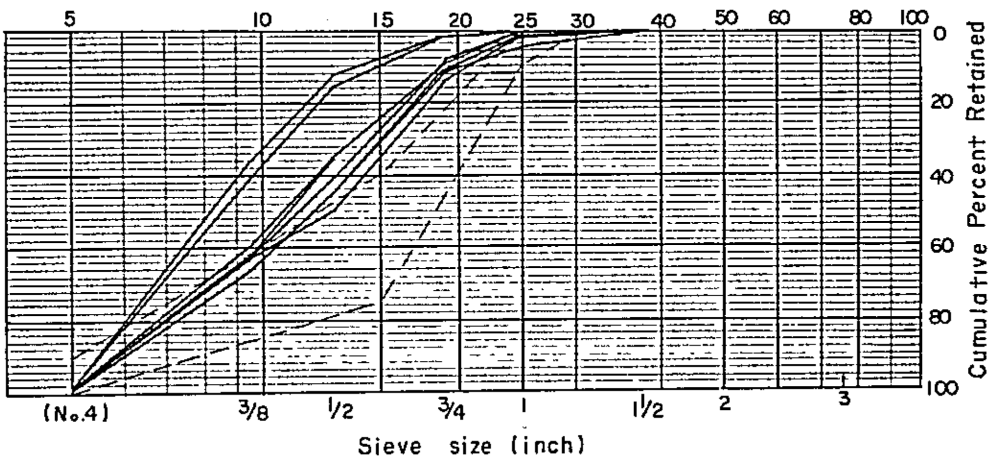
1) SIEVE ANALYSIS

SITE: B

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	5				6			
Weight of sample	5,000 grms		5,000 grms		5,000 grms		5,000 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2								
1½	0	0	0	0	0	C	0	0
1	43	0.9	107	2.1	90	1.8	55	1.1
3/4	372	7.4	676	13.5	439	8.8	567	11.4
1/2	2,043	40.8	1,989	39.8	2,259	45.2	2,222	44.5
3/8	3,145	62.9	3,151	63.0	3,152	63.0	3,348	67.0
No.4	5,000	100.0	5,000	100.0	5,000	100.0	5,000	100.0
Max. size	20 mm		22 mm		20 mm		20 mm	
F.M.	6.70		6.77		6.72		6.78	

Sample No.	7				8			
Weight of sample	4,957 grms		4,912 grms		1,420 grms		1,370 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2								
1½	0	0	0	0	0	0	0	0
1	222	4.5	180	3.7	13	0.9	12	0.9
3/4	472	9.5	459	9.3	20	1.4	20	1.5
1/2	1,732	35.0	1,690	34.4	178	12.5	204	14.8
3/8	2,940	59.3	3,041	62.0	527	37.1	559	40.6
No.4	4,957	100.0	4,912	100.0	1,420	100.0	1,370	100.0
Max. size	20 mm		20 mm		15 mm		15 mm	
F.M.	6.69		6.71		6.38		6.42	



GRAVEL TEST

SITE: B

2) UNIT WEIGHT

Sample No.		6 and 7			
Weight of sample	(grm)	18,726	18,626		
Volume of sample	(cm^3)	10,776	10,776		
Unit weight	(kg/m^3)	1,740	1,730		

3) SPECIFIC GRAVITY and ABSORPTION

Sample No.		6			
[Surface dry condition]	Weight in air (grm) A =	2,106.3	2,052.1		
	Weight in water(grm) B =	1,288.0	1,256.9		
Weight, oven dry condition	(grm) C =	2,080.6	2,025.9		
Specific gravity	A/(A - B)	2.58	2.58		
Absorption	(A - C)/C x 100 (%)	1.23	1.28		

GRAVEL TEST

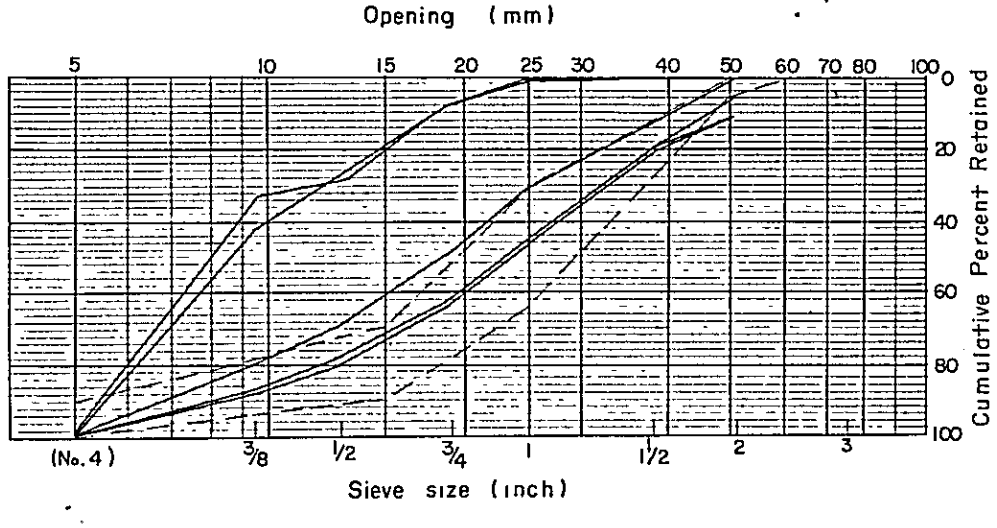
1) SIEVE ANALYSIS

SITE: C

W: Cumulative weight retained (grm) F.M.: Fineness modulus
%: Cumulative percent retained

Sample No.	9				10			
Weight of sample	2,120 grms		2,120 grms		15,000 grms		15,000 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2						(0)		(0)
1½	0	0	0	0	1,645	11.0	1,645	11.0
1	32	1.5	18	0.8	4,570	30.4	4,652	31.0
3/4	166	7.8	173	8.2	7,275	48.5	7,278	48.5
1/2	601	28.3	582	27.5	10,344	69.0	10,338	69.0
3/8	720	34.0	914	43.1	12,088	80.0	12,016	80.1
No.4	2,120	100.0	2,120	100.0	15,000	100.0	15,000	100.0
Msx. size	18 mm		18 mm		40 mm		40 mm	
F.M.	6.42		6.51		7.39		7.40	

Sample No.	11 - 1				11 - 2			
Weight of sample	20,833 grms		20,544 grms		18,841 grms		18,728 grms	
Sieve size (inch)	W	%	W	%	W	%	W	%
2	1,192	5.7	1,192	5.8	2,077	11.0	2,077	11.1
1½	4,250	20.4	4,199	20.4	3,802	20.2	3,632	19.4
1	9,910	47.6	9,647	47.0	8,456	44.9	8,399	44.8
3/4	13,218	63.5	12,996	63.2	11,861	62.9	11,690	62.4
1/2	16,680	80.1	16,458	80.0	14,925	78.2	14,755	78.8
3/8	18,291	87.8	18,160	88.4	16,400	87.0	16,230	86.6
No.4	20,833	100.0	20,544	100.0	18,841	100.0	18,728	100.0
Max. size	45 mm		45 mm		50 mm		50 mm	
F.M.	7.72		7.72		7.70		7.68	



GRAVEL TEST

SITE: C

2) UNIT WEIGHT

Sample No.		10		11-1 and 11-2	
Weight of sample	(grm)	19,656	19,656	20,226	20,026
Volume of sample	(grm)	10,776	10,776	10,776	10,776
Unit weight	(kg/m^3)	1,820	1,820	1,880	1,860

3) SPECIFIC GRAVITY AND ABSORPTION

Sample No.		11 - 1		11 - 2	
Surface dry condition	Weight in air (grm) A =	5,053.5	5,135.0	5,023.3	5,083.9
	Weight in water(grm) B =	3,120.4	3,192.5	3,099.1	3,134.5
Weight, oven dry condition	(grm) C =	5,022.6	5,102.7	4,989.6	5,050.6
Specific gravity	A/(A - B)	2.62	2.64	2.61	2.61
Absorption	(A - C)/C x 100 (%)	0.62	0.63	0.68	0.66

COMPRESSIVE STRENGTH TEST OF CONCRETE

1) DESIGN MIX

Cement:	250 kg/m^3	Gravel:	1,380 kg/m^3
Water:	150 kg/m^3	Sand:	640 kg/m^3
W/C:	60 %		

2) RESULTS OF TESTS

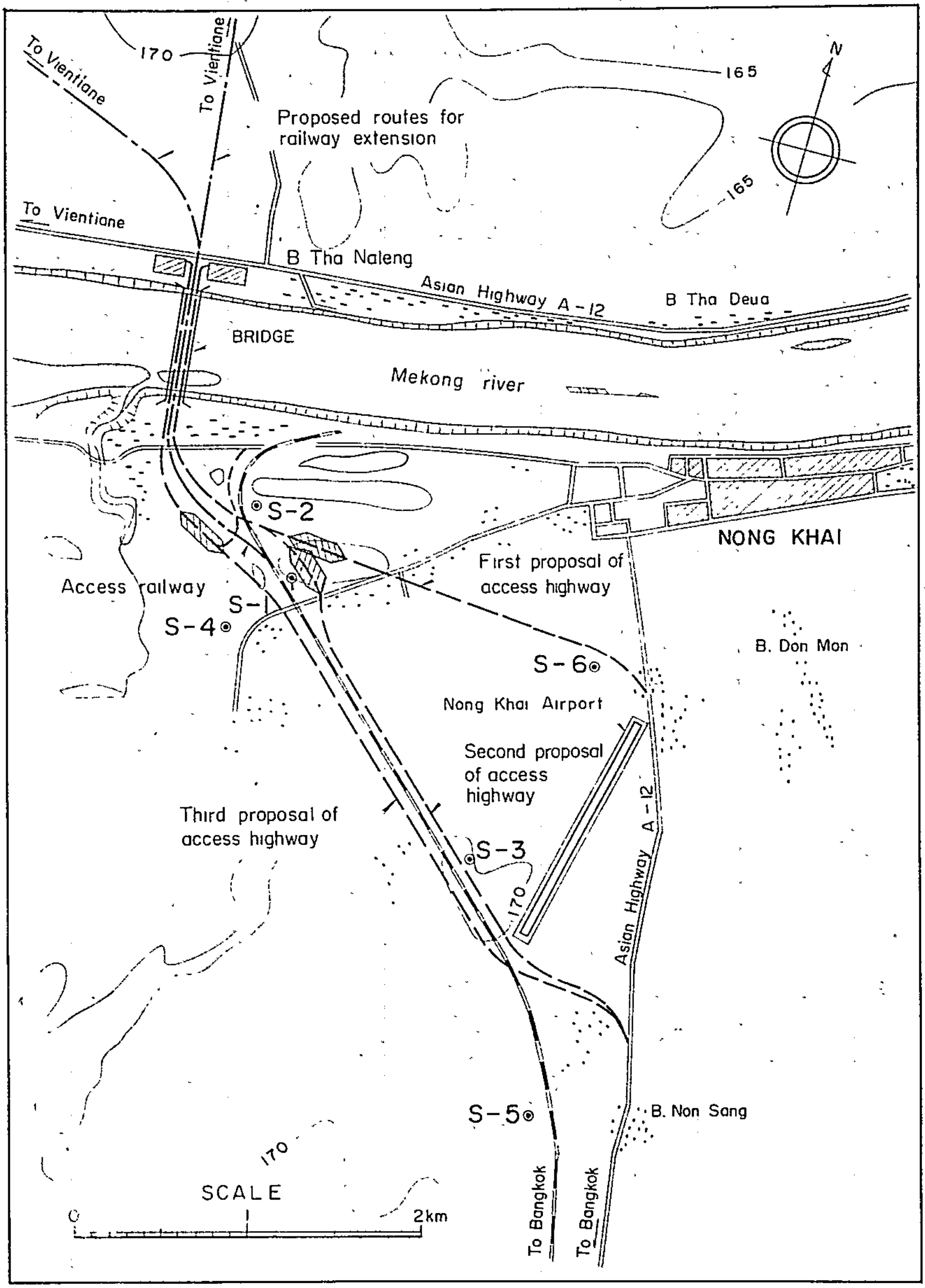
Sampling site		Weight	Apparent density	Slump	Compressive strength	
Sand	Gravel	(kg)	(kg/m^3)	(cm)	(kg/cm^2)	
A	A	13.48 13.43 13.52	2,550 2,540 2,550	6.5, 6.5	σ_7	109 104 95
	Mean	13.48	2,550	6.5		103
	A,B,C	13.08 12.90 13.05 12.91 12.95	2,470 2,440 2,460 2,440 2,440	7.2, 7.7	σ_{28}	108 114 133 107 113
	Mean	12.98	2,450	7.5		113
B	B,C	13.10 13.14 12.92 12.97 13.04	2,470 2,480 2,440 2,450 2,460	7.0, 7.5	σ_{28}	172 169 172 175 164
	Mean	13.03	2,460	7.3		170
C	C	13.06 13.45 13.16	2,460 2,540 2,480	10.1, 10.9	σ_7	105 105 115
					Mean	108
		13.37 13.34 13.40 13.46	2,530 2,520 2,530 2,540		σ_{28}	178 177 176 172
	Mean	13.32	2,510	10.5	Mean	176

Remarks:

1) Specimen size: 15 cm dia. x 30 cm high (V = 5,300 cm^3)
2) Cement used: Ordinary Portland cement made in Thailand (Tiger brand)
3) σ_7 : Compressive strength at 7-day age
4) σ_{28}: Compressive strength at 28-day age

3.2 Embankment Material

LOCATION OF SAMPLING PLACES
FOR HIGHWAY EMBANKMENT MATERIAL



Summary of soil test

Location: Nong Khai

Items	Unit	Characteristics					
Sample No.		1	2	3	4	5	6
I. Observation		Grey brown	Grey brown	Yellow brown	Yellow brown	Yellow brown	Red brown
II. Properties							
(1) Natural water contents, ω	%	32.20	30.71	9.56	12.41	14.27	14.21
(2) Specific gravity of soil, G		2.73	2.75	2.71	2.70	2.71	2.72
III. Grain size							
(1) Proportion							
i) Gravel part	%	0	0	6.0	0	8.0	0
ii) Sand part	%	0.1	1.0	24.0	5.0	12.0	8.0
iii) Silt part	%	26.9	38.0	38.0	68.0	41.0	58.0
iv) Clay part	%	73.0	61.0	32.0	27.0	39.0	34.0
(2) Maximum diameter	mm	0.105	0.105	4.8	0.42	4.8	0.25
(3) 60 % diameter, D_{60}	mm	0.032	0.0049	0.037	0.047	0.04	0.04
(4) Grain size classification		Clay	Clay	Clay	Silty clay loam	Clay	Silty clay
(5) Unified classification		CH	CH	CL	ML or CL	CH	MH or CH
(6) AASHO's classification		A-7	A-7	A-7	A-6	A-7	A-7
IV. Consistency							
(1) Liquid limit, L.L.	%	63.52	56.55	45.20	34.50	50.80	54.70
(2) Plastic limit, P.L.	%	28.32	25.07	16.81	16.04	16.61	16.00
(3) Plasticity index, P.I.		35.20	31.48	28.39	18.46	34.19	38.70
(4) Flow index, F.I.		9.73	13.60	13.12	9.76	13.60	6.80
V. Compaction							
(1) Optimum water contents		17.8	17.7	12.5	13.2	12.0	14.0
(2) Max. density, d_{max}	g/cm^3	1.638	1.750	1.970	1.918	1.896	1.881
VI. Shearing strength							
(1) Triaxial compression							
i) Cohesion, c	kg/cm^2	2.05	1.75	1.10	1.10	1.55 2.10	1.75 1.75
ii) Internal friction angle, ϕ		33°00'	16°42'	33°01'	19°18'	21°48' 33°01'	30°58' 16°46'
VII. Consolidation							
(1) Initial void ratio e_o		0.539	0.573	0.383	0.381	0.407 0.586	0.335 0.398
(2) Preconsolidation load, P_o	kg/cm^2	0.58	0.61	0.35	0.47	0.91 0.78	0.69 0.60
(3) Compression index, C_c		0.539	0.573	0.383	0.381	0.407 0.386	0.335 0.398
(4) Coef. of consolidation, Cv	cm^2/sec	0.58	0.61	0.35	0.47	0.91 0.78	0.69 0.60
(5) Coef. of volume compressibility, M_v	cm^2/g	0.195	0.196	0.150	0.148	0.086 0.083	0.259 0.266
(6) Coef. of permeability k	cm/sec	$4.4x10^{-3}$	$1.1x10^{-2}$	$7.0x10^{-3}$	$9.8x10^{-3}$	$1.9x10^{-2}$ $1.6x10^{-2}$	$1.7x10^{-3}$ $4.7x10^{-3}$
VIII. Modified C.B.R.		1.31		1.11		6.20	0.68
IX. Swelling test							
(1) Case 1							
Curing period							
0 day, Swelling ratio	%	22.84		21.34		9.21	58.28
Direct compression, C	kg/cm^2	0.112		0.062		0.17	0.028
ϕ	°	0°55'		2°07'		23°16'	0°24'
τ	kg/cm^2	0.128		0.099		0.60	0.035
1 day, Swelling ratio	%	-		12.98		4.31	-
Direct compression, C	kg/cm^2	-		0.26		0.14	-
ϕ	°	-		0°04'		28°49'	-
τ	kg/cm^2	-		0.27		0.69	-
7 days, Swelling ratio	%	-		11.10		5.52	-
Direct compression, C	kg/cm^2	-		0.24		0.25	-
ϕ	°	-		3°27'		25°39'	-
τ	kg/cm^2	-		0.30		0.73	-
14 days, Swelling ratio	%	-		19.15		11.56	-
Direct compression, C	kg/cm^2	-		0.10		0.24	-
ϕ	°	-		6°17'		20°19'	-
τ	kg/cm^2	-		0.21		0.61	-
(2) Case 2							
Surcharge load							
0.15 kg/cm^2, Swelling ratio	%	1.50		0.90		- 0.79	-
Direct compression, C	kg/cm^2	0.62		0.18		0.20	-
ϕ	°	2°52'		15°39'		31°48'	-
τ	kg/cm^2	0.67		0.76		0.82	-
0.30 kg/cm^2, Swelling ratio	%	- 0.75		- 0.05		- 1.39	-
Direct compression, C	kg/cm^2	0.48		0.70		0.57	-
ϕ	°	5°43'		2°52'		18°16'	-
τ	kg/cm^2	0.58		0.75		0.90	-
0.45 kg/cm^2, Swelling ratio	%	0.76		- 0.10		- 2.31	-
Direct compression, C	kg/cm^2	0.78		0.52		0.33	-
ϕ	°	7°59'		11°19'		25°11'	-
τ	kg/cm^2	0.92		0.72		0.80	-
(3) Case 3							
Mixing ratio							
30 %, Swelling ratio	%	-		30.55		16.13	-
Direct compression, C	kg/cm^2	-		0.28		0.12	-
ϕ	°	-		21°49'		32°38'	-
τ	kg/cm^2	-		0.68		0.76	-
60 %, Swelling ratio		-		27.52		12.34	-
Direct compression, C	kg/cm^2	-		0.17		0.15	-
ϕ	°	-		23°17'		31°48'	-
τ	kg/cm^2	-		0.60		0.77	-
(4) Case 4							
Curing period							
3 day, Swelling ratio	%	-		5.21		0.18	-
Direct compression, C'	kg/cm^2	-		1.12		3.20	-
ϕ	°	-		33°02'		1°44'	-
τ	kg/cm^2	-		1.77		3.23	-
7 days, Swelling ratio	%	-		3.55		1.09	-
Direct compression, C	kg/cm^2	-		1.60		0.77	-
ϕ	°	-		11°52'		51°49'	-
τ	kg/cm^2	-		1.81		2.04	-

Remarks:-

(1) The details of the cases in the swelling test are described in this paragraph of the report.

(2) In making CBR and swelling tests, the sample No.1 was mixed with the sample No.2, and the sample No.3 with the sample No.4, because of the similar characteristic each other.

(3) The CBR test was made after the samples were saturated with water for four days.

(4) The specimen that was used for the swelling test was 6 cm in diameter and 2 cm in height.

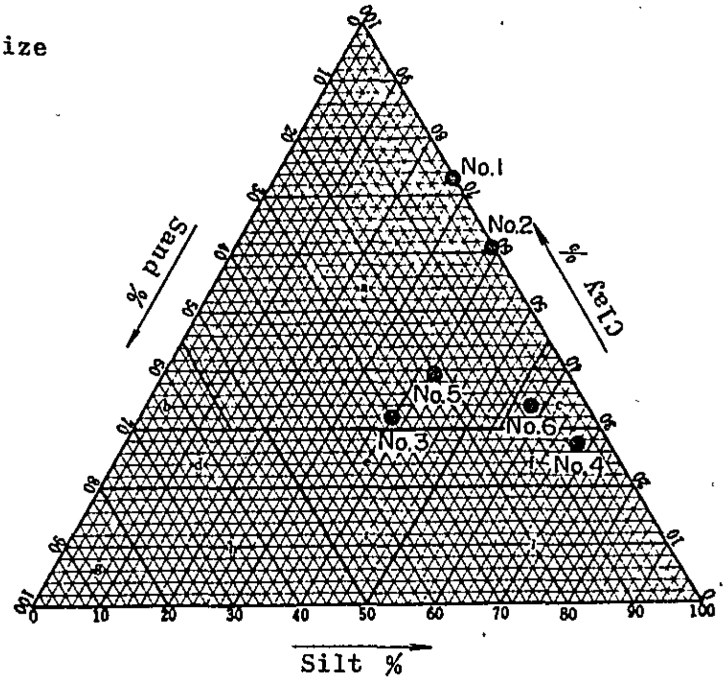
(5) The negative swelling ratio means the compression ratio.

GRAIN SIZE ANALYSIS

Location Nong Khai

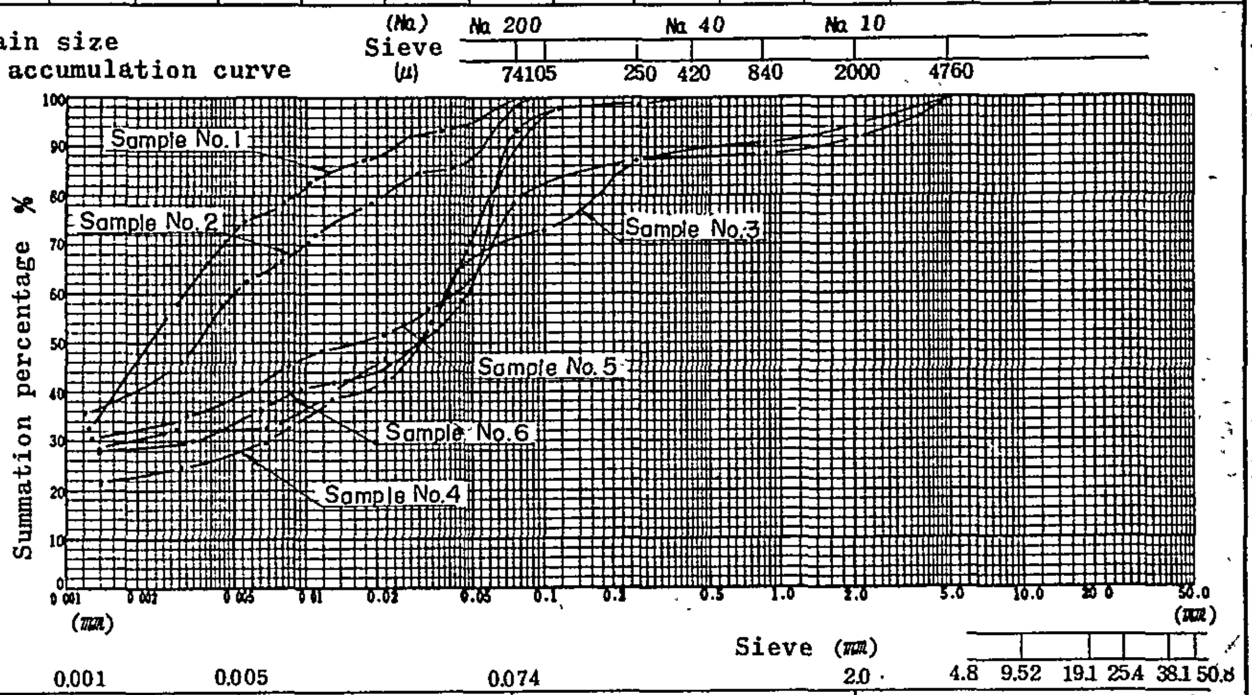
Soil classification of grain size

- a CLAY
- b SANDY CLAY
- c SILTY CLAY
- d SANDY CLAY LOAM
- e CLAYEY LOAM
- f SILTY CLAY LOAM
- g SAND
- h SANDY LOAM
- i LOAM
- j SILTY LOAM



Sample No.	Gravel %	Sand %	Silt %	Clay %	Max, size mm	D60 mm	D10 mm	Uniformity Coeff	2000μ sieve	420μ sieve	74μ sieve	Sign of Plotted part on triangular diagram	Classification	Remarks
									Passed Percentage					
1	0	0.1	26 9	73	0 105	0.0032	—	—	100	100	99.9	a	CLAY	
2	0	1	38	61	0 105	0.0049	—	—	100	100	98.9	a	CLAY	
3	6	24	38	32	4.8	0.037	—	—	94.1	900	70 2	a	CLAY	
4	0	5	68	27	0.42	0.047	—	—	100	100	94 8	f	SILTY CLAY LOAM	
5	8	12	4 1	39	4.8	0.04	—	—	92.2	87.5	79.7	a	CLAY	
6	0	8	58	34	0 25	0.04	—	—	100	100	92.1	c	SILTY CLAY	

Grain size accumulation curve



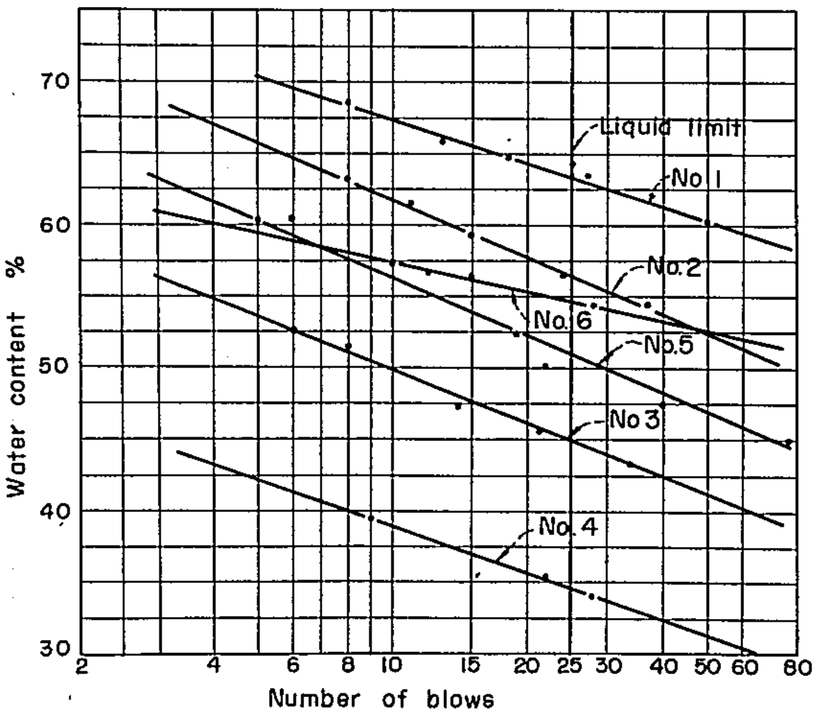
0.001	0.005	0.074	2.0	
Colloid	Clay	Silt	Sand	Gravel

N.K. Frome No.

