SUPPORTING REPORT D
URGENT PROJECT

1. GENERAL

Taking into account the priority sequence of the drainage zones as well as the drainage facilitie in the Supporting Report C, the phased implementation of the construction of phasing programmes, I and II is discussed.

In this chapter, the work which has to be urgently implemented will be identified from the proposed phase-1 program. The preliminary design will be conducted for the selected urgent work.

2. IDENTIFICATION OF URGENT PROJECT

So as to select the urgent works, the ongoing work for which planning and/or designing has already been executed by the concerned agencies and the postponable work of which implementation is less urgent, will be eliminated from the Phase-I programme. The ongoing and postponable work are detailed as described below:

1) The 1,000 m section of the Begunbari khal to be improved by installing a culvert between Mirpur and Green roads will be undertaken by RAJUK's ongoing programme during the construction of the proposed road.

2) The 600 m section of the Begunbari khal to be improved by installing a culvert between Airport Road and the Railway will be undertaken by WASA's on going programme.

3) The 700 m section of the Paribagh khal to be improved by installing a culvert will be undertaken by DWASA's ongoing programme.

4) The following three sections of khal improvement by installing culverts are postponable from the urgent work because they are less urgent. The implementation will be undertaken by WASA as Phase-I work in the near future.

   - The 400 m section of the Begunbari khal between Railway and Tongi Diversion road.

- The 400 m section of the Segunbagicha khal between DPHE store circle and North-South road. Dredging work will be included in the urgent work to improve the flow capacity of the khal.

- The 500 m section of the Segunbagicha khal between Circular road and Bangladesh Bank building. Dredging work will be included in the urgent work to improve the flow capacity of the khal.

Therefore, the construction of the total 3,600 m long culverts is deducted form the Phase-I work. The urgent work is identified as shown below:

		Phase-I work		Urgent work (Percentage of Phase-I)		
1)	River Dredging	7,200	m	7,200	m	(100%)
2)	Slope Protection	1,000	m	1,000	m	(100%)
3)	Culvert	5,800	m	2,200	m	(38%)
4)	Bridge Culvert	5	places	5	plc.	(100%)
5)	Pump Station	10	m^3/s	10	m^3/s	(100%)
6)	Sluice Gate	1	place	1	plc.	(100%)

Table D.1 and Figs. D.1 and D.2 show breakdown and location of the urgent work respectively.

3. Preliminary Design

3.1 Pump Station

(1) Design Criteria

With respect to the design of the Kallyanpur pump station the following major design criteria will be applied:

a Pump capacity in urgent program: 10 m^3/s

b Design water levels: Regulating pond: HWL+5.00 m GTS
LWL+4.00 m GTS
(maintaining level)
LLWL+3.50 m GTS

Buriganga river: HHWL+8.35 m GTS
(100 year frequency)
HWL+6.00 m GTS
(2 year frequency)

c	Pump actual head:	+2.00 m
d	Pump total head:	+3.40 m(rough estimate as shown in Fig. D.3)
e	Pumping period:	July to October
f	Ground elevation at pump station yard:	+ 6.30 m GTS

The pump facilities shall be principally designed to the required capacity under the actual head of 2.00 m between HWL + 6.00 m and LWL + 4.0 m of the river and the pond respectively. Even if the discharge efficiency is decreased, the pump facility design shall be such that it will be possible to discharge within the range of the actual heads of 3.35 m and 2.50 m under the water level conditions as shown below in the table and in Fig. D.3:

	Pump actual head	River side WL	Pound side WL
(1)	3.35 m	+ 8.35 m (HHWL)	+ 5.00 m (HWL)
(2)	2.50 m	+ 6.00 m (HWL)	+ 3.50 m (LLWL)

(2) Pump Type

Based on the criteria of the total pump head of approx. 3.4 m and a total flow of 10.0 m^3/s, the following three (3) alternative pump types are considered:

Alternative 1: Vertical axial flow pump
Alternative 2: Horizontal mixed flow pump
Alternative 3: Submersible motor pump

In addition to the alternatives mentioned above, it is common to envisage other various pump types for pumping large flows over low heads: horizontal axial flow, vertical mixed flow, centrifugal flow and screw pump types as shown in Fig. D.4. For the Kallyanpur pump station, however, these pump types are less suited considering pump suitability, pumping efficiency, operation and maintenance characteristics and construction cost. The pump type study, therefore, will be limited to a comparison of the above three (3) alternatives.

