outlet gate will be an additional gate for confirming the safety against external floods. During dry seasons, the gates are fully opened or operated based on the water use rule of the regulating pond.

Of the gate types considered (roller, slide and flap), the use of the roller gate is proposed and steel material with corrosion resistant paint are to be used for the gate-leaf. For hoisting the gate leaves, the pin-jack type is recommended.

The gate structure will be constructed directly on the subsoil with a spread foundation. Main features that apply to the spread foundation are:

(1) At the site of gate construction, the flood protection dike with 4 m top width and an 8 m height was constructed in mid 1989 by a GDFCD Project. Acceleration of the strengthening of the silty subsoil, therefore, is expected; residual settlement is assumed in negligible.

(2) To avoid seepage failure of the gate structure caused by water flow through apertures due to heterogeneity foundation between the structure and earth dike, a spread foundation is preferable to a pile foundation, allowing the same behavior for both foundations. For confirming the safety against seepage failure, a cutoff wall made of steel sheet piles will be provided beneath and at the sides of the gate.

The main features and the typical gate design are illustrated in Table 5.4 and Fig.5.5 respectively.

5.3.3 Khal Improvement

The proposed khal improvement work consists of dredging, sodding protection, brick protection, construction of box culverts and bridges.

(1) Cross Section Type and Protection Works

Trapezoidal shape is applied for the khal sections where comparatively easy land acquisition is expected. A slope of 1:1.5-1:2.0 is provided with sodding protection and a slope of 1:1 is protected by brick. Selection of the slope types is made based on land acquisition conditions.

As discussed in the previous Chapter, rectangular shaped box culverts are proposed for the khal sections located in the highly urbanized areas and where land acquisition is difficult. The box culvert is to be constructed in reinforced concrete using the spread foundation.

The typical section of the proposed khal improvement in the urgent project is as illustrated in Fig. 5.6.

(2) Bridge Culvert

At cross roads and railway crossing, the reconstruction of existing box culverts and bridges is proposed in order to eliminate the flood discharge bottlenecks. The proposed box culverts are to be made of reinforced concrete with spread foundations. A girder type bridge is proposed when reconstructing the existing railway bridge because of the necessity to perform fast and safe construction under conditions requiring the frequent passing of trains.

Typical proposed box culvert and bridge designs are as illustrated in Figs. 5.7 and 5.8.

5.4. OPERATION, MAINTENANCE, AND ORGANIZATION

In March 1989, the Drainage Circle division undertaking the operation and maintenance work of the drainage facilities in Dhaka city was transferred to DWASA from DPHE. DWASA has a staff of 74 (4 engineers and 70 supporting personnel).

The present major operation and maintenance (O&M) work of the Drainage Circle is limited to:

(1) Cleaning of critical parts of the khals and drainage pipes
(2) Operation and maintenance of the Narinda pump station

Although DWASA's annual budget totals Tk 755.2 milion, the O&M budget for khal, drainage pipes and pump station is an average Tk 1.0, 4.5 and 1.5 million respectively. Due to the small budget, the above work is conducted at an unsatisfactory level.

5.4.1 Required Operation and Maintenance Work

To sustain the expected effects of the existing and proposed drainage system of the Project area (C, F and H zones), the following major O&M work shall be performed:

(1) Dredging of deposits and removal of garbage from the 22.1 km of both open and closed khals.
(2) Cleaning of the 68.1 km of existing drainage pipes.
(3) Operation and maintenance of one pump station.
(4) Operation and maintenance of one sluice gate.
(5) Land use control, in cooperation with the agencies concerned, to maintain the regulating pond and khal areas, and to assure the required elevation of new land development.

5.4.2 Required Operation and Maintenance Equipment

Except for manual tools, no special equipment are provided at present.

Provision of the following equipment is required to satisfactorily implement the above-mentioned O&M work:

(1)	Garbage trolley (mechanically operated):	4 ea.
(2)	Trucks for sludge transportation:	2 ea.
(3)	Cleaning equipment (truck mounted, with crane):	2 ea.
(4)	Cleaning equipment (backet machine, mechanically operated):	2 ea.
(5)	Cleaning equipment (small, manual operation):	10 ea.
(6)	Small pumps for dewatering:	10 ea.
(7)	Supervision vehicles:	
	- Four-wheel-drive cars:	3 ea.
	- Pickup trucks:	4 ea.
	- Motor cycles:	16 ea.

5.4.3 Cleaning of Khals and Drainage Pipes

All the khals and drainage pipes are to be cleaned once a year. The cleaning will be performed manually and mechanically.

5.4.4 Operation Rule of Pump Station

The pump and gate operation period begins when the flood water levels of the rivers reach 4.0 m GTS and end when they recede again to 4.0 m GTS. The period is usually from early July to mid-October (See Fig. 5.9).

During the flood season, the water levels of the regulating ponds shall be maintained below 4.0 m GTS. to handle storm runoffs.
Estimated yearly operating hours will be 450 on an average.

5.4.5 Land Use control

The following land use controls are required to sustain the full functioning of the proppsed structural drainage improvement plans.

(1) Preservation of Regulating Pond Area

At Kallyanpur the proposed regulating pond areas of 208 ha shall be preserved to assure the expected effects of pump drainage. Adverse effects due to reduction of regulating pond areas are considerable.

(2) Preservation of Khal Areas

The existing khal areas are subject to reclamation or by the encroachment of buildings.

The minimum khal sections to be maintained are illustrated in Fig. C.13. In addition, inspection road widths shall be maintained on one or both banks of the khal.

(3) Control of Land Fill Elevation for Urban Development

Pressure of urban development in the low-lying areas of the Kallyanpur area will continue to grow after completion of the Project.

Land fill elevation shall be controlled in conformance with the proposed design high water level inside the protection dikes. The lowest land fill elevation for

urban development is proposed to be +6.00 m GTS (design high water level +5.00 m plus 1.0 m allowance).

5.4.6 Required Organization

For implementation of the urgent project, the Drainage Circle division of DWASA must be strengthened.

(1) Required Organization for Construction

The required organization for the construction of the proposed urgent works is shown in Fig. 5.10. A total staff of 108 persons will be required to support the organization (the breakdown is shown in Supporting Report D, section.4.5)

The organization will be restructured for operation and maintenance after completion of the construction..

(2) Required Organization for Operation and Maintenance

The required organization for the operation and maintenance of the drainage systems in Dhaka city after completion of the proposed project is shown in Fig. 5.10.

A total of 131 persons will be required for the organization (the breakdown is shown in Supporting Report Table D.7).

5.5. PROJECT COST

5.5.1. Basis for Cost Estimates

The estimation of the project cost consisting of (1) the construction cost of the facilities, (2) engineering service fees, (3) land acquisition and compensation cost, (4) customs duty & sales tax (CDST) and office establishment cost was conducted based on the following conditions:

(1) The estimates are made on the assumption that all construction work will be contracted to general contractors by international tender.

(2) All base costs are expressed under the economic conditions prevailing in September, 1989.

(3) The exchange rates of foreign currencies are considered as follows:
US$1.00 = Tk 32.20 = ¥141.00 (Tk 1.00 = ¥4.38)

(4) The cost is classified into foreign currency and local currency portions.

(5) A constant allowance of 25% is added to the direct construciton costs for the contractor's overhead and profit.

(6) A contingency allowance and engineering design/supervision fees is earmarked at 20% of the total construction costs.

5.5.2 Estimated Project Cost

The total project cost, including construction, engineering, land acquisition, CDST, and contingencies, amounts to Tk 1,335.4 million at 1989 prices as shown in the below table.

Project Cost

unit : million Tk

Item		Cost
A.	Construction Cost	863.6
	(1) Pump Station	226.7
	(2) Sluice Gate	50.9
	(3) Khal Improvement	586.0
B.	Physical Contingency	86.4
C.	Engineering	86.4
D.	Land Acquisition	157.6
E.	Office Establishment	26.4
F.	Customs Duty & Tax	115.0
	Total	1,335.4

5.5.3 Operation and Maintenance Cost

The operation and maintenance costs for the drainage facilities include personnel expense, electricity expense for running the pump and gate, and cleaning and repair expense. Annual operation and maintenance for the Project Area (C, F and H drainage zones) is estimated to be 13.0 million Tk as shown below:

Annual Operation and Maintenance Cost

Item	Cost (million Tk)	Remarks (Million Tk)
Pump Station	3.2	
Electricity	(1.2)	
Maintenance of Pump	(1.5)	
Maintenance of Pond	(0.5)	
Cleaning of Drainage Pipe	0.7	0.01 x 68.1 km = 0.7
Maintenance of Khal	0.4	0.02 x 22.1 km = 0.4
O & M of Vehicle and Other Equipment	3.5	
Personnel Expense, Office Accommodation, etc.	5.2	
SUBTOTAL	12.0	
Total	13.0	

5.6 Implementation Schedule

The urgent project covering zones C, F, H is divided into two (2) packages (I and II) for the staged construction in consideration of financial constraints. Construction work in zones F and H is proposed to be package I and zone C is proposed to be package II as described below:

Package I for zones F and H

(1)	Pump station:	1 place
(2)	Sluice gate:	1 place
(3)	Channel culvert:	0.8 km
(4)	Bridge culvert:	1 place
(5)	Dredging:	3.3 km

Package II for zone C

(1)	Channel culvert:	1.4 km
(2)	Bridge culvert:	3 place
(3)	Railway bridge:	1 place
(4)	Brick protection:	1.0 km
(5)	Dredging:	3.9 km

In view of the proposed approximately 2.5 year construction period for each package, the construction schedule is prepared as shown in Fig. 5.11.

