

TABLE 8A-5

Table 8A-5 ADDITIONAL UPHILL GRADE COSTS (% of Level Tangent Costs)

Motor Cycle (M/C) and Passenger Car (P/C)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	4.36	9.08	14.04	19.14	23.73	30.11	36.46
24	5.06	10.60	16.28	22.07	28.37	34.86	42.18
32	5.47	11.54	17.71	24.00	30.74	37.83	45.97
40	6.67	13.01	19.54	26.19	33.26	40.92	49.69
48	6.04	12.49	19.22	26.01	33.26	41.13	50.27
56	5.98	12.40	19.19	26.09	33.46	41.63	50.95
64	5.85	12.13	18.81	25.86	33.40	41.59	50.93
72	5.61	11.93	18.36	25.28	32.78	41.12	50.58
80	5.47	11.52	17.79	24.64	32.00	40.32	49.82
88	5.33	11.08	17.18	23.84	31.19	39.41	48.87

Heavy Bus (H/B) and Medium Truck (M/T)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	4.33	8.90	14.00	19.64	25.98	33.15	41.57
24	5.21	10.80	17.29	24.26	32.20	41.35	52.27
32	6.16	12.75	20.53	29.20	39.06	51.09	66.39
40	7.10	14.65	24.08	34.68	48.45	63.93	88.34
48	8.15	16.76	27.74	41.35	60.59	77.87	-
56	9.26	19.17	31.85	49.76	73.66	-	-
64	10.48	21.90	36.29	60.97	-	-	-
72	11.85	24.79	41.04	-	-	-	-
80	13.43	27.36	45.71	-	-	-	-
88	14.24	29.74	-	-	-	-	-

Light Bus (L/B) and Light Truck (L/T)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	3.76	7.94	12.55	17.72	23.54	30.31	38.27
24	4.39	9.20	14.54	20.45	27.20	34.90	44.05
32	4.93	10.17	15.99	22.54	29.84	38.34	48.32
40	5.21	10.81	17.07	23.95	31.89	40.88	51.39
48	5.42	11.44	18.03	25.31	33.47	44.63	53.97
56	5.73	11.96	18.83	26.42	34.97	45.13	56.20
64	6.00	12.45	19.56	27.34	36.15	46.22	58.15
72	6.26	13.04	20.35	28.38	37.45	47.80	60.37
80	6.52	13.49	21.09	29.42	38.79	49.82	63.57
88	6.75	14.00	21.82	30.46	40.30	51.12	65.24

Heavy Truck (H/T)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	8.65	17.22	25.67	33.98	42.40	50.33	58.64
24	12.15	24.27	36.51	48.79	61.16	73.45	87.27
32	14.61	29.37	44.77	60.81	77.61	95.49	116.07
40	16.52	33.38	51.65	71.92	95.29	120.57	-
48	17.99	36.68	57.80	83.37	-	-	-
56	19.62	40.21	64.52	97.25	-	-	-
64	20.05	42.49	70.22	-	-	-	-
72	20.87	45.29	-	-	-	-	-
80	22.12	-	-	-	-	-	-
88	23.10	-	-	-	-	-	-

TABLE 8A-6

Table 8A-6 REDUCTION FOR DOWNHILL GRADE COSTS (% of Level Tangent Costs)

Motor Cycle (M/C) and Passenger Car (P/C)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	3.74	12.26	12.09	11.82	11.24	10.44	8.92
24	4.40	11.55	14.62	14.30	13.69	12.96	11.48
32	4.99	11.16	16.90	16.53	15.99	15.23	13.86
40	5.25	10.47	15.86	18.50	17.93	17.29	15.97
48	5.47	10.51	15.61	19.68	19.97	19.22	18.08
56	5.67	10.56	15.42	19.36	21.69	21.14	19.97
64	5.80	10.62	15.30	19.21	22.81	22.87	21.67
72	5.73	10.70	15.66	19.53	22.99	24.78	23.52
80	5.75	10.81	15.77	19.71	23.13	26.03	25.18
88	5.75	11.01	16.04	20.45	23.84	26.28	26.81

Heavy Bus (H/B) and Medium Truck (M/T)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	5.37	9.54	13.50	16.61	17.35	16.86	16.36
24	6.79	11.88	16.13	19.17	20.80	20.02	19.17
32	7.83	13.60	18.13	20.77	22.78	22.49	21.34
40	8.51	14.99	20.70	21.78	23.59	24.49	23.11
48	8.92	16.02	19.81	22.39	24.33	25.11	24.51
56	9.02	16.28	20.03	22.61	24.47	24.86	24.13
64	8.94	16.06	19.99	22.14	23.30	22.61	-
72	8.85	15.37	20.03	21.90	-	-	-
80	8.73	14.49	19.38	-	-	-	-
88	8.92	13.47	18.28	-	-	-	-

Light Bus (L/B) and Light Truck (L/T)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	3.86	7.21	10.26	11.05	10.55	9.82	8.33
24	4.39	8.11	11.71	13.32	12.80	12.21	10.83
32	4.69	8.46	12.68	15.27	14.86	14.28	13.07
40	4.96	8.76	13.12	16.55	16.85	16.40	15.27
48	5.06	9.26	13.91	17.07	19.05	18.51	17.60
56	5.55	9.67	14.41	17.56	20.79	20.62	19.78
64	5.42	10.14	15.16	18.30	21.59	22.82	21.97
72	5.70	10.67	16.10	19.79	23.09	25.29	24.68
80	5.98	11.13	16.83	21.28	24.74	27.51	27.47
88	6.24	11.96	17.67	23.35	27.35	29.75	29.65

Heavy Truck (H/T)

SPEED (km/h)	GRADE (%)						
	1	2	3	4	5	6	7
16	8.07	11.67	15.28	14.35	11.56	9.26	7.00
24	10.30	14.85	18.70	17.28	14.53	11.51	8.36
32	11.95	17.91	21.23	19.59	17.16	13.75	-
40	13.05	19.75	21.73	20.38	18.53	14.95	-
48	13.59	20.90	21.81	20.83	19.25	-	-
56	12.99	20.63	21.77	-	-	-	-
64	12.80	20.41	22.59	-	-	-	-
72	10.43	19.47	22.66	-	-	-	-
80	11.96	18.37	-	-	-	-	-
88	12.40	17.58	-	-	-	-	-

TABLE 8A-7
1 of 2Table 8A-7 ADDITIONAL COST PER SPEED CHANGE CYCLE ABOVE CONTINUING AT INITIAL SPEED
(% of Level Tangent Cost per km at Initial Speed)

Motor Cycle (M/C) and Passenger Car (P/C)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	6.55	-	-	-	-	-	-	-	-	-
24	13.13	4.71	-	-	-	-	-	-	-	-
32	21.35	11.47	6.21	-	-	-	-	-	-	-
40	31.25	20.75	14.73	8.04	-	-	-	-	-	-
48	42.90	31.99	25.71	18.42	10.04	-	-	-	-	-
56	56.34	45.25	38.80	31.48	22.74	12.43	-	-	-	-
64	71.98	60.79	54.22	46.86	38.14	27.95	15.21	-	-	-
72	89.77	78.59	72.07	64.66	55.95	46.03	33.19	18.19	-	-
80	110.16	98.99	92.37	84.97	76.21	66.53	53.92	39.14	21.42	-
88	133.35	122.03	115.53	107.98	99.11	89.36	77.14	62.71	45.36	24.74

Light Bus (L/B) and Light Truck (L/T)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	7.02	-	-	-	-	-	-	-	-	-
24	13.41	5.04	-	-	-	-	-	-	-	-
32	21.80	12.25	6.61	-	-	-	-	-	-	-
40	32.04	21.55	15.46	8.37	-	-	-	-	-	-
48	44.19	32.96	26.49	19.04	10.25	-	-	-	-	-
56	58.36	46.55	39.79	32.05	23.13	12.50	-	-	-	-
64	74.52	62.30	55.36	47.40	38.24	27.52	15.02	-	-	-
72	92.45	79.84	72.80	64.77	55.58	44.93	32.45	17.61	-	-
80	111.73	100.50	91.84	83.86	74.67	64.17	51.81	37.28	20.22	-
88	131.66	118.89	111.74	103.83	94.81	84.36	72.45	58.39	41.82	22.54

TABLE 8A-7
2 of 2Table 8A-7 ADDITIONAL COST PER SPEED CHANGE CYCLE ABOVE CONTINUING AT INITIAL SPEED
(% of Level Tangent Cost per km at Initial Speed)

Heavy Bus (H/B) and Medium Truck (M/T)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	9.74	-	-	-	-	-	-	-	-	-
24	19.07	6.78	-	-	-	-	-	-	-	-
32	30.66	16.83	8.95	-	-	-	-	-	-	-
40	43.63	29.12	20.91	11.25	-	-	-	-	-	-
48	58.39	43.52	35.12	25.31	13.69	-	-	-	-	-
56	74.64	59.77	51.32	41.61	30.05	16.41	-	-	-	-
64	92.74	78.01	69.60	59.99	51.71	35.24	19.33	-	-	-
72	112.45	97.91	89.71	80.31	69.31	56.33	40.91	22.36	-	-
80	133.58	119.47	111.44	102.24	91.59	79.04	64.20	46.50	25.36	-
88	155.53	141.85	134.14	125.26	115.00	102.91	88.77	71.92	51.84	28.00

Heavy Truck (H/T)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	17.01	-	-	-	-	-	-	-	-	-
24	35.79	14.75	-	-	-	-	-	-	-	-
32	61.34	42.47	21.02	-	-	-	-	-	-	-
40	93.05	66.71	49.76	27.78	-	-	-	-	-	-
48	130.11	102.41	84.85	62.61	34.78	-	-	-	-	-
56	171.27	143.59	125.78	103.48	75.91	41.92	-	-	-	-
64	215.90	188.86	171.16	149.36	122.51	89.54	49.28	-	-	-
72	262.58	236.37	219.46	198.55	172.84	141.38	103.07	56.25	-	-
80	309.51	284.64	268.60	248.80	224.63	195.11	159.27	115.53	62.71	-
88	352.90	329.71	314.79	296.50	274.13	246.88	213.77	173.52	125.09	67.35

TABLE 8A-8
1 of 2Table 8A-8 ADDITIONAL TIME FOR SPEED CHANGE CYCLE ABOVE CONTINUING AT INITIAL SPEED
(% of Initial Time per km at Initial Speed)

Motor Cycle (M/C) and Passenger Car (P/C)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	2.42	-	-	-	-	-	-	-	-	-
24	4.80	1.10	-	-	-	-	-	-	-	-
32	7.97	2.98	1.12	-	-	-	-	-	-	-
40	11.92	5.60	3.20	1.12	-	-	-	-	-	-
48	16.61	8.98	5.95	3.36	1.10	-	-	-	-	-
56	22.06	13.10	9.46	6.22	3.36	1.06	-	-	-	-
64	28.29	17.98	13.63	9.73	6.21	3.26	1.02	-	-	-
72	35.28	23.62	18.50	13.90	9.65	5.98	3.02	0.94	-	-
80	42.96	30.00	24.08	18.72	13.68	9.20	5.44	2.80	0.88	-
88	51.39	37.05	30.36	24.11	18.30	12.94	8.27	5.02	2.46	0.79

Light Bus (L/B) and Light Truck (L/T)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	1.79	-	-	-	-	-	-	-	-	-
24	3.65	1.13	-	-	-	-	-	-	-	-
32	6.18	2.75	1.31	-	-	-	-	-	-	-
40	9.44	4.96	3.04	1.40	-	-	-	-	-	-
48	13.49	7.82	5.42	3.26	1.44	-	-	-	-	-
56	18.37	11.48	8.51	5.82	3.47	1.51	-	-	-	-
64	24.19	16.00	12.35	9.09	6.14	3.65	1.60	-	-	-
72	30.96	21.31	16.99	13.03	9.50	6.41	3.82	1.73	-	-
80	38.96	27.84	22.72	18.08	13.84	10.08	6.72	3.92	1.76	-
88	48.22	35.55	29.66	24.11	19.01	14.43	10.38	6.95	4.14	1.94

TABLE 8A-8
2 of 2Table 8A-8 ADDITIONAL TIME FOR SPEED CHANGE CYCLE ABOVE CONTINUING AT INITIAL SPEED (2)
(% of Initial Time per km at Initial Speed)

Heavy Bus (H/B) and Medium Truck (M/T)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	2.35	-	-	-	-	-	-	-	-	-
24	5.28	1.49	-	-	-	-	-	-	-	-
32	9.38	3.94	1.70	-	-	-	-	-	-	-
40	14.68	7.44	4.48	1.80	-	-	-	-	-	-
48	21.12	12.00	8.26	4.85	1.87	-	-	-	-	-
56	28.73	17.70	13.05	8.90	5.10	2.02	-	-	-	-
64	37.57	24.58	19.01	13.95	9.47	5.31	1.98	-	-	-
72	42.24	29.06	23.30	17.98	13.25	8.77	4.86	1.79	-	-
80	58.64	42.08	34.64	27.76	21.44	15.44	10.16	5.76	2.24	-
88	71.02	52.98	44.62	36.70	29.48	22.53	16.19	10.82	6.25	2.82

Heavy Truck (H/T)

INITIAL SPEED (km/h)	REDUCED SPEED (km/h)									
	Stop	16	24	32	40	48	56	64	72	80
16	2.35	-	-	-	-	-	-	-	-	-
24	5.52	1.32	-	-	-	-	-	-	-	-
32	10.21	3.81	1.60	-	-	-	-	-	-	-
40	16.64	7.80	4.48	1.88	-	-	-	-	-	-
48	25.06	13.68	9.02	5.14	2.11	-	-	-	-	-
56	35.90	22.06	15.90	10.53	5.99	2.46	-	-	-	-
64	49.66	33.54	25.92	18.94	12.67	7.42	3.14	-	-	-
72	67.32	48.96	40.10	31.46	23.40	15.91	9.43	4.10	-	-
80	90.72	69.60	59.20	48.96	39.04	29.76	21.12	13.28	6.24	-
88	122.67	97.86	85.71	73.74	62.04	50.69	39.60	29.04	18.83	9.15

Appendix 9

ROAD INVENTORY

Appendix 9

ROAD INVENTORY

ABBREVIATION

Table 9A-1 Road Inventory, Segment 1 (Nong Bua - Route 11)

Table 9A-2 Road Inventory, Segment 4 (Route 11 - Nong Ngu Luam)

Table 9A-3 Road Inventory, Segment 8 (Nong Ngu Luam - Hin Dat Yai)

Table 9A-4 Road Inventory, Segment 9 (Wang Phikun - Sap Mai Daeng)

Table 9A-5 Road Inventory, Segment 10 (Hin Dat Yai - Sap Mai Daeng)

Table 9A-6 Road Inventory, Segment 11 (Hin Dat Yai - Khao Khát)

Table 9A-7 Road Inventory, Segment 14 (Khao Khát - Sap Samo Thot (N))

Table 9A-8 Road Inventory, Segment 15 (Sap Mai Daeng - Sap Samo Thot (S))

Table 9A-9 Road Inventory, Segment 27 & 29 (Wang Katha - Non Puai)

Table 9A-10 Road Inventory, Segment 28 (Huai Nam Dam - Lup Pho)

Table 9A-11 Road Inventory, Segment 30 (Non Puai - Lup Pho)

C-P-n(ϕ)-L : PIPE CULVERT

C-B-n(AxB)-L : BOX CULVERT

n : Number of rows

ϕ : Diameter (cm)

A : Width (m)

B : Height (m)

L : Length (m)

Br-C(WxL) : CONCRETE BRIDGE

Br-T(WxL) : TIMBER BRIDGE

W : Carriageway Width (m)

L : Bridge length (m)

E. : EARTH

S.A.P. : SOIL AGGREGATE PAVEMENT

S.B.S.T. : SINGLE BITUMINOUS SURFACE TREATMENT

D.B.S.T. : DOUBLE BITUMINOUS SURFACE TREATMENT

TABLE 9A-2
1 of 3

Table 9A-2

ROAD INVENTORY

SEGMENT 4 (ROUTE 11 - NONG NGU LUAM, 32.0 km)
MINE ROAD & RURAL ROAD

STATION (km)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NAME OF VILLAGE		ROUTE 11			BAN PAK DONG								MUANG RAE				
TERRAIN		PLAT															
LAND USE	LEFT					FOREST/PADDY							MAIZE		VILLAGE	MAIZE	
	RIGHT					FOREST/PADDY							MAIZE		VILLAGE	MAIZE	
CARRIAGEWAY WIDTH (m)		5.3	4.8	4.8	5.0	4.8	3.7	4.0	5.5	5.5	5.2	5.0	5.2	5.2	3.7	3.2	3.0
ROAD FORMATION WIDTH (m)		8.8	8.5	8.0	7.5	7.0	5.6	7.4	8.7	8.0	7.2	7.0	7.2	8.4	5.8	6.0	5.5
ROAD SURFACE	TYPE									S.A.P.							
	CONDITION							FAIR/POOR								POOR	
ALIGNMENT	HORIZONTAL									FAIR						BAD	
	VERTICAL									FAIR							
EARTH WORK	LEFT	CUTTING DEPTH (m)			0.3	0.3							1.0				
		EMBANKMENT HEIGHT (m)									0.6		0.4		0.5		1.5
	RIGHT	CUTTING DEPTH (m)				0.3							0.5	0.3	0.5		
		EMBANKMENT HEIGHT (m)				0.5					0.5					0.3	
OVERFLOW SECTION	LENGTH (km)																
	FLOOD HEIGHT (m)																
SIDE DITCH	LEFT	WIDTH (m)			1.0		0.7					0.5					
		DEPTH (m)			0.2		0.4					0.4					
	RIGHT	WIDTH (m)				0.5	1.0					1.5	0.8	1.0			
		DEPTH (m)				0.2	0.3					0.3	0.2	0.4			
BRIDGE AND DRAINAGE STRUCTURES		C-P(60)-8.2	C-P(60)-7.0	C-P(60)-7.8	C-P(60)-8.0	C-P(60)-8.2	Bx-T(3.5x13.0)	C-P-2(120)-6.0	C-P(80)-6.0	C-P(60)-9.0	C-P(80)-8.2	Bx-T(2.5x6.5)	C-P(100)-8.5	Bx-T(3.0x5.0)	C-P(60)-8.0		

Table 9A-3

ROAD INVENTORY

SEGMENT 8 (NONG NGU LUAM - HIN DAT YAI, 13.3 km)
RURAL ROAD

STATION (km)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	13.3			
NAME OF VILLAGE		NONG NGU LUAM			NONG CHAI KHOI							HIN DAT YAI							
TERRAIN		PLAT				ROLLING					PLAT								
LAND USE	LEFT	MAIZE/FOREST			VILLAGE		MAIZE		VILLAGE BEANS		MAIZE								
	RIGHT	MAIZE/FOREST			VILLAGE		MAIZE		VILLAGE BEANS		MAIZE								
CARRIAGEWAY WIDTH (m)		3.8	4.3	4.8	4.8	3.4	3.7	2.8	2.7	3.0	2.7	2.5	3.2	3.0	2.9				
ROAD FORMATION WIDTH (m)		6.0	6.8	7.0	7.8	6.4	6.6	4.7	4.7	5.0	5.0	5.0	5.7	5.0	5.3				
ROAD SURFACE	TYPE	S.A.P.																	
	CONDITION	POOR			BAD		VERY BAD		BAD			VERY BAD		POOR					
ALIGNMENT	HORIZONTAL	PAIR																	
	VERTICAL					POOR			BAD				POOR						
EARTH WORK	LEFT	CUTTING DEPTH (m)					0.3								0.2				
		EMBANKMENT HEIGHT (m)	0.4	0.5												0.4	1.0		
	RIGHT	CUTTING DEPTH (m)					0.3												
		EMBANKMENT HEIGHT (m)	0.5												0.5	1.0			
OVERFLOW SECTION	LENGTH (km)																		
	FLOOD HEIGHT (m)													0.2	0.5				
SIDE DITCH	LEFT	WIDTH (m)																	
		DEPTH (m)																	
	RIGHT	WIDTH (m)																	
		DEPTH (m)																	
BRIDGE AND DRAINAGE STRUCTURES		C-P (80)-10.1	C-P (80)-10.1	C-P (60)-9.4	B-T (3.7x9.4)		C-P (40)-7.0	B-T (3.0x9.0)	C-P (40)-7.5	C-P (40)-7.1	C-P (40)-6.0	C-P-2 (60)-6.2	C-P (40)-6.8	C-P (60)-7.0	C-P (40)-7.6	C-P (60)-5.0	C-P (100)-8.5	C-P (60)-6.0	C-P (60)-6.4