Through comparison of the advantages and disadvantages of each pump type described below, the vertical axial flow pump (Alternative 1) is proposed.

Alternative 1: Vertical axial flow pump

Advantage:

- It can be operated at high reliability over a wide range of flows with easy operation and maintenance.

Disadvantage:

- Compared to the horizontal mixed flow type, this type saves about 5% in costs for civil works, but requires additional costs for mechanical equipment. As a result, the total construction cost is larger.

Alternative 2: Horizontal mixed flow pump

Advantage:

- Dismantling of the pump for inspection and repair is simple.
- Only a small vertical clearance is required inside the pump house for dismantling and removing the pump.
- Total construction cost, including costs for equipment and civil works, is less than for vertical axial flow type.

Disadvantage:

- The following many requirements are to be dealt with when starting pump operations:
  - (a) Start the vacuum pump
  - (b) Confirm that there is a full supply of water in the intake casing
  - (c) Switch on main pump
  - (d) Start opening the discharge valve
  - (e) Fully open the discharge valve
  - (f) Stop vacuum pump operation

  Due to these complicated pre-operational requirements, operation reliability of this type is lower than for that of the vertical axial flow type. A more detailed inspection of the many pieces of auxiliary equipment is required in comparion to the vertical axial flow type.

Alternative 3: Submersible motor pump

Advantage:

- Total construction cost is: approximately half of that for the other two (2) alternatives.

Disadvantage:

- Pump life is very short: assumed to be 5-7 years, approximately one-third of the other two (2) alternatives.
- Frequent maintenance work is required.

(3) Number of Pump Units

In the urgent program, the provision of three (3) pump units is proposed by taking into account the operational risk and construction cost. Installation of a small number of pump units will lower the construction cost. Provision of a large number of pump units will lower the risk of pump operation trouble.

With regard to the Kallyanpur pump station, a future programme will provide additional pump units having a total capacity of 10 m^3/s. Thus, the number of pump units provided in the urgent programme are two (2) or three (3) that have a total capacity of 10 m^3/s.

In case two (2) units are provided, however, the operational risk will be 50% higher if one pump develops troubles. If three (3) units are provided, the risk will be reduced by 13% to 37%.

(4) Power Source of Pump Operation

As alternatives for the pump power source, the electrical motor driven type and the diesel engine driven type were studied. Comparing the two types, the electrical motor driven type (180 kw each) was adopted taking into account its ease of operation and maintenance and the availability of electricity in Dhaka. A backup electric power source will be provided to handle such emergencies as power failures.

(5) Other Equipment

Other equipment, including travelling overhead cranes, facilities for minor in-station repairs, water level recorders, and manual raking screens are to be provided.

(6) Civil Works

At the site of construction , the silt layers of soft, medium, and stiff are found to a depth of 12 m from the ground surface of +5.0 m GTS, overlying stiff sand layers. Considering the total weight of the pump station it will be necessary to provide a pile foundation. Approximately 100 piles each having a load capacity of 35 ton/pile will be required.

The substructure will be constructed using reinforced concrete. The inlet, suction and discharge basins of the substructure shall be sized in accordance with inflow and discharge hydraulic requirements for pumping operation. The general layout of a pump station and associated sluice gate are shown in Fig. D.5 and the typical design of civil works is shown in Figs. D.6 and D.7.

The superstructure will have to accommodate following spaces and functions:

1. Pump/motor equipment room
2. Electrical panel room
3. Repair Workshop
4. Stores (tools, spare parts)
5. Control room, toilet

Considering the efficient use of building spaces, the required spaces and functions are to be combined in a main building of the pump station; the layout will be arranged as shown in Fig. D.8.

In addition, a sub-building of 90 m^2 will have to be constructed using a RC-framed brick wall structure for the staff's resting room and meeting room by taking into account continuous operations during rainy seasons (Fig.D.9).

3.2 Sluice Gate

The sluice gate associated with the pumping station will consist of a 60 m long gate-culvert with a gate leaf at the inlet and the outlet as shown in Fig. D.10. Since the pump discharge basin is connected to the gate-culvert between both gates, the outlet gate is fully opened although the inlet gate is closed for pump discharge in rainy seasons . In case there is no rain in spite of the higher water level in the river, both gates are fully closed for flood protection, i.e., the outlet gate will be an additional gate for confirming the safety against external floods. During dry seasons, they are fully opened or operated based on the water use rule of the regulating pond.
The proposed structural type and dimensions of the gates are shown in Table D.4. Main features considered for the design are as follows:

(1) Of the gate types considered (roller, slide, and flap), the roller gate is proposed by taking into account its ease of operation and maintenance. For hoisting the gate leaves, the pin-jack type with an electric motor is recommended.