TABLE 5.1 IDENTIFICATION OF URGENT PROJECT

ZONE	PHASE-1		IMPLEMENTATION			REMARKS
	WORK ITEM	QUANTITY	UNDER PLANNING/ DESIGNING WORKS	POSTPONABLE WORKS	URGENT WORKS	
C	KHAL IMPROVEMENT					
	(1) Gerani Khal (K-4) K4 : L = 1,800m	. River Dredging = 1,800 m	-	-	. River Dredging = 1,800 m	
		. Slope Protection = 1,000 m	-	-	. Slope Protection = 1,000 m	
		. Bridge Culvert = 1 place	-	-	. Bridge Culvert = 1 place	
	(2) Segunbagicha Khal (K-5)					
	. K5-1 : L = 700m	. River Dredging = 700 m	-	-	. River Dredging = 700 m	
	. K5-2 : L = 500m	. River Dredging = 500 m	-	-	. River Dredging = 500 m	
		. Bridge Culvert = 2 places	-	-	. Bridge Culvert = 2 places	
	. K5-3 : L = 500m	. River Dredging = 500 m	-	-	. River Dredging = 500 m	
		. Channel Culvert = 500 m	-	. Channel Culvert = 500 m	-	
		. Bridge Culvert = 1 place	-	-	. Bridge Culvert = 1 place	
	. K5-4 : L = 1,400m	. Channel Culvert = 1,400 m	-	-	. Channel Culvert = 1,400 m	
	. K5-5 : L = 400m	. River Dredging = 400 m	-	-	. River Dredging = 400 m	
		. Channel Culvert = 400 m	-	. Channel Culvert = 400 m		
	Sub - Total (L = 5,300m)	. River Dredging = 3,900 m	-	-	. River Dredging = 3,900 m	
		. Slope Protection = 1,000 m	-	-	. Slope Protection = 1,000 m	
		. Channel Culvert = 2,300 m	-	. Channel Culvert = 900 m	. Channel Culvert = 1,400 m	
		. Bridge Culvert = 4 places	-	-	. Bridge Culvert = 4 places	
F	KHAL IMPROVEMENT					
	(1) Begunbari Khal (K9,K10)					
	. K9-1 : L = 400m	. Channel Culvert = 400 m	-	. Channel Culvert = 400 m	-	
	. K9-2 : L = 600m	. Channel Culvert = 600 m	. Channel Culvert = 600 m	-	-	
	. K10-1 : L = 800m	. Channel Culvert = 800 m	-	-	. Channel Culvert = 800 m	
	. K10-2 : L = 1,000m	. Channel Culvert = 1,000 m	. Channel Culvert = 1,000 m	-	-	
	(2) Paribagu Khal (K11)					
	. K11 : L = 700 m	. Channel Culvert = 700 m	. Channel Culvert = 700 m		-	
	Sub-Total (L = 3,500 m)	. Channel Culvert = 3,500 m	. Channel Culvert = 2,300 m	. Channel Culvert = 400 m	. Channel Culvert = 800 m	
H	KHAL IMPROVEMENT					
	Kallyanpur Khal (K14)					
	. K14 : L = 3,300m	. River Dredging = 3,300 m	-	-	. River Dredging = 3,300 m	
		. Bridge Culvert = 1 place	-	-	. Bridge Culvert = 1 place	
	PUMP STATION	. Pump Station = 10 m3/S	-	-	. Pump Station = 10 m3/S	
	SLUICE GATE	. Sluice Gate = 1 place	-	-	. Sluice Gate = 1 place	
	Sub-Total (L = 3,300m)	. River Dredging = 3,300 m	-	-	. River Dredging = 3,300 m	
		. Bridge Culvert = 1 place	-	-	. Bridge Culvert = 1 place	
		. Pump Station = 10 m3/S	-	-	. Pump Station = 10 m3/S	
		. Sluice Gate = 1 place	-	-	. Sluice Gate = 1 place	
	TOTAL					
	KHAL IMPROVEMENT	: (L = 12,100m)				
	(1) River Dredging	: (L = 7,200m)	-	-	(1) River Dredging : 7,200 m	
	(2) Slope Protection	: (L = 1,000m)	-	-	(2) Slope Protection : 1,000 m	
	(3) Channel Culvert	: (L = 5,800m)	(3) Channel Culvert = 2,300 m	(3) Channel Culvert = 1,300 m	(3) Channel Culvert : 2,200 m	
	(4) Bridge Culvert	: (n = 5 place)	-	-	(4) Bridge Culvert : 5 places	
	PUMP STATION	: (Q = 10.0m3/S)	-	-	PUMP STATION : 10.0 m3/S	
	SLUICE GATE	: (n = 1 place)	-	-	SLUICE GATE : 1 place	

Table 5.2 SUMMARY OF PROPOSED WORKS FOR URGENT PROJECT

Item	Description	Unit	Total Quantity	Zone			Remarks
				C	F	H	
A. Pump Station	Q=10m^3/s(3.3m^3/sx3)	place	1	-	-	1	
B. Sluice Gate	Q 2.5 m x H 2.5 m x 2	place	1	-	-	1	
C. Khal Improvement		m	9,400	5,300	800	3,300	
1. Channel Culvert	B =2.5 m - 5.0 m x H = 3.8 - 4.3 m	m	2,200	1,400	800	-	
2. Sodding	slope = 1 : 2 to 1 : 1.5	m	6,200	2,900	-	3,300	
3. Brick Protection	slope = 1 : 1	m	1,000	1,000	-	-	
4. Dredging	L = 7,200 m	1,000 m^3	245.6	188.1	8.0	49.5	
5. Bridge Culvert	B =5.0 m - 12.0 m x H = 4.3 - 5.0 m	place (m)	4 (89)	3 (42)	-	1 (47)	
6. Railway Bridge	L = 12.0 m x 3 Lanes W = 19.0 m	place	1	1	-	-	

Table 5.3 Main Feature of Pump Station
(Vertical Axial Flow Pump)

Item	Description	Remarks
1. Hydraulic requirements		
- Pump capacity	10.00 m^3/s	for urgent program
- Actual loss head	2.00 m (HWL+6.00 - LWL+4.00)	Design water level
	2.50 m (HWL+6.00 - LWL+3.50)	Possible operation-(1)
	3.35 m (HWL+8.35 - LWL+5.00)	Possible operation-(2)
- Total loss head	3.40 m	
- Regulating pond	227 ha	Swamp area/paddy field
2. Pump Installation		
- Main pump	3.3 m3/s x 3 units, ø1200	Vertical axial flow pump
- Main motor	180 kw x 3 units	
- Main electric panel	High voltage 10sets, low boltage 2sets	2-incoming power lines
- Overhead crane	1 set, 16 ton capacity	
- Auxiliary equipment	1 set,	

Table 5.4 Main Feature of Sluice Gate
(Steel Roller Gate)

Item	Description	Remarks
1. Design water level		
- River side	HHWL + 8.35 m GTS	
- Pond side	LLWL + 3.50 m GTS	
2. Sluice gate size		
- Inlet gate	H 2.5 m x W 2.5 m x 2 spans	
- Outlet gate	H 2.5 m x W 2.5 m x 2 spans	
- Gate-Culvert	H 2.5 m x W 2.5 m x 2 boxes, L=60.0 m	
3. Gate leaf	4 gate leaves	
- Structure	Skin plate with beam	
- Material	Steel	
- Hoisting	Pin-jack type	
- Water seal	Four-sided rubber seal	
4. Operation Bridge	Length 18.0 m	
	Width 1.0 m	

TABLE 5.5 PROJECT COST

Unit : Million Tk 1989 Price

ITEM	ZONE	DESCRIPTION	Construction Cost			REMARKS
			F/C	L/C	TOTAL	
A. Pump Station						
P1	H	10.0m3/s	180.9	45.8	226.7	
Subtotal			180.9	45.8	226.7	
B. Sluice Gate						
G6	H	2.5x2.5x2x66.5(m)	36.4	14.5	50.9	
Subtotal			36.4	14.5	50.9	
C. Khal Improvement						
K4	C	L=1,800m	19.9	33.3	53.2	
K5	C	L=3,500m	200.0	155.2	355.2	
K10	F	L= 816m	84.6	69.0	153.6	
K14	H	L=3,300m	12.5	11.5	24.0	
Subtotal		L=9,416m	317.0	269.0	586.0	
SUBTOTAL(A-C)	-	-	534.3	329.3	863.6	
D. Physical Contingency	-	-	47.5	38.9	86.4	
SUBTOTAL(A-D)	-	-	581.8	368.2	950.0	
E. Engineering	-	-	64.8	21.6	86.4	
F. Land Acquisition	-	-	0.0	157.6	157.6	
G. Office Establishment	-	-	0.0	26.4	26.4	
H. Customs Duty & Tax	-	-	0.0	115.0	115.0	
TOTAL(A-H)	-	-	646.6	688.8	1335.4	

TABLE 5.6 DISBURSEMENT SCHEDULE OF URGENT PROJECT

PACKAGE - I FOR ZONE F AND H

(Unit : Million Tk in 1989 Price)

