The gates are roller type and are 6.0 m x 6.0 m in size.

The typical gate design is illustrated in Fig. 8.2.

8.3 Pump Station

The proposed works include the rehabilitation of the existing Narinda pump station with a 9.6 m^3/s capacity and the installation of an additional Narinda pump station with a 9.2 m^3/s capacity.

The basic hydraulic requirements of both pump stations are shown in Table 8.1.

The pump stations are designed to meet the above-mentioned hydraulic requirements.

The main features of the proposed rehabilitation and additional installation of the pump stations are shown in Table 8.2.

The locations and layouts of the existing and new pump stations are illustrated in Fig. 8.3 and Fig. 8.4.

A rehabilitation plan, taking into consideration the following two (2) steps, is proposed in order to solve the existing problems mentioned in 3.2.3.

Step 1:

(1) Reconstruction of discharge pipes

The requirement of the excessive pump-up head is attributed to the high elevation of the crest point (8.699 m G.T.S.) and outlet point (6.600 m G.T.S.) of the existing discharge pipes (See Fig. 8.5). No siphonage is available in this discharge system.

The existing outlets of the discharge pipe are extended downward to reduce the required pump-up head by siphonage.

(2) Installation of Automatic Trash Rake

Automatic trash rakes of four (4) sets are to be installed for quick removal of collected garbage (See Fig. 8.5).

Step 2:

The existing pumps are to be replaced by new ones in order to obtain higher pump efficiency. The replacement is expected when the life of the existing pump is at an end.

The existing motors are to be replaced to meet the specifications of the replaced pumps.

8.4 Khal Improvement

The proposed khal improvement works consist of dredging, sodding protection, brick protection, construction of retaining walls, bridges, and box culverts.

(1) Cross Section Type and Protection Works

Trapezoidal shape is applied for the khal sections where comparatively easy land acquisition is expected. A slope 1:1.5-1:2.0 is provided with sodding protection and a slope 1:0.7-1:1 is protected by brick.

A rectangular shape is proposed for the khal sections where land acquisition is difficult. The rectangular shape is supported by retaining walls.

The typical section of the proposed khal improvement is illustrated in Fig. 8.6.

(2) Box Culvert and Bridge

Reconstruction of existing box culverts and bridge is proposed for the crossing sections of the roads and railway. The proposed box culverts are made of reinforced concrete. A girder type bridge is proposed for the reconstructions of the existing railway bridge because of necessity to perform fast and safe construction work under the conditions of requiring the frequent passage of trains.

The typical designs of the proposed box culverts and bridge are illustrated in Fig. 8.7 and Fig. 8.8.

8.5 Drainage Pipe

Brick type drainage pipes having diameters of 1.5-3.7 m are recommended. For pipes more than 3.0 m in diameters under heavy load conditions, the reinforced concrete box culvert type is being used. Under light load conditions, brick type of pipe having four (4) layers of arched brick is to be used.

The typical design of the proposed drainage pipes is illustrated in Fig. 8.7.

The proposed work is summarized in Table 8.3.

Table 8.1 Basic Hydraulic Requirements of Pump Station

Item	Additional Pump Station	Existing Pump Station to be Rehabilitated	Remarks
Pump capacity	9.2 m3/s	9.6 m3/s	
L.W.L (Inner Side)	+3.2 m	+3.2 m	
H.W.L (Inner Side)	+4.5 m	+4.5 m	
H.W.L (Outer Side)	+5.4 m	+5.4 m	2-year Frequency
H.W.L (Outer Side)	+6.6 m	+6.6 m	30-year Frequency
Total Design Head	≈ 3.8 m	-	

Table 8.2 Main Features of Rehabilitation and Additional Installation of Pump Stations

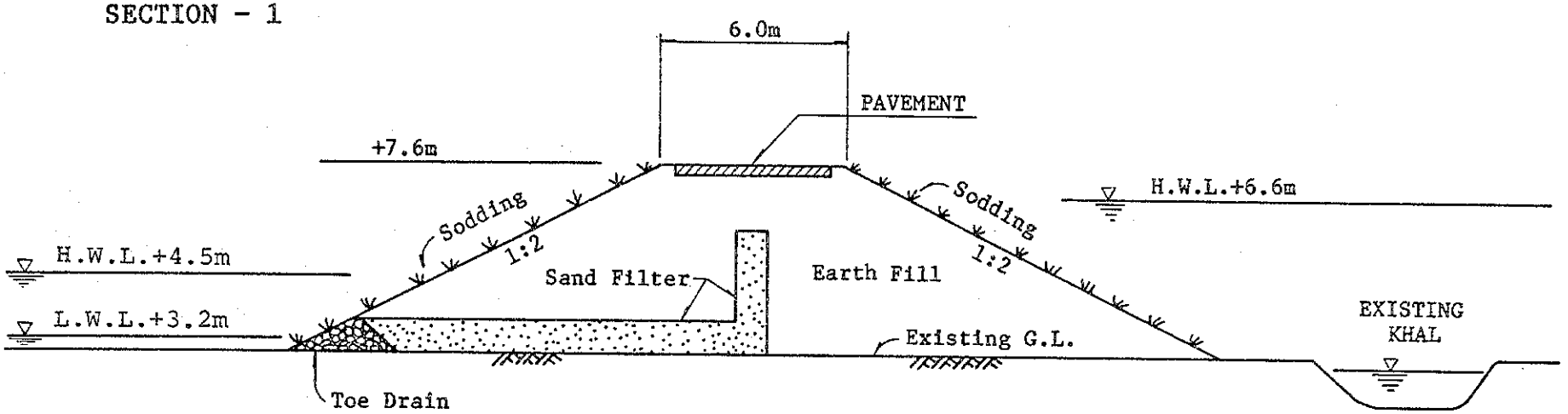
Item	Sub-Item	Rehabilitation of Existing P.S.	Additional Installation of P.S.
A. Main Pump			
	1. Total Capacity	9.6 m3/s	9.2 m3/s
	2. Type	Vertical Axial Flow Pump	Vertical Axial Flow Pump
	3. Diameter	Ø 1,000 mm	Ø 1,000 mm
	4. Capacity x Unit	2.4 m3/s x 4 sets	2.3 m3/s x 4 sets
B. Main Electric Motor		140 kw x 4 sets	132 kw x 4 sets
C. Electric Panel		*	11 sets
D. Automatic Trash Rake		4 sets	4 sets
E. Overhead Crane		*	1 set
F. Other Auxiliary Equip.		1 set	1 set

Note: Items shown with * are utilizing existing equipment.

Table 8.3 Summary of Proposed Works

Item	Description	Unit	Zone			Total	Remarks
			B	C	F		
A. Dike	H = 6.0 m	m		4800		4800	
B. Pump station	9.2 & 9.6 m3/s	place m3/s	2 18.8			18.8	Rehabilitation and New
C. Gate	6.0 m x 6.0 m	place	1	1		2	
D. Khal Improvement Works		m	4200	5100	3800	13100	
1. Dredging		1000 m3	106.9	154.6	33.7	295.2	
2. Sodding		1000 m2	54	25	53	132	
3. Brick Protection		m	400	1180	700	2280	
4. Retaining Wall	Concrete Panel	m		480	280	760	
5. Box Culvert	B 4-7 m x H 4-6 m	m	25 (1 place)	192 (12 places)	147 (8 places)	364 (21 places)	
6. Railway Bridge	L = 12 m X 3	place		1		1	
E. Drain Pipe		m	4280	4810	3410	12500	
1. Brick Pipe	D=1.5 - 3.7 m	m	2050	4110	3410	9570	
2. Box Culvert	av. 3 m x 3 m	m	2230	700		2930	

SECTION - 1



SECTION - 2

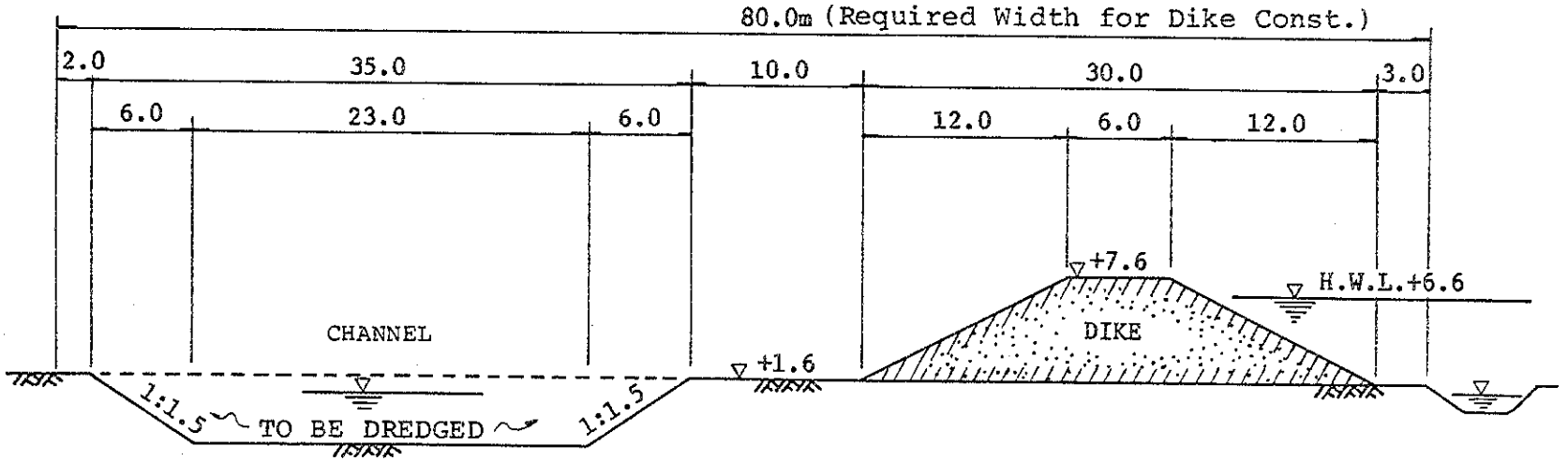


FIG. 8.1 TYPICAL DESIGN OF DIKE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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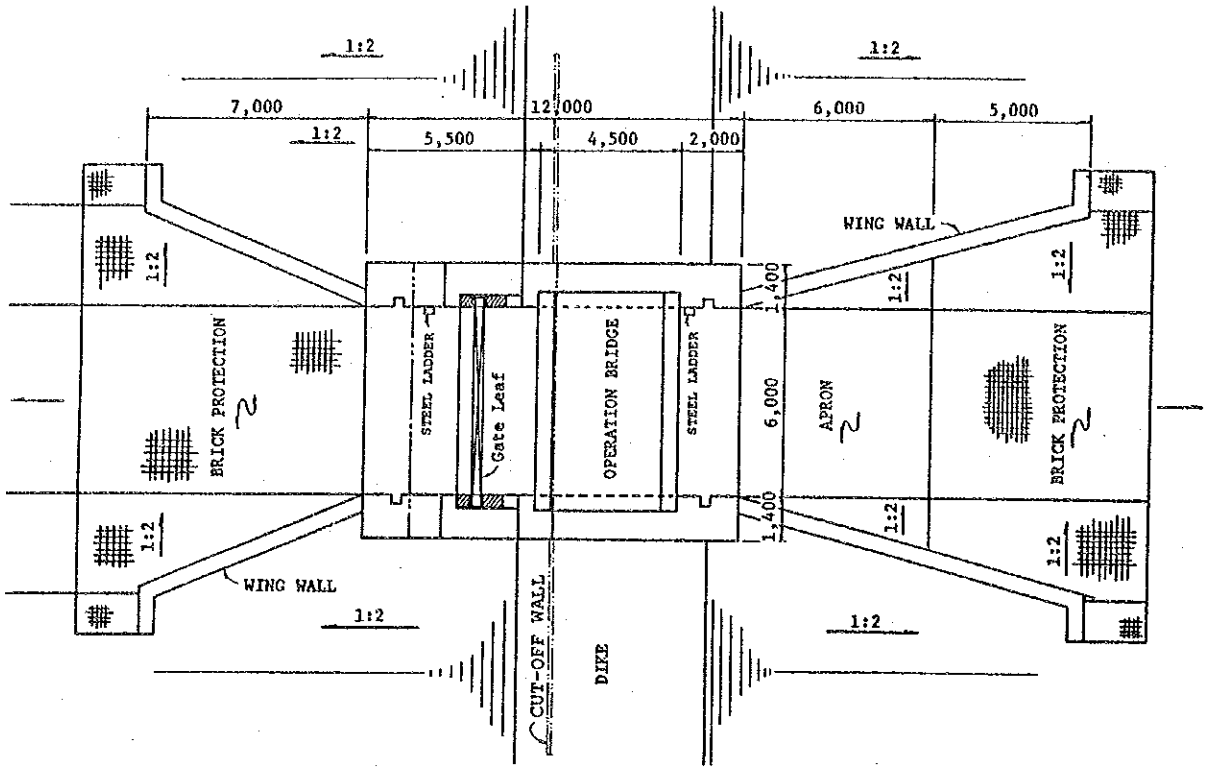

