Table E.8 UNIT PRICES OF TYPICAL MATERIALS

Item	Description	Unit	Price (TK) in 1989	Foreign (%)	Local (%)
Bricks		1000 psc	2,700	20	80
Mortar (1:2)		m^3	4,000	40	60
Ready mixed concrete (1:3:5)	100 kg/cm^2	do.	4,700	40	60
Ready mixed concrete (1:2:4)	210 kg/cm^2	do.	5,200	45	55
Cement (50kg/bag)	Portland	bag	180	60	4 0
Sand	use of concrete	m^3	460	15	85
Crushed stone		do.	1,060	15	85
Riprap (Gravel)	50-150 mm	do.	780	15	85
Brick Chips		do.	1,60	15	85
Deformed Bar	SD 30	t	25,000	80	20
Steel sheet pile		do.	23,300	100	0
Structural steel		do.	17,300	100	0
Timber	Low Class	m^3	14,000	0	100
Timber	High Class	do.	19,000	80	20
Gasoline		L	13.2	90	10
Diesel oil		do.	6.9	90	10
Plywood	900 x 1800	pc	270	80	20
Welding Rod		kg	60	80	20

TABLE E.9 FREIGHT FOR TYPICAL ITEMS

Unit : TK/Freight Ton 1989 Price

Item	Packing	Shipping	Ocean Freight	Unloading	Land Transport	Insurance	Total
Sheet Pile	930	884	5,214	675	1,300	133	9,136
Pump Equipment	2,790	884	5,214	675	1,300	3,013	13,876
Gate Equipment	2,326	884	5,214	675	1,300	1,127	11,526
Construction Machinery	930	884	5,214	675	1,300	388	9,391
Miscellaneous Goods	2,790	884	5,214	675	1,300	407	11,270

TABLE E.10 UNIT CONSTRUCTION COST OF GENERAL ITEMS

Item	Description	Unit	Price (TK) in 1989	Foreign (%)	Local (%)
Excavation	Backhoe	m3	309	60	40
	Man power	do.	135	0	100
Dredging	Khal improvement	do.	200	60	40
Back filling	Backhoe	do.	303	60	40
	Man power	do.	104	0	100
Concrete work	100 kg/cm2	do.	5,530	40	60
	210 kg/cm2	do.	6,668	45	55
Reinforcement work		t	63,594	70	30
Form Work		m2	912	50	50
Brick Work		m3	3,400	30	70
Road Pavement		m2	1,200	40	60
Sodding		do.	60	0	100
Sheet pile driving		m	3,420	80	20
Concrete pile driving (400mm x 400mm)		m	4,000	70	30

TABLE E.11 UNIT CONSTRUCTION COST OF EACH FACILITY

(1989 Price)

Item	Description	Unit	Unit Construction Cost 1,000 Tk
A. Protection Work			
1. Brick Protection	Slope 1:1	TK/m	30.3
2. Sodding			0.6
B. Box Culvert	2.5x3.8m	TK/m	139.9
	5.0x3.8		194.0
	5.0x4.3		214.1
	5.5x4.3		233.2
	6.0x4.5		256.5
	6.0x5.0x2		489.7

TABLE E.12 UNIT CONSTRUCTION COST OF PROTECTION WORK (For 1.0m Length both Sides)

(1989 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C(%)	L/C (%)		F/C	L/C	Total
1. Brick protection (Slope 1:1)								
1. Excavation	m3	135	60	40	11.6	940	626	1,566
2. Brick Work	do.	3,400	30	70	6.4	6,528	15,232	21,760
3. Brick Chips	do.	1,250	15	85	3.8	713	4037	4,750
4. Levelling Concrete	do.	5,530	40	60	0.2	442	664	1,106
5. Backfill	do.	104	60	40	2.6	131	87	218
6. Miscellaneous	LS	150	25	75	1.0	225	675	900
Total			30	70		8979	21321	30,300
II. Sodding Protection								
Sodding	m2	60	0	100	10.0		600	600
Total			0	100			600	600

TABLE E.13 (a) UNIT CONSTRUCTION COST OF BOX CULVERT (1) - (For 1 m Lenght)

(1989 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C(%)	L/C (%)		F/C	L/C	Total
A. 2.5m x 3.8m								
1. Excavation	m3	309	60	40	17.00	3,152	2,101	5,253
2. Levelling Concrete	m3	5,530	40	60	0.36	796	1,195	1,991
3. Concrete	m3	6,668	45	55	6.48	19,444	23,765	43,209
4. Form	m2	912	50	50	14.51	6,617	6,616	13,233
5. Re - Bar	t	63,594	70	30	0.58	25,820	11,065	36,885
6. Backfill	m3	303	60	40	17.0	3,091	2,060	5,151
7. Miscellaneous	LS	34,178	57	43	1.0	19,472	14,706	34,178
Total			56	44		79,392	61,508	139,900
B.5.0m x 3.8m								
1. Excavation	m3	309	60	40	26.60	4,931	3,288	8,219
2. Levelling Concrete	m3	5,530	40	60	0.62	1,372	2,057	3,429
3. Concrete	m3	6,668	45	55	9.80	29,406	35,940	65,346
4. Form	m2	912	50	50	21.94	10,005	10,004	20,009
5. Re - Bar	t	63,594	70	30	0.88	39,174	16,789	55,963
6. Backfill	m3	303	60	40	26.60	4,836	3,224	8,060
7. Miscellaneous	LS	32,974	58	42	1.0	19,160	13,814	32,974
Total			56	44		108,884	85,116	194,000
C. 5.0m x4.3m								
1. Excavation	m3	309	60	40	30.00	5,562	3,708	9,270
2. Levelling Concrete	m3	5,530	40	60	0.62	1,372	2,057	3,429
3. Concrete	m3	6,668	45	55	10.30	30,906	37,774	68,680
4. Form	m2	912	50	50	23.06	10,516	10,515	21,031
5. Re - Bar	t	63,594	70	30	0.92	40,954	17,552	58,506
6. Backfill	m3	303	60	40	30.00	5,454	3,636	9,090
7. Miscellaneous	LS	44,094	58	42	1.0	25,502	18,592	44,094
Total			56	44		120,266	93,834	214,100

Note : including Preparation and Temporary work

TABLE E.13 (b) UNIT CONSTRUCTION COST OF BOX CULVERT (2) - (For 1 m Lenght)

(1989 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C(%)	L/C (%)		F/C	L/C	Total
D. 5.5m x 4.3m								
1. Excavation	m3	309	60	40	32.30	5,989	3,992	9,981
2. Levelling Concrete	m3	5,530	40	60	0.67	1,482	2,223	3,705
3. Concrete	m3	6,668	45	55	10.80	32,406	39,608	72,014
4. Form	m2	912	50	50	24.18	11,026	11,026	22,052
5. Re - Bar	t	63,594	70	30	0.97	43,180	18,506	61,686
6. Backfill	m3	303	60	40	32.30	5,872	3,915	9,787
7. Miscellaneous	LS	53,975	57	43	1.0	30,815	23,160	53,975
Total			56	44		130,770	102,430	233,200
E. 6.0m x 4.5m								
1. Excavation	m3	309	60	40	36.00	6,674	4,450	11,124
2. Levelling Concrete	m3	5,530	40	60	0.72	1,593	2,389	3,982
3. Concrete	m3	6,668	45	55	11.50	34,507	42,175	76,682
4. Form	m2	912	50	50	25.75	11,742	11,742	23,484
5. Re - Bar	t	63,594	70	30	1.03	45,851	19,651	65,502
6. Backfill	m3	303	60	40	36.60	6,.545	4,363	10,908
7. Miscellaneous	LS	64,818	57	43	1.0	36,848	27,970	64,818
Total			56	44		143,760	112,740	256,500
F. 6.0m x 5.0m x 2								
1. Excavation	m3	309	60	40	67.50	12,515	8,343	20,858
2. Levelling Concrete	m3	5,530	40	60	1.38	3,052	4,579	7,631
3. Concrete	m3	6,668	45	55	24.18	72,554	88,678	161,232
4. Form	m2	912	50	50	54.13	24,684	24,683	49,367
5. Re - Bar	t	63,594	70	30	2.17	96,599	41,400	137,999
6. Backfill	m3	303	60	40	67.50	12,272	8,181	20,453
7. Miscellaneous	LS	92,160	58	42	1.0	53,213	38,947	92,160
Total			56	44		274,889	214,811	489,700

Note : including Preparation and Temporary work

TABLE E.14 UNIT CONSTRUCTION COST OF RAILWAY BRIDGE
(at Segunbagicha)

(1989 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C(%)	L/C (%)		F/C	L/C	Total
I. Preparation Work	LS	315,000	40	60	1.0	126,000	189,000	315,000
II. Direct Construction Cost								
A. Foundation (R.C. Pile)								
0.4 x 0.4 x 15 m	Piece	29,100	70	30	42.0	855,540	366,660	1,222,200
Subtotal			70	30		855,540	366,660	1,222,200
B. Abutment								
1. Excavation	m3	309	60	40	2640.0	489,456	326,304	815,760
2. Backfill	do.	303	60	40	1860.0	338,148	225,432	563,580
3. Levelling Concrete	do.	5,530	40	60	10.9	24,111	36,166	60,277
4. Concrete	do.	6,668	45	55	300.0	900,180	1,100,220	2,000,400
5. Re-Bar	t	63.594	70	30	30.0	1,335,474	572,3461	1,907,820
6. Form	m2	912	50	50	418.0	190,608	190,608	381,216
7.Miscellaneous	LS	232,650	70	30	1.0	162,855	69,795	232,650
Subtotal			58	42		3,440,832	2,520,871	5,961,703
C. Wing Wall (t=0.50m)								
1. Concrete	m3	6,668	45	55	65.0	195,039	238,381	433,420
2. Re - Bar	t	63,594	70	30	7.8	347,223	148,810	496,033
3. Form	m2	912	50	50	260.0	118,560	118,560	237,120
4.Miscellaneous	LS	60,489	70	30	1.0	42,342	18,147	60,489
Subtotal			57	43		703,164	523,898	,227,062
III. Temporary Work	LS	1,800,000	70	30	1.0	1,260,000	540,000	1,800,000
IV. Prefabricated Steel Structure								
Main Girder (12 m) x 3								
1. Girder	t	10,000	100	0	33.0	3,300,000		3,300,000
2. Installation	LS	1,650,000	100	0	1.0	1,650,000		1,650,000
3. Miscellaneous	do.	200,000	90	10	1.0	180,000	20,000	200,000
Subtotal			100	0		5,130,000	20,000	5,150,000
Total			73	27		11,515,536	4,160,429	15,675,965

Note : . Preparation work (site clearing,site office motor pool, survey works, soil boring, safety control, etc.)

TABLE E.15 Unit Construction Cost of Pump Station : Q=10.0m3/s
(at kallyanpur)

(1989 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C(%)	L/C(%)		F/C	L/C	Total
I. Preparation Work	LS.	2,700,000	40	60	1.0	1,080,000	1,620,000	2,700,000
II. Direct Construction Cost								
1. Excavation	m3	135	60	40	1,500.0	121,500	81,000	202,500
2. Embankment	do	600	60	40	12,500.0	4,500,000	3,000,000	7,500,000
3. Backfill	do	104	60	40	280.0	17,472	11,648	29,120
4. R.C.Pile (L=15m) 0.4 x 0.4m	m	4,000	70	30	1,500.0	4,200,000	1,800,000	6,000,000
5. Concrete	m3	6,668	45	55	1,514.0	4,542,908	5,552,444	10,095,352
6. Re - Bar	t	63,594	70	30	150.0	6,677,370	2,861,730	9,539,100
7. Form	m2	912	50	50	2,650.0	1,208,400	1,208,400	2,416,800
8. Building	LS.	28,400,000	40	60	1.0	11,360,000	17,040,000	28,400,000
9. Miscellaneous works	LS.	8,663,250	57	43	1.0	4,939,275	3,723,975	8,663,250
Subtotal			52	48		37,566,925	35,279,197	72,846,122
III. Mechanical & Electrical Facilities								
1. ø1200 Pump	place	16,260,000	100	0	3.0	48,780,000	0	48,780,000
2. 132kw Main Motor	do	7,160,000	100	0	3.0	21,480,000	0	21,480,000
3. Pipe and Valve	do	4,385,000	100	0	3.0	13,155,000	0	13,155,000
4. Electrical Facilities	LS.	41,255,000	80	20	1.0	33,004,000	8,251,000	41,255,000
5. Crane and Spare Parts	do	7,820,000	100	0	1.0	7,820,000	0	7,820,000
6. Installation	do	14,264,000	95	5	1.0	13,550,800	713,200	14,264,000
7. Miscellaneous	do	4,440,000	100	0		4,440,000	0	4,440,000
Subtotal			94	6		142,229,800	8,964,200	151,194,000
Total			80	20		180,876,725	45,863,397	226,740,122

Note : * Preparation work (site clearing, site office, motor pool, survey works, soil boring, safety control, etc.)

TABLE E.16 UNIT CONSTRUCITON COST OF SLUICE GATE
(at Kallyanpur)

(1989 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C(%)	L/C(%)		F/C	L/C	Total
I. Preparation Work	LS.	650,000	40	60	1.0	260,000	390,000	650,000
II. Direct Construction Cost								
1. Excavation	m3	309	60	40	6,348.0	1,176,919	784,613	1,961,532
2. Backfill	do	303	60	40	4,900.0	890,820	593,880	1,484,700
3. Sheet Pile (Type II)	m	3,420	80	20	2,600.0	7,113,600	1,778,400	8,892,000
4. Concrete	m3	6,668	45	55	1,080.0	3,240,648	3,960,792	7,201,440
5. Re-Bar	t	63,594	70	30	97.0	4,318,033	1,850,585	6,168,618
6. Form	m2	912	50	50	2,303.0	1,050,168	1,050,168	2,100,336
7. Bridge Installation	LS.	1,286,000	55	45	1.0	707,300	578,700	1,286,000
8. Miscellaneous Work	do	6,752,235	57	43	1.0	3,826,564	2,925,671	5,752,235
Subtotal			62	38		22,324,052	13,522,809	35,846,861
III. Gate Leaf and Equipment								
1. Gate Leaf and Sheet	LS.	8,027,924	100	0	1.0	8,027,924	0	8,027,924
2. Hoist Machine	do	4,067,836	100	0	1.0	4,067,836	0	4,067,836
3. Installation	do	1,300,000	90	10	1.0	1,170,000	130,000	1,300,000
4. Miscellaneous	do	1,000,000	55	45	1.0	550,000	450,000	1,000,000
Subtotal						13,815,760	580,000	14,395,760
Total			72	28		36,399,812	14,492,809	50,892,621

TABLE E.17 OFFICE ESTABLISHMENT COST (1)

(ANNUAL EXPENSES OF DWASA'S PERSONNEL/OFFICE ACCOMMODATION FOR CONSTRUCTION SUPERVISION)

(1989 Price)