(2) For flood protection purposes, gate leaf material commonly used is either steel or alloyed aluminium materials. It is recommended, in this project, that the steel material be used for sluice gate leaves, with corrosion resistant paint.

(3) Although the gate structure will be constructed directly on the subsoil -piles are not reguired- some of the subgrade's soft soil may have to be replaced by well-compacted sandy soil. Main features that apply to the direct foundation are:

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

To avoid seepage failure of the gate structure caused by water flow through aperture in to the heterogeneity foundation between the structure and earth dike, a direct foundation is preferable to a pile foundation. 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.

(4) Automatic water level indicators should be provided at each gate to indicate the water levels on both sides of the gate.

The typical gate designs are illustrated in Figs. D.10 and D.11.

3.3 Khal Improvement

The proposed typical cross sections of the khal improvement are:

- Trapezoidal shape with 1:1.5-2.0 slope protected by sodding (open channel)
- Trapezoidal shape with 1:1 slope protected by brick (open channel)
- Rectangular shape with box culvert (covered channel)

The proposed khal improvement works consist of dredging, sodding protection, brick protection, construction of box culverts and bridges are summarized in Table D.5 and the typical sections of the khal improvement are shown in Fig. D.12.

(1) Cross Section Type and Protection Work

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 described in Supporting Report C, rectangular shaped box culverts are proposed for khal sections located in highly urbanized areas and where land acquisition is difficult. The box culvert is to be constructed of reinforced concrete using a direct foundation.

The typical design of the proposed khal improvement in the urgent project is as illustrated in Fig. D.13.

(2) Box Culvert and Bridge

At crossroads and railway crossings, the reconstruction of existing box culverts and bridges is proposed . The proposed box culverts are to be made of reinforced concrete. 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 design are illustrated in Figs. D.14 and D. 15.

4. OPERATION, MAINTENANCE, AND ORGANIZATION

In March 1989, the Drainage Circle undertaking the operation and maintenance work for Dhaka city's drainage facilities was transferred to DWASA from DPHE (DWASA's organization chart is shown in Fig. D.18).

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 755.2 million Tk, the present O&M budget for khals, drainage pipes and pump stations is an average of 1.0, 4.5 and 1.5 million Tk respectively per year. Due to the small budget, the above work could be conducted at an unsatisfactory level.

4.1 Required Operation and Maintenance Work

To sustain the expected effects of the existing and proposed drainage systems in 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.

4.2 Required Operation and Maintenance Equipment

Except for manual tools, no special equipment is 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)	Vehicles for supervision:	
	- Four-Wheel-Drive Cars:	3 ea.
	- Pickup Trucks:	4 ea.
	- Motor cycles:	16 ea.

4.3 Operation and Maintenance of Khals, Drainage Pipes and Pump Station

(1) Cleaning of Khals and Drainage Pipe

All the khals and drainage pipes are to be cleaned once a year. The cleaning will be performed manually and mechanically as illustrated in Fig. D.16.

(2) Operation rule of Pump Station

The pump and gate operation period begins when the flood water levels of the rivers reach 4.0 m G.T.S and ends when they recedes again to 4.0 m GTS. The period is usually from early July to mid-October (See Fig. D.17).

During the flood season, the water level of the regulating ponds shall be maintained below 4.0 m G.T.S. to handle the storm runoffs.
Estimated yearly operating hours will be 250 on an average.

(3) Maintenance of Pump Station

Major maintenance work at the pump station is as follows:

a) Daily maintenance (during pump operation)

- check electric current of motor
- check temperature of motor bearing
- check vibration of pump and motor

b) Every six (6) month maintenance

- check pump sealing components
- check motor and pump lubrication oil
- check gauge and indicator
- check insulation of motor

c) Annual maintenance

- check electric panel
- check motor of automatic trash rake
- check paint of all equipment

d) Every three (3) to four (4) years maintenance

- overhaul/check pump and motor
- replace rotating parts of pump
- replace gauge and indicator
- replace parts of electric panel
- replace parts of automatic trash rake
- repaint all equipment

4.4 Land Use control

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

(1) Preservation of Regulating Pond Area

At Kallyanpur, the proposed regulating pond area of 208 ha shall be preserved to assure the expected effects of pump drainage.