	ITEM	CURRENCY	1st YEAR	2nd YEAR	3rd YEAR	4th YEAR	TOTAL COST F/C	TOTAL COST L/C	TOTAL COST 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	220.88	26.79	373.60	375.92	749.52
		F/C	11.24	96.16	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	2nd YEAR	3rd YEAR	4th YEAR	TOTAL COST F/C	TOTAL COST L/C	TOTAL COST 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			

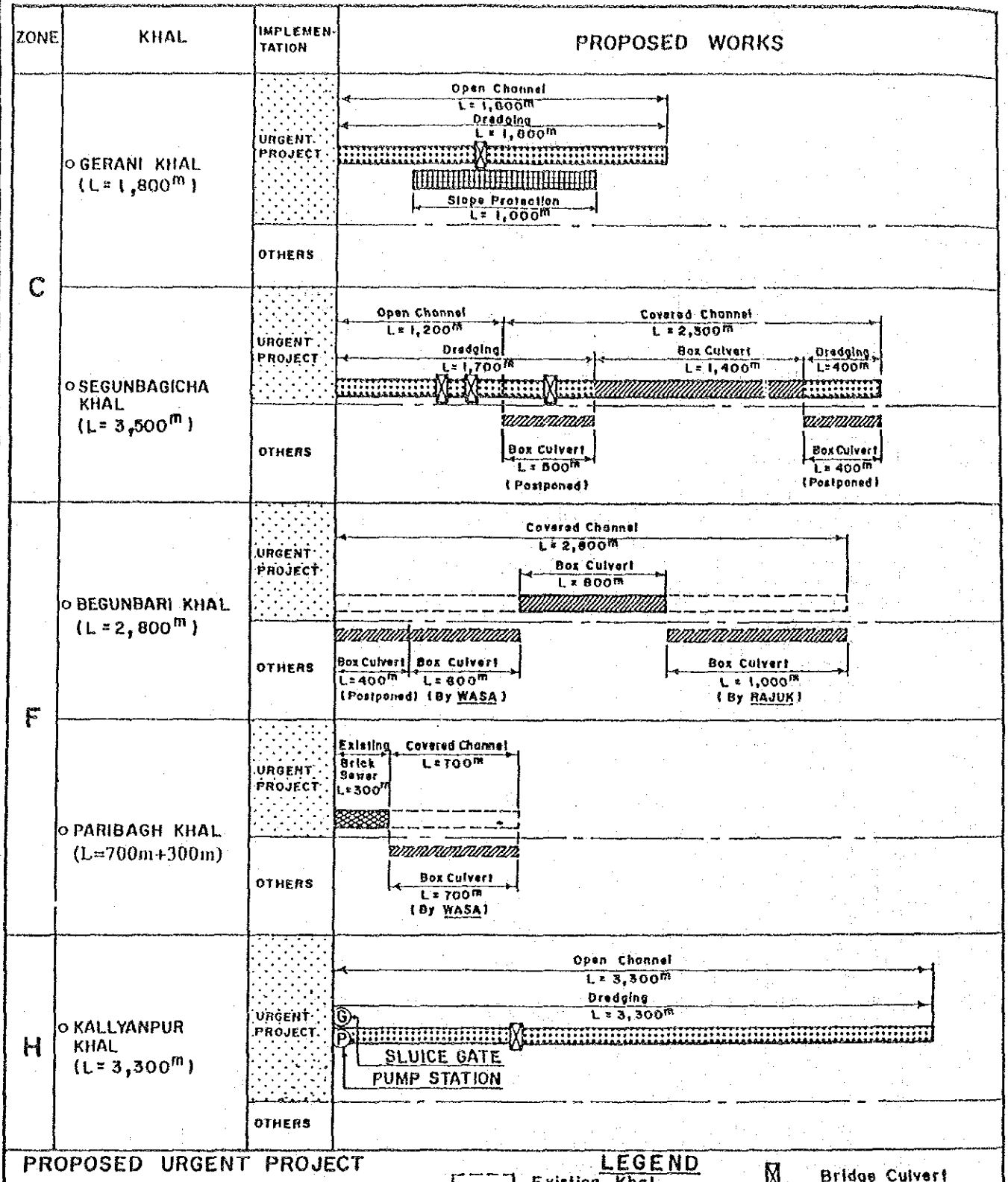