Liquid Limit and Plastic Limit Tests

Result of Test

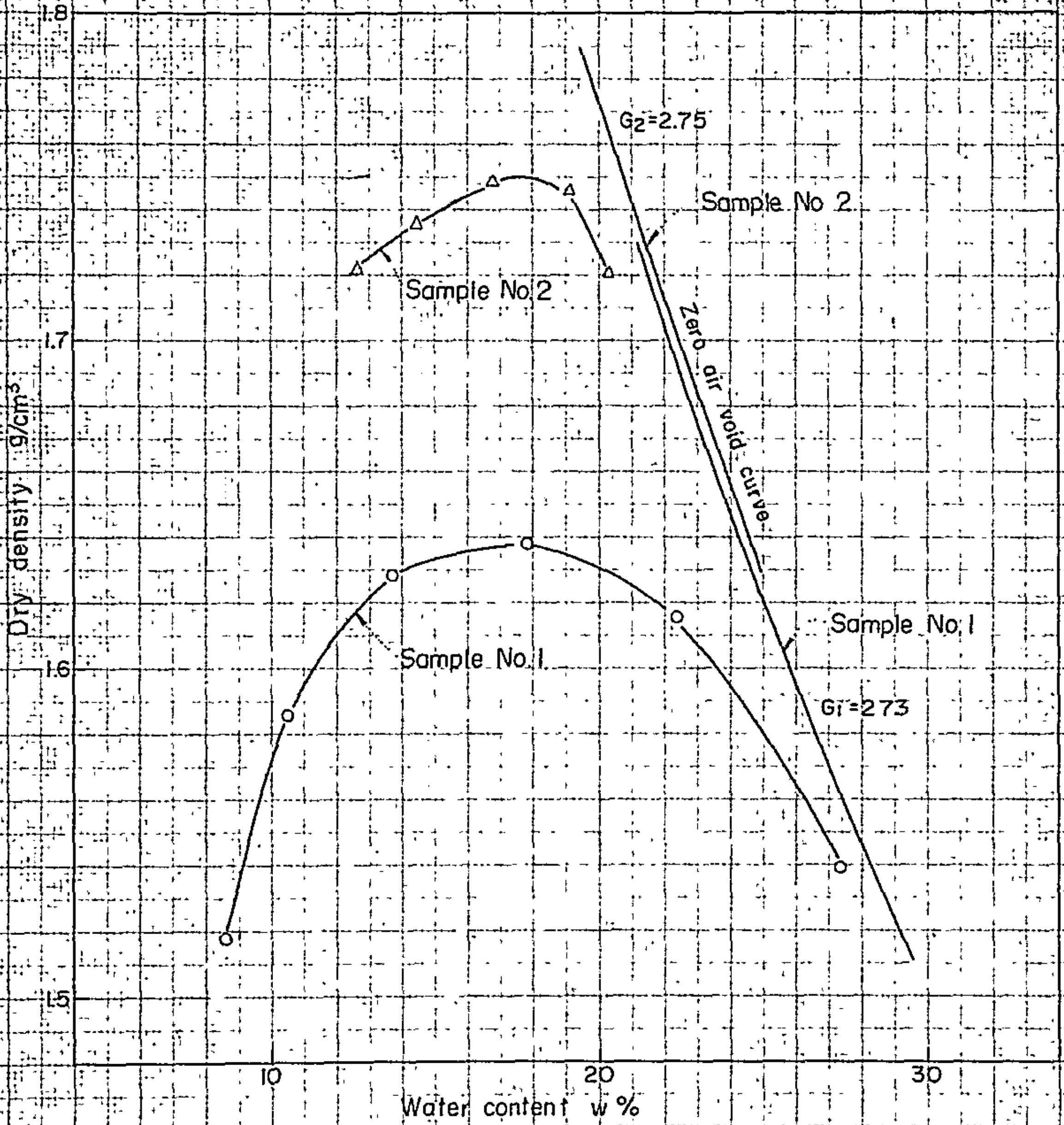
Sample No.	Liquid limit	Plastic limit			Plasticity index	Flow index
		(1)	(2)	Mean		
1	63.52	28.82	27.82	28.32	35.20	9.73
2	56.55	25.08	25.05	25.07	31.48	13.60
3	45.20	16.72	16.90	16.81	28.39	13.12
4	34.50	16.01	16.06	16.04	18.46	9.76
5	50.80	16.71	16.50	16.61	34.19	13.60
6	54.70	16.07	15.93	16.00	38.70	6.80



Remarks : The soil passing 0.4 mm sieve was used for the test to decide the liquid and plastic limits.

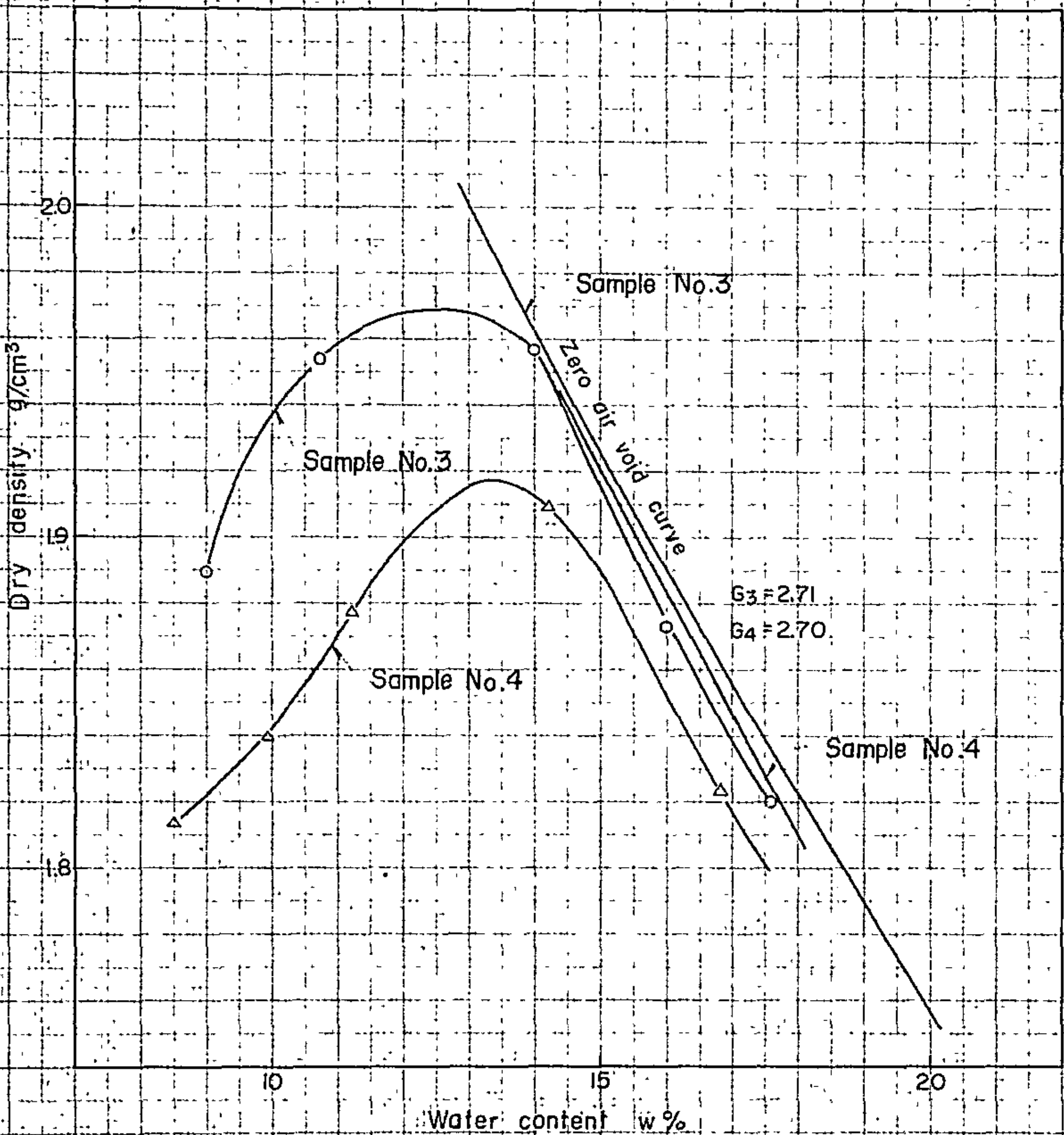
COMPACTION TEST - I

Sample No.	Optimum water content	Max. dry density
1	17.8 %	1.638 g/cm³
2	17.7	1.750



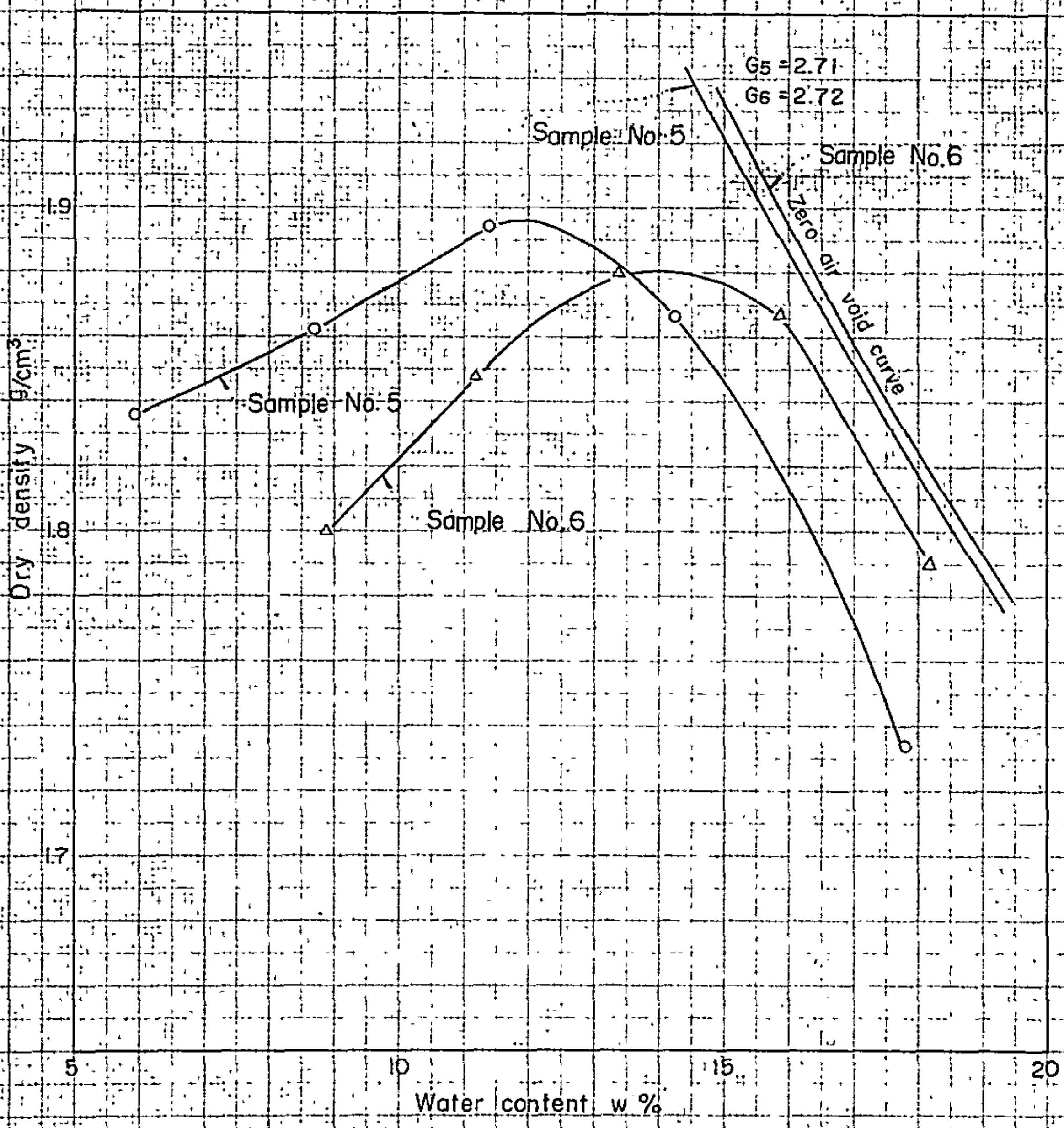
COMPACTION TEST - 2

Sample No.	Optimum water content	Max. dry density
3	12.5 %	1.970 g/cm³
4	13.2	1.918



COMPACTION TEST - 3

Sample No.	Optimum water content	Max. dry density
5	12.0	1.896
6	14.0	1.881



Direct Shear Test - 1

Case No.	Test condition	Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ	Shearing strength τ (kg/cm^2)
(1)	Curing period, 0 day	1 & 2	1.445 1.453 1.428	0.6 1.1 1.1	0.121 0.208 0.129	0.112	$0^\circ 55'$	0.128
		3 & 4	1.559 1.542 1.620	0.6 1.6 2.1	0.0831 0.112 0.140	0.062	$2^\circ 07'$	0.099
		5	1.830 1.725 1.876 1.764	0.6 1.1 1.6 2.1	0.396 0.741 0.869 1.329	0.17	$23^\circ 16'$	0.60
		6	1.222 1.309 1.197	0.1 0.6 1.1	0.0265 0.0542 0.0358	0.028	$0^\circ 24'$	0.035
	Curing period, 1 day	3 & 4	1.734 1.690 1.693	0.6 1.1 1.6	0.269 0.240 0.270	0.26	$0^\circ 04'$	0.27
		5	1.753 1.738 1.817	0.6 1.1 1.6	0.491 0.770 1.039	0.14	$28^\circ 49'$	0.69
	Curing period, 7 days	3 & 4	1.766 1.766 1.648	0.6 1.1 1.6	0.271 0.369 0.332	0.24	$3^\circ 27'$	0.30
		5	1.758 1.776 1.784	0.6 1.1 1.6	0.548 0.782 1.025	0.25	$25^\circ 39'$	0.73
	Curing period, 14 days	3 & 4	1.616 1.587 1.544 1.598	0.6 1.1 1.6 2.1	0.153 0.308 - 0.278	0.1	$6^\circ 17'$	0.21
		5	1.658 1.709 1.691 1.699	0.6 1.1 1.6 2.1	0.494 0.675 1.036 1.217	0.24	$20^\circ 19'$	0.61

<u>Direct Shear Test - 2</u>

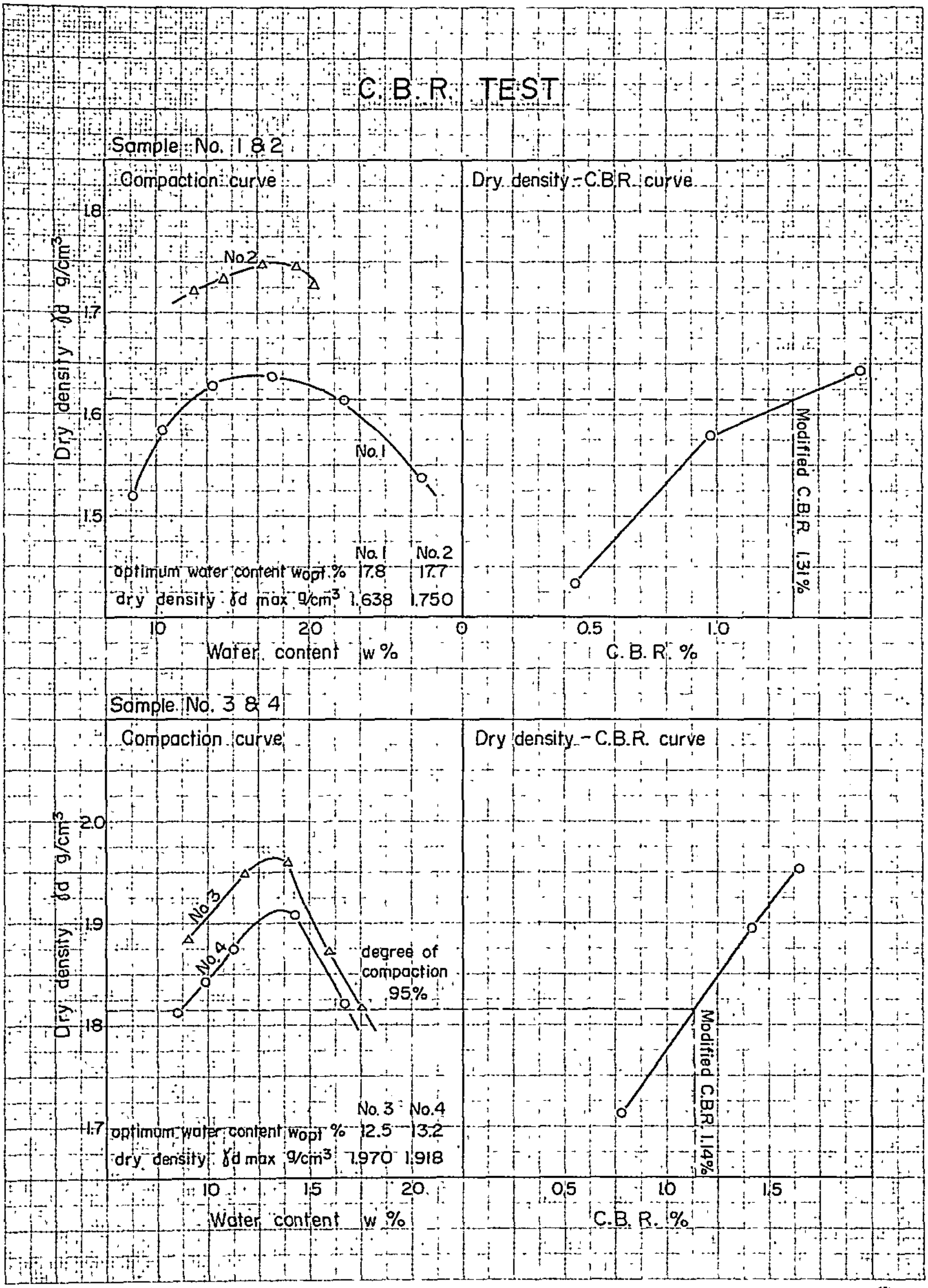
Case No.	Test condition	Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ	Shearing strength τ (kg/cm^2)
			1.688	0.6	0.655			
		1 & 2	1.703	1.1	0.677	0.62	$2^{o}52'$	0.67
			1.722	1.6	0.960			
			1.958	0.6	0.634			
	Surcharge load, 0.15 kg/cm^2	3 & 4	1.986	1.1	0.793	0.48	$15^{o}39'$	0.76
			1.978	1.6	1.036			
			1.903	0.6	0.573			
		5	1.827	1.1	0.909	0.20	$31^{o}48'$	0.82
			1.922	1.6	1.216			
			1.734	0.6	0.521			
		1 & 2	1.729	1.1	0.663	0.48	$5^{o}43'$	0.58
			1.713	1.6	0.633			
			1.992	0.6	0.729			
(2)	Surcharge load, 0.30 kg/cm^2	3 & 4	1.985	1.1	0.885	0.70	$2^{o}52'$	0.75
			1.946	1.6	0.774			
			1.934	0.6	0.770			
		5	1.932	1.1	0.940	0.57	$18^{o}16'$	0.90
			1.928	1.6	1.104			
			1.706	0.6	0.879			
		1 & 2	1.707	1.1	0.990	0.78	$7^{o}59'$	0.92
			1.741	1.6	1.020			
			1.965	0.6	0.659			
	Surcharge load, 0.45 kg/cm^2	3 & 4	1.965	1.1	0.713	0.52	$11^{o}19'$	0.72
			1.981	1.6	0.856			
			1.933	0.6	0.602			
		5	1.945	1.1	0.845	0.33	$25^{o}11'$	0.80
			1.971	1.6	1.121			

Direct Shear Test - 3

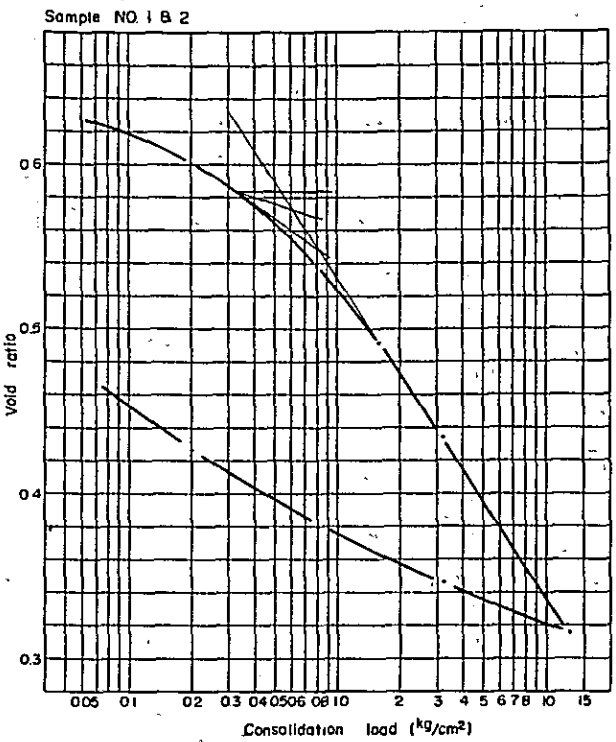
Case No.	Test condition	Sample No.	Dry density (g/cm^3)	Normal stress (kg/cm^2)	Maximum shear stress (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ	Shearing strength τ (kg/cm^2)
(3)	Mixing ratio, 30 %	3 & 4	1.394	0.6	0.480	0.28	21°49'	0.68
			1.616	1.1	0.600			
			1.600	1.6	1.023			
			1.622	2.1	1.140			
		5	1.759	0.6	0.516	0.12	32°38'	0.76
			1.800	1.1	0.856			
			1.784	1.6	1.157			
			1.668	2.1	1.486			
	Mixing ratio, 60 %	3 & 4	1.569	0.6	0.403	0.17	23°17'	0.60
			1.581	1.1	0.629			
			1.599	1.6	0.891			
			1.557	2.1	1.311			
		5	1.687	0.6	0.515	0.15	31°48'	0.77
			1.771	1.1	0.847			
			1.738	1.6	1.152			
			1.710	2.1	1.489			
(4)	Curing period, 1 day	3 & 4	1.900	0.6	1.526	1.12	33°02'	1.77
			1.790	1.1	2.359			
			1.838	2.1	2.444			
		5	1.905	0.6	3.243	3.20	1°44'	3.23
			1.903	1.6	3.880			
			1.900	2.1	3.268			
	Curing period, 7 days	3 & 4	1.831	0.6	1.786	1.60	11°52'	1.81
			1.838	1.1	1.829			
			1.977	1.6	2.753			
		5	1.858	0.6	1.556	0.77	51°49'	2.04
			1.838	1.1	2.210			
			1.880	2.1	2.352			

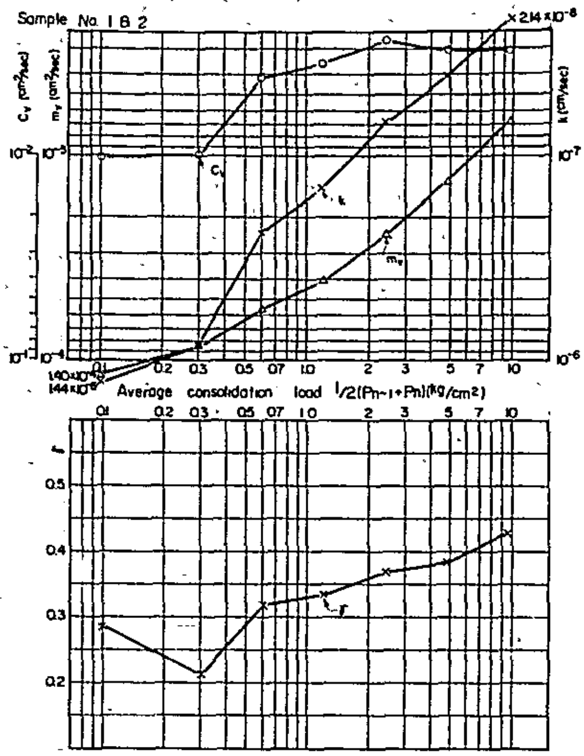
Triaxial Compression Test

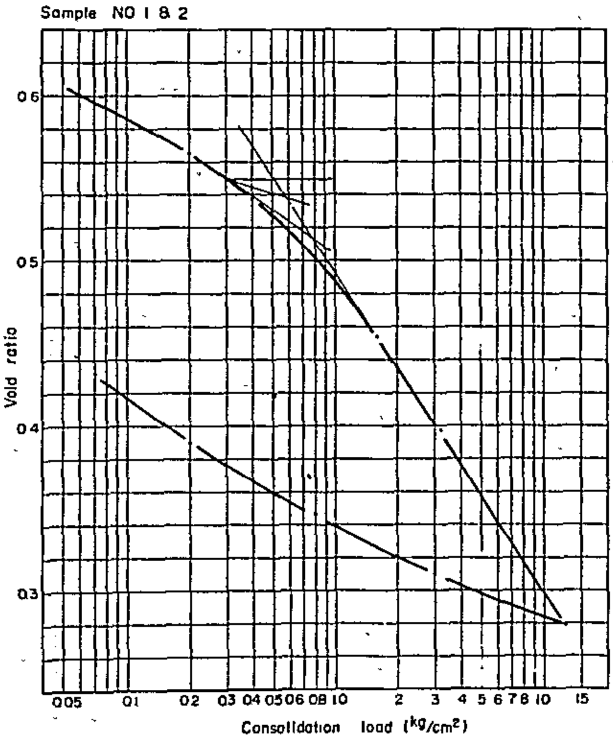
Sample No.	Dry density γ_d (g/cm^3)	Lateral pressure σ_3 (kg/cm^2)	Max. compression stress σ_1 (kg/cm^2)	Cohesion c (kg/cm^2)	Internal friction angle ϕ
1 & 2	1.720	0.5	10.48	2.05	35°00'
	1.720	1.0	12.72		
	1.725	1.5	10.88		
	1.715	2.0	14.92		
	1.402	1.0	3.961	1.75	16°42'
	1.398	2.0	6.490		
	1.396	3.0	7.502		
	1.382	4.0	7.734		
3 & 4	1.920	0.5	5.41	1.10	33°01'
	1.927	1.0	10.18		
	1.922	1.5	10.19		
	1.926	2.0	9.17		
	1.600	1.0	4.029	1.10	19°18'
	1.605	2.0	5.226		
	1.603	3.0	6.153		
5	1.903	0.5	9.90	2.10	33°01'
	1.900	1.0	12.19		
	1.901	1.5	11.64		
	1.904	2.0	12.37		
	1.618	1.0	4.703	1.55	21°48'
	1.615	2.0	7.118		
	1.611	3.0	8.263		
6	1.889	0.5	7.64	1.75	30°58'
	1.884	1.0	8.44		
	1.889	1.5	9.83		
	1.881	2.0	14.26		
	1.599	1.0	4.286	1.75	16°42'
	1.606	2.0	6.520		
	1.596	3.0	7.575		
	1.589	4.0	8.444		

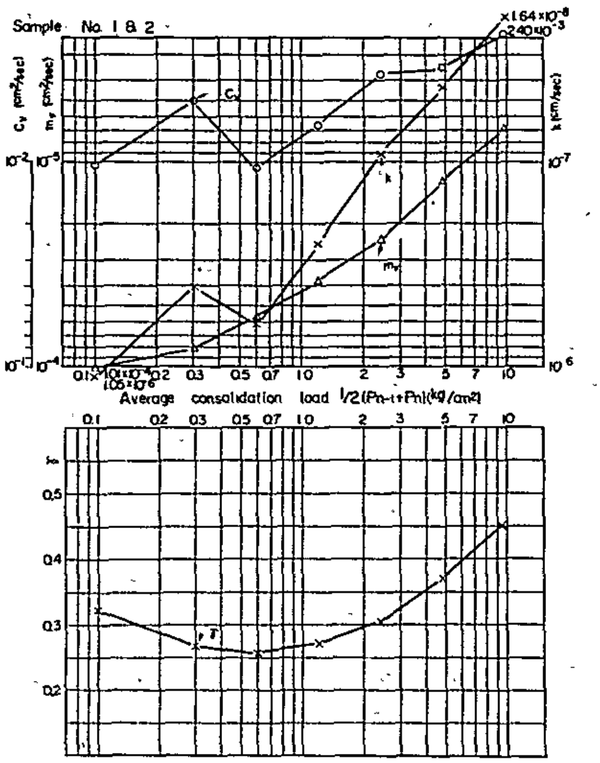

C.B.R. TEST
Sample No. 1 & 2
Compaction curve
Dry density - C.B.R. curve
Dry density γd g/cm3
1.8
1.7
1.6
1.5
No.2
No.1
No.1 No.2
optimum water content wopt % 17.8 17.7
dry density γd max g/cm3 1.638 1.750
10
20
Water content w %
0
0.5
1.0
C.B.R. %
Modified C.B.R. 1.31%
Sample No. 3 & 4
Compaction curve
Dry density - C.B.R. curve
Dry density γd g/cm3
2.0
1.9
1.8
1.7
No.3
No.4
degree of compaction 95%
No.3 No.4
optimum water content wopt % 12.5 13.2
dry density γd max g/cm3 1.970 1.918
10
15
20
Water content w %
0.5
1.0
1.5
C.B.R. %
Modified C.B.R. 1.14%