POSITION	UNIT RATE	1. SUPERINTENDING ENGRS OFFICE		2. EXECUTIVE ENGRS OFFICE		3. SUBDIVISIONAL ENGRS OFFICE		TOTAL	
		STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT
PERSONEL EXPENSE	(TK/MAM/PAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)
(1) SUPERINTENDING ENG.	7,500	1	90,000	-	-	-	-	1	90,000
(2) EXECUTIVE ENG.	6,000	-	-	2	144,000	-	-	2	144,000
(3) SUBDIVISIONAL ENG.	5,000	-	-	-	-	4	240,000	4	240,000
(4) SUB-ASSISTANT ENG.	4,000	-	-	-	-	8	384,000	8	384,000
(5) STENOGRAPHER	2,200	1	26,400	-	-	-	-	1	26,400
(6) HEAD ASSISTASNT (UDA)	2,200	1	26,400	2	52,800	4	105,600	7	184,800
(7) ESTIMATOR	4,000	1	48,000	2	96,000	-	-	3	144,000
(8) DRAFTSMAN	4,000	1	48,000	2	96,000	-	-	3	144,000
(9) ACCOUNTANT	2,200	-	-	2	52,800	-	-	2	52,800
(10) ACCOUNT ASSISTANT	2,000	1	24,000	2	48,000	4	96,000	7	168,000
(11) CASHIER	2,000	-	-	2	48,000	-	-	2	48,000
(12) WORK ASSISTANT	2,000	-	-	-	-	16	384,00	16	384,000
(13) CUM TYPIST L.D.A.	2,000	1	24,000	2	48,000	4	96,000	7	168,000
(14) DRIVER	2,700	1	32,400	2	64,800	4	129,600	7	226,800
(15) PUMP OPERATER	2,000	-	-	-	-	8	192,000	8	192,000
(16) ASST. PUMP OPERATER	1,500	-	-	-	-	8	144,000	8	144,000
(17) M.L.S.S	1,500	2	36,000	4	72,000	16	288,000	22	396,000
SUBTOTAL (1)	-	10	355,200	22	722,400	76	2,059200	108	3,136,800
OFFICE ACCOMMODATION ETC.									
(1) OFFICE ACCOMMODATION	LS.	200,000		400,000		400,000		1,00,000	
(2) T.A.D.A/OTHER ALLOWANCE	LS.	80,000		80,000		160,000		320,000	
(3) STATIONARY	LS.	60,000		120,000		80,000		260,000	
(4) CONTINGENCY	LS.	20,000		40,000		40,000		100,000	
SUBTOTAL (2)	-	360,000		640,000		680,000		1,680,000	
TOTAL	-	715,200		1,362,400		2,739,200		4,816,800	

TABLE E.18 PROCUREMENT COST OF VEHICLE FOR DWASA'S CONSTRUCTION SUPERVISION

UNIT : 1,000 TK.1989 PRICE

VEHICLE/MOTORCYCLE	NO	UNIT PRICE			TOTAL PRICE
		C.I.F	C.D.S.T.	TOTAL	
(1) FOUR WHEEL DRIVE CAR	2	560	420	980	1,960
(2) PICKUP CAR	4	337	253	590	2,360
(3) 90 cc MOTORCYCLE	8	45	135	180	1,440
TOTAL	15	-	-	-	5,760

TABLE E.19 OFFICE ESTABLISHMENT COST (2)

(ANNUAL EXPENSES OF DWASAS PERSONNEL/OFFICE ACCOMMODATION FOR OPERATION AND MAINTENANCE)

POSITION	UNIT RATE	1. SUPERINTENDING ENGRS OFFICE		2. EXECUTIVE ENGRS OFFICE		3. SUBDIVISIONAL ENGRS OFFICE		TOTAL	
		STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT
PERSONAEL EXPENSE	(TK/MAN/PAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)
(1) SUPERINTENDING ENG.	7,500	1	90,000	-	-	-	-	1	90,000
(2) EXECUTIVE ENG.	6,000	-	-	2	144,000	-	-	2	144,000
(3) SUBDIVISIONAL ENG.	5,000	-	-	-	-	4	240,000	4	240,000
(4) SUB-ASSISTANT ENG.	4,000	-	-	-	-	8	384,000	8	384,000
(5) STENOGRAPHER	2,200	1	26,400	-	-	-	-	1	26,400
(6) HEAD ASSISTANT ENG.	2,200	1	26,400	2	52,800	4	105,600	7	184,800
(7) ESTIMATOR	4,000	1	48,000	2	96,000	-	-	3	144,000
(8) DRAFTSMAN	4,000	1	48,000	2	96,000	-	-	3	144,000
(9) ACCOUNT ASSISTANT	2,200	-	-	2	52,800	-	-	2	52,800
(10) ACCOUNT ASSISTANT	2,000	1	24,000	2	48,000	4	96,000	7	168,000
(11) CASHER	2,000	-	-	2	48,000	-	-	2	48,000
(12) WORK ASSISTANT	2,000	-	-	-	-	16	384,000	16	384,000
(13) CUM TYPIST L.D.A.	2,000	1	24,000	2	48,000	4	96,000	7	168,000
(14) DRIVER	2,700	1	32,400	2	64,800	4	129,600	7	226,800
(15) PUMP OPERATER	2,000	-	-	-	-	8	192,000	8	192,000
(16) ASST.PUMP OPERATER	1,500	-	-	-	-	8	144,000	8	144,000
(17) CLEANER	1,500	-	-	-	-	20	360,000	20	360,000
(18) M.L.S.S	1,500	2	36,000	4	72,000	16	288,000	20	396,000
SUBTOTAL (1)	-	10	355,200	22	722,400	96	2,419,200	128	3,496,600
OFFICE ACCOMMODATION									
(1) OFFICE ACCOMMODATION	LS	200 ,000		400 ,000		40 ,000		100 ,000	
(2) T.A.D.A/OTHER ALLOWANCE	LS	80 ,000		80 ,000		160 ,000		320 ,000	
(3) STATIONARY	LS	60 ,000		120 ,000		80 ,000		260 ,000	
(4) CONTINGENCY	LS	20 ,000		40 ,000		40 ,000		100 ,000	
SUBTOTAL (2)	-	360 ,000		640 ,000		680 ,000		1,650 ,000	
TOTAL	-	715 ,000		1,362 ,400		3,099 ,000		5,176 ,800	

TABLE E.20 PROCUREMENT COST OF O & M EQUIPMENT

UNIT : 1,000 TK, 1989 PRICE

ITEM	NO.	UNIT PRICE			TOTAL PRICE
		C.I.F	C.D.S.T	TOTAL	
(1) GARBAGE TROLLEY	4	1,115	835	1,950	7,800
(2) TRUCK (4 t)	2	810	610	1,420	2,840
(3) TRUCK WITH CRANE (4 t)	2	1,930	1,450	3,380	6,760
(4) BUCKET MACHINE	2	1,640	1,230	2,870	5,740
(5) CLEANING EQUIPMENT (MANUAL OPERATION)	10	3	2	5	50
(6) PUMP (Ø 6")	10	370	280	650	6,500
(7) FOUR WHEEL DRIVE CAR	1	560	420	980	980
(8) MOTORCYCLE	8	45	135	1,440	160
TOTAL	39				32,110

TABLE E.21 DISBURSEMENT SCHEDULE OF URGENT PROJECT

PACKAGE - I FOR ZONE F AND H

(UNIT : MILLION Tk IN 1989 PRICE)

	ITEM	CURRENCY	1st YEAR	2 nd YEAR	3rd YEAR	4th YEAR	TOTAL COST		
							F/C	L/C	TOTAL
H	1.PUMP STATION	L/C	-	15.27	30.53	-	180.90	45.80	226.70
		F/C	-	60.33	120.57	-			
		E/T	-	75.60	151.10	-			
	2.SLUICE GATE	L/C	-	-	14.50	-	36.40	14.50	50.90
		F/C	-	-	36.40	-			
		E/T	-	-	50.90	-			
	3.BRIDGE CULVERT (AT MILLPUR Rd.)	L/C	-	-	-	5.40	6.70	5.40	12.10
		F/C	-	-	-	6.70			
		E/T	-	-	-	12.10			
	4.DREDGING	L/C	-	-	2.42	3.58	5.90	6.00	11.90
		F/C	-	-	2.38	3.52			
		E/T	-	-	4.80	7.10			
F	5.CHANNEL CULVERT	L/C	-	19.73	39.44	9.83	84.60	69.00	153.60
		F/C	-	24.17	48.36	12.07			
		E/T	-	43.90	87.80	21.90			
SUBTOTAL (1-5)		L/C	-	35.00	86.89	18.81	314.50	140.70	455.20
		F/C	-	84.50	207.71	22.29			
		E/T	-	119.50	294.60	41.10			
6 .PHYSICAL CONTINGENCY		L/C	-	5.39	13.28	1.85	25.00	20.52	45.52
		F/C	-	6.56	16.18	2.26			
		E/T	-	11.95	29.46	4.11			
SUBTOTAL (1-6)		L/C	-	40.39	100.17	20.66	339.50	161.22	500.72
		F/C	-	91.06	223.89	24.55			
		E/T	-	131.45	324.06	45.21			
7 .ENGINEERING		L/C	3.76	1.70	3.41	2.53	34.10	11.40	45.50
		F/C	11.24	5.10	10.19	7.57			
		E/T	15.00	6.80	13.60	10.10			
8 .LAND ACQUISITION		L/C	-	77.60	-	-	0.00	77.60	77.60
		F/C	-	-	-	-			
		E/T	-	77.60	-	-			
9 .ADMINISTRATION		L/C	-	4.80	4.80	3.60	0.00	13.20	13.20
		F/C	-	-	-	-			
		E/T	-	4.80	4.80	3.60			
10 .CUSTOMS DUTY & TAX		L/C	-	-	112.50	-	0.00	112.50	112.50
		F/C	-	-	-	-			
		E/T	-	-	112.50	-			
TOTAL (1-10)		L/C	3.76	124.49	220.68	26.79	373.60	375.92	749.52
		F/C	11.24	98.16	234.08	32.12			
		E/T	15.00	220.65	454.96	58.91			

PACKAGE - II FOR ZONE C

(UNIT : MILLION Tk IN 1989 PRICE)

	ITEM	CURRENCY	1st YEAR	2 nd YEAR	3rd YEAR	4th YEAR	TOTAL COST		
							F/C	L/C	TOTAL
C	1.CHANNEL CULVERT	L/C	-	29.98	59.96	44.96	164.80	134.90	299.70
		F/C	-	36.62	73.24	54.94			
		E/T	-	66.60	133.20	99.90			
	2.BRIDGE CULVERT	L/C	-	3.01	4.49	-	9.20	7.50	16.70
		F/C	-	3.69	5.51	-			
		E/T	-	6.70	10.00	-			
	3.RAILWAY BRIDGE	L/C	-	-	1.55	1.55	12.60	3.10	15.70
		F/C	-	-	6.30	6.30			
		E/T	-	-	7.85	7.85			
	4.BRICK PROTECTION	L/C	-	-	-	26.30	10.70	26.30	37.00
		F/C	-	-	-	10.70			
		E/T	-	-	-	37.00			
	5.DREDGING	L/C	-	-	8.35	8.35	22.60	16.70	39.30
		F/C	-	-	11.30	11.30			
		E/T	-	-	19.65	19.65			
SUBTOTAL (1-5)		L/C	-	32.99	74.35	81.16	219.90	188.50	408.40
		F/C	-	40.31	96.35	83.24			
		E/T	-	73.30	170.70	164.40			
6 .PHYSICAL CONTINGENCY		L/C	-	3.29	7.67	7.38	22.50	18.34	40.84
		F/C	-	4.04	9.4	9.06			
		E/T	-	7.33	17.07	16.44			
SUBTOTAL (1-6)		L/C	-	36.28	82.02	88.54	242.40	206.84	449.24
		F/C	-	44.35	105.75	92.30			
		E/T	-	80.63	187.77	180.84			
7 .ENGINEERING		L/C	3.39	1.52	3.02	2.27	30.70	10.20	40.90
		F/C	10.21	4.58	9.08	6.82			
		E/T	13.60	6.10	12.10	9.10			
8 .LAND ACQUISITION		L/C	-	80.00	-	-	0.00	80.00	80.00
		F/C	-	-	-	-			
		E/T	-	80.00	-	-			
9 .ADMINISTRATION		L/C	-	4.80	4.80	3.60	0.00	13.20	13.20
		F/C	-	-	-	-			
		E/T	-	4.80	4.80	3.60			
10 .CUSTOMS DUTY & TAX		L/C	-	-	2.48	-	0.00	2.48	2.48
		F/C	-	-	-	-			
		E/T	-	-	2.48	-			
TOTAL (1-10)		L/C	3.39	122.60	92.32	94.41	273.10	312.72	585.82
		F/C	10.21	48.93	114.83	99.13			
		E/T	13.6	171.53	207.15	193.54			

		Work Item	Quantity	1st Year	2nd Year	3rd Year	4th Year	Remarks
Package -I		1. Project Preparation	1 L.s	- - - - -				Financial Arrangement
	H - Zone	2. Pump Station	1 place					
		3. Sluice Gate	1 place		Manufacturing			
		4. Bridge Culvert (at Millpur Rd.)	1 place					
		5. Dredging	3.3 km					
	F - Zone	6. Channel Culvert	0.8 km					
		7. Land Acquisition	1 L.s					
		8. Administration	1 L.s	- - - - - - - - -				
		9. Engineering	1 L.s	D/D				
Package - II		1. Project Preparation	1 L.s	- - - - -				Financial Arrangement
	C - Zone	2. Channel Culvert	1.4 km					
		3. Bridge Culvert	3 place					
		4. Railway Bridge	1 place					
		5. Brick Protection	1.0 km					
		6. Dredging	3.9 km					
		7. Land Acquisition	1 L.s					
		8. Administration	1 L.s	- - - - - - - - -				
		9. Engineering	1 L.s	D/D		C/S		

FIG. E. 1 CONSTRUCTION SCHEDULE OF URGENT PROJECT

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

SUPPORTING REPORT - F -

PROJECT EVALUATION

SUPPORTING REPORT F
PROJECT EVALUATION

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SUPPORTING REPORT F
PROJECT EVALUATION

1 GENERAL

This up-dated edition of the project evaluation features the following revisions.

(1) Base costs and benefits in previous evaluation study were based on 1986 price information. This base was increased by 5 to 6 per cent to obtain a new 1989 base price. This updated cost and benefit information can provide for more accuracy in decision making for policy implementation.

(2) The new analytical framework corresponds to the change in the priority areas. Since the World Bank had decided to implement flood mitigation works in drainage zone B, this zone B is replaced by zone H. The analysis is thus, based on zones of C, F and H in this study instead of B, C, and F in the previous study.

(3) To update the analytical framework corresponding to the new project package. Flood mitigation works of the drainage zones of F and H are designed to be implemented in one project package and therefore, both drainage zones are integrated into one project.

In assessing the investment efficiency of the project, the project benefit is estimated based on the assumption that the benefit is integratedly deriven from both the GDFCD project and the proposed phased program for Zones C, F and H. And the cost of the GDFCD is thus also included in cost estimation of this project evaluation.

All the analytical methods and procedures except the points above are identical to the previous report for consistency.

2 IDENTIFICATION OF BENEFITS

Project benefits are based on the magnitude of reduction of the potential flood damage which results from the project. This magnitude is the difference in flood damage potential between "with the project" and "without the project."

Benefits identified are as follows;

(1) Reduction of general property damage
(2) Reduction of public property damage
(3) Reduction of income/sales loss
(4) Reduction of vehicle running costs
(5) Improvement of public health and amenities
(6) Creation of employment opportunity.

Of the benefits above, four tangible benefits of (1) to (4) are quantified in monetary terms.

This project is designed in cooperation with the GDFCD Project and the expected project benefits can be generated only when the GDFCD Project will be implemented. In this evaluation, total amount of the project benefit is estimated based on the assumption that this GDFCD Project would be implemented.

3 ESTIMATE OF ECONOMIC BENEFITS

The economic benefit of the project is estimated by a four step procedure. The first step is to convert the damage figures of houses and other properties into the 1989 figures. The second, step is to estimate the flood damage potential by flood frequency. The third step is to convert the flood damage potential by flood frequency into the average annual flood damage potantial. Lastly, project benefit is derived in accordance with the design flood frequency of each flood mitigation work.

First, value of the house is converted into the 1989 price by increasing the 1986 figures according to the increase of price in cost of housing construction since 1986. This increase is reported to have been 6.7 per cent annum. Other damage figures estimated in 1986 are all converted into the 1989 figures by proceeding the same method.

Secondly, the flood damage potential is estimated for the cases of four (4) cases of flood frequency; 1-year, 5-year, 10-year and 30-year in 1989 and 2000. Results are tabulated in Table F-1.

Table F-1 Summary of Economic Benefit

(unit; million Tk, 1989 prices)

	Package I (F and H Zones)		Package II (C Zone)	
	1989	2000	1989	2000
1-year Frequency Flood	108.3	315.5	41.7	72.4
5-year Frequency Flood	192.7	468.9	96.6	210.9
10-year Frequency Flood	229.0	536.0	120.3	270.5
30-year Frequency Flood	286.7	642.0	157.7	365.0

These figures contains the flood damage potential resulting from both the internal and external floods. More detailed figures are shown in Tables F-2 through F-7 by drainage zone.