FIG. 5.1 IDENTIFICATION OF URGENT PROJECT

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

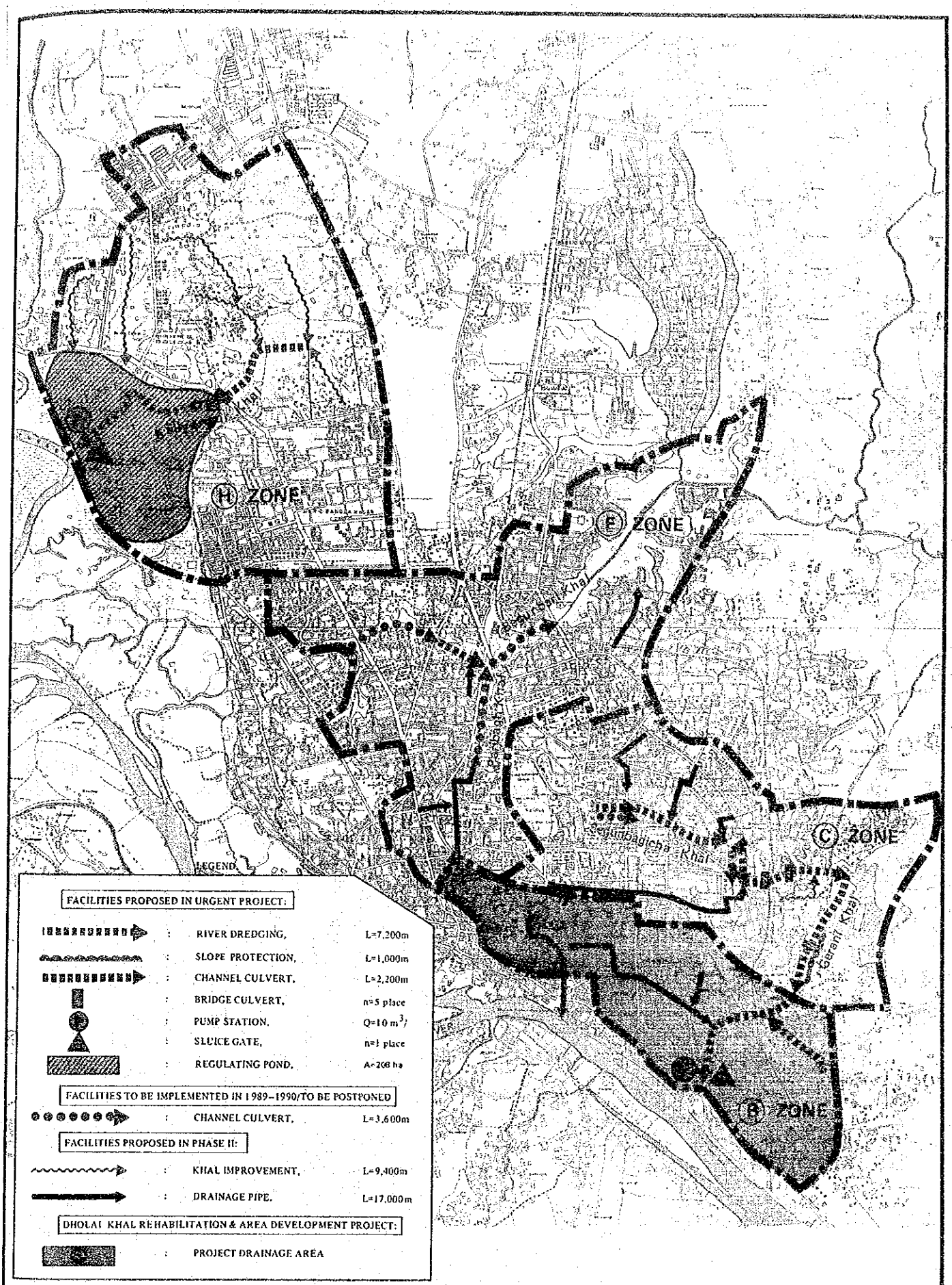


FIG. 5.2 LOCATIONS OF PROPOSED FACILITIES IN URGENT PROJECT

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

PLAN

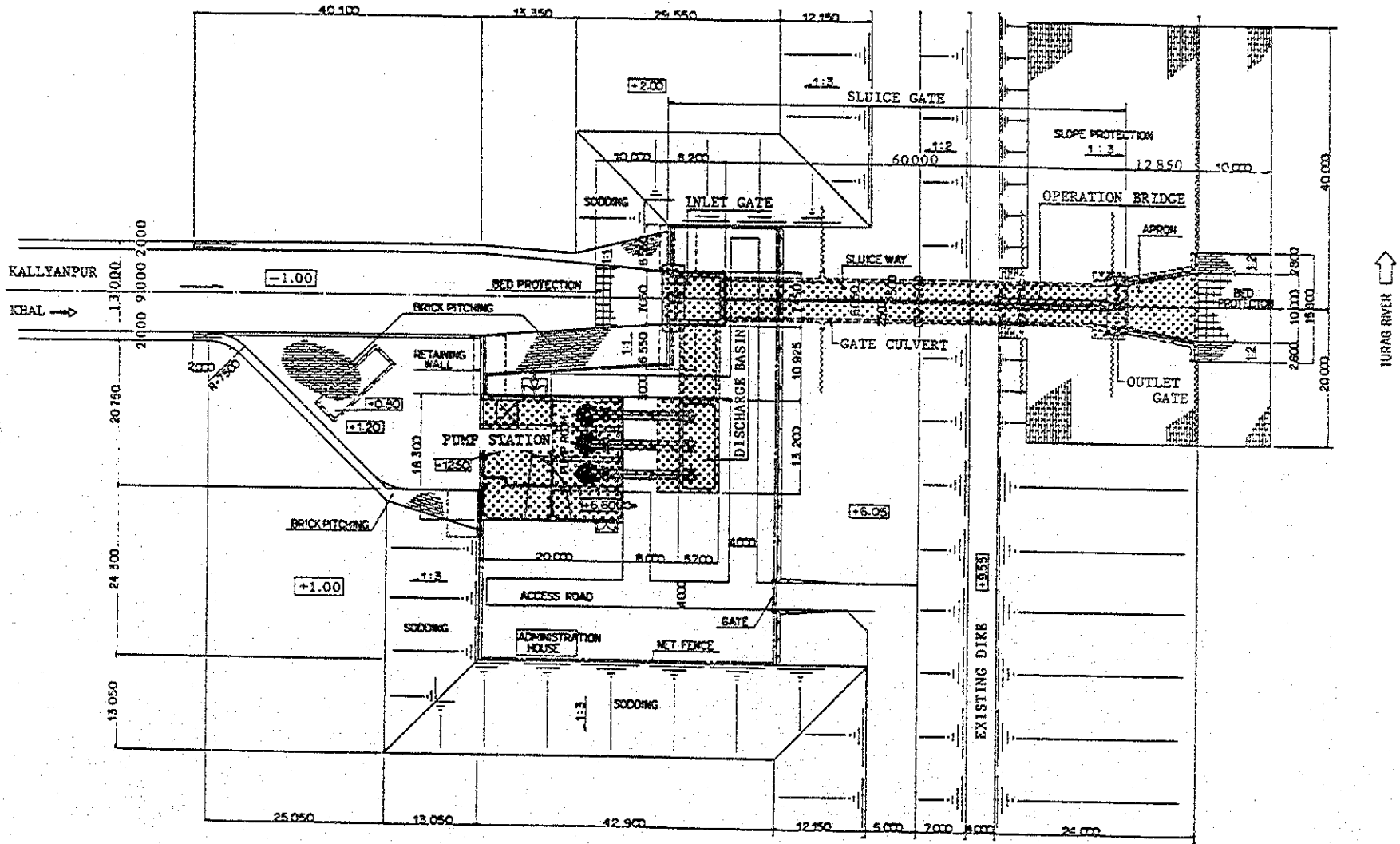
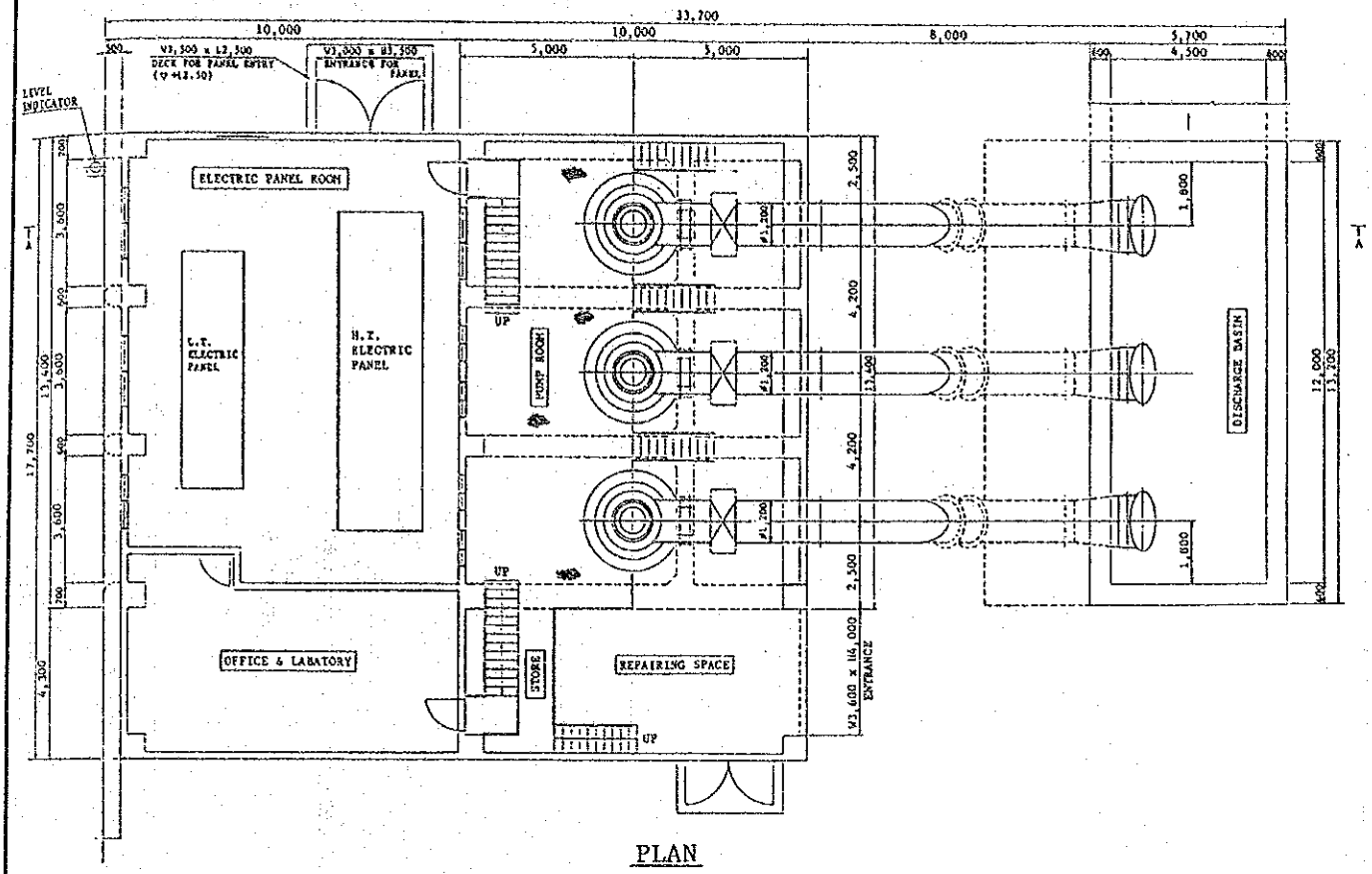
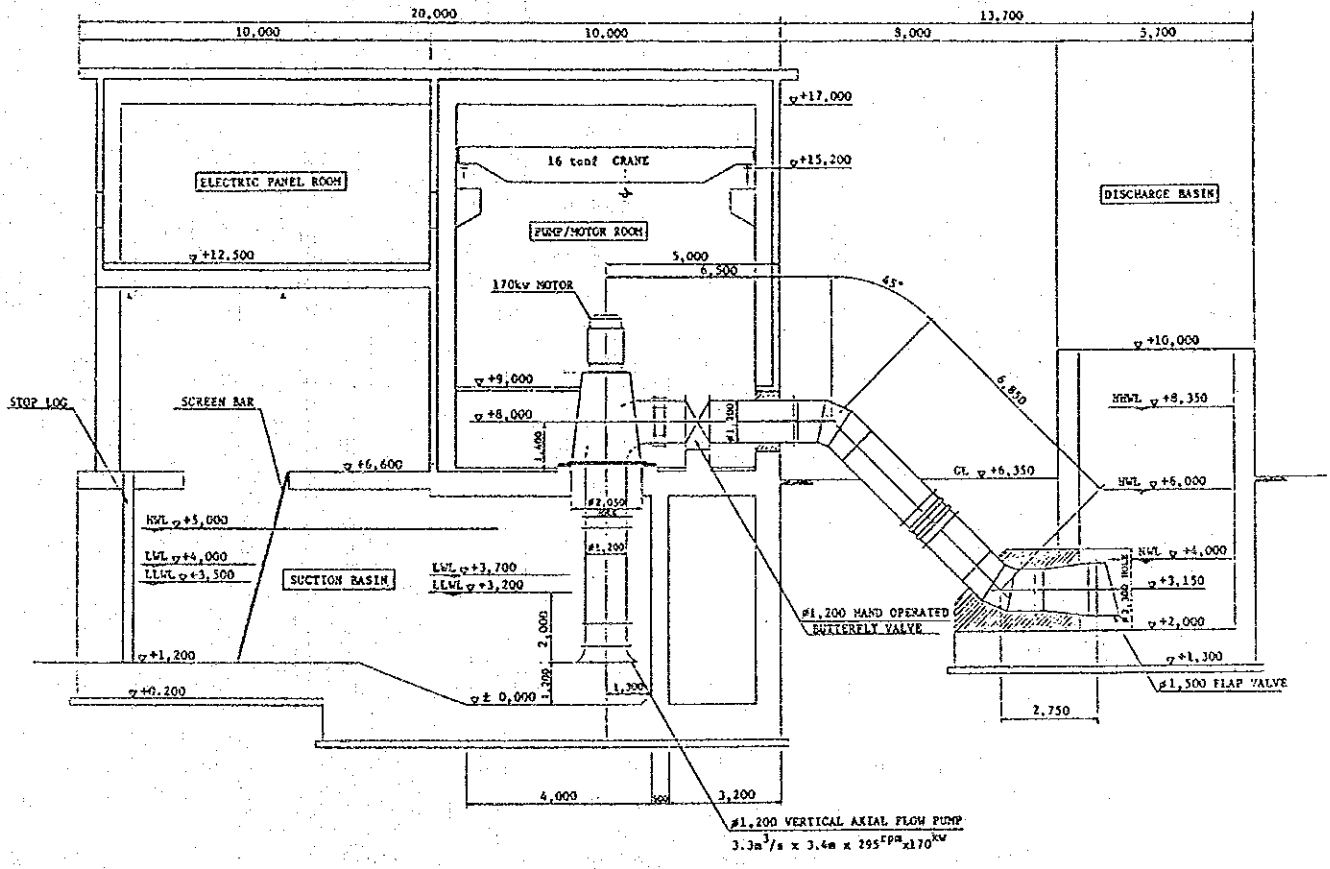