Table 9A-4

ROAD INVENTORY

SEGMENT 9 (WANG PHIKUN - SAP MAI DAENG, 12.3 km)
ARD ROAD

STATION (km)		0	1	2	3	4	5	6	7	8	9	10	11	12	12.3	
NAME OF VILLAGE		WANG PHIKUN			BONG BUN CHALOEN								SAP MAI DAENG			
TERRAIN		FLAT														
LAND USE	LEFT	MAIZE			PADDY		MAIZE									
	RIGHT	MAIZE			PADDY		MAIZE									
CARRIAGEWAY WIDTH (m)		6.5	5.5	6.5	6.5	3.5	5.0	5.3	5.5	5.5	4.5	5.0	5.0	5.0		
ROAD FORMATION WIDTH (m)		9.5	8.3	9.5	8.8	6.5	7.5	7.5	7.0	7.3	8.0	8.2	8.5	8.0		
ROAD SURFACE	TYPE	S.A.P.														
	CONDITION	FAIR				BAD		FAIR								
ALIGNMENT	HORIZONTAL															
	VERTICAL															
EARTH WORK	LEFT	CUTTING DEPTH (m)				0.5		1.5		1.5			1.0			
		EMBANKMENT HEIGHT (m)				0.5		0.6		0.5			1.3			
	RIGHT	CUTTING DEPTH (m)				1.5										
		EMBANKMENT HEIGHT (m)	0.4				0.7		0.6		1.0		0.5			
OVERFLOW SECTION	LENGTH (km)				0.4					0.3						
	FLOOD HEIGHT (m)				0.3					1.0						
SIDE DITCH	LEFT	WIDTH (m)						1.5		3.5						
		DEPTH (m)						0.8		0.5						
	RIGHT	WIDTH (m)						4.0								
		DEPTH (m)						0.5								
BRIDGE AND DRAINAGE STRUCTURES			C-P (80)-9.3	Br-T (3.5x15.0)	C-P (100)-10.0		C-P (80)-9.5	C-P (80)-10.0	C-P (80)-9.5	C-P (80)-9.0	C-P (80)-8.5	C-P (80)-5.0	C-P-3 (80)-6.2	C-P (60)-11.0	C-P (60)-11.5	C-P (80)-10.3

Table 9A-5

ROAD INVENTORY

SEGMENT 10 (HIN DAT YAI - SAP MAI DAENG, 6.0 km)
ARD ROAD

STATION (km)		0	1	2	3	4	5	6													
NAME OF VILLAGE		HIN DAT YAI		SAP PHRAIWAN			SAP MAI DAENG														
TERRAIN		ROLLING			FLAT																
LAND USE	LEFT				MAIZE																
	RIGHT				MAIZE																
CARRIAGEWAY WIDTH (m)		4.3	5.0	5.2	5.2	5.3	4.8	4.7													
ROAD FORMATION WIDTH (m)		7.0	7.8	8.5	8.0	8.5	7.3	8.2													
ROAD SURFACE	TYPE				S.A.P.																
	CONDITION				FAIR																
ALIGNMENT	HORIZONTAL				FAIR																
	VERTICAL				FAIR																
EARTH WORK	LEFT	CUTTING DEPTH (m)																			
		EMBANKMENT HEIGHT (m)	0.5	1.0	0.8	0.3	1.3	0.6	1.7												
	RIGHT	CUTTING DEPTH (m)																			
		EMBANKMENT HEIGHT (m)	0.5	0.7	1.2	0.6	1.3	0.8	1.5												
OVERFLOW SECTION	LENGTH (km)				0.1																
	FLOOD HEIGHT (m)				0.2																
SIDE DITCH	LEFT	WIDTH (m)																			
		DEPTH (m)																			
	RIGHT	WIDTH (m)																			
		DEPTH (m)																			
BRIDGE AND DRAINAGE STRUCTURES		C-P-2 (80)-14.0	C-P-2 (80)-15.0	C-P-2 (80)-14.0	C-P-2 (60)-10.0	C-P (40)-5.0	C-P-2 (80)-10.0	C-P (60)-10.0	C-P-3 (80)-11.0	C-P-3 (100)-11.0	2x-T (3.0x9.0) (BROKEN)	C-P (80)-16.0	C-P (80)-6.8	C-P-2 (100)-16.2	C-P (100)-15.2	C-P (100)-15.2					

Table 9A-6

ROAD INVENTORY

SEGMENT 11 (HIN DAT YAI - KHAO KHAT, 4.7 km)
RURAL ROAD

STATION (km)		0	1	2	3	4	4.7
NAME OF VILLAGE		HIN DAT YAI →			← KHAO KHAT		
TERRAIN		ROLLING					
LAND USE	LEFT	MAIZE			VILLAGE MAIZE		
	RIGHT	MAIZE			VILLAGE MAIZE		
CARRIAGEWAY WIDTH (m)		3.0	2.8	2.9	3.0	3.0	
ROAD FORMATION WIDTH (m)		5.5	5.2	5.7	5.8	4.5	
ROAD SURFACE	TYPE	S.A.P.					
	CONDITION	POOR					
ALIGNMENT	HORIZONTAL	FAIR					
	VERTICAL	BAD					
EARTH WORK	LEFT	CUTTING DEPTH (m)	0.2			0.2	
		EMBANKMENT HEIGHT (m)					
	RIGHT	CUTTING DEPTH (m)				0.2	
		EMBANKMENT HEIGHT (m)					
OVERFLOW SECTION	LENGTH (km)			0.3			
	FLOOD HEIGHT (m)			0.5			
SIDE DITCH	LEFT	WIDTH (m)				0.3	
		DEPTH (m)				0.3	
	RIGHT	WIDTH (m)				0.3	
		DEPTH (m)				0.3	
BRIDGE AND DRAINAGE STRUCTURES			C-2 (40) - 5.8		C-2 (60) - 5.0 C-2 (60) - 7.0	C-2 (50) - 6.0 C-2 (50) - 6.0	C-2 (60) - 6.4

Table 9A-7

ROAD INVENTORY

SEGMENT 14 (KHAO KHAT - SAP SAMO THOT (N), 6.7 km)

RURAL ROAD

STATION (km)		0	1	2	3	4	5	6	6.7											
NAME OF VILLAGE		KHAO KHAT ↗				↖ SAP SAMO THOT (N)														
TERRAIN		FLAT																		
LAND USE	LEFT					MAIZE						VILLAGE								
	RIGHT					MAIZE						VILLAGE								
CARRIAGEWAY WIDTH (m)		2.8	3.0	3.2	3.0	3.0	3.0	3.0	3.0											
ROAD FORMATION WIDTH (m)		5.5	5.5	5.7	5.5	5.2	5.3	6.0												
ROAD SURFACE	TYPE					S.A.P.						S.B.S.T.								
	CONDITION					POOR						FAIR								
ALIGNMENT	HORIZONTAL					FAIR														
	VERTICAL	BAD					FAIR													
EARTH WORK	LEFT	CUTTING DEPTH (m)																		
		EMBANKMENT HEIGHT (m)	0.5	0.5	0.7	0.5	1.2													
	RIGHT	CUTTING DEPTH (m)																		
		EMBANKMENT HEIGHT (m)	1.0	0.5	0.7	0.5	1.0													
OVERFLOW SECTION	LENGTH (km)																			
	FLOOD HEIGHT (m)																			
SIDE DITCH	LEFT	WIDTH (m)																		
		DEPTH (m)																		
	RIGHT	WIDTH (m)																		
		DEPTH (m)																		
BRIDGE AND DRAINAGE STRUCTURES						C-P (80) - 8.0			C-P-2 (60) - 11.2 B-T (3.0x4.5)			B-T (2.8x9.5) C-P (60) - 7.8 C-P-2 (60) - 8.2			C-P (80) - 8.5			C-P (80) - 6.0		

Table 9A-9

ROAD INVENTORY

SEGMENT 27 & 29 (WANG KATHA - NON PUAI, 33.0 km)
ARD ROAD 11010 & RURAL ROAD

STATION (km)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
NAME OF VILLAGE		WANG KATHA			HUAI SAPAN										KHOK SA-AT			
TERRAIN		ROLLING																
LAND USE	LEFT	FOREST																
	RIGHT	FOREST																
CARRIAGEWAY WIDTH (m)		4.3	4.5	3.9	3.8	4.3	4.3	4.2	4.0	4.2	4.1	4.0	4.3	4.0	4.3	4.5	4.0	
ROAD FORMATION WIDTH (m)		6.1	5.8	5.8	5.8	7.0	7.0	6.0	5.0	5.2	5.4	5.5	6.7	5.8	6.8	7.4	7.0	
ROAD SURFACE	TYPE	S.A.P.																
	CONDITION	FAIR																
ALIGNMENT	HORIZONTAL	FAIR			BAD		FAIR			BAD		FAIR						
	VERTICAL	FAIR			BAD		FAIR			BAD		FAIR			BAD		FAIR	
EARTH WORK	LEFT	CUTTING DEPTH (m)	1.5															
		EMBANKMENT HEIGHT (m)	1.1	0.8	0.5	0.6	0.9	0.5	1.0			0.8	0.8	0.6		0.8		
	RIGHT	CUTTING DEPTH (m)	0.7															
		EMBANKMENT HEIGHT (m)	0.5	0.7	0.3		0.5	0.5	0.9			1.0	1.0	0.5	0.9		0.9	
OVERFLOW SECTION	LENGTH (km)	0.05																
	FLOOD HEIGHT (m)	0.5																
SIDE DITCH	LEFT	WIDTH (m)	1.5	1.5						1.5		2.0		1.0		1.0		
		DEPTH (m)	0.3	0.4						0.3		0.5		0.7		1.5		
	RIGHT	WIDTH (m)	1.5	3.0			2.0			1.2		1.5		1.5				
		DEPTH (m)	0.2	0.5			0.4			0.5		0.5		0.5				
BRIDGE AND DRAINAGE STRUCTURES		C-P-2(60)-12.3 C-P(60)-12.4	C-P(60)-12.4 C-P-3(60)-13.4	C-P-2(80)-14.8 C-P(60)-12.4 C-P(60)-10.4	Br-T(4.0x25.3) C-P-2(60)-13.5 C-P(80)-14.4	C-P(50)-12.3 C-P-2(60)-12.6 C-P-2(60)-13.4	C-P-2(50)-12.4 C-P-2(50)-12.4	C-P(50)-12.4 C-P(60)-12.4 C-P-2(60)-12.3 C-P-2(60)-12.5	C-P(60)-13.4 C-P-2(80)-12.5 C-P(50)-12.3 Br-T(4.0x25.5)	C-P-2(80)-13.4 C-P-2(60)-13.4	C-P-2(80)-14.5	C-P-2(60)-12.8 C-P-2(60)-12.4	C-P(60)-12.4 C-P-2(60)-12.4 C-P(60)-12.8 C-P(60)-12.0	C-P(80)-13.4 C-P(80)-12.4				

Table 9A-9

ROAD INVENTORY

SEGMENT 27 & 29 (WANG KATHA - NON PUAI, 33.0 km) - Continued
ARD ROAD 11010 & RURAL ROAD

STATION (km)		30	31	32	33
NAME OF VILLAGE		PAKHAI CHONG MAEO	RURAL ROAD		NON PUAI
TERRAIN		TERRACE			
LAND USE	LEFT	FOREST	JUTE/PADDY		
	RIGHT	FOREST	JUTE/PADDY		
CARRIAGEWAY WIDTH (m)		3.0	3.5		
ROAD FORMATION WIDTH (m)		4.5	4.8	3.0	4.5
ROAD SURFACE	TYPE	S.A.P.			
	CONDITION	FAIR			
ALIGNMENT	HORIZONTAL	FAIR	BAD	FAIR	
	VERTICAL	FAIR			
EARTH WORK	LEFT	CUTTING DEPTH (m)			
		EMBANKMENT HEIGHT (m)			
	RIGHT	CUTTING DEPTH (m)			
		EMBANKMENT HEIGHT (m)			
OVERFLOW SECTION	LENGTH (km)		1.1		
	FLOOD HEIGHT (m)		0.5		
SIDE DITCH	LEFT	WIDTH (m)			
		DEPTH (m)			
	RIGHT	WIDTH (m)			
		DEPTH (m)			
BRIDGE AND DRAINAGE STRUCTURES		C-P (60)-8.0	C-P (60)-8.0 B-C (7.0x1.00) UNDER CONST.	C-P (100)-8.4	

TABLE 9A-10
1 of 3

Table 9A-10

ROAD INVENTORY

SEGMENT 28 (HUAI NAM DAM - LUP PHO, 33.0 km)
IRD ROAD

STATION (km)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15													
NAME OF VILLAGE		<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">↑</div> HUAI NAM DAM </div>																												
TERRAIN		ROLLING																												
LAND USE	LEFT	FOREST																												
	RIGHT	FOREST																												
CARRIAGEWAY WIDTH (m)			3.5	4.0	3.5	3.5	4.0	3.5	3.5	3.5	3.5	3.8	3.5	3.5	4.0	4.0	3.5													
ROAD FORMATION WIDTH (m)		4.5	5.0	8.5	7.0	6.5	7.0	7.3	7.5	7.5	7.5	7.0	8.0	10.0	10.0	8.5	8.5													
ROAD SURFACE	TYPE	E. S.A.P. E.																												
	CONDITION	BAD FAIR BAD FAIR																												
ALIGNMENT	HORIZONTAL	FAIR																												
	VERTICAL	FAIR BAD PAIR BAD PAIR BAD PAIR BAD PAIR																												
EARTH WORK	LEFT	CUTTING DEPTH (m)	0.3	0.5	0.6	2.5										0.2														
		EMBANKMENT HEIGHT (m)					0.8	0.5	0.8		0.5																			
	RIGHT	CUTTING DEPTH (m)		0.5	0.6	2.5																								
		EMBANKMENT HEIGHT (m)					1.0		0.6		0.5																			
OVERFLOW SECTION	LENGTH (km)																													
	FLOOD HEIGHT (m)																													
SIDE DITCH	LEFT	WIDTH (m)																												
		DEPTH (m)																												
	RIGHT	WIDTH (m)																												
		DEPTH (m)																												
BRIDGE AND DRAINAGE STRUCTURES			C-P(100)-7.2		C-P(100)-11.0	Bx-C(6.5x20.0)	C-P(60)-10.0	Bx-C(6.5x20.0)	C-P(100)-12.0	C-P(60)-10.0		C-P(100)-16.0		C-P(80)-10.3		C-P(60)-10.3	C-P(80)-10.3	C-P(80)-10.0	C-P(100)-12.0	C-P(100)-12.0	C-P(100)-12.2	C-P(100)-12.3		C-B(2.4x2.4)-16.0		C-P(60)-8.0	C-P(60)-13.2	C-P(100)-14.0	C-B(2.4x2.4)-14.0	C-P(100)-17.0

Table 9A-10

ROAD INVENTORY

SEGMENT 28 (HUAI NAM DAM - LUP PHO, 33.0 km) - Continued

IRD ROAD

STATION (km)		15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
NAME OF VILLAGE																	
TERRAIN						ROLLING						FLAT			ROLLING		
LAND USE	LEFT					FOREST						PADDY		CASSAVA		FOREST	
	RIGHT					FOREST						PADDY		CASSAVA		FOREST	
CARRIAGEWAY WIDTH (m)		3.5	3.5	3.5	4.0	3.5	3.5	4.0	4.5	4.5	3.7	3.5	3.0	4.0	3.8	3.0	3.0
ROAD FORMATION WIDTH (m)		8.5	7.5	7.5	8.5	7.8	7.0	7.5	8.0	7.0	8.0	8.5	6.5	8.0	7.3	7.0	7.5
ROAD SURFACE	TYPE					S.A.P.								S.A.P.			
	CONDITION					FAIR								GOOD			
ALIGNMENT	HORIZONTAL		BAD						FAIR								
	VERTICAL		FAIR		BAD		FAIR	BAD					FAIR				
EARTH WORK	LEFT	CUTTING DEPTH (m)			1.6												
		EMBANKMENT HEIGHT (m)	1.7			2.5	0.8			0.9	1.2	0.8	1.9			1.3	
	RIGHT	CUTTING DEPTH (m)			1.5												
		EMBANKMENT HEIGHT (m)	1.5	2.5		3.5	1.0			0.9	0.8	1.0	0.8	1.8		1.0	1.3
OVERFLOW SECTION	LENGTH (km)																
	FLOOD HEIGHT (m)																
SIDE DITCH	LEFT	WIDTH (m)															
		DEPTH (m)															
	RIGHT	WIDTH (m)															
		DEPTH (m)															
BRIDGE AND DRAINAGE STRUCTURES			C-P(100)-14.2 C-P(60)-12.0		C-P(100)-15.0 C-P(100)-16.2	C-P(100)-14.0 C-P(100)-16.0	C-P(60)-17.5		C-P(60)-10.0 C-B(1.8x1.8)-16.0		C-P(60)-8.3		C-P-2(100)-11.0 C-P-2(100)-11.2 C-P-2(20)-11.0	Br-C(6.5x20.0) C-P(100)-11.1 C-P(150)-14.4 Br-C(6.5x20.0)		C-P(80)-10.5 C-P(100)-11.5 C-P(100)-10.0	C-P-2(100)-12.4 C-P-2(100)-12.3

Table 9A-11

ROAD INVENTORY

SEGMENT 30 (NON PUAI - LUP PHO, 6.0 km)