Adverse effects caused by reducing the regulating pond area are considerable and are assessed below:

- If, due to urbanization, the proposed Kallyanpur regulating pond is reclaimed by 50%, the ponds high water level will rise 0.4-0.5m higher than the design high water level (5.00 m GTS).
- To maintain the pond's high water level below 5.00 m GTS. in this situation, the pump capacity shall be increased from the original 20.0 m^3/s to 80.0 m^3/s.

(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 G.T.S. (design high water level +5.00 m plus 1.0 m allowance).

4.5 Required Organization

(1) Required Organization for Construction

The required organization for the construction of the proposed urgent works is shown in Fig. D.19.

A total staff of 108 persons will be required to supprot the organization (the breakdown is shown in Table D.6).

(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. D.19.

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

(3) Job Staff Members

The job of each staff member is described below:

Superintending Engineer:

1) Controlling officer of Project
2) Policy planner of project
3) Monitoring
4) Evaluation
5) Overall quantity control & supervision of work

Executive Engineer:	1) Engineer in charge of field 2) Responsible for planning, design, cost estimating of project 3) Tendering of work 4) Field supervision, control subordinate field officer & staff 5) Quality control 6) Control of financial matters 7) Progress report
Subdivisional Engineer:	1) Preparation of cost estimates 2) Field work supervision 3) Control of direct field supervisions 4) Quality control 5) Measurement of work 6) Custody of project materials & tools 7) Progress report
Subdivisional Engineer (Electrical):	1) In charge of pump station & equipment 2) Operation of pumps 3) Supervision of maintenance work of pumps & equipment 4) Custody of equipment, tools & plants
Sub-asst. Engineer:	1) Supervision of work 2) Preparation of cost estimate & drawing 3) Measurement of work 4) Implementation of work guidelines
Sub-asst. Engineer (Electrical):	1) Supervision of pump operation 2) Maintenance of pumps 3) Record keeping on pump operations & maintenance
Work Assistant:	1) Primary supervisor of work 2) Records of field progress & Problems

Cleaner:	1) Minor cleaning of drainage pipes 2) Cleaning of catchpits, manholes & attending to problems

TABLE D.1 IDENTIFICATION OF URGENT PROJECT

ZONE	PHASE-1 WORK ITEM	PHASE-1 QUANTITY	IMPLEMENTATION: UNDER PLANNING/ DESIGNING WORKS	IMPLEMENTATION: POSTPONABLE WORKS	IMPLEMENTATION: URGENT WORKS	REMARKS
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 = 3,500m)	. 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 D.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 D.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 head loss	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 head loss	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 moter	180 kw x 3 units	2-incoming power lines
- Main electric panel	High voltage 10sets, low boltage 2sets	
- Overhead crane	1 set, 16 ton capacity	
- Auxiliary equipment	1 set,	
3. Spare parts		
- Main pump	Shaft sleeve (3 sets), bearing (6 sets)	
	Gages (3 sets), gland packing (6 sets)	
- Main motor	Bearing (6 sets)	
- Electric panel	Lamps (200%), fuses (200%),	
	Relays (200%)	
4. Civil stracture		
- Foundution	RC-pile foundation	
- Substructure	Reinforced concrete	
- Superstructure	RC-framed brick wall, 354 m^2	
5. Miscellaneous		
- Sub-building	RC-framed brick wall, 90 m^2	
- pump well	1 set	

Table D.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	Vertical axial flow pump
- 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=56.0 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. Civil structure		
- Foundation	Direct foundation	
- Culvert structure	Reinforced concrete	
- Operation bridge	Steel girder bridge	Load = 0.25 t/m^2
	L=18.0 m x W=1.1 m	Deflection = 1/400
- Cutoff wall	Steel sheet-pile wall (II-type)	

Table D.5(a) Khal Improvement work (1)