Thirdly, the flood damge potential by frequency is converted into the average annual damages by the following function;

$$D = \Sigma\{(N_{m-1} - N_m) \times (L_{m-1} + L_m)/2\}$$

where,
- D: Average annual flood damage
- N: Probability of flood
- L: Damage potential corresponding to probability of flood
- m: Ordinal number

Results are shown below;

(unit; million Tk, 1989 price)

Items	Package I (F and H Zones)	Package II (C Zone)
Average Annual Flood Damage Potantial in 1989	142.9	71.0
Average Annual Flood Damage Potential in 2000	340.8	151.2

Figures above indicate that, without any flood mitigation project, F and H zones are expected to suffer 158.7 million Tk of flood damage annually. As this flood damage

potential will increase in parallel with the population growth and town development in the area, it reaches 403.3 million Tk in 2000.

In C zone, the flood damage potential amounts 75.4 million Tk annually and it is expected to increase up to 158.6 million Tk in 2000 if any new flood mitigation measures will not be taken as suggested in this report.

Lastly, project benefit is derived in accordance with the designed flood frequency for each flood protection work. All the proposed facilities are designed enough to cope with (1) 100-year frequency of the external flood and (2) 5-year frequency of the internal flood. Therefore, in calculating the reduction of the average annual damage, damage potentials corresponding to the design flood frequency of each flood protection works are incorporated in the function above. Benefits of the project are summarized in Table F-8.

Table F-8 Reduction in Averege Annual Flood Damage in 1989 and 2000
(unit; million Tk, 1989 price)

Items	Package I (F and H Zones)	Package II (C Zone)
Reduciton in a Annual Flood Damage in 1989	142.9	71.0
Reduction in a Annual Flood Damage in 2000	340.8	151.2

Annual flood damage of in-between years are estimated by interpolating the figures of 1989 and 2000, while the figures after 2000 are estimated by increasing the 2000 figure at the rate of price increase expected.

Table F-2 Summary of Flood Damage Potential (C DRAINAGE ZONE ONLY)
(Inundation)

(Unit : million TK. in 1986 Prices)

Items	1986				2000			
	1 / 1	1 / 5	1 / 10	1 / 30	1 / 1	1 / 5	1 / 10	1 / 30
A. General Property								
(1) Houses	23.0	21.0	20.2	18.9	25.1	23.0	22.0	20.6
(2)Household Articles	0.1	0.4	0.5	0.7	0.1	0.4	0.6	0.8
(3) Commercial Buildings (depreciating assets & stocks)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	23.1	21.4	20.7	19.6	25.2	23.4	22.6	21.4
B. Public Property								
(1) Electric Facilities	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(2) Telecommunication Facilities	1.2	1.3	1.4	1.5	1.5	1.9	2.1	2.4
(3) Public Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Roads	1.8	2.0	2.1	2.3	0.0	10.8	15.4	22.8
(5) Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	3.1	3.4	3.6	3.9	1.6	12.9	17.7	25.4
C. Agricultural Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Income/Sales Loss Potential								
(1) Labour	0.3	0.2	0.2	0.1	0.6	0.5	0.4	0.3
(2) Shop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(3) Electricity Sales	0.2	0.2	0.2	0.3	0.2	0.3	0.4	0.4
(4) Transport Charges								
Bus	1.2	1.2	1.2	1.2	1.7	2.0	2.1	2.3
Rickshaw	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Subtotal	1.7	1.7	1.7	1.7	2.8	3.0	3.1	3.3
E. Vehicle's Running Costs								
(1) Operating Costs	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(2) Time Costs Vehicles	0.4	0.2	0.2	0.1	0.4	0.3	0.3	0.2
Passengers	0.6	0.4	0.3	0.1	0.7	0.5	0.4	0.3
Subtotal	1.0	0.6	0.5	0.2	1.2	0.9	0.7	0.5
Grand Total	28.9	27.2	26.5	25.3	30.8	40.1	44.1	50.5

Table F-3 Summary of Flood Damage Potential (C DRAINAGE ZONE ONLY)
(Flood)

(Unit : million TK, in 1986 Prices)

Items	1986				2000			
	1 / 1	1 / 5	1 / 10	1 / 30	1 / 1	1 / 5	1 / 10	1 / 30
A. General Property								
(1) Houses	10.2	53.0	71.5	100.8	33.9	89.2	113.1	150.9
(2)Household Articles	0.0	1.3	1.9	2.7	0.1	2.1	3.0	4.3
(3) Commercial Buildings (depreciating assets & stocks)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	10.2	54.4	73.4	103.5	34.0	91.3	116.0	155.2
B. Public Property								
(1) Electric Facilities	0.0	0.2	0.3	0.4	0.1	0.5	0.7	0.9
(2) Telecommunication Facilities	0.5	3.6	5.0	7.1	2.0	8.3	11.0	15.2
(3) Public Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Roads	0.8	5.5	7.5	10.8	0.0	55.3	79.2	117.0
(5) Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	1.4	9.3	12.8	18.2	2.2	64.1	90.8	133.1
C. Agricultural Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Income/Sales Loss Potential								
(1) Labour	0.1	0.5	0.6	0.9	0.9	1.7	2.1	2.7
(2) Shop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(3) Electricity Sales	0.1	0.6	0.8	1.1	0.3	1.4	1.8	2.5
(4) Transport Charges								
Bus	0.5	3.1	4.2	5.9	2.3	8.4	11.0	15.1
Rickshaw	0.0	0.3	0.4	0.5	0.3	0.8	1.0	1.4
Subtotal	0.8	4.4	5.9	8.4	3.8	12.3	15.9	21.7
E. Vehicle's Running Costs								
(1) Operating Costs	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3
(2) Time Costs Vehicles	0.2	0.5	0.6	0.8	0.6	1.1	1.3	1.7
Passengers	0.2	0.8	1.0	1.3	1.0	1.8	2.1	2.6
Subtotal	0.5	1.3	1.7	2.3	1.6	3.0	3.6	4.6
Grand Total	12.8	69.4	93.8	132.4	41.6	170.7	226.4	314.5

Table F-4 Summary of Flood Damage Potential (F DRAINAGE ZONE ONLY)
(Inundation)

(Unit : million TK. in 1986 Prices)

Items	1986				2000			
	1 / 1	1 / 5	1 / 10	1 / 30	1 / 1	1 / 5	1 / 10	1 / 30
A. General Property								
(1) Houses	47.8	41.4	38.6	34.2	56.8	51.9	49.9	46.5
(2)Household Articles	0.2	2.7	3.7	5.4	0.6	4.5	6.2	8.9
(3) Commercial Buildings (depreciating assets & stocks)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	48.0	44.0	42.3	39.6	57.4	56.5	56.1	55.4
B. Public Property								
(1) Electric Facilities	0.2	0.4	0.4	0.5	0.5	1.1	1.3	1.7
(2) Telecommunication Facilities	3.5	5.8	6.8	8.3	8.1	18.3	22.8	29.8
(3) Public Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Roads	5.5	18.3	23.8	32.6	12.2	14.3	15.1	16.6
(5) Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	9.2	24.5	31.0	41.4	20.7	33.7	39.2	48.0
C. Agricultural Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Income/Sales Loss Potential								
(1) Labour	0.9	0.9	0.8	0.8	3.3	4.1	4.5	5.0
(2) Shop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(3) Electricity Sales	0.6	1.0	1.2	1.4	1.4	3.0	3.8	4.9
(4) Transport Charges								
Bus	3.5	5.1	5.7	6.8	9.6	18.7	22.7	28.9
Rickshaw	0.3	0.5	0.6	0.7	0.9	1.8	2.2	2.8
Subtotal	5.4	7.4	8.3	9.7	15.1	27.7	33.1	41.7
E. Vehicle's Running Costs								
(1) Operating Costs	0.1	0.1	0.1	0.1	0.3	0.3	0.4	0.4
(2) Time Costs Vehicles	1.1	0.9	0.8	0.7	2.4	2.6	2.7	2.9
Passengers	1.7	1.4	1.3	1.1	3.8	4.1	4.3	4.5
Subtotal	3.0	2.5	2.2	1.9	6.5	7.1	7.4	7.8
Grand Total	65.6	78.4	83.9	92.6	99.7	124.9	135.7	152.9

Table F-5 Summary of Flood Damage Potential (F-DRAINAGE ZONE ONLY)
(Flood)

(Unit : million TK. in 1986 Prices)

Items	1986				2000			
	1 / 1	1 / 5	1 / 10	1 / 30	1 / 1	1 / 5	1 / 10	1 / 30
A. General Property								
(1) Houses	0.0	10.1	14.5	21.4	0.0	10.5	15.0	22.1
(2)Household Articles	0.0	1.0	1.4	2.1	0.0	1.3	1.9	2.8
(3) Commercial Buildings (depreciating assets & stocks)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	11.1	15.9	23.4	0.0	11.8	16.9	24.9
B. Public Property								
(1) Electric Facilities	0.0	0.1	0.2	0.2	0.0	0.3	0.4	0.6
(2) Telecommunication Facilities	0.0	1.8	2.5	3.8	0.0	4.8	6.8	10.1
(3) Public Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Roads	0.0	6.2	8.9	13.2	0.0	3.2	4.6	6.7
(5) Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	8.1	11.6	17.2	0.0	8.2	11.8	17.4
C. Agricultural Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Income/Sales Loss Potential								
(1) Labour	0.0	0.2	0.3	0.5	0.0	0.9	1.3	2.0
(2) Shop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(3) Electricity Sales	0.0	0.3	0.4	0.6	0.0	0.8	1.1	1.7
(4) Transport Charges								
Bus	0.0	1.5	2.1	3.2	0.0	4.8	6.8	10.1
Rickshaw	0.0	0.2	0.2	0.3	0.0	0.5	0.7	1.0
Subtotal	0.0	2.2	3.1	4.6	0.0	7.0	9.9	14.7
E. Vehicle's Running Costs								
(1) Operating Costs	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
(2) Time Costs Vehicles	0.0	0.2	0.3	0.5	0.0	0.6	0.8	1.2
Passengers	0.0	0.3	0.5	0.7	0.0	0.9	1.3	1.9
Subtotal	0.0	0.6	0.8	1.2	0.0	1.5	2.2	3.3
Grand Total	0.0	22.0	31.5	46.5	0.0	28.5	40.8	60.3

Table F-6 Summary of Flood Damage Potential (H DRAINAGE ZONE ONLY)
(Inundation)

(Unit : million TK. in 1986 Prices)

Items	1986				2000			
	1 / 1	1 / 5	1 / 10	1 / 30	1 / 1	1 / 5	1 / 10	1 / 30
A. General Property								
(1) Houses	13.2	7.1	4.5	0.3	13.9	12.9	12.4	11.7
(2)Household Articles	0.2	0.3	0.3	0.4	0.3	1.0	1.3	1.8
(3) Commercial Buildings (depreciating assets & stocks)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	13.4	7.3	4.8	0.7	14.2	13.8	13.7	13.5
B. Public Property								
(1) Electric Facilities	0.1	0.1	0.1	0.0	0.2	0.3	0.3	0.3
(2) Telecommunication Facilities	2.3	1.5	1.1	0.5	3.7	4.5	4.8	5.3
(3) Public Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Roads	3.6	3.1	2.9	2.6	5.2	10.2	12.4	15.9
(5) Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	6.1	4.7	4.1	3.1	9.1	15.0	17.5	21.5
C. Agricultural Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Income/Sales Loss Potential								
(1) Labour	0.6	0.3	0.1	-0.1	1.5	1.1	0.9	0.7
(2) Shop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(3) Electricity Sales	0.4	0.2	0.2	0.1	0.6	0.7	0.8	0.9
(4) Transport Charges								
Bus	2.3	1.3	0.9	0.2	4.4	4.7	4.8	4.9
Rickshaw	0.2	0.1	0.1	0.0	0.4	0.4	0.5	0.5
Subtotal	3.5	2.0	1.3	0.2	7.0	7.0	7.0	6.9
E. Vehicle's Running Costs								
(1) Operating Costs	0.1	0.0	0.0	0.0	0.2	0.1	0.1	0.0
(2) Time Costs Vehicles	0.7	0.3	0.1	-0.2	1.1	0.7	0.6	0.3
Passengers	1.1	0.5	0.2	-0.2	1.8	1.2	0.9	0.5
Subtotal	2.0	0.8	0.4	-0.4	3.0	2.0	1.6	0.9
Grand Total	24.9	14.8	10.5	3.6	33.4	37.8	39.7	42.8

Table F-7 Summary of Flood Damage Potential (H DRAINAGE ZONE ONLY)
(Flood)

(Unit : million TK. In 1986 Prices)

Items	1986				2000			
	1 / 1	1 / 5	1 / 10	1 / 30	1 / 1	1 / 5	1 / 10	1 / 30
A. General Property								
(1) Houses	9.4	34.5	45.3	62.4	75.2	92.3	99.7	111.4
(2)Household Articles	0.1	2.1	3.0	4.3	1.5	7.8	10.5	14.9
(3) Commercial Buildings (depreciating assets & stocks)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	9.5	36.6	48.3	66.7	76.7	100.2	110.3	126.3
B. Public Property								
(1) Electric Facilities	0.1	0.5	0.6	0.9	1.1	1.9	2.3	2.8
(2) Telecommunication Facilities	1.7	8.1	10.9	15.2	20.2	33.0	38.6	47.3
(3) Public Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Roads	2.6	19.6	26.9	38.5	27.9	78.4	100.1	134.5
(5) Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	4.3	28.1	38.3	54.6	49.2	113.3	140.9	184.6
C. Agricultural Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Income/Sales Loss Potential								
(1) Labour	0.4	1.0	1.3	1.7	8.3	7.8	7.5	7.2
(2) Shop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(3) Electricity Sales	0.3	1.3	1.8	2.5	3.3	5.4	6.3	7.8
(4) Transport Charges								
Bus	1.7	6.9	9.1	12.6	24.0	34.1	38.5	45.4
Rickshaw	0.2	0.6	0.9	1.2	2.3	3.3	3.7	4.3
Subtotal	2.5	9.9	13.0	18.1	37.9	50.6	56.0	64.7
E. Vehicle's Running Costs								
(1) Operating Costs	0.1	0.1	0.2	0.2	0.9	0.7	0.7	0.6
(2) Time Costs Vehicles	0.5	1.1	1.3	1.7	5.9	5.0	4.6	3.9
Passengers	0.8	1.7	2.1	2.7	9.5	8.0	7.3	6.2
Subtotal	1.4	2.9	3.6	4.7	16.4	13.7	12.5	10.7
Grand Total	17.8	77.5	103.3	144.0	180.1	277.7	319.7	386.3

4 ESTIMATION OF ECONOMIC COST

In this study, all the costs are re-calculated based on the price information in 1989 instead of that in 1986 and modifications in work components are also incorporated. Estimation procedure of economic costs are kept same as the previous study.

In the economic analysis of the project, the nominal project cost measured in 1989 market price is converted into economic cost which excludes the part of transfer items such as tax, duties and subsidies.

In estimating the economic cost, the conversion factors estimated in the previous study are adopted without any change which were estimated by work items and are shown in Table F-9.

Table F-9 Conversion Factors for Each Construction Work

Dike Conversion Factor	0.888
Gate Conversion Factor	0.928
Pump Station Conversion Factor	0.994
Khal Improvement Conversion Factor	0.819
Drainage Pipe Conversion Factor	0.819
Land Acquisition	1.000

Each conversion factor is calculated by weighting the specific conversion factor of each material with the composition share of value. The are summarized in previous Supporting Report M with calculation procedures.

Flows of nominal cost and economic cost by drainage zone are shown in Tables F-10 and F-11.

For the Packave I (F and H drainage zones), the estimated economic cost is 2,713.0 million Tk. (including design fee of 8.5 million Tk.) which is 89.8 per cent of the nominal project cost of 3,020.7 million Tk. The operation and maintenance cost is 923.4 million Tk. over the whole project life period.