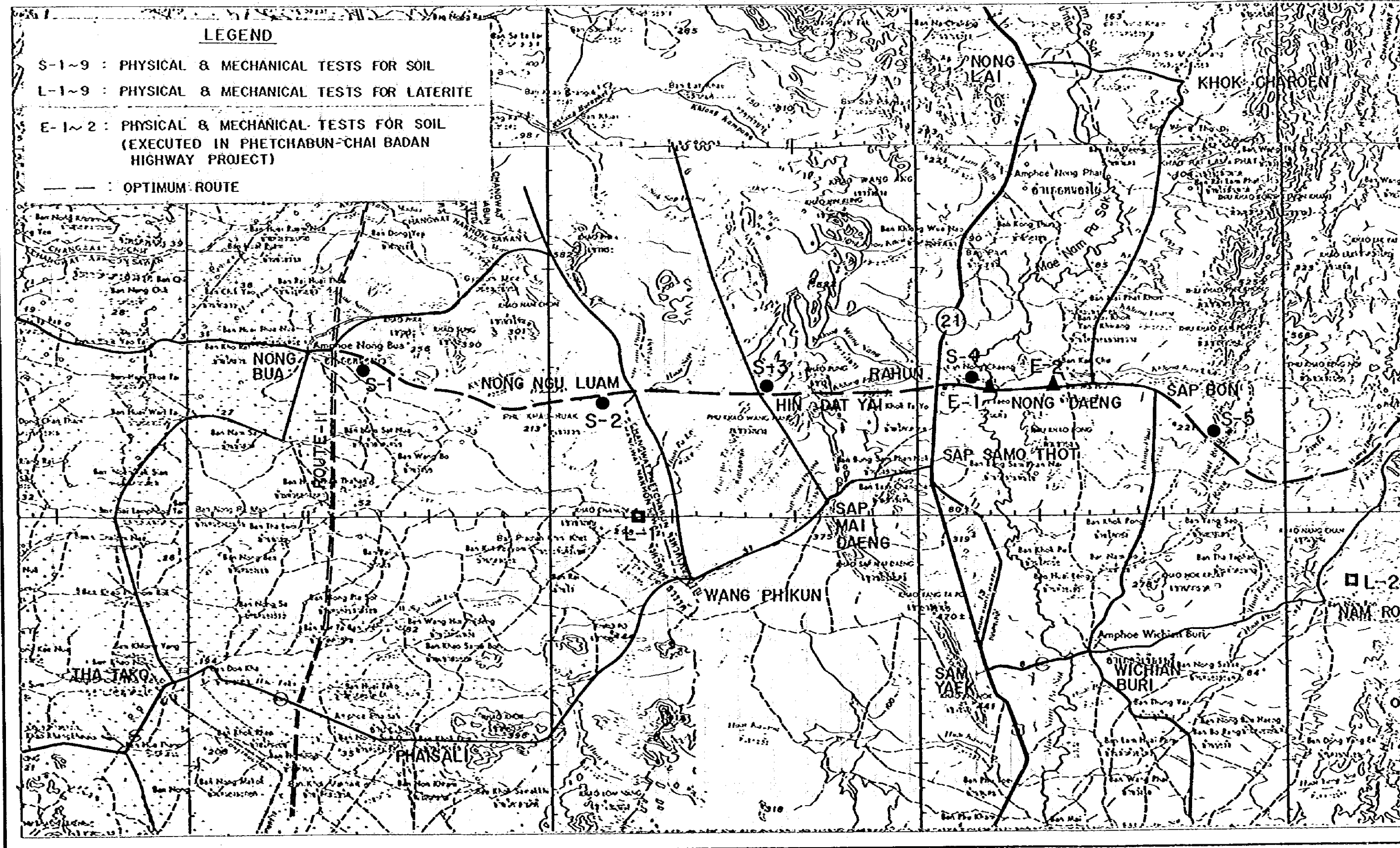
RURAL ROAD

STATION (km)		0	1	2	3	4	5	6														
NAME OF VILLAGE		NON PUAI																LUP PHO				
TERRAIN		FLAT																				
LAND USE	LEFT	PADDY/FOREST/KENAF																				
	RIGHT	PADDY/FOREST/KENAF																				
CARRIAGEWAY WIDTH (m)																						
ROAD FORMATION WIDTH (m)		4.8	5.4	5.0	5.0	6.0	5.0	4.4														
ROAD SURFACE	TYPE	S.A.P.																				
	CONDITION	FAIR																				
ALIGNMENT	HORIZONTAL								BAD													
	VERTICAL				BAD																	
EARTH WORK	LEFT	CUTTING DEPTH (m)																				
		EMBANKMENT HEIGHT (m)																				
	RIGHT	CUTTING DEPTH (m)																				
		EMBANKMENT HEIGHT (m)																				
OVERFLOW SECTION	LENGTH (km)								1.0													
	FLOOD HEIGHT (m)								0.3													
SIDE DITCH	LEFT	WIDTH (m)																				
		DEPTH (m)																				
	RIGHT	WIDTH (m)																				
		DEPTH (m)																				
BRIDGE AND DRAINAGE STRUCTURES		C-P (50)-7.0 C-P (50)-8.2 C-P (50)-9.0 C-P (40)-8.2 C-P (40)-8.1 C-P (40)-7.8 Br-T (3.6x15.5) Br-T (3.6x6.0) Br-T (3.6x11.7) Br-T (3.4x17.8)																				

Appendix 10

SOIL AND MATERIAL INVESTIGATION

FIGURE 10A-1 LOCATION OF



IOA-1 LOCATION OF SOIL SAMPLINGS

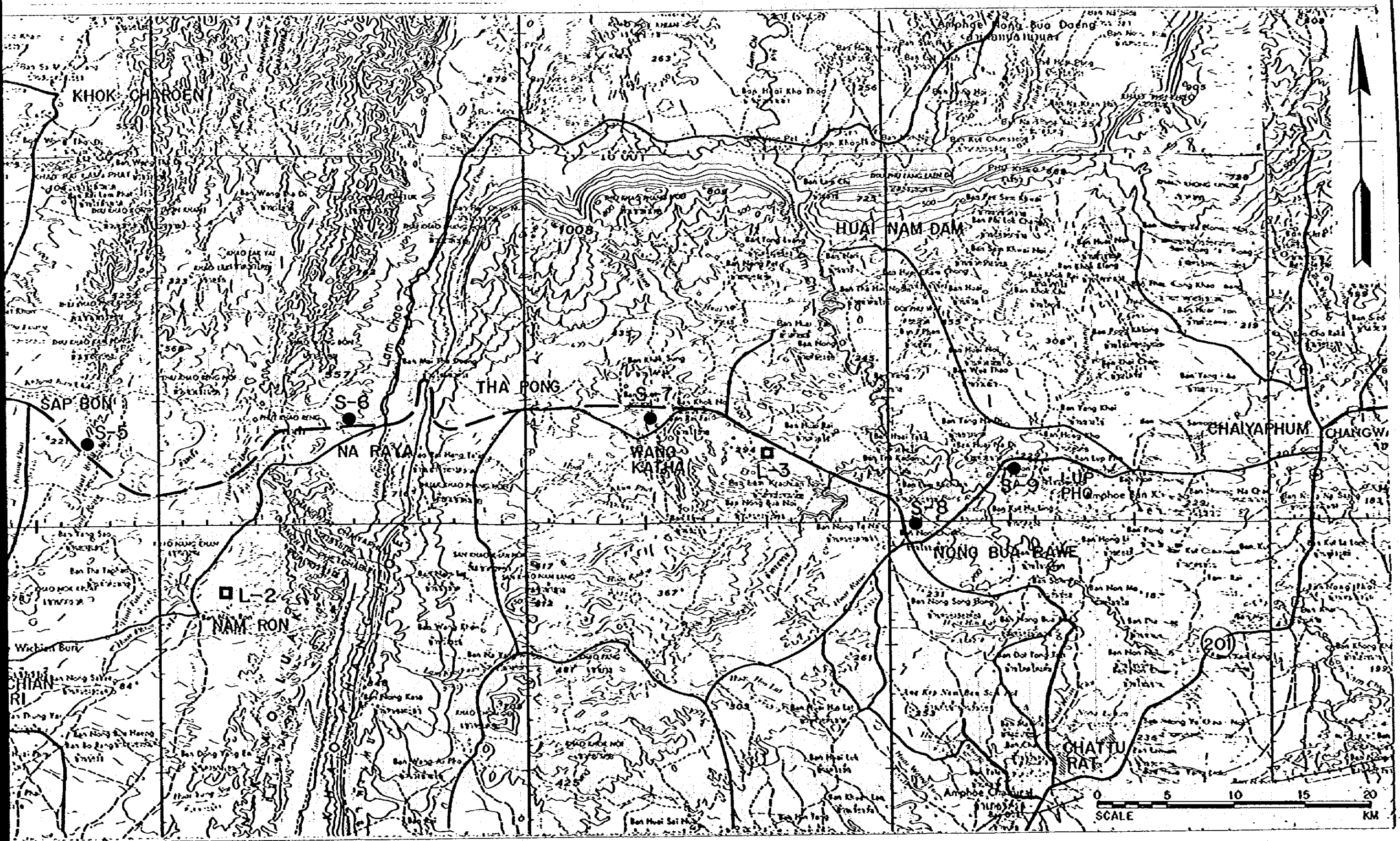
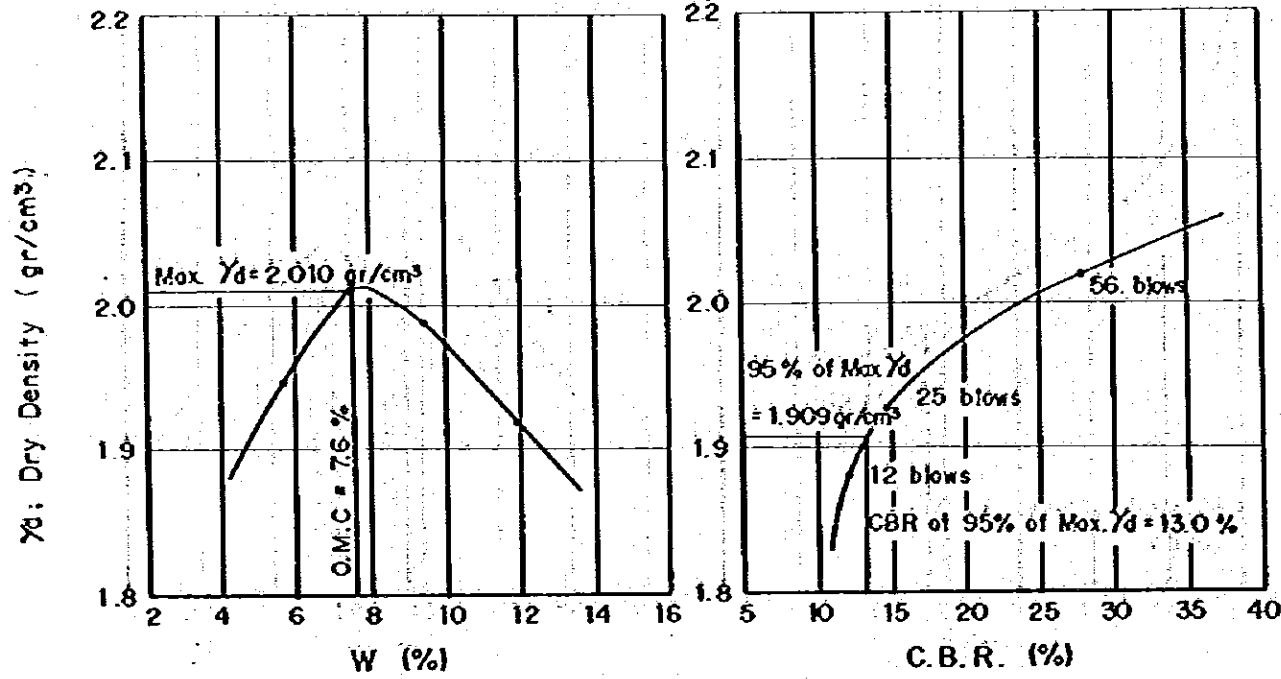
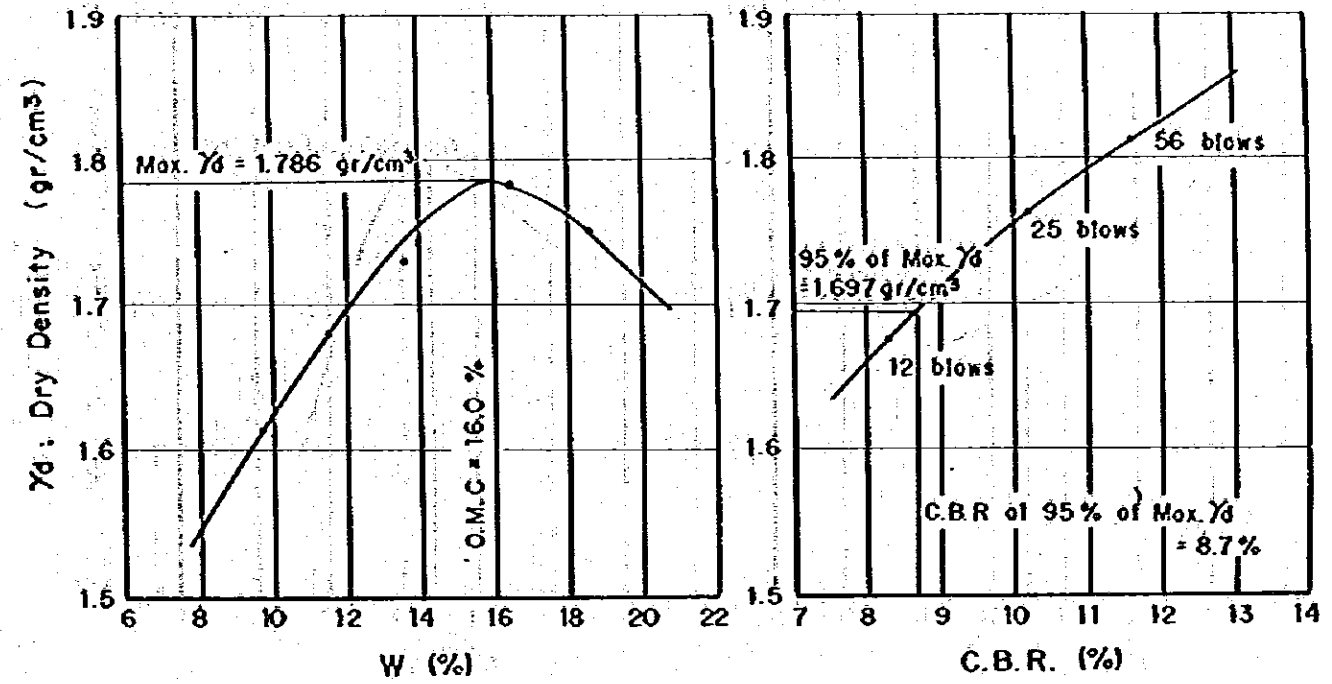


Figure IOA-2 SOIL TEST RESULTS (1)

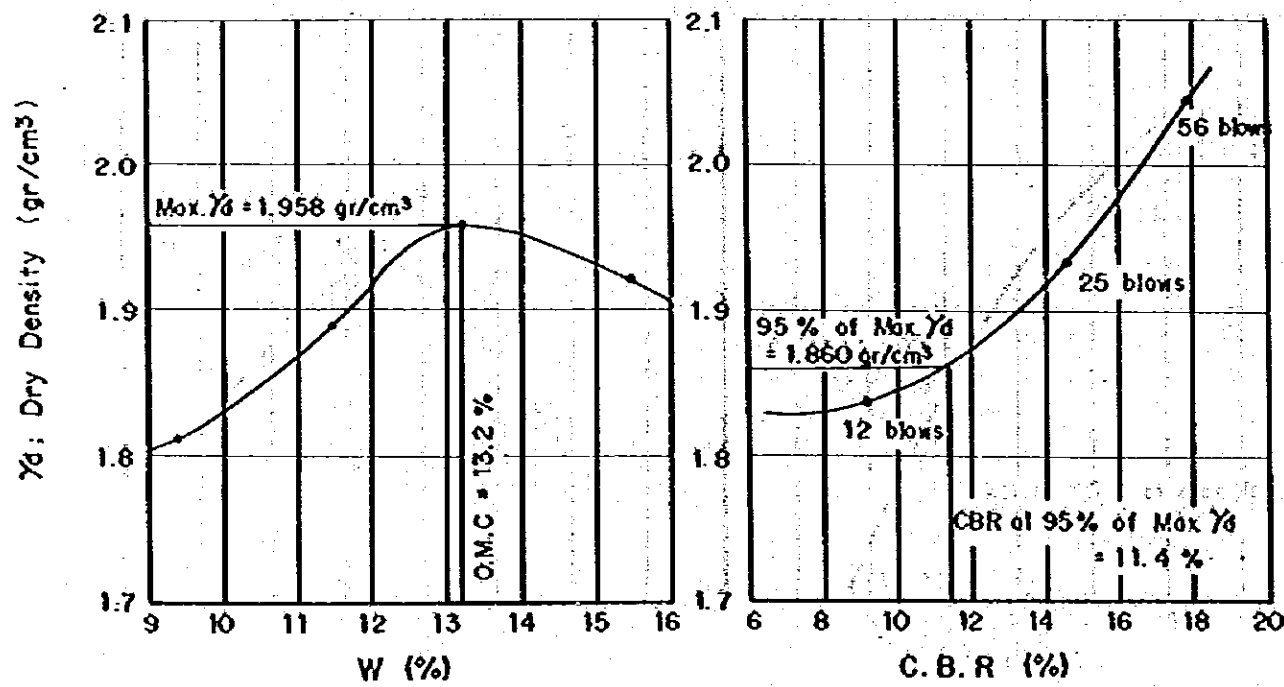
SAMPLE S-1
(SEGMENT - 2)



SAMPLE S-3
(SEGMENT - 7)



SAMPLE S-2
(SEGMENT - 5)



SAMPLE S-4
(SEGMENT - 18)