FIG. 5. 3 GENERAL LAYOUT OF PUMP STATION AND SLUICE GATE

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

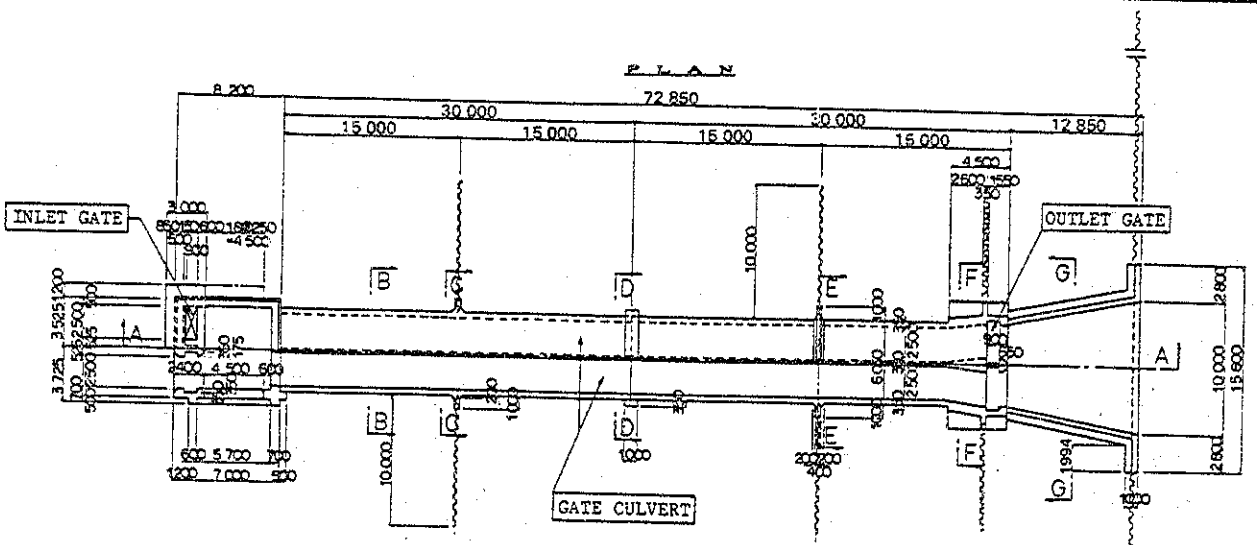


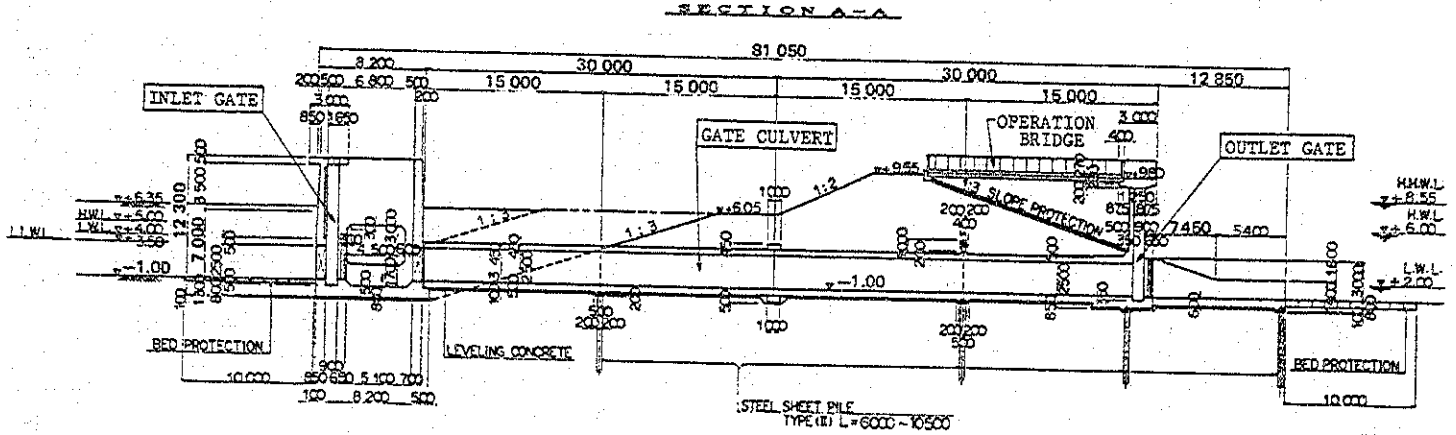
PLAN



SECTION

FIG. 5.4 TYPICAL DESIGN OF PUMP STATION





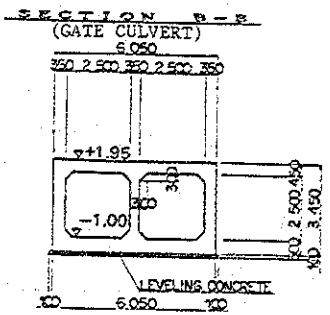
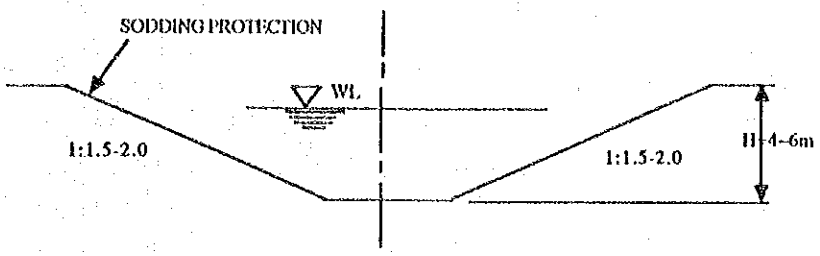
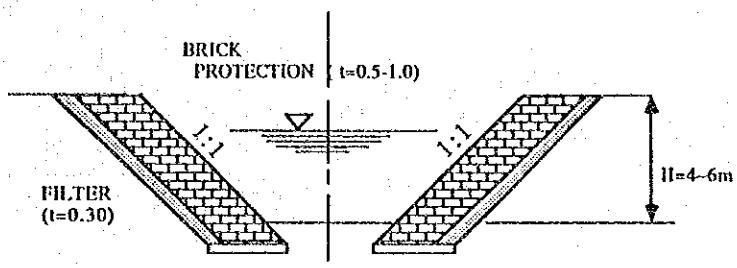


FIG. 5.5 TYPICAL DESIGN OF SLUICE GATE

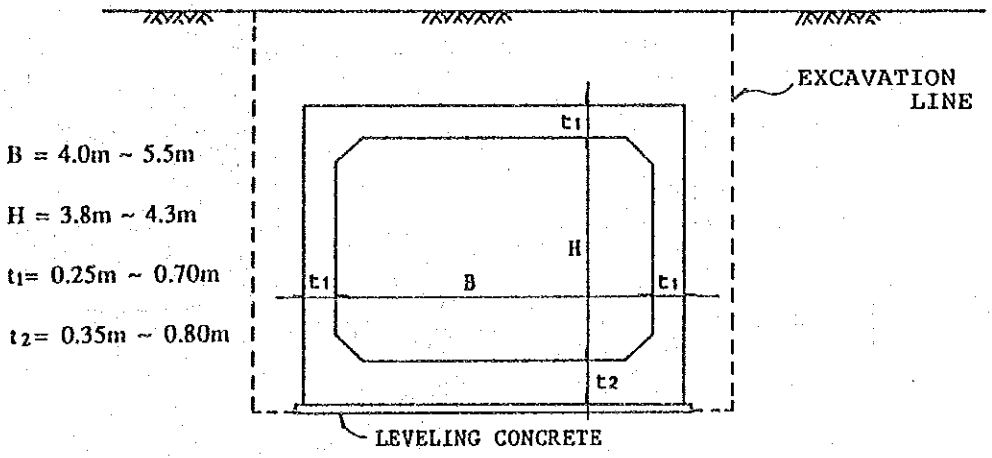
TYPE - 1 : TRAPEZOIDAL TYPE (1) - SODDING PROTECTION