Table F-10 NOMINAL COST FLOW OF THE PROJECT

(UNIT: MILLION TK)

Drainage Zone	Work Items	Design Phase	Phase I			Phase II		Total
		1989	1990	1991	1992	1993	1994	
B	Design	2.0	0.0	0.0	0.0	0.0	0.0	2.0
	Pump Station	0.0	51.6	51.6	51.6	0.0	0.0	154.8
	Sluice Gate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Khal Improvement	0.0	31.0	31.0	31.0	0.0	0.0	93.0
	Drainage Pipe	0.0	0.0	0.0	0.0	147.6	147.6	295.2
	Land Acquisition	0.0	13.9	13.9	0.0	0.0	0.0	27.8
	Contingency	0.0	19.3	19.3	16.5	29.5	29.5	114.1
	Sub-total	2.0	115.8	115.8	99.1	177.1	177.1	686.9
	O/M Cost	0.0	0.0	0.0	0.0	3.3	3.3	6.6
	Total	2.0	115.8	115.8	99.1	180.4	180.4	693.5
C	Design	4.6	0.0	0.0	0.0	0.0	0.0	4.6
	Dike	0.0	85.7	85.7	85.7	0.0	0.0	257.1
	Pump Station	0.0	57.0	57.0	57.0	0.0	0.0	171.0
	Khal Improvement	0.0	198.0	198.0	198.0	8.7	8.7	611.4
	Drainage Pipe	0.0	0.0	0.0	0.0	103.2	103.2	206.4
	Land Acquisition	0.0	40.0	40.0	0.0	4.8	0.0	84.8
	Contingency	0.0	76.1	76.1	68.1	23.4	22.5	266.2
	Sub-total	4.6	456.8	456.8	408.8	140.1	134.4	1,601.5
	O/M Cost	0.0	0.0	0.0	0.0	13.2	13.2	26.4
	Total	4.6	456.8	456.8	408.8	153.3	147.6	1,627.9
F	Design	5.1	0.0	0.0	0.0	0.0	0.0	5.1
	Dike	0.0	107.7	107.7	107.6	0.0	0.0	323.0
	Pump Station	0.0	71.7	71.7	71.6	0.0	0.0	215.0
	Khal Improvement	0.0	251.8	251.8	251.7	0.0	0.0	755.3
	Drainage Pipe	0.0	0.0	0.0	0.0	58.5	58.5	117.0
	Land Acquisition	0.0	18.4	18.4	0.0	0.0	0.0	36.8
	Contingency	0.0	90.0	90.0	86.3	11.6	11.6	289.5
	Sub-total	5.1	539.6	539.6	517.2	70.1	70.1	1,741.7
	O/M Cost	0.0	0.0	0.0	0.0	16.2	16.2	32.4
	Total	5.1	539.6	539.6	517.2	86.3	86.3	1,774.1
H	Design	3.4	0.0	0.0	0.0	0.0	0.0	3.4
	Dike	0.0	58.7	58.7	58.7	0.0	0.0	176.1
	Pump Station	0.0	75.6	75.6	75.5	113.4	113.3	453.4
	Sluice Gate	0.0	17.0	17.0	16.9	0.0	0.0	50.9
	Khal Improvement	0.0	5.6	5.6	5.6	107.2	107.1	231.1
	Land Acquisition	0.0	34.0	34.0	0.0	46.4	0.0	114.4
	Contingency	0.0	37.7	37.7	30.4	54.7	44.8	205.3
	Sub-total	3.4	228.6	228.6	187.1	321.7	265.2	1,234.6
	O/M Cost	0.0	0.0	0.0	0.0	6.0	6.0	12.0
	Total	3.4	228.6	228.6	187.1	327.7	271.2	1,246.6

Drainage Zone	Work Items	Conversion to Economic Price
B	Design	1.000
	Pump Station	0.994
	Sluice Gate	0.928
	Khal Improvement	0.819
	Drainage Pipe	0.819
	Land Acquisition	1.000
	Contingency	1.000
	Sub-total	
	O/M Cost	1.000
	Total	-
C	Design	1.000
	Dike	0.888
	Pump Station	0.994
	Khal Improvement	0.819
	Drainage Pipe	0.819
	Land Acquisition	1.000
	Contingency	1.000
	Sub-total	
	O/M Cost	1.000
	Total	-
F	Design	1.000
	Dike	0.888
	Pump Station	0.994
	Khal Improvement	0.819
	Drainage Pipe	0.819
	Land Acquisition	1.000
	Contingency	1.000
	Sub-total	
	O/M Cost	1.000
	Total	-
H	Design	1.000
	Dike	0.888
	Pump Station	0.994
	Sluice Gate	0.928
	Khal Improvement	0.819
	Land Acquisition	1.000
	Contingency	1.000
	Sub-total	
	O/M Cost	1.000
	Total	-

Remarks :

	Total Cost	-(Design Fee)	- (O/M Cost)	
Construction Cost of C Zone	1627.9	-4.6	-26.4 =	1596.9
Construction Cost of F Zone	1774.1	5.1	32.4 =	1811.6
Construction Cost of H Zone	1246.6	3.4	12 =	1262

Table F-11 ECONOMIC COST FLOW OF THE PROJECT

(UNIT: MILLION TK)

Drainage Zone	Work Items	Design Phase	Phase I			Phase II		Total
		1989	1990	1991	1992	1993	1994	
B	Design	2.0	0.0	0.0	0.0	0.0	0.0	2.0
	Pump Station	0.0	51.3	51.3	51.3	0.0	0.0	153.9
	Sluice Gate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Khal Improvement	0.0	25.4	25.4	25.4	0.0	0.0	76.2
	Drainage Pipe	0.0	0.0	0.0	0.0	120.9	120.9	241.8
	Land Acquisition	0.0	13.9	13.9	0.0	0.0	0.0	27.8
	Contingency	0.0	19.3	19.3	16.5	29.5	29.5	114.1
	Sub-total	2.0	109.9	109.9	93.2	150.4	150.4	615.7
	O/M Cost	0.0	0.0	0.0	0.0	3.3	3.3	6.6
	Total	2.0	109.9	109.9	93.2	153.7	153.7	622.3
C	Design	4.6	0.0	0.0	0.0	0.0	0.0	4.6
	Dike	0.0	76.1	76.1	76.1	0.0	0.0	228.3
	Pump Station	0.0	56.7	56.7	56.7	0.0	0.0	170.0
	Khal Improvement	0.0	162.2	162.2	162.2	7.1	7.1	500.7
	Drainage Pipe	0.0	0.0	0.0	0.0	84.5	84.5	169.0
	Land Acquisition	0.0	40.0	40.0	0.0	4.8	0.0	84.8
	Contingency	0.0	76.1	76.1	68.1	23.4	22.5	266.2
	Sub-total	4.6	411.0	411.0	363.0	119.8	114.1	1,423.7
	O/M Cost	0.0	0.0	0.0	0.0	13.2	13.2	26.4
	Total	4.6	411.0	411.0	363.0	133.0	127.3	1,450.1
F	Design	5.1	0.0	0.0	0.0	0.0	0.0	5.1
	Dike	0.0	95.6	95.6	95.5	0.0	0.0	286.8
	Pump Station	0.0	71.3	71.3	71.2	0.0	0.0	213.7
	Khal Improvement	0.0	206.2	206.2	206.1	0.0	0.0	618.6
	Drainage Pipe	0.0	0.0	0.0	0.0	47.9	47.9	95.8
	Land Acquisition	0.0	18.4	18.4	0.0	0.0	0.0	36.8
	Contingency	0.0	90.0	90.0	86.3	11.6	11.6	289.5
	Sub-total	5.1	481.5	481.5	459.2	59.5	59.5	1,546.3
	O/M Cost	0.0	0.0	0.0	0.0	16.2	16.2	32.4
	Total	5.1	481.5	481.5	459.2	75.7	75.7	1,578.7
H	Design	3.4	0.0	0.0	0.0	0.0	0.0	3.4
	Dike	0.0	52.1	52.1	52.1	0.0	0.0	156.4
	Pump Station	0.0	75.1	75.1	75.0	112.7	112.6	450.7
	Sluice Gate	0.0	15.8	15.8	15.7	0.0	0.0	47.2
	Khal Improvement	0.0	4.6	4.6	4.6	87.8	87.7	189.3
	Land Acquisition	0.0	34.0	34.0	0.0	46.4	0.0	114.4
	Contingency	0.0	37.7	37.7	30.4	54.7	44.8	205.3
	Sub-total	3.4	219.3	219.3	177.8	301.6	245.1	1,166.7
	O/M Cost	0.0	0.0	0.0	0.0	6.0	6.0	12.0
	Total	3.4	219.3	219.3	177.8	307.6	251.1	1,178.7

For the Package II (C drainage zone), the project cost in 1989 prices is 1,672.9 million Tk. while the estimated economic cost at 1989 prices is reduced to be 1,423.7 million Tk. (including design fee of 4.6 million Tk.). Economic price of the project is reduced to 87.5 per cent of the original nominal cost. And, the operation and maintenance cost of 503.4 million Tk is needed in the whole project life.

5 ECONOMIC EVALUATION

This project was evaluated by three evaluation indicators; economic internal rate of return (EIRR), net present value (NPV), and cost-benefit ratio (B/C), based on the slightly different assumptions compared with those in the previous study.

Assumptions are as follows:

(1) Benefits of the project are assumed to increase linearly to the year 2000, and increase at 5 per cent annually after 2000.

(2) The project costs are disbursed over 5 years (1989/90 thru 1993/94) according to the implementation schedule proposed. The original disbursement year was six years.

(3) The project benefits are reckoned over 25 years (1995 thru 2024).

(4) Discount rate adopted in this evaluation is 8 %.

Total flow of economic costs and benefits are summarized in Tables F-12, F-13 and F-14. All the evaluation indicators show a high investment efficiency, and encourage project approval. A summary is shown in Table F-15.

Table F-15 Summary of Economic Evaluation

	EIRR (%)	B/C	NPV (million Tk)
Package I (F an H Zones)	10.7	2.28	961.7
Package II (C Zone)	9.0	1.81	172.9
Packages I & II (C, F and H Zones)	9.3	1.90	760.1

Three major indicators show a high return on the project in terms of investment efficiency.

TABLE F-12 FLOWS OF ECONOMIC COSTS AND BENEFITS (PACKAGE II, C DRAINAGE ZOEN ONLY)

YEAR	CONSTRUCTION					LAND ACQUI-SITION COST	CONTIN-GENCY	TOTAL ECONOMIC CONST. COST	O & M COSTS	FACILITY REPLACEMENT COSTS		TOTAL ECONOMIC COSTS	TOTAL ECONOMIC BENEFITS	NET BALANCE
	DESIGN	DIKE	PUMP STATION	KHAL IMPROVE-MENT	DRAINAGE PIPE					GATE	PUMP STATION			
1989	4.6	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0		4.6		-4.6
1990	0.0	76.1	56.7	162.2	0.0	40.0	76.1	411.0	0.0	0.0		411.0		-411.0
1991	0.0	76.1	56.7	162.2	0.0	40.0	76.1	411.0	0.0	0.0		411.0		-411.0
1992	0.0	76.1	56.7	162.2	0.0	0.0	68.1	363.0	0.0	0.0		363.0		-363.0
1993	0.0	0.0	0.0	7.1	84.5	4.8	23.4	119.8	13.2	0.0		133.0		-133.0
1994	0.0	0.0	0.0	7.1	84.5	0.0	22.5	114.1	13.2	0.0		127.3		-127.3
1995									15.9	0.0		15.9	114.7	98.8
1996									15.9	0.0		15.9	122.0	106.1
1997									15.9	0.0		15.9	129.3	113.4
1998									15.9	0.0		15.9	136.6	120.7
1999									15.9	0.0		15.9	143.9	128.0
2000									15.9	0.0		15.9	151.2	135.3
2001									15.9	0.0		15.9	158.7	142.8
2002									15.9	0.0		15.9	166.7	150.8
2003									15.9	0.0		15.9	175.0	159.1
2004									15.9	0.0		15.9	183.8	167.9
2005									15.9	0.0	11.9	27.8	193.0	165.2
2006									15.9	0.0	11.9	27.8	202.6	174.8
2007									15.9	0.0	11.9	27.8	212.7	184.9
2008									15.9	0.0		15.9	223.4	207.5
2009									15.9	0.0		15.9	234.5	218.6
2010									15.9	0.0		15.9	246.3	230.4
2011									15.9	0.0		15.9	258.6	242.7
2012									15.9	0.0		15.9	271.5	255.6
2013									15.9	0.0		15.9	285.1	269.2
2014									15.9	0.0		15.9	299.3	283.4
2015									15.9	0.0		15.9	314.3	298.4
2016									15.9	0.0		15.9	330.0	314.1
2017									15.9	0.0		15.9	346.5	330.6
2018									15.9	0.0		15.9	363.8	347.9
2019									15.9	0.0		15.9	382.0	366.1
2020									15.9	0.0		15.9	401.1	385.2
2021									15.9	0.0		15.9	421.2	405.3
2022									15.9	0.0		15.9	442.3	426.4
2023									15.9	0.0		15.9	464.4	448.5
2024									15.9	0.0		15.9	487.6	471.7
TOTAL	4.6	228.3	170.0	500.7	169.0	84.8	266.2	1,423.7	503.4	0.0	35.7	1,962.8	7,862.2	5,899.5
											P.V. =	1,242.3	2,245.8	172.9
											N.P.V. =			172.9
											I.R.R. =			8.96%
											B/C =			1.81

TABLE F-13 FLOWS OF ECONOMIC COSTS AND BENEFITS (PACKAGE I, F & H DRAINAGE ZONES)

YEAR	CONSTRUCTION						LAND ACQUI-SITION COST	CONTIN-GENCY	TOTAL ECONOMIC CONST. COST	O & M COSTS	FACILITY REPLACEMENT COSTS		TOTAL ECONOMIC COSTS	TOTAL ECONOMIC BENEFITS	NET BALANCE
	DESIGN	DIKE	PUMP STATION	SLUICE GATE	KHAL IMPROVE-MENT	DRAINAGE PIPE					GATE	PUMP STATION			
1989	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.0	0.0	0.0	8.5		-8.5
1990	0.0	147.8	146.4	15.8	210.8	0.0	52.4	127.7	700.9	0.0	0.0	0.0	700.9		-700.9
1991	0.0	147.8	146.4	15.8	210.8	0.0	52.4	127.7	700.9	0.0	0.0	0.0	700.9		-700.9
1992	0.0	147.7	146.2	15.7	210.7	0.0	0.0	116.7	637.0	0.0	0.0	0.0	637.0		-637.0
1993	0.0	0.0	112.7	0.0	87.8	47.9	46.4	66.3	361.1	22.2	0.0	0.0	383.3		-383.3
1994	0.0	0.0	112.6	0.0	87.7	47.9	0.0	56.4	304.6	22.2	0.0	0.0	326.8		-326.8
1995									0.0	29.3	0.0	0.0	29.3	250.7	221.4
1996									0.0	29.3	0.0	0.0	29.3	268.6	239.3
1997									0.0	29.3	0.0	0.0	29.3	286.6	257.3
1998									0.0	29.3	0.0	0.0	29.3	304.5	275.2
1999									0.0	29.3	0.0	0.0	29.3	322.5	293.2
2000									0.0	29.3	0.0	0.0	29.3	340.8	311.5
2001									0.0	29.3	0.0	0.0	29.3	357.8	328.5
2002									0.0	29.3	0.0	0.0	29.3	375.7	346.4
2003									0.0	29.3	0.0	0.0	29.3	394.5	365.2
2004									0.0	29.3	0.0	0.0		414.3	414.3
2005										29.3	0.0	23.8		435.0	435.0
2006										29.3	0.0	23.8		456.7	456.7
2007										29.3	0.0	23.8		479.6	479.6
2008										29.3	0.0	11.9		503.5	503.5
2009										29.3	0.0	11.9		528.7	528.7
2010										29.3	0.0	0.0		555.1	555.1
2011										29.3	0.0	0.0		582.9	582.9
2012										29.3	0.0	0.0		612.0	612.0
2013										29.3	0.0	0.0		642.6	642.6
2014										29.3	0.0	0.0		674.8	674.8
2015										29.3	0.0	0.0		708.5	708.5
2016										29.3	0.0	0.0		743.9	743.9
2017										29.3	0.0	0.0		781.1	781.1
2018										29.3	0.0	0.0		820.2	820.2
2019										29.3	0.0	0.0		861.2	861.2
2020										29.3	0.0	0.0		904.3	904.3
2021										29.3	0.0	0.0		949.5	949.5
2022										29.3	0.0	0.0		997.0	997.0
2023										29.3	0.0	0.0		1,046.6	1,046.6
2024										29.3	0.0	0.0		1,099.1	1,099.1
TOTAL	8.5	443.2	664.4	47.2	807.9	95.8	151.2	494.8	2,713.0	923.4	0.0	95.2	3,021.1	17,698.8	14,677.7
												P.V. =	2,215.5	5,041.8	961.7
												N.P.V. =			961.7
												I.R.R. =			10.65%
												B/C =			2.28