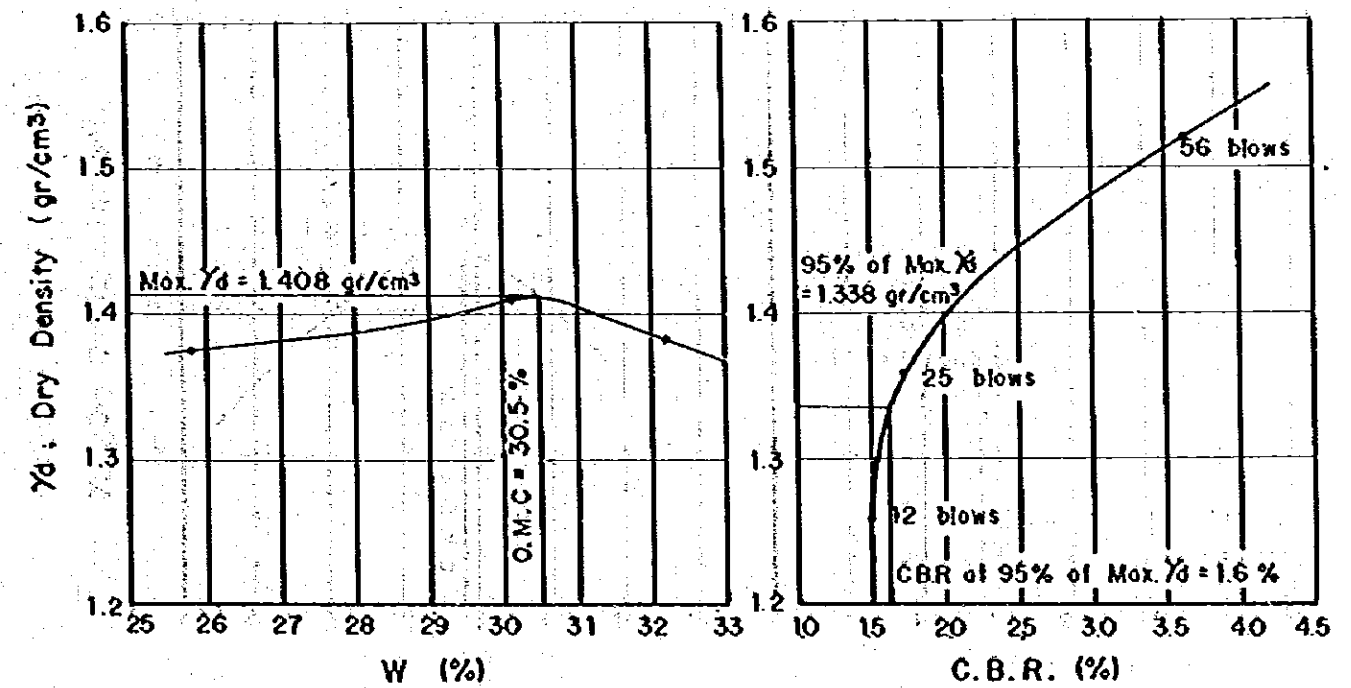
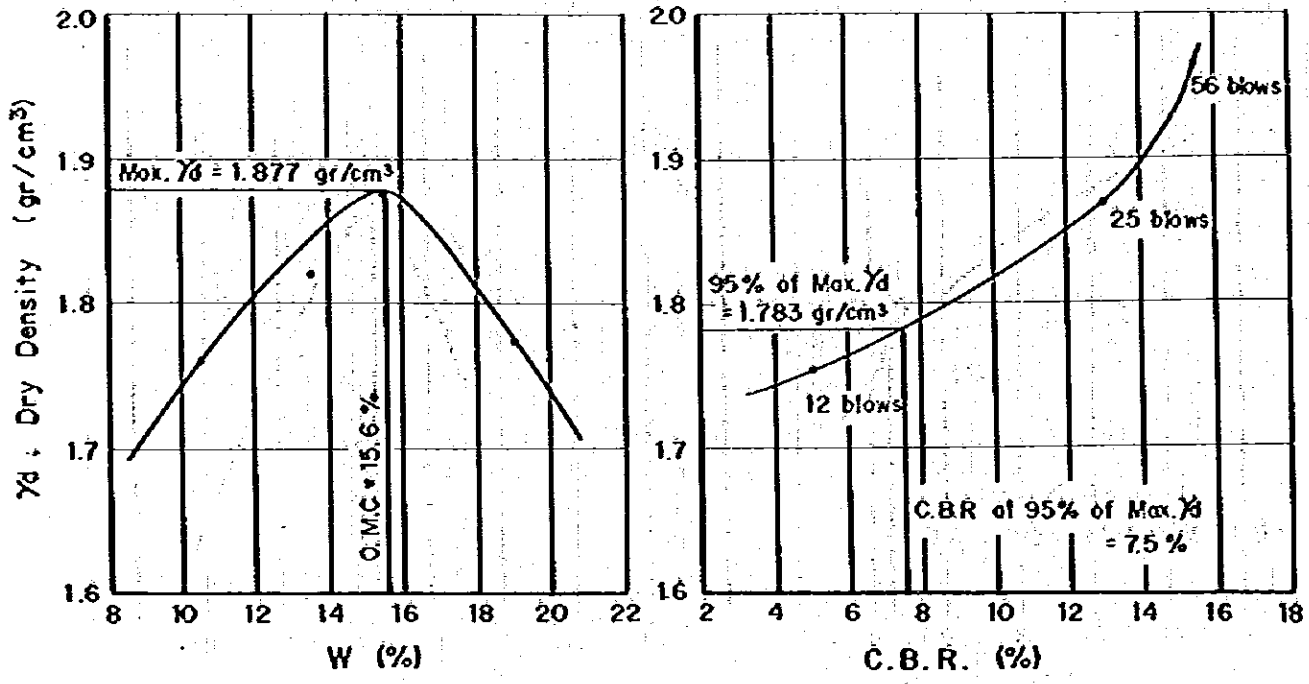
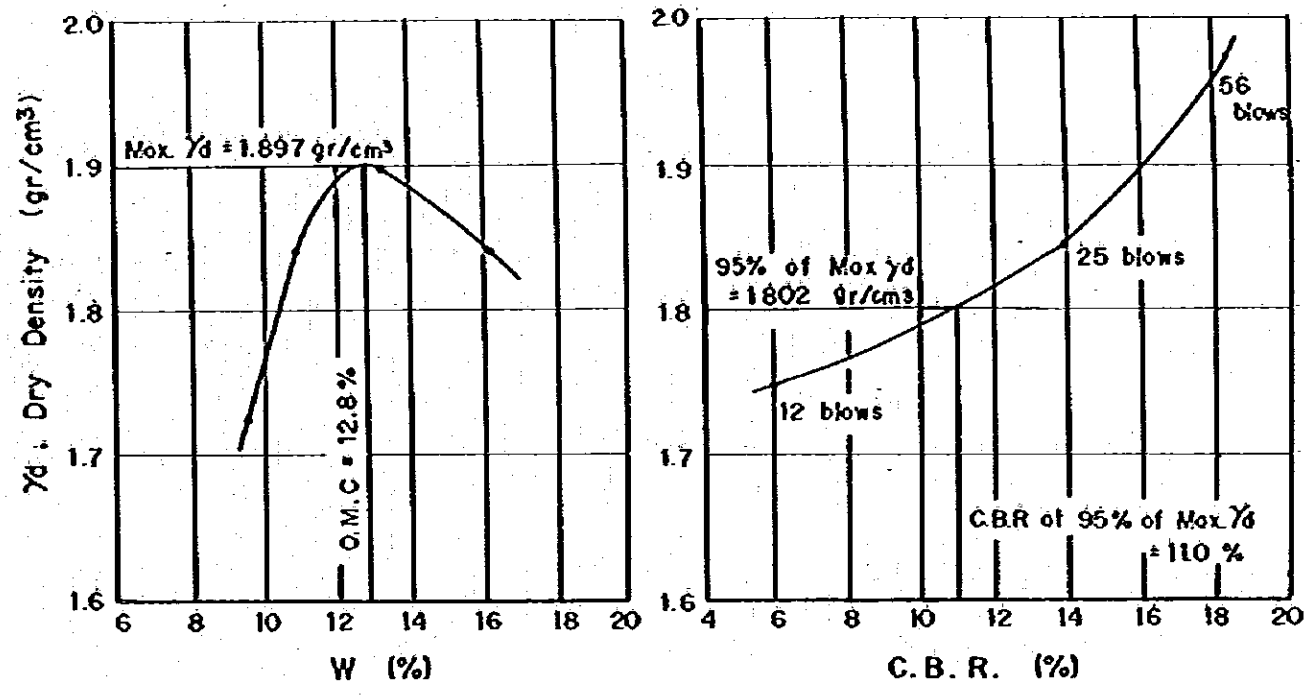


Figure IOA-2 SOIL TEST RESULTS (2)

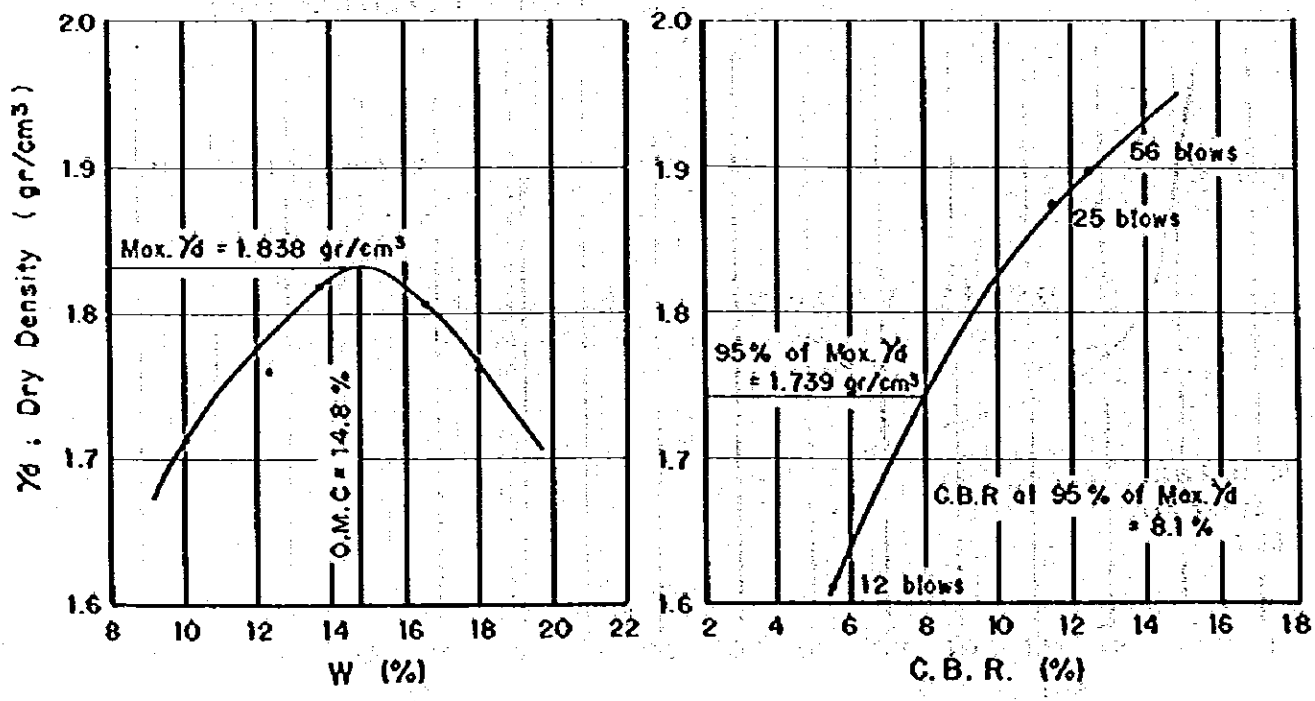
SAMPLE S-5
(SEGMENT-21)



SAMPLE S-7
(SEGMENT-27)



SAMPLE S-6
(SEGMENT-22)



SAMPLE S-8
(SEGMENT-29)

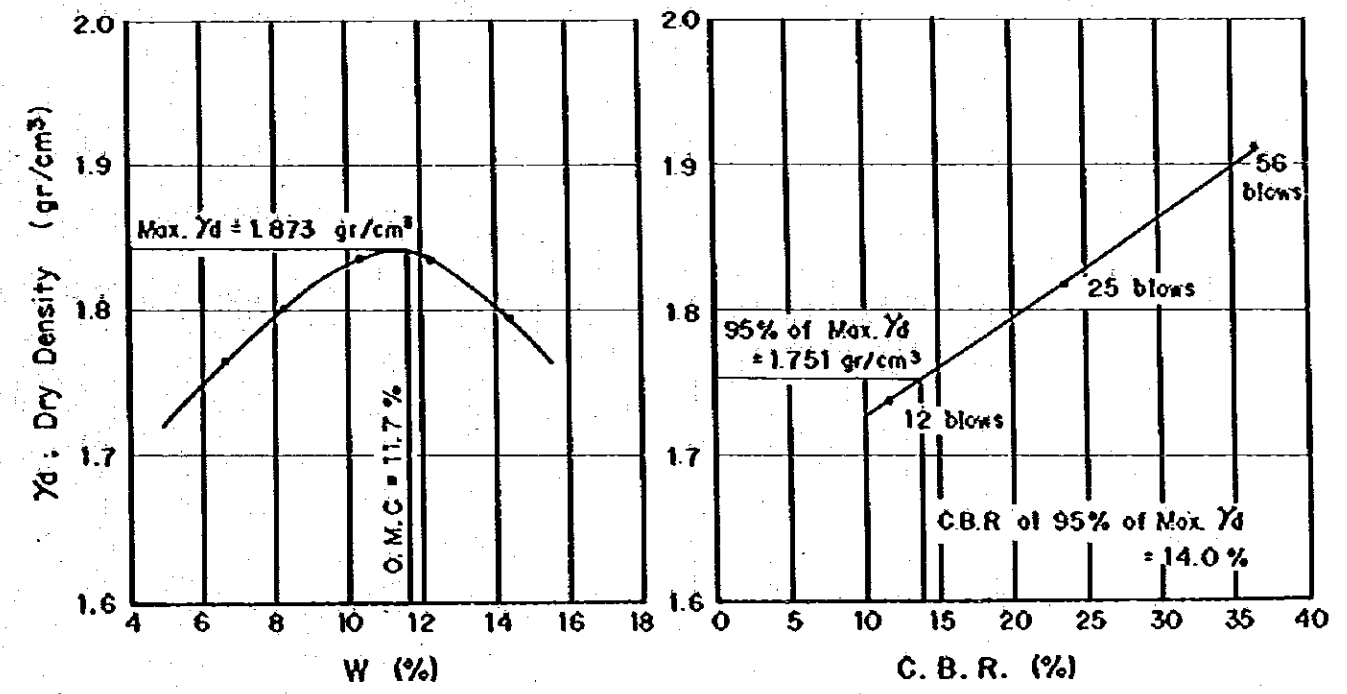
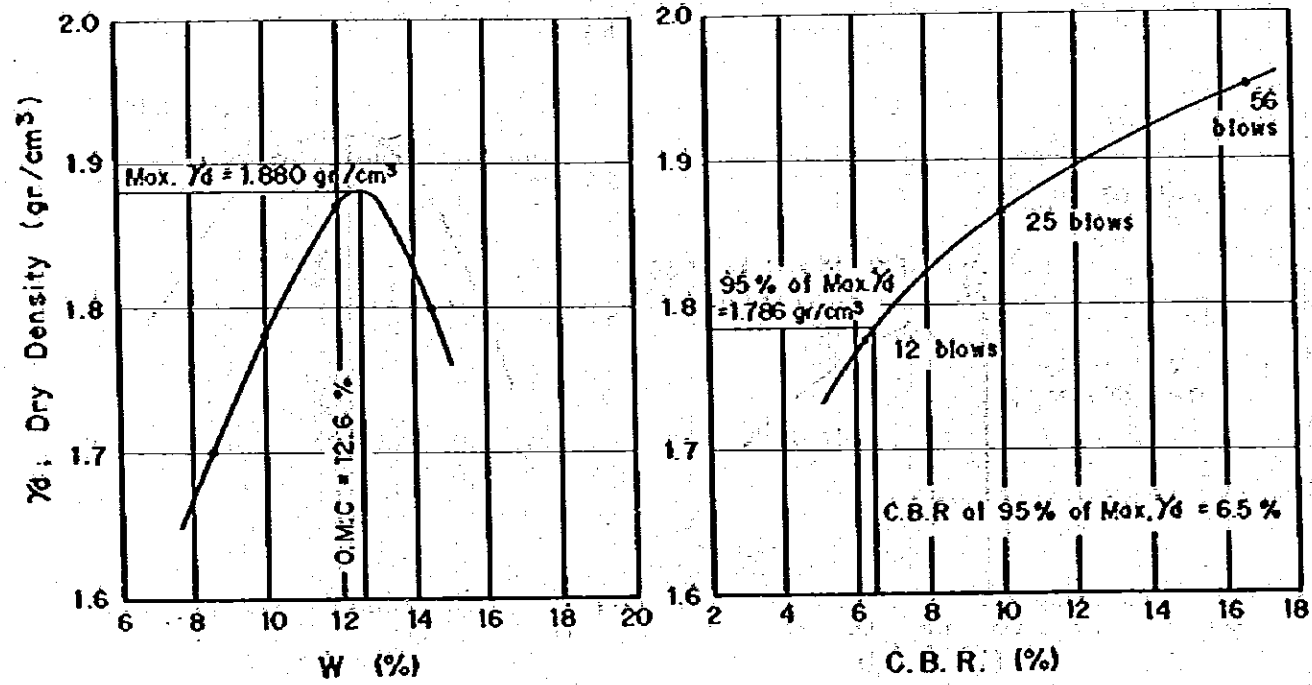


Figure IOA-2 SOIL TEST RESULTS (3)

SAMPLE S-9
 (SEGMENT-30)



SAMPLE E-1
 (SEGMENT-18)

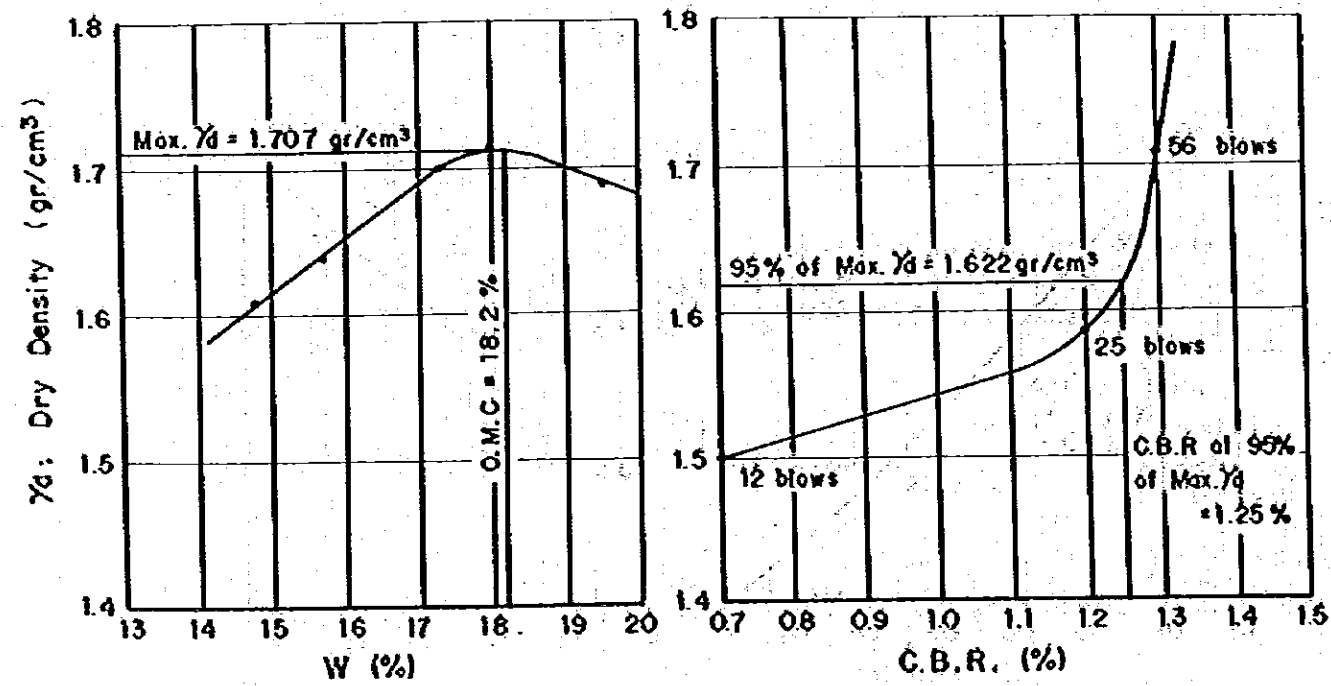
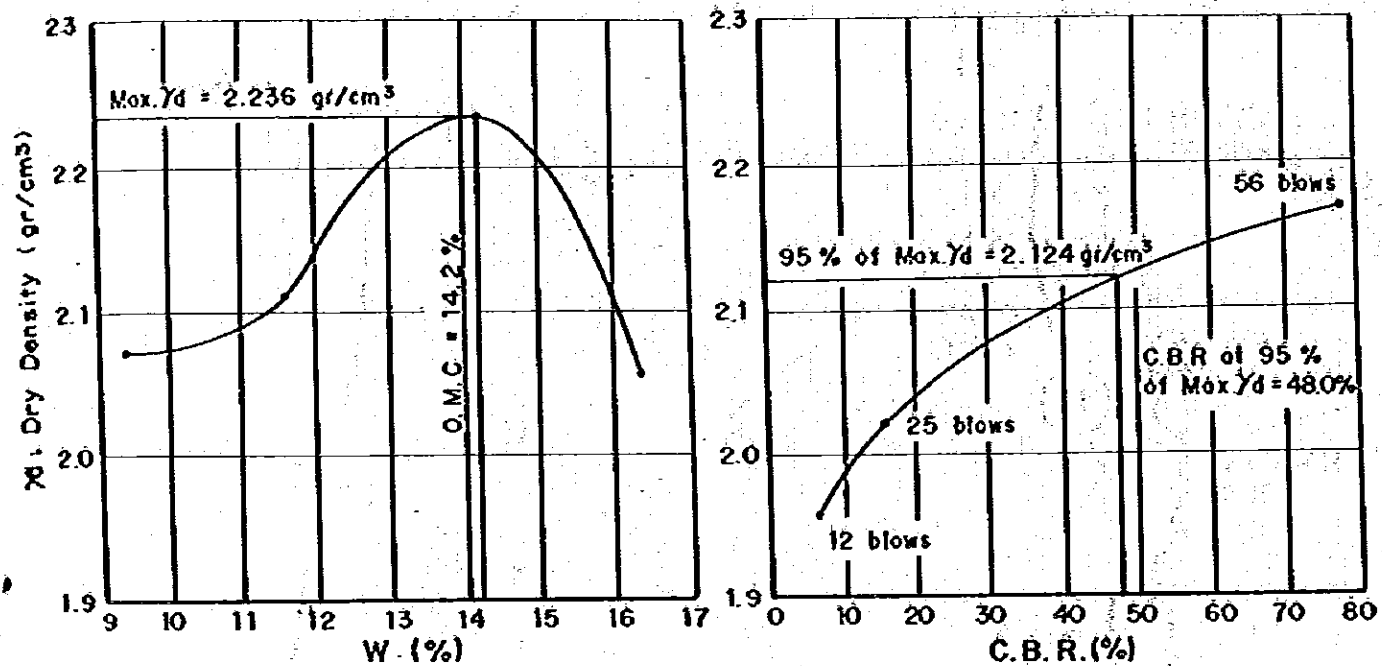
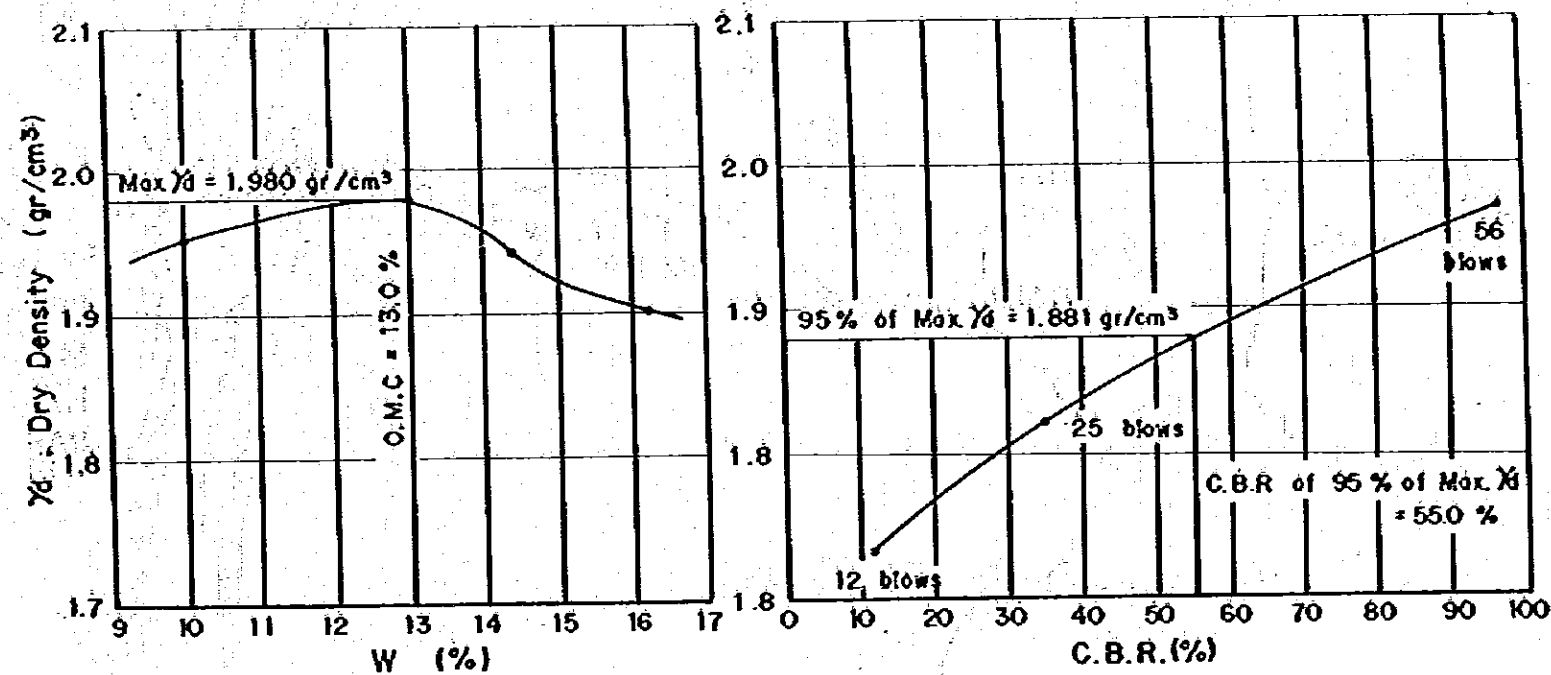