CONSOLIDATION TEST — 1



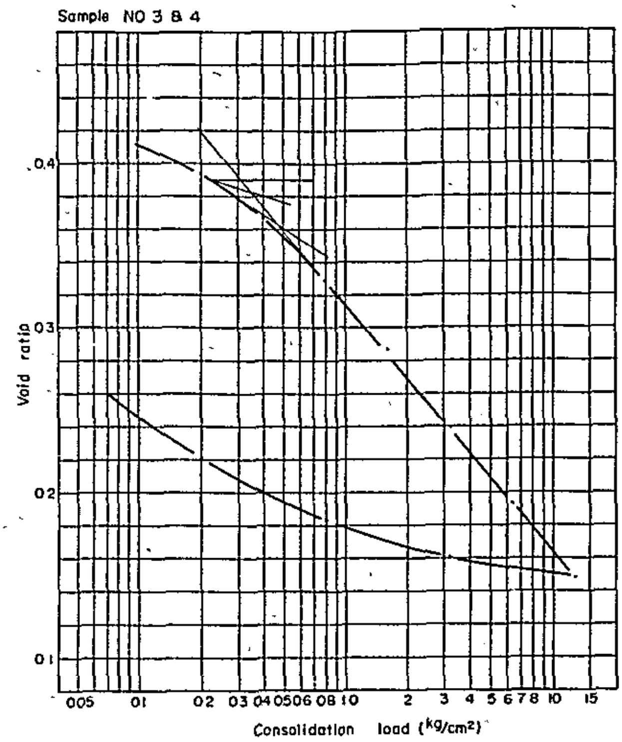


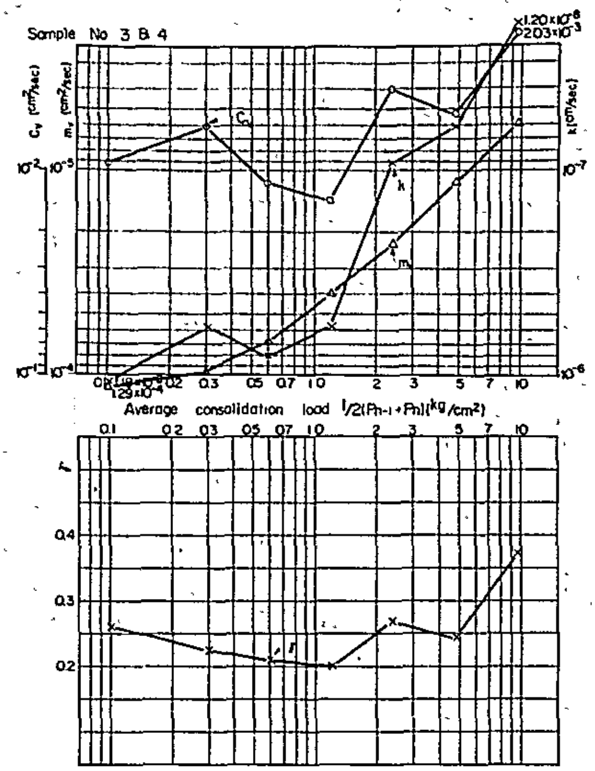


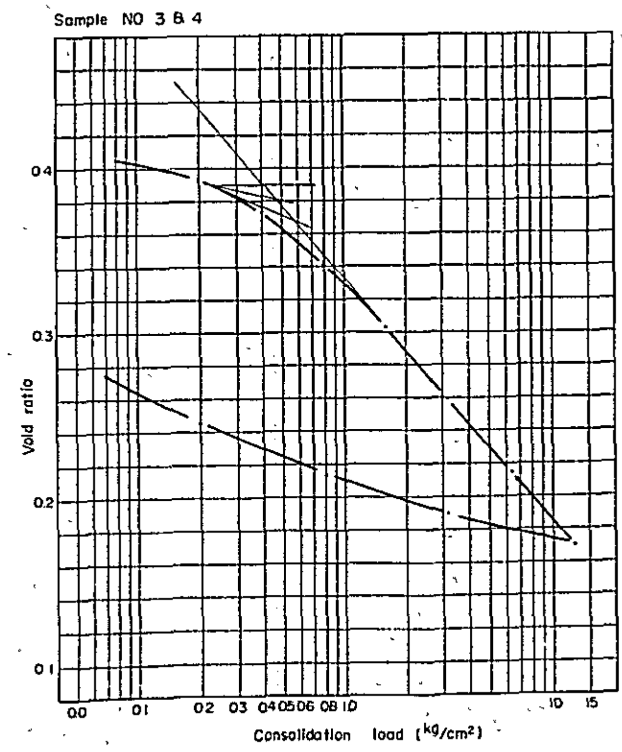


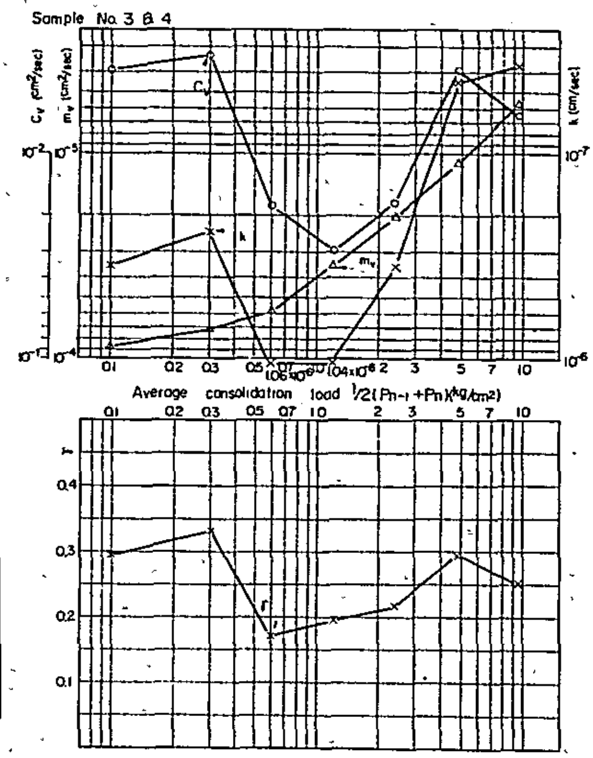
Remarks. c_v Coefficient of consolidation
m_v. Coefficient of volume compressibility
k : Coefficient of permeability
r Primary compression ratio

CONSOLIDATION TEST — 2





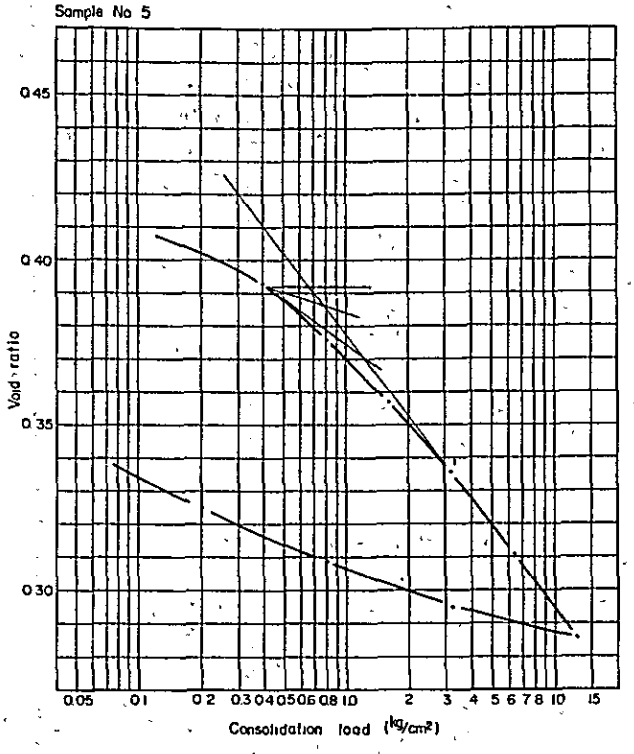




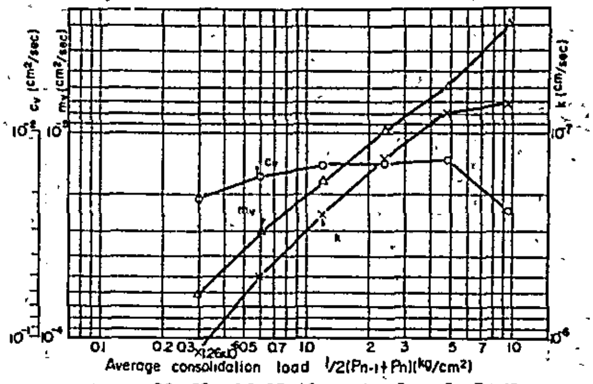
Remarks c_v . Coefficient of consolidation
m_v . Coefficient of volume compressibility
k : Coefficient of permeability
r Primary compression ratio

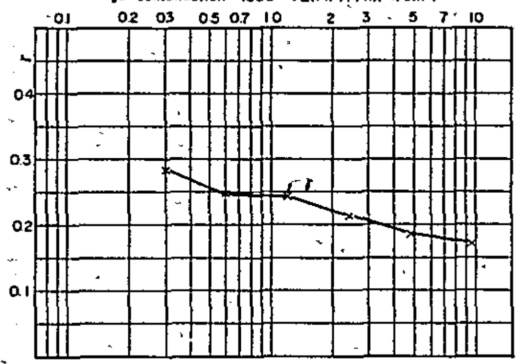
CONSOLIDATION TEST — 3

Sample No 5

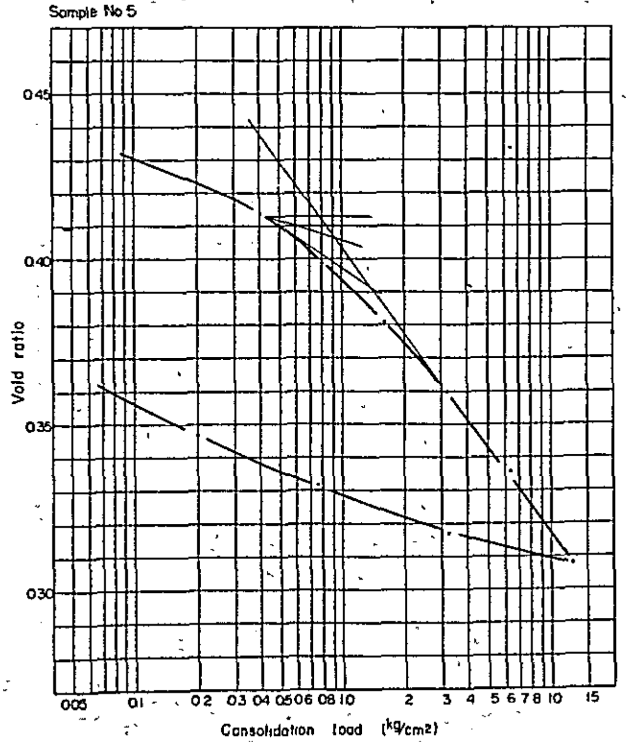


Sample No 5

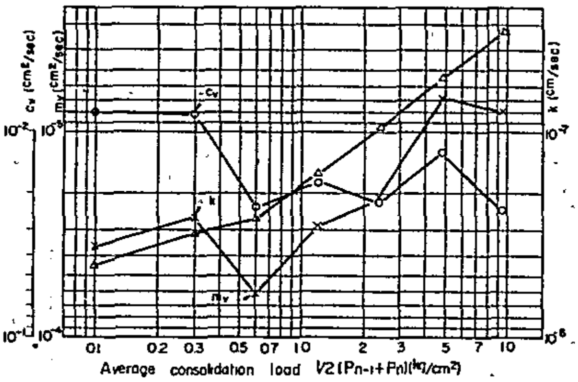


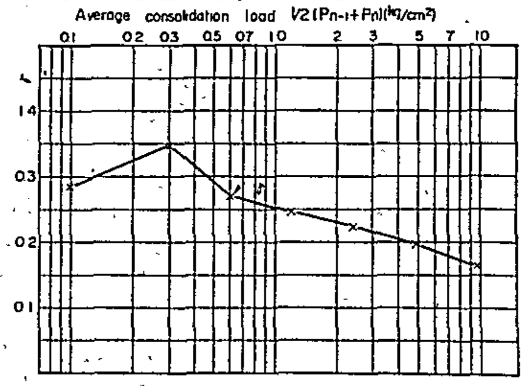


Sample No 5



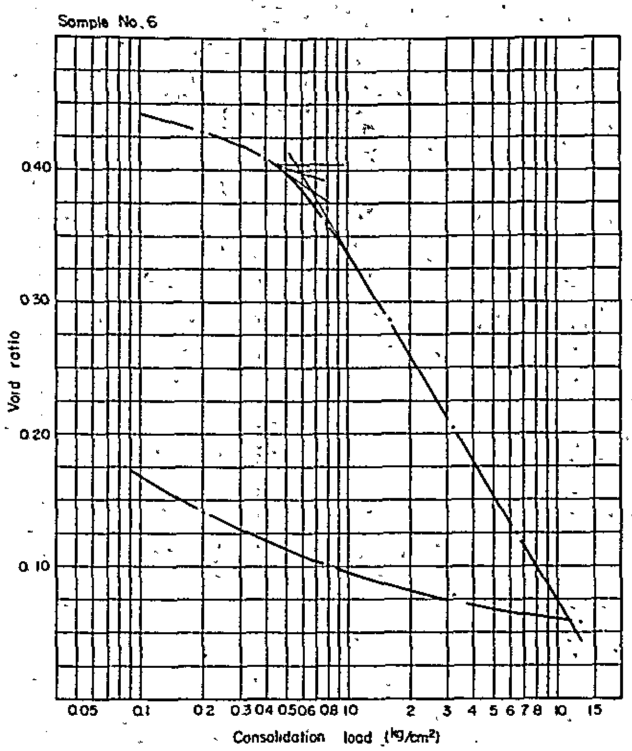
Sample No 5

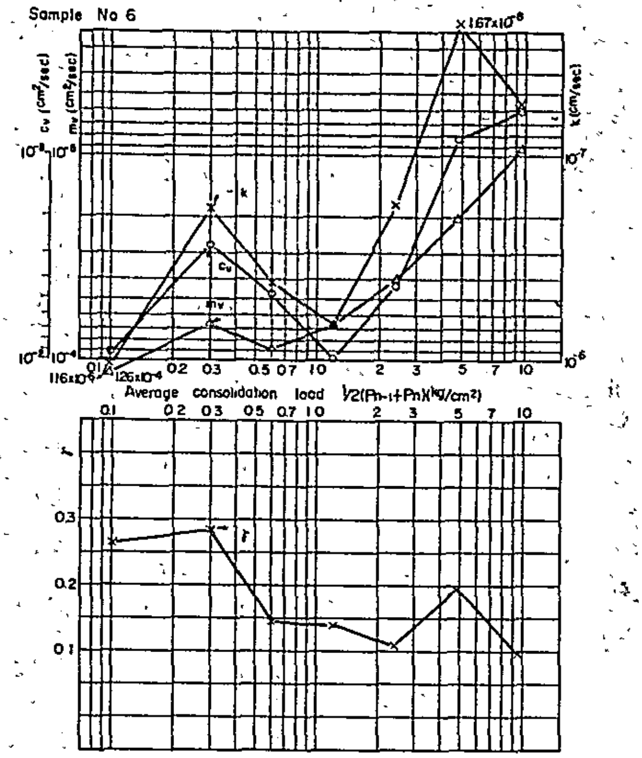


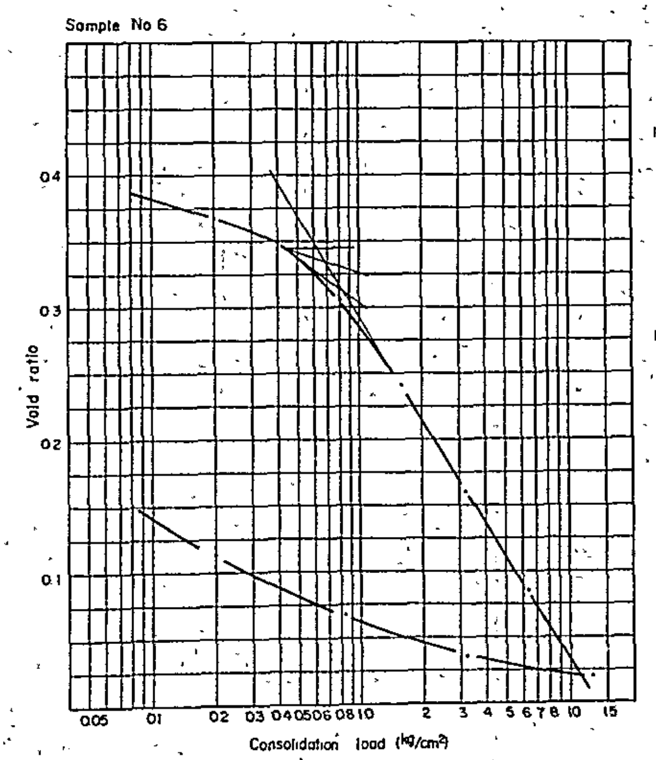


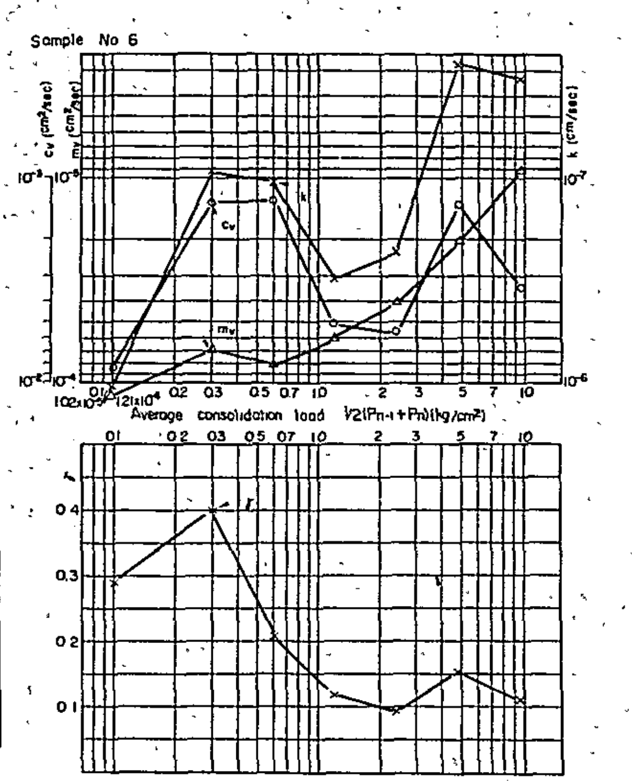
Remarks c_v : Coefficient of consolidation
m_v : Coefficient of volume compressibility
k : Coefficient of permeability
r : Primary compression ratio

CONSOLIDATION TEST — 4









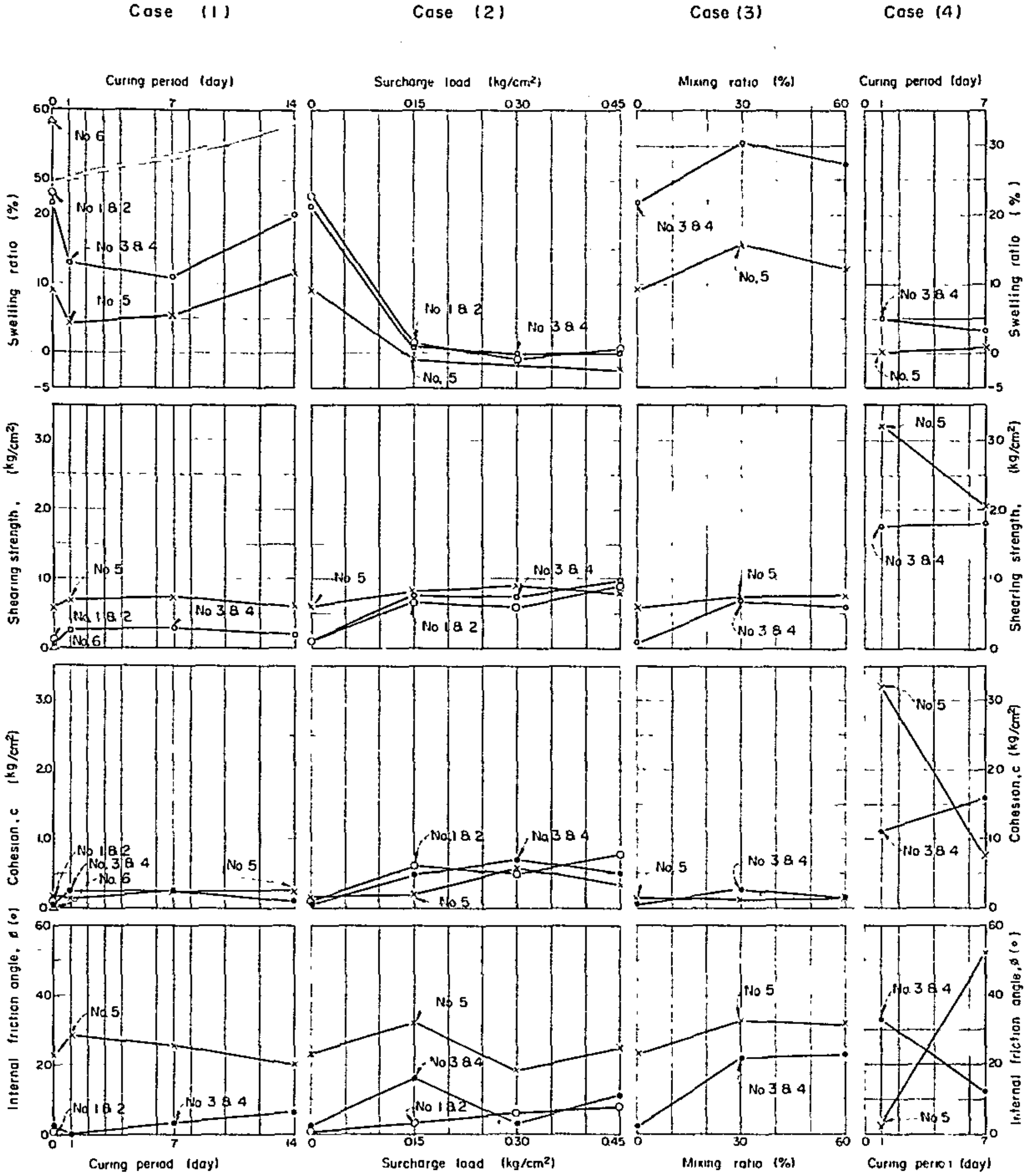
Remarks c_v : Coefficient of consolidation
m_v : Coefficient of volume compressibility
k : Coefficient of permeability
γ : Primary compression ratio

Swelling Test

Unit: Percent

	1 & 2				3 & 4					5					6				
	(1)	(2)	(3)	Mean	(1)	(2)	(3)	(4)	Mean	(1)	(2)	(3)	(4)	Mean	(1)	(2)	(3)	(4)	Mean
1. Case (1)																			
Curing period, 0 day	24.26	21.21	23.04	22.84	26.37	24.99	21.43	12.55	21.34	5.05	12.15	6.29	13.45	9.24	47.41	60.27	65.85	59.60	58.28
1 day	-	-	-	-	11.59	13.29	14.05	-	12.98	4.84	6.33	1.76	-	4.31	-	-	-	-	-
7 days	-	-	-	-	8.39	9.95	14.97	-	11.10	6.05	5.74	4.77	-	5.52	-	-	-	-	-
14 days	-	-	-	-	15.56	22.66	21.63	-	19.95	13.09	10.11	11.47	-	11.56	-	-	-	-	-
2. Case (2)																			
Surcharge load, 0.15 kg/cm^2	3.10	1.18	0.16	1.50	2.61	0.13	-0.04	-	0.90	-0.79	-0.77	-0.81	-	-0.79	-	-	-	-	-
0.30 kg/cm^2	-0.98	-0.91	-0.36	-0.75	-0.03	-0.04	-0.08	-	-0.05	-1.85	-1.38	-0.95	-	-1.39	-	-	-	-	-
0.45 kg/cm^2	1.31	0.98	-0.02	0.76	-0.07	-0.05	-0.18	-	-0.10	-2.04	-2.36	-2.52	-	-2.31	-	-	-	-	-
3. Case (3)																			
Mixing ratio, 30 %	-	-	-	-	33.45	32.90	28.12	27.74	30.55	14.90	16.23	15.89	17.49	16.13	-	-	-	-	-
60 %	-	-	-	-	27.31	27.05	29.61	26.11	27.52	11.12	9.76	13.26	15.22	12.34	-	-	-	-	-
4. Case (4)																			
Curing period, 1 day	-	-	-	-	4.19	10.45	0.14	6.05	5.21	0.11	0.21	0.21	-	0.18	-	-	-	-	-
7 days	-	-	-	-	4.05	4.19	2.40	-	3.55	0.64	1.19	0.33	1.1	1.09	-	-	-	-	-

SWELLING TEST



Remarks Case (1) The samples were molded in the state of optimum water content and saturated with water after curing for several days at the unloaded condition

Case (2) The samples were molded in the state of optimum water content and saturated with water at the loaded condition after the compressive deformation due to loading was almost completed (generally after 24 hours)

Case (3) The samples were mixed with the sand of 0.3millimeter in maximum size by 30 percent of the soil sample in weight in the state of optimum water content or by 60 percent of it and saturated with water at the unloaded condition immediately after molding

Case (4) The samples were mixed with cement by five percent in weight in the state of optimum water content and saturated with water after curing for several days at the unloaded condition

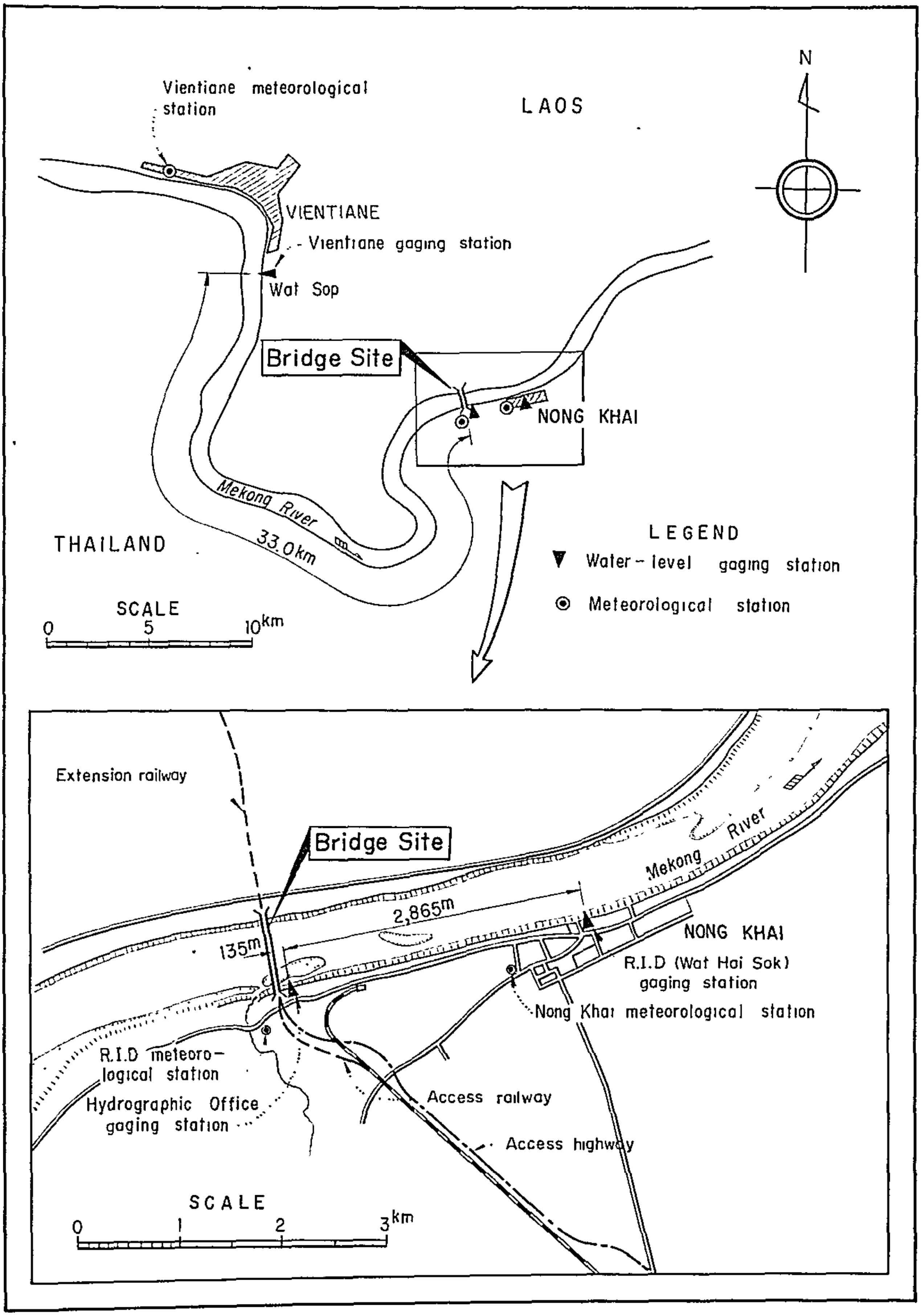
APPENDIX IV

HYDROLOGY

CONTENTS

4.1. Hydrologic Data

LOCATION OF THE WATER-LEVEL GAGING STATIONS AND THE METEOROLOGICAL STATIONS



Hydrologic data collected in the first and second phase investigations

Data	Available Period					
	Vientiane	Hydro. Office	R.I.D.			
			W.H.S. /1	B.D.K. /2	W.S.K. /3	A.T.B. /4
Water-level	Jan.'66-Apr.'66	Jun.'64-Apr.'68	Jun.'55-Mar.'68	Jan.'63-Dec.'67 *	Jan.'63-Dec.'67 *	Jan.'63-Dec.'67 *
Water-level and discharge	Jan.'66-Mar.'67	-	-	-	-	-
Water temperature	Jan.'60-Dec.'61	-	-	-	-	-
Flow velocity	-	1966-1968	-	-	-	-
Flow velocity at the flood time	-	Sept.'66	-	-	-	-
Stage hydrograph	-	-	Jun.'37-Mar.'66	-	-	-
Flood hydrograph	1923-1967 *	-	-	-	-	-

Remarks

/1 ...... W.H.S.: Wat Hai Sok gaging station

/2 ...... B.D.K.: Ban Dok Kham gaging station

/3 ...... W.S.K.: Wat Sri Mong Kol gaging station

/4 ...... A.T.B.: Ampho Tha Bo gaging station

* ...... The data asterisked are not compiled in Appendices because they were not available for the hydrologic analysis on the Second Phase Report.