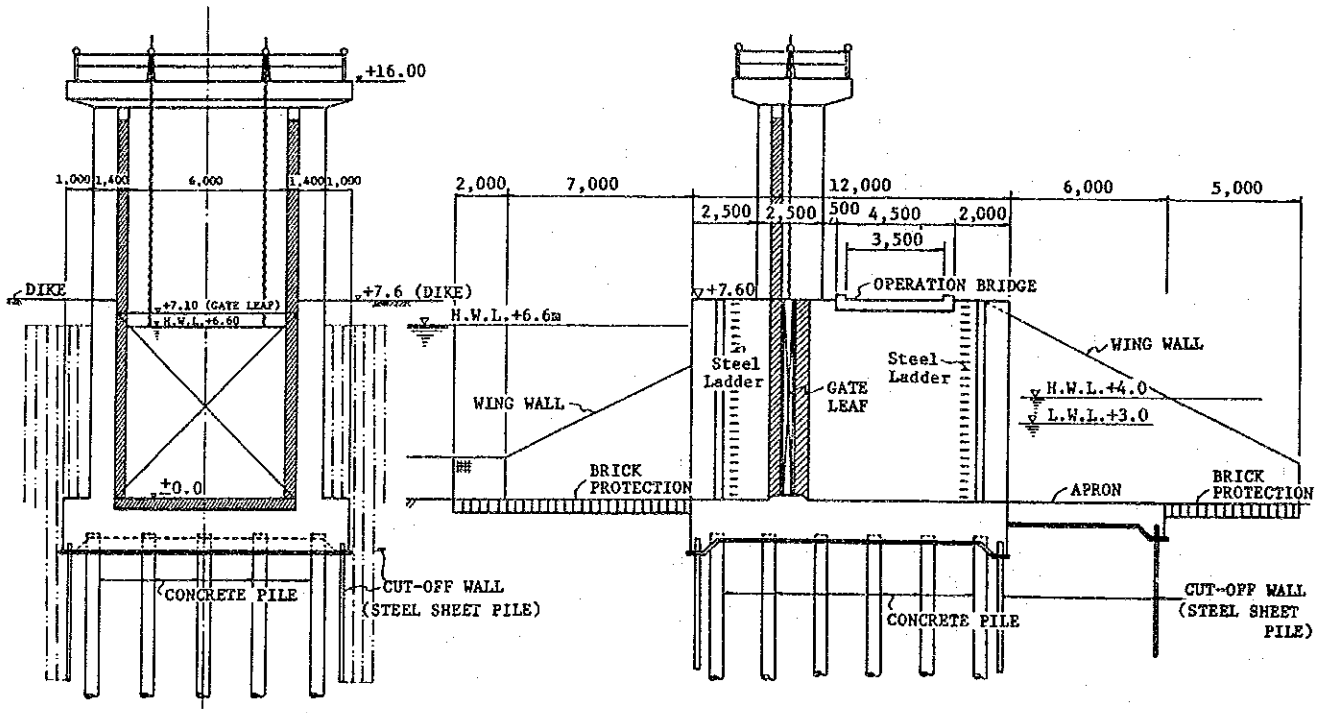

FIG. 8.2 TYPICAL DESIGN OF GATE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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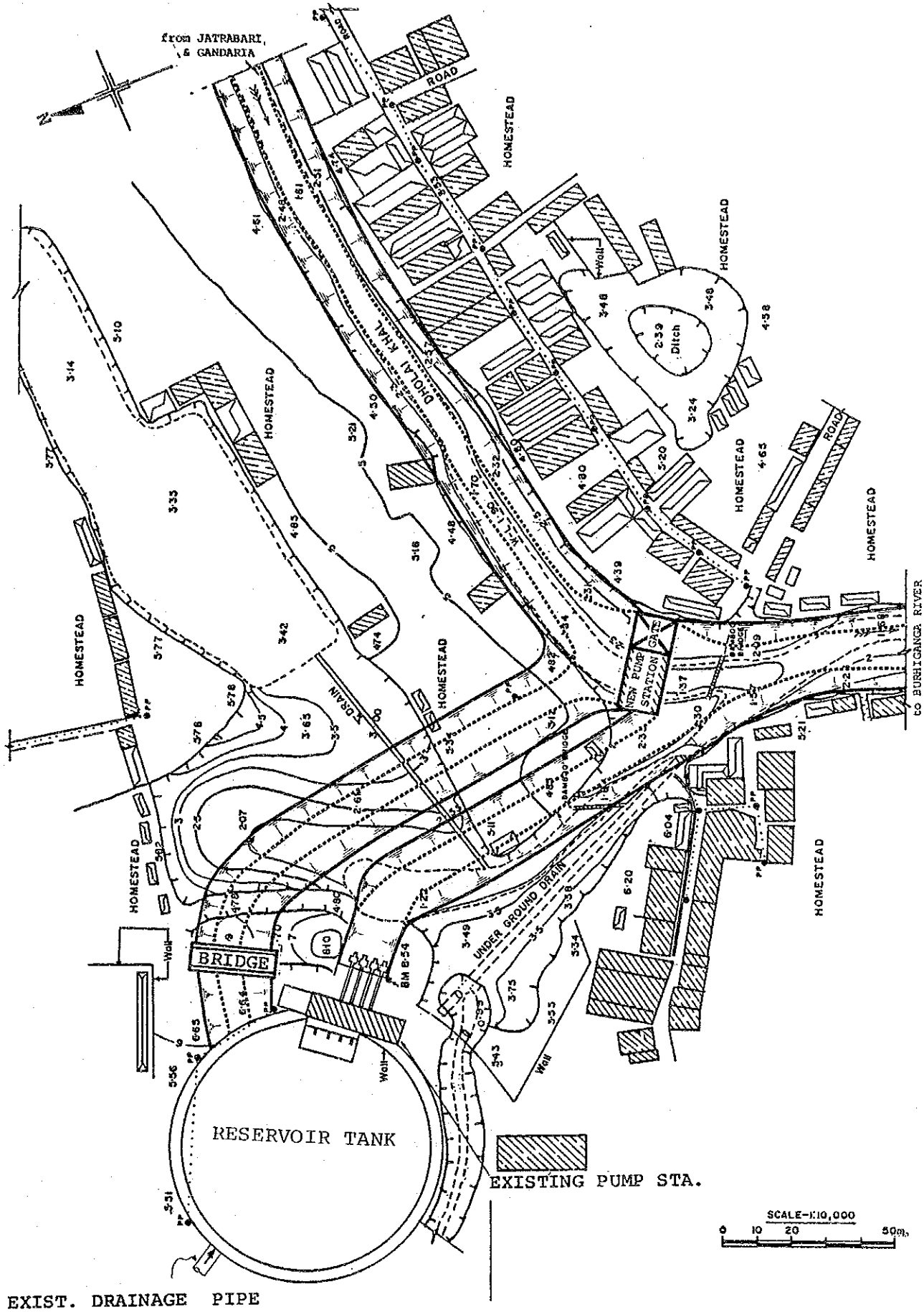
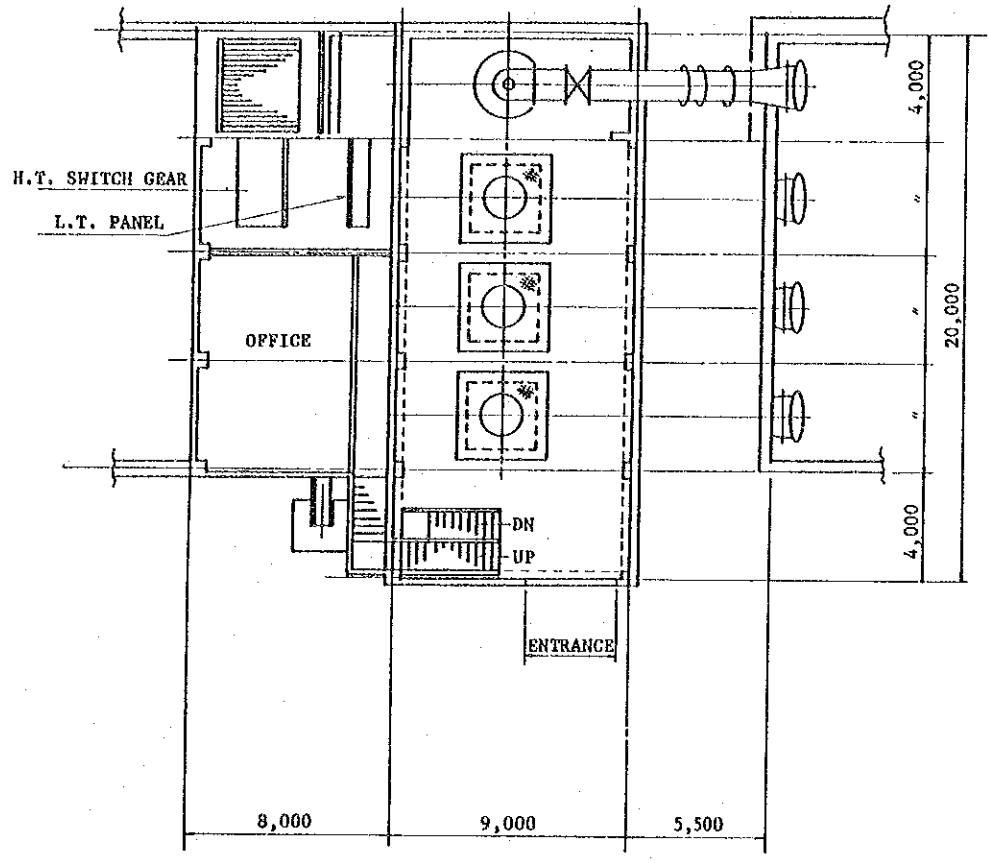
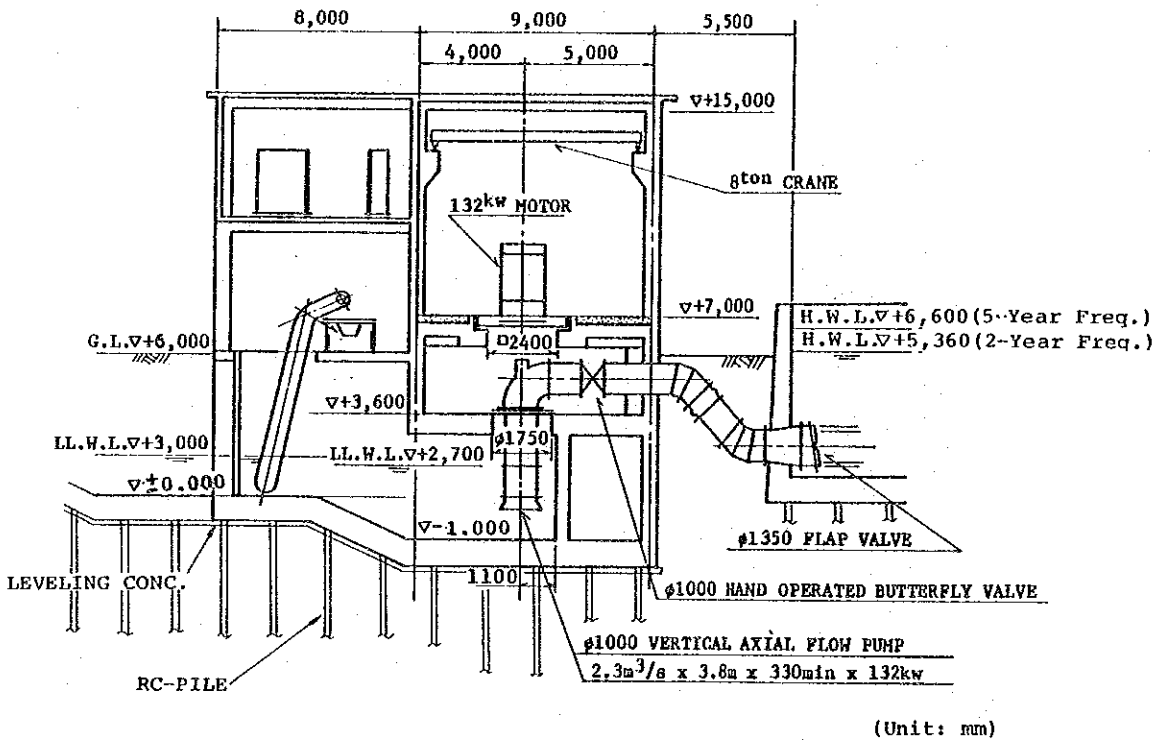


FIG. 8.3 LOCATION OF NEW PUMP STATION

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH





(Unit: mm)

FIG. 8.4 TYPICAL DESIGN OF NEW PUMP STATION

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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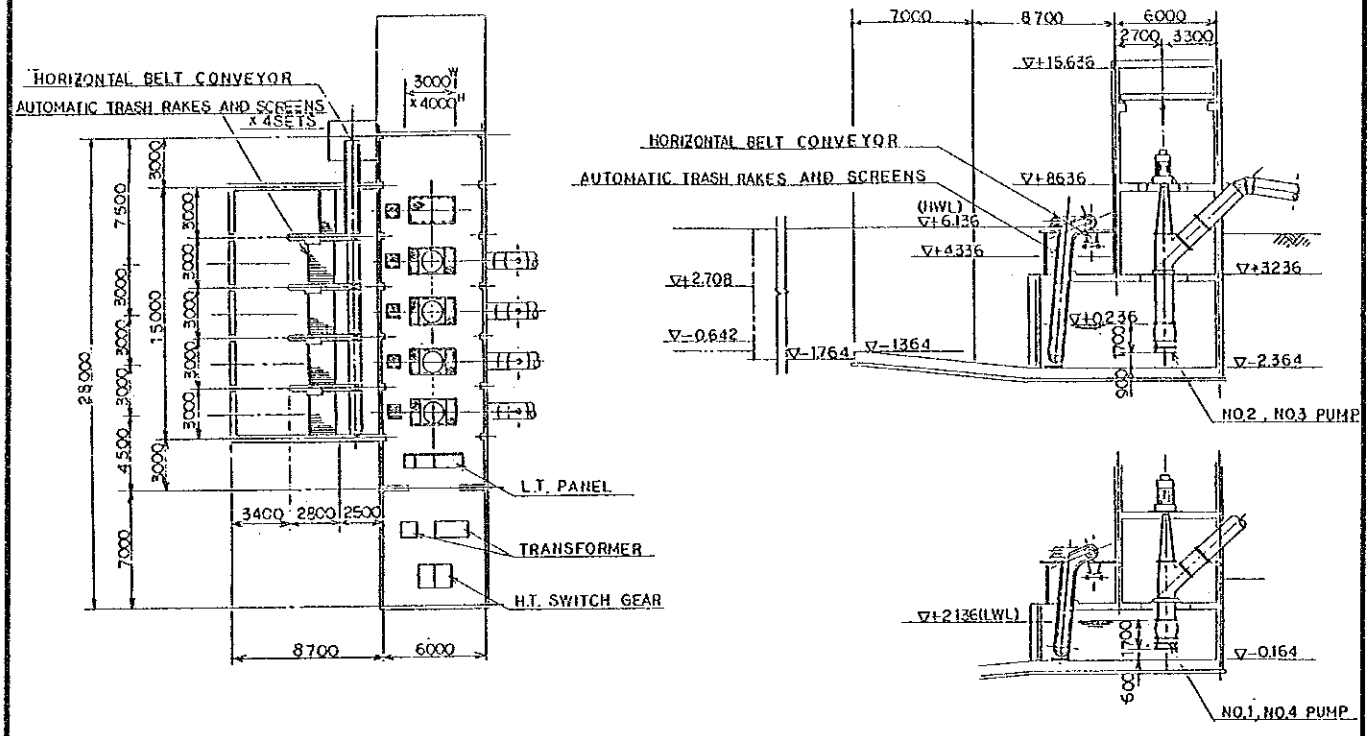
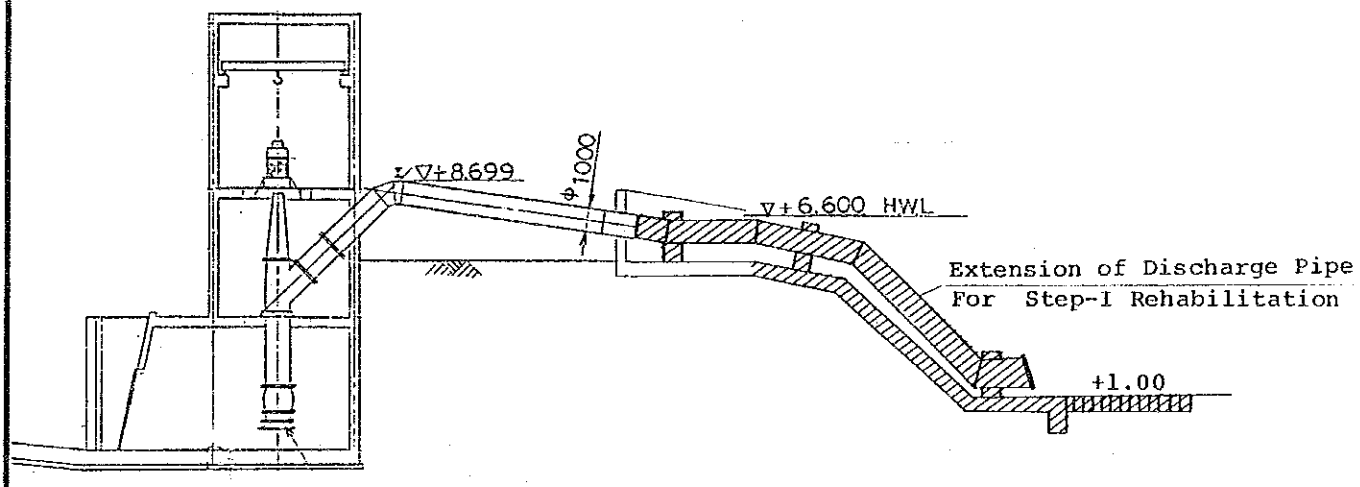


General Arrangement of Pump Equipment Rehabilitation

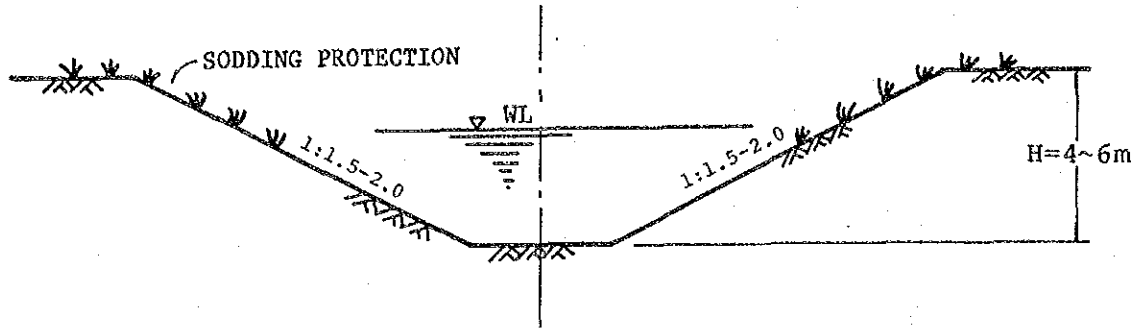


Extension Plan of Discharge Pipe

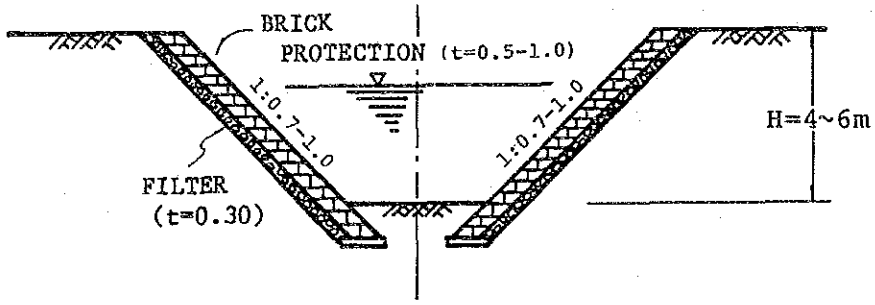
FIG. 8.5 REHABILITATION OF EXISTING NARINDA PUMP STATION

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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