TYPE - 2 : TRAPEZOIDAL TYPE (2) - BRICK PROTECTION



TYPE - 3 SINGLE BOX CULVERT



TYPE - 4 DOUBLE BOX CULVERT

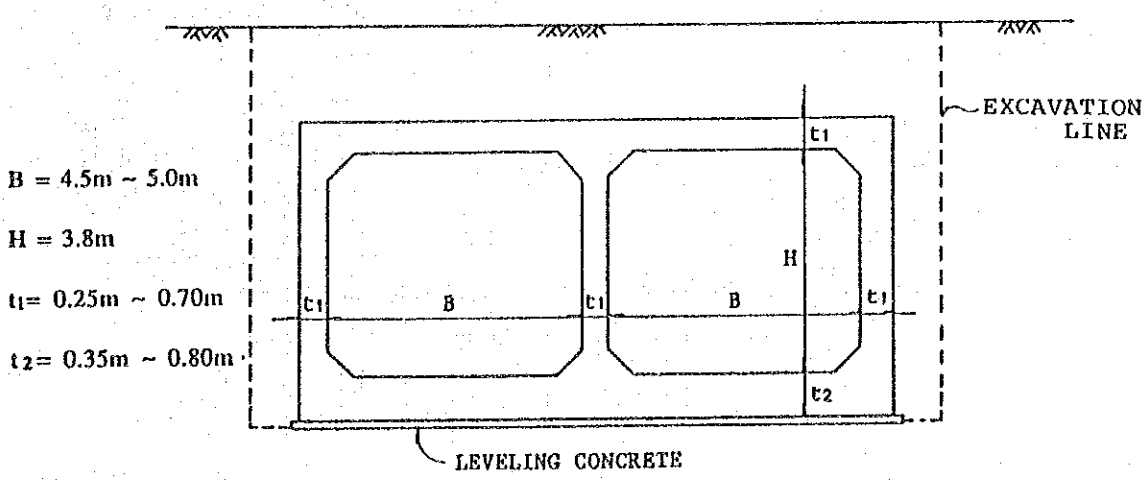


FIG. 5.6 TYPICAL SECTION OF KHAL IMPROVEMENT

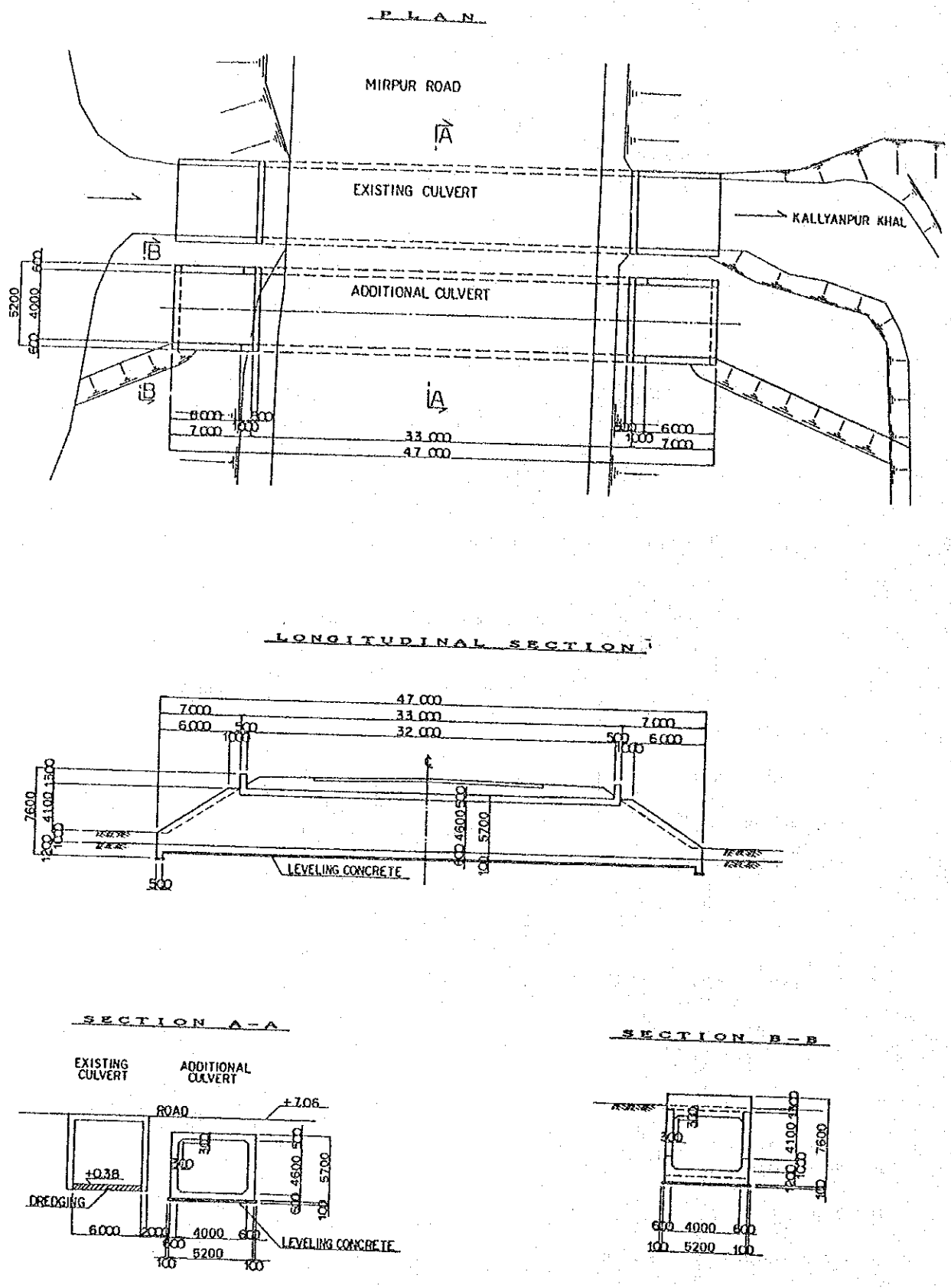


FIG. 5.7 TYPICAL DESIGN OF BRIDGE CULVERT AT KALLYANPUR KHAL

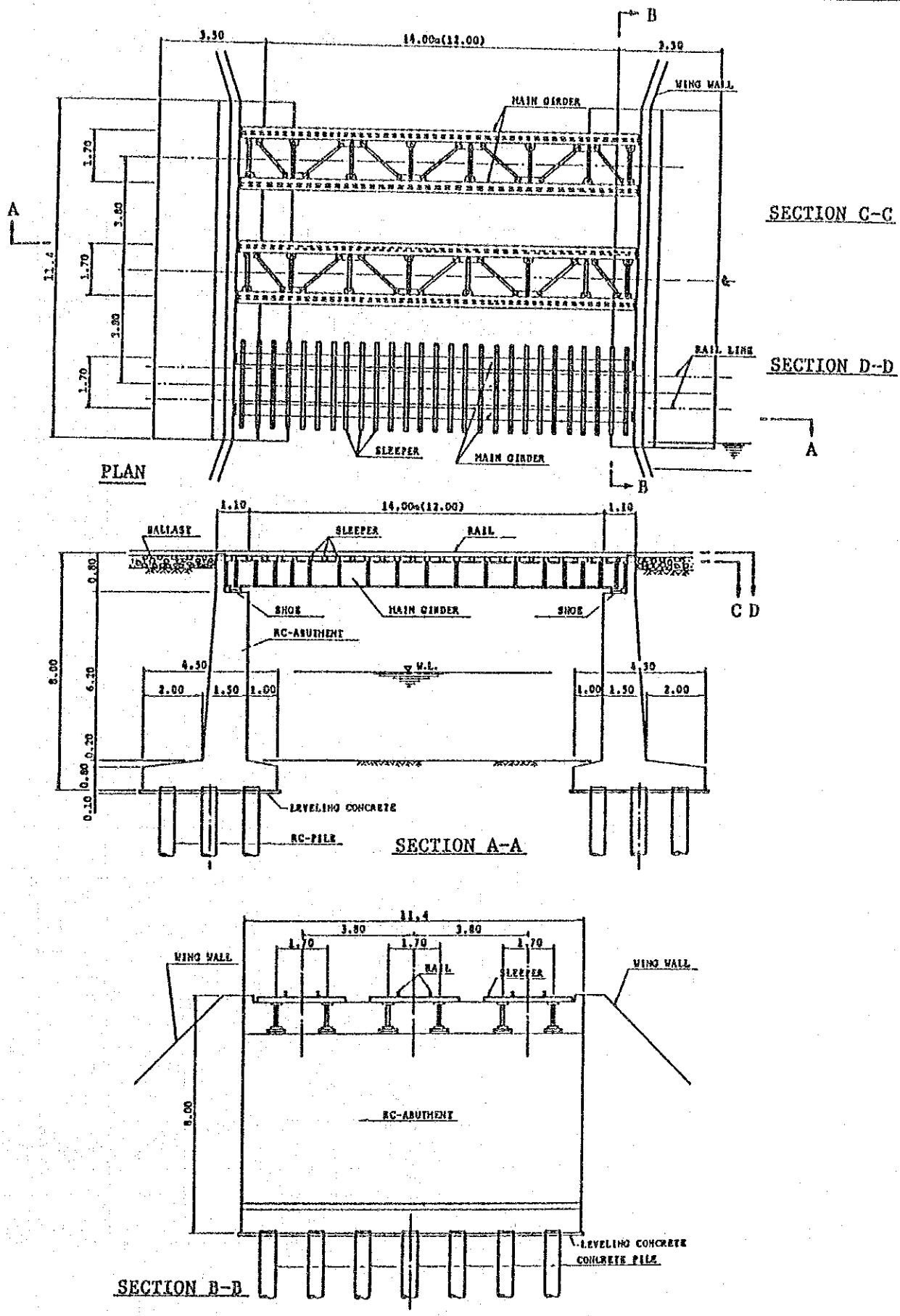
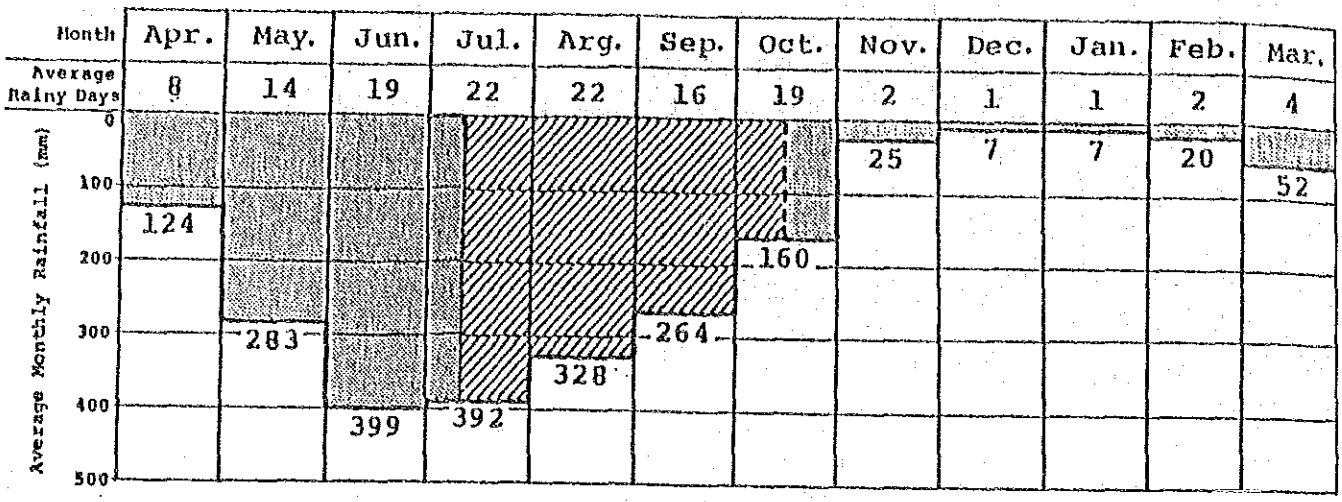