WATER LEVEL AND DISCHARGE

STATION *Hydrographic Office*

River system. *Mekong* Name of stream: ______ Drainage area (Km²): ______ Year *1964*

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1											–		1
2											–		2
3											–		3
4											–		4
5											–		5
6											–		6
7											–		7
8											–		8
9											–		9
10											–		10
11											157.52		11
12											157.54		12
13											157.71		13
14											157.84		14
15											157.78		15
16											157.65		16
17											157.50		17
18											157.37		18
19											157.21		19
20											157.11		20
21											157.18		21
22											157.33		22
23											157.55		23
24											157.73		24
25											157.93		25
26											158.41		26
27											158.61		27
28											158.71		28
29											158.86		29
30											159.21		30
31													31
MAX													MAX
MIN													MIN
TOTAL													TOTAL
DAYS													DAYS
MEAN													MEAN

H : W. S. EL. in *m*, Q : Discharge in *m³/sec.* N.K. Form №1201

Zero point of water gauge: El. *154.211m*

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system. Mekong Name of stream: Drainage area (Km²): Year 1964

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	159.45		161.37		164.01		161.91		159.51		158.32		1
2	159.32		161.91		163.69		161.71		159.42		158.02		2
3	159.08		162.37		163.34		161.60		159.36		157.83		3
4	158.83		162.47		163.18		161.85		159.30		157.72		4
5	158.72		162.29		163.04		162.15		159.21		157.76		5
6	158.93		161.93		163.09		162.20		159.14		157.80		6
7	161.45		161.58		163.36		161.85		159.10		157.73		7
8	164.38		161.55		164.09		161.52		158.95		157.59		8
9	164.56		161.77		164.85		161.33		158.85		157.47		9
10	165.32		162.13		165.07		161.33		158.72		157.40		10
11	165.41		162.31		164.91		162.22		158.60		157.38		11
12	165.12		162.36		164.73		162.73		158.50		157.37		12
13	165.84		162.31		164.57		162.74		158.43		157.31		13
14	164.29		162.19		164.38		162.57		158.35		157.23		14
15	165.00		162.10		164.02		162.33		158.20		157.15		15
16	163.62		162.20		163.99		162.05		158.16		157.08		16
17	163.16		162.72		163.89		161.82		158.08		157.01		17
18	162.72		163.20		163.82		161.62		158.01		156.96		18
19	162.38		163.37		163.54		161.37		157.95		156.90		19
20	162.11		163.31		164.08		161.17		157.88		156.87		20
21	161.75		163.16		163.93		161.01		157.82		156.82		21
22	161.63		163.13		163.64		160.84		157.74		156.79		22
23	161.75		163.68		163.41		160.66		157.72		156.74		23
24	161.95		164.26		163.39		160.53		157.71		156.71		24
25	161.80		164.79		163.28		160.48		157.65		156.69		25
26	161.67		165.18		163.21		160.44		157.63		156.72		26
27	161.65		165.81		163.06		160.34		157.74		156.72		27
28	161.61		165.63		163.88		160.10		158.38		156.70		28
29	161.44		165.18		162.10		159.91		158.64		156.65		29
30	161.43		164.84		162.28		159.76		158.55		156.63		30
31	161.16		164.38				159.61				156.60		31
MAX	165.84		165.81		165.07		162.74		163.64		158.32		MAX
MIN	158.72		161.37		162.28		159.61		157.63		156.60		MIN
TOTAL	5027.53		5055.48		4912.33		5001.75		4753.36		4872.67		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	162.18		163.08		163.74		161.35		158.44		157.18		MEAN

H : W.S.EL in m, Q: Discharge in m3/sec N.K.Form No.1202

Zero point of water gauge: El. 154.211 m

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system. Mekong   Name of stream: Drainage area (Km²):   Year 1965

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	156.57		155.86		155.34		154.87		154.94		156.10		1
2	156.55		155.84		155.32		154.86		154.90		156.30		2
3	156.53		155.82		155.30		154.84		154.88		156.52		3
4	156.50		155.78		155.30		154.84		154.86		156.61		4
5	156.48		155.79		155.29		154.85		154.87		156.66		5
6	156.46		155.79		155.29		154.87		154.89		156.72		6
7	156.43		155.79		155.25		154.84		154.91		156.82		7
8	156.39		155.80		155.22		154.84		155.01		156.90		8
9	156.36		155.83		155.10		154.84		155.09		156.90		9
10	156.34		155.82		155.16		154.84		155.07		156.92		10
11	156.31		155.81		155.14		154.86		155.07		156.96		11
12	156.27		155.81		155.12		154.86		155.16		157.13		12
13	156.23		155.80		155.09		154.90		155.24		157.39		13
14	156.20		155.79		155.07		154.91		155.34		157.63		14
15	156.17		155.78		155.06		154.91		155.40		157.89		15
16	156.16		155.76		155.04		154.89		155.42		158.62		16
17	156.14		155.75		155.04		154.90		155.39		158.33		17
18	156.13		155.77		155.06		154.89		155.34		158.70		18
19	156.13		155.79		155.06		154.92		155.20		159.13		19
20	156.13		155.78		155.05		154.91		155.16		159.32		20
21	156.12		155.71		155.04		154.98		155.61		159.53		21
22	156.09		155.65		155.02		155.03		155.05		159.47		22
23	156.10		155.59		155.01		155.07		155.07		159.47		23
24	156.13		155.54		155.01		155.10		155.19		159.60		24
25	156.16		155.50		155.01		155.12		155.45		159.89		25
26	156.13		155.45		155.02		155.12		155.52		160.21		26
27	156.08		155.40		155.00		155.08		155.54		160.52		27
28	156.07		155.37		154.98		155.04		155.59		160.66		28
29	155.96				154.95		155.01		155.62		160.56		29
30	155.93				154.92		154.97		155.70		160.71		30
31	155.90				154.89				155.84				31
MAX	156.57		155.86		155.34		155.12		155.84		160.71		MAX
MIN	155.90		155.37		154.89		154.84		154.86		156.10		MIN
TOTAL	4843.15		4360.17		4808.15		4647.96		4812.32		4748.17		TOTAL
DAYS	31		28		31		30		31		30		DAYS
MEAN	156.23		155.72		155.10		154.93		155.24		158.27		MEAN

H : W.S. EL. in m, Q: Discharge in m^3/sec,   N.K.Form №1201

Zero point of water gauge: El. 154.211^m

WATER LEVEL AND DISCHARGE

STATION *Hydrographic Office*

River system. *Mekong* Name of stream: ______ Drainage area (Km²). ______ Year *1965*

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	160.90		162.26		162.90		161.51		163.64		158.40		1
2	160.89		162.29		162.67		161.28		163.29		158.31		2
3	160.77		162.56		162.41		161.01		162.72		158.21		3
4	160.67		162.61		162.35		160.78		162.23		158.15		4
5	160.54		162.72		162.46		160.63		162.15		158.06		5
6	160.49		162.49		162.25		160.53		162.83		158.00		6
7	160.74		162.12		162.01		160.45		163.56		157.95		7
8	160.86		161.75		161.91		160.43		163.65		157.89		8
9	160.78		161.50		162.18		160.44		163.15		157.83		9
10	160.72		161.10		162.56		160.39		162.56		157.79		10
11	161.02		161.07		162.87		160.39		162.00		157.73		11
12	161.74		161.41		162.98		160.32		161.56		157.66		12
13	161.99		161.98		162.91		160.24		161.20		157.62		13
14	161.83		162.61		162.85		160.13		160.88		157.66		14
15	161.60		162.91		162.93		160.01		160.58		157.53		15
16	161.33		162.82		162.94		159.98		160.24		157.54		16
17	161.02		162.82		162.91		159.96		160.02		157.58		17
18	160.84		163.11		162.79		159.95		159.83		157.59		18
19	160.98		163.33		162.76		159.88		159.65		157.53		19
20	161.70		163.53		162.69		159.69		159.50		157.56		20
21	161.65		163.44		162.69		159.58		159.37		157.42		21
22	161.40		163.34		162.63		159.54		159.24		157.72		22
23	161.63		163.07		162.35		159.37		159.13		158.68		23
24	161.78		162.78		162.09		159.20		159.03		159.35		24
25	161.73		162.64		161.89		159.02		158.96		159.41		25
26	161.61		162.73		161.86		158.85		158.86		159.06		26
27	161.63		162.79		161.92		158.70		158.77		158.64		27
28	162.56		162.70		161.88		158.68		158.70		158.29		28
29	162.60		162.78		161.82		159.76		158.60		158.02		29
30	162.40		162.95		161.75		162.53		158.49		157.78		30
31	162.33		163.04				163.93				157.63		31
MAX	162.60		163.53		162.98		163.93		163.65		159.41		MAX
MIN	160.49		161.07		161.75		160.01		158.49		157.42		MIN
TOTAL	5002.73		5039.25		4873.21		4967.15		4821.39		4898.59		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	161.38		162.56		162.44		160.23		160.81		158.02		MEAN

H: W S. EL. in *m*, Q: Discharge in *m3/sec* N.K.Form №1202

Zero point of water gauge: El. *154.211m*

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system. Mekong Name of stream: ______ Drainage area (Km²): ______ Year 1966

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	157.48		156.35		155.73		155.20		155.33		156.77		1
2	157.38		156.37		155.71		155.20		155.30		156.89		2
3	157.29		156.43		155.69		155.19		155.37		157.05		3
4	157.21		156.46		155.67		155.18		155.23		157.13		4
5	157.06		156.45		155.65		155.15		155.20		157.13		5
6	157.11		156.38		155.63		155.12		155.18		157.03		6
7	157.06		156.33		155.61		155.11		155.22		157.13		7
8	157.02		156.26		155.58		155.11		155.19		157.08		8
9	156.98		156.21		155.54		155.17		155.19		157.14		9
10	156.94		156.17		155.51		155.26		155.21		157.24		10
11	156.91		156.13		155.48		155.30		155.23		157.42		11
12	156.86		156.00		155.48		155.33		155.28		157.67		12
13	156.84		156.06		155.48		155.34		155.35		157.81		13
14	156.82		156.04		155.47		155.35		155.43		157.91		14
15	156.79		156.01		155.46		155.34		155.56		158.02		15
16	156.75		155.99		155.44		155.34		155.67		158.15		16
17	156.72		155.96		155.45		155.29		155.76		158.31		17
18	156.67		155.93		155.43		155.27		155.77		158.48		18
19	156.63		155.89		155.42		155.28		155.79		158.74		19
20	156.60		155.86		155.41		155.37		155.81		159.02		20
21	156.60		155.84		155.43		155.41		155.86		159.55		21
22	156.52		155.82		155.43		155.46		156.03		159.93		22
23	156.49		155.81		155.41		155.35		156.47		160.12		23
24	156.46		155.79		155.34		155.32		157.03		160.18		24
25	156.44		155.77		155.30		155.30		157.10		160.36		25
26	156.42		155.76		155.27		155.38		156.98		160.77		26
27	156.38		155.75		155.20		155.33		157.00		161.02		27
28	156.35		155.75		155.19		155.39		157.04		161.31		28
29	156.34				155.20		155.39		157.13		161.64		29
30	156.35				155.19		155.36		157.06		161.63		30
31	156.35				155.17				156.87				31
MAX	157.48		156.46		155.73		155.46		157.13		161.64		MAX
MIN	156.34		155.75		155.17		155.11		155.18		156.77		MIN
TOTAL	4859.82		4369.57		4818.97		4658.59		4832.64		4758.63		TOTAL
DAYS	31		28		31		30		31		30		DAYS
MEAN	156.77		156.06		155.45		155.28		155.89		158.62		MEAN

H : W.S.EL. in m, Q: Discharge in m³/sec, N.K.Form №1201

Zero point of water gauge: El. 154.211 m

HQD-2

WATER LEVEL AND DISCHARGE

STATION *Hydrographic Office*

River system. *Mekong* Name of stream: ______ Drainage area (Km²): ______ Year *1966*

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	161.40		162.75		167.43		162.29		160.42		157.85		1
2	160.99		163.37		167.52		162.03		160.25		157.79		2
3	160.60		164.01		167.72		161.79		160.45		157.71		3
4	160.27		164.28		167.97		161.68		160.49		157.65		4
5	160.00		164.42		168.14		161.76		160.33		157.60		5
6	160.26		165.03		168.23		161.82		160.06		157.54		6
7	161.80		165.50		168.29		162.08		159.80		157.48		7
8	162.52		165.46		168.36		162.62		159.61		157.44		8
9	162.60		165.30		168.38		163.20		159.43		157.41		9
10	162.58		165.15		168.39		163.27		159.20		157.42		10
11	162.29		165.08		168.35		162.96		159.15		157.43		11
12	161.97		164.97		168.23		162.54		159.03		157.43		12
13	161.76		164.93		168.07		162.12		158.91		157.37		13
14	161.49		164.97		167.82		161.76		158.81		157.29		14
15	161.20		164.99		167.51		161.46		158.73		157.22		15
16	161.16		165.05		167.13		161.20		158.64		157.13		16
17	161.37		165.26		166.75		161.01		158.57		157.07		17
18	161.86		165.44		166.51		160.91		158.51		157.02		18
19	162.58		165.48		166.26		160.97		158.44		156.97		19
20	163.07		165.34		165.92		161.22		158.38		156.93		20
21	163.13		165.12		165.57		161.51		158.32		156.92		21
22	163.20		165.02		165.19		161.71		158.23		156.91		22
23	163.16		165.24		164.74		161.61		158.16		156.92		23
24	163.01		165.86		164.27		161.34		158.09		156.93		24
25	162.78		166.04		163.90		161.07		158.05		156.89		25
26	162.60		166.16		163.67		160.89		158.01		156.83		26
27	162.31		166.40		163.51		160.65		157.98		156.76		27
28	162.07		166.65		163.23		160.47		157.94		156.69		28
29	162.74		166.89		162.90		160.67		157.94		156.64		29
30	161.45		167.13		162.55		160.53		157.91		156.59		30
31	161.83		167.33				160.55				156.55		31
MAX	163.16		167.33		168.39		163.27		160.49		157.85		MAX
MIN	161.40		162.75		162.55		160.47		157.91		156.55		MIN
TOTAL	5020.85		5124.62		4992.51		5009.69		4767.84		4872.38		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	161.94		165.31		166.42		161.60		158.92		157.17		MEAN

H : W. S. EL. in *m*, Q: Discharge in *m³/sec* N.K.Form No.1202

Zero point of water gauge: El. *154.211 m*

HQD-1

WATER LEVEL AND DISCHARGE

STATION Hydrographic Office

River system. Mekong   Name of stream: ______   Drainage area (Km²): ______   Year 1967

	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	156.51		155.87		155.31		155.10		155.76		156.01		1
2	156.48		155.83		155.28		155.06		155.76		155.98		2
3	156.44		155.80		155.25		155.02		155.82		155.90		3
4	156.41		155.76		155.23		154.98		155.82		155.84		4
5	156.36		155.74		155.24		154.95		155.78		155.84		5
6	156.32		155.72		155.29		154.94		155.71		155.91		6
7	156.29		155.69		155.33		154.93		155.61		156.00		7
8	156.26		155.66		155.32		154.95		155.54		156.07		8
9	156.24		155.66		155.29		155.00		155.49		156.30		9
10	156.20		155.66		155.24		155.03		155.49		156.67		10
11	156.18		155.65		155.20		154.98		155.61		157.08		11
12	156.18		155.67		155.18		154.95		155.68		157.75		12
13	156.18		155.71		155.17		154.92		155.71		158.38		13
14	156.20		155.70		155.16		154.93		155.77		158.35		14
15	156.23		155.68		155.19		154.96		155.81		158.16		15
16	156.21		155.64		155.25		155.01		155.85		157.94		16
17	156.17		155.60		155.30		155.08		155.87		157.72		17
18	156.18		155.56		155.34		155.12		155.93		157.52		18
19	156.21		155.53		155.38		155.20		155.92		157.35		19
20	156.27		155.40		155.40		155.30		155.86		157.27		20
21	156.29		155.48		155.39		155.39		155.83		157.24		21
22	156.27		155.46		155.32		155.46		155.80		157.26		22
23	156.26		155.43		155.26		155.51		155.70		157.31		23
24	156.23		155.41		155.19		155.57		155.56		157.45		24
25	156.16		155.40		155.16		155.64		155.48		157.28		25
26	156.09		155.38		155.13		155.67		155.45		157.14		26
27	156.05		155.36		155.08		155.70		155.46		157.00		27
28	156.00		155.34		155.06		155.74		155.52		156.97		28
29	155.96				155.07		155.77		155.65		156.99		29
30	155.94				155.08		155.79		155.81		157.06		30
31	155.91				155.10				155.94				31
MAX	156.51		155.87		155.40		155.79		155.94		158.38		MAX
MIN	155.91		155.34		155.06		154.92		155.45		155.84		MIN
TOTAL	4842.68		4356.79		4812.19		4656.65		4826.99		4709.74		TOTAL
DAYS	31		28		31		30		31		30		DAYS
MEAN	156.22		155.60		155.23		155.27		155.71		156.99		MEAN

H : W. S. EL. in m, Q: Discharge in m³/sec.   N.K.Form No.1201

Zero point of water gauge: El. 154 211 m

WATER LEVEL AND DISCHARGE

STATION *Hydrographic Office*

River system. *Mekong* Name of stream: ______ Drainage area (Km²): ______ Year *1967*

	July		Aug		Sept		Oct		Nov		Dec		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	157.23		162.74		161.08		163.03		158.64		158.32		1
2	157.41		162.53		160.93		162.91		158.68		158.12		2
3	157.52		162.25		160.77		163.03		158.65		157.92		3
4	157.70		161.86		160.62		163.01		158.57		157.78		4
5	157.85		161.45		160.51		162.84		158.45		157.65		5
6	157.78		161.02		160.41		162.57		158.35		157.58		6
7	157.67		160.62		160.40		162.31		158.23		157.52		7
8	157.69		160.25		160.43		162.08		158.18		157.46		8
9	157.69		159.90		160.49		161.84		158.13		157.38		9
10	157.71		159.71		160.72		161.61		158.14		157.39		10
11	157.79		159.74		161.03		161.37		158.10		157.22		11
12	157.79		160.14		161.04		161.12		158.06		157.15		12
13	157.70		160.83		161.33		160.84		157.96		157.08		13
14	157.66		161.50		161.63		160.84		157.84		157.04		14
15	157.66		162.00		161.98		160.30		157.78		156.96		15
16	157.73		161.85		162.72		160.07		157.74		156.92		16
17	158.19		161.60		163.48		159.90		157.69		156.90		17
18	158.73		161.53		163.90		159.78		157.65		156.88		18
19	158.96		161.87		163.88		159.73		157.76		156.88		19
20	158.96		162.33		163.45		159.78		158.34		156.93		20
21	159.35		162.85		163.00		160.01		158.94		157.00		21
22	160.37		163.73		162.75		160.28		159.01		157.00		22
23	160.79		164.05		162.65		160.21		159.89		156.92		23
24	160.63		164.09		162.63		159.85		158.77		156.84		24
25	160.31		165.00		162.99		159.51		158.79		156.77		25
26	159.97		164.65		163.48		159.22		158.73		156.71		26
27	159.74		163.10		163.74		159.60		158.56		156.65		27
28	159.70		162.57		163.68		158.81		158.34		156.61		28
29	161.66		162.13		163.69		158.69		158.23		156.57		29
30	162.86		161.70		163.38		158.63		158.43		156.52		30
31	162.98		161.31				158.62				156.48		31
MAX	162.98		165.00		163.90		163.03		159.01		158.32		MAX
MIN	157.23		159.71		160.40		158.62		157.65		156.48		MIN
TOTAL	4925.78		5020.90		4862.79		4982.39		4750.63		4871.11		TOTAL
DAYS	31		31		30		31		30		31		DAYS
MEAN	158.90		161.96		162.09		160.72		158.35		157.13		MEAN

H: W.S.EL. in *m*, Q: Discharge in *m³/sec* N.K.Form №1202

Zero point of water gauge: El. *154.211 m*

HQD-1

WATER LEVEL AND DISCHARGE

STATION *Hydrographic Office*

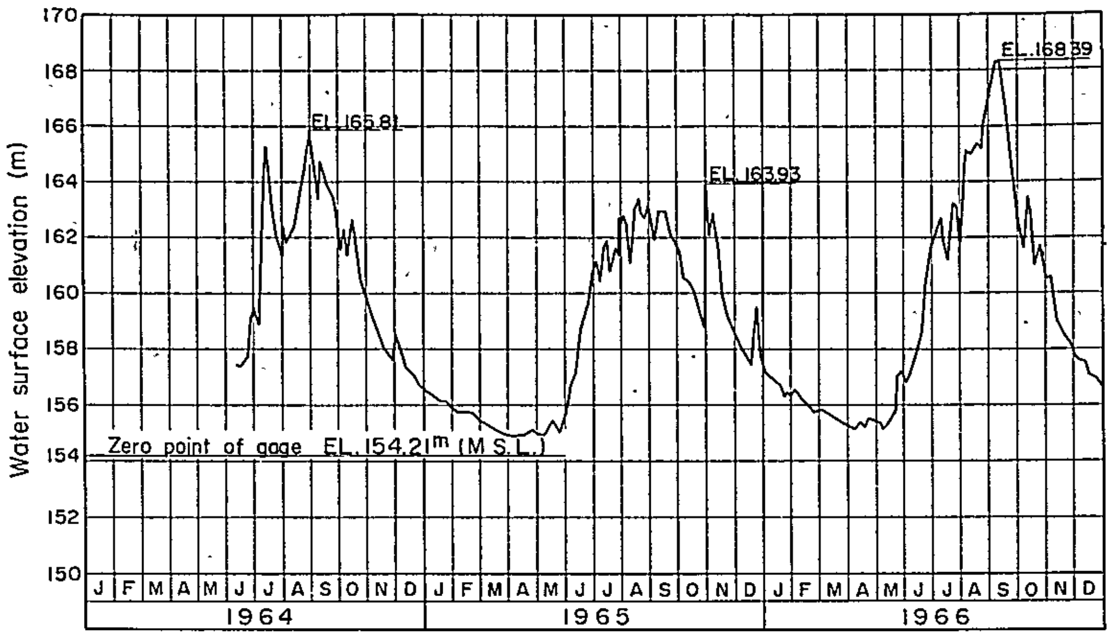
River system. *Mekong* Name of stream: ______ Drainage area (Km²): ______ Year *1968*

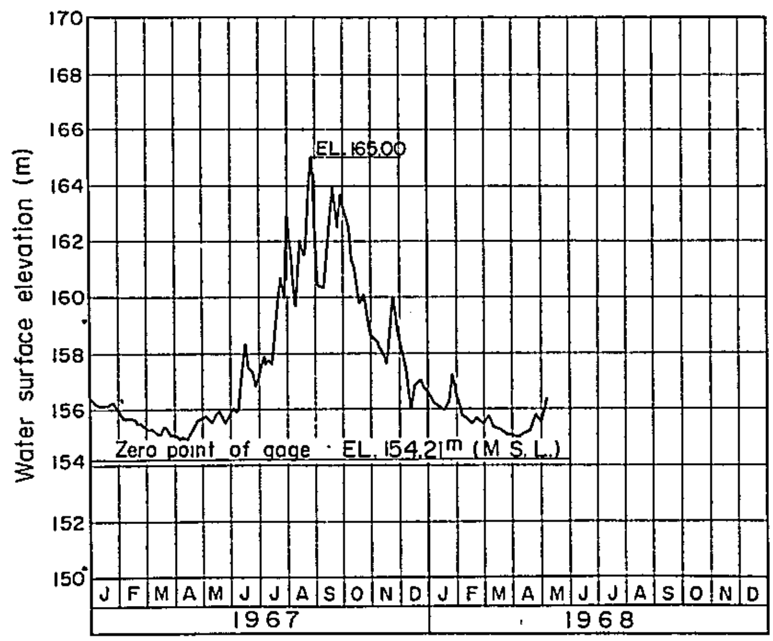
	Jan		Feb		Mar		Apr		May		June		
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q	
1	156.44		156.09		155.49		155.02		155.65				1
2	156.41		155.99		155.55		155.02		155.81				2
3	156.38		155.94		155.65		155.01		156.00				3
4	156.34		155.88		155.72		155.01		156.14				4
5	156.31		155.86		155.75		155.03		156.26				5
6	156.28		155.82		155.70		155.03						6
7	156.25		155.79		155.60		155.01						7
8	156.23		155.75		155.31		155.00						8
9	156.21		155.72		155.42		155.02						9
10	156.20		155.69		155.40		155.06						10
11	156.17		155.65		155.37		155.07						11
12	156.16		155.62		155.38		155.06						12
13	156.13		155.59		155.39		155.07						13
14	156.11		155.56		155.38		155.08						14
15	156.08		155.55		155.33		155.16						15
16	156.07		155.53		155.29		155.22						16
17	156.03		155.52		155.27		155.22						17
18	156.01		155.51		155.28		155.20						18
19	156.00		155.54		155.22		155.23						19
20	156.00		155.66		155.20		155.30						20
21	156.02		155.65		155.17		155.42						21
22	156.08		155.67		155.14		155.56						22
23	156.05		155.70		155.11		155.68						23
24	156.31		155.65		155.05		155.80						24
25	156.58		155.60		155.03		155.81						25
26	157.04		155.53		155.07		155.72						26
27	157.06		154.48		155.04		155.61						27
28	156.79		155.45		155.03		155.55						28
29	156.54		155.45		155.02		155.50						29
30	156.34				155.05		155.57						30
31	156.20				155.04								31
MAX	157.06		156.09		155.75		155.81						MAX
MIN	156.00		155.45		155.02		155.00						MIN
TOTAL	4844.82		4513.44		4814.45		4658.04						TOTAL
DAYS	31		29		31		30						DAYS
MEAN	156.28		155.64		155.31		155.27						MEAN

H : W.S.EL. in *m*, Q: Discharge in *m³/sec*, N.K.Form No.1201

Zero point of water gauge: El. *154.211 m*

WATER-LEVEL OF THE MEKONG AT HYDROGRAPHIC OFFICE G. S.

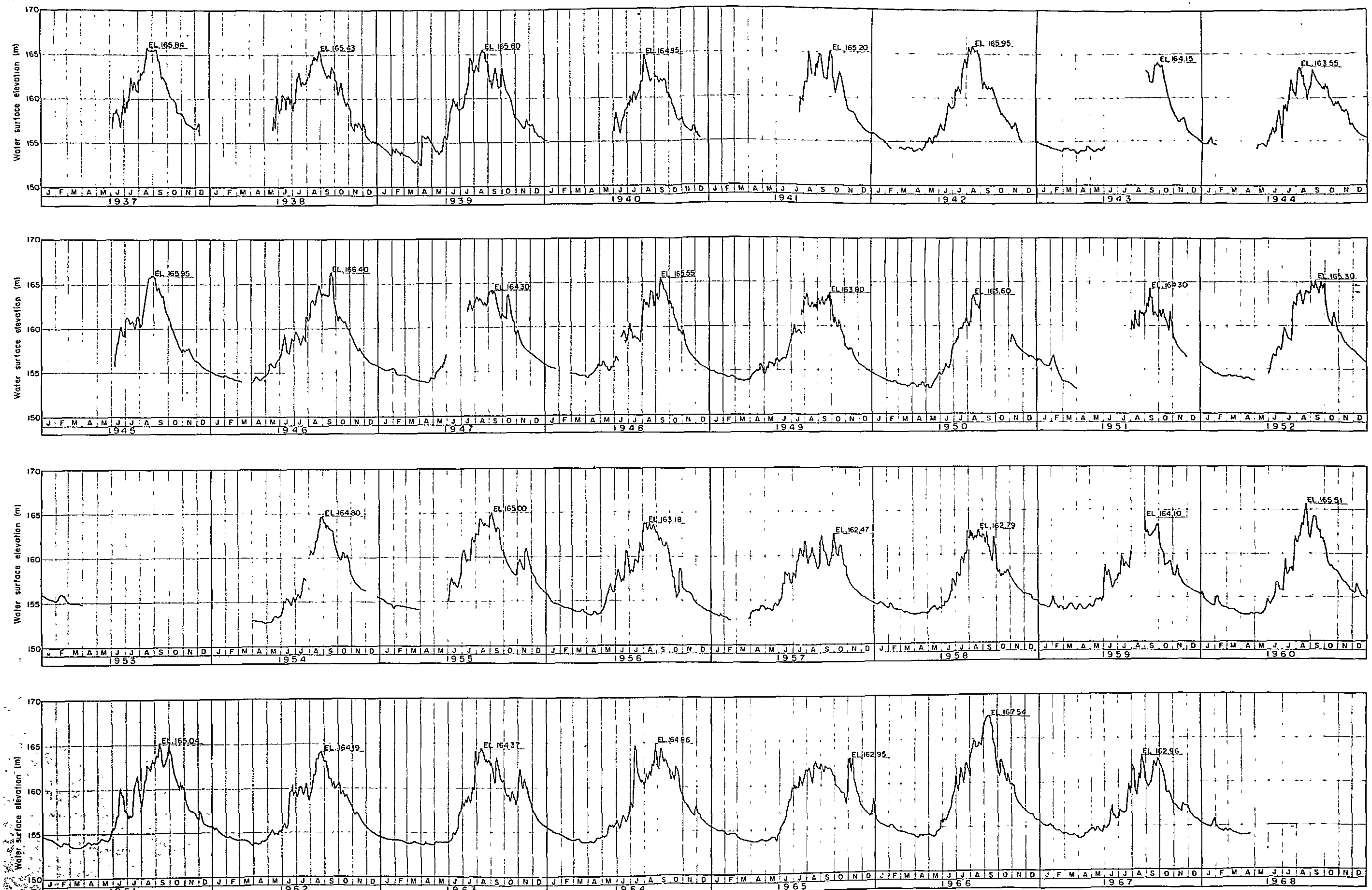




Remarks :

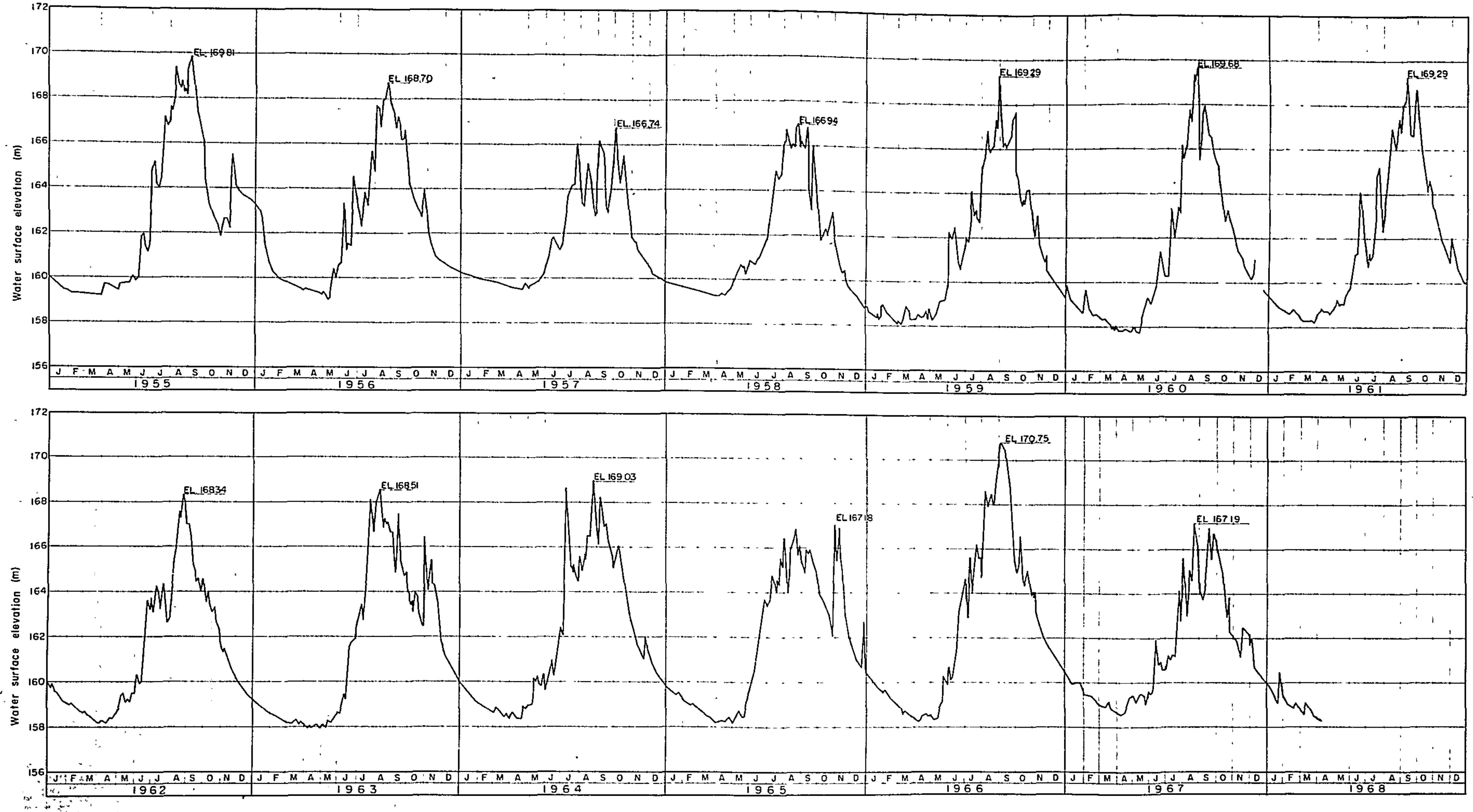
1) Gage was installed on June 11,'64 and data were taken ever since.
2) Figures given here show daily mean value of three readings a day taken at 6:00, 12:00 and 18.00.