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



TYPE - 3 : CONCRETE PANEL WALL TYPE (1) - WITH BRACING BEAM

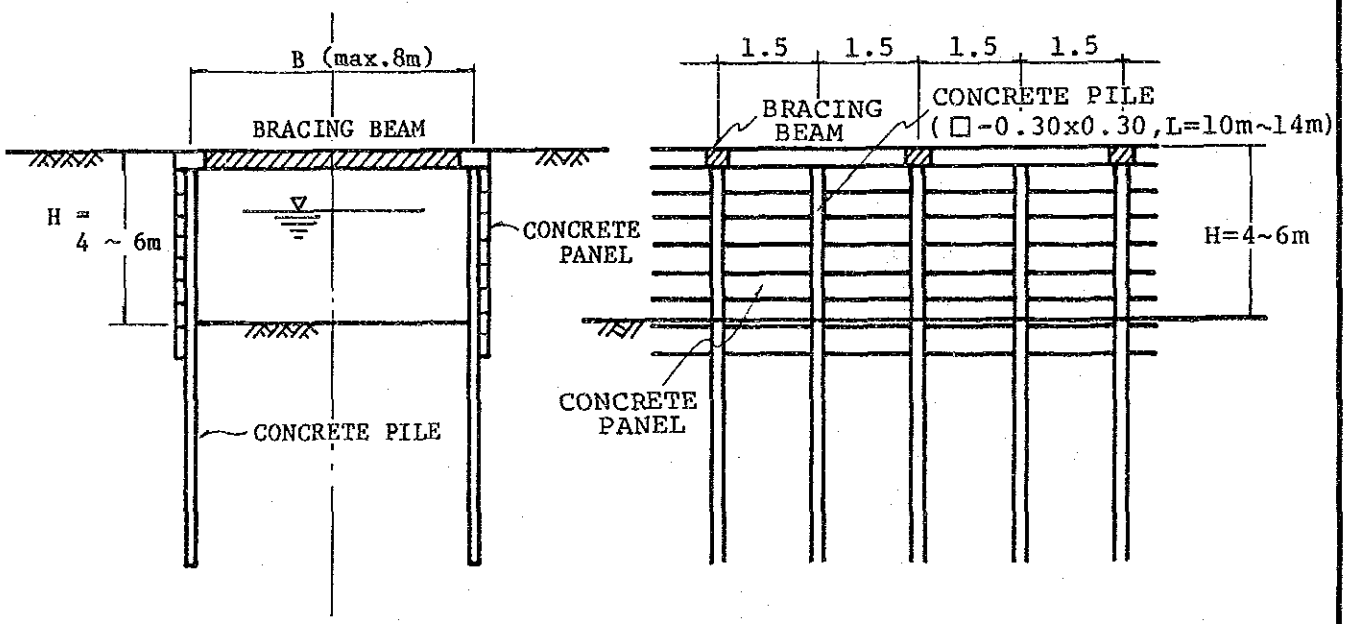
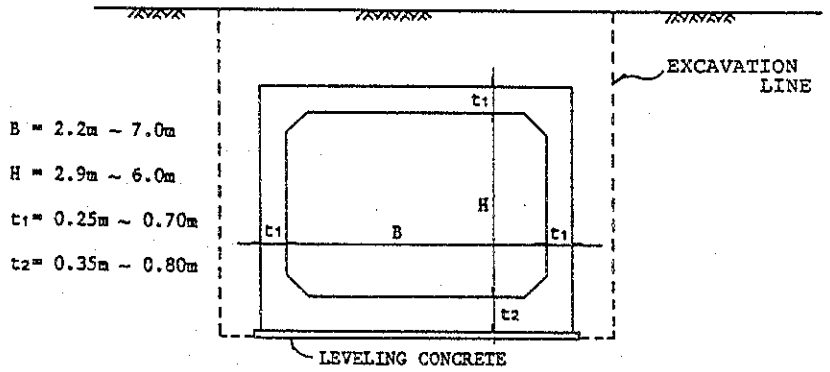


FIG. 8.6 TYPICAL DESIGN OF KHAL IMPROVEMENT

TYPE - 1 SINGLE BOX CULVERT

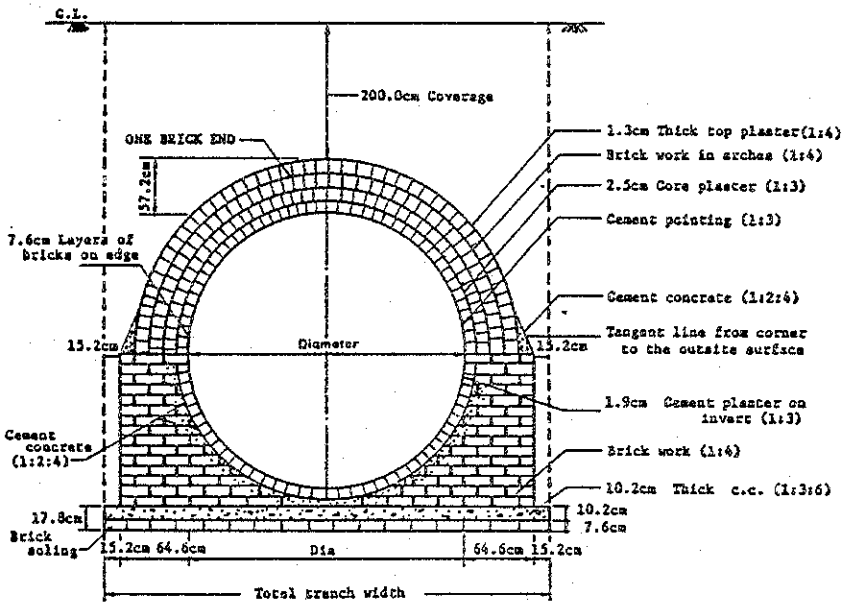


B = 2.2m ~ 7.0m

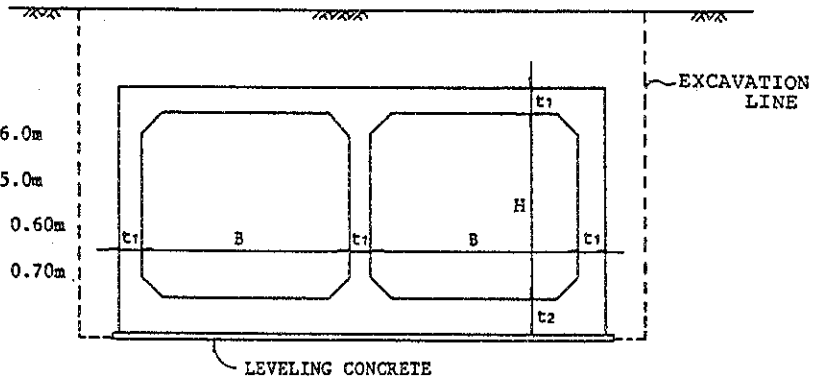
H = 2.9m ~ 6.0m

t_1 = 0.25m ~ 0.70m

t_2 = 0.35m ~ 0.80m



TYPE - 2 DOUBLE BOX CULVERT



B = 4.5m ~ 6.0m

H = 4.5m ~ 5.0m

t_1 = 0.45m ~ 0.60m

t_2 = 0.55m ~ 0.70m

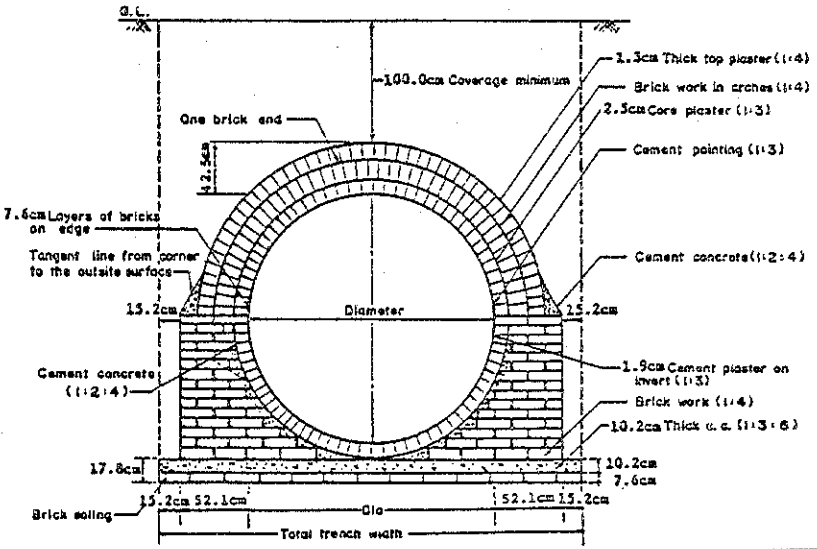


FIG. 8.7 TYPICAL DESIGN OF RC-BOX CULVERTS AND BRICK PIPES

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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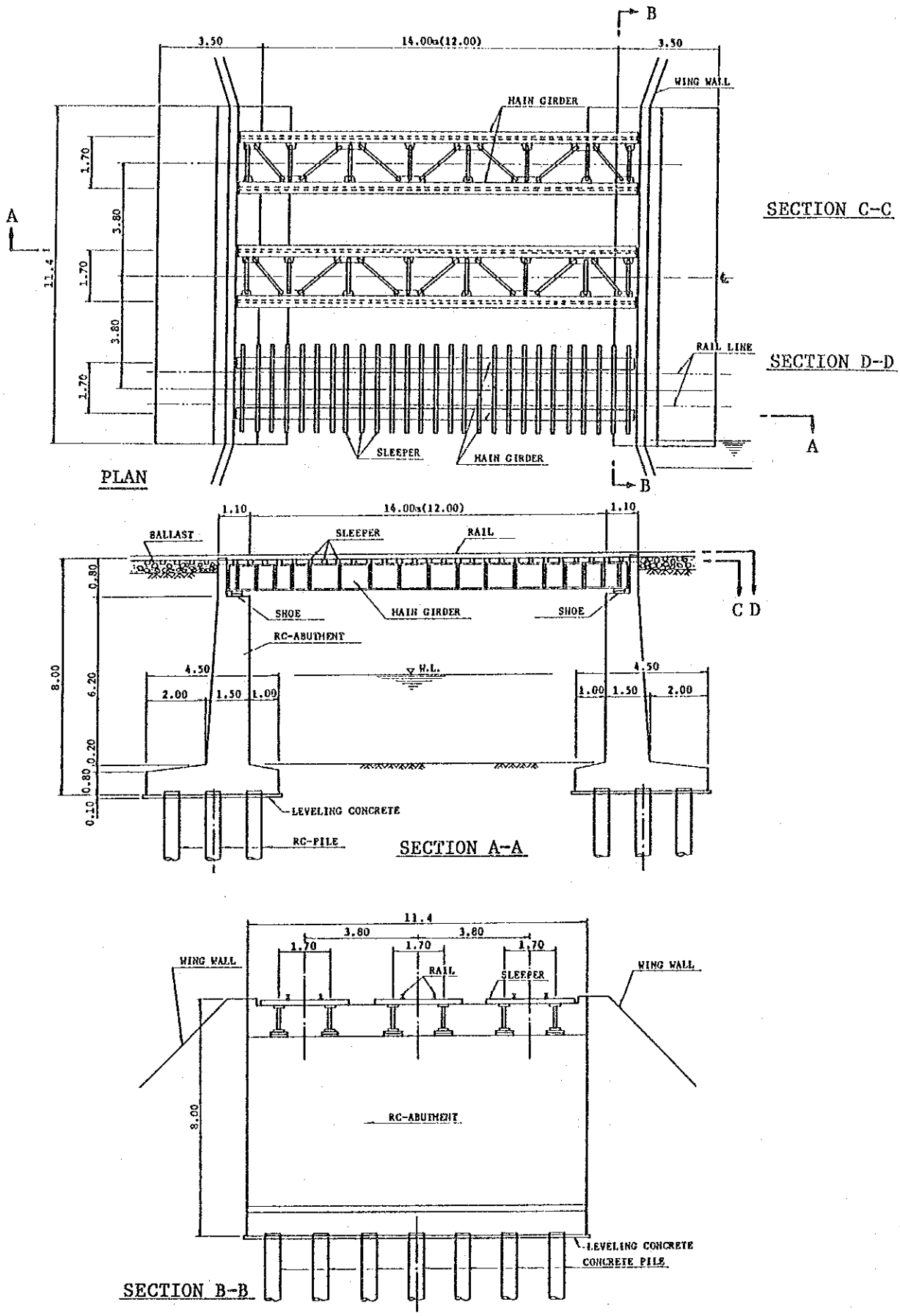
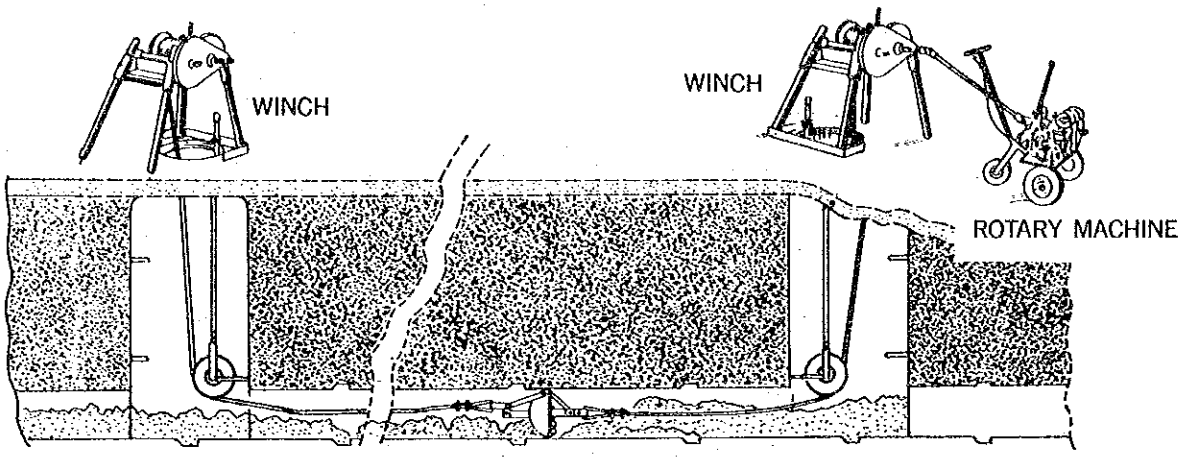
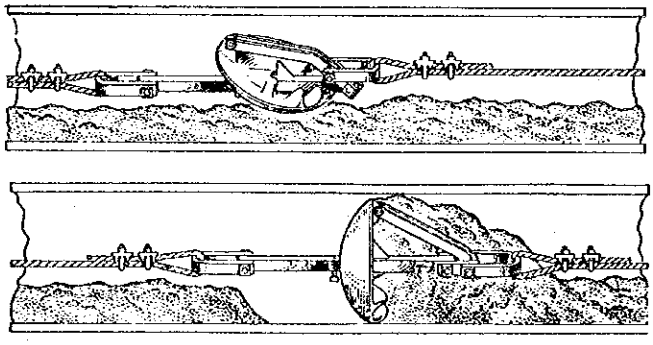


FIG. 8.8 TYPICAL DESIGN OF RAILWAY BRIDGE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH





CULVERT SCRAPPER

DRAINAGE PIPE CLEANING MACHINE

CHAPTER 9
OPERATION / MAINTENANCE, AND ORGANIZATION

CHAPTER 9. OPERATION/MAINTENANCE AND ORGANIZATION

9.1 Required Operation and Maintenance Work

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

(1) Cleaning of critical parts of the drainage pipes

(2) Operation and maintenance of the Narinda pump station

The present O&M budget is 2.0 - 2.5 million TK per year on an average. Due to the small budget, the above work is conducted at an unsatisfactory level even when no other work is being done.

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

(1) Cleaning the 91.2 km of drainage pipes (existing: 78.7 km, proposed: 12.5 km).

(2) Dredging of deposits and removal of garbage from the 13.1 km of khals.

(3) Maintenance of the 4.8 km of dikes.

(4) Operation and maintenance of two (2) pump stations and two (2) control gates.

(5) Land use control, in cooperation with the agencies concerned, to maintain the regulating ponds and the khal areas, and to assure the required elevation of new land development.

9.2 Required Operation and Maintenance Equipment

No special equipment, except for four (4) small pump units 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 nos.
(2)	Trucks for sludge transportation:	2 nos.
(3)	Cleaning equipment (small, mechanically operated):	4 nos.
(4)	Cleaning equipment (truck mounted):	2 nos.
(5)	Small pumps for dewatering:	10 nos.
(6)	Supervision vehicles (car):	7 nos.
(7)	Supervision vehicles (motor cycle):	8 nos.
(8)	Miscellaneous equipment	1 set

9.3 Operation Rule of Pump Station

Pump operation period begins when the flood water level of the rivers reaches 3.8 m G.T.S. and ends when it recedes to 3.8 m G.T.S. The period is usually from early July to mid-October (See Fig. 9.1).

During the flood season, the water level of the regulating ponds shall be maintained below 3.2 m G.T.S. to meet the coming storm runoffs.

Estimated yearly operating hours will be 250 on an average.

9.4 Land Use Control

The following land use controls are required to sustain the full functioning of the structural drainage improvement plans proposed in 7.5.

9.4.1 Preservation of Regulating Pond Area

The proposed regulating pond areas (Gandaria area of 47 ha and Jatrabari area of 138 ha) shall be preserved to assure the expected effects of pump drainage.

Adverse effects due to the reduction of the regulating pond areas are considerable (See Supporting Report I, Page 42).

9.4.2 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. 7.7 to Fig. 7.10. In addition, inspection road widths shall be maintained on one or both side banks of the khal.

9.4.3 Control of Land Fill Elevation for Urban Development

Pressure of urban development in the low-lying areas of the Gandaria area (B III area) and the Jatrabari area (C II area) will further grow after completion of the Project.

Land fill elevation shall be controlled to conform to the proposed design high water level inside the protection dikes or roads. The lowest land fill elevation for urban development is proposed to be 5.50 m G.T.S. (design high water level 4.50 m plus 1.0 m allowance).

9.5 Required Organization

Special organizations for the Project shall be set up in DPHE.

9.5.1 Required Organization for Construction

The required organization for construction of the proposed flood protection and internal drainage works is shown in Fig. 9.2-(1).

The organization consists of 15 engineers and other supporting staffs.

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

9.5.2 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. 9.2-(2).