Figure 10A-2 SOIL TEST RESULTS (4)

SAMPLE L-1-B



SAMPLE L-3-B



SAMPLE L-2-B

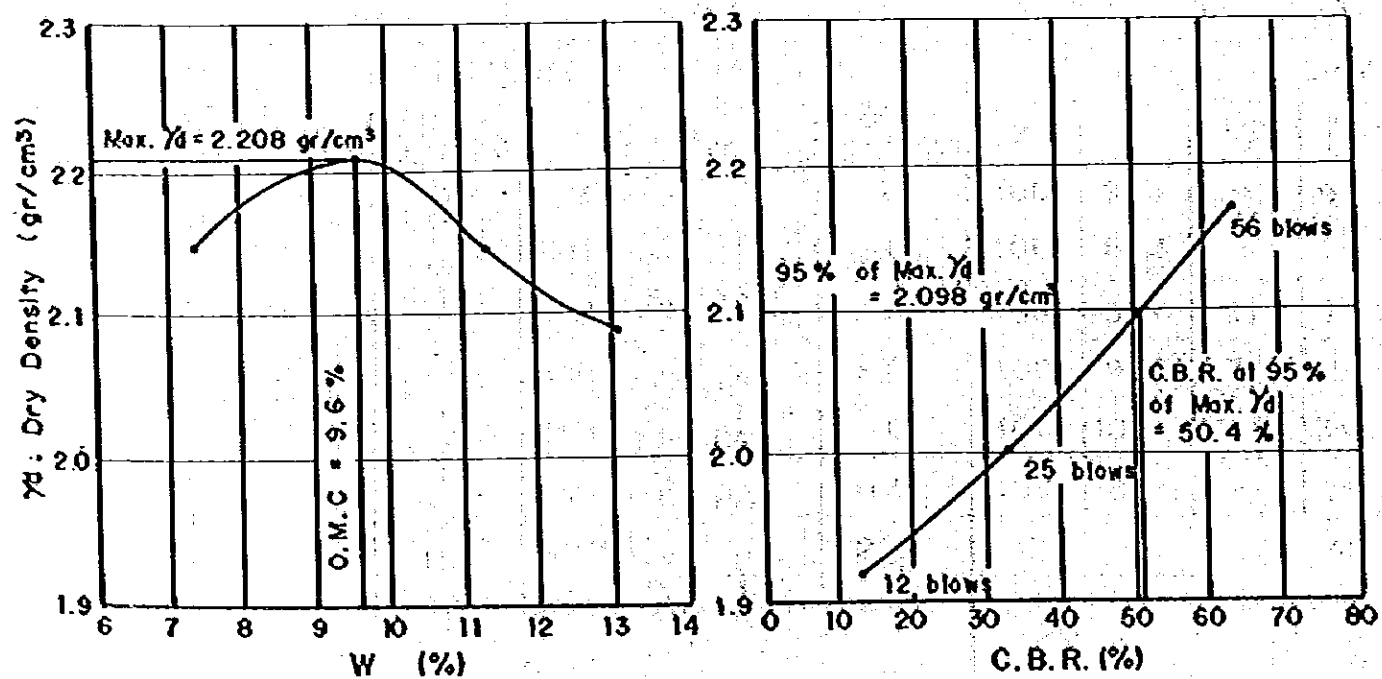
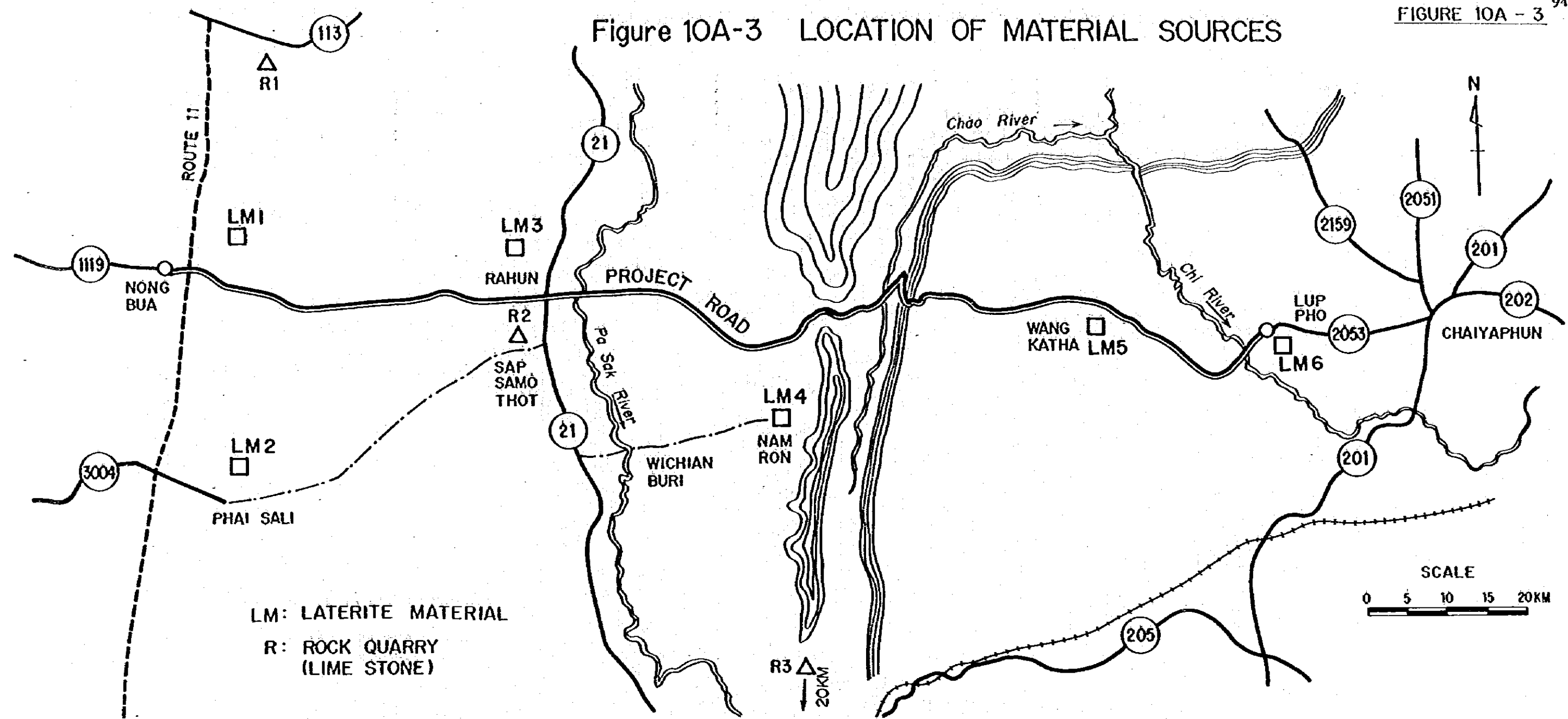


Figure 10A-3 LOCATION OF MATERIAL SOURCES



LM: LATERITE MATERIAL
 R: ROCK QUARRY (LIME STONE)

MATERIAL	SOURCE OF MATERIAL			SIEVE ANALYSIS (%)									ATTERBERG LIMIT (%)		C B R (%)	REMARKS
	ROAD CATEGORY	LOCATION	OFF SET (KM)	2"	1"	1/2"	3/4"	3/8"	# 4	# 10	# 40	# 200	LL	PI		
LM1	MINE ROAD	5KM FROM NONG BUA	0	100	94.3	-	91.3	79.6	62.6	44.5	31.8	26.6	43.0	18.0	36.0	
LM2	RURAL ROAD	3KM FROM PHAI SALI	0	100	89.3	-	85.7	59.3	41.5	28.3	15.3	6.2	26.0	9.8	28.0	
LM3	ROUTE 21	10KM FROM SAP SAMO THOT	5.0	100	99.0	81.0	71.0	68.0	55.0	44.0	32.0	28.0	-	-	-	
LM4	ARD ROAD	18KM FROM WICHIAN BURI	3.0	100	99.0	79.0	70.0	65.0	56.0	46.0	30.0	20.0	33.0	11.8	-	BAN NAM RON
LM5	ARD ROAD	15KM FROM NONG BUA RAWE	2.0	100	100	100	100	99.0	72.0	27.0	10.0	2.0	26.5	6.6	-	BAN DON MA KOK
LM6	ROUTE 2053	3KM FROM LUP PHO	0.3	100	86.4	-	36.8	29.5	12.5	39.0	28.0	23.5	35.0	11.0	-	
R1	ROUTE 113	30KM FROM NONG BUA	2.0	ABRASION TEST 30.0%										-	BAN KHAO SAI	
R2	ROUTE 21	2KM FROM SAP SAMO THOT	4.0											-		
R3	ROUTE 205	20KM FROM LAM NARAI	1.0	ABRASION TEST 26.8%										87.0	BAN KHAO TAMBON	

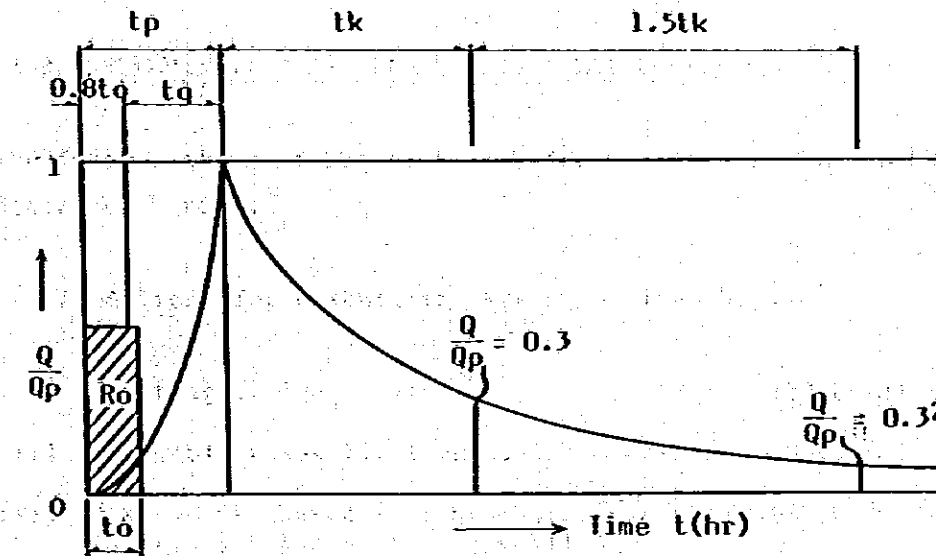
Appendix 11

HYDROLOGICAL STUDY

Appendix 11
HYDROLOGICAL STUDY

discharge occurred in unit time. The calculation method used in the study was Nakayasu's Method, which is explained herein.

The unit hydrograph is considered to have the form shown in the following figure:



11-1 UNIT HYDROGRAPH METHOD

The Unit Hydrograph Method was advocated by Sherman. This method bases on the following three assumptions:

- a) In the same river basin, the time between the beginning of flood and the occurrence of peak discharge and duration of flood discharge are constant regardless of the rainfall intensity.
- b) In the same river basin, the time proportion corresponding to the changes of discharge is kept constant regardless of the intensity of the effective rainfall.
- c) The discharge by the effective rainfall in long duration can be calculated by the sum of discharges corresponding to the rainfalls in short divided durations.

In other words, the factors which specify the form of unit hydrograph are the characteristics of the respective river basin rather than those of rainfall.

Many calculation methods have been studied to formulate the unit hydrograph which shows the relationship between unit effective rainfall and unit

The increasing and decreasing curves in the figure are expressed by the following equations:

Increasing Curve $\frac{Q}{Q_p} = \left(\frac{t}{t_p}\right)^{2.4} \dots\dots\dots (1)$

Decreasing Curve $\frac{Q}{Q_p} = 0.3^{\frac{t-t_p}{t_k}} \left(1 \geq \frac{Q}{Q_p} \geq 0.3\right) \dots\dots\dots (2)$

$\frac{Q}{0.3Q_p} = 0.3^{\frac{t-(t_p+t_k)}{1.5t_k}} \left(0.3 \geq \frac{Q}{Q_p} \geq 0.3^2\right) \dots\dots (3)$

$\frac{Q}{0.3^2 Q_p} = 0.3^{\frac{t-(t_p+t_k+1.5t_k)}{2.0t_k}} \left(0.3^2 \geq \frac{Q}{Q_p}\right) \dots (4)$

Where, Q : Discharge at time t (m^3/sec)
 Q_p : Peak discharge by the effective rainfall R_o in a time of t_o (m^3/sec)
 t_p : Time in which the discharge increases from zero to the peak (hr)
 t_k : Time in which the discharge decreases from Q_p to $0.3Q_p$ (hr)

$t_k = 1.5t_g$ (for the river that the flood appears slowly and disappears quickly) (hr)
 $t_k = 3.0t_g$ (for the river that the flood appears quickly and disappears slowly) (hr)
 t_p : Time in which the discharge increases from zero to the peak (Q_p) (hr).

These equations are for the case that the unit time (t_o) is taken as 0.5 to 1.0 times of the time lag between the beginning and the peak of flood (t_g), which is measured starting from the time point of 0.8 t_o .

The total flood discharge (Q_t) is calculated as follows by the integration of Q , based on the above equations, (1), (2), (3) and (4):

$$Q_t = \int_0^{\infty} Q \cdot dt = Q_p(0.3t_p + t_k) \dots\dots\dots (5)$$

Where, Q_t : Total flood discharge (m^3)

On the other hand, the total flood discharge is also given by the following equation:

$$Q_t = 0.2778R_o \cdot A \dots\dots\dots (6)$$

Where, R_o : Effective rainfall (mm)
 A : Catchment area (km^2)

Therefore, the peak discharge (Q_p) is calculated from the equations (5) and (6).

$$Q_p = \frac{0.2778A \cdot R_o}{0.3t_p + t_k} \dots\dots\dots (7)$$

t_p is expressed from the previous figure as follows:

$$t_p = 0.8 t_o + t_g \dots\dots\dots (8)$$

The figures of t_g and t_k are given as follows:

$$t_g = 0.21L^{0.7} \quad (L < 15)$$

$$t_g = 0.4 + 0.058L \quad (L > 15)$$

Where, t_g : Time lag between the beginning and the peak of flood (hr)

L : Length of river channel (km)

11-2 DETERMINATION OF BRIDGE LENGTH FOR RELIEF OPEN

The determination of bridge length for relief open for Road Segment 18 is described herein.

The conditions for calculation are summarized below:

- i) Existing bridge length : 133.8 (m)
- ii) Allowable water level on upstream area : 80.0 (m)
- iii) Maximum discharge (R_o : Discharge curve : 1987.0 (m^3/sec) in Figure 11A-2 of Appendix-11)
- iv) Water level - Reserved volume curve, shown in Figure 11A-3
- v) Water level - Discharge curve at downstream, shown in Figure 11A-4

At first, the water level on upstream area was checked for the existing bridge length, but it exceeded the allowable one. Then, the bridge length was prolonged and another calculation was made until the calculated water level becomes below the allowable one. The water level - discharge curves are shown in Figures 11A-5, 11A-6, 11A-7, and 11A-8 for the existing bridge length of 34.4 meters and the prolonged 233, 283 and 333 meters, respectively. The results are summarized as follows and illustrated in Figure 11A-9.