FIG. 5.8 TYPICAL DESIGN OF RAILWAY BRIDGE

AVERAGE MONTHLY RAINFALL AND RAINY DAYS



SEASONAL VARIATION OF BURIGANGA RIVER WATER LEVEL AT MILL BARRACK STATION

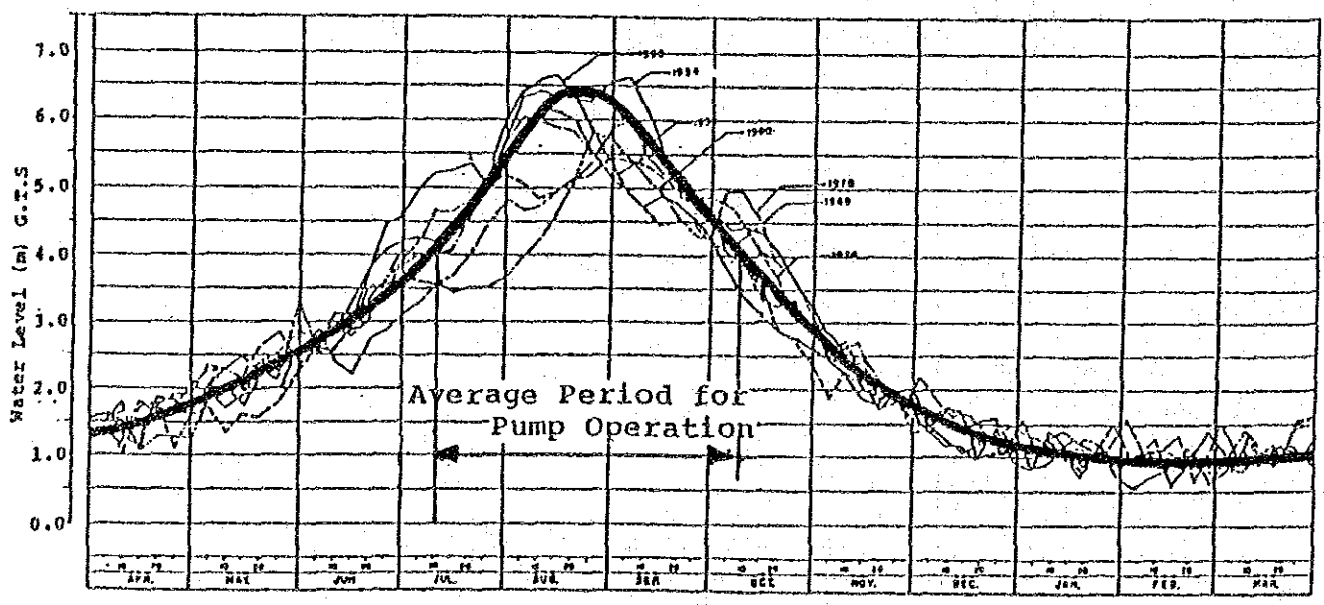
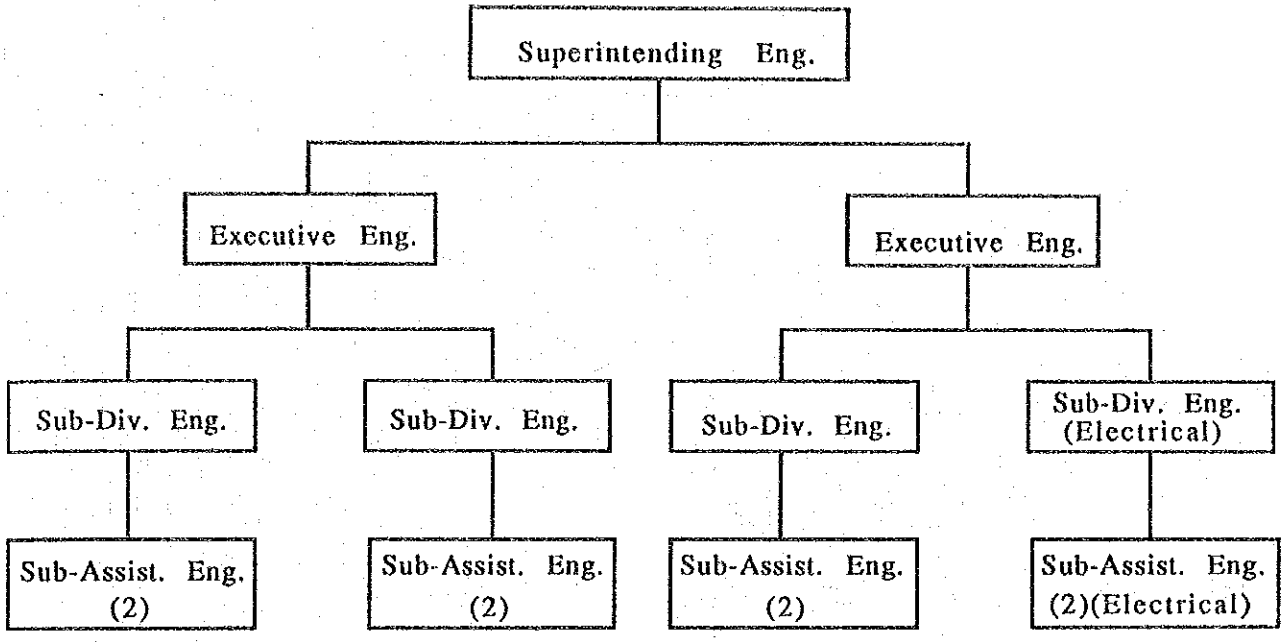