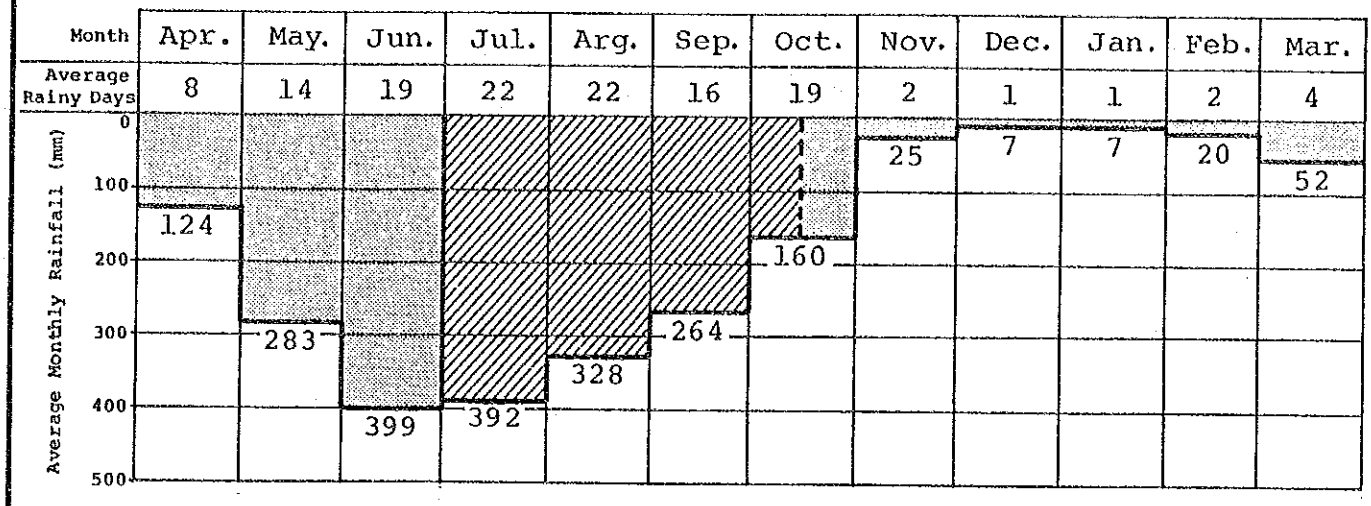
The organization consists of 15 engineers and other supporting staffs.

9.6 Training of Staff

Training of the Government staffs involved in the Project is required for the good development, and operation and maintenance of drainage facilities. The training will be performed through:

- On the job training
- Participation in workshops
- Overseas training

AVERAGE MONTHLY RAINFALL AND RAINY DAYS



SEASONAL VARIATION OF BURHIGANGA RIVER WATER LEVEL AT MILL BARRACK STATION

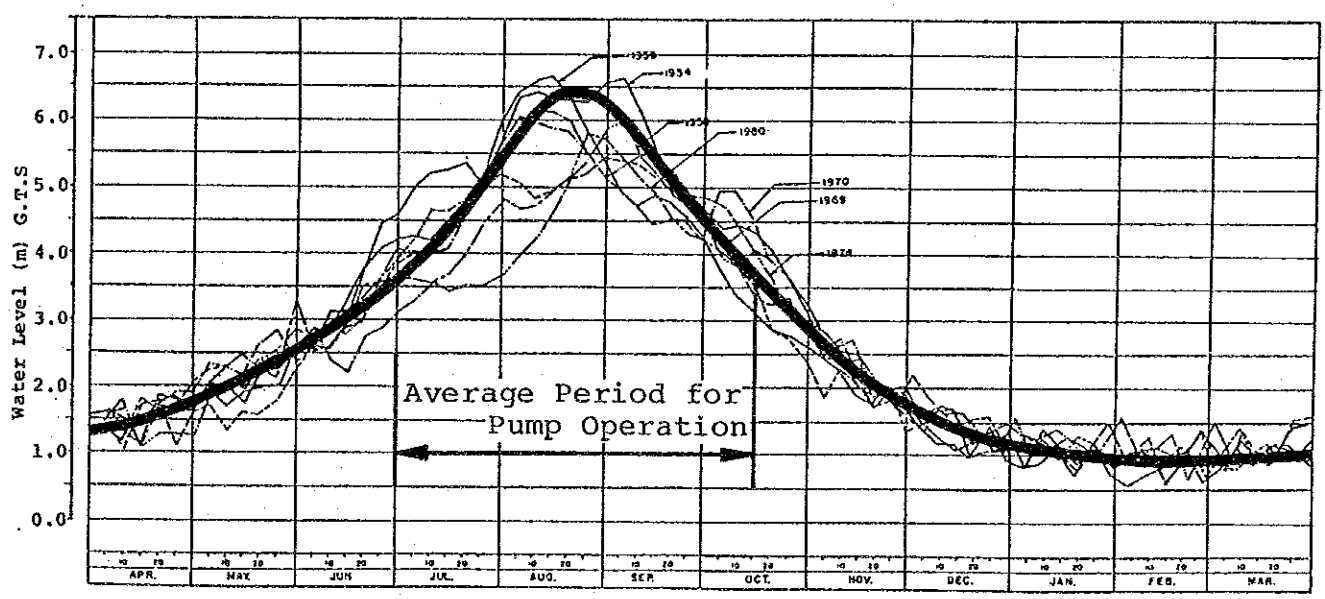


FIG. 9.1 SEASONAL VARIATION OF BURHIGANGA RIVER WATER LEVEL AND AVERAGE MONTHLY RAINFALL

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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Fig. 9.2-(1) Organization for Construction

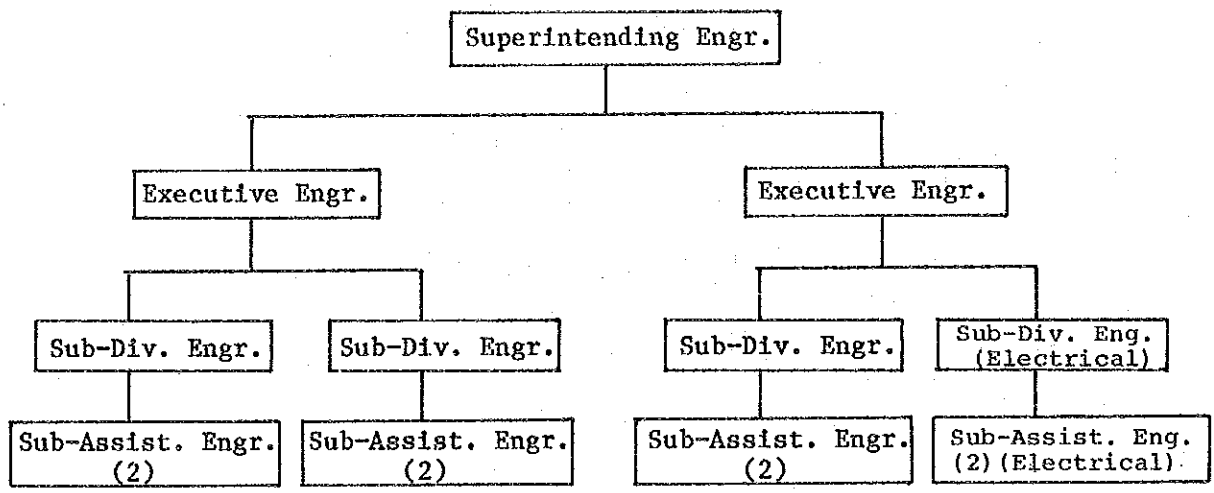


Fig. 9.2-(2) Organization for Operation and Maintenance

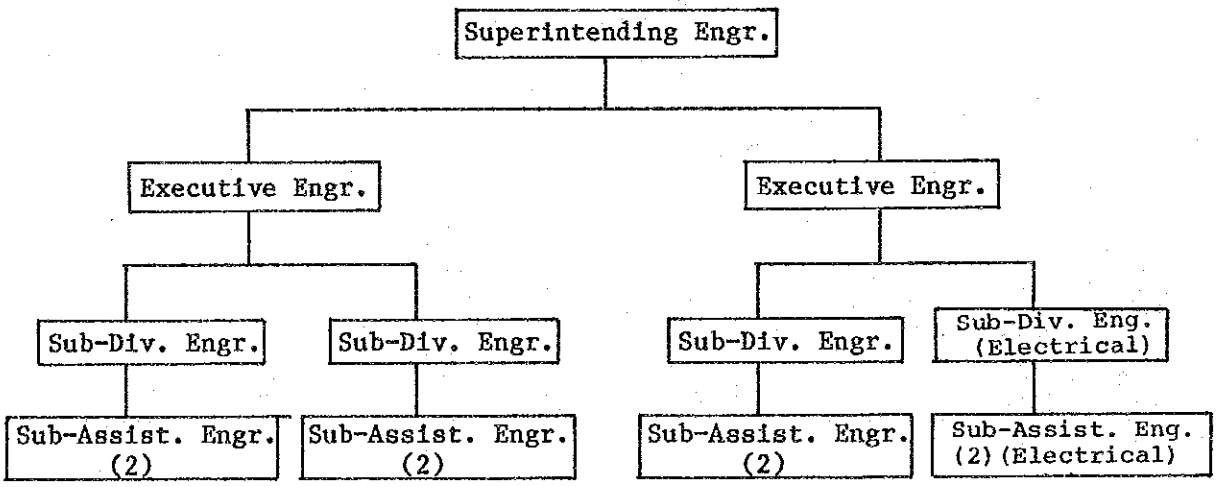


FIG. 9.2	ORGANIZATION FOR CONSTRUCTION, AND OPERATION/MAINTENANCE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

NOTES AND COINS OF BANGLADESH

CHAPTER 10
PROJECT COST AND IMPLEMENTATION SCHEDULE

CHAPTER 10. PROJECT COST AND IMPLEMENTATION SCHEDULE

10.1 Bases for Cost Estimates

The estimation of the project cost, consisting of (1) 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 works will be contracted to general contractors by international tender.

(2) The all base costs are expressed under the economic conditions prevailing in December, 1986.

(3) The exchange rates of foreign currencies are considered as follows: US$1.00 = TK30.00 = ¥150. (TK1.00 = ¥5.)

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

(5) A constant allowance of 20% is added to the direct construction costs for contractor's overhead and profit.

(6) A physical contingency allowance which is an amount added to a "risk-free" base cost is estimated at 10% of the total construction costs.

(7) Engineering design and supervision fees are assumed to be 10% of the construction cost.

(8) Annual price escalation is considered to be 2% for foreign currency (F/C) and 10% for local currency (L/C).

Note: If a bank commission is required, it will be paid from the 10% contingency fee.

10.2 Estimated Project Cost

The total project cost, including construction, engineering, land acquisition, CDST, office establishment and contigencies, amounts to 1,790.3 million Taka at 1986 prices as shown in the following Table. Of this amount, the foreign currency component is 875.4 million Taka and the local currency component is 914.9 million Taka. The breakdown of the estimated project cost is shown in Table 10.1.

The project cost including price contigency for six (6) years is estimated to be 2,609.2 million TK as shown also in the following Table.

Project Cost

(Unit: million TK)

Item	Cost
A. Construction Cost	1,237.3
(1) Dike	(186.2)
(2) Pump Station	(319.9)
(3) Gate	(69.5)
(4) Khal Improvement	(286.7)
(5) Drainage Pipe	(375.0)
B. Physical Contingency	123.7
C. Engineering	136.1
D. Land Acquisition	83.0
E. Office Establishment	25.5
F. Customs Duty & Tax	184.7
Project Cost (1) (at 1986 Price)	1,790.3
G. Price Contingency (1988/1989 - 1993/1994)	818.9
Project Cost (2) (with Price Contingency)	2,609.2

10.3 Operation and Maintenance Costs

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.

The annual operation and maintenance cost for the entire Dhaka city area is estimated to be 37.7 million Tk, of which 25.4 million TK is required for the Project Area (B, C, and F drainage zones).

The breakdown of the above operation and maintenance cost is shown in Table 10.2.

10.4 Implementation Schedule

The proposed facilities will be completed within six (6) years according to the staged construction plan.

(1) Top priority will be given to the construction of the flood protection dikes with gates. This work is not only required to prevent floods from the outer areas but also is a prerequisite for pump drainage of internal storm water.

(2) Construction of the pump station (Narinda) and improvement of main khals such as Segunbagicha will be given priority in order to lower the flood water level of the inner areas. Lowering of the inner flood water level will facilitate the internal drainage through the drains.

(3) The remaining sub-khals and sub-drainage pipes will be constructed stage by stage in consideration of the yearly disbursement capacity of finance.

The proposed implementation schedule is shown in Table 10.3.

Table 10.1 Summary of Project Cost

Unit : Million TK, 1986 Price

Item	Zone	Description	Construction Cost			Remarks
			F/C	L/C	Total	
A. Dike	C	L = 4,800 m H = 6.0 m	70.7	115.5	186.2	
B. Pump Station						
1. NARINDA (Rehabilitation)	B	Q = 9.6 m3/s	90.5	6.6	97.1	
2. do. (New)	B	Q = 9.2 m3/s	181.5	41.3	222.8	
Subtotal		Q = 18.8 m3/s	272.0	47.9	319.9	
C. Gate						
1. NARINDA	B	6 m x 6 m	27.7	11.8	39.5	
2. GERANI KHAL	C	do.	22.6	7.4	30.0	
Subtotal			50.3	19.2	69.5	
D. Khal Improvement Works						
1. DHOLAI KHAL	B	L = 3,000 m	10.9	11.3	22.2	
2. GANDARIA KHAL	B	L = 1,200 m	5.3	11.0	16.3	
3. GERANI KHAL	C	L = 2,100 m	5.3	4.7	10.0	
4. SEGUNBAGICHA KHAL	C	L = 3,000 m	75.6	66.0	141.6	
5. BEGUNBARI KHAL	F	L = 2,800 m	11.3	13.9	25.2	
6. PARIBAG KHAL	F	L = 1,000 m	33.1	38.3	71.4	
Subtotal		L = 13,100 m	141.5	145.2	286.7	
E. Drain Pipe						
1. NARINDA	B	L = 4,280 m	90.6	88.2	178.8	
2. SEGUNBAGICHA	C	L = 4,810 m	53.0	72.0	125.0	
3. BEGUNBARI	F	L = 3,410 m	24.9	46.3	71.2	
Subtotal		L = 12,500 m	168.5	206.5	375.0	
SUBTOTAL (A-E)	-	-	**703.0**	**534.3**	**1,237.3**	
F. Physical Contingency (10 %)	-	-	70.3	54.4	123.7	
SUBTOTAL (A-F)	-	-	**773.3**	**597.7**	**1,361.0**	
G. Enginsering	-	-	102.1	34.0	136.1	
H. Land Acquisition	-	-	-	83.0	83.0	
I. Office Establishment			-	25.5	25.5	
J. Customs Duty & Sales Tax	-	-	-	184.7	184.7	
TOTAL(A-J)	-	-	**875.4**	**914.9**	**1,790.3**	
K. Price Contingency (1988/1989-1993/1994)			110.0	708.9	818.9	
TOTAL(A-K)			**985.4**	**1,623.8**	**2,609.2**	

Table 10.2 Annual Operation and Maintenance Cost

(Unit: million TK, 1986 price)

Item	Cost *	Cost **	Remarks
Pump Station	4.0	(4.0)	
Electricity	2.2	(2.2)	
Maintenance of Pump	0.8	(0.8)	
Maintenance of Pond	1.0	(1.0)	
Cleaning of Drainage Pipe	18.8	(11.3)	0.125 x 150 km (90 km) = 18.8 (11.3)
Maintenance of Khal	5.0	(1.3)	0.1 x 50 km (13 km) = 5.0 (1.3)
Maintenance of Dike	0.5	(0.5)	0.1 x 5 km = 0.5
O&M of Vehicle and Other Equipment	2.5	(2.5)	
Staff Salary, Office Accommodation, etc.	3.5	(3.5)	
Sub-Total	34.3	(23.1)	
Contingency (10%)	3.4	(2.3)	
Total	37.7	(25.4)	

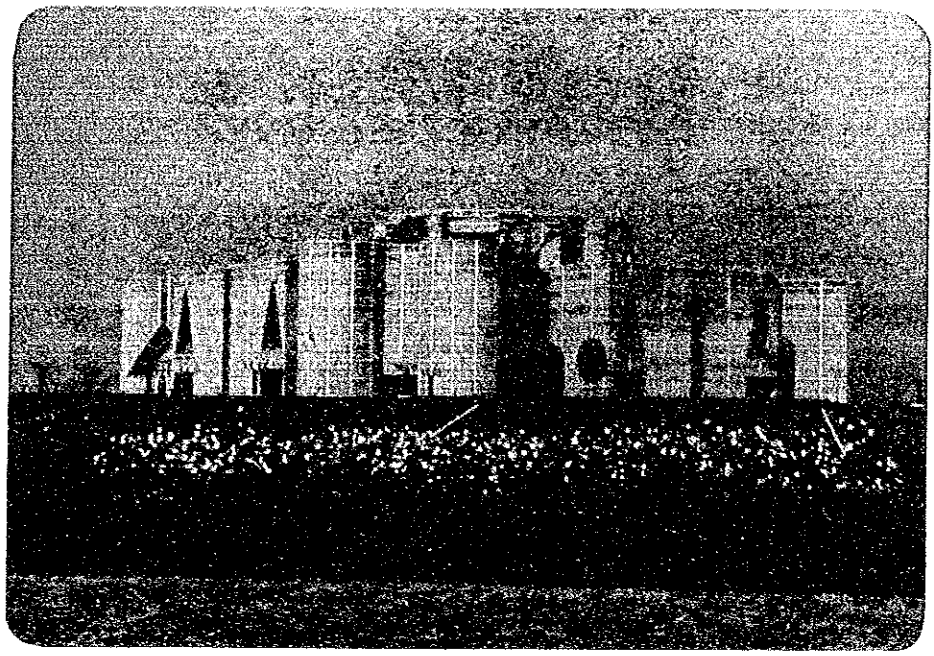
Note: * Figures are costs for the entire Dhaka city area.