<u>Bridge Length (m)</u>	<u>Inflow Volume (m³/sec)</u>	<u>Base Flow Discharge (m³/sec)</u>	<u>Calculated Water Level (m)</u>
133.8	1987	739.4	80.60
233.0	1987	852.3	80.62
283.0	1987	888.4	80.26
333.0	1987	936.1	79.84

Note: Allowable water level is 80.0 (m).

Based on the above, the required bridge length for relief open was concluded as 176 meters.

Table 11A-1 RAINFALL PATTERN (Effective Rainfall)

TABLE 11A-1

Time (hr)	(mm)		
	Total Rainfall	Loss	Effective Rainfall
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	8.1	8.0	0.1
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.4	0.4	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.2	0.2	0.0
13	3.7	3.6	0.1
14	12.1	11.2	0.9
15	129.4	40.6	88.8
16	0.0	0.0	0.0
17	0.0	0.0	0.0
18	0.0	0.0	0.0
19	0.0	0.0	0.0
20	0.0	0.0	0.0
21	0.0	0.0	0.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
Total	153.9		89.9

TABLE 11A-2 DRAINAGE CAPACITY OF BRIDGES AND CULVERTS IN OPTIMUM ROUTE

Catching Basin No.	Existing Structure		Discharge Calculation						Capacity Calculation				
	Station (km)	Type of Structure	Catchment Area (km ²)	Length of River Channel (km)	Height Difference (m)	Unit Hydrograph		Design Discharge (m ³ /sec)	Proposed Structure	Area of Water Way (m ²)	Hydraulic Radius (m)	Velocity (m/sec)	Capacity (m ³ /sec)
						Time lag tp(hr)	Peak discharge Qp (m ³ /sec)						
1	5 + 850	-	1.9	4.0	45	0.82	0.28	25	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27
2	8 + 150	-	1.5	2.0 0.8	25 120	0.42	0.43	39	Box Culvert 2(2.1x2.1)	8.8	0.70	4.80	42
3	10 + 700	-	8.8	4.3 0.9	25 290	1.34	0.79	71	Concrete Bridge (7.0x20.0)	40.5	2.04	1.91	77
4	12 + 50	-	1.0	2.0	20	0.44	0.27	24	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27
5	12 + 400	-	3.3	3.0 0.6	20 220	0.86	0.46	42	Concrete Bridge (7.0x15.0)	25.5	1.72	2.03	51
6	13 + 50	-	43.5	15.0	65	5.46	0.96	86	Concrete Bridge (7.0x25.0)	62.1	2.47	2.58	160
7	15 + 350	-	118.0	27.0 3.0	105 140	10.74	1.33	119	Concrete Bridge (7.0x25.0)	62.1	2.47	2.58	160
8	37 + 100	-	1.6	3.1 1.3	100 260	0.39	0.50	45	Box Culvert 2(2.1x2.1)	8.8	0.70	6.23	48
9	42 + 950	-	4.7	4.5 0.3	100 90	0.62	0.92	83	Concrete Bridge (7.0x25.0)	62.1	2.47	1.64	102
10	50 + 300	Timber Bridge (4.3x18.3)	6820	217	230	92.6	8.90	1987	Concrete Bridge (7.0x21.0)	Bridge for Relief Open	Refer to Hydrological Study in Appendix-11		
	50 + 600	Timber Bridge (4.4x25.0)							Concrete Bridge (7.0x24.0)				
	50 + 900	Timber Bridge (4.4x15.5)							Concrete Bridge (7.0x16.0)				
	51 + 700	-							Concrete Bridge (7.0x176.0)				
11	53 + 950	Timber Bridge (4.2x5.0)	1.3	2.0	10	0.67	0.23	21	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27

TABLE 11A-2 DRAINAGE CAPACITY OF BRIDGES AND CULVERTS IN OPTIMUM ROUTE (Cont'd)

Catching Basin No.	Existing Structure		Discharge Calculation						Capacity Calculation				
	Station (km)	Type of Structure	Catchment Area (km ²)	Length of River Channel (km)	Height Difference (m)	Unit Hydrograph		Design Dis-charge (m ³ /sec)	Proposed Structure	Area of Water Way (m ²)	Hydraulic Radius (m)	Velo-city (m/sec)	Capacity (m ³ /sec)
						Time lag tp(hr)	Peak Dis-charge Qp(m ³ /sec)						
12	56 + 100	-	1.8	2.5	30	0.49	0.44	39	Box Culvert 2(2.1x2.1)	8.8	0.70	4.80	42
13	63 + 100	Timber Bridge (4.2 x 15.0)	5.8	3.0 1.0	10 60	1.36	0.52	46	Concrete Bridge (7.0x15.0)	25.5	1.72	2.03	51
14	66 + 950	-	3.1	3.0 0.8	40 140	0.59	0.64	57	Concrete Bridge (7.0x15.0)	25.5	1.72	2.87	73
15	71 + 200	-	23.9	14.5 2.0	120 120	3.73	0.77	70	Concrete Bridge (7.0x15.0)	25.5	1.72	4.05	104
16	72 + 900	-	78.0	16.2 7.7	120 315	4.90	1.92	169	Concrete Bridge (7.0x30.0)	88.0	2.89	2.87	252
17	77 + 300	-	2.3	3.5 1.3	60 100	0.64	0.43	38	Box Culvert 2(2.1x2.1)	8.8	0.70	4.80	42
18	80 + 100	-	1.9	3.5	70	0.51	0.45	40	Box Culvert 2(2.1x2.1)	8.8	0.70	4.80	42
19	84 + 800	-	0.8	2.5 0.5	65 80	0.24	0.40	26	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27
20	86 + 800	-	6.6	7.8	180	1.04	0.77	69	Concrete Bridge (7.0x15.0)	25.5	1.72	2.73	70
21	89 + 100	-	1.5	3.0 0.8	38 110	0.61	0.30	26	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27
22	89 + 400	-	1.3	3.5 0.8	40 130	0.74	0.21	19	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27
23	89 + 800	-	1.5	3.5 0.4	40 70	0.73	0.25	22	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27
24	92 + 900	-	10.9	7.2 2.8	70 180	1.81	0.73	65	Concrete Bridge (7.0x20.0)	40.5	2.04	2.27	92
25	95 + 50	-	53.2	10.7 0.8	120 120	2.24	2.87	258	Concrete Bridge (7.0x40.0)	152.5	3.72	2.16	330

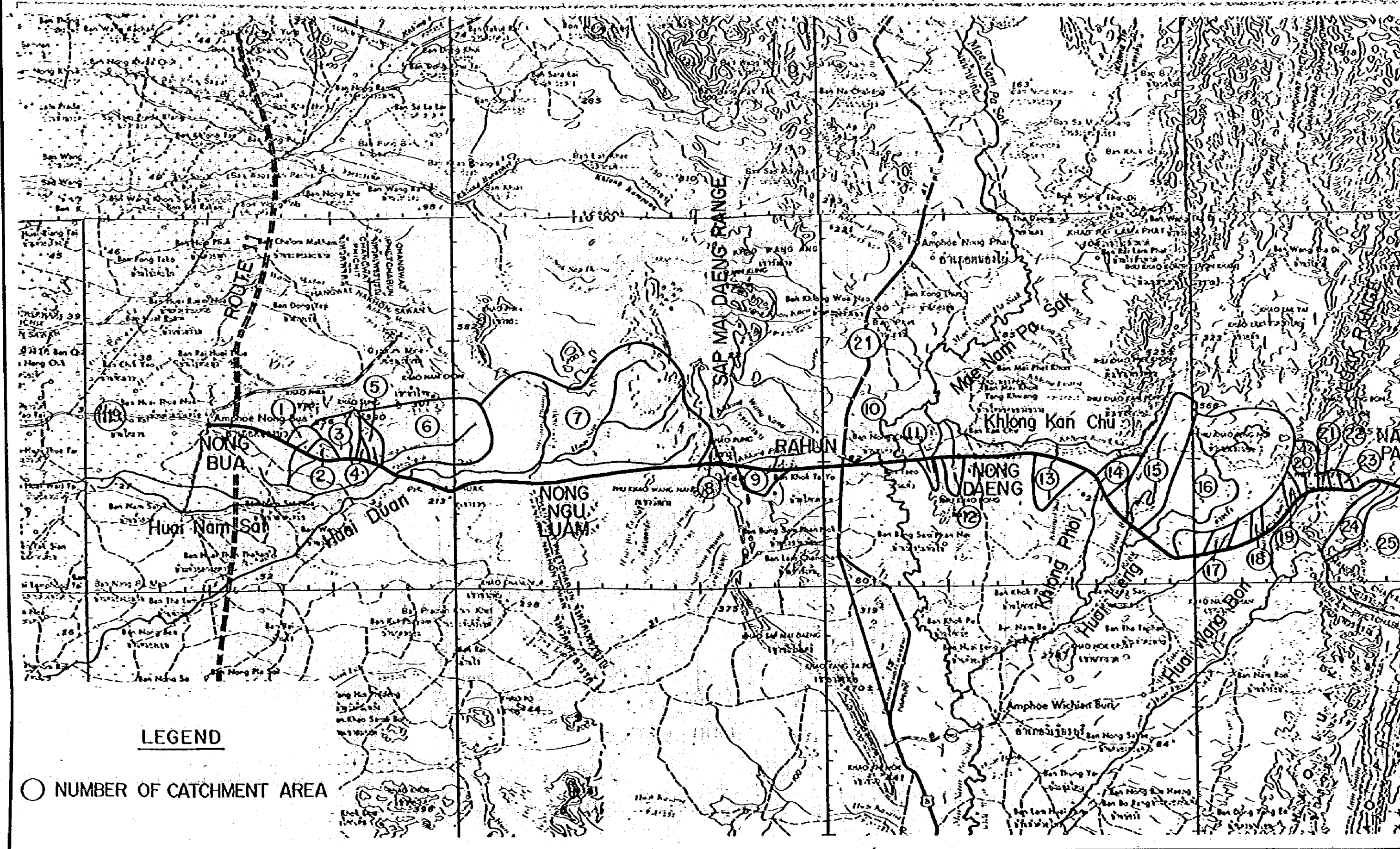
TABLE 11A-2
3 of 3

TABLE 11A-2 DRAINAGE CAPACITY OF BRIDGES AND CULVERTS IN OPTIMUM ROUTE (Cont'd)

Catching Basin No.	Existing Structure		Discharge Calculation						Capacity Calculation								
	Station (km)	Type of Structure	Catchment Area (km ²)	Length of River Channel (km)	Height Difference (m)	Unit Hydrograph		Design Discharge (m ³ /sec)	Proposed Structure	Area of Water Way (m ²)	Hydraulic Radius (m)	Velocity (m/sec)	Capacity (m ³ /sec)				
						Time lag tp(hr)	Peak Discharge Qp(m ³ /sec)										
26	106 + 650	-	2.7	5.0	140	0.59	0.55	48	Box Culvert 2(2.1x2.1)	8.8	0.70	5.52	48				
27	112 + 400	-	121.7	9.0 12.0	80 480	3.28	4.48	404	Concrete Bridge (7.0x40.0)	152.5	3.72	3.40	518				
28	114 + 400	-	1.5	2.5 0.5	25 50	0.37	0.49	27	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27				
29	116 + 300	-	0.9	2.5	35	0.45	0.24	22	Box Culvert 2(2.1x2.1)	8.8	0.70	3.94	27				
30	121 + 100	-	6.8	5.5 1.0	40 40	1.56	0.53	47	Concrete Bridge (7.0x10.0)	15.0	1.43	3.58	53				
31	121 + 900	-	24.2	7.5 3.5	60 250	2.13	1.37	123	Concrete Bridge (7.0x20.0)	40.5	2.04	3.22	130				
32	126 + 500	-	10.0	5.0	100	0.73	1.65	149	Concrete Bridge (7.0x25.0)	62.1	2.47	2.58	160				
33	131 + 250	-	26.0	5.0 1.0	80 20	1.41	2.23	200	Concrete Bridge (7.0x30.0)	88.0	2.89	2.87	252				
34	141 + 250	Timber Bridge (4.0 x 20.3)	16.5	7.0 5.0	25 40	4.12	0.48	43	Concrete Bridge (7.0x25.0)	62.1	2.47	1.17	73				
35	143 + 700	Timber Bridge (4.0 x 20.4)	57.7	12.0 6.0	25 50	8.25	0.84	76	Concrete Bridge (7.0x30.0)	88.0	2.89	1.30	114				
36	158 + 900	Timber Bridge (3.6 x 15.5)	313.4	30.0 10.0	100 500	13.61	2.78	250	Concrete Bridge (7.0x30.0)	88.0	2.89	1.83	160				
	159 + 100	Timber Bridge (3.6 x 6.0)							Concrete Bridge (7.0x25.0)					62.1	2.47	1.64	102
	159 + 250	Timber Bridge (3.6 x 11.7)							Concrete Bridge (7.0x30.0)					88.0	2.89	1.83	160
	159 + 800	Timber Bridge (3.4 x 17.8)							Concrete Bridge (7.0x30.0)					88.0	2.89	1.83	760