WATER LEVEL OF THE MEKONG AT R.I.D. (WAT HAI SOK) GAGING STATION



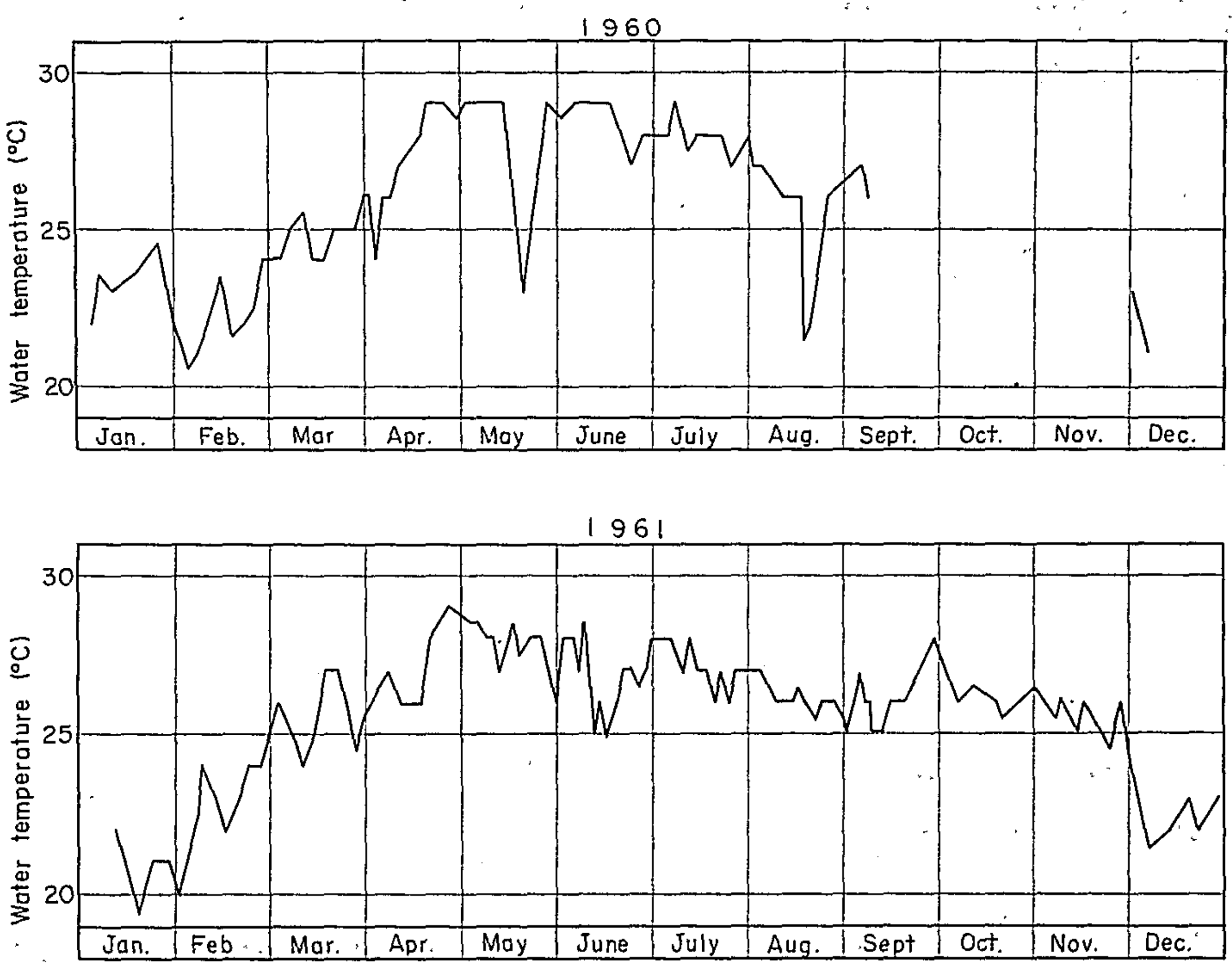
Remarks : Zero point of present staff gage, EL. 153.000

WATER-LEVEL OF THE MEKONG AT VIENTIANE (WAT SOP) GAGING STATION

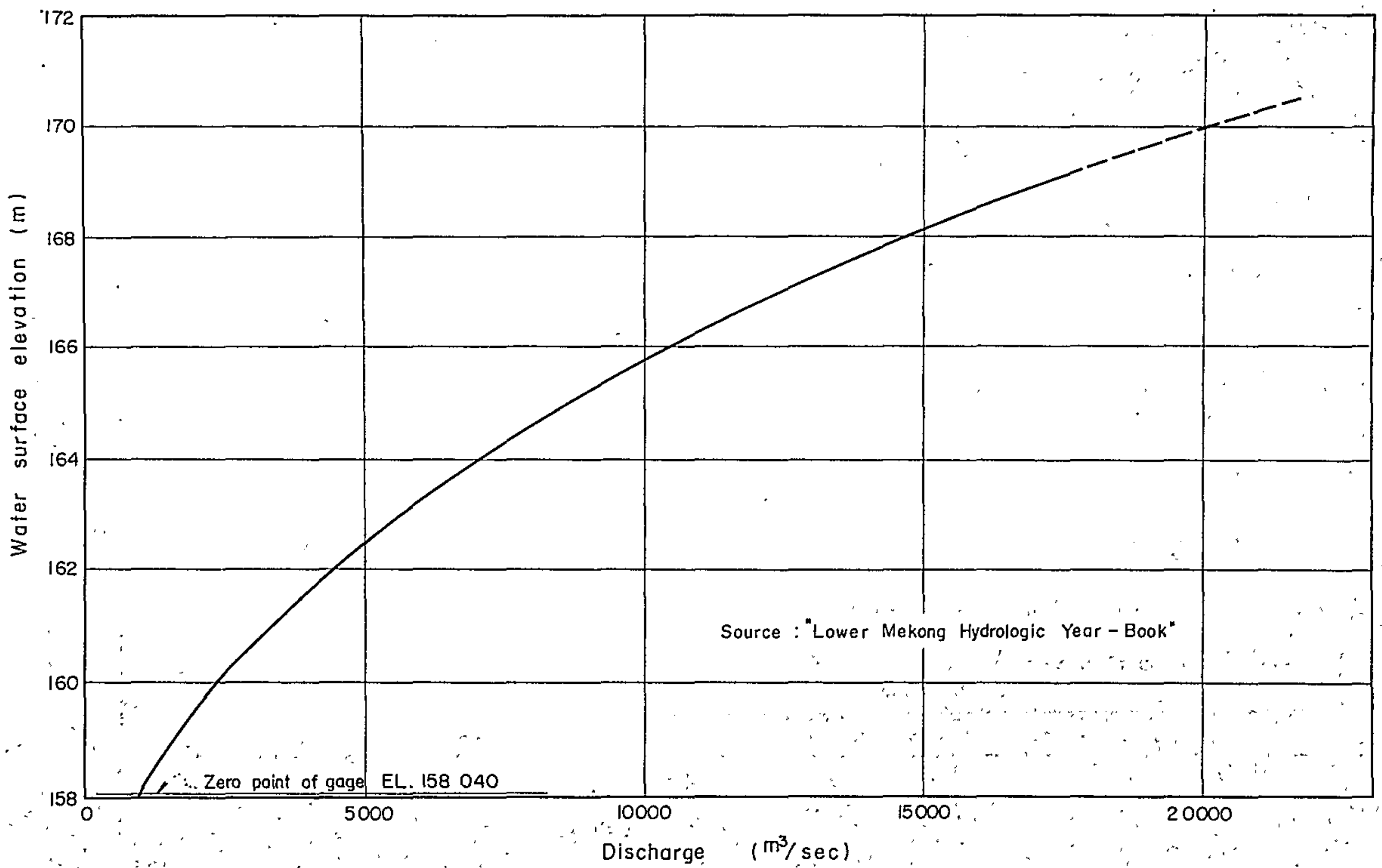


Remarks : Zero point of gage EL. 158.040 m

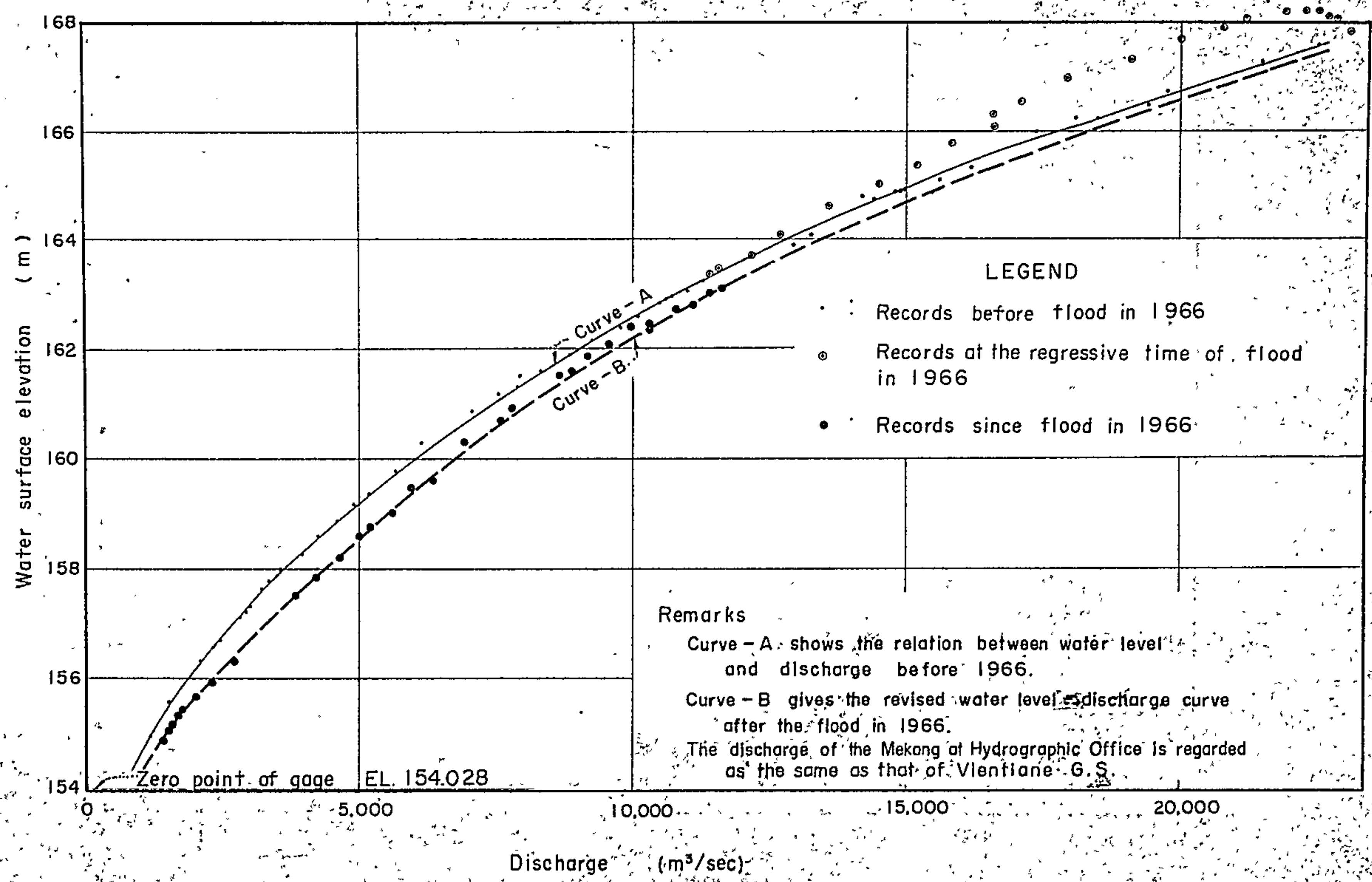
WATER TEMPERATURE OF THE MEKONG
NEAR VIENTIANE



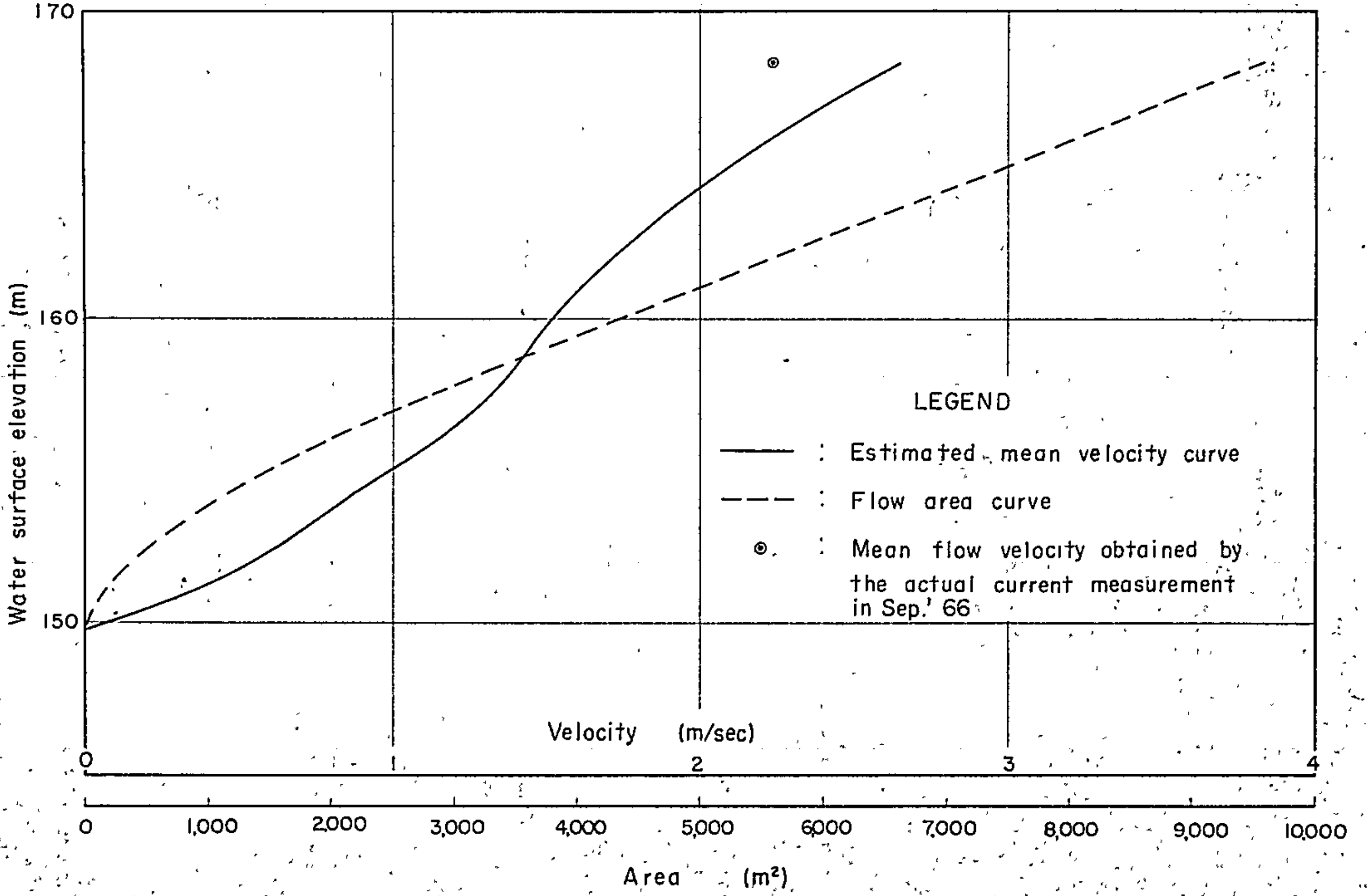
WATER LEVEL — DISCHARGE CURVE AT VIENTIANE (WAT SOP) G.S.



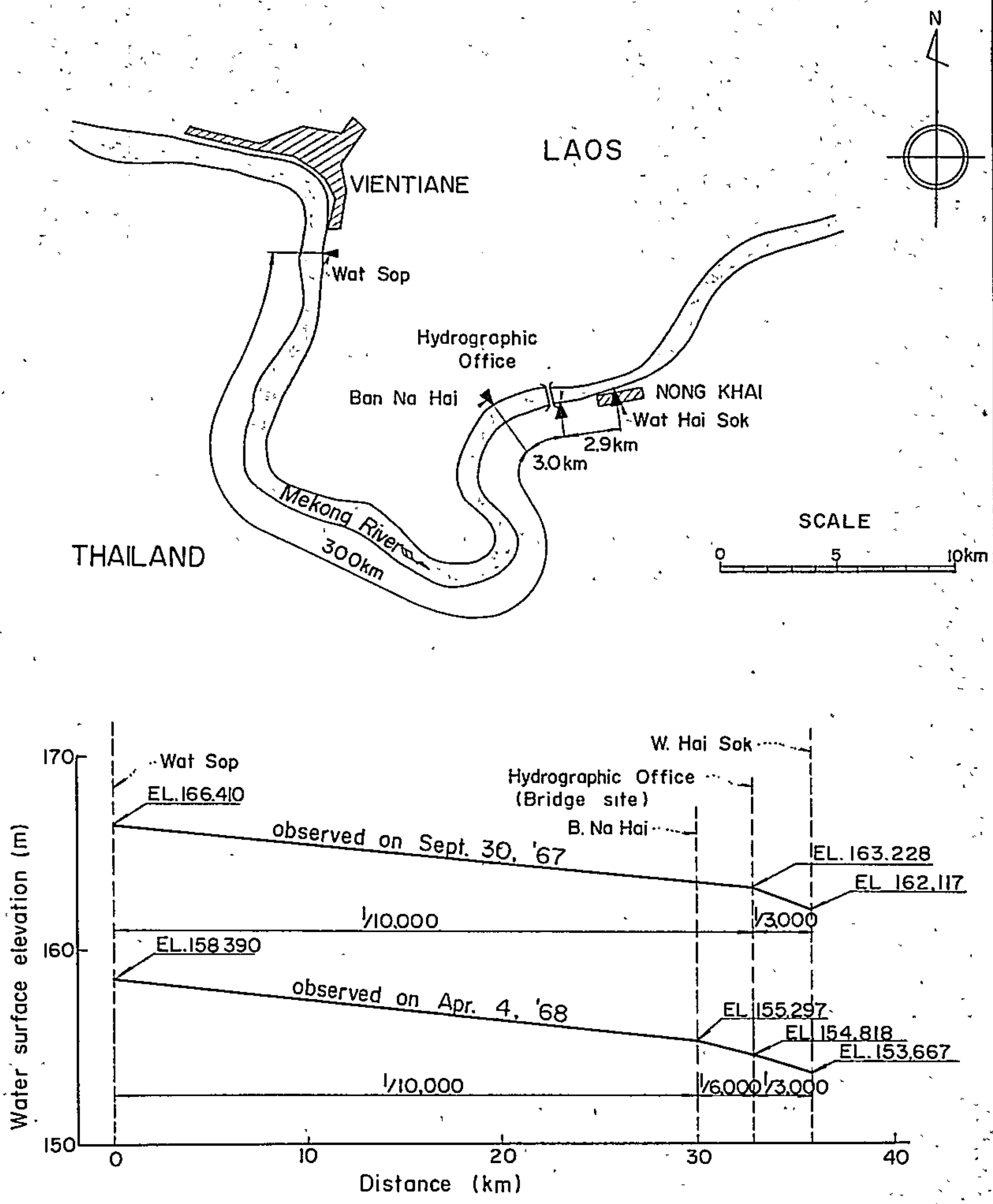
WATER LEVEL—DISCHARGE CURVES AT HYDROGRAPHIC OFFICE G.S.



FLOW AREA AND MEAN FLOW VELOCITY OF THE MEKONG AT THE BRIDGE SITE



OBSERVATION OF WATER SURFACE GRADE



Remarks:

In both the first and second phase investigations, water stages were observed simultaneously at different places up-and downstream from the bridge site.

Based on the results of survey and the Manning's formula, the roughness coefficients "n" of the Mekong at the immediately up and downstream reaches of the bridge site were estimated at 0.032 and 0.046 in the dry season and 0.025 and 0.049 in the rainy season respectively.

4.2. Probability Calculation

This probability calculation is to estimate probable high-water levels at the bridge site of the Mekong, for the purpose of determining the Design High-water Level for the bridge planning.

Probability Calculation

1. General

The Plan of Operation provides that the Nong Khai/Vientiane Bridge is required to have a vertical clearance of 10 meters above preponderant high-water level for the sake of navigation on the Mekong. It suggests that the bottom surface of the bridge girder at its both ends, under which a course for navigation would be provided, is 10 meters above preponderant high-water level. This kind of preponderant high-water level is one of the planning criteria for bridge. In this sense, the preponderant high-water level is called design high-water level hereinafter.

The design high-water level is decided by means of the probability calculation referring to the water-level records of the Mekong in the past years.

2. Condition

There are two water-level gaging stations near the bridge site, one belongs to the Hydrographic Office and is located 135 meters downstream of the bridge site, and the other is R.I.D.'s gaging station at Wat Hai Sok located 3,000 meters downstream of the bridge site.

The gaging station of the Hydrographic Office was established in June 1964 and R.I.D.'s gaging station was established in 1937. R.I.D.'s gaging station has therefore been keeping the water-level records for many years. For this reason, the design high-water level is estimated according to the following procedure.

(1) To calculate probable high-water levels from the past water-level records at R.I.D.'s gaging station.

(2) To estimate the relationship between the water-levels of both the gaging stations.

(3) To assume from this relationship the probable high-water levels at the Hydrographic Office.

(4) Finally, to estimate the probable high-water levels at the bridge site from the probable high-water levels at the Hydrographic Office, based upon the fact that the water surface slope of the Mekong ranges from 1/3,000 to 1/4,000 both in dry and rainy seasons.

The water-level records of R.I.D.'s gaging station are available during the period from 1937 to 1967, excluding four years; 1943, 1950, 1953 and 1959. In these four years, the records are not available.

The highest high-water level of each year is taken, and the calculation of the probable high-water levels is made in accordance with the order-statistic method on the assumption that the samples would describe the log-normal distribution.

The followings are calculating formulas:-

$$\xi = \alpha \, (\log x - \log x_o)$$

or $$\log x = \frac{1}{\alpha} \xi + \log x_o$$

where,
- x : Probable high-water level
- x_o : Geometric mean of the annual highest high-water levels
- ξ : Normal variable for an arbitrary year

The normal varinble is calculated from the following formula.

$$\phi_o \, (\xi) = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} e^{-\xi} \, d\xi = 1 - W_o \, (\xi)$$

where,
- ϕ_o : Non-exceeding probability (Gaussian distribution function)
- W_o : Exceeding probability

The value α is a parameter which indicates the degree of dispersion and is calculated from the following formula.

$$\frac{1}{\alpha} = \frac{\sigma_{\log x}}{\sigma_{\xi}}$$

$$\sigma_{\log x} = \sqrt{\frac{1}{n}\sum(\log x_i)^2 - (\log x_o)^2}$$

Where, x_i : Observation value

n : Number of observation

σ_ξ : Product rate of probability of observation values

3. Probability calculation

(1) Probable high-water levels at R.I.D.'s gaging station

The basic calculation given in Table A.4.2.2. is made from the values of observation, the highest high-water levels of each year at R.I.D.'s gaging station.

$$\sigma_{\log x} = \sqrt{\frac{1}{27} \times 12.3261 - 0.66524^2} = 0.1182$$

σ_ξ = 0.6908 in case of n = 27 according to Hazen's method

$$\frac{1}{\alpha} = \frac{0.1182}{0.6908} = 0.1711$$

Consequently,

$$\log x = 0.1711\,\xi + 0.66524$$

From this equation, the probable high-water levels in eight recurrence years are given in the following table, and Fig.4.2.1.

Table A.4.2.1. Probable high-water levels in R.I.D.'s gaging station

Recurrence year	ξ	log x	x	W.L.
2	0	0.66524	4.63	164.63
5	0.5951	0.76707	5.85	165.85
10	0.9062	0.82030	6.61	166.61
20	1.1630	0.86426	7.32	167.32
40	1.3859	0.90237	7.99	167.99
50	1.4520	0.91372	8.20	168.20
100	1.6450	0.94670	8.85	168.85
200	1.8215	0.97690	9.48	169.48

Table A.4.2.2 <u>Basic calculation</u>

i	Year	H.W.L.	x_i	$\log x_i$	$(\log x_i)^2$
1	1966	167.58	7.58	0.87967	0.77382
2	1946	166.40	6.40	0.80618	0.64993
3	1942	165.95	5.95	0.77452	0.59988
4	1945	165.95	5.95	0.77452	0.59988
5	1937	165.84	5.84	0.76641	0.58737
6	1960	165.72	5.72	0.75740	0.57365
7	1939	165.60	5.60	0.74819	0.55979
8	1948	165.55	5.55	0.74429	0.55397
9	1938	165.43	5.43	0.73480	0.53993
10	1952	165.30	5.30	0.72428	0.55128
11	1941	165.20	5.20	0.71600	0.51266
12	1949	165.08	5.08	0.70586	0.49823
13	1955	165.02	5.02	0.70070	0.49098
14	1940	164.95	4.95	0.69461	0.48248
15	1964	164.90	4.90	0.69020	0.47638
16	1954	164.80	4.80	0.68124	0.46409
17	1963	164.39	4.39	0.64246	0.41275
18	1947	164.30	4.30	0.63347	0.40128
19	1951	164.30	4.30	0.63347	0.40128
20	1962	164.21	4.21	0.62428	0.38972
21	1949	163.80	3.80	0.57978	0.33614
22	1956	163.77	3.77	0.57634	0.33217
23	1944	163.55	3.55	0.55023	0.30275
24	1958	163.04	3.04	0.48283	0.23312
25	1965	162.98	2.98	0.47422	0.22488
26	1967	162.97	2.97	0.47276	0.22350
27	1957	162.47	2.47	0.39270	0.15421
Total				17.96141	12.32613

$$\log x_o = \frac{1}{n} \sum \log x_i = \frac{1}{27} \times 17.96141 = 0.66524$$

(2) Probable high-water levels at the Hydrographic Office

The relationship between R.I.D.'s gaging station and the Hydrographic Office concerning the water-levels recorded on same days during the period of June 1964 to April 1968, is given in Fig. 4.2.2.

The distance between these two gaging stations is only 2,865 meters, and there seems not to be the increase or decrease of discharge. Based upon the above relationship, the probable high-water levels at the Hydrographic Office can be obtained from those of R.I.D. gaging station in Table A.4.2.1. The figures obtained are shown in Table A.4.2.3.

(3) Probable high-water levels at the bridge site

The bridge site is located 135 meters upstream of the Hydrographic Office. Assuming that the water surface slope of the Mekong is 1/3,000 to 1/4,000, the water level at the bridge site will be 4 cm higher than that at the Hydrographic Office.

The probable high-water levels at the bridge site are given in Table A.4.2.3.