** Figures in parentheses are costs for the Projected Area (B, C and F drainage zones).

Table 10.3 Implementation Schedule

Unit : Million Tk , 1986 Price

ZONE	WORK ITEM	QUANTITY	CONSTRUCTION COST	DESIGN STAGE	CONSTRUCTION STAGE				
				FIRST YEAR 1988/ '89	SECOND YEAR 1989/ '90	THIRD YEAR 1990/ '91	FOURTH YEAR 1991/ '92	FIFTH YEAR 1992/ '93	SIXTH YEAR 1993/ '94
B	(1) PUMP STATION (REHABIL)	9.6 m3/s	97.1		21.6 Step I				75.5 Step II
	(2) GATE (NARINDA)	1 place	39.5		39.5 1 place				
	(3) KHAL IMPROVEMENT								
	1.DHOLAI KHAL (K-1)	3.0 km	22.2			22.2 3.0 km			
	2.GANDARIA KHAL (K-2)	1.2 km	16.3					16.3 1.2 km	
	(4) DRAINS								
	1. D-1	2.80 km	90.7		51.9 0.75 km [Main	29.7 1.55 km Drainage pipe]			9.1 0.5 km [Branch]
	2. D-2	1.48 km	88.1					59.5 1.0 km	28.6 0.48 km
	(5) LAND ACQUISITION	4.50 ha	[9.7]	[8.4] 3.4 ha		[1.3] 1.1 ha			
C	(1) DIKE	4.80 km	186.2			93.1 2.4 km	93.1 2.4 km		
	(2) GATE	1 place	30.0				30.0 1 place		
	(3) PUMP STATION (ADDITION)	9.2 m3/S	222.8		73.5 Whole Civil + Mech.	73.6 (4.6 m3/s)		75.7 Mech.(4.6m3/s)	
	(4) KHAL IMPROVEMENT								
	1. GERANI KHAL (K-3)	2.10 km	10.0					10.0 2.10km	
	2. SEGUNBAGICHA KHAL (K-4)	3.00 km	141.6			25.9 Box Cul 9 places	92.8 3.0 km	22.9 Box Cul 4 places(No.2,3,5,14)	
	(5) DRAINS								
	1. D-3	2.50 km	82.2				61.7 1.4 km	20.5 1.1 km	
	2. D-4	0.54 km	7.5						7.5 0.54 km
	3. D-5	0.72 km	14.3					14.3 0.72km	
	4. D-6	1.05 km	21.0						21.0 1.05 km
	(6) LAND ACQUISITION	42.70 ha	[58.6]		[55.6] 40.2 ha	[3.0] 23.5 ha			
F	(1) KHAL IMPROVEMENT								
	1. BEGUNBARI (K-5)	2.80 km	25.2						25.2 2.8 km
	2. PARIBAGH (K-6)	1.00 km	71.4					35.7 0.5 km	35.7 0.5 km
	(2) DRAINS								
	1. D-7	1.10 km	23.2						23.2 1.10 km
	2. D-8	0.45 km	7.0						7.0 0.45 km
	3. D-9	1.86 km	41.0					20.5 0.93 km	20.5 0.93 km
	(3) LAND ACQUISITION	4.80 ha	[14.7]			[1.7] 0.3 ha	[13.0] 4.5 ha		
	(1) SUB TOTAL		1237.3		186.5	244.5	277.6	275.4	253.3
	(2) CONTINGENCY		123.7		18.6	24.5	27.8	27.5	25.3
	TOTAL OF (1)+(2)		1361.0		205.1	269.0	305.4	302.9	278.6
	(3) ENGINEERING		136.1	46.1 (D/D)	18.0	18.0	18.0	18.0	18.0
	TOTAL OF (1)+(2)+(3)		1497.1	46.1	223.1	287.0	323.4	320.9	296.6
	LAND ACQUISITION (4)		[83.0]	8.4	55.6	6.0	13.0	0	0
	OFFICE ESTABLISH. (5)		[25.5]	9.0	3.3	3.3	3.3	3.3	3.3
	CUSTOMS DUTY/TAX(6)		[184.7]	0.0	27.8	48.5	11.9	51.8	44.7
	TOTAL OF (4)+(5)+(6)		[293.2]	17.4	86.7	57.8	28.2	55.1	48.0
	TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)		1,790.3	63.5	309.8	344.8	351.6	376.0	344.6
	(7) PRICE CONTINGENCY		818.9	11.6	82.9	133.1	167.2	199.5	224.6
	TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)+(7)		2,609.2	75.1	392.7	477.9	518.8	575.5	569.2



NATIONAL ASSEMBLY BUILDING

CHAPTER 11
PROJECT EVALUATION

CHAPTER 11. PROJECT EVALUATION

11.1 Identification of Benefits

Benefits of this drainage system improvement project are defined as an incremental difference between the flood damage potential cases "with the project" and "without the project". This is equivalent to the magnitude of reduction in flood damage.

The following benefits are identified in this project:

(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) Increase in available land and its value
(6) Improvement of public health and amenities
(7) Creation of employment opportunity

Four (4) of the benefits mentioned above; reduction of general property damage, public property damage, income/sales loss, and vehicle's running costs, are direct benefits and estimated in monetary terms.

The estimated reduction of the flood damage potential of 1-year, 5-year, 10-year and 30-year flood frequencies in 1986 and 2000 are shown below:

(Unit: Million TK, 1986 price)

	1986	2000
1-year frequency flood	187.4	335.4
5-year frequency flood	339.5	589.8
10-year frequency flood	403.5	699.6
30-year frequency flood	506.5	873.3

These figures cover the flood damage potential attributable to both the internal and external floods.

11.2 Estimate of Annual Benefits

Average annual flood damage reduction is calculated by the following equation:

$$D = \sum \left[(Nm-1 - Nm) \times (Lm-1 + Lm)/2 \right]$$

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

In estimating the average annual damage, (1) 30-year frequency for the external flood and (2) 5-year frequency for the internal flood are adopted as the maximum frequency up to which annual damage reduction is accumulated because those are corresponding to the design flood frequency of each flood protection works. Results are shown below;

D_{1986} = 243.5 million TK
D_{2000} = 424.9 million TK

11.3 Estimate of Economic Costs

For economic analysis, the nominal project cost is converted into economic cost which excludes the portions of transfer items (tax, duties and subsidy).
The economic costs were calculated by using general conversion factors estimated by each work item.

The project cost at 1986 prices is 1,790.3 million TK (Refer to 10.2). The estimated economic cost at 1986 prices is 1,428.8 million TK.

The required annual operation and maintenance cost is 25.4 million TK (Refer to 10.3).

11.4 Economic Evaluation

The economic evaluation of the project was made in terms of the internal rate of return (IRR), net present value (NPV) and benefit-cost ratio (B/C), based on the following assumptions:

(1) Benefits of the project are assumed to increase linearly up to 2000, and kept constant after 2000.

(2) The project costs are disbursed over 6 years (1988/1989 thru 1993/1994) according to the implementation schedule proposed in Table 10.3.

(3) The project benefits are reckoned over 20 years (1995 thru 2023).

(4) Discount rate is 14.2%

The results are as follows:

IRR = 17.1%
B/C = 1.24
NPV = 188.9 million TK

The above IRR was examined by sensitivity analysis. The IRR decreases to 12.5% when the economic benefit becomes less by 30%, while the IRR decreases to 13.6% if the economic cost increases by 30%. In any case, the IRR indicates high economic efficiency.

11.5 Social Impact

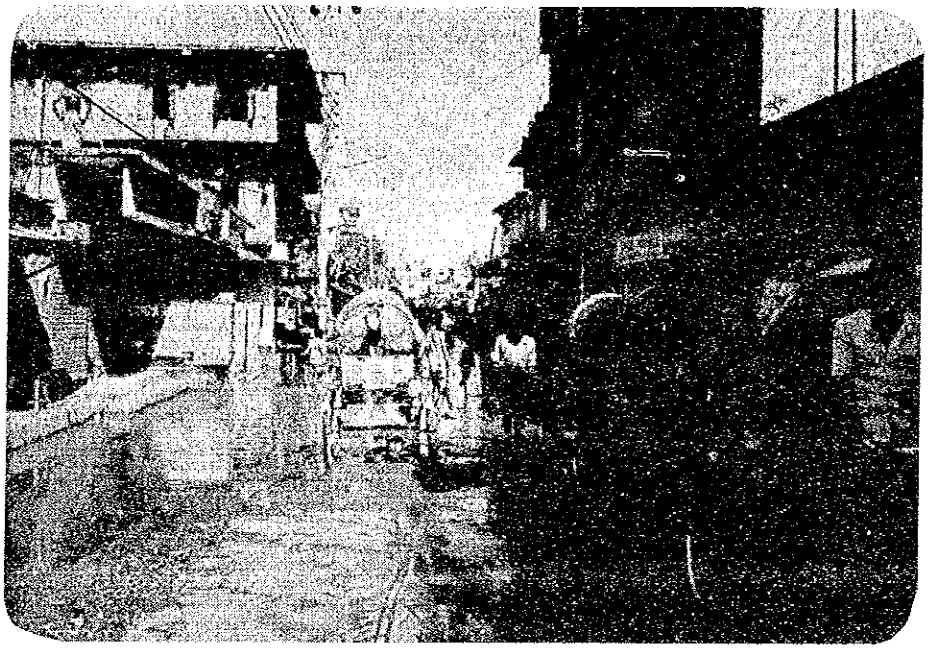
The major social impacts of the Project are as follows:

(1) Land use of the flood prone areas will be enhanced. The estimated maximum flood prone area is 1,220 ha.

(2) Environment of people's public health and amenities will be improved. The maximum beneficial people in 2000 is estimated to be 660 x 10^3 persons.

(3) Employment opportunity of 7.9 million person-day will be directly created by the project during six (6) years.

1987 FLOOD AT KALLYANPUR



1987 FLOOD AT BASABO

CHAPTER 12
SUPPLEMENTARY STUDY

CHAPTER 12. SUPPLEMENTARY STUDY

12.1 Alternative Khal Improvement Plan

12.1.1 General

The JICA Study Team recommended khal improvement by the open channel method for all stretches of the existing khals in the Project Area (B, C, and F drainage zones) after an elaborate comparison between the open channel method and the covered channel method using long box culverts (Refer to 7.4.3).

In the course of the Study, however, DPHE requested the preparation of a khal improvement plan showing the covered channel method as an alternative for the sections of the highly urbanized areas. The request was made with a view to hold further discussions about how to attain the integrated development of the areas, including the following objectives, with the limited financial resources:

(1) Mitigation of the flood problems
(2) Improvement of the sanitary environment and amenities
(3) Development of the khal land

In response to the request by DPHE, an alternative khal improvement plan using the covered channel type is prepared for the following sections:

(1)	Segunbagicha:	2.1 km, Circular Road to DPHE Store Circle
(2)	Begunbari:	1.8 km, Airport Road to Dhanmondi Lake
(3)	Parigabh:	1.0 km, Bengunbari Khal Junction to New Elephant Road
	Total =	4.9 km

The locations are illustrated in Fig. 12.1.

12.1.2 Proposed Khal Improvement by Covered Channel Type

(1) Design Discharge

The design discharges of the covered channel type khal improvements are the same as those for the open channel type (See Fig. 7.6).

(2) Longitudinal and cross section

The khal improvement is to be constructed by reinforced concrete culvert boxes for the highly urbanized sections of Segunbagicha, Begunbari and Paribagh Khals having a total distance of 4.9 km.

The proposed longitudinal and cross sections are illustrated in Fig. 12.2 - 12.4.

12.1.3 Project Cost

The net construction cost of khal improvement by covered channel type increases by 419.6 million TK, compared to the open channel type.

As a result, the estimated total project cost of B, C, and F drainage zones amounts to 2,251.9 million TK at 1986 prices as shown below. It costs 461.6 million TK more than the original proposal (1,790.3 million TK).

Project Cost
(Covered Channel Type)

(Unit: TK)

Item	Cost
A. Construction Cost	1,656.9
(1) Dike	(186.2)
(2) Pump station	(319.9)
(3) Gate	(69.5)
(4) Khal Improvement	(706.3)
(5) Drainage Pipe	(375.0)
B. Physical Contigency	165.7
C. Engineering	136.1
Sub Total	1,958.7
D. Land Acquisition	83.0
E. Office Establishment	25.5
F. Custom Duty & Tax	184.7
Project Cost (1) (at 1986 Price)	2,251.9
G. Price Contingency (1988/1989 - 1993/1994)	1,021.8
Project Cost (2) (with Price Contingency)	3,273.7

The breakdown of the project cost is shown in Table 12.1

12.1.4 Implementation Schedule

The proposed works are executed by stage construction according to the implementation priority described in 10.4.

The proposed implementation schedule for six (6) years completion is shown in Table 12.2

12.2 Drainage Improvement Plan of D and H Drainage Zone

12.2.1 General

The present rates of urban land use in D and H drainage zones are 59% and 62% respectively. The rate, however, are expected to increase to 71% and 91% by the year 2000 respectively, due to the increasing population pressure. Both drainage zones are already confronted with sprawling urban developments here and there, which will further aggravate the existing flood problems.

In view of these circumstances, basic drainage plans which suggest the guidelines for the development of flood-free urban areas are prepared for D and H drainage zones.

12.2.2 Planning Policy and Hydraulic Design Criteria

The applied planning policy and hydraulic design criteria are the same as those employed in the preparation of the drainage improvement plans for B, C, and F drainage zones except for the design flood water level (Refer to 7.2.).

Design flood water level:

- The flood water level with a 30-year frequency (6.60 m G.T.S. for D zone, 7.30 m G.T.S. for H zone) is applied for the design of flood protection works.

- 2-year frequency flood water level (5.36 m G.T.S. for D zone, 5.96 m G.T.S. for H zone) is employed as the design outlet water level for internal drainage works.

12.2.3 Review of Drainage Zone

12.2.3-1 Review of Drainage Zone Boundary

The boundary of D drainage zone proposed in the phased program is revised corresponding to the boundary change of the adjoining C and F drainage zones.

No revision is made for the boundary of H drainage zone. However, since Kallyanpur and Sher-e-Bangla Nagar areas in the H drainage zone are quite different in topographic and land use conditions, the H zone is divided into two sub-drainage zones and illustrated in Fig. 12.5

The revised zone areas of D and F are presented as follows:

Revised Drainage Zone Area

Drainage Zone	Original Area (km^2)	Revised Area (km^2)
D: Bashabo Zone	8.32	7.46
H: Kallyanpur Zone	12.78	12.78
(H-I sub-zone)	(9.40)	(9.40)
(H-II sub-zone)	(3.38)	(3.38)
Total	21.10	20.24

12.2.3-2 Demarcation of Gravity and Pump Drainage Areas

Ground elevation and area curves were made for the following drainage zones and sub-zones to demarcate gravity and pump drainage areas:

D zone: (Bashabo zone: 7.46 km^2)

H zone: H-I (Kallyanpur area: 9.40 km^2)
H-II (Sher-e-Bangla Nagar area: 3.38 km^2)

Ground elevation and area curves of the above drainage zones and sub-zones are illustrated in Fig. 12.5

In consideration of flood and drainage conditions corresponding to ground elevation, the following conclusions are reached for flood protection and drainage of each zone and sub-zones (Refer to Supporting Report N, 3.3.2).

D-zone: Flood protection works and pump drainage are required.
H-I sub-zone: Flood protection works and pump drainage are required.
H-II sub-zone: No flood protection works are required and gravity flow drainage is possible.

12.2.4 Proposed Drainage Improvement Plan

12.2.4-1 Flood Protection

(1) Bashabo zone (D zone)

D zone covers 6.49 km^2 of low lying land below the design flood level of 6.60 m G.T.S. out of the total area of 7.46 km^2.

Construction of dike is proposed to prevent the floods from the Balu River.

The main features of the proposed dike are,

- Total length: 5.0 km
- Design flood water level: 6.60 m G.T.S.
- Freeboard: 1.0 m
- Crown elevation: 7.60 m G.T.S.

The proposed dikes are provided with a control gates of 6x6 m in size to drain flash floods during off season of pump drainage together with control gates of the same size attached to the proposed pump stations.

Location of the proposed flood protection works is illustrated in Fig. 12.6.

(2) Kallyanpur area (H-I sub-zone)

H-I sub-zone covers 7.97 km^2 of low-lying land below the design flood level of 7.30 m G.T.S. out of the total area of 9.40 km^2.

Raising of the Dhaka-Aricha Road is proposed to prevent the floods from the Buriganga River. The main features of the proposed road raising are:

- Total length: 3.0 km
- Design flood water level: 7.3 m G.T.S.
- Freeboard: 1.0 m
- Crown elevation: 8.3 m G.T.S.

Two (2) control gates of 2x2 m in size are installed in the Dhaka-Archa Road to drain flash floods during the off season pump drainage together with a control gate (6x6 m in size) attached to the proposed pump station.

Location of the proposed flood protection works is illustrated in Fig. 12.7.