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FIGURE 11A-1 CATCHME



LEGEND

○ NUMBER OF CATCHMENT AREA

RE 11A-1 CATCHMENT AREAS

CATCHMENT AREAS FIGURE 11A-1

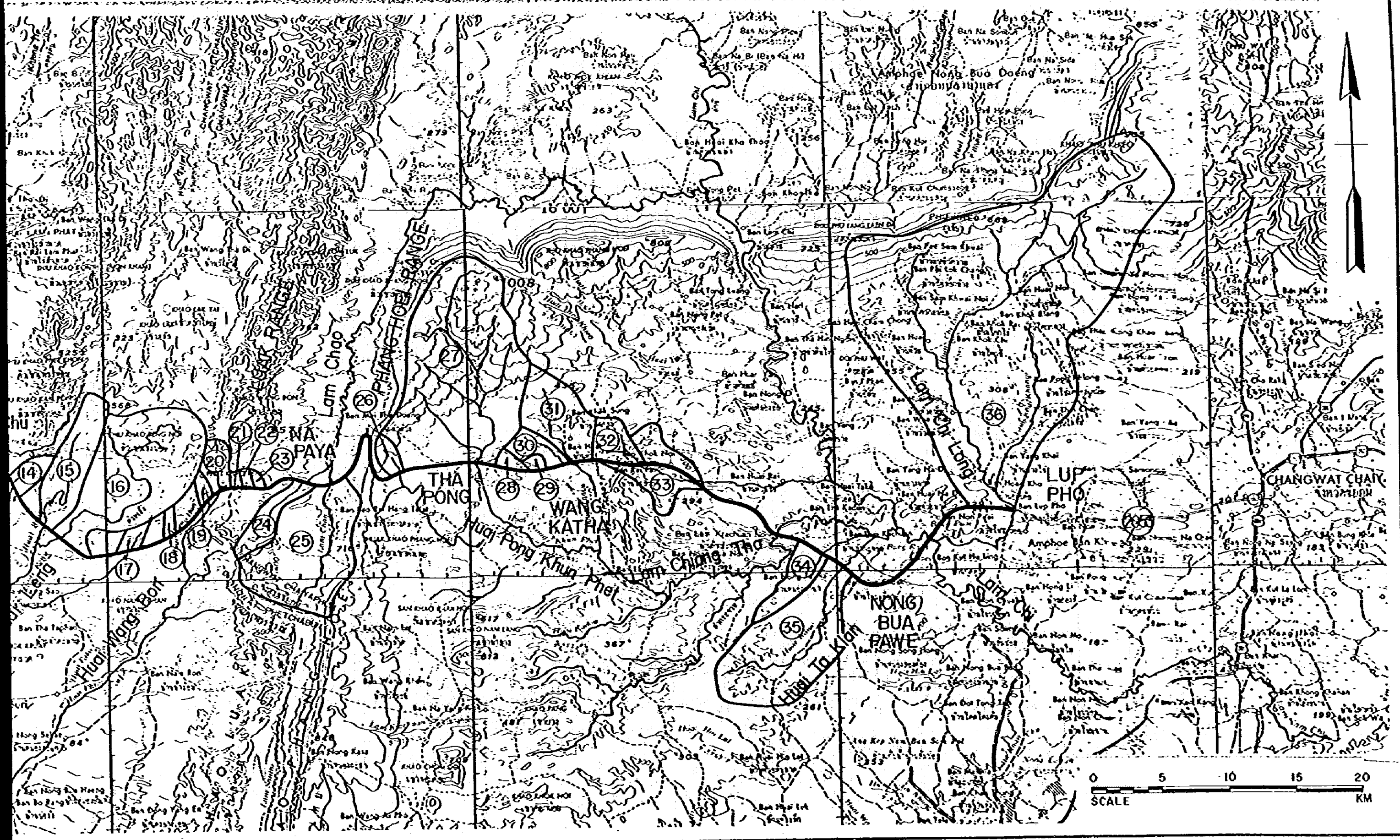


Figure 11A-2 DISCHARGE CURVE

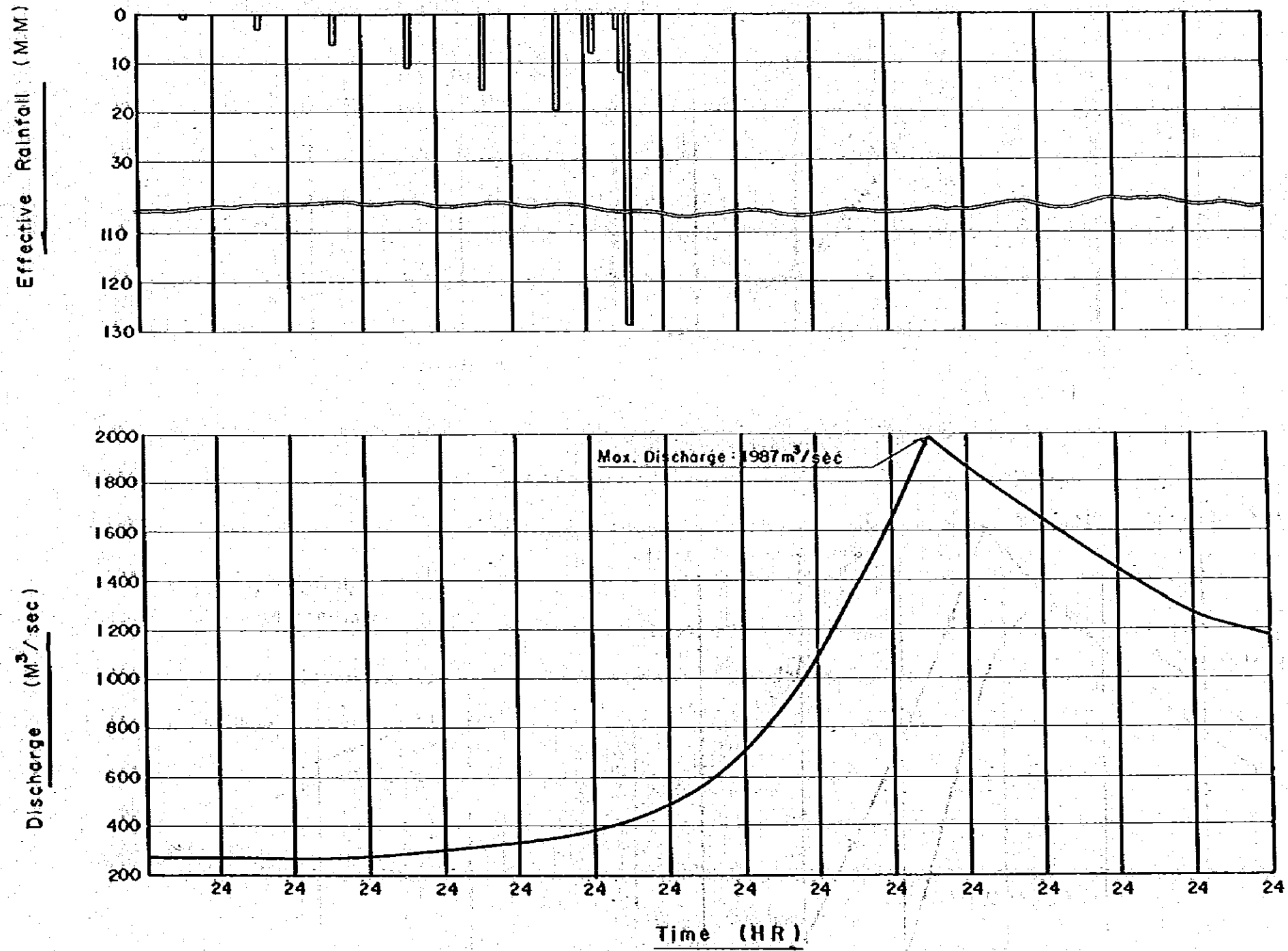


Figure 11A-3 WATER LEVEL - RESERVED VOLUME CURVE

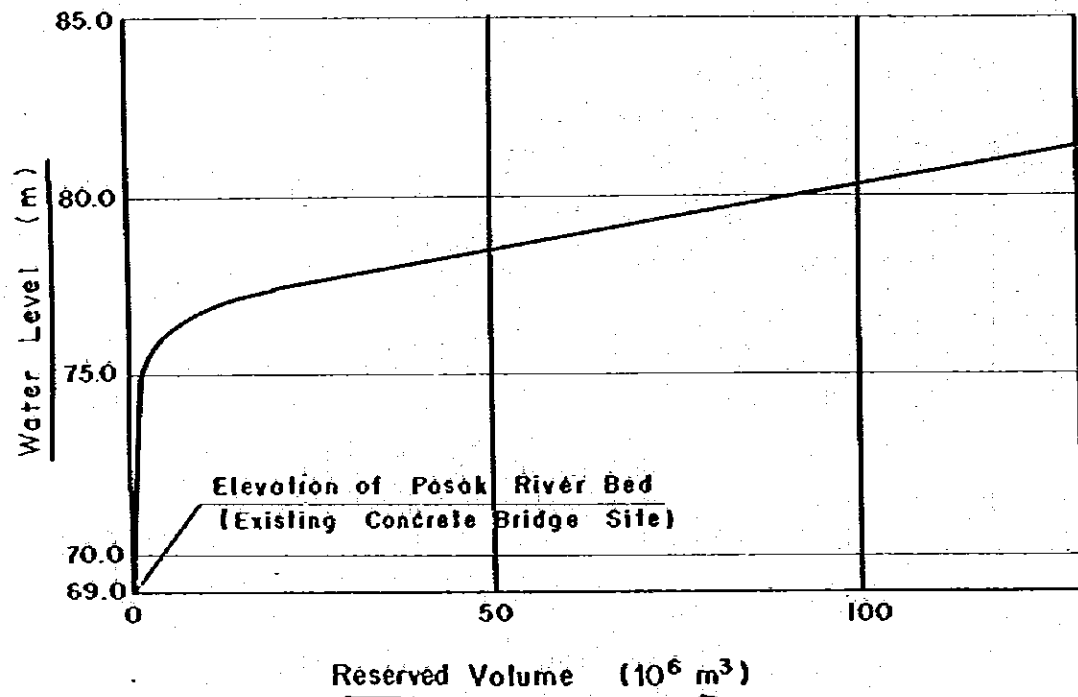


Figure 11A-5 WATER LEVEL AND DISCHARGE (Bridge Length 133.8m : Existing Bridge)

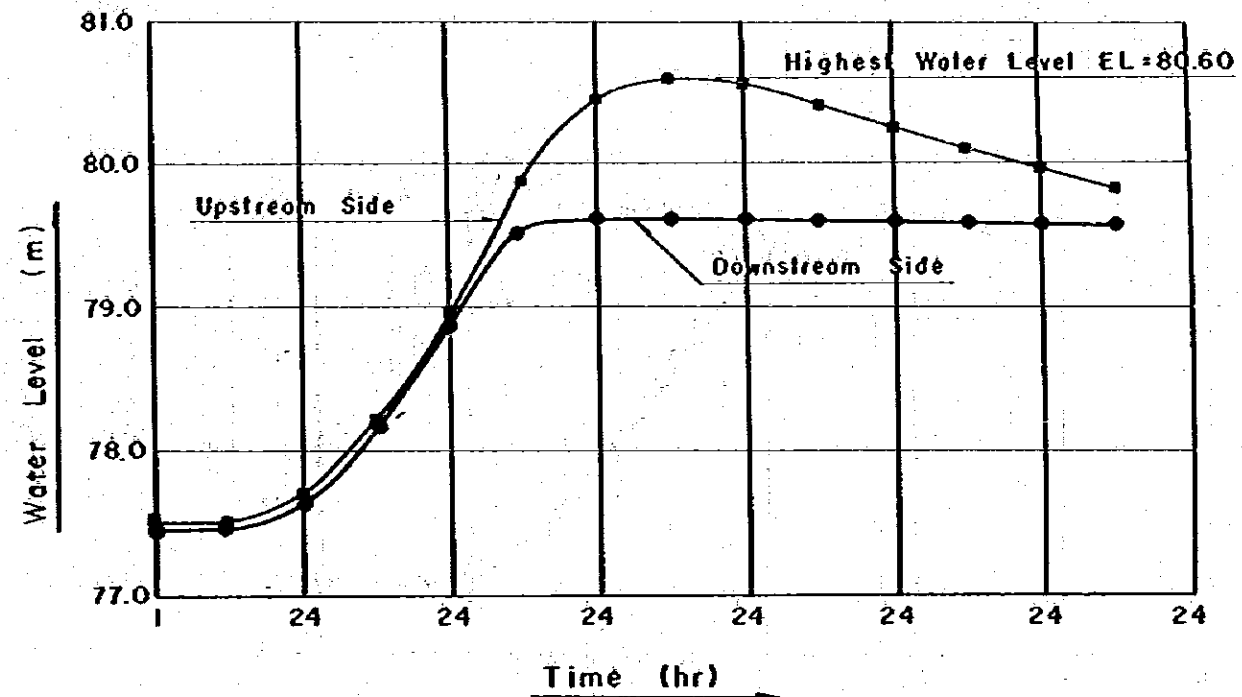


Figure 11A-4 WATER LEVEL - DISCHARGE CURVE (Downstream)

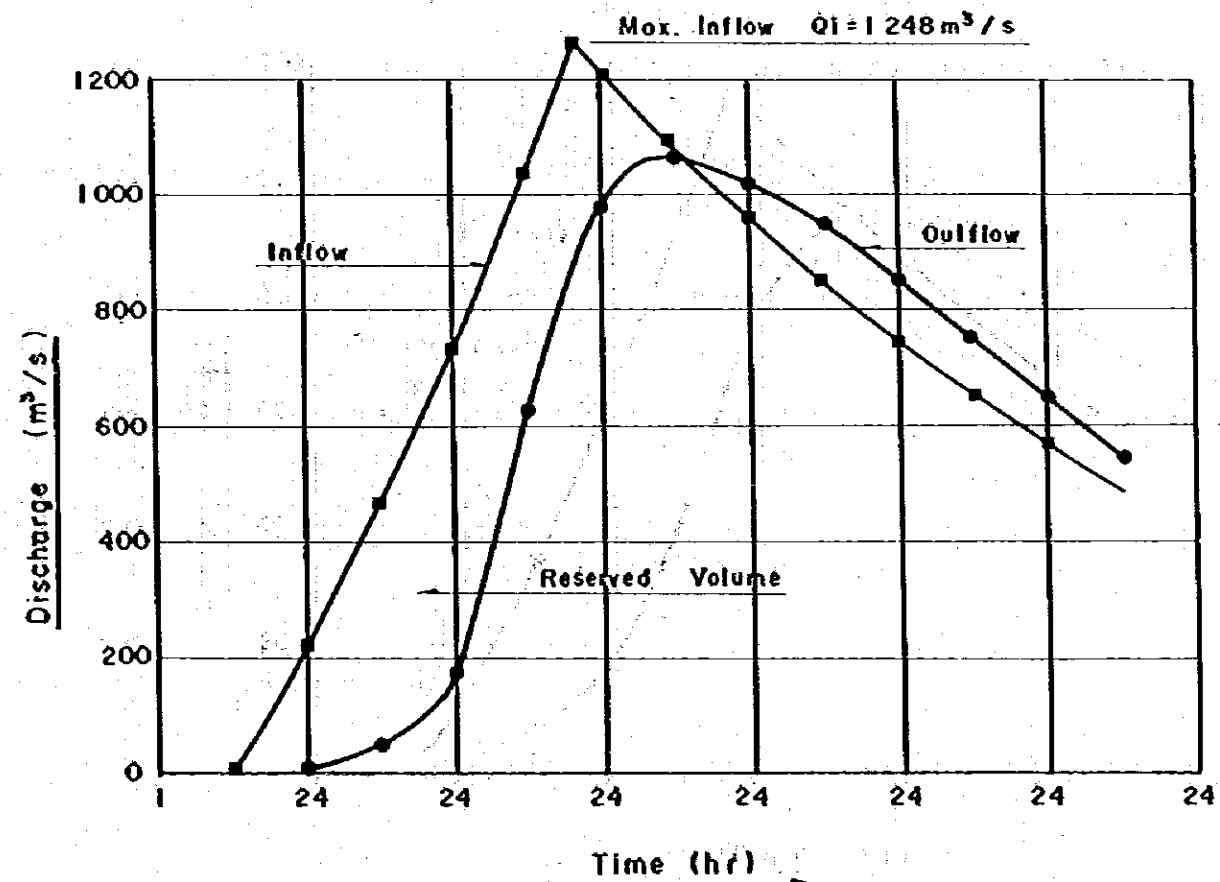
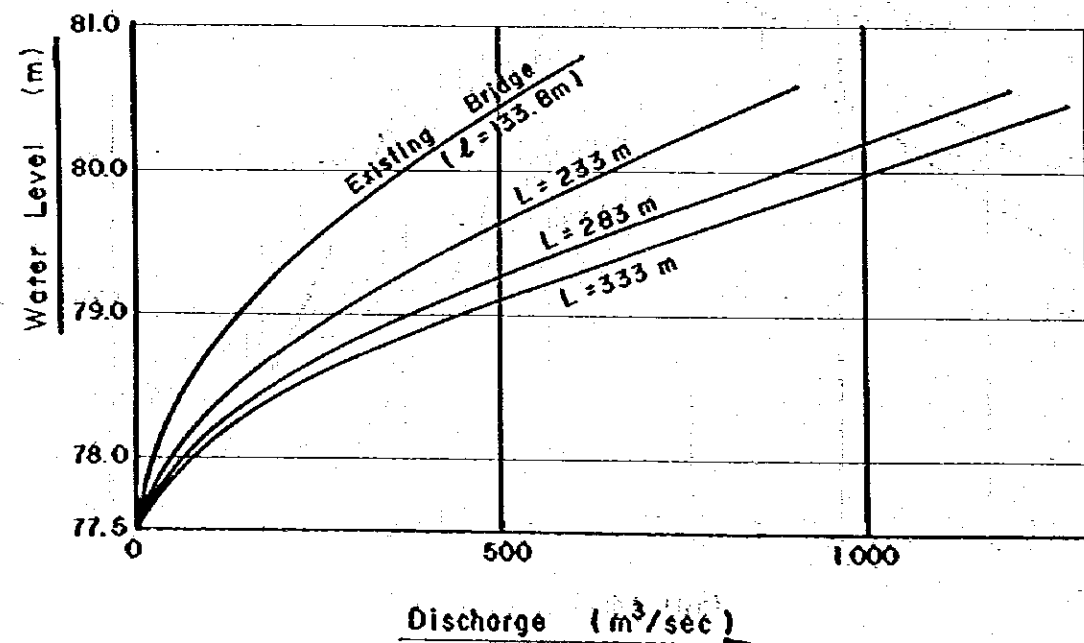


Figure 11A-6 WATER LEVEL AND DISCHARGE
(Bridge Length 233m)

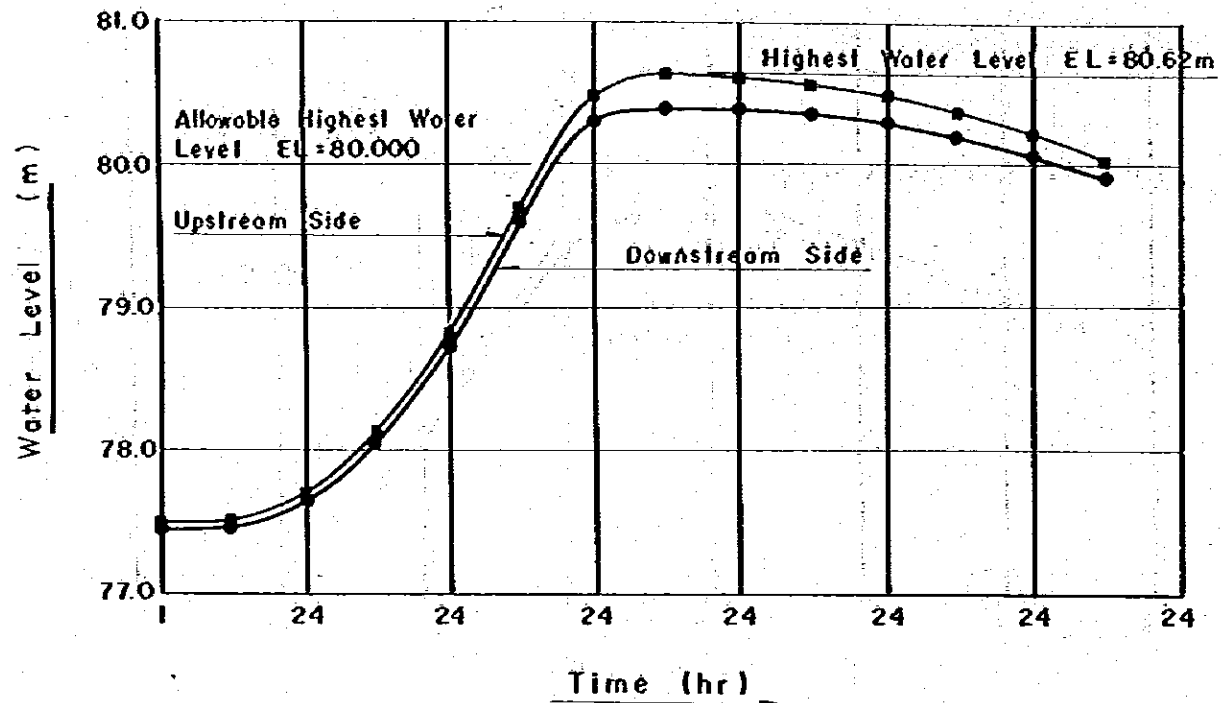


Figure 11A-7 WATER LEVEL AND DISCHARGE
(Bridge Length 283m)