TABLE F-14 FLOWS OF ECONOMIC COSTS AND BENEFITS (C, F, & H DRAINAGE ZONES)

YEAR	CONSTRUCTION						LAND ACQUI-SITION COST	CONTIN-GENCY	TOTAL ECONOMIC CONST. COST	O & M COSTS	FACILITY REPLACEMENT COSTS		TOTAL ECONOMIC COSTS	TOTAL ECONOMIC BENEFITS	NET BALANCE
	DESIGN	DIKE	PUMP STATION	SLUICE GATE	KHAL IMPROVE-MENT	DRAINAGE PIPE					GATE	PUMP STATION			
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
1990	223.9	223.9	203.1	15.8	384.2	0.0	92.4	203.8	1,346.9	0.0	0.0	0.0	1,346.9		-1,346.9
1991	223.9	223.9	203.1	15.8	384.2	0.0	92.4	203.8	1,346.9	0.0	0.0	0.0	1,346.9		-1,346.9
1992	223.8	223.8	202.9	15.7	384.0	0.0	0.0	184.8	1,234.9	0.0	0.0	0.0	1,234.9		-1,234.9
1993	0.0	0.0	112.7	0.0	7.1	132.4	51.2	89.7	393.2	35.4	0.0	0.0	428.6		-428.6
1994	0.0	0.0	112.6	0.0	7.1	132.4	0.0	78.9	331.1	35.4	0.0	0.0	366.5		-366.5
1995									0.0	45.2	0.0	0.0	45.2	365.4	320.2
1996									0.0	45.2	0.0	0.0	45.2	390.7	345.5
1997									0.0	45.2	0.0	0.0	45.2	415.9	370.7
1998									0.0	45.2	0.0	0.0	45.2	441.2	396.0
1999									0.0	45.2	0.0	0.0	45.2	466.4	421.2
2000									0.0	45.2	0.0	0.0	45.2	492.0	446.8
2001									0.0	45.2	0.0	0.0	45.2	516.6	471.4
2002									0.0	45.2	0.0	0.0	45.2	542.4	497.2
2003									0.0	45.2	0.0	0.0	45.2	569.5	524.3
2004										45.2	0.0	0.0		598.0	598.0
2005										45.2	0.0	35.7		627.9	627.9
2006										45.2	0.0	35.7		659.3	659.3
2007										45.2	0.0	35.7		692.3	692.3
2008										45.2	0.0	11.9		726.9	726.9
2009										45.2	0.0	11.9		763.2	763.2
2010										45.2	0.0	0.0		801.4	801.4
2011										45.2	0.0	0.0		841.5	841.5
2012										45.2	0.0	0.0		883.6	883.6
2013										45.2	0.0	0.0		927.7	927.7
2014										45.2	0.0	0.0		974.1	974.1
2015										45.2	0.0	0.0		1,022.8	1,022.8
2016										45.2	0.0	0.0		1,074.0	1,074.0
2017										45.2	0.0	0.0		1,127.7	1,127.7
2018										45.2	0.0	0.0		1,184.0	1,184.0
2019										45.2	0.0	0.0		1,243.2	1,243.2
2020										45.2	0.0	0.0		1,305.4	1,305.4
2021										45.2	0.0	0.0		1,370.7	1,370.7
2022										45.2	0.0	0.0		1,439.2	1,439.2
2023										45.2	0.0	0.0		1,511.2	1,511.2
2024										45.2	0.0	0.0		1,586.7	1,586.7
TOTAL	671.5	671.5	834.4	47.2	1,166.6	264.9	236.0	761.0	4,653.0	1,426.8	0.0	130.9	5,130.6	25,561.0	20,430.4

P.V. =	3,832.3	7,287.6	760.1
N.P.V. =			760.1
I.R.R. =			9.27%
B/C =			1.90

Other evaluation indicators of the project are shown in Table F-16. Population which will be free from the stagnating water reaches 856 thousand, equivalent to 32 per cent of the whole population of the Dhaka in 2000.

Table F-16 Other Major Indicators of Economic Evaluation

	Area Affected (maximum) (case in 2000) (km2)	Population Affected (Maximum) (case in 2000) (x 1000)	Employment Opportunity (x 1000)
Package I (F and H Zones)	15.91	610,200	210 (C, F & H) (in three years)
Package II (C Zone)	5.72	245,800	

Construction itself will contribute to the creation of mew employment since the total project will require 210,000 man-days. Considering the un-employment at present, it is sure that new job positions will be filled with present unemployed or under-employed persons. This is another project contribution to the national welfare.

6 SOCIAL IMPACT

This drainage system improvement project makes the following social contributions:

(1) Improvement of business efficiency: The center of government and business activities such as banks and commerce concentrates in the flood prone area. It is expected that eradication the discontinuity of business/commercial activities can contribute to higher efficiency.

(2) Improvement of land use potential: Land use of the flood prone areas will be enhanced. For example, new flood free areas can be used for housing for the houseless in Dhaka.

(3) Improvement of sanitary conditions: The environment for public health and amenities will be improved. 802,000 persons are expected to benefit from the project in 2000.

(4) Improvement of town image: This is the integrated effect of all the social impacts above. And it is also expected to attract direct investment from foreign countries.

(5) Creation of employment opportunities: This project has a significant effect on the creation of employment opportunities, and this direct effect of the project reaches 210,000 person-days over the first three years

7 CONCLUSION OF ECONOMIC EVALUATION

This drainage system improvement project proves high investment efficiency and various kinds of social impacts can work for up-lifting the social welfare of the people in Dhaka. Thus, the implementation of this project is strongly recommended.

This drainage system improvement project shows remarkably high economic internal rate of return for the flood mitigation project since flood mitigation projects with IRR of 3 to 4 per cent are the usual case.

And eradication of flooding is expected to activate the economic activities through the improvement of business efficiency, sanitation and town image. The impact of employment creation will also contribute to up-lift the national welfare.

SUPPORTING REPORT - G -

TOPOGRAPHIC SURVEY

SUPPORTING REPORT G
TOPOGRAPHIC SURVEY

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SUPPORTING REPORT G
TOPOGRAPHIC SURVEY

1. GENERAL

A topographic survey of the five (5) existing khals and eight (8) drainage pipe trunks located in the first priority area (C, F and H zones) was conducted for the planning and designing of the drainage facilities. The survey was implemented by a local consultant company, the Development Design Consultants Ltd., under the supervision of a JICA survey expert.

General contents of the topographic survey are as follows:

1) Route setting by field reconnaissance
2) Setting of bench marks and traverse points
3) Levelling survey
4) Traversing survey
5) Plane table survey
6) Longitudinal and cross section survey

The drainage facilities to be surveyed are as follows:

(1) Zone C:
- Gerani and Segunbagicha khals
- Drainage pipes of D.3, D.4, D.5 and D.6

(2) Zone F
- Begunbari and Paribagh khals
- Drainage pipes of D.7, D.8, D.9 and D.9-1

(3) Zone H
- Kallyanpur khal,
- Kallyanpur pump station

Location of the survey is illustrated in Fig. G.1.

2. CONTENTS OF SURVEY

2.1 Route Setting

Before the commencement of the topographic survey, the survey team accompanied by a JICA expert conducted a field reconnaissance in order to confirm the survey routes and prepare a survey plan.

2.2 Setting of Bench Marks and Traverse Points

The required permanent and temporary bench marks (B.M.,T.B.M.) and traverse points were established at adequate points on the existing roads and structures. The points were marked either by concrete nails or by arrows. Locations of the bench marks are illustrated in Fig.G.2

2.3 Levelling Survey

The levelling survey was carried out for all new bench marks and traverse points by using the GTS elevation of the bench marks established in a previous survey that were based on the National bench mark (Line 771, G.T.3.B.M.No.38 H=24.034 feet) located at Lamuna park.

A round survey was applied for the levelling survey. The allowable error was regulated to be within $e=10mm\sqrt{S}$, where S is the survey length (km).

Bench mark heights are shown in Table G.1.

2.4 Traversing Survey

With the use of an electronic distance meter (EDM), a closed or open traverse survey of approx. 30 km long was conducted along the proposed drainage facilities.

Allowable error for the traverse survey are :

- closure error in direction angle :
  $e=30''\sqrt{n}$, where n is the number of traversing point
- closure error in coordinate distance:
  e=1/5,000

The traverse network map is presented in Data Book I.

2.5 Plane Table Survey

Based on the results of the levelling and traverse surveys, a plane table survey was conducted for the proposed drainage facilities. A scale of 1/500 was applied to the survey. The survey quantities are summerized below:

Name of Khal	Length (km)	Survey Area (ha)
Gerani Khal	1.88	12.85
Segunbaficha Khal	4.97	67.77
Begunbari Khal	2.90	20.66
Paribagh Khal	1.20	8.40
Kallyanpur Khal + Pump Station	5.91	70.70
D.3	2.75	19.60
D.4	0.82	7.68
D.5	1.11	3.69
D.6	1.59	13.36
D.7	1.64	9.00
D.8	0.45	9.90
D.9	1.55	14.57
D.9-1	0.68	9.00
Total	27.45	267.18

2.6 Logitudinal and Cross Sectional Surveys

Logitudinal and cross sectional surveys for the five (5) proposed khal improvements and the eight (8) drainage pipe trunks were conducted based on the result of the levelling survey for the bench marks and traverse points. The khal cross sectional survey was conducted at approximately 50 meter intervals.

Quantitties of longitudinal and cross sectional surveys are shown below :

Name of Khal Drainage Pipe	Length of Longitudinal Section Survey (km)	No. of Cross Sectional Survey (section)
Gerani Khal	1.83	44
Segunbaficha Khal	3.92	83
Begunbari Khal	2.89	67
Paribagh Khal	1.06	27
Kallyanpur Khal + Pump Station	5.86	120
D.3	1.07	18
D.4	0.37	10
D.5	1.50	7
D.6	0.46	11
D.7	1.64	17
D.8	0.45	8
D.9	1.55	16
D.9-1	0.68	4
Total	23.28	432

3. SURVEY DRAWINGS

All survey drawings are presented in Data Book I. Drawing scales are as follows :

- Levelling Survey Network : S=1/10,000
- Location Map of Bench Mark and Traverse Point : S=1/10,000
- Plan of Pump Station, Khal and Drainage Pipe : S=1/500
- Longitudinal Section : S_V=1/100, S_H=1/500
- Cross Section : S=1/100

List of surveys and the number of sheets are as follows :

Name of Facility	Plan (sheet)	Longitudinal Section (sheet)	Cross Section (sheet)
Gerani Khal	4	7	10
Segunbagicha Khal	10	14	20
Begunbari Khal	8	10	18
Paribagh Khal	2	4	6
Kallyanpur Khal + Pump Station	10	20	27
D.3	5	10	2
D.4	1	3	1
D.5	2	4	1
D.6	3	5	2
D.7	3	5	3
D.8	2	2	2
D.9	3	5	3
D.9-1	1	2	1
Total	54	91	96

Table G.1 Description and Heights of Bench Marks

BM Name	Description of Bench Marks	Height above M.S.L. (GTS) (Meter)
	Line Begunbari Khal	
J 6	East side of Island on Satraster More. (Old)	8.149
J 7	On the plinth of gate of Bangladesh Ceramic Tejgaon Industrial area. (Old)	7.917
J 8	On the Pillar of gate of Bangladesh Forms & Publication. (Old)	8.133
A 49	Market on Bridge right side of Tongi-diversion Road over Begunbari Khal.	7.499
A 51	Marked on Railway Bridge over Begunbari Khal East side of Kawran Bazar.	7.594
TBM 6	Marked on west side of Bridge near Sunderban Hotel	7.214
	Line Paribag Khal	
TBM 7	Marked on the plinth level of Sonali Bank at Paribag Branch.	8.579
TBM 8	Marked on the Bridge over Paribag Khal near Paribag Mosque. (T.S. No. 66)	8.633
	Line D9	
TBM 8/1	Marked on the plinth level of Mohasin Hall	8.309
TNM 9	Marked on the base of power pole at Palasy More.	7.951
TBM 10	Marked on the plinth level of Shaheen X-ray Clinic at Bakshibazar More.	8.297
	Line D3	
TBM 11	Marked on the plinth level of Drug House at Chankhar Pool.	7.830
TBM 13	Marked on the wall of gate at Fair Service & Civil Defence Headquarters at Gulistan.	7.963
TBM 9/4	Marked on the road at Tikatoly Traffic Island.	7.227
ALL 9	Marked on the Traverse Point near P.D.B. Substation, Motijheel.	5.764

BM Name	Description of BenchMarks	Height above M.S.L. (GTS) (Meter)
	Line Segunbagicha Khal	
TBM S2	Marked on the Parapet of culvert over Segunbagicha, Khal which is near Abu Tahers Shop, Segunbagicha.	6.754
TBM S3	Marked on the plinth level of Hotel Shahin 15/3 Bijoynager Road.	6.632
TBM S5	Marked on the Parapet wall l of culvert at Purana Paltan near Rahim Hair Cutting Shop.	6.306
TBM S6	Marked on the base of power pole near Fakirapool Over Tank.	6.134
TBM S7	Marked on the Bridge over Segunbagicha khal, near Hotel Aman, Fakirapool.	6.067
TBM S9	Marked on the Bridge over Segunbagicha Khal, south side of Notre Dame College, Traverse Point No. A4.	7.147
TBM S10	Marked on the Bridge over Segunbagicha Khal west side of Kamalapur Bazar.	6.416
BM H2	BM established on the plinth level of Pump House of Gopibug Railway Coloney No. A/44 (PLD)	6.521
BM H3	BM established on the plinth east side of the Bridge at Kamalapur Railway Station. (OLD)	6.744
TBM S11	Marked on the pillar of Mr. Jahangir Alams House west of Railway Bridge, south of Kamalapur Railway Station.	7.490
TBM S12	Marked on the Pucca Drain at Railway Mess Coloney	6.434
TBM S13	Marked bottom of the window of B.M.D.B. Office, south side of Bangladesh Bank.	7.058
	Line S3	
TBM S1	On the foot path, west boundary wall of Fishery Bhaban, near Ramna Park.	6.828

BM Name	Description of Bench Marks	Height above M.S.L. (GTS) (Meter)
	Line D6	
TBM 2	Marked on the plinth level of Arab Bangladesh Bank at Kakrail.	6.768
TBM 3	Marked on the plinth level of Santinager Clinic, left side of road to Malibag.	7.019
GTS o BM	BM No. 38 Line No. 771 (Akhaura to Dhaka and Pachuria) Situated in a Circular Plot of ground in front of R & H and Ramna Park. It consists of a stone monolith 2 feet square at its base and 3 feet 4 inches high.	7.327