Table A.4.2.3 Probable high-water levels at the Hydrographic Office and the bridge site

Recurrence Years	R.I.D.	Hydrographic Office	Bridge site
2	164.63	165.49	165.53
5	165.85	166.68	166.72
10	166.61	167.41	167.45
20	167.32	168.10	168.14
40	167.99	168.74	168.78
50	168.20	168.95	168.99
100	168.85	169.60	169.64
200	169.48	170.20	170.24

Remarks: The figures are based on the elevations of zero point of the staff gage given at each gaging station.

(4) Conclusion

Based on the water-level records of R.I.D.'s gaging station, the number of days per year and the maximum duration in days in which the past water levels were above the probable high-water levels given in Table A.4.2.3. are studied for the determination of the design high-water level.

Table A.4.2.4. The number of days per year and the maximum duration in days

Recurrence Year	2	5	10	20	50	100	200
Probable H.W.L. / Calendar year	164.63	165.85	166.61	167.32	168.20	168.85	169.48
1937	25	0	0	0	0	0	0
1938	11	0	0	0	0	0	0
1939	14	0	0	0	0	0	0
1940	2	0	0	0	0	0	0
1941	12	0	0	0	0	0	0
1942	25	3	0	0	0	0	0
1943	-	-	-	-	-	-	-
1944	0	0	0	0	0	0	0
1945	21	4	0	0	0	0	0
1946	10	5	0	0	0	0	0
1947	0	0	0	0	0	0	0
1948	9	0	0	0	0	0	0
1949	0	0	0	0	0	0	0
1950	-	-	-	-	-	-	-
1951	0	0	0	0	0	0	0
1952	11	0	0	0	0	0	0
1953	-	-	-	-	-	-	-
1954	4	0	0	0	0	0	0
1955	6	0	0	0	0	0	0
1956	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0
1959	-	-	-	-	-	-	-
1960	6	0	0	0	0	0	0
1961	4	0	0	0	0	0	0
1962	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0
1964	3	0	0	0	0	0	0
1965	0	0	0	0	0	0	0
1966	31	20	14	7	0	0	0
1967	0	0	0	0	0	0	0
Total	194	32	14	7	0	0	0
Ratio	1/50	1/310	1/700	1/1400	0	0	0
Max. duration in days	29	20	14	7	0	0	0

According to the results given in Table A.4.2.4., the past water levels remained one day in 50 days above the probable high-water level of the two-year recurrence, one day in 310 days in the case of a five-year recurrence and one day in 700 days in the case of a ten-year recurrence.

The case of the two-year recurrence shows quite a high percentage and the other two show very low percentage.

The maximum duration in days occurred in 1966, in which the highest water-level is equivalent to the probable high-water level of 25-year recurrence. It was 29 days in the case of a probable high-water level of the two-year recurrence, 20 days in the case of a five-year recurrence and 14 days in the case of a ten-year recurrence respectively.

In view of the above facts, it seems most appropriate to decide the design high-water level on the basis of the probable high-water level of 5-year recurrence, which is EL 166.72 at the bridge site.

Consequently, the design water-level for bridge planning is decided as the elevation EL 167 taking the allowance of 28 centimeters.

Fig. 4.2.1 PROBABLE HIGH-WATER LEVEL AT R.I.D. (WAT HAI SOK) G.S.

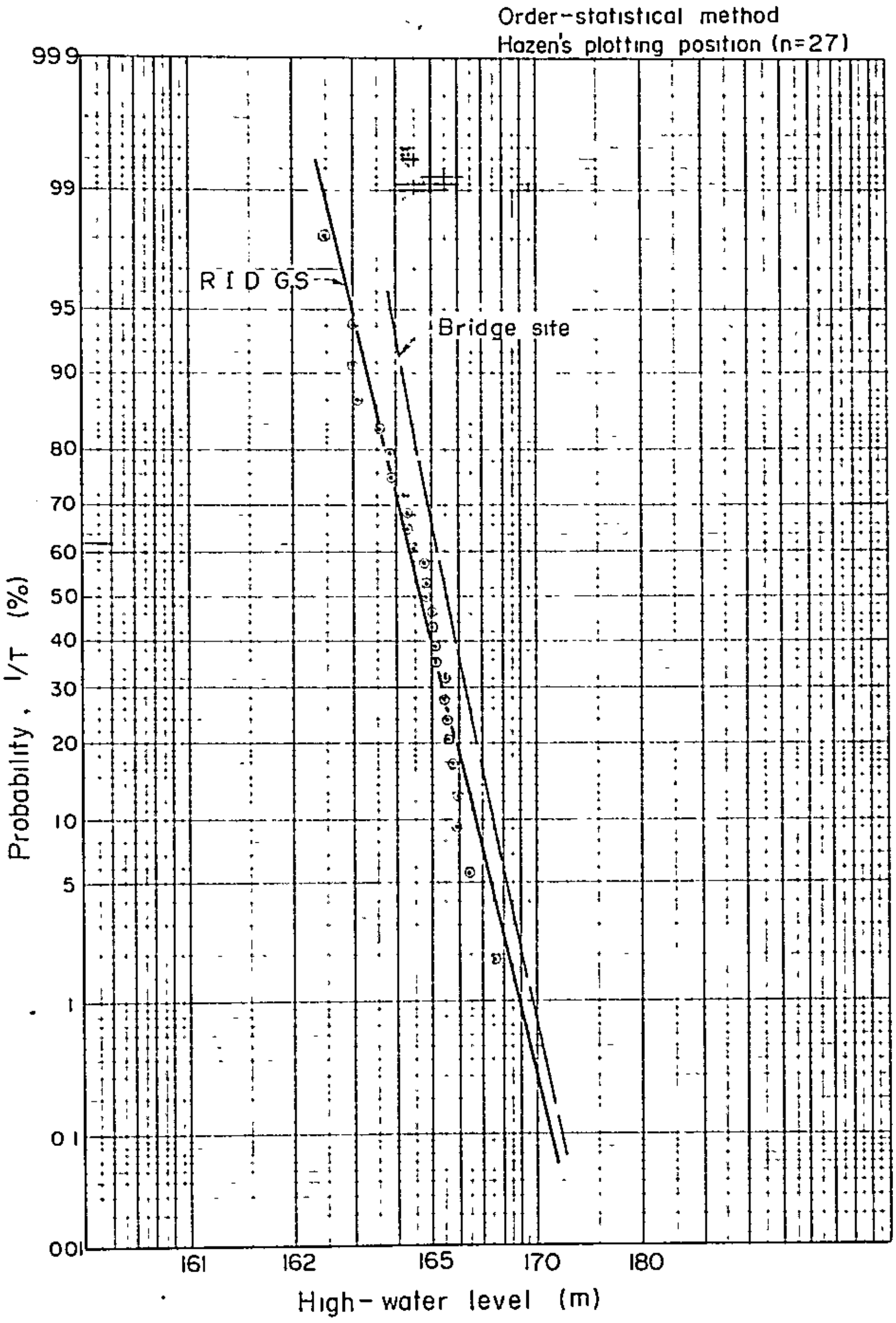
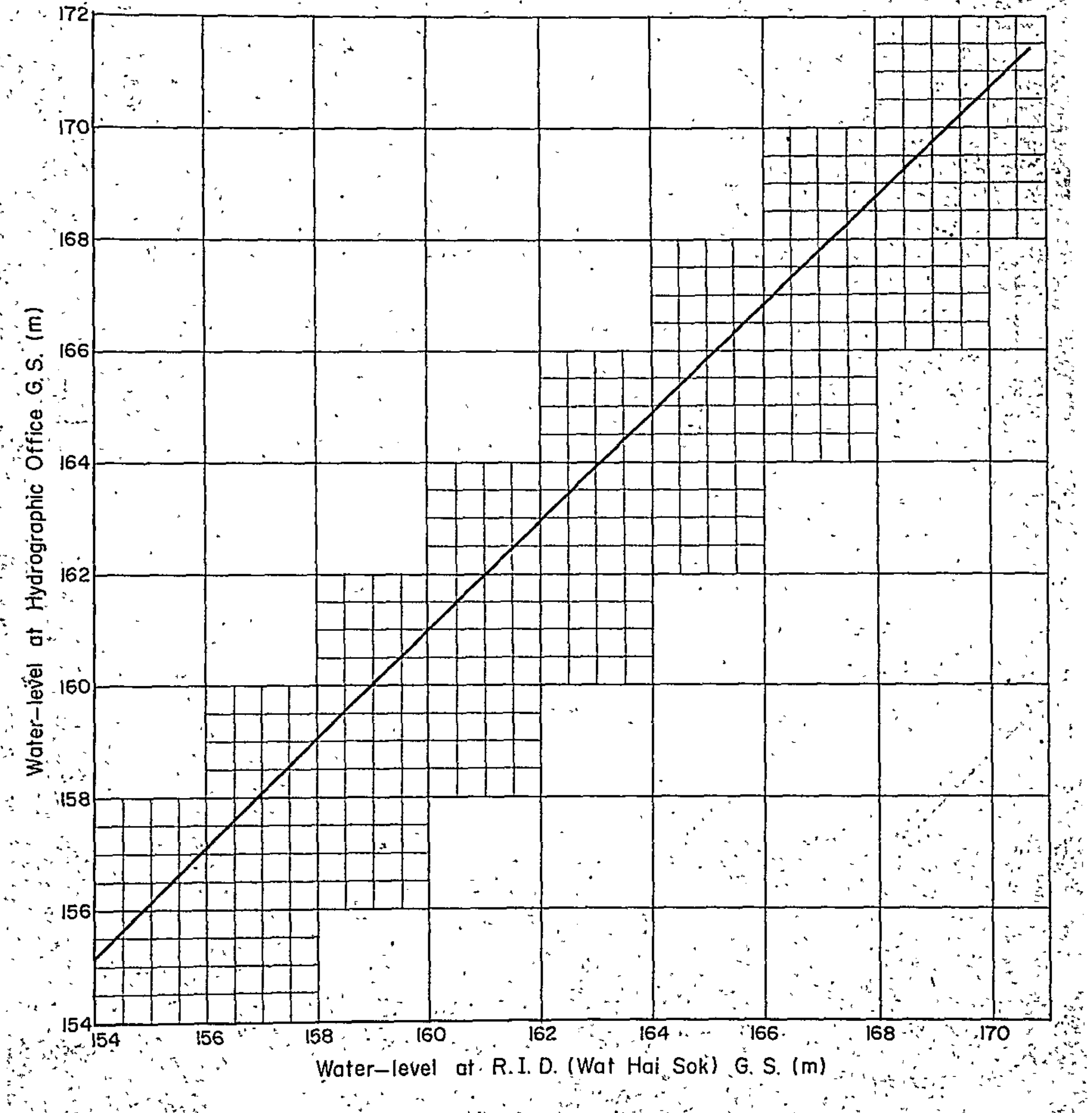


Fig.4.2.2. RELATION OF WATER-LEVEL BETWEEN R.I.D.(WAT HAI SOK) G.S. AND HYDROGRAPHIC OFFICE G.S.



APPENDIX V

METEOROLOGY

CONTENTS

Remarks:

Location of the meteorological stations are shown in the figure at page 93.

Meteorological Data Collected in the First and Second Phase Investigations

Data	Available Period		
	Vientiane	Nong Khai	R.I.D. /1
Air temperature	Jan.'58-Feb.'68*	Mar.'64-Dec.'67	Jan.'65-Apr.'68*
Daily rainfall	Jan.'58-May '68*	Jan.'64-Dec.'67*	Apr.'55-Apr.'68
Relative humidity	Jan.'58-Feb.'68*	Mar.'64-Dec.'67	-
Evaporation	Jan.'58-Feb.'68*	-	-
Prevailing wind direction and wind velocity	Jan.'59-Apr.'68	Feb.'66-Dec.'67	-

Remarks

/1 .... R.I.D. Meteorological station at Nong Khai

* .... The data asterisked were not compiled in the Appendices because they were not available for the meteorological analysis on the Second Phase Report.

DAILY RAINFALL RECORD

STATION: R.I.D. (Nong Khai)

El. ______ Annual total: 1157.5 Year 1958

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1									27.6				1
2				3.2	57.6								2
3													3
4					6.9		4.4	19.0					4
5						24.5							5
6					7.4	31.2		16.2	2.8				6
7						3.4	9.0		30.0				7
8							18.0	13.6					8
9							11.5						9
10				10.3				8.1	45.5				10
11					1.4	5.2		17.5	2.6				11
12					4.8	14.6		14.1					12
13					6.7	13.1				4.6			13
14						7.7				14.2			14
15								50.6		6.4			15
16						1.8		2.2					16
17					8.3	52.5			9.5				17
18						8.0		6.4	8.2				18
19						1.5			1.4				19
20							61.2						20
21						10.6	9.0		7.0				21
22					1.5		6.0		2.4				22
23							9.7						23
24					35.3	56.7	11.7						24
25						1.1	2.0	5.5					25
26						40.9							26
27						62.6		34.6					27
28							7.8	70.0					28
29							85.0						29
30					1.8		12.5						30
31								9.1					31
Max				10.3	57.6	62.6	85.0	70.0	45.5	14.2			Max
Days				2	10	16	13	13	10	3			Days
Total				13.5	131.7	335.4	247.8	266.9	137.0	25.2			Total

Unit: m.m.

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R.I.D. (Nong Khai)

El. ______ Annual total: 1607.2 Year 1959

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M \ D
1						2.9			7.7				1
2						9.3	7.3	12.1	5.9				2
3		4.3					9.0	3.6					3
4								4.6	34.0				4
5		0.7			2.0		2.6		23.1				5
6									116.5				6
7									10.0				7
8							3.0		122.2				8
9								3.7	60.5				9
10			0.5		12.8		82.4		132.3				10
11							19.2						11
12			0.2				20.3		67.2				12
13									26.8				13
14									25.4				14
15					1.0				16.0				15
16				26.3		0.8	11.0	40.0					16
17					46.8	11.8		18.0					17
18							10.1	1.3	6.7				18
19			0.8				7.3	12.6					19
20							2.2	0.9	57.4				20
21					5.0		2.9	40.7					21
22			5.6	27.6	43.5	7.8			3.9				22
23				9.2	10.9	10.0		1.5					23
24					21.5	0.3	13.9	25.6	3.6				24
25							2.2	7.8	8.2				25
26			2.8					3.2					26
27			1.3		20.5	16.6	34.5	11.8					27
28						23.7	9.7	44.5					28
29							1.1	8.1					29
30							59.0						30
31					15.6								31
Max		4.3	5.6	27.6	46.8	23.7	82.4	44.5	132.3				Max
Days		2	6	3	9	9	18	17	18				Days
Total		5.0	11.2	63.1	179.6	83.2	297.7	240.0	727.4				Total

Unit: mm

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R.I.D.(Nong Khai)

El. ______ Annual total: 1616.5 Year 1960

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1		3.4			3.0		1.7			4.3			1
2								3.2		1.8			2
3					12.5	62.0	53.1	42.1	0.2				3
4						9.0	10.1		8.5				4
5						0.6			4.2				5
6								5.4	11.8				6
7								23.0	54.0				7
8					4.9			34.0	152.8				8
9						12.1		38.7	19.4				9
10					19.1				2.5				10
11		4.6				2.0	18.4	2.0	20.5				11
12		4.4	8.3				20.0	3.5					12
13							4.0	25.1		18.3			13
14								14.5	45.2	8.5			14
15					3.1	1.3	15.2						15
16						0.7	13.5	4.9		3.5			16
17					1.4			8.1					17
18					3.8			52.7					18
19								66.7	13.1				19
20					39.4		17.5	14.1		23.0			20
21					3.7	8.7							21
22			7.0		20.3		26.2	44.6	4.8				22
23					13.3		1.5	2.0	26.3				23
24				4.2	17.0	5.8	16.9	58.2	5.5				24
25		3.0	2.4				27.7	3.2	11.8				25
26		1.0				1.3		3.0	8.9				26
27			34.7						31.6				27
28						8.1		3.8	9.3				28
29				14.3			35.6	0.5	12.6				29
30						1.3		24.9					30
31							23.1	9.7					31
Max		4.6	34.7	14.3	39.4	62.0	53.1	66.7	152.8	23.0			Max
Days		5	4	2	12	12	15	24	19	6			Days
Total		16.4	52.4	18.5	141.5	112.9	284.5	487.9	443.0	59.4			Total

Unit: mm

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION R.I.D. (Nong Khai)

El. ______ Annual total: 1686.5 Year 1961

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1			11.4				2.2		15.7	43.4			1
2								2.1	19.1	4.6			2
3					24.6								3
4			06					20.5	13.1				4
5						7.6		7.5	26				5
6			0.3				1.6	9.7	1.1				6
7			11.4			1.2	2.8		20.8				7
8						9.0	2.5		9.4				8
9				20.9		10.7	6.4	7.6	105.7	77.6			9
10						14.7	7.5		1.7				10
11				9.1	26.3	7.6		5.3	35				11
12						17.6		4.3					12
13						8.9		26.6	4.2				13
14						8.5		4.8	16.2				14
15						0.5		28.7	52				15
16						3.7	1.9		8.5				16
17					33.8	18.4	6.3	1.4	16.4				17
18					38.4		333		15.2				18
19				3.8	0.6		16.2	24.1	20.4				19
20					7.6		0.4	6.0	8.2				20
21					60.6		2.2	144.1	44.7				21
22					0.4								22
23						2.1		0.3					23
24					65.2	17.8			11.2				24
25					1.6	385			72.0				25
26				5.6		0.8		37.5	3.2				26
27					19.7	0.5	8.6	2.4					27
28					16.0		14.5	2.5					28
29		8.5			2.2	304	1.03	14.9	239				29
30				13.5	0.2		2.2		5.9				30
31							53.3	9.7					31
Max		8.5	11.4	20.9	65.2	38.5	53.3	144.1	105.7	77.6			Max
Days		1	4	5	14	18	17	20	24	3			Days
Total		8.5	23.7	52.9	297.2	198.5	172.2	360.0	447.9	125.6			Total

Unit: m.m.

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R.I.D. (Nong Khai)

El.____ Annual total: 1857.7 Year: 1962

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec.	M / D
1			1.6		4.6	49.7	48.2	21.9	2.6				1
2			0.2				0.8	12.6	5.3				2
3				10.9	4.6	1.6		31.4	33.4				3
4						12.9		11.5	5.8	13.9			4
5				2.4	16.9	4.7			0.7	8.9			5
6			1.0					9.2		79.1			6
7								45.1		11.4			7
8					56.9			13.3		29.6			8
9			0.7			24.4			8.3				9
10			✓11.1			20.0	11.5	5.5	10.6	1.2			10
11						0.8	6.7	60.0	17.3	0.8			11
12				19.3	14.2	29.5	4.7	35.6				1.3	12
13							48.0	11.5	4.4				13
14							31.8			10.7			14
15						4.2	38.6						15
16		5.2					1.4		0.5				16
17			9.3			68.6	3.0	12.4	21.6				17
18		10.0			73.9	28.7	16.2	3.1	19.2				18
19		1.3				5.7	27.1	29.0	0.1				19
20				0.1			1.6	13.3					20
21					20.0			6.3					21
22				5.5	26.5				74.5				22
23				6.9			0.6	20.0	19.7				23
24				10.0	4.3	1.5	16.3	2.4	21.0				24
25				6.4	2.3		4.3	39.4	0.7				25
26						19.7		28.6					26
27			2.4	2.9					29.8				27
28				1.2					40.8				28
29				26.2					1.2				29
30				22.5	3.2	0.2		6.8					30
31					5.8		5.7	35.4					31
Max		10.0	11.1	26.2	73.9	68.6	48.2	60.0	74.5	79.1		1.3	Max
Days		3	7	12	12	15	17	22	20	8		1	Days
Total		16.5	26.3	114.3	233.2	272.2	266.5	454.3	317.5	155.6		1.3	Total

Unit: m m

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION : R.I.D. (Nong Khai)

El. Annual total : 1,308.0 Year 1963

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1							0.2	5.3	2.4				1
2						1.0		0.8					2
3					12.6	40.4	1.6		2.8				3
4						38.6	29.8						4
5					11.7		0.2	2.0	13.0	24.0	18.6		5
6					12.4	1.4		21.1		2.3			6
7				75.0				20.6		0.7	4.5	1.1	7
8					1.3	7.7		25.9	4.3			0.8	8
9			0.4			48.2			33.1		41.5		9
10						33.8	0.5		37.4				10
11								6.2					11
12						2.2	3.4	11.4	0.5				12
13							14.9	0.8					13
14													14
15			0.7			27.9	24.3						15
16				1.3	1.1	6.2			6.0				16
17				1.3			1.7		11.7				17
18				4.0	15.8		3.7	6.1	55.9				18
19				2.2	64.8		5.5	12.4	8.3				19
20					5.5	38.5	7.6						20
21							6.8						21
22							2.7	4.1	6.3				22
23							3.0	11.2					23
24		0.7			17.8		16.1	0.5	4.0				24
25					0.8		33.1	0.7					25
26					33.3	42.6	9.7	36.0	3.6	4.4			26
27							6.4	3.9		18.1			27
28				15.9	2.6	6.7		1.5		0.2			28
29							4.9			9.7			29
30					10.7		56.7						30
31							2.4						31
Max		0.7	0.7	75.0	64.8	48.2	56.7	36.0	55.9	24.0	41.5	1.1	Max
Days		1	2	6	13	13	22	18	14	7	3	2	Days
Total		0.7	1.1	99.7	190.4	295.2	235.2	170.5	189.3	59.4	64.6	1.9	Total

Unit : m.m.

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R. I. D. (Nong Khai)

El. ______ Annual total: 1585.5 Year 1964

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1				3.5	29.3				15.0	20.0			1
2					0.7		5.7		1.5	3.4			2
3					59.0	6.3	8.4		25.6	25.7			3
4					25.1		8.7	25.7	13.0	3.4			4
5						8.9			11.0				5
6						23.7		2.5	21.2				6
7			1.7			7.1	34.5	3.1	8.4				7
8				6.0	14.5		2.5			24.9			8
9						3.1		7.2		6.4			9
10				7.7	1.2			3.7		15.6			10
11				15.0	4.3	1.8	65.0						11
12				14.0		4.3			4.0				12
13				21.0		1.3		50.0	27.0	6.3			13
14			3.0				8.4	9.8					14
15					2.0	46.0		2.3	28.8	13.5			15
16					0.7	3.3			5.5				16
17				22.1			3.7		18.3				17
18					21.8	7.5			41.9				18
19									11.2				19
20			8.8			42.0							20
21				4.2	69.7	3.8	37.2	12.0					21
22			6.3			0.4	15.0	0.9	0.7	8.0			22
23					49.2	5.7		16.0	8.9	20.1			23
24				9.8	9.8			1.7		11.2			24
25					23.1	7.4	0.5	42.5					25
26						33.7		4.6					26
27					17.2	0.2		3.7	26.2				27
28				14.5	18.9	2.1		1.2	0.5				28
29					27.1			38.5					29
30				2.6	4.3			0.6					30
31								16.0					31
Max			8.8	22.1	69.7	46.0	65.0	50.0	28.8	25.7			Max
Days			4	11	18	19	11	19	18	12			Days
Total			19.8	120.4	377.9	208.6	189.6	242.0	268.7	158.5			Total

Unit: m.m.

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R. I. D. (Nong Khai)

El. ______ Annual total: 1339.8 Year 1965

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1					1.9			6.6					1
2	5.2								26.7				2
3									1.6				3
4						5.2	10.0	4.2	5.0		2.2		4
5				16.6		5.7			0.9	4.0			5
6				2.0		13.1	7.9		63.3				6
7					0.2	29		0.6	20.5				7
8				15.1		1.5		1.0	5.6	3.2			8
9						2.2			55.0				9
10						3.7				3.5			10
11				28		32.1	21.8		555	1.9			11
12						9.8	11.4						12
13					8.7	2.3		65.6	20.3				13
14						10.4			10.8				14
15					1.0	44.2							15
16					118.0	59.1		1.4					16
17								1.5					17
18				33.7		2.3		14.6					18
19						0.3		14.5					19
20					4.2	32.2		29.1	11.5				20
21						9.1	57.8	16.0	1.1				21
22				405		8.2		1.8					22
23					0.4	14	9.2	56.2					23
24				36.5			8.7		14.3	7.2			24
25				0.8			1.5			0.7			25
26				12.9			6.4	19.2					26
27					2.1	04	14.2	0.7		2.5			27
28					16.8	12.1		0.9					28
29					2.6	123	12.2	4.5					29
30					4.1	11.8							30
31					14.6								31
Max	5.2			40.5	118.0	59.1	57.8	65.6	63.3	7.2	2.2		Max
Days	1			9	12	23	11	17	14	7	1		Days
Total	5.2			160.9	174.6	282.3	161.1	238.4	292.1	23.0	2.2		Total

Unit: m.m.

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION: R.I.D. (Nong Khai)

El. ______ Annual total: 1529.7 Year 1966

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1				0.2			2.3	16.6					1
2							12.9	35.6	12.2				2
3			7.6		58.5	3.4	3.4	17.5					3
4					1.7	15.0	2.8	10.8					4
5				2.5		65.0		7.7					5
6					30.0	5.4			10.7				6
7								2.8					7
8						0.6		0.6					8
9					14.3	10.1		2.0	20.5	15.7			9
10								6.0		2.8			10
11								71.6					11
12				1.7				6.4					12
13				14.3			22.7		5.5				13
14					15.1				25.3				14
15					10.9	36.2	30.0	22.5	0.8				15
16				5.0	42.8		3.2	158.5					16
17					7.9		3.1						17
18					21.2		1.1						18
19					21.0	33.3	17.2						19
20				0.6	5.7		10.2	5.4					20
21				81.4			3.5	37.3					21
22						25.5	2.5	30.3					22
23					12.0		18.6	11.2					23
24				12.4	11.5			5.6					24
25					30.1	5.6		4.2		35.4			25
26					15.5	1.8		15.7		14.6			26
27				13.8	21.7	2.5		21.0					27
28							16.9	5.4					28
29						1.2	0.8						29
30								71.8					30
31								2.5					31
Max			7.6	81.4	58.5	65.0	30.0	158.5	25.3	35.4			Max
Days			1	9	16	13	16	24	6	4			Days
Total			7.6	131.9	319.9	205.6	151.2	569.0	75.0	68.5			Total

Unit: MM

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION R.I.D. (Nong Khai)

El. ______ Annual total: 1326.4 Year 1967

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1			1.2		22.3								1
2			19.0			1.9	26.3						2
3						6.0							3
4						0.2	2.6	0.1					4
5						3.2	3.5						5
6				4.0		21.8			34				6
7						4.3	2.0	4.5					7
8			7.2		0.2	26.2		12.9					8
9						0.5	20.9	5.2					9
10					9.5		11.0	24.0	16.3				10
11						3.2		5.8			17.3		11
12				3.0		11.0	4.8	2.3			4.5		12
13				22.0	0.5		25.0	3.5					13
14													14
15				18.1			26.2						15
16					13.5		10.0		36.8				16
17			4.5	2.5	14.7				18.8				17
18					21.3								18
19					4.1			49.1	27.0				19
20			16.1			53.5		221.2	8.4				20
21				0.4				7.0	31.8				21
22				52.5			12.3	56.9	2.8				22
23		2.6					2.9	3.4					23
24							13.5	11.7					24
25						0.5	3.8	2.2					25
26				47.5			11.9	2.5	20.8				26
27						0.3		4.7	3.6				27
28					2.8	62.0		21.0					28
29					12.2	3.0		8.4					29
30													30
31			12.2										31
Max		2.6	19.0	52.5	22.3	62.0	26.3	221.2	36.8		17.3		Max
Days		1	6	8	10	15	15	14	10		2		Days
Total		2.6	60.2	150.0	101.1	197.6	176.7	446.4	169.7		21.8		Total

Unit: mm

N. K. Form No. 1101

DAILY RAINFALL RECORD

STATION R.I.D. (Nong Khai)

El.______ Annual total:______ Year 1968

D \ M	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	M / D
1													1
2													2
3													3
4				2.7									4
5				19.5									5
6													6
7			25.0	2.3									7
8			3.2										8
9													9
10			1.0										10
11													11
12			3.5										12
13													13
14													14
15				25.2									15
16													16
17													17
18													18
19													19
20													20
21													21
22													22
23													23
24													24
25													25
26													26
27													27
28													28
29													29
30													30
31													31
Max			25.0	19.5									Max
Days			4	4									Days
Total			32.7	49.7									Total

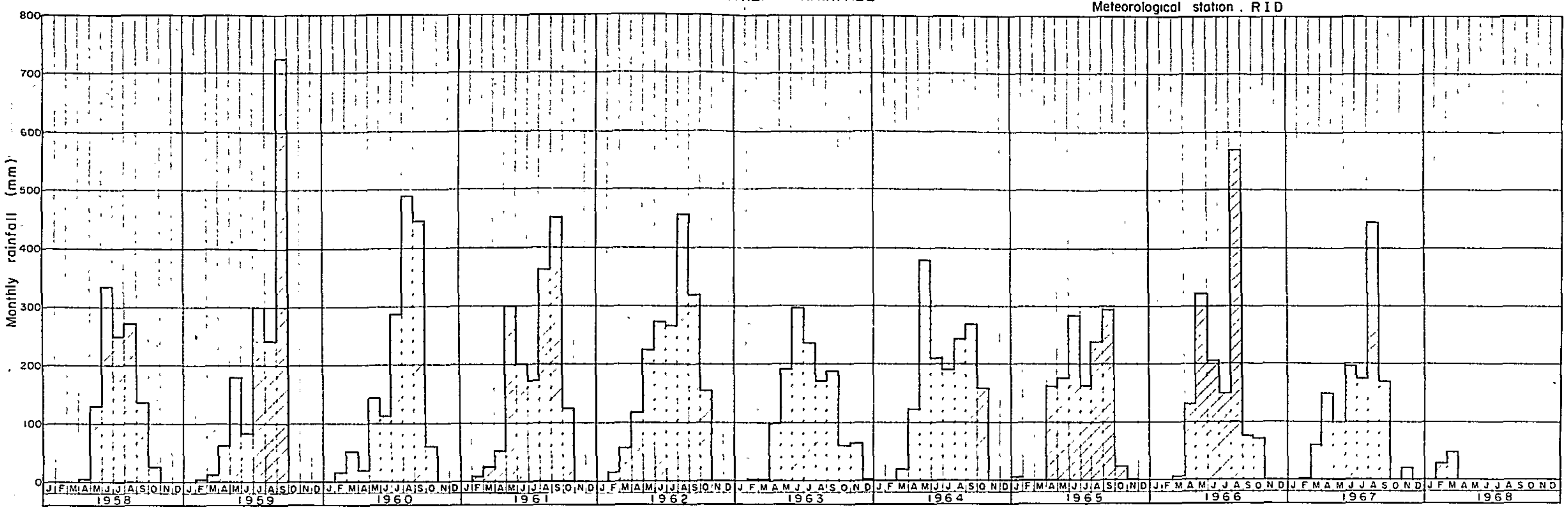
Unit: m.m.