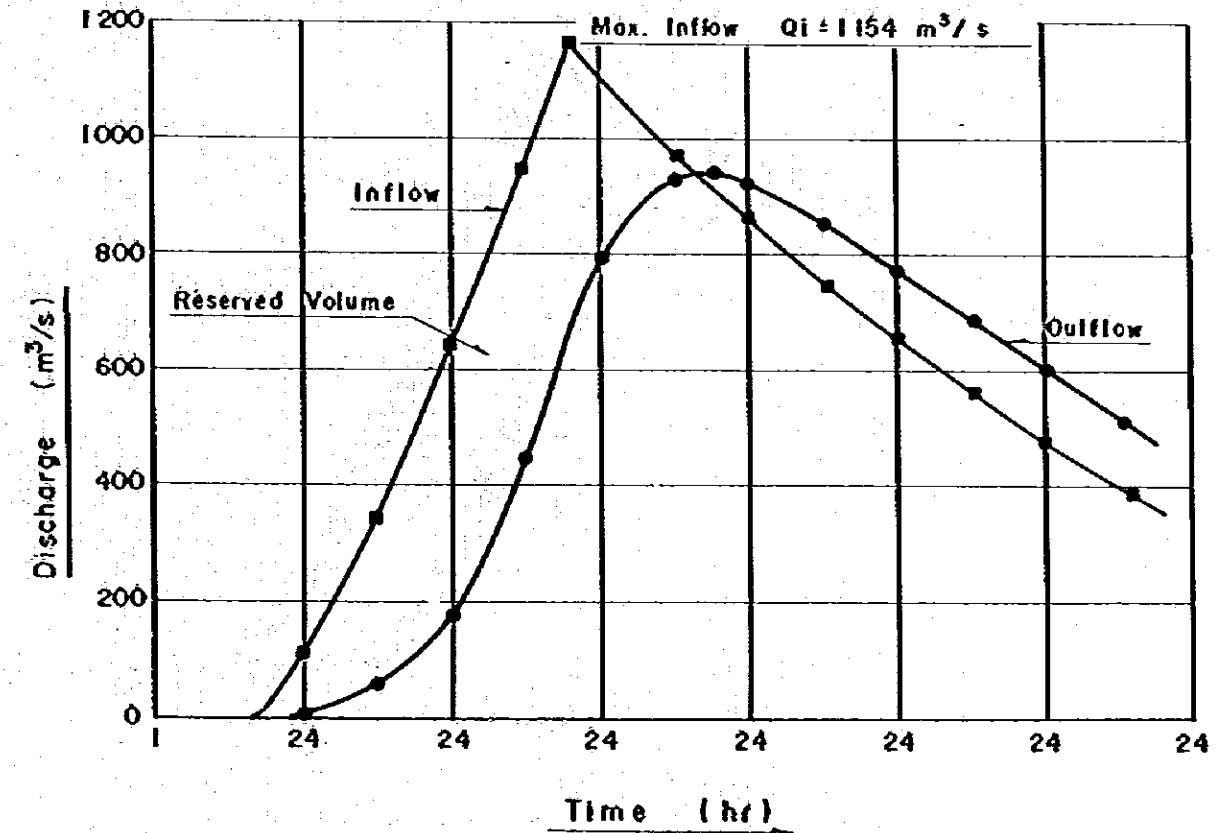
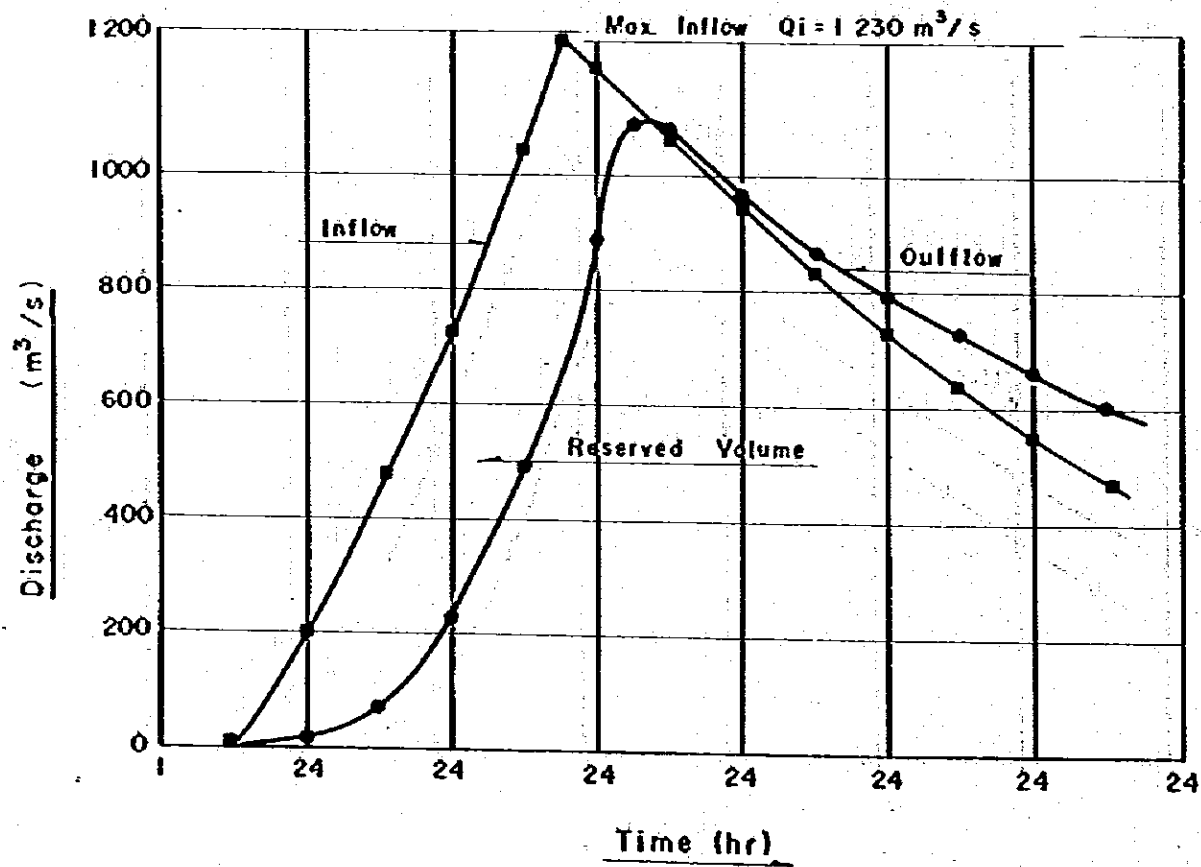
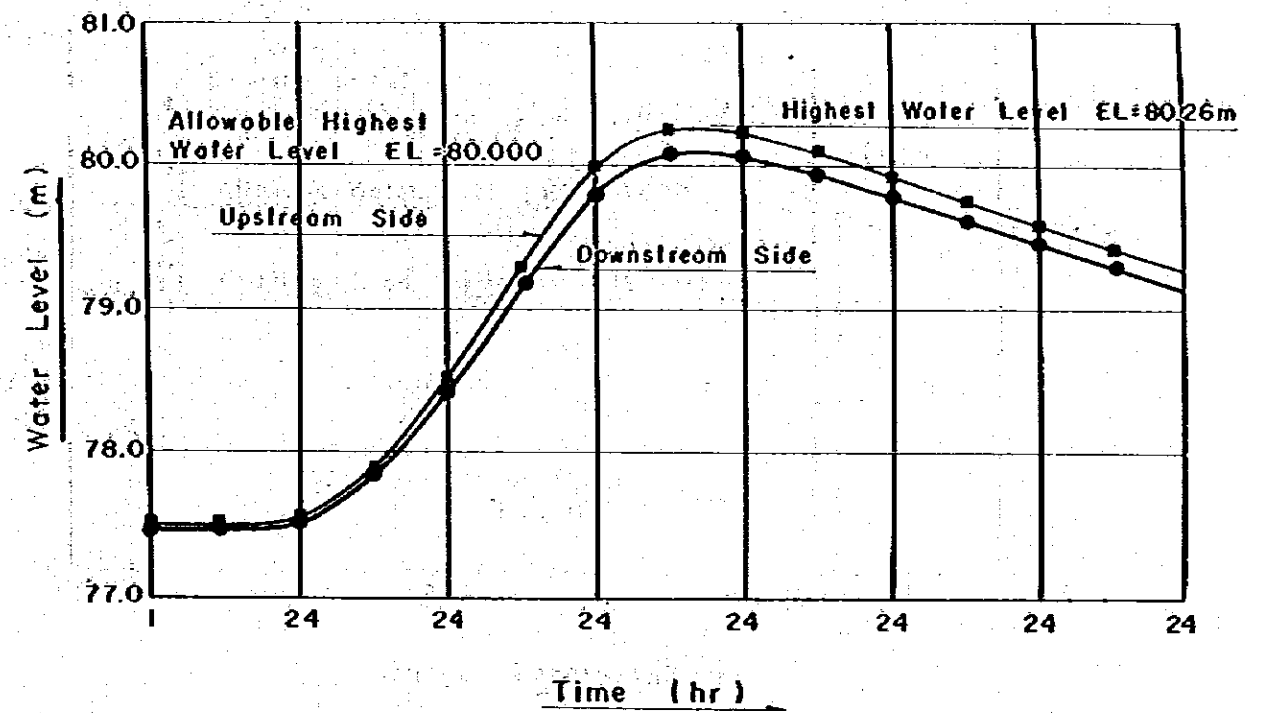


Figure 11A-8 WATER LEVEL AND DISCHARGE
(Bridge Length 333 m)

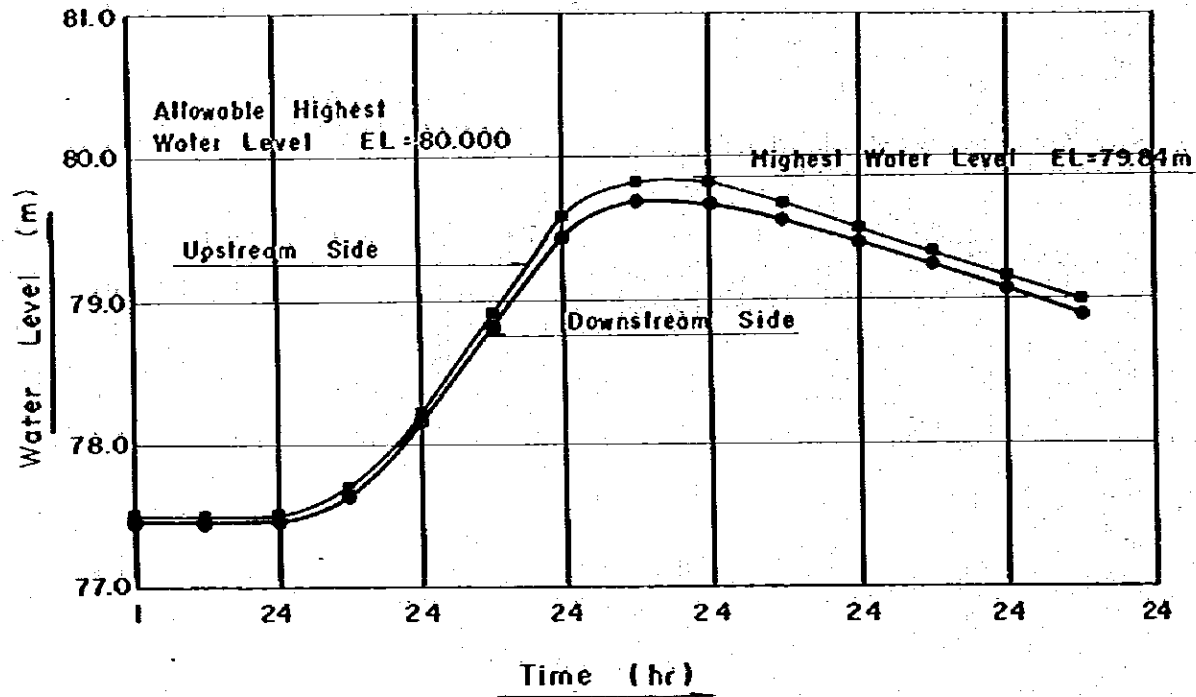
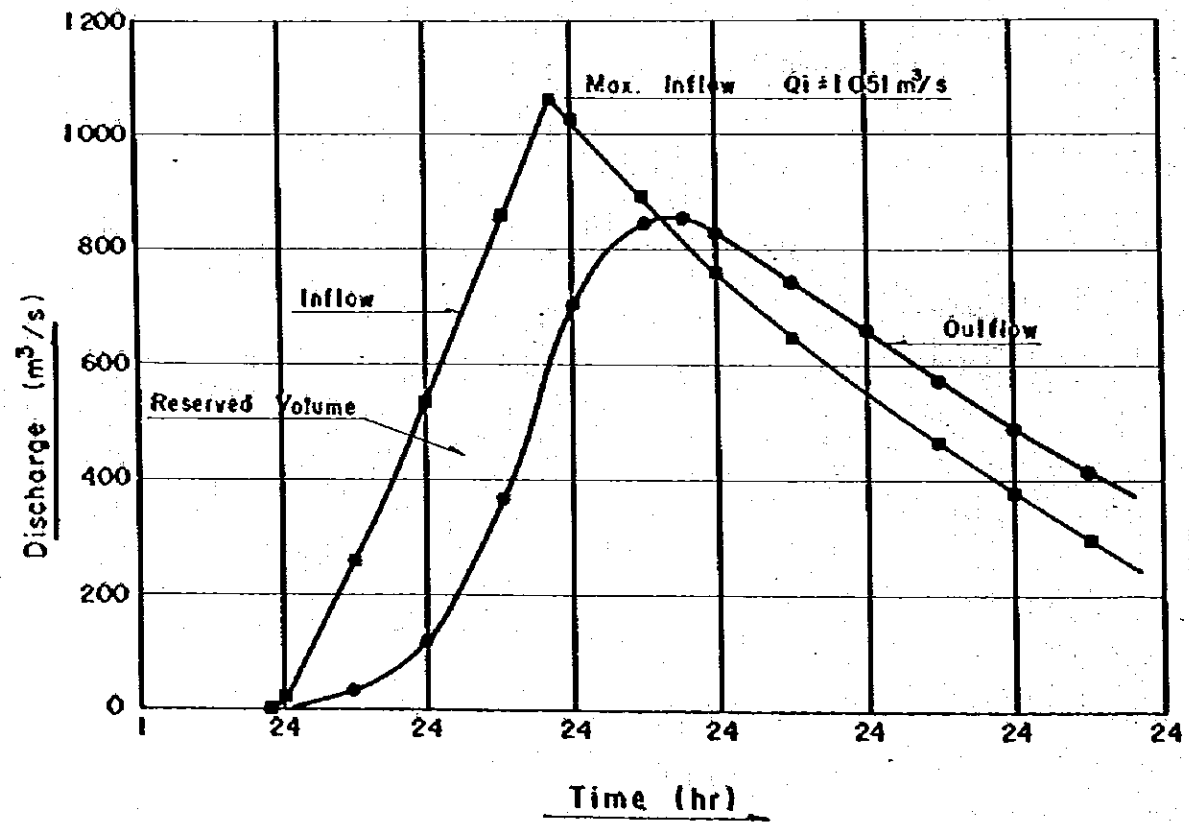
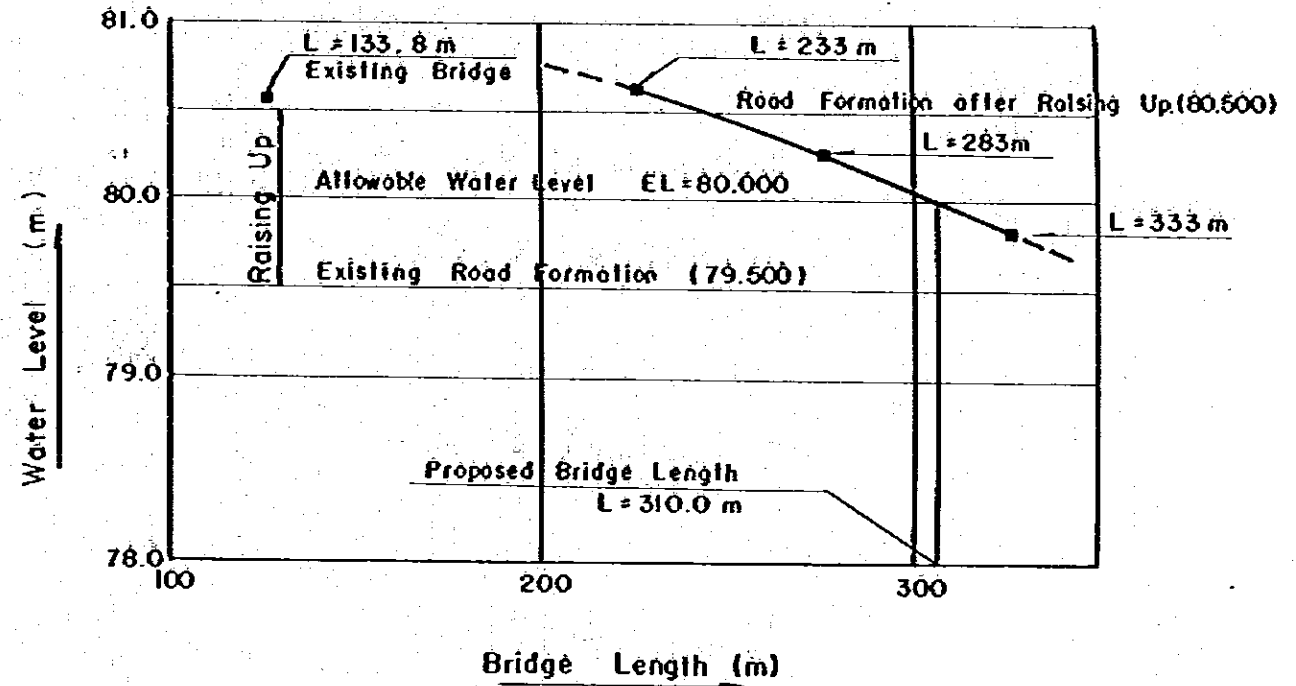


Figure 11A-9 BRIDGE LENGTH FOR RELIEF OPEN



Appendix 12

LIST OF BRIDGES

TABLE 12A-1 LIST OF BRIDGES

TABLE 12A-1
1 of 2

ROAD SECTMENT NO.	LOCATION 1/	EXISTING BRIDGE		PROPOSED BRIDGE		REMARKS	ROAD SECTMENT NO.	LOCATION 1/	EXISTING BRIDGE		PROPOSED BRIDGE		REMARKS
		TYPE 2/	WIDTH & LENGTH (m)	TYPE 3/	LENGTH (m)				TYPE 2/	WIDTH & LENGTH (m)	TYPE 3/	LENGTH (m)	
3*	3.6	-	-	C-S	20.0	Long Du River	10	3.4	T	3.0x9.0	C-S	15.0	
4	4.7	T	3.5x13.0	C-S	20.0		10	4.5	-	-	C-S	15.0	
4	10.7	T	2.5x8.5	C-S	15.0		11	2.4	-	-	C-S	15.0	
4	15.8	T	3.2x8.5	C-S	15.0		12*	7.6	-	-	C-S	25.0	
4	23.3	T	3.2x12.6	C-S	20.0		14	5.2	T	3.0x4.5	-	-	To be replaced with Box Culvert
4	24.1	T	3.0x14.0	C-S	20.0		14	5.9	T	2.8x9.5	-	-	do
4	24.7	-	-	C-S	30.0		15	3.5	T	3.8x18.0	C-S	20.0	
4	30.6	T	3.0x24.5	C-S	15.0		16	1.6	-	-	C-S	15.0	
4	30.8	T	3.0x11.5	C-S	15.0		16	3.5	-	-	C-S	25.0	
5*	0.7	-	-	C-S	15.0		16	5.0	-	-	C-S	25.0	
5*	1.4	-	-	C-S	25.0	Nam Sat River	17	6.2	-	-	C-S	25.0	
5*	3.7	-	-	C-S	25.0	Duan River	18*	3.0	T	(4.3x18.3)	C-S	21.0	No Bridge (Carried away)
6	4.4	-	-	C-S	20.0		18*	3.3	T	(4.4x25.0)	C-S	24.0	do
6	5.3	-	-	C-S	40.0		18*	3.6	T	4.4x15.5	C-S	16.0	
6	11.7	-	-	C-S	30.0		18*	4.4	-	-	C-S	105.0	Relief Open
6	19.3	-	-	C-S	25.0		18*	4.8	C	7.0x75.0	-	-	Pasak River
6	19.8	-	-	C-S	30.0		18*	6.7	T	4.2x5.0	-	-	To be replaced with Box Culvert
6	21.8	-	-	C-S	40.0		19 ^{4/}	3.0	T	4.2x15.0	C-S	15.0	
8	3.8	T	3.7x9.4	C-S	15.0		20	0.0	-	-	C-S	100.0	Pasak River
8	5.5	T	3.0x9.0	C-S	15.0		20	1.0	-	-	C-S	100.0	Relief Open
8	11.0	-	-	C-S	15.0		20	2.3	-	-	C-S	20.0	
8	12.0	-	-	C-S	20.0		20	5.4	-	-	C-S	20.0	
9	1.6	T	3.5x15.0	C-S	25.0		20	9.4	-	-	C-S	30.0	
9	5.6	T	4.0x11.3	C-S	20.0		20	11.3	-	-	C-S	20.0	
10	1.2	-	-	C-S	15.0		20	11.8	-	-	C-S	20.0	
10	2.0	-	-	C-S	20.0		20	14.1	-	-	C-S	30.0	

TABLE 12A-1 LIST OF BRIDGES (cont'd)

TABLE 12A-1
2 of 2

ROAD SEGMENT NO.	LOCATION 1/	EXISTING BRIDGE		PROPOSED BRIDGE		REMARKS	ROAD SEGMENT NO.	LOCATION 1/	EXISTING BRIDGE		PROPOSED BRIDGE		REMARKS
		TYPE 2/	WIDTH & LENGTH (m)	TYPE 3/	LENGTH (m)				TYPE 2/	WIDTH & LENGTH (m)	TYPE 3/	LENGTH (m)	
21*	1.6	-	-	C-S	15.0		27*	4.5	T	4.0x25.3	C-S	25.0	
21*	5.8	-	-	C-S	15.0		27*	9.3	T	4.0x22.5	C-S	30.0	
21*	7.5	-	-	C-S	30.0	Leng River	27*	15.5	C	7.0x105.0	-	-	Chang Tha River
22*	11.2	-	-	C-S	15.0		27*	19.3	T	4.0x20.3	C-S	25.0	
23*	1.2	-	-	C-S	20.0		28	0.0	-	-	C-S	100.0 ^{5/}	Chi River
23*	3.4	-	-	C-S	40.0	Chao River	28	2.6	C	6.5x20.0	-	-	
23*	20.7	-	-	C-S	40.0	Pong Khun Phet River	28	3.9	C	6.5x20.0	-	-	
25*	3.8	-	-	C-S	10.0		28	20.8	-	-	C-S	15.0	
25*	4.6	-	-	C-S	20.0		28	25.9	C	6.5x20.0	-	-	
26	1.3	-	-	C-S	15.0		28	26.6	C	6.5x20.0	-	-	
26	8.4	-	-	C-S	20.0		29*	0.7	T	4.0x20.4	C-S	30.0	
26	9.2	-	-	C-S	25.0		29*	9.3	C	7.0x100.0	-	-	Chi River
26	12.4	-	-	C-S	25.0		30*	4.6	T	3.6x15.5	C-S	30.0	Chi Long River
26	14.5	-	-	C-S	20.0		30*	4.8	T	3.6x6.0	C-S	25.0	do
26	15.2	-	-	C-S	20.0		30*	5.0	T	3.6x11.7	C-S	30.0	do
26	19.1	-	-	C-S	20.0		30*	5.5	T	3.4x17.8	C-S	30.0	do
26	20.6	-	-	C-S	25.0								

Notes:

- 1/ Location means distance (km) from the beginning point of each road segment.
 2/ C : Concrete Bridge.
 T : Timber Bridge.
 3/ C-S : Short Span Concrete Bridge
 4/ Segment No. 19 is included in Phetchabun - Chai Badan Highway Project.
 5/ Under Construction as of August 1979.
 * Marks show the segments in the Optimum route.