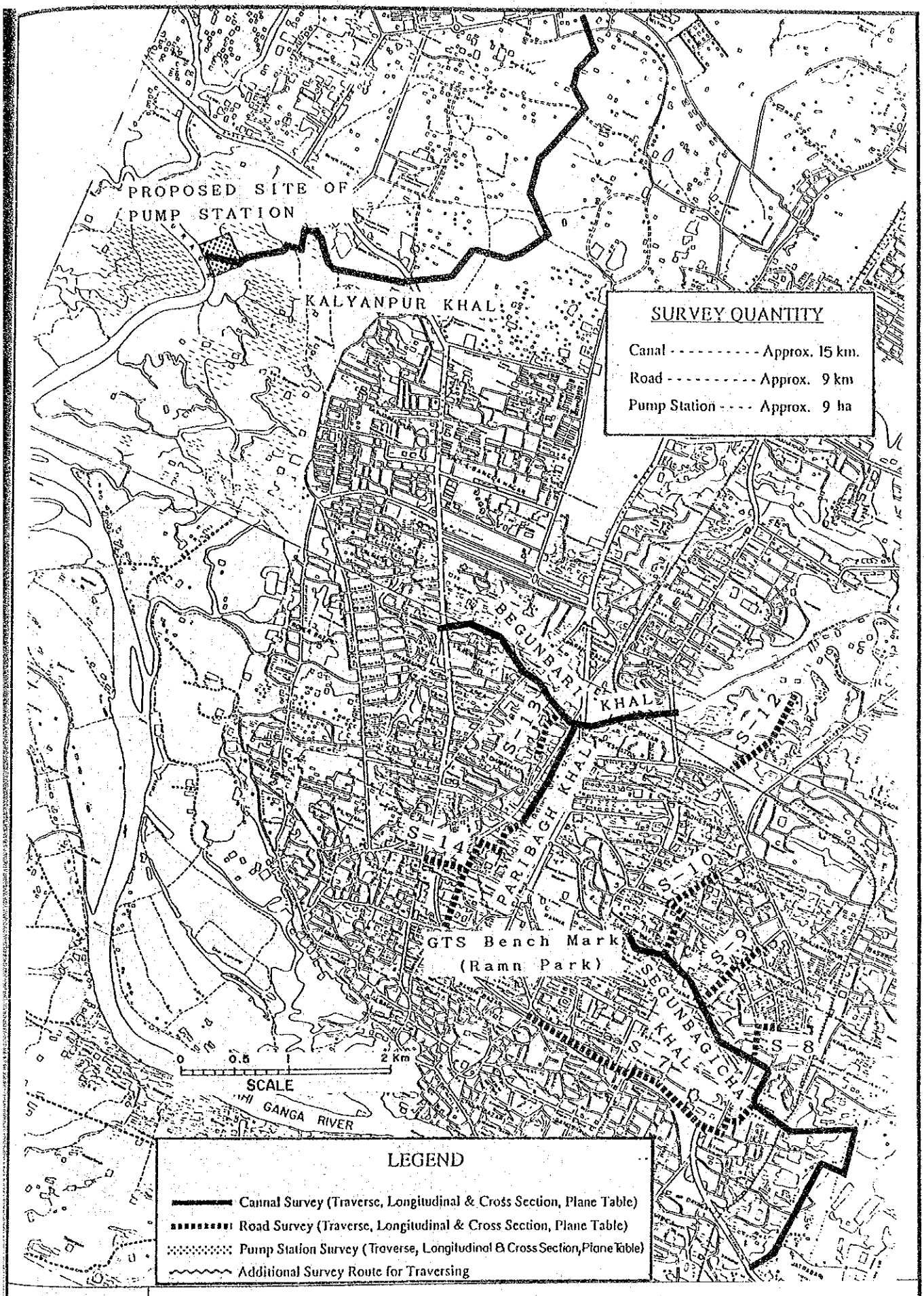

FIG. G. 1 LOCATION OF TOPOGRAPHIC SURVEY

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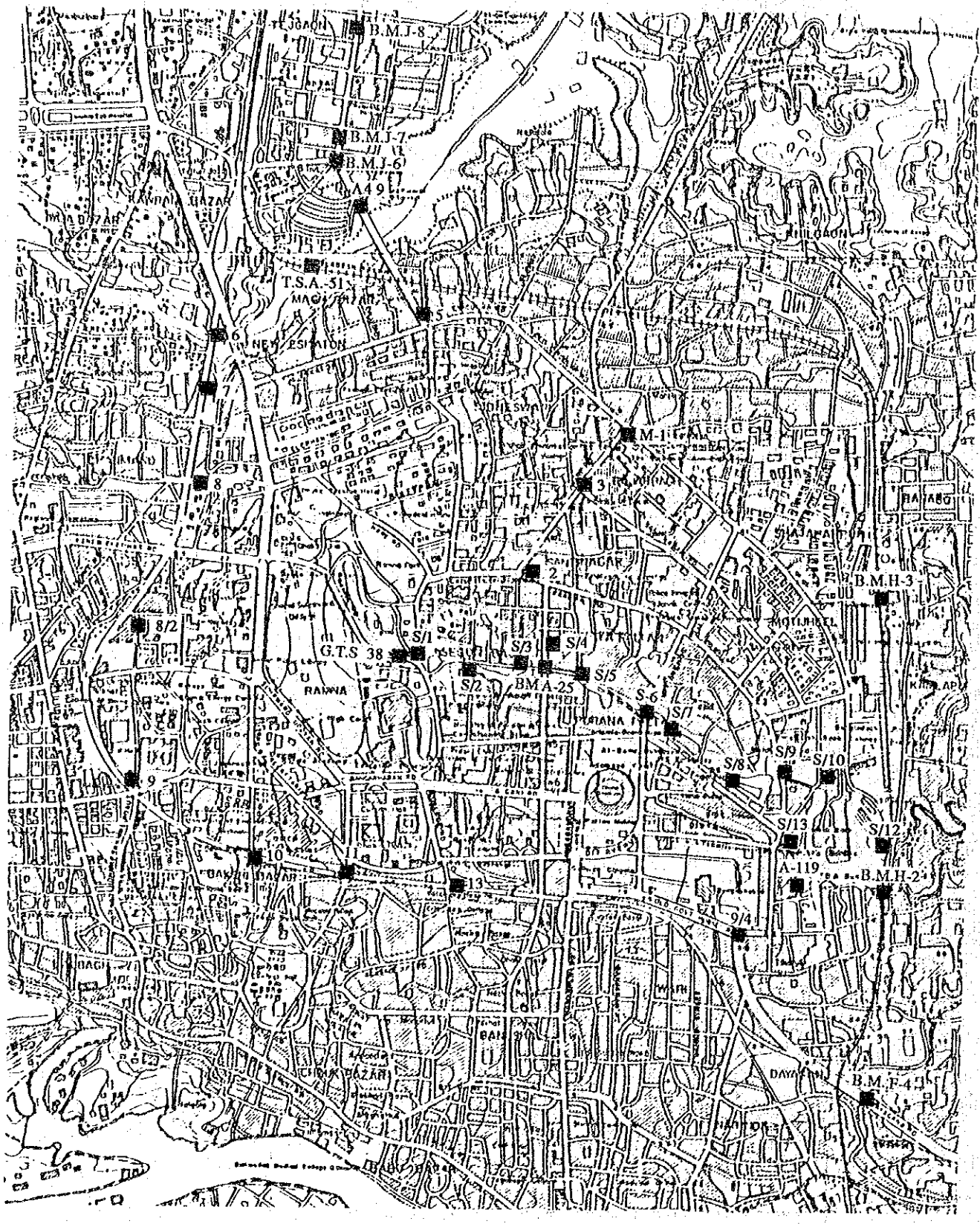

FIG. G. 2 LOCATION OF BENCH MARKS

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SUPPORTING REPORT H

SOIL SURVEY

SUPPORTING REPORT H
SOIL SURVEY

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SUPPORTING REPORT H
SOIL SURVEY

1. GENERAL GEOLOGY

The general geology of the project area (Zones C, F and H) is characterized by the Madhupur Jungle Terrace and the flood plains of the Buriganga and Balu rivers as described below.

(1) Zone C (Segunbagicha khal drainage zone):
Flood plain of the Buriganga River and the Madhupur Jungle Terrace

(2) Zone F (Begunbari khal drainage zone):
Flood plain of the Balu River and the Madhupur Jungle Terrace

(3) Zone H (Kallyanpur khal drainage zone):
Flood plain of the Buriganga River

The surface soil in the terrace area consists of oxidized red clay containing calcareous nodules. The surface soil in the surrounding flood plains is grey in colour.

In the Project Area, silt and clay are predominant in the upper layer of the subsoil, having an approximate thickness of 10 to 15 m. Sand occupies the major portion of the lower deposits.

The ground elevation of the Project Area is lower than 8 meters above mean sea level.

2. GEOLOGY ALONG KHAL AND DRAINAGE PIPE

2.1 Outline of the Soil Investigation

The JICA study team conducted a soil investigation along the khals and drainage pipes to survey subsoil conditions for the design of the channel structures and the pumping station. The survey was conducted by a local survey company, Soil Tech International, under the supervision of the JICA Study Team. The soil investigation consists of the following:

(1) Machine Boring at 16 (sixteen) Places
- Standard penetration test
- Disturbed soil sampling from each interval
- Undisturbed soil sampling at 19 (nineteen) points

(2) Test Pit Survey
- 2 (two) locations around the source of filling materials

(3) Laboratory Testing
a) Natural moisture content
b) Specific gravity
c) Atterberg limit
d) Density
e) Grain size analysis
f) Consolidation test
g) Unconfined compression test
h) Triaxial compression test

Locations of the soil surveys are shown in Fig. H.1 and the outline is tabulated in Table H.1. Contents of laboratory testing are shown in Table H.2.

2.2 Survey Results

Soil profiles along the khals and drainage pipes, together with the N-values obtained through SPT, are shown in Figs. from H.2 to H.5. According to the profiles, subsoil layer conditions are as follows:

- Surface layers with thickness of around 8 meters are silt or silt with clay. The N-values range from 1 to 10 in most locations.

- The noncohensive soil appearing about 8 m below the surface mainly consists of fine to medium sand with silt. N-values have a tendency to increase as the depth increases.

Summary of the laboratory test results are shown in Tables H.3 through H.7 and Fig. H.6. The results are summarized as follows:

- Test of embankment fill material reveals that it is a silty soil having the cohesion in the range of 11 - 15 psi (0.77 - 1.05 kg/cm^2), and its permeability is around 10^{-7} cm/sec.
- Specific gravity is about 2.65.
- Silt is predominant.
- Strain at failure ranges from 10.7 - 5.3%.
- Values of ø and C are as follows:

		Zone C	Zone F	Zone H
ø (degree)		5.8 - 24.5	4.0 - 22.5	6.5 - 31.5
C	(psi)	1.2 - 10.8	2.0 - 5.2	2.9 - 7.5
C	(kg/cm^2)	0.08 - 0.76	0.14 - 0.36	0.20 - 0.53

Relation between N-value and bearing capacity for sandy soils and for clayey soils were calculated as tabulated in Tables H.8 and H.9. The summary of the results are shown below.

Sandy Soils		
N-Value	Allowable Bearing Capacity	
	tons/sq.ft	ton/m^2
4	0.4	4.3
4 - 10	0.4 - 0.7	4.3 - 7.5
10 - 30	0.7 - 2.5	7.5 - 26.9
30 - 50	2.5 - 4.5	26.9 - 48.4
Over 50	4.5	48.4

Cohesive Soils		
N-Value	Bearing Capacity, tons/sq.ft. (t/m^2)	
	Sq.Footings	Cont.Footings
2	0.3 (3.2)	0.22 (2.4)
2 - 4	0.30 - 0.60 (3.2 - 6.4)	0.22 - 0.45 (2.4 - 4.8)
4 - 8	0.60 - 1.20 (6.4 - 12.9)	0.45 - 0.90 (4.8 - 9.7)
8 - 15	1.20 - 2.40 (12.9 - 25.8)	0.90 - 1.80 (9.7 - 19.4)
15 - 30	2.40 - 4.80 (25.8 - 51.7)	1.80 - 3.60 (19.4 - 38.7)
Over 30	Over 4.8 (51.7)	Over 3.6 (38.7)

Table H.1(1) List of Soil Survey

Sl. No.	Location	Bore Hole No.	Depth (M)	No. of Undisturbed Sample
01	Segunbagicha Khal	5/1	15.30	1
02	Segunbagicha Khal	5/2	15.30	1
03	Segunbagicha Khal	5/3	15.30	1
04	Segunbagicha Khal	5/4	15.30	1
05	Segunbagicha Khal	5/5	15.30	2
06	Segunbagicha Khal	D/1	10.30	1
07	Begunbari Khal	B/1	15.30	1
08	Begunbari Khal	B/2	15.30	1
09	Begunbari Khal	B/5	15.30	1
10	Begunbari Khal	D/2	10.30	1
11	Begunbari Khal	D/3	10.30	1
12	Begunbari Khal	B/3	15.30	1
13	Begunbari Khal	B/4	15.30	1
14	Kalyanpur Khal	P/1 Pump station	30.30	2
15	Kalyanpur Khal	P/2 Pump station	30.30	2
16	Kalyanpur Khal	K/1	15.30	1
17	Kalyanpur	M/1 Embankment fill material	2 - 3 test pit	Nil
18	Shisharchar	M/2 Embankment fill material	2 - 3 test pit	Nil

Table H.2 Contents of Laboratory Testing

Item		Unit	Embank-ment	Pump Station	Khal	Drain Culvert
			Material	Foundation	Foundation	Foundation
Field Work	Number of Site	site	2	2	11	3
	Boring Depth	meter	3	30	15	10
	Standard Penetration Test	test	-	60	165	30
	Thin-Walled Tube Sampling	sample	-	4	11	3
	Insitu Wet Density Test	test	2	-	-	-
Laboratory Test	Specific Gravity	test	2	4	22	6
	Moisture Content	test	2	4	22	6
	Particle Size Analysis	test	2	4	22	6
	Liquid Limit	test	2	4	22	6
	Plastic Limit	test	2	4	22	6
	Wet Density	test	-	4	22	6
	Compaction Test	test	2	-	-	-
	Unconfined Compression Test	test	2	4	11	3
	Unconsolidated Un-drained Strength under Triaxial Compression	test	2	4	11	3
	Consolidation Test	test	-	4	-	-
	Permeability	test	2	-	-	-

Table H.3 Summary of Laboratory Test Results
(Zone C: Segunbagicha Khal and Drain)

Borehole No.		S/1		S/2		S/3		S/4		S/5			D/1	
Sample No.		D-3	U-1	D-4	U-1	U-1	D-6	U-1	D-7	U-1	U-2	D-8	D-3	U-1
Depth in meter		3.00 to 3.45	5.55 to 6.00	4.00 to 4.45	5.55 to 6.00	2.55 to 3.00	6.00 to 6.45	3.55 to 4.00	7.00 to 7.45	2.55 to 3.00	4.55 to 5.00	8.00 to 8.45	3.00 to 3.45	3.55 to 4.00
Moisture content (Natural)		22.23	22.46	35.80	53.20	25.23	26.13	23.70	20.03	25.40	20.74	18.96	19.60	23.20
Specific gravity		2.657	2.647	2.653	2.65		2.664	2.653	2.67	2.647	2.662	2.67	2.656	2.653
Atterberg limits	Liquid limit, Lw	52.00	49.00	60.00	69.50	N.P	N.P	50.70	N.P	51.00	N.P	N.P	51.00	53.50
	Plastic limit, Pw	29.10	27.00	29.20	32.20	N.P	N.P	28.00	N.P	27.60	N.P	N.P	27.00	29.00
Density	Wet (lbs/cft)	125.88	122.80	114.03	103.90	116.37	115.60	115.67	125.99	121.99	124.00	128.60	125.30	121.11
	Dry (lbs/cft)	103.00	100.33	84.00	67.80	92.92	91.67	98.39	104.13	97.40	102.70	108.11	104.70	98.30
Grain size analysis	Gravel (%)													
	Sand (%)	15	42	4	5	44	48	34	72	5	62	80	20	16
	Silt (%)	76	58	54	71	56	52	56	28	77	38	20	76	78
	Clay (%)	9	-	42	24	-	-	10	-	18	-	-	4	6
Consolidation test	Natural void ratio, e_o													
	Compression index, Cc													
Unconfined compression tests	Strain at failure (%)		8.92		10.71	7.14		7.14		8.92	5.35			5.35
	Stress undist. (lbs./sq. inch)		39.68		2.62	6.44		23.03		23.77	12.12			15.90
	Stress remould. (lbs./sq. inch)		25.09		1.56	3.38		12.65		16.68	6.83			8.82
	Sensitivity		1.58		1.68	1.90		1.82		1.42	1.77			1.80
Tri-axial compression Qc tests	ø (degree)		22.00		5.80	23.00		11.00		19.50	24.50			18.00
	C (p.s.i.)		10.80		1.20	3.00		6.00		3.00	2.90			6.50