N. K. Form No. 1101

RAINFALL, AIR TEMPERATURE AND RELATIVE HUMIDITY

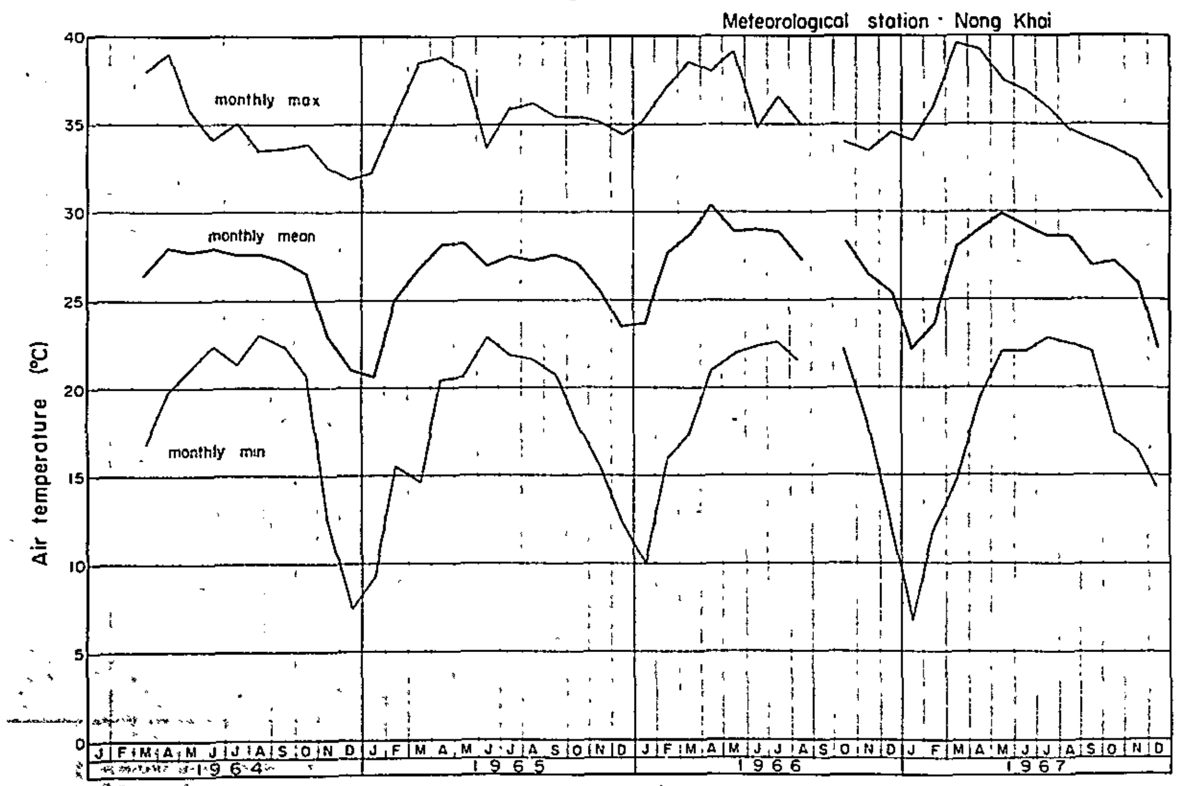
MONTHLY RAINFALL

Meteorological station . RID



AIR TEMPERATURE

Meteorological station · Nong Khai

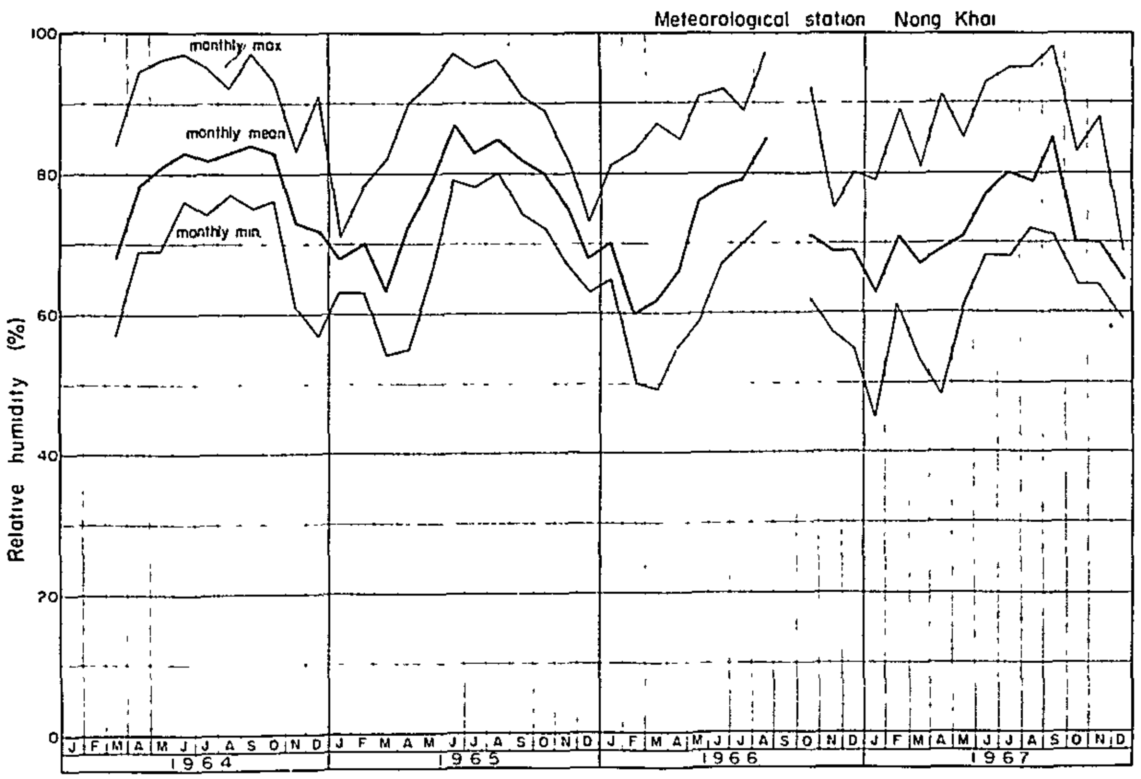


Remarks . These lines are described based on the daily-max, daily-mean and daily-min air temperature records

It was due to flood that records in September 1966 were not registered

RELATIVE HUMIDITY

Meteorological station Nong Khai



Remarks These lines are described based on the daily-mean relative humidity records

It was due to flood that records in September 1966 were not registered

Daily Prevailing Wind Direction and Mean Wind Velocity at Nong Khai Meteorological Station

Year: 1966

Date	Jan/1		Feb.		Mar.		Apr.		May		Jun.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1			W	0.6	NE	1.4	SE	1.9	SE	2.3	SW	1.2
2			W	0.5	NE	2.1	SW	1.6	SE	1.4	SW	2.3
3			W	0.6	SE	0.6	SW	1.2	E	3.3	SW	1.2
4			W	0.6	SW	1.0	SE,SW	1.2	NE	1.2	SW	1.2
5			E	1.0	W	0.6	SW	1.4	SE	1.2	SW	1.2
6			NE	1.9	N	1.0	E	1.9	SW	1.2	SW	0.6
7			E	1.0	SW	0.8	SW	1.4	NE	1.2	SW	1.2
8			E	0.8	N	2.3	NE	1.6	NE	1.2	SW	1.9
9			E	1.0	NE	0.4	SW	1.2	SW	1.6	SW	1.6
10			W	1.2	S	1.2	NE	1.9	SW	2.0	SW	1.9
11			NE	0.6	NE	0.8	N	1.0	SW	1.2	SW	1.9
12			NE	2.3	NW	1.0	NE	2.1	SW	1.6	SW	2.5
13			SE	2.3	W	1.0	SW	1.4	SW	1.0	SW	2.5
14			E	1.6	NW	1.2	SW	1.4	SW	2.3	E	1.4
15			W	1.0	W	1.4	SW	1.4	E	1.2	SW	1.2
16			W	0.8	W	1.0	SW	1.6	SW	1.2	SW	1.0
17			W	0.8	E	1.2	S,W	1.9	SW	2.7	SW	1.0
18			NE	1.0	SW	1.0	NE	3.9	SW	2.5	NE	2.9
19			W	1.4	SE	2.4	SW	1.2	SW	1.6	SW	1.6
20			W	0.8	E	1.6	SW	2.7	NE	2.9	SW	1.0
21			NE	0.8	SW	1.2	E	3.5	E	3.9	SW	1.9
22			SW	1.4	SW	2.9	NE	0.8	E	1.0	SW	1.2
23			E	3.7	SW	1.0	W	1.0	SW	0.8	SW	2.5
24			NE	2.1	SW	1.0	SW	1.4	SW	2.7	SW	1.0
25			W	0.8	SW	1.0	SW	1.0	E	1.2	SW	1.4
26			NE	1.2	E	2.3	SW	2.1	NE,SW	3.5	SW	1.0
27			NE	1.6	E	2.5	SW	2.1	SW	1.4	SW	0.6
28			E	1.2	SE	1.0	SW	0.8	SW	1.6	NE,SW	1.2
29					SW	1.0	SW	1.2	SW	1.5	SW	1.2
30					E	2.0	NE	3.1	SW	1.8	SW	2.1
31					E	1.2			SW	1.2		

/1 : No available data in January

Abbreviation:

Dir. ...... Prevailing direction

Vel. ...... Mean wind velocity in m/sec.

- continued

Year: 1966

Date	Jul.		Aug.		Sep./1		Oct.		Nov.		Dec.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1	SW	0.4	E	1.4	-	-	NE	1.3	WE	2.4	NE	3.6
2	SW	1.0	SW	2.1	-	-	NE	0.4	E	3.5	NE	5.6
3	SW	1.6	NE	0.6	-	-	NE	0.6	NW	1.0	NE,SW	0.5
4	SW	1.2	SE	1.0	-	-	NE	1.6	NE	1.2	N	0.7
5	SW	1.4	SW	0.6	-	-	NE	0.9	NE	2.1	NE	0.7
6	SW	1.2	W	0.8	-	-	NE	1.8	SW	4.7	E	0.8
7	SW	1.0	SW	0.8	-	-	NE	1.3	NE	0.6	N	0.5
8	SW	1.6	SW	2.3	-	-	NE	0.9	NE	0.2	NE	0.2
9	SW	1.6	SW	0.4	-	-	NE	0.8	NE	0.1	NE	0.2
10	SW	1.2	SW	1.2	-	-	E	0.9	NE	0.4	NE	0.4
11	SW	1.0	SW	0.8	-	-	W	2.1	NE	0.3	E	0.6
12	SW	1.4	SW	1.0	-	-	NE	0.7	E	0.4	NE	1.1
13	SW	1.6	SW	1.0	-	-	SW	0.8	E	0.4	NE	0.7
14	SW	1.4	SW	1.2	-	-	SW,NE	0.6	E	0.9	NE	0.4
15	NW	1.2	SW	1.4	-	-	E,W	1.0	NE	1.1	E	0.5
16	SW	0.8	SW	1.0	-	-	E	0.8	NE	0.3	E	0.5
17	NE,SW	1.4	NE	1.2	-	-	NE	1.5	NE	1.5	ESE	0.2
18	S	1.4	SW	1.0	-	-	NE	1.8	NE	0.9	NW	0.4
19	E	1.4	W	2.5	-	-	NE	2.5	NE	0.4	W	0.2
20	SW	2.1	SW	1.6	-	-	NE	1.9	NE	0.9	E	0.4
21	SE,SW	1.4	SW	1.2	-	-	NE	2.4	NE	5.9	E,S	1.1
22	SW	1.4	SW	2.9	-	-	NE	1.4	NE	1.8	W	0.8
23	SW	1.4	SW	1.0	-	-	SW	1.2	NE	0.4	N	0.2
24	SW	1.6	C	1.0	-	-	SW	0.8	NE	0.5	ENE	0.8
25	SW	2.9	SW	1.0	-	-	SE	0.6	NE	1.1	NE	0.7
26	NW,SW	3.3	SW	2.3	-	-	E	1.8	NE	2.3	NE	0.7
27	SW	2.8	SW	2.5	-	-	E	1.0	NE	0.2	NE	1.8
28	SW	1.0	SW	0.8	-	-	E	1.8	ENE	0.2	NE	1.1
29	SW	1.9	E	1.0	-	-	NE	1.4	NW	0.6	NE	0.2
30	SW	1.9	SW	2.1	-	-	NE	0.6	NE	2.6	NE	0.4
31	SW	1.9	SE	1.2	-	-	NE	1.1			NE	0.6

/1 : No observation due to flood in September.

Abbreviation:

Dir. ...... Prevailing direction

Vel. ...... Mean wind velocity in m/sec.

Daily Prevailing Wind Direction and Mean Wind Velocity at Nong Khai Meteorological Station

Year: 1967

Date	Jan.		Feb.		Mar.		Apr.		May		Jun.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1	NE	1.2	NW	2.1	NE	1.4	SW	1.0	S	1.1	SE	1.4
2	NE	3.1	E	1.4	SE	1.4	SW	1.2	S	1.3	SE,SW	1.2
3	NE	6.4	E	4.0	W	1.0	SW	1.9	W	1.2	SW	1.0
4	NE	3.0	NE	0.8	W	1.2	SW	1.0	N	1.4	SW	1.0
5	NE	1.5	NE	2.7	SE	1.6	SE	2.9	SW	0.8	SE	1.4
6	C	0.4	NE	3.5	SE	4.5	SE	1.2	S	1.4	E	1.2
7	C	0.7	NE	1.6	SE	3.1	SW	1.4	C	1.3	SW	1.2
8	NE	1.4	NE	1.0	SE	1.2	SW	0.8	SE	4.7	W	1.2
9	C	0.5	E	1.2	E	1.9	SW	1.4	SW	1.4	SE	3.5
10	NE	1.2	NE	1.0	E	2.7	SW	1.2	SE	1.6	SW	1.0
11	NE	3.7	SE	3.1	E	1.0	SW	1.2	SE	1.9	E	1.4
12	NE	1.2	NE	2.3	E	1.0	SW	1.9	W	0.6	E	1.4
13	NE	2.5	SE	1.0	E	1.2	SW	1.2	SW	1.6	SE	0.8
14	NE	0.7	NE	3.7	E	1.2	SW	1.4	SE	2.5	SW	0.8
15	NE	1.8	NE	1.9	E	2.1	E	2.1	SE	1.6	W	1.2
16	NE	2.8	NE	1.2	C	0.6	C	0.8	SE	4.1	SW	1.2
17	NE	2.2	NE	2.3	NE	1.2	SE	1.9	E	4.5	SW	2.1
18	NE	1.5	NE	3.1	C	0.6	SW	1.0	E	1.6	SW	2.1
19	SE	0.4	NE	1.2	SE	0.6	SW	1.9	W	2.5	SW	2.1
20	NE	0.8	NW	1.0	SW	0.8	SE,SW	1.6	SW	1.9	SW	1.9
21	E	1.0	C	0.6	S	0.8	SE	2.4	SE	0.8	SE,SW	1.0
22	E	0.8	NW	0.6	C	0.6	SW	1.8	SW	4.4	SW	1.2
23	C	2.7	W	1.0	C	0.2	SW	1.2	SW	4.1	W	1.2
24	SE	0.6	SE	1.0	E	1.9	SE	1.0	SW	2.3	SW	1.4
25	SW	0.5	E	1.4	E	1.9	SE	1.6	SW	2.4	E	1.0
26	SW	2.1	E	5.2	NW	0.8	SE,SW	2.1	SW	2.0	SW	2.5
27	SW	1.0	SE	4.7	W	0.8	SE	1.9	SW	0.8	SE	2.3
28	SW	1.0	E	2.1	SW	1.2	S	1.3	SE	3.7	SE	1.9
29	SW	1.0			SW	1.2	S	0.6	SW	1.9	SW	2.1
30	E	0.8			SW	0.8	SSW	1.2	SW	1.2	SW	1.4
31	NE	5.2			SW	1.2			SW	2.7		

Abbreviation:

Dir. ...... Prevailing direction

Vel. ...... Mean wind velocity in m/sec.

- continued

Year: 1967

Date	Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
1	SW	1.4	SW	1.9	SW	2.5	NE	1.4	E	2.9	NE	1.2
2	E	0.8	SW	3.3	SW	1.2	E	1.6	NE	4.3	NE	0.8
3	E	1.0	SW	4.3	SW	2.7	E	2.0	NE	4.0	NE	0.6
4	C	1.2	SW	3.1	W	2.1	NE	2.0	NE	2.4	NE	0.5
5	SW	2.5	SW	2.5	NE	1.2	E	1.2	NE	4.2	NE	0.3
6	SW	3.1	SW	2.1	SW	1.0	E	1.2	NE	2.9	NE	0.7
7	SW	1.2	SW	2.3	E	0.6	NE	1.2	NE	3.2	NE	1.0
8	SW	1.2	SW	1.0	NE	1.6	NE	0.8	NE	3.3	NE	1.2
9	SE	1.0	E	1.2	NE,SW	1.6	W	1.2	NE	2.1	NE	0.6
10	SW	1.2	E	1.2	NE	1.0	SW	0.8	NE	2.9	E	1.4
11	E	1.0	E,W	1.0	N	0.8	E	1.6	NE	5.2	E	0.6
12	SE,SW	1.6	SW	1.2	NE	0.6	SW	1.0	E	9.5	NE	1.0
13	SW	1.6	W	1.6	W	0.6	E	0.8	E	4.6	E	1.6
14	SE,SW	1.4	SW	2.0	W	0.6	E	0.8	NE	4.9	NE	0.6
15	E	1.0	W	1.0	NE	1.2	E	1.9	NE	3.2	NE	0.4
16	E	0.4	SE	1.2	E	1.2	W	1.0	NE	2.8	NE	0.2
17	SW	1.0	SW	1.6	NE	1.2	W	1.2	NE	3.2	NE	0.8
18	SW	1.4	SW	1.4	NE	1.2	E,W	0.8	NE	2.9	NE	0.6
19	S,W	1.4	SW	1.2	SW	0.8	NE	1.0	NE	2.9	NE	0.4
20	W	1.6	E	0.8	SW	2.1	E	1.0	NE	2.5	NE	0.3
21	NE	1.6	SW	1.4	SW	1.0	NE	1.2	NE	2.8	NE	0.3
22	E	1.2	SW	1.2	E	0.6	NE	1.6	NE	2.5	NE	0.3
23	W	1.4	SW	2.3	SE	1.4	NE	1.0	NE	2.5	NE	0.5
24	SW	1.4	SW	1.4	E	0.6	NE	2.1	W	2.1	NE	0.3
25	SW	1.9	E	1.0	E	0.8	NE	0.8	NE	3.1	NE	0.3
26	SW	1.2	W	0.8	E	1.0	NE	1.2	NE	2.8	NE	0.3
27	SW	1.4	E	2.3	E	1.4	NE	1.2	NE	0.8	NE	0.3
28	SW	3.1	SW	1.2	E	0.8	NE	1.2	NE	1.2	NE	0.3
29	SW	1.4	SW	3.1	C	0.2	NE	0.8	E	3.1	E	0.5
30	NE	1.2	W	1.9	W	1.0	W	1.2	E	3.1	NE	0.4
31	SW	1.2	SW	1.6			NE	0.8			NE	0.4

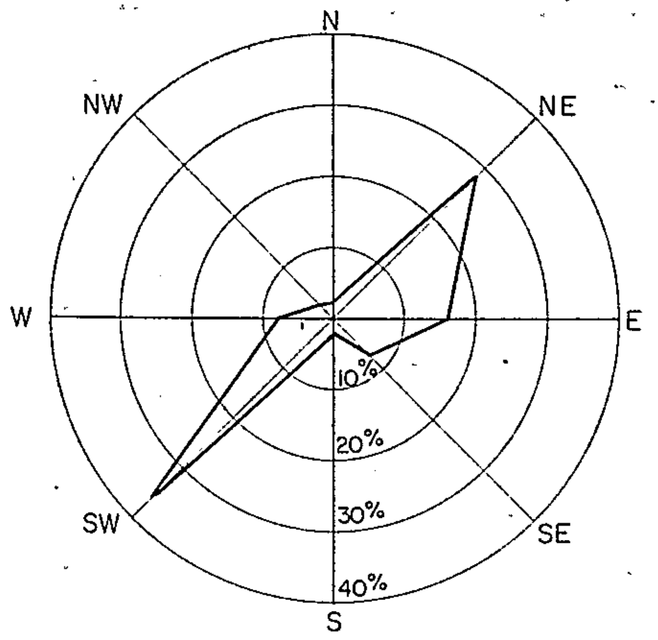
Abbreviation:

Dir. ...... Prevailing direction

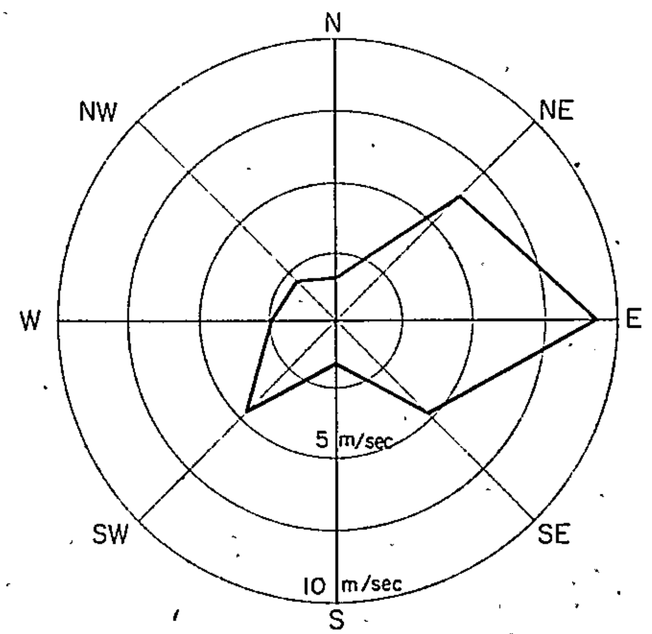
Vel. ...... Mean wind velocity in m/sec.

WIND DIAGRAM

Meteorological station : Nong Khai
Period : Feb. 1966 to Dec. 1967



DAILY PREVAILING DIRECTION



MAX. WIND VELOCITY

Monthly Max. Wind Velocity and Its Direction
at Vientiane Meteorological Station

Period : 1959 to 1968

	1959		1960		1961		1962		1963	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Jan.	ENE	5	ENE	4	SSW	4	SSE	3	SW	7
Feb.	NNW	4	E	8	E	3	ENE	3	E	4
Mar.	Var.	–	NW	4	ESE	4	E	3	Var.	–
Apr.	Var.	–	S	10	S	10	SSW	8	Var.	–
May	Var.	–	ENE	5	NNE	8	NW	3	SSE	3
Jun.	Var.	–	E	4	SW	4	N	3	N	3
Jul.	WNW	13	NE	3	ENE	6	W	8	SW	3
Aug.	WNW	5	ESE	4	SSW	3	ENE	8	N	3
Sep.	WSW	6	NE	4	WNW	3	W	4	WSW	4
Oct.	NE	5	SE	5	WNW	5	NE	1	SE	2
Nov.	E	5	ESE	3	NNW	4	N	6	N	2
Dec.	ESE	8	ENE	5	N	2	NNE	5	N	2

	1964		1965		1966		1967		1968	
	Dir.	Vel	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Jan.	ESE	3	E	3	NNW	4	E	8	SE	3
Feb.	WSW	6	S	3	NE	4	E	4	E	8
Mar.	ESE	3	E	4	W	4	S	9	ESE	27
Apr.	NNW	4	W	4	N	10	SSE	8	SSE	8
May	S	4	W	10	NE	4	N	9		
Jun.	NNW	4	N	3	NNW	4	NNW	7		
Jul.	SSE	3	W	8	SE	5	W	8		
Aug.	S	3	NW	20	N	3	SW	6		
Sep.	S	3	W	4	S	4	SW	7		
Oct.	SW	2	NE	7	ESE	4	ESE	6		
Nov.	W	3	E	4	N	5	E	6		
Dec.	SE	3	–	–	–	–	E	3		

Remarks : Dir. = Wind direction

Vel. = Monthly max. wind velocity in m/sec

APPENDIX VI

ECONOMIC SURVEY

The data given here are concerned with the general economy, from which the future traffic and the benefits are estimated.

CONTENTS

Population of Vientiane City in 1966
(by Census in 1966)

	Male	Female	Total
Laotian	50,348	45,768	96,116
Foreigner	18,518	17,619	36,137
Total	68,866	63,387	132,253

Population of Nong Khai Prefecture in 1966
(by Bureau of Statistics of Nong Khai Prefecture)

Country	Population
Nong Khai	69,390
Phong Visay	69,789
Muang Kan	55,697
Saika	29,140
Sri Chieng Mai	28,967
Tha Bo	44,850
Total	297,833

Gross National Product of Laos

Year	Estimated gross national product (10^6 US$)				Population (10^3 persons)				Estimated gross national product per head (US$)	
	Laos	Self-supporting economy	Market economy	Vientiane	Laos	Self-supporting economy	Market economy	Vientiane	Self-supporting economy	Market economy
1962	159.6	115.4	44.2	-	2,450	2,082.5	367.5	-	55.43	120.20
1963	166.9 (1.046)	119.4 (1.035)	47.5 (1.075)	-	2,509 (1.024)	2,133 (1.024)	376 (1.024)	-	55.98 (1.01)	126.21 (1.05)
1964	174.5 (1.046)	123.5 (1.034)	51.0 (1.074)	-	2,569 (1.024)	2,184 (1.024)	385 (1.024)	-	56.54 (1.01)	132.52 (1.05)
1965	182.9 (1.048)	127.9 (1.036)	55.0 (1.078)	-	2,635 (1.026)	2,240 (1.026)	395 (1.026)	-	57.11 (1.01)	139.15 (1.05)
1966	187.4 (1.025)	131.0 (1.024)	56.4 (1.024)	18.4	2,698 (1.024)	2,293 (1.024)	405 (1.024)	132	57.11 (1.00)	139.15 (1.00)
1967	196.1 (1.046)	135.5 (1.034)	60.6 (1.074)	19.7 (1.071)	2,765 (1.025)	2,350 (1.025)	415 (1.025)	135 (1.025)	57.68 (1.01)	146.11 (1.05)
1973	261.3 (1.051)	166.9 (1.036)	94.4 (1.078)	30.7 (1.077)	3,207 (1.025)	2,725 (1.025)	482 (1.025)	157 (1.025)	61.23 (1.01)	195.80 (1.05)
1990	630.0 (1.056)	300.6 (1.035)	329.4 (1.076)	108.2 (1.086)	4,880 (1.025)	4,146 (1.025)	734 (1.025)	241 (1.025)	72.51 (1.01)	448.76 (1.05)

Remarks: Figures in the brackets show index to value of the foregoing year.