12.2.4-2 Pump Drainage

(1) Required pump and regulating pond capacities

The required pump and regulating pond capacities were calculated by the mass curve method under the same conditions as given for B and F zones. The results are as follows:

Required Capacity	C zone	H-I sub-zone
Pump (m^3/s)	8.5	10.7
Regulating Pond ($10^6/m^3$)	0.96	1.21

(2) High water level of regulating pond

The design high water levels of the regulating ponds in the D zone and H-I sub-zone are proposed to be 4.5 and 5.0 m G.T.S. respectively through the following considerations:

- The lowest evaluation of the existing developed land in D zone and H-I sub-zones are approximately 5.5 and 6.0 m G.T.S.

- It is recommended that future land development be made in conformity with the elevation of the neighboring built-up land.

- A hydraulic head difference of approximately 1.0 m will be required for satisfactory drainage of the above mentioned low-lying developed land.

(3) Low water level of regulating pond

The design low water level of the regulating pond is fixed at 3.0 m G.T.S. for D zone and 3.6 m G.T.S. for H-I sub-zone in consideration of:

- Ground elevation of the proposed regulating ponds
- River flood hydrograph and required period of pump operation.

(4) Proposed regulating pond

The proposed regulating ponds provided with required storage capacities between H.W.L. and L.W.L. are delineated as shown in Fig. 12.6 and Fig. 12.7. The provided surface area and storage capacities of the regulating ponds are:

- D zone pond:

Surface area:	0.75 km^2
Storage capacity:	975 x 10^3 m^3

- H-I sub-zone pond:

Surface area:	1.15 km^2
Storage capacity:	1,263 x 10^3 m^3

(5) Site of pump stations

The proposed sites of the two (2) pump stations are shown in Fig. 12.6 and Fig. 12.7.

12.2.4-3 Khal Improvement and Drainage Pipe

(1) D zone

The existing khals or natural water courses are widened or dredged in 14 stretches to drain a total catchment area of 6.67 km^2. The total improvement length reaches 11.65 km. A trunk drainage pipe with a diameter of 2.2 m is installed extending a distance of over 1.45 km to drain the Rajabagh area of 0.5 km^2. The proposed design discharges and cross sections of the khal improvements and drainage pipe are illustrated in Fig. 12.8.

Location of the proposed khal improvements and drainage pipe is installed in Fig. 12.6.

(2) H-I sub-zone

The existing khals and natural water courses are improved in 13 stretches to drain a total catchment area of 8.19 km^2. The total improvement length reaches 12.60 km. A trunk drainage pipe of 2.8 m diameter with a length of 0.8 km is installed to drain the Mirpur area of 0.64 km^2.

The proposed design discharges and cross sections of the khal improvements and drainage pipe are illustrated in Fig. 12.9. Location of the proposed khal improvements and drainage pipe is illustrated in Fig. 12.7.

(3) H-II sub-zone

Nine (9) additional trunk drainage pipes are proposed to drain a total catchment area of 3.38 km^2. One (1) line is installed along the Dhaka-Aricha Road and made of a box culvert with a diameter ranging from 3x3 m to 3.6x3.6 m. The remaining eight (8) lines ranging from 1.6 to 3.6 m in diameter are connected with the box culvert line.

The proposed design discharge and cross sections of the drainage pipes are illustrated in Fig. 12.9. Location of the proposed drainage pipes is illustrated in Fig. 12.7.

Table 12.1 Summary of Project Cost (Covered Channel Type)

Unit : Million TK ,1986 Price

Item	Zone	Description	Construction Cost			Remarks
			F/C	L/C	Total	
A. Dike	C	L = 4,800 m H = 6.0 m	70.7	115.5	186.2	
B. Pump Station						
1. NARINDA (Rehabilitation)	B	Q = 9.6 m3/s	90.5	6.6	97.1	
2. do. (New)	B	Q = 9.2 m3/s	181.5	41.3	222.8	
Subtotal		Q = 18.8 m3/s	272.0	47.9	319.9	
C. Gate						
1. NARINDA	B	6 m x 6 m	27.7	11.8	39.5	
2. GERANI KHAL	C	do.	22.6	7.4	30.0	
Subtotal			50.3	19.2	69.5	
D. Khal Improvement Works						
1. DHOLAI KHAL	B	L = 3,000 m	10.9	11.3	22.2	
2. GANDARIA KHAL	B	L = 1,200 m	5.3	11.0	16.3	
3. GERANI KHAL	C	L = 2,100 m	5.3	4.7	10.0	
4. SEGUNBAGICHA KHAL	C	L = 3,000 m	164.5	129.4	293.9	
5. BEGUNBARI KHAL	F	L = 2,800 m	133.9	111.0	244.9	
6. PARIBAG KHAL	F	L = 1,000 m	65.6	53.4	119.0	
Subtotal		L = 13,100 m	385.5	320.8	706.3	
E. Drainage Pipe						
1. NARINDA	B	L = 4,280 m	90.6	88.2	178.8	
2. SEGUNBAGICHA	C	L = 4,810 m	53.0	72.0	125.0	
3. BEGUNBARI	F	L = 3,410 m	24.9	46.3	71.2	
Subtotal		L = 12,500 m	168.5	206.5	375.0	
SUBTOTAL (A-E)	-	-	**947.0**	**709.9**	**1,656.9**	
F. Phisical Contingency (10 %)	-	-	94.7	71.0	165.7	
SUBTOTAL (A-F)	-	-	**1,041.7**	**780.9**	**1,822.6**	
G. Engineering	-	-	102.1	34.0	136.1	
SUBTOTAL(A-G)			**1,143.8**	**814.9**	**1,958.7**	
H. Land Acquisition	-	-	0.0	83.0	83.0	
I. Office Establishment			0.0	25.5	25.5	
J. Customs Duty & Tax	-	-	0.0	184.7	184.7	
SUBTOTAL(A-J)	-	-	**1,143.8**	**1,108.1**	**2,251.9**	
K. Price Contingency (1988/'89-1993/'94)			146.5	875.3	1,021.8	
TOTAL (A - K)			1,290.3	1,983.4	3,273.7	

Table 12.2 Implementation Schedule (Covered Channel Type)

Unit : Million Tk , 1986 Price

ZONE	WORK ITEM	QUANTITY	CONSTRUCTION COST	DESIGN STAGE	CONSTRUCTION STAGE				
				FIRST YEAR 1988/ '89	SECOND YEAR 1989/ '90	THIRD YEAR 1990/ '91	FOURTH YEAR 1991/ '92	FIFTH YEAR 1992/ '93	SIXTH YEAR 1993/ '94
B	(1) PUMP STATION (REHABILI	9.6 m3/s	97.1		21.6 Step I				75.5 Step II
	(2) GATE (NARINDA)	1 place	39.5		39.5 1 place				
	(3) KHAL IMPROVEMENT								
	1.DHOLAI KHAL (K-1)	3.0 km	22.2			22.2 3.0 km			
	2.GANDARIA KHAL (K-2)	1.2 km	16.3					16.3 1.2 km	
	(4) DRAINS								
	1. D-1	2.80 km	90.7		51.9 0.75 km	29.7 1.55 km			9.1 0.5 km
	2. D-2	1.48 km	88.1		[Main	Drainage pipe]		59.5 1.0 km	[Branch 28.6 0.48 km
	(5) LAND ACQUISITION	4.50 ha	[9.7]	[8.4] 3.4 ha		[1.3] 1.1 ha			
C	(1) DIKE	4.80 km	186.2			93.1 2.4 km	93.1 2.4 km		
	(2) GATE	1 place	30.0				30.0 1 place		
	(3) PUMP STATION (ADDITION	9.2 m3/S	222.8		73.5	73.6		75.7	
	(4) KHAL IMPROVEMENT				Whole Civil + Mech.	(4.6 m3/s)		Mech.(4.6m3/s)	
	1. GERANI KHAL (K-3)	2.10 km	10.0					10.0 2.10km	
	2. SEGUNBAGICHA KHAL (K-4)	3.00 km	293.9		73.5	73.5	73.5	73.4	
	(5) DRAINS								
	1. D-3	2.50 km	82.2				61.7 1.4 km	20.5 1.1 km	
	2. D-4	0.54 km	7.5						7.5 0.54 km
	3. D-5	0.72 km	14.3					14.3 0.72km	
	4. D-6	1.05 km	21.0						21.0 1.05 km
	(6) LAND ACQUISITION	42.70 ha	[58.6]		[55.6] 40.2 ha	[3.0] 23.5 ha			
F	(1) KHAL IMPROVEMENT								
	1. BEGUNBARI (K-5)	2.80 km	244.9				80.0	80.0	84.9
	2. PARIBAGH (K-6)	1.00 km	119.0						119.0
	(2) DRAINS								
	1. D-7	1.10 km	23.2						23.2 1.10 km
	2. D-8	0.45 km	7.0						7.0 0.45 km
	3. D-9	1.86 km	41.0					20.5 0.93 km	20.5 0.93 km
	(3) LAND ACQUISITION	4.80 ha	[14.7]			[1.7] 0.3 ha	[13.0] 4.5 ha		
	(1) SUB TOTAL		1656.9		260.0	292.1	338.3	370.2	396.3
	(2) CONTINGENCY		165.7		26.0	29.2	33.8	37.0	39.7
	TOTAL OF (1)+(2)		1822.6		286.0	321.3	372.1	407.2	436.0
	(3) ENGINEERING		136.1	46.1 (D/D)	18.0	18.0	18.0	18.0	18.0
	TOTAL OF (1)+(2)+(3)		1958.7	46.1	304.0	339.3	390.1	425.2	454.0
	LAND ACQUISITION (4)		[83.0]	8.4	55.6	6.0	13.0	0	0
	OFFICE ESTABLISH. (5)		[25.5]	9.0	3.3	3.3	3.3	3.3	3.3
	CUSTOMS DUTY/ TAX(6)		[184.7]	0.0	27.8	48.5	11.9	51.8	44.7
	TOTAL OF (4)+(5)+(6)		[293.2]	17.4	86.7	57.8	28.2	55.1	48.0
TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)			2,251.9	63.5	390.7	397.1	418.3	480.3	502.0
	(7) PRICE CONTENGENCY (1988/89 - 1993/94)		1,021.8	11.6	102.8	149.9	191.3	252.1	314.1
TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)+(7)			3,273.7	75.1	493.5	547.0	609.6	732.4	816.1

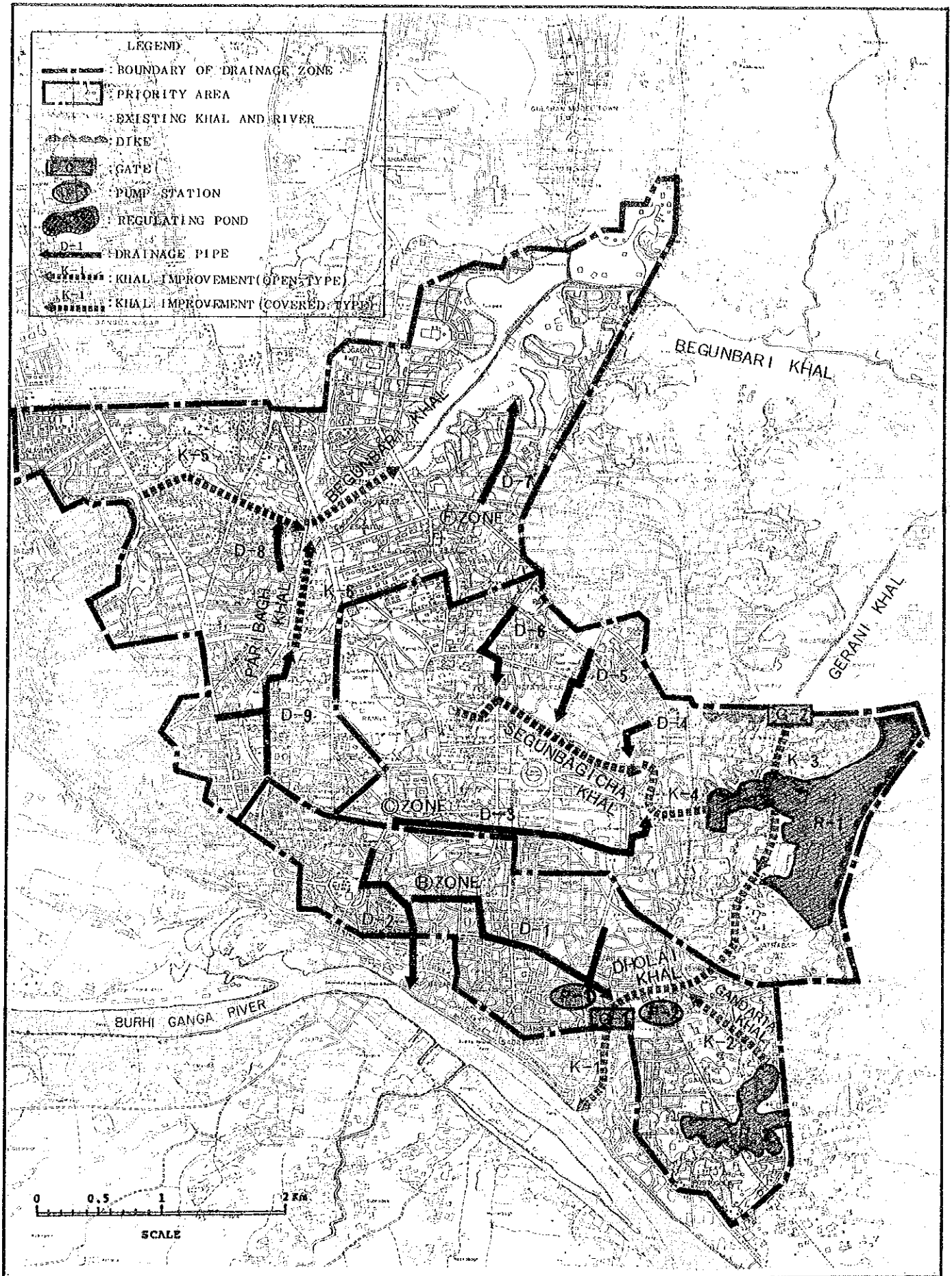


FIG. 12.1 PROPOSED FLOOD PROTECTION AND DRAINAGE SYSTEM (COVERED CHANNEL TYPE)