N.P: Non Plastic

Table H.4 Summary of Laboratory Test Results
(Zone F: Begunbari Khal and Drains)

Borehole No.		D/2		B/1		B/2		B/5		D/3	
Sample No.		D-4	U-1	D-3	U-1	D-4	U-1	U-1	D-8	U-1	D-7
Depth in meter		4.00 to 4.45	5.55 to 6.00	3.00 to 3.45	5.55 to 6.00	4.00 to 4.45	6.55 to 7.00	5.55o 6.00	8.00 to 8.45	5.55 to 6.00	7.00 to 7.45
Moisture content (Natural)		24.80	28.34	36.06	39.22	107.50	55.12	27.94	23.50	27.80	22.20
Specific gravity		2.653	2.659	2.647	2.653	2.653	2.656	2.656	2.662	2.656	2.664
Atterberg limits	Liquid limit, Lw	59.10	44.00	75.20	71.90	129.60	72.60	66.70	N.P	57.80	33.11
	Plastic limit, Pw	29.16	25.40	41.70	38.20	57.40	35.70	31.70	N.P	28.50	19.20
Density	Wet (lbs/cft)	125.50	122.87	110.05	111.40	83.10	106.96	123.10	116.20	121.11	123.11
	Dry (lbs/cft)	100.60	95.73	80.88	80.20	40.04	68.95	96.17	94.14	94.76	100.80
Grain size analysis	Gravel (%)										
	Sand (%)	4	6	3	-	3	-	17	31	14	49
	Silt (%)	84	85	53	78	75	81	72	63	76	51
	Clay (%)	12	9	44	22	22	19	11	6	10	-
Consolidation test	Natural void ratio, e_o										
	Compression index, Cc										
Unconfined compression tests	Strain at failure (%)		5.35		7.14		8.92	5.35		7.14	
	Stress undist. (lbs./sq. inch)		20.87		14.43		5.37	35.18		11.12	
	Stress remould. (lbs./sq. inch)		12.08		7.86		2.99	24.78		6.32	
	Sensitivity		1.72		1.835		1.796	1.42		1.76	
Tri-axial compression Qc tests	ø (degree)		15.50		12.50		7.50	22.50		11.50	
	C (p.s.i.)		3.30		3.50		2.00	5.25		3.50	

N.P: Non Plastic

Table H.5 Summary of Laboratory Test Results
(Zone F: Begunbari Khal)

Borehole No.		B/3		B/4	
Sample No.		U-1	D-6	U-1	D-7
Depth in meter		4.55 to 5.00	6.00 to 6.45	5.55 to 6.00	7.00 to 7.45
Moisture content (Natural)		54.70	30.30	38.20	23.76
Specific gravity		2.65	2.653	2.656	2.662
Atterberg limits	Liquid limit, Lw	95.10	41.90	95.20	N.P
	Plastic limit, Pw	45.80	23.10	40.70	N.P
Density	Wet (lbs/cft)	104.70	115.80	114.20	121.99
	Dry (lbs/cft)	67.71	88.80	82.65	98.60
Grain size analysis	Gravel (%)				
	Sand (%)	-	10	4	52
	Silt (%)	64	80	71	39
	Clay (%)	36	10	25	9
Consolidation test	Natural void ratio, e_o				
	Compression index, Cc				
Unconfined compression tests	Strain at failure (%)	10.71		5.35	
	Stress undist. (lbs./sq. inch)	4.87		20.90	
	Stress remould. (lbs./sq. inch)	2.68		13.46	
	Sensitivity	1.81		1.55	
Tri-axial compression Qc tests	ø (degree)	4.00		16.00	
	C (p.s.i.)	2.50		4.70	

N.P: Non Plastic

Table H.6 Summary of Laboratory Test Results
(Zone H: Kallyanpur Khal and Pump Station)

Borehole No.		P/1			P/2			K/1	
Sample No.		D-4	U-1	U-2	U-1	D-7	U-2	U-1	D-7
Depth in meter		4.00 to 4.55	5.55 to 6.00	9.55 to 10.00	5.55 to 6.00	7.00 to 7.45	9.55 to 10.00	5.55 to 6.00	7.00 to 7.45
Moisture content (Natural)		36.65	59.10	41.03	38.70	42.80	43.00	28.98	48.50
Specific gravity		2.679	2.626	2.659	2.651	2.651	2.659	2.659	2.647
Atterberg limits	Liquid limit, Lw	N.P	76.90	N.P	40.10	51.60	N.P	47.40	80.60
	Plastic limit, Pw	N.P	35.80	N.P	25.40	28.20	N.P	25.40	41.66
Density	Wet (lbs/cft)	111.74	102.20	116.70	112.20	109.00	115.00	118.01	104.70
	Dry (lbs/cft)	81.77	64.20	82.70	80.90	76.30	80.20	91.50	70.50
Grain size analysis	Gravel (%)								
	Sand (%)	18	3	15	3	-	16	3	-
	Silt (%)	78	78	85	91	90	84	83	44
	Clay (%)	4	19	-	6	10	-	14	56
Consolidation test	Natural void ratio, e_o		1.551	1.004	1.008		1.070		
	Compression index, Cc		0.51	0.097	0.120		0.092		
Unconfined compression tests	Strain at failure (%)		8.92	5.35	8.92		5.35	10.71	
	Stress undist. (lbs./sq. inch)		13.61	9.93	11.88		9.93	27.15	
	Stress remould. (lbs./sq. inch)		8.42	4.68	8.24		4.29	17.83	
	Sensitivity		1.616	2.12	1.44		2.314	1.52	
Tri-axial compression Qc tests	ø (degree)		6.50	17.50	21.00		31.50	25.00	
	C (p.s.i.)		5.50	7.50	3.60		2.90	4.50	

N.P: Non Plastic

Table H.7 Summary of Laboratory Test Results
(Zone H: Test Pits for Fill Material)

Borehole No.		M1	M2
Sample No.			
Depth in meter		2.00 to 3.00	2.00 to 3.00
Moisture content (Natural)		34.94	26.85
Specific gravity		2.656	2.650
Atterberg limits	Liquid limit, Lw	44.11	58.90
	Plastic limit, Pw	24.60	30.00
Density	Wet (lbs/cft)		
	Dry (lbs/cft)		
Grain size analysis	Gravel (%)		
	Sand (%)	4	-
	Silt (%)	85	92
	Clay (%)	11	8
Consolidation test	Natural void ratio, e_o		
	Compression index, Cc		
Unconfined compression tests	Strain at failure (%)	5.35	5.35
	Stress undist. (lbs./sq. inch)	44.12	54.40
	Stress remould. (lbs./sq. inch)	32.60	42.30
	Sensitivity	1.353	1.286
Tri-axial compression Qc tests	ø (degree)	26.50	23.50
	C (p.s.i.)	11.00	15.00
Compaction test	Max. AASHO density (lbs/cft.)	107.00	104.00
	op. moisture content (%)	95.50	20.80

N.P: Non Plastic

Table H.8 Relation between N-Value and Allowable Bearing Power for Sandy Soils

N-Value	Relative Density		Angle of Internal Friction (degree)	Allowable Bearing Capacity qu (Tons/sq.ft) Safety factor = 3.0
4	Very loose	0.2	30	0.4
4 - 10	Loose	0.2 - 0.4	30 - 35	0.4 - 0.7
10 - 30	Medium dense	0.4 - 0.6	35 - 40	0.7 - 2.5
30 - 50	Dense	0.6 - 0.8	40 - 45	2.5 - 4.5
Over 50	Very dense	0.8	45	4.5

Table H.9 Relation between N-Value and Bearing Capacity for Clayey and Silty Soils

N-Value	Consistency	Bearing Capacity: qu (ton/ft^2)	Bearing Capacity: qu	
			For Sq. Footings 1.2 qu	For Continuous Footings 0.9 qu
2	Very soft*	0.25	0.30	0.22
2 - 4	Soft*	0.25 - 0.50	0.30 - 0.60	0.22 - 0.45
4 - 8	Medium stiff	0.50 - 1.00	0.60 - 1.20	0.45 - 0.90
8 - 15	Stiff	1.00 - 2.00	1.20 - 2.40	0.90 - 1.80
15 - 30	Very stiff	2.00 - 4.00	2.40 - 4.80	1.80 - 3.60
Over 30	Hard	Over 4.00	Over 4.80	Over 3.60

Ref.: "Foundation Engineering"
K. Terzaghi

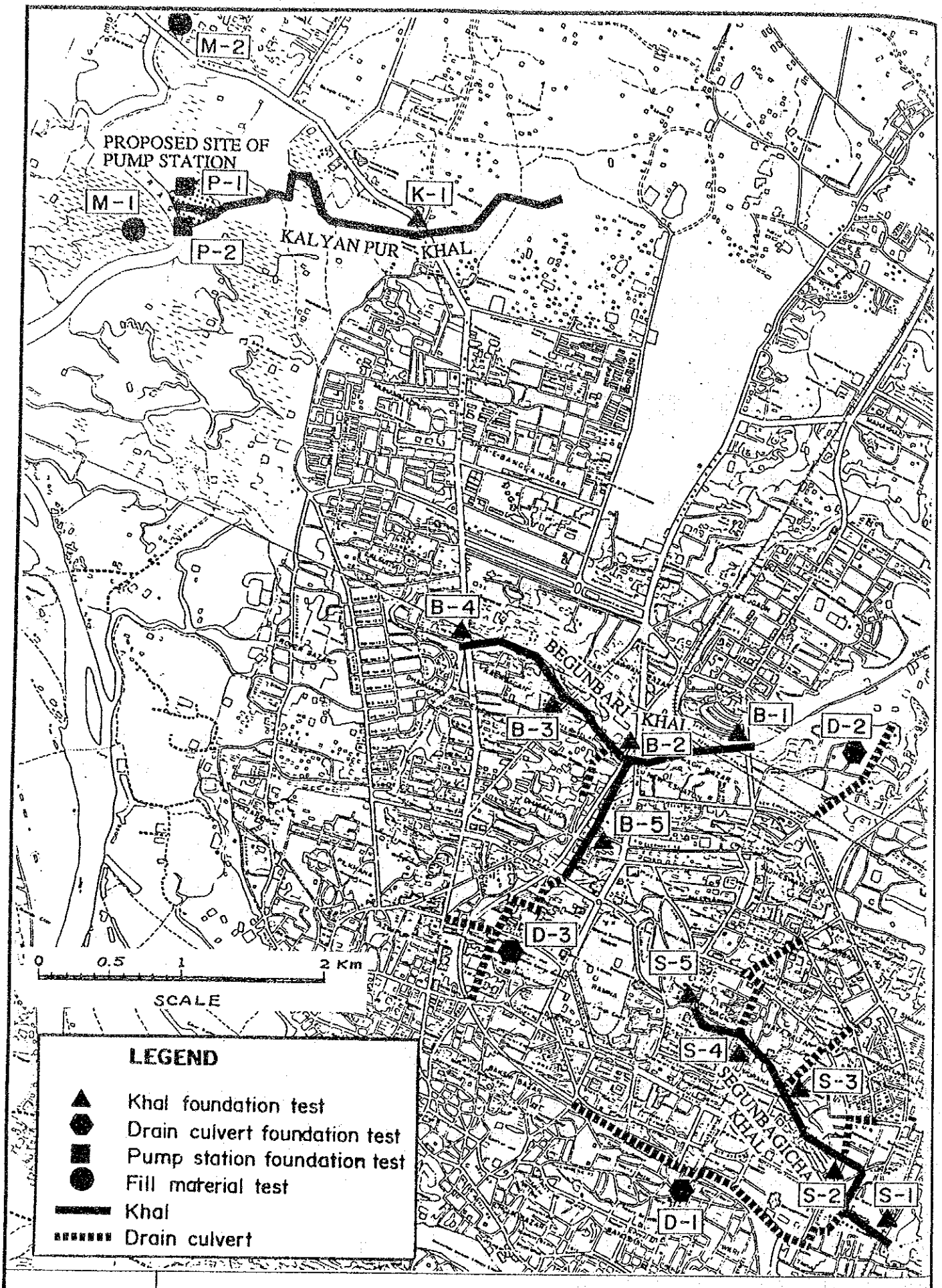

FIG. H. 1 LOCATION OF SOIL SURVEY

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

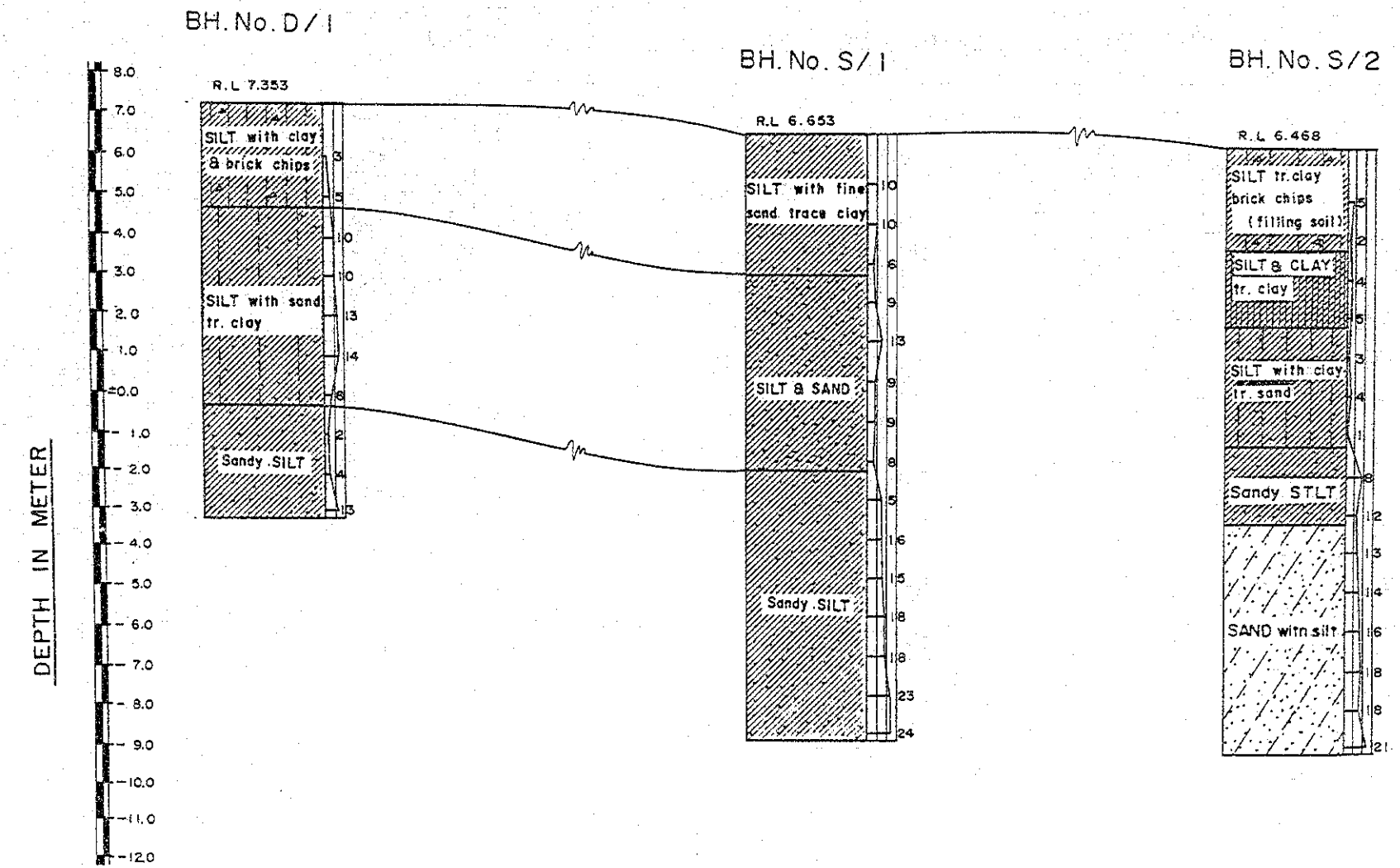

FIG. H. 2 SOIL PROFILE AT SEGUNBAGICHA KHAL (1)