Major Industries in Laos

Item	Number of factory	Unit	Annual production						Remarks
			1962	1963	1964	1965	1966	1967	
Match manufactory	1	case	-	-	-	2,500	3,000	3,500	1 case = 7,200 boxes, 1 box = 50 matches
Cigarette manufactory	3	case	-	-	-	40,570	46,000	50,000	1 case = 50 cartoons, 1 cartoon = 10 packages, 1 package = 20 cigarettes
Rubber sandal manufactory	4	dz.	-	-	30,000	56,000	72,000	78,000	
Pizzy drink manufactory	6	btl.	5,400,000	5,700,000	6,300,000	6,800,000	7,200,000	8,000,000	1 at Saravane, 1 at Savannakhet, 3 in Vientiane, 1 at Luang-Prabang
Plastic bag manufactory	2	ton	-	-	-	72	72	75	Polyethylene bags
Mechanical rice-mill	208	ton	-	-	88,200	100,000	110,000	110,000	8 of 1st class (2,400 tons/year and per unit) 10 of 2nd class (1,500 tons/year and per unit) 190 of 3rd class (200 tons/year and per unit)
Textile printing	1	m	-	-	-	-	600,000	600,000	
Alcohol distillery	14	litre	-	-	1,200,000	1,200,000	1,800,000	1,800,000	Small distilleries capable of production from 150 to 200 litres/day
Power saw-mills	76	m^3	-	-	150,000	156,000	160,000	200,000	Sawn wood
Ice manufactory	8	ton	-	-	20,000	26,000	30,000	35,000	4 in Vientiane, 1at Luang-Prabang, 1 at Savannakhet, 1 at Pakse and 1 at Khammuane
Candle manufactory	3	case	-	36,000	36,000	40,000	40,000	45,000	1 case = 100 packages

Export of Laos in 1966

Articles	Weight (kg)	Exported to	Amount (Kips)
Musical instruments "Kha drum"	35	England	50,000
Bensoin in bulk and dust	300	U.S.A.	1,700,000
- do -	1,000	France	5,712,400
Tin ore	12,040		3,563,640
Cardamon	114,608	Hongkong	10,008,800
Tin ore	480,700	Penang	218,680,800
Dried cuttle fish	6,680	Thailand	1,649,280
Vegetables	2,000	"	832,000
Dried fruits	580	"	340,000
Green coffee-bean	1,500	"	150,000
Tree-barks "Penak boug"	29,000	"	292,500
Benzoin in bulk and dust	1,800	"	9,529,500
Fruits preserved in cans	9,950	"	1,760,000
Other preserved fruits	11,465	"	1,453,200
Crushed stones	1,050,000	"	1,290,000
Raw tin ore	2,000	"	60,000
Monosodium glutamate	6,220	"	2,100,000
Woods only barked and sawn of all kinds	7,087,097	"	37,825,074
Wooden furnitures	500	"	20,000
Waste irons	78,126	"	277,000
Waste coppers	22,800	"	1,150,000
Green coffee-beans	493,314	Singapore	53,558,080
Cardamom	57,780	"	5,342,400
Paddy bran	18,880	"	37,760
Soya seed	21,440	South Vietnam	343,000
	9,509,815		357,725,434

Import of Laos in 1966

Articles	Weight (kg)	Amount (Kips)
Rice and other cereals	42,150,225	2,492,026,152
Foodstuff, sugar and other food preparations	2,077,025	266,133,592
All oil products (aircraft and motor-car gasolines, oils, greases)	81,131,828	1,381,481,563
Structural metals, cement asbestos cement bolt and nut works, spanners, line	19,744,472	587,266,751
Other electric machinery and apparatus	2,039,014	833,092,444
Motor cars, tractors and cycles	2,465,060	1,271,250,396
Total	170,089,248	10,017,158,506

Level of Monthly Consumption in Nong Khai and Vientiane

(Unit: tons)

	Gasoline	Cement	Rice	Steel bar	Beer	Hog	Refrig-eration	Water melon
Nong Khai prefecture	600	250	2,500	150	16	-	2	3
Vientiane city	750	1,650	1,500	200	40	74	10	135

(Unit: tons/1,000 persons)

	Gasoline	Cement	Rice	Steel bar	Beer	Hog	Refrig-eration	Water melon
Nong Khai prefecture	8.65	3.60	36.02	2.16	0.23	-	0.03	0.04
Vientiane city	5.67	12.47	11.34	1.51	0.30	0.56	0.08	1.02

Remarks: (1) In the estimation of consumption per 1,000 persons, population (69,400) as of December 1966 for Nong Khai prefecture and population (132,300) as of July 1966, respectively, were used.

(2) The values of cement and water melon in Nong Khai prefecture are doubtful if they are of Nong Khai prefecture.

Prices in Nong Khai and Vientiane - 1

Items	Unit	Nong Khai (Baht)	Nong Khai (Kip)	Vientiane (Kip)
1. Miscellaneous sereals				
Rice (Laos)	kg	2.35	58.75	76
Rice (ordinary)	"	2.65	66.25	98
Bread	"		25	83
Cassava	"	2.5	62.5	70
Black bean	"	5	125	110
2. Vegetables				
Convalvulus	kg	2	50	80
Tomato	"	0.50	12.5	50
Chilipepper	"	6	150	300
War gourd	"	1	25	65
Chinese cabbage	"	3	75	100
Lettuce	"	2	50	50
Beefsteak plant	"	5	125	60
Cabbage	"	1	25	30
Green piece	"	6	150	200
Japanese onion	"	2	50	100
Garlics	"	6	150	150
Bean sprouts	"	2.5	62.5	50
Cucumber	"	1	25	130, 20
Dry onion	"	6	150	200
Potato	"	6	150	280
Manpao	"	0.75	18.75	25
Wild tomato	"	3	75	150
Long bean	"	4	100	100
3. Fruits				
Apple	kg	5	125	250

Item	Unit	Nong Khai (Baht)	Nong Khai (Kip)	Vientiane (Kip)
Banana	kg	4	100	150-200
Water melon	no.	5	125	300
Shaddock	"	3.5	87.5	120
Orange	kg	4	100	120-200
Pineapple	no.	4	100	180
Coconut	"	1.5	37.5	30
Grape	kg	12	300	400
4. Meat and eggs				
Beef	kg	14	350	450
Pork (with bone)	"	12	300	500
Pork (fat of meat)	"	12	300	500
Pork (high quality)	"	17	425	500
Port (with hide)	"	10	250	420
Chicken	no.	10	250	800-1000
Duck's egg	"	0.6	15	17
Fish	kg	14-15	350-375	600
		18-20	450-500	
Fish (salted)	"	20-25	550-625	700
5. Dry food and condiments				
Dried onion	kg	2.5	62.5	70
Dry cattle fish	"	17-28	425-700	650-800
Thin threads of beach-jelly	"	16	400	500-700
Salt	"	0.5	6.2	25
6. Other foodstuff				
Condensed milk	can	2.5-3.0	62.5-75	11.0

Prices in Nong khai and Vientiane - 2

Items	Unit	Nong Khai (Baht)	Nong Khai (Kip)	Vientiane (Kip)
Lard	kg	12	300	300
Soup (Chinese style)	bottle	5-6	125-150	100
Black coffee	cup	0.5	12.5	15
Milk coffee	"	1	25	25
Ice		0.4	10	15
7. Electricity and fuel				
Electricity	kWh	1.30	32.5	40
Petroleum	lit.	50	2	36
Electric bulbs	no.	4-5	100-125	140
8. Daily commodities				
Saucer	no.	3-5	75-125	170
Nail	kg	5	125	150
Aluminum streaming basket	no.	18	450	450-550
Washing soap	box	9	225	200
Toilet soap	no.	3	75	70
Vacuum bottle	"	70	1,750	1,350
		40	1,000	570
Soap	"	0.5	12.5	20
Powder soap	box	8	200	85
Toilet paper	no.	3	75	60
Match	10 boxes	2	50	50
9. Medicals				
Aspirin	tab.	0.10	2.5	7.5
Quinine	"	0.05	1.25	7.5
10. Charges				
Hair dressing (man)	person	5-7	125-175	150
Hair dressing (woman)	"	10-15	250-375	300

Item	Unit	Nong Khai (Baht)	Nong Khai (Kip)	Vientiane (Kip)
City bus	km	0.50	12.5	30
Movie (2nd class)	person	3-5	75-125	100
Play (2nd class)	"	2-3	50-75	100
Drama and sports	"	"	"	100
11. Magazines and smoking				
Daily paper	no.	0.5-1.0	12.5-25	50
Weekly magazine	"	3.0-3.5	75-87.5	140
Tabbaco	box	2.5-3.5	62.5-87.5	20
12. Electric instruments				
Refrigerator	no.	3,675	91,875	60,000
Fan	"	604	15,100	16,000
13. Vehicles				
Bicycle (Thailand)	no.	550	13,750	14,500
Bicycle (Japan)	"	850	21,250	18,000
Motorcycle	"	6,200	155,000	135,000
14. Construction material				
Cement	ton	-	14,000	19,000
Steel bar (9 mm dia.)	"	3,080	77,000	78,000
Steel bar (6 mm dia.)	"	3,250	81,250	100,000
Steel plate		20.5		380
Veneer		50	1,250	1,400
Timber		900	22,500	12,800

Ferry Freight at Nong Khai

(Unit: tons)

Year	Freight from Laos	Freight to Laos
1962	2,511	30,045
1963	5,328	30,822
1964	32,524	30,766
1965	2,328	38,540
1966	10,463	42,459
1967	34,858	83,095

Ferry Freight at Sri Chieng Mai in 1967

(Unit: tons)

Month	Freight from Laos	Freight to Laos
Jan.	6.7	6.7
Feb.	8.7	21.7
Mar.	3.1	177.9
Apr.	9.7	7.6
May	0.1	90.0
June	1.8	212.0
July	0.2	34.4
Aug.	11.0	89.4
Sep.	1.6	48.4
Oct.	7.5	195.7
Nov.	3.6	82.2
Dec.	4.4	18.5
Total	58.8	985.2

APPENDIX VII

OTHER PLANNING DATA

CONTENTS

Other Planning Data

Many kinds of planning data listed below were collected during the First and the Second Phase Investigations. These data are useful for the feasibility study on Nong Khai/Vientiane Bridge Project, but are voluminous. Therefore, the data compiled in Appendices are limited to only the important ones for use as reference.

Collected data

1) Design standards of highway and railway in Thailand.

2) Over-all road network plans in Laos and Thailand.

3) Map of city plan of Vientiane.

4) Regulations for aviation in Thailand.

* 5) Data relative to the expenses of compensation for various kinds of land, houses and valuable trees, current prices of local materials and daily or monthly salaries of technicians and laborers in and around Vientiane and Nong Khai.

* 6) Data concerning the present car ferry services crossing the Mekong between Tha Naleng and Nong Khai.

7) Sources of electricity available for construction work near the bridge site.

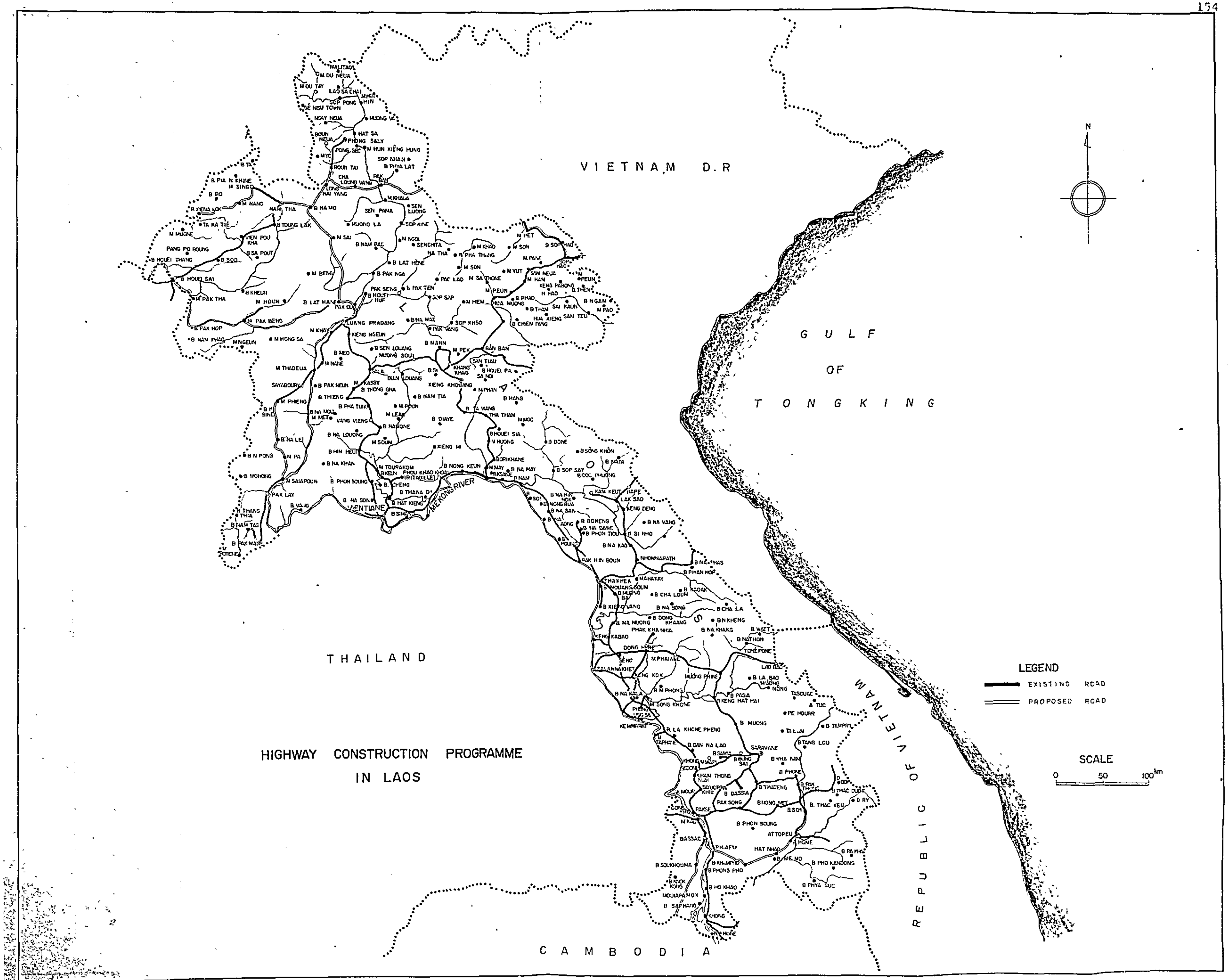
8) Data in regard to the river-bed erosion due to the structure built in the river.

9) Seismic data

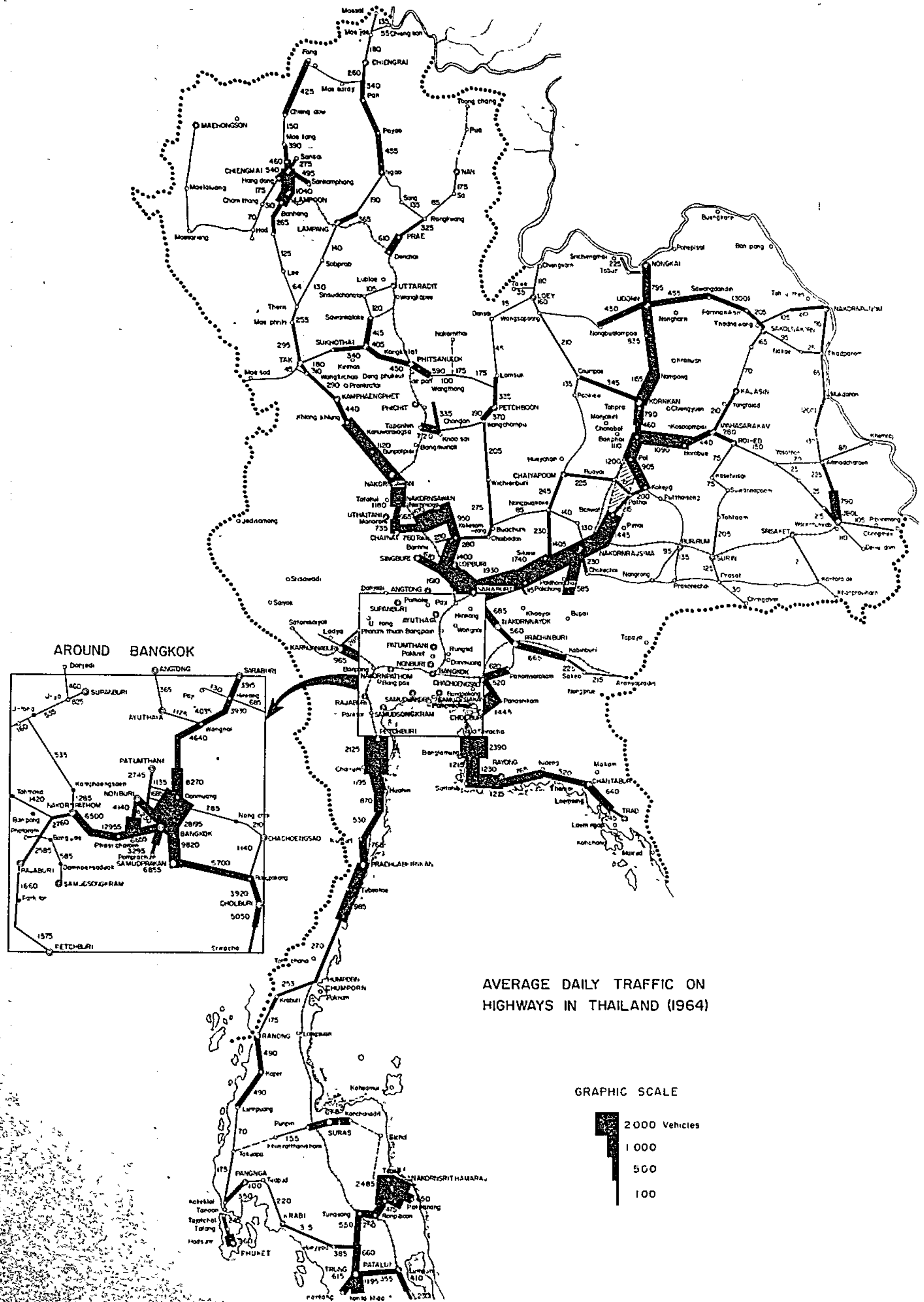
10) Maps covering a part of the project area or the whole

Remarks

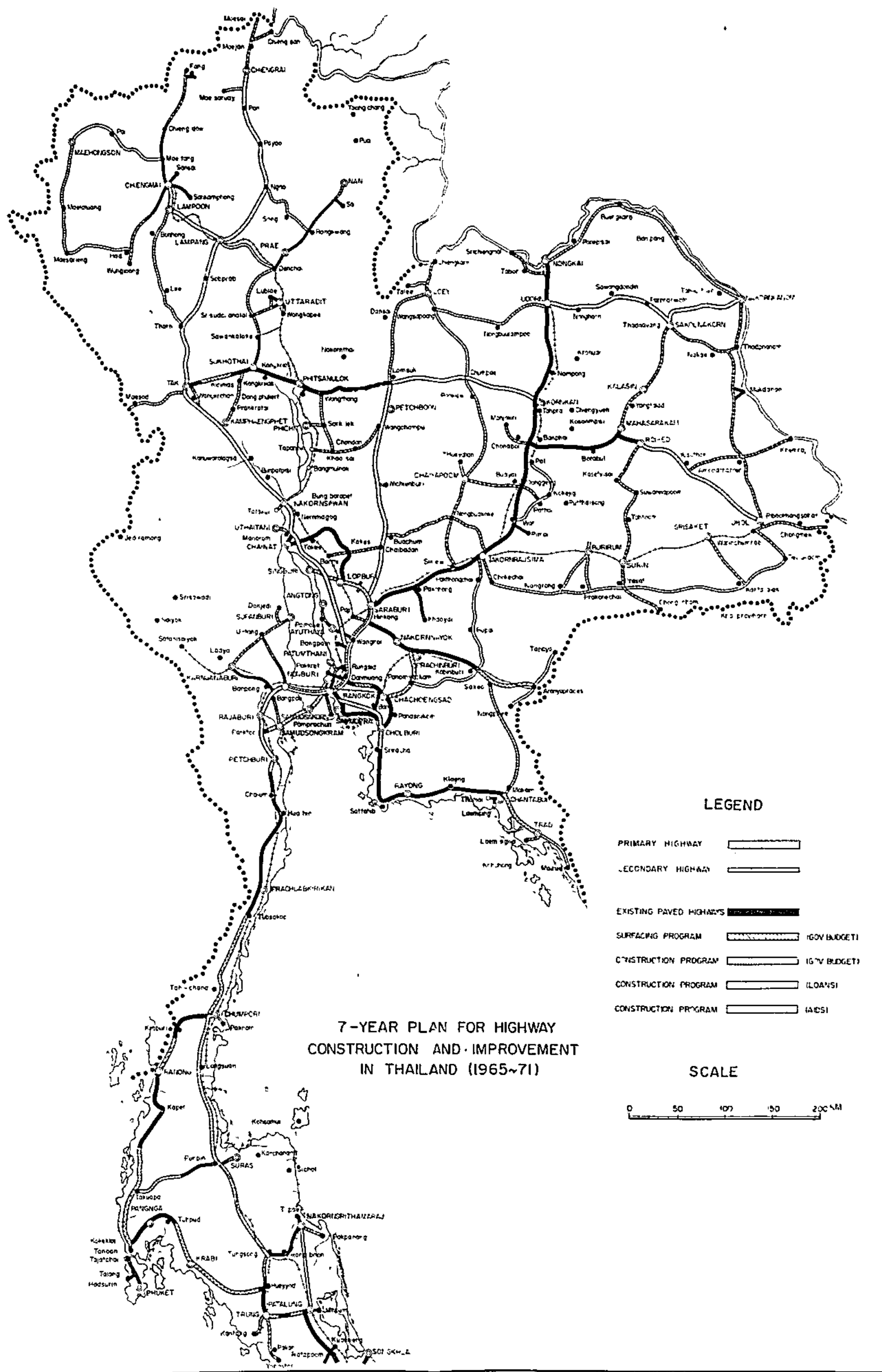
* These data were used for the estimation of the construction cost and for the study of the additional ferry construction as the alternative plan of the bridge, but were not compiled in this "Appendices" as well as in the Second Phase Report.



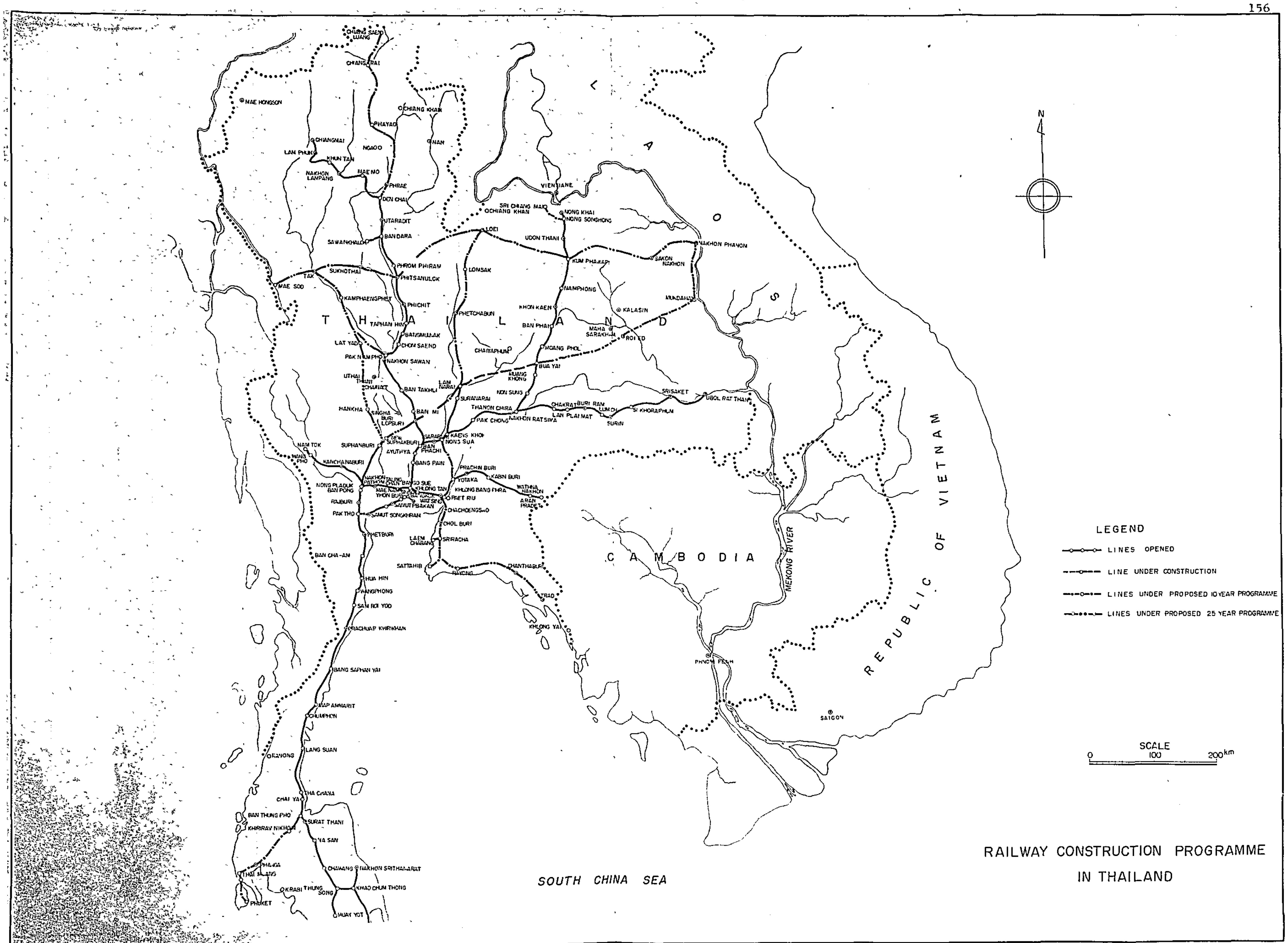
HIGHWAY CONSTRUCTION PROGRAMME IN LAOS



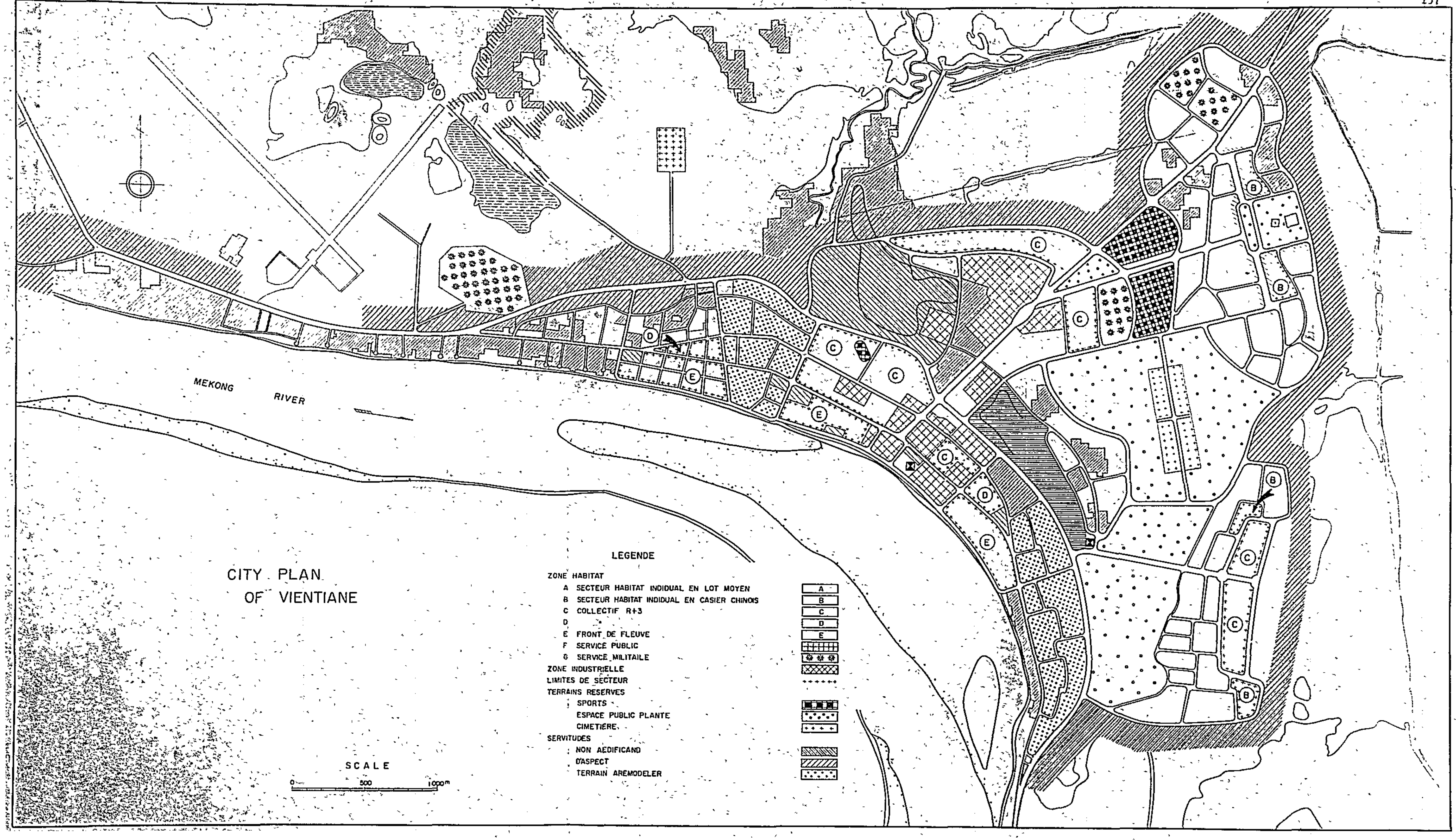
AVERAGE DAILY TRAFFIC ON HIGHWAYS IN THAILAND (1964)



7-YEAR PLAN FOR HIGHWAY CONSTRUCTION AND IMPROVEMENT IN THAILAND (1965~71)



RAILWAY CONSTRUCTION PROGRAMME IN THAILAND



CITY PLAN
OF VIENTIANE
MEKONG
RIVER
LEGENDE
ZONE HABITAT
A SECTEUR HABITAT INDIDUAL EN LOT MOYEN
B SECTEUR HABITAT INDIDUAL EN CASIER CHINOIS
C COLLECTIF R+3
D
E FRONT DE FLEUVE
F SERVICE PUBLIC
G SERVICE MILITAILE
ZONE INDUSTRIELLE
LIMITES DE SECTEUR
TERRAINS RESERVES
SPORTS
ESPACE PUBLIC PLANTE
CIMETIERE
SERVITUDES
NON AEDIFICAND
D'ASPECT
TERRAIN AREMODELER
SCALE
0
500
1000m