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA 1987A.D

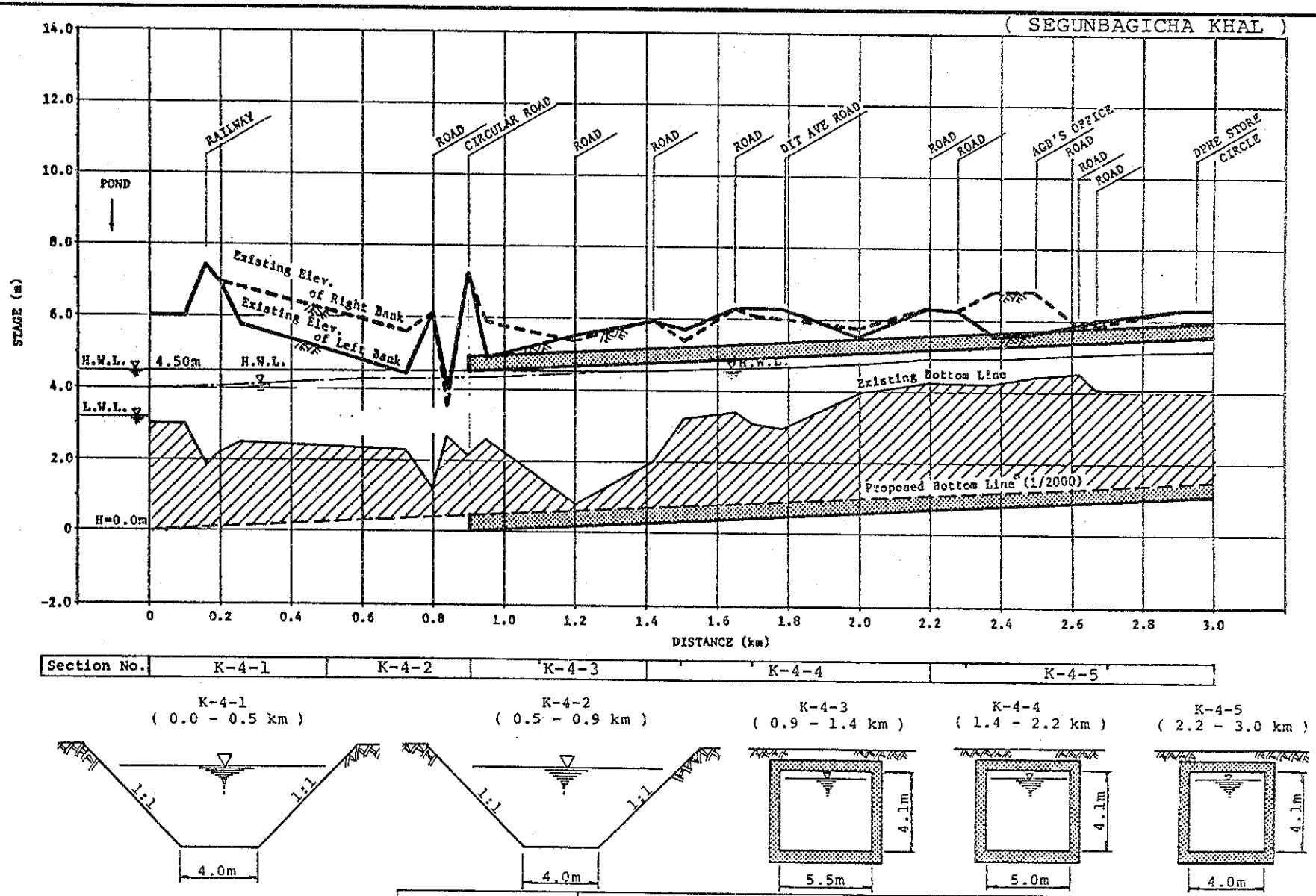
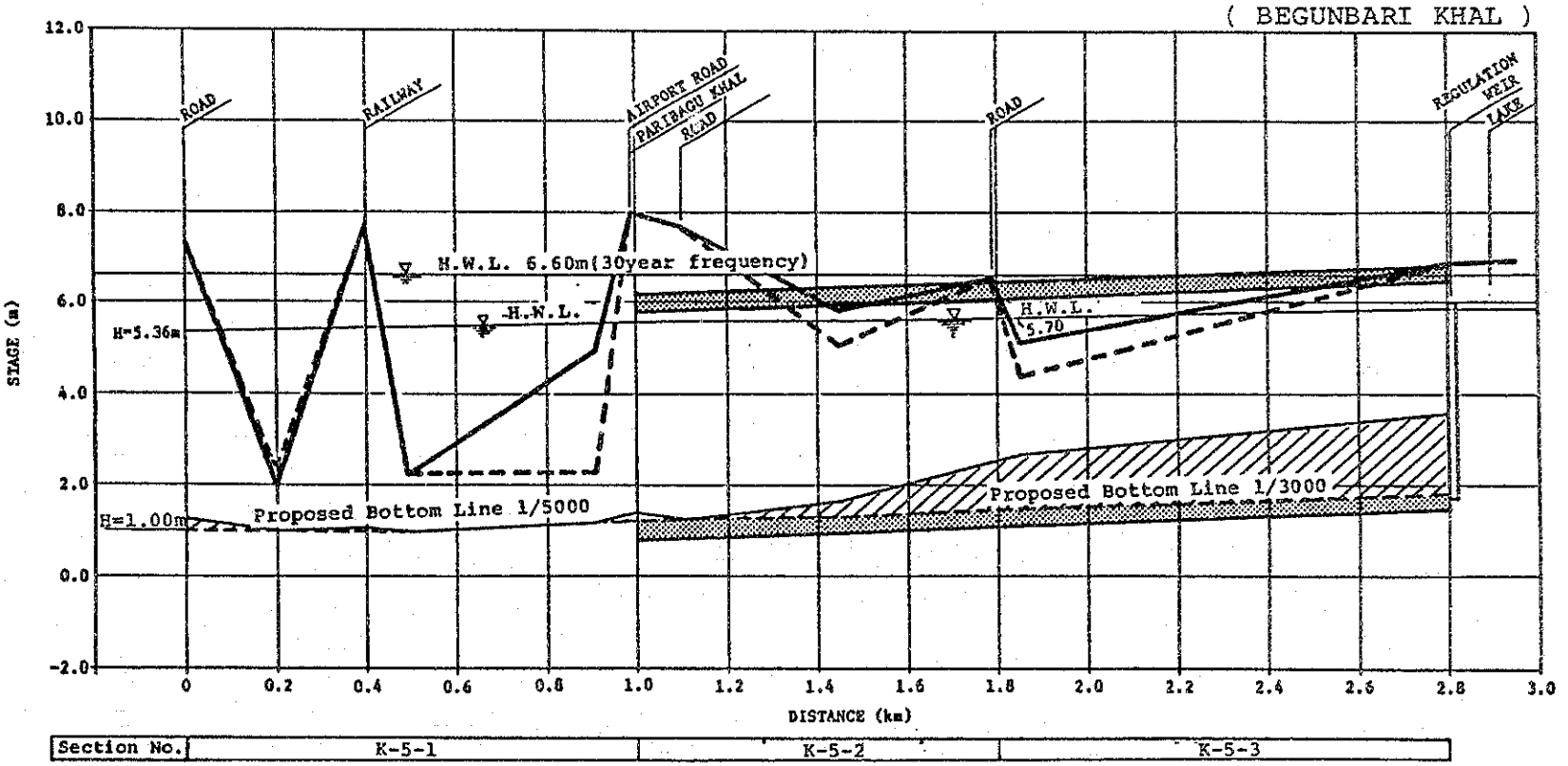


FIG.12.2 PROPOSED LONGITUDINAL AND CROSS SECTIONS OF SEGUNBAGICHA KHAL (COVERED CHANNEL TYPE)

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA 1987 A.D



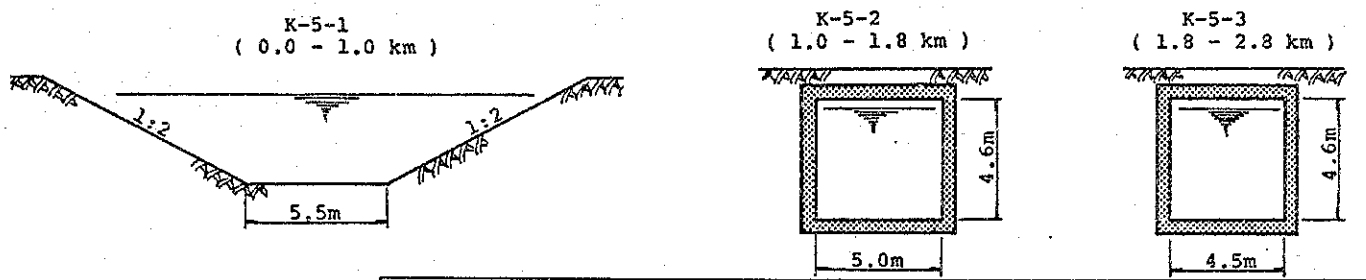


FIG. 12.3 PROPOSED LONGITUDINAL AND CROSS SECTIONS OF BEGUNBARI KHAL (COVERED CHANNEL TYPE)

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA 1987 A.D

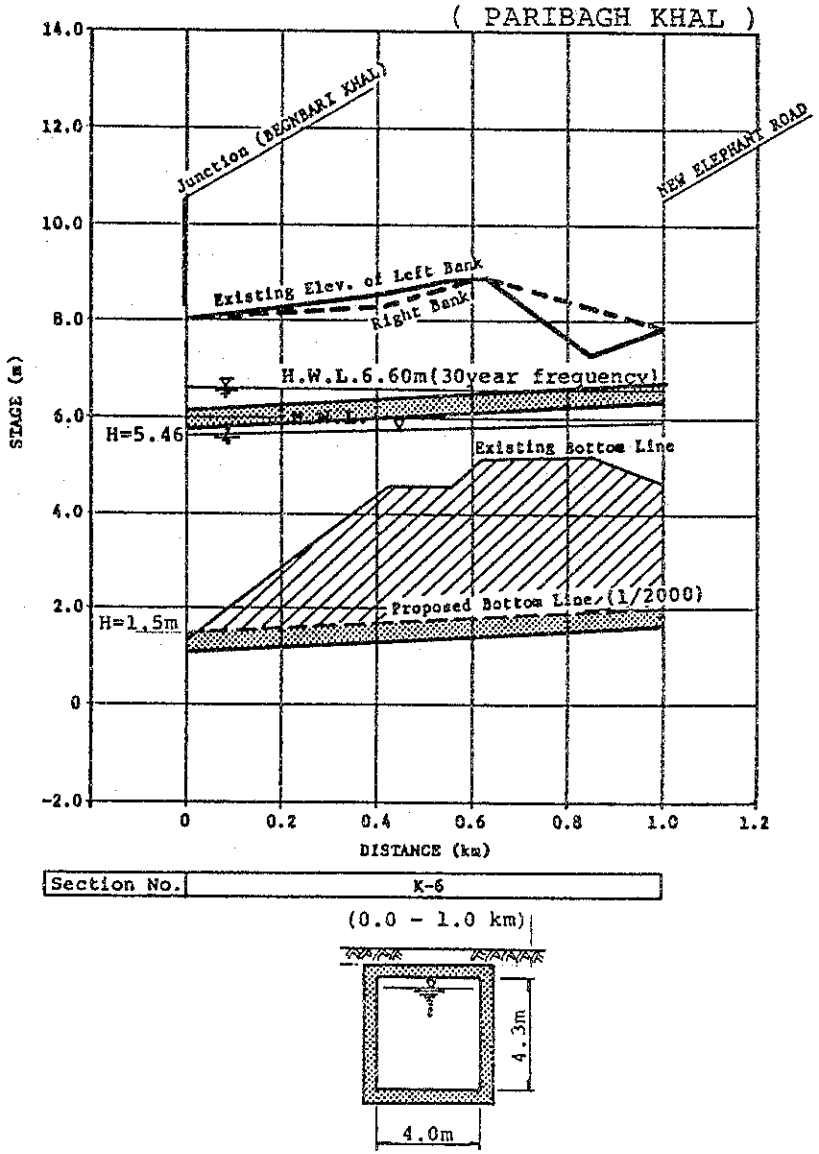
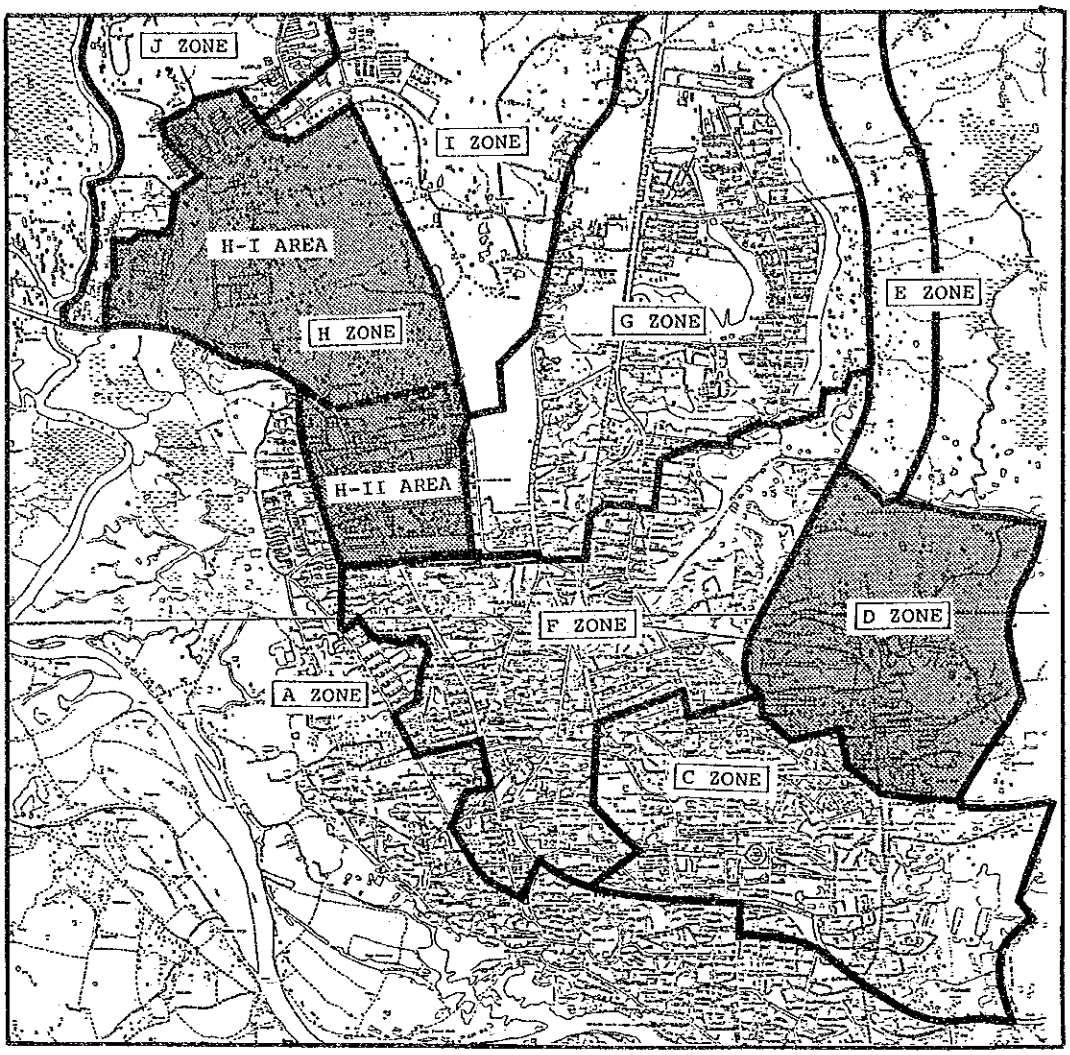


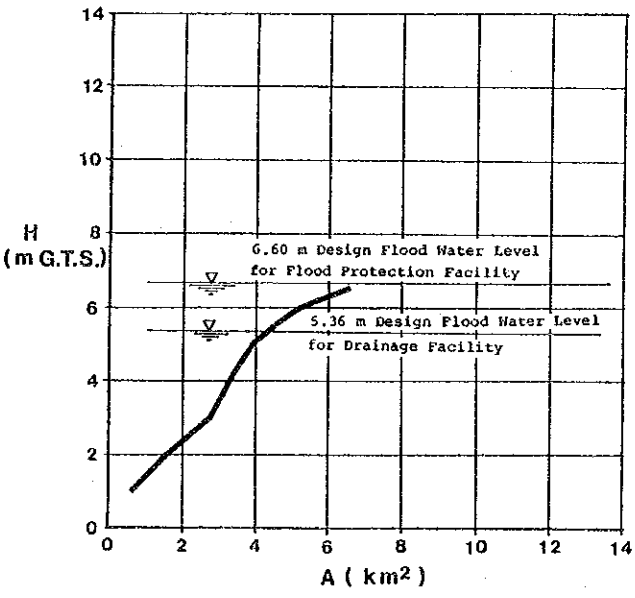
FIG. 12.4 PROPOSED LONGITUDINAL AND CROSS SECTIONS OF PARIBAGH KHAL (COVERED CHANNEL TYPE)

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

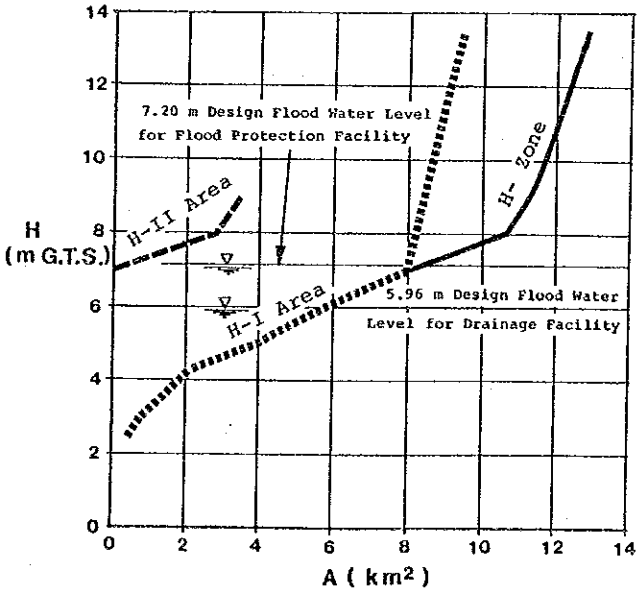
JICA 1987A.D



Plan



D Zone



H Zone

FIG. 12.5 GROUND ELEVATION AND AREA CURVES

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA 1987A.D

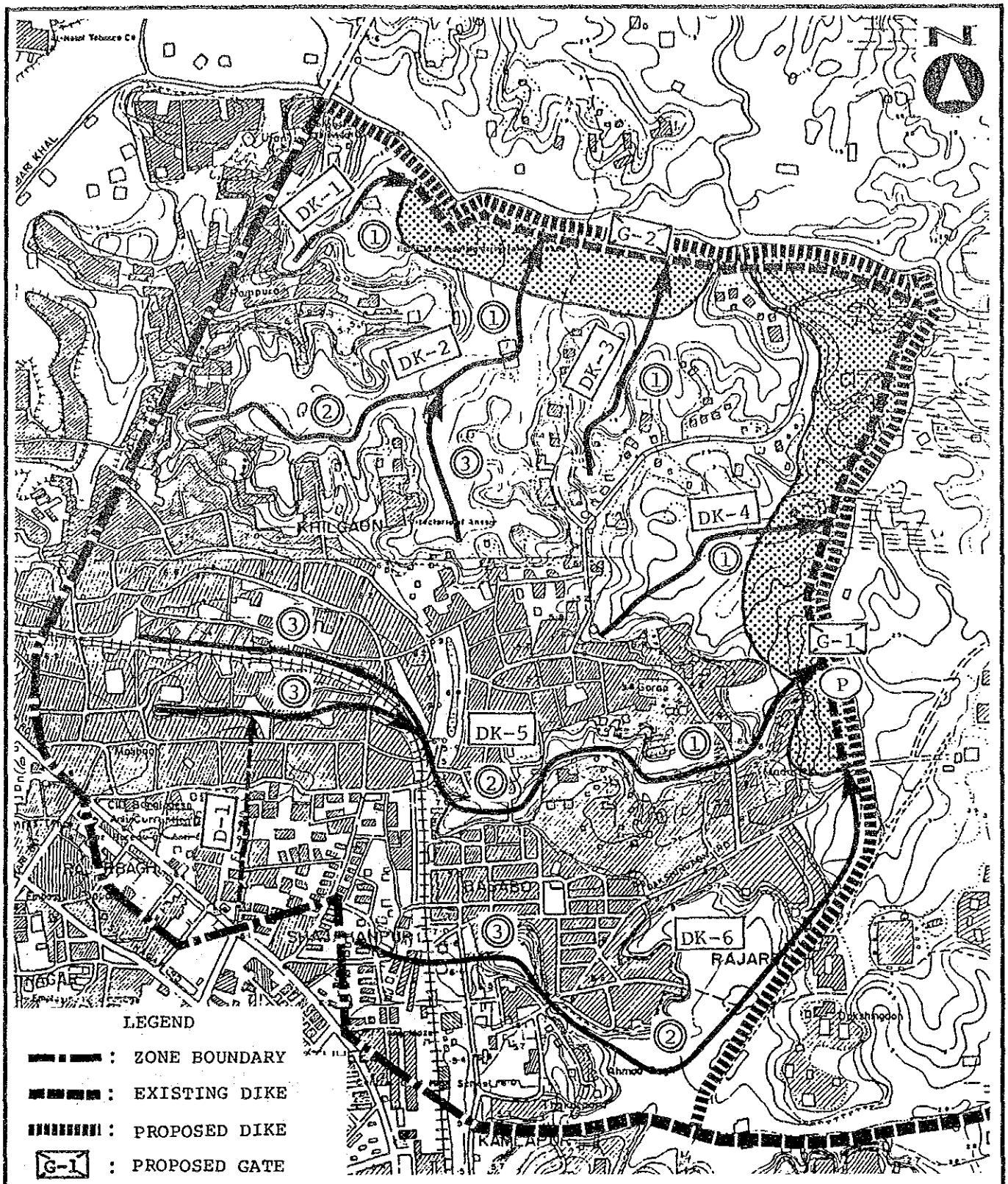


FIG. 12.6 LOCATION OF PROPOSED FLOOD PROTECTION AND DRAINAGE FACILITIES IN D ZONE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