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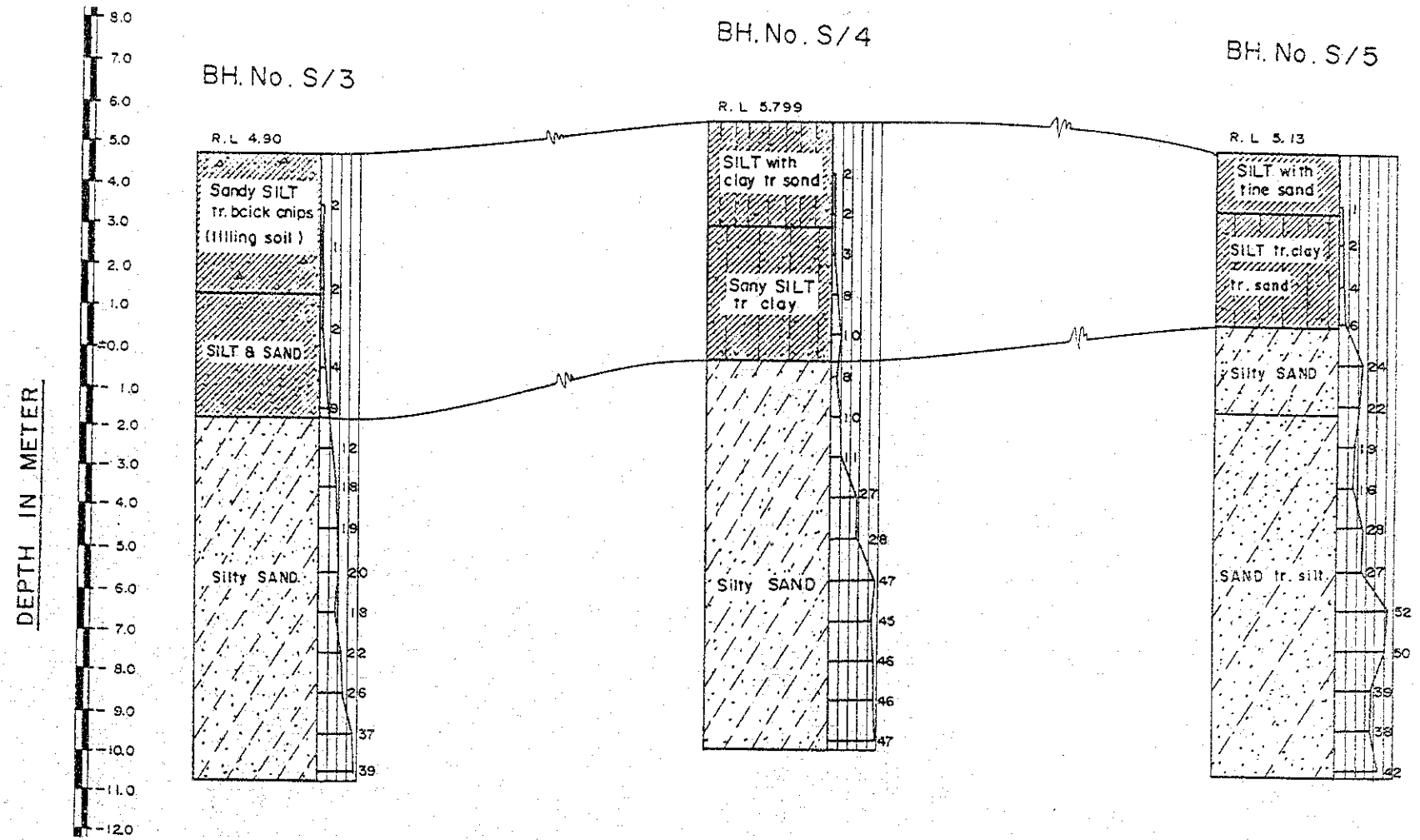

FIG. H. 3 SOIL PROFILE AT SEGUNBAGICHA KHAL (2)

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

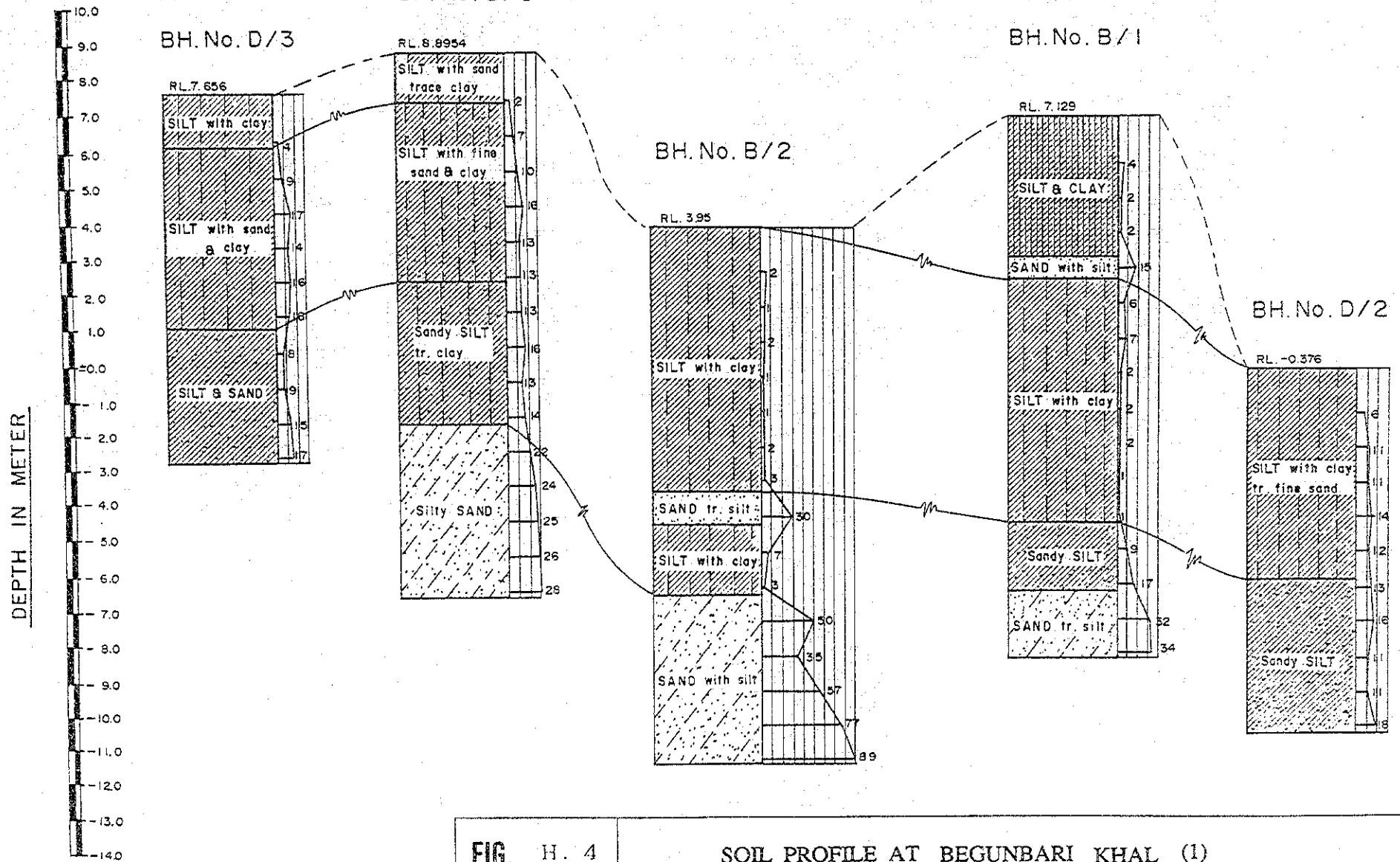

FIG. H. 4 SOIL PROFILE AT BEGUNBARI KHAL (1)

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

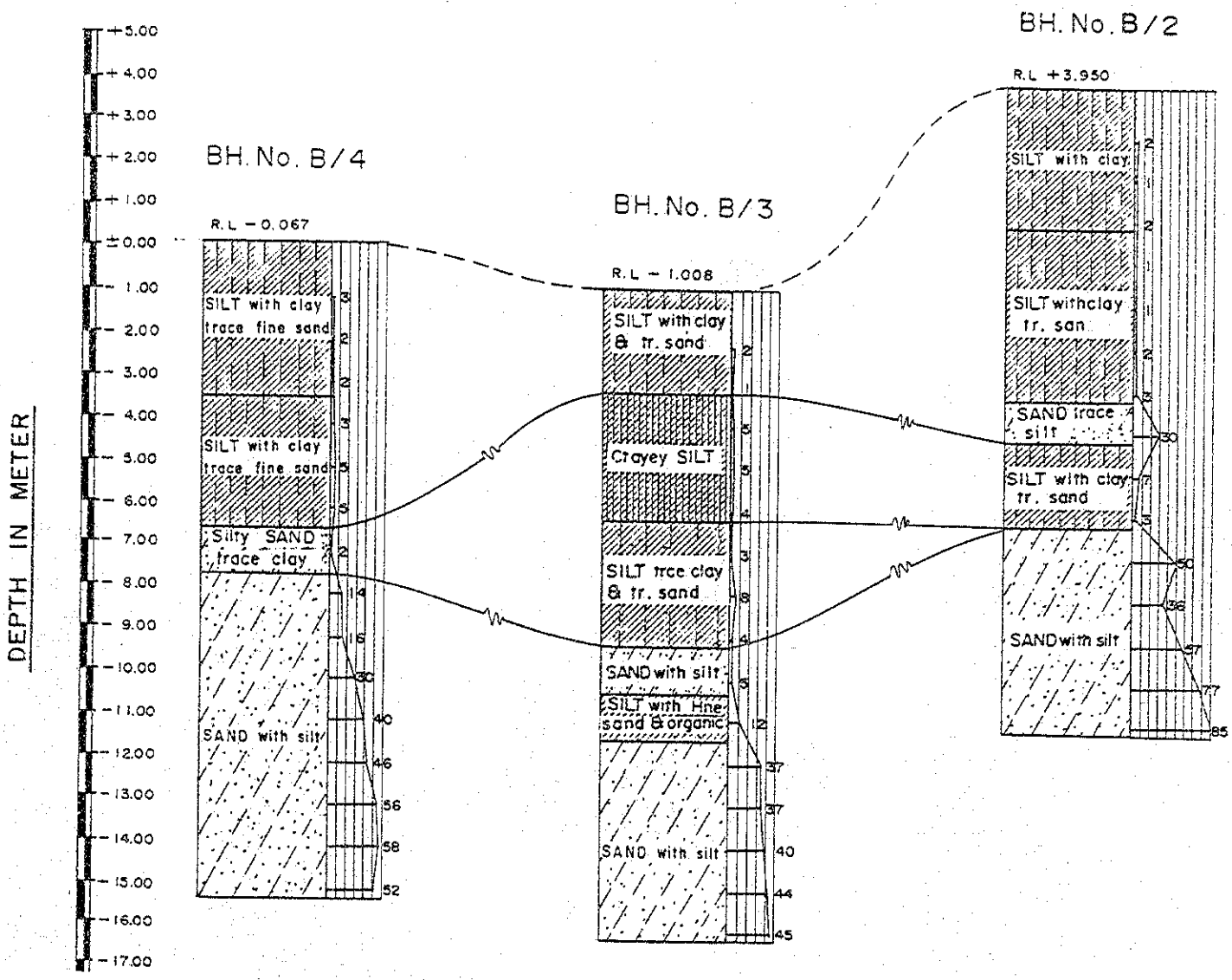

FIG. H. 5 SOIL PROFILE AT BEGUNBARI KHAL (2)

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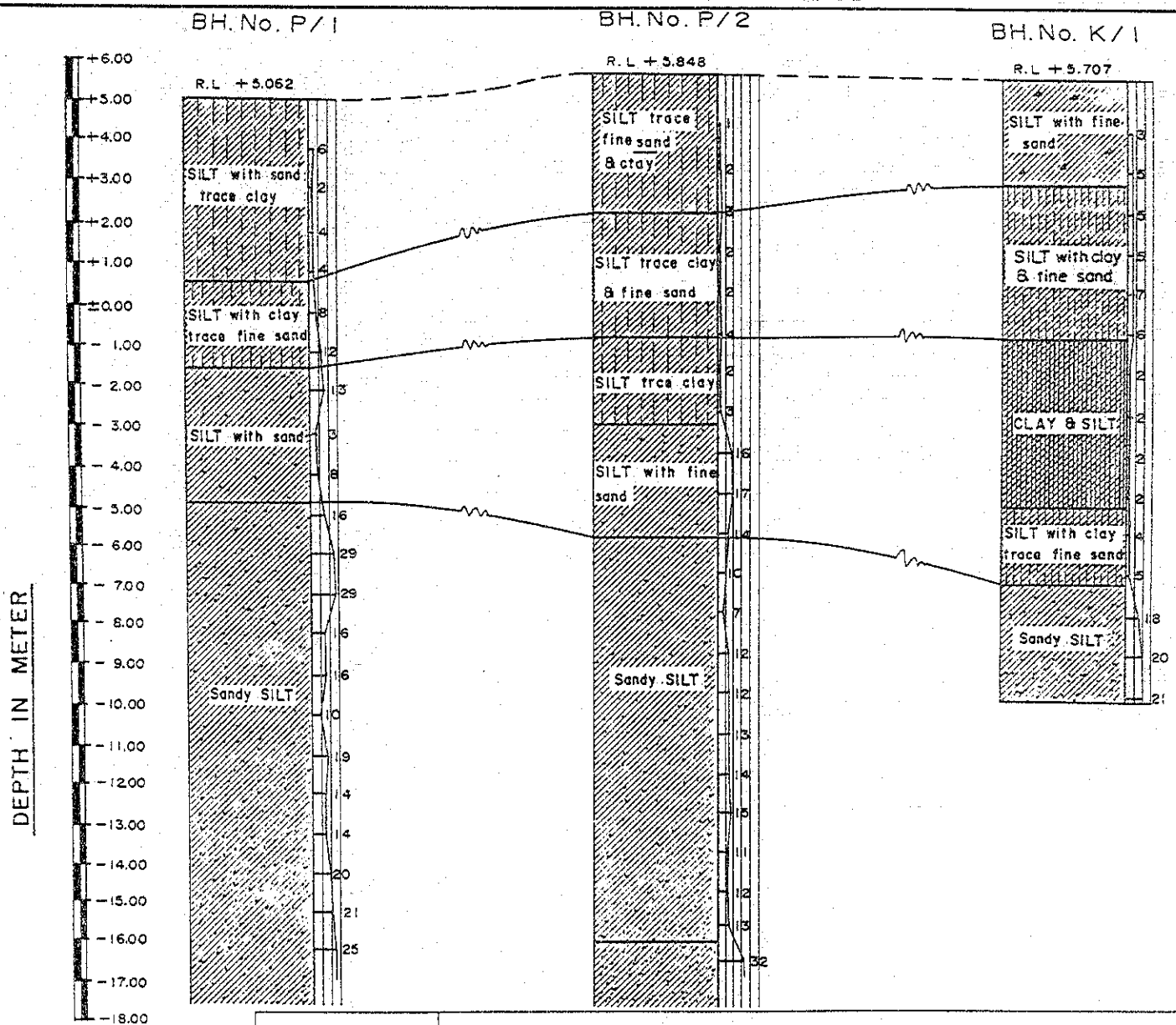

FIG. H. 6 SOIL PROFILE AT KALLYANPUR KHAL

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

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