FIG. 5.9 SEASONAL VARIATION OF BURIGANGA RIVER WATER LEVEL AND AVERAGE MONTHLY RAINFALL

(1) PROPOSED ORGANIZATION OF THE DRAINAGE CIRCLE FOR CONSTRUCTION



(2) PROPOSED ORGANIZATION OF THE DRAINAGE CIRCLE FOR OPERATION AND MAINTENANCE

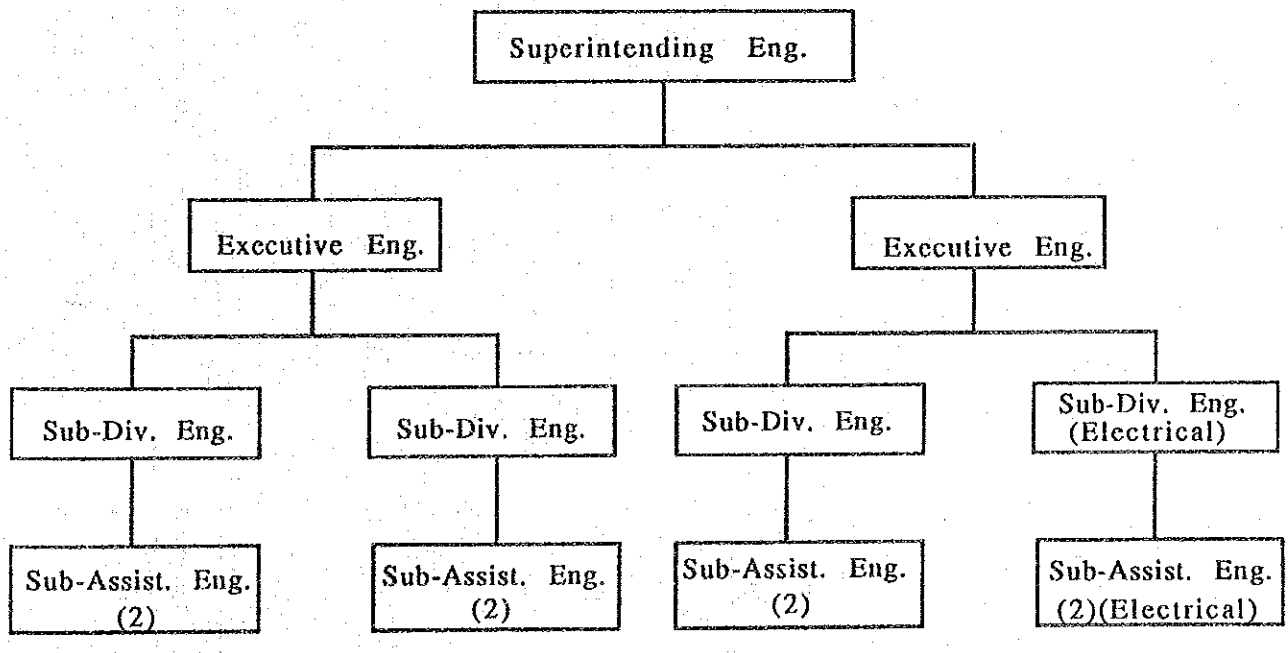
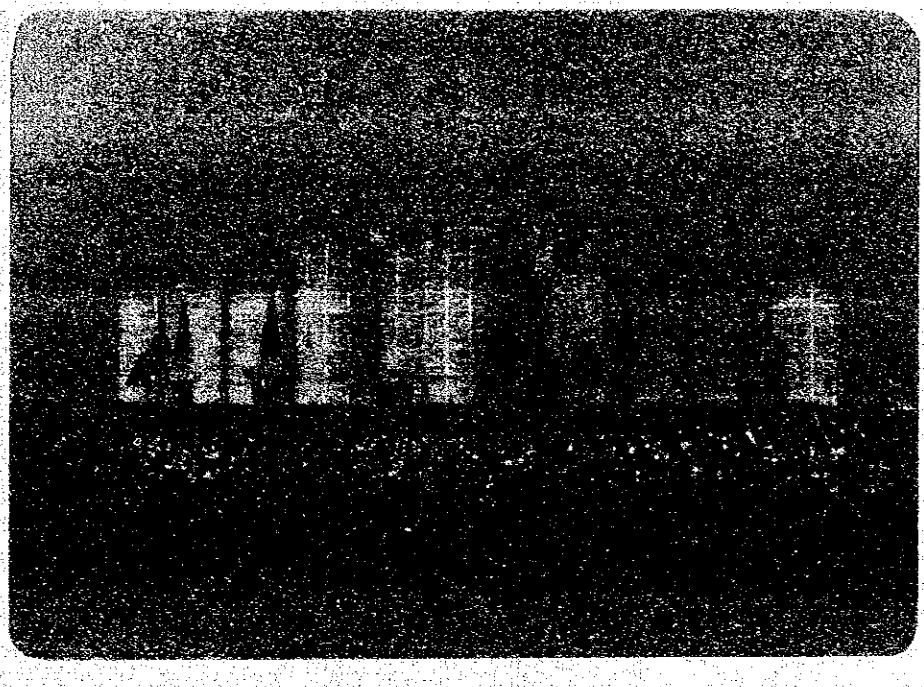


FIG. 5.10 PROPOSED ORGANIZATION FOR CONSTRUCTION AND OPERATION / MAINTENANCE

		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					
	H - Zone	3. Sluice Gate	1 place		Manufacturing			
	H - Zone	4. Bridge Culvert (at Millpur Rd.)	1 place					
	H - Zone	5. Dredging	3.3 km					
	P - 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					
	C - Zone	3. Bridge Culvert	3 place					
	C - Zone	4. Railway Bridge	1 place					
	C - Zone	5. Brick Protection	1.0 km					
	C - Zone	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. 5.11 CONSTRUCTION SCHEDULE OF URGENT PROJECT

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



NATIONAL ASSEMBLY BUILDING

CHAPTER 6

PROJECT EVALUATION

CHAPTER 6 PROJECT EVALUATION

6.1 General

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

(1) to up-date the cost and benefit information of the 1986 prices and convert them into 1989 prices,

(2) to up-date the analytical framework corresponding to the change in the priority areas from B, C and F to C, F and H, and

(3) to up-date the analytical framework corresponding to the introduction of project packages (package I and II).

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 propsoed 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 procedure except the points above are kept same as the previous report in order to keep the analytical consistency.

6.2 Identification of Benefits

Benefit of this drainage system improvement project is defined as a magnitude of reduction in flood damage potential attributable to the project. This magnitude is measured by quantifying a 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.

6.3 Estimate of Economic Benefits

The economic benefit of the project is estimated by proceeding four steps. The first step is a core of the up-dating works and contains the works which convert the damage figures of houses and other properties estimated in the year 1986 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 potential. Lastly, project benefit is derived in accordance with the designed flood frequency of each flood mitigation work.

First, value of the house is converted into the 1989 price by expanding the 1986 figures according to the increase of price in cost of housing construction since 1986. This increase is reported to be 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 at the cases of four (4) kinds of flood frequency; 1-year, 5-year, 10-year and 30-year in 1989 and 2000. Results are tabulated below;

(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

Thirdly, the flood damage potential by flood 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 prices)

Items	Package I (F and H Zones)	Package II (C Zone)
Average Annual Flood Damage in 1989	158.7	75.4
Average Annual Flood Damage in 2000	403.3	158.6

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 sufficient 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 up to the design flood frequency of each flood protection works are incorporated in the function above. Benefit of the project are summarized below;

(unit; million Tk, 1989 price)

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

6.4 Estimation of Economic Cost

In the economic analysis of the project, the nominal project cost measured in 1989 market price is converted into economic cost which excludes the portion 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 modification.

As for the Packege 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.

As for the Packege II (C drainage zone), the project cost at 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. In addition, the operation and maintenance cost of 503.4 million Tk is required in the whole project life.

6.5 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 original study.

Assumptions are as follows;

(1) Benefits of the project are assumed to increase linearly up to the year 2000, and keep increasing tendency at 5 per cent annum after 2000.

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

(3) The project benefits are reckoned over 30 years (1995 thru 2024).

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

All the results show high and sufficient to approve the project, which are shown below;

	EIRR (%)	B/C	NPV (million Tk)
Package I (F and 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

6.6 Social Impact

This drainage system improvement project enhances the following social contributions;

(1) Improvement of business efficiency

Central function of the government and business activities such as banks and commerce concentrates in the flood prone area. And it is thus expected that eradicating the discontinuity of business/commercial activities can contribute to the higher efficiency in business/commercial fields.

(2) Improvement of land use potential

Land use of the flood prone areas will be enhanced. For example,new flood free area can be utilized for the housing development in order to resolve the houseless migrants from outside of Dhaka.

(3) Improvement of sanitary conditions

Environment of people's public health and amenities will be improved. The maximum beneficial people in 2000 is estimated to be 802,000 persons.

(4) Improvement of town image

This is the integrated effect of all the social impacts above. And it is also expected to contribute to attract the direct investment from foreign country.

(5) Creation of Employment opportunity

This project has a significant effect on the creation of job opportunity, and this direct effect of the project reaches 210,000 person-day over the first three years.

6.7 Conclusion of Project Evaluation

This drainage system improvement project is strongly recommended in terms of economic evaluation and the magnitude of the social impacts.

This drainage system improvement project shows remarkably high economic internal rate of return for the flood mitigation project since flood mitigation project with IRR of 3 to 4 per cent are the usual case. And eradication of flood is expected to activate the economic activities through the improvement of business efficiency, sanitary situation and town image. The impact of employment creation will also contribute to calm the poor fertility situation at the bottom of the society.

DISCUSSION BETWEEN DWASA AND JICA MISSION

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

Chapter 7 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

1) In this study, the original 1987 JICA project has been revised to account for information obtained from the disastrous flood of 1988 and for more recent related projects. In this new study, drainage Zone H has been added to Zones B, C, and F in the Phase I programme area.

2) Since the proposed Phase I and II programmes were reassessed with the knowledge of other ongoing projects, it was possible to exclude the flood protection dike for Greater Dhaka City, and the Dholai khal improvement which included installation of the new Narinda pump station. The resulting combined Phases I and II plans thus comprises 7 control gates, 2 pump stations, 36.35 km of khal improvement, and 17.0 km of drainage pipes and has a total project cost of Tk 4,478.7 million. Equally important to the project are non-structural measures to reserve the two proposed regulating ponds and to strictly enforce controls necessary to maintain the cross sectional area of the khals themselves.

3) Beyond the need for the re-definition of the two phase programmes, this study defines an "Urgent Project" which omits tasks which are included in other projects and considered as postponable, even though necessary to complete Phase I of the overall project. This Urgent Project consists of 9,400 m of khal improvements, 1 pump station, and 1 sluice gate with a total project cost of Tk 1,335.4 million. Recommendations for institutional measures remain unchanged.

4) The proposed projects are technically, economically, and socially justified. Implementation of the Urgent Project is recommended as soon as possible in consideration of the present serious flood problems.