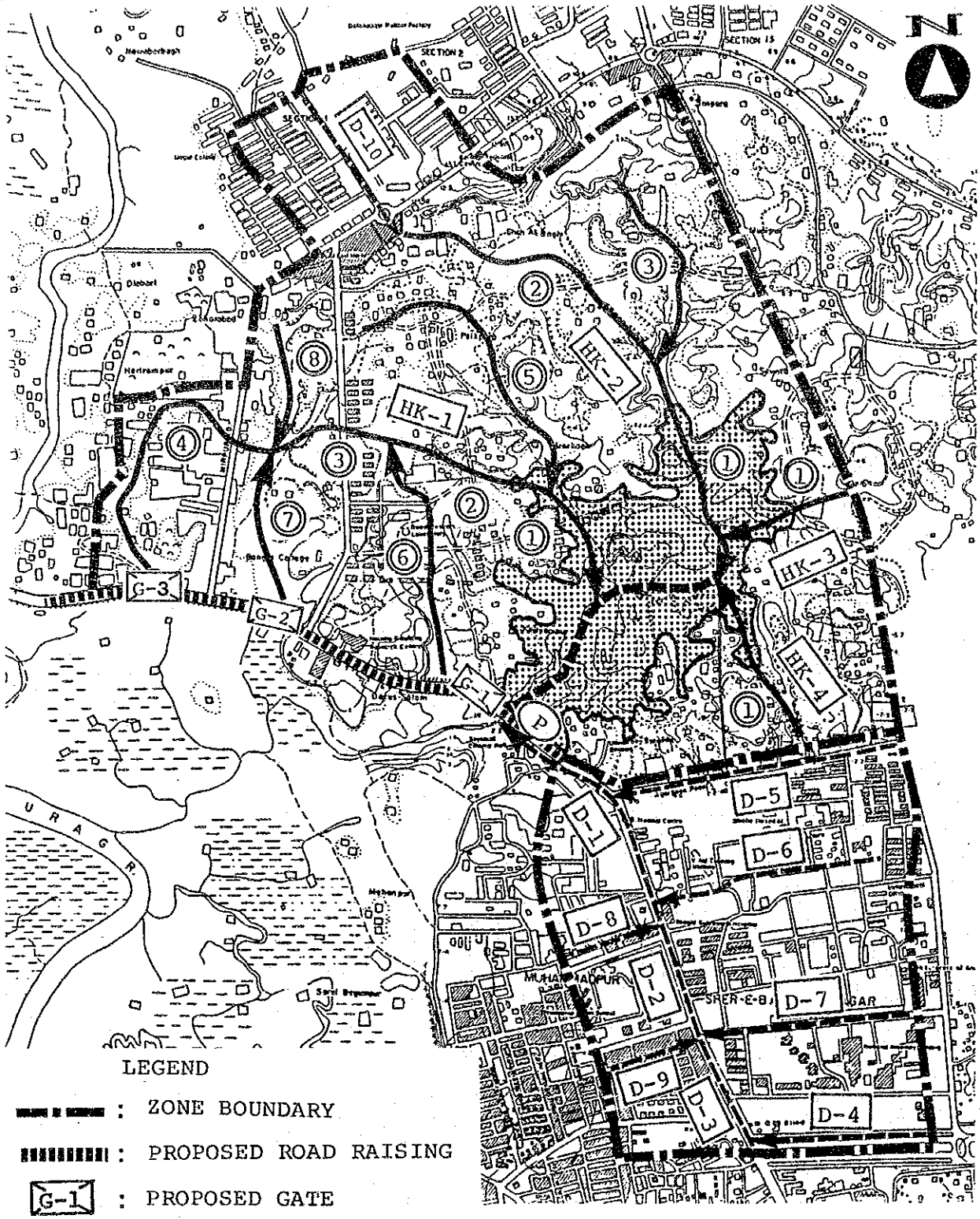
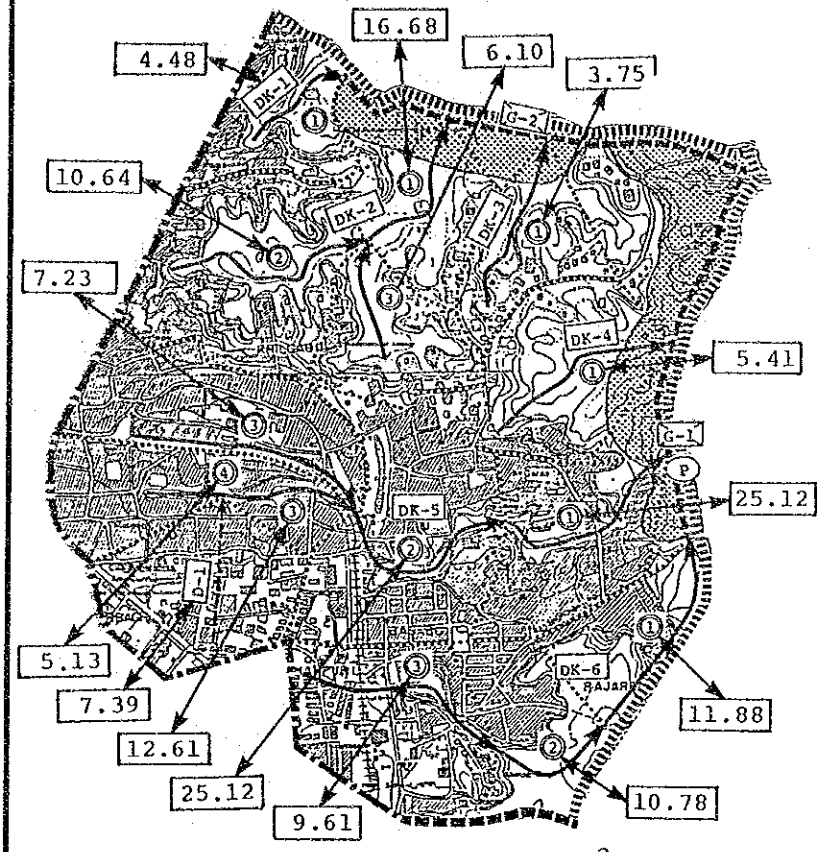
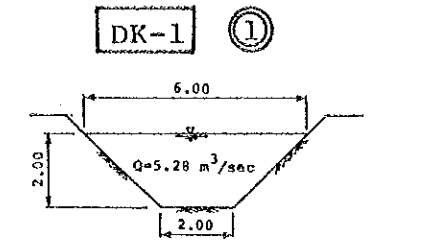


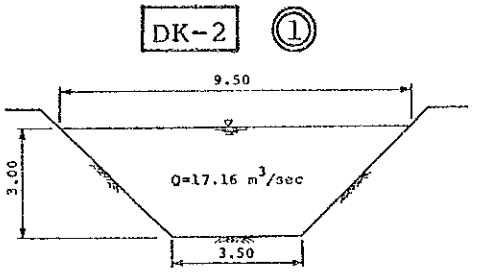
FIG. 12.7 LOCATION OF PROPOSED FLOOD PROTECTION AND DRAINAGE FACILITIES IN H ZONE

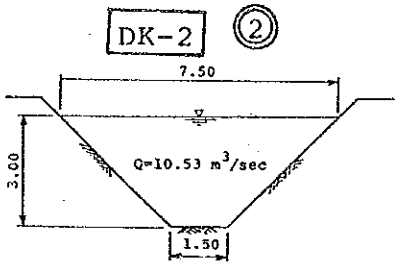
STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

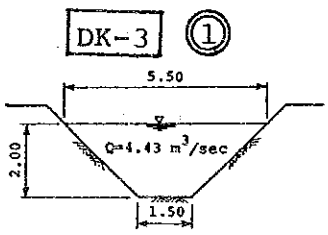


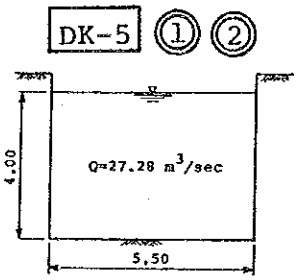
DESIGN DISCHARGE (Unit: m^3/sec)

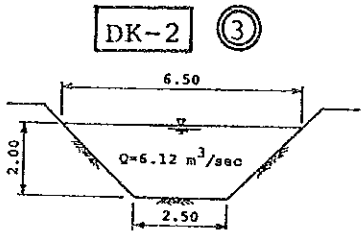


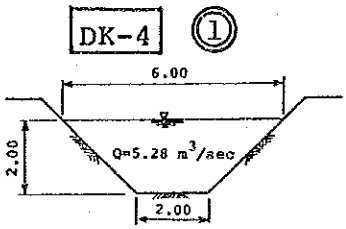


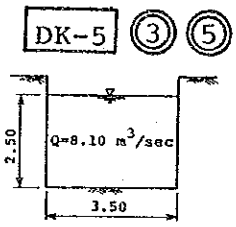


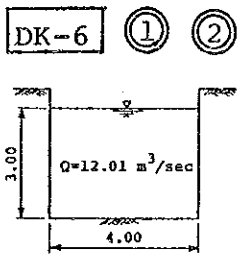


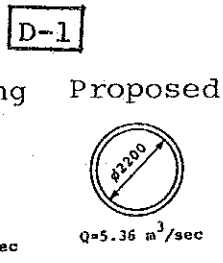


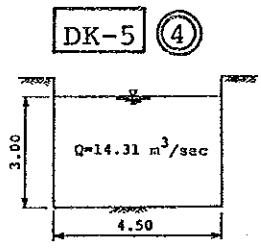


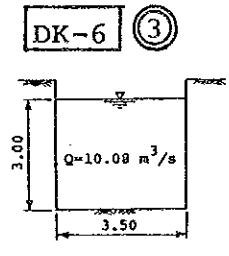












PROPOSED CROSS SECTION OF KHAL IMPROVEMENT AND DRAINAGE PIPE

FIG. 12.8 DESIGN DISCHARGES AND PROPOSED CROSS SECTIONS OF KHAL AND PIPE IN D ZONE

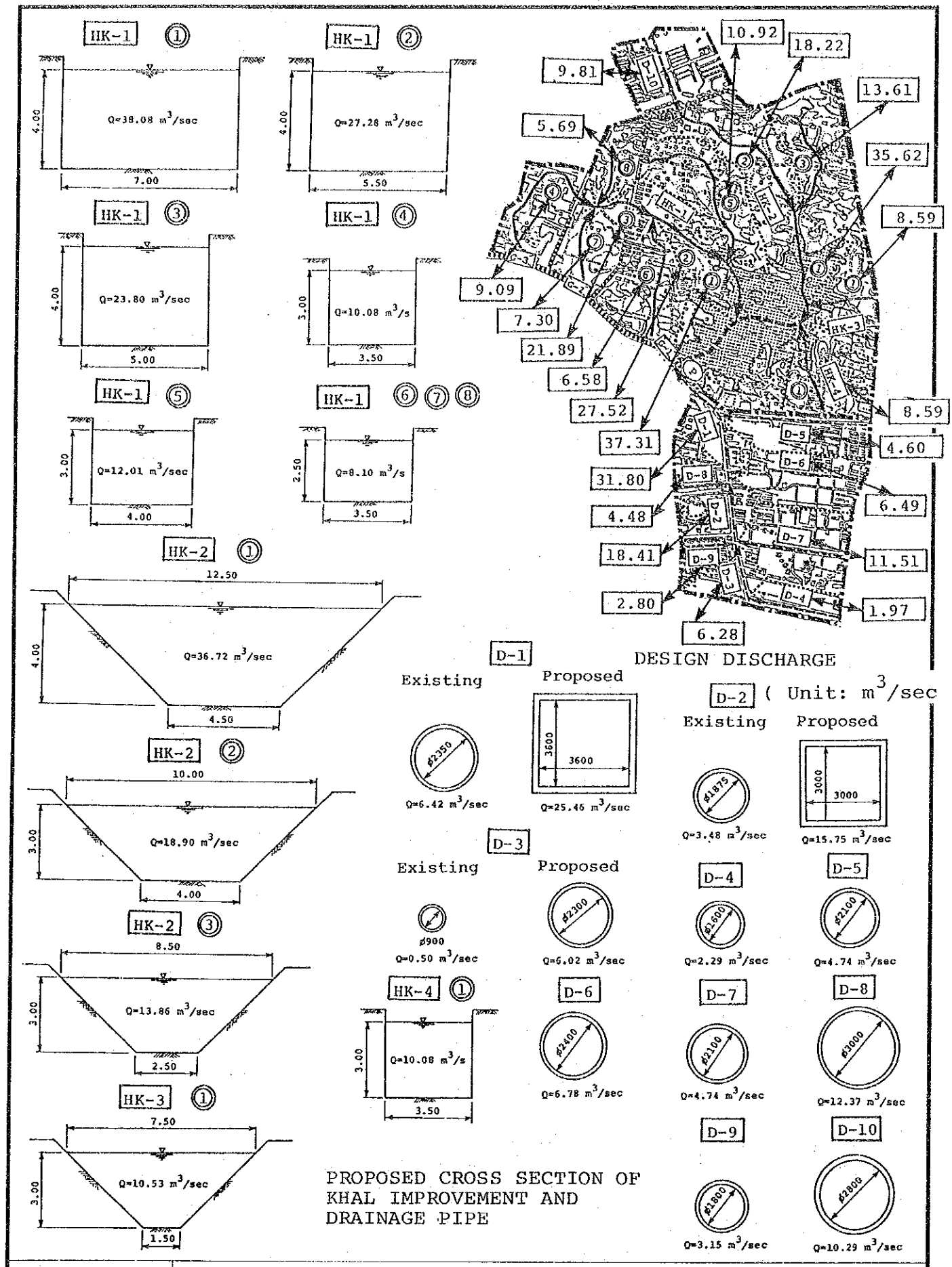


FIG. 12.9 DESIGN DISCHARGES AND PROPOSED CROSS SECTIONS OF KHAL AND PIPE IN H ZONE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

1987 FLOOD AT CIRCULAR ROAD

CHAPTER 13
CONCLUSION AND RECOMMENDATIONS

CHAPTER 13 CONCLUSION AND RECOMMENDATIONS

(1) The proposed Project is technically, economically and socially justified. Urgent implementation of the Project is recommended in consideration of the present serious flood problems.

(2) Because of the high costs required for the detailed design and construction of the Project, foreign financial aid shall be obtained.

(3) The detailed design of the Project shall commence as soon as possible. The detailed design will include the following major works:

- Topographic survey and geological investigation
- Preparation of detailed design and drawings for flood protection works, pump stations, khal improvements, and drainage pipes
- Identification of land acquisition requirements
- Estimate of required costs
- Preparation of detailed construction and procurement schedules
- Preparation of tender documents for construction and procurement contracts
- Preparation of operation and maintenance manual

(4) In the detailed design stage, the proposed flood protection and drainage plans shall be coordinated in greater detail with the other relevant urban development plans. Especially, the multiple use of the proposed dikes for road and regulating pond areas shall be discussed at greater length.

(5) The required land acquisition shall be completed before commencement of construction so that the smooth implementation of the Project, including financial aid procurement, can be attained.

(6) Land use or its development of the proposed regulating pond areas and khals must be strictly controlled, so that the expected hydraulic balance may not be disturbed.

(7) A special organization for the Project shall be set up in DPHE expeditiously.