ZONE	KHAL	KHAL SEC-TION	SECTION LENGTH	IMPROVEMENT LENGTH (m)			KHAL DREDGING (m3)	LAND ACQUISITION (ha)	REMARKS
				TRAPEZOIDAL (SODDING)	TRAPEZOIDAL (BRICK)	RECTANGULAR (CHANNEL CULVERT)			
C	Gerani	K4	1,800	800	1,000	-	54,000 m3	1.1	
	Segunbagicha	K5-1	700	700	-	-	25,900 m3	0.3	
		K5-2	500	500	-	-	20,000 m3	0.4	
		K5-3	500	500	-	-	30,000 m3	0.2	
		K5-4	1,400	-	-	1,400	39,000 m3	0.4	
		K5-5	400	400	-	-	19,200 m3	0.2	
	Subtotal	-	5,300	2,900	1,000	1,400	188,100 m3	2.6	
F	Begunbari	K9-1	400*	-	-	-	-	-	*By others
		K9-2	600*	-	-	-	-	-	*By others
		K10-1	800	-	-	800	8,000 m3	0.2	
		K10-2	1,000*	-	-	-	-	-	*By others
	Subtotal	-	2,800	-	-	800	8,000 m3	0.2	
H	Kallyanpur	K14-1	3,000	3,000	-	-	37,500 m3	3.2	
		K14-2	300	300	-	-	12,000 m3	1.1	
	Subtotal	-	3,300	3,300	-	-	49,500 m3	4.3	
	Total	-	800 m (11,400)	6,200 m	1,000 m	2,200 m	245,600 m3	7.1	

Table D.5(b) Khal Improvement Work (2) - Bridge/Box Culvert

ZONE	KHAL	KHAL NO.	EXISTING		REQUIRED SIZE* (m x m)	PROPOSED			REMARKS
			TYPE	SIZE* (m x m)		TYPE	SIZE* (m x m)	LENGTH (m x m)	
C	Gerani	K4	-	-	12.0 x 5.0	Box Culvert	6.0x5.0x2	10.0	
	Segunbagicha	K5-2	Box Culvert	9.6 x 5.2	12.0 x 5.0	Box Culvert	6.0x5.0x2	17.0	
		K5-2	Bridget	5.6 x 3.9	12.0 x 5.0	Bridge	L = 12.0 m	19.0	Railway
		K5-3	Pipe	2xDia=2.0m	5.5 x 4.3	Box Culvert	5.5 x 4.3	15.0	
		K5-4	-	-	5.0 x 4.3	Box Culvert	5.0 x 4.3	(1,400.0)	
F	Begunbari	K10-1	Box Culvert	6.5 x 5.1	Additional 2.5 x 3.8	Box Culvert	2.5 x 3.8	(100.0)	Additional
		K10-1	-	-	5.0 x 3.8	Box Culvert	5.0 x 3.8	(700.0)	
H	Kallyanpur	K14	Box Culvert	6.0 x 5.0	Additional 4.0 x 4.6	Box Culvert	4.0 x 4.6	47.0	Additional

Total length
- •Bridge Culvert = 89.0 m
- •Railway Bridge = 19.0 m
- •Culvert= 2,200 m

Table D.6 Required Staff for Construction

	Superintending Eng.'s Office	Executive Eng.'s Office (2)	Subdivisional Eng.'s Office (4)	Total
Superintending Eng.	1			1
Executive Eng.		2		2
Subdivisional Eng.			4	4
Sub-assistant Eng.			8	8
Stenographer	1			1
Head Assistant (UDA)	1	2	4	7
Estimator	1	2		3
Draftsman	1	2		3
Accountant		2		2
Accounting Assistant	1	2	4	7
Cashier		2		2
Work Assistant			16	16
L.D.A.cum Typist	1	2	4	7
Driver	1	2	4	7
Pump Operator			8	8
Assistant Pump Operator			8	8
M.L.S.S.	2	4	16	22
Total	10	22	76	108

Table D.7 Required Staff for Operation and Maintenance

	Superintending Eng.'s Office	Executive Eng.'s Office (2)	Subdivisional Eng.'s Office (4)	Total
Superintending Eng.	1			1
Executive Eng.		2		2
Subdivisional Eng.			4	4
Sub-assistant Eng.			8	8
Stenographer	1			1
Head Assistant (UDA)	1	2	4	7
Estimator	1	2		3
Draftsman	1	2		3
Accountant	2		2	
Accounting Assistant	1	2	4	7
Cashier		2		2
Work Assistant			16	16
L.D.A.cum Typist	1	2	4	7
Driver	1	2	4	7
Pump Operator			8	8
Assistant Pump Operator			8	8
Cleaner			20	20
M.L.S.S.	2	4	16	22
Total	10	22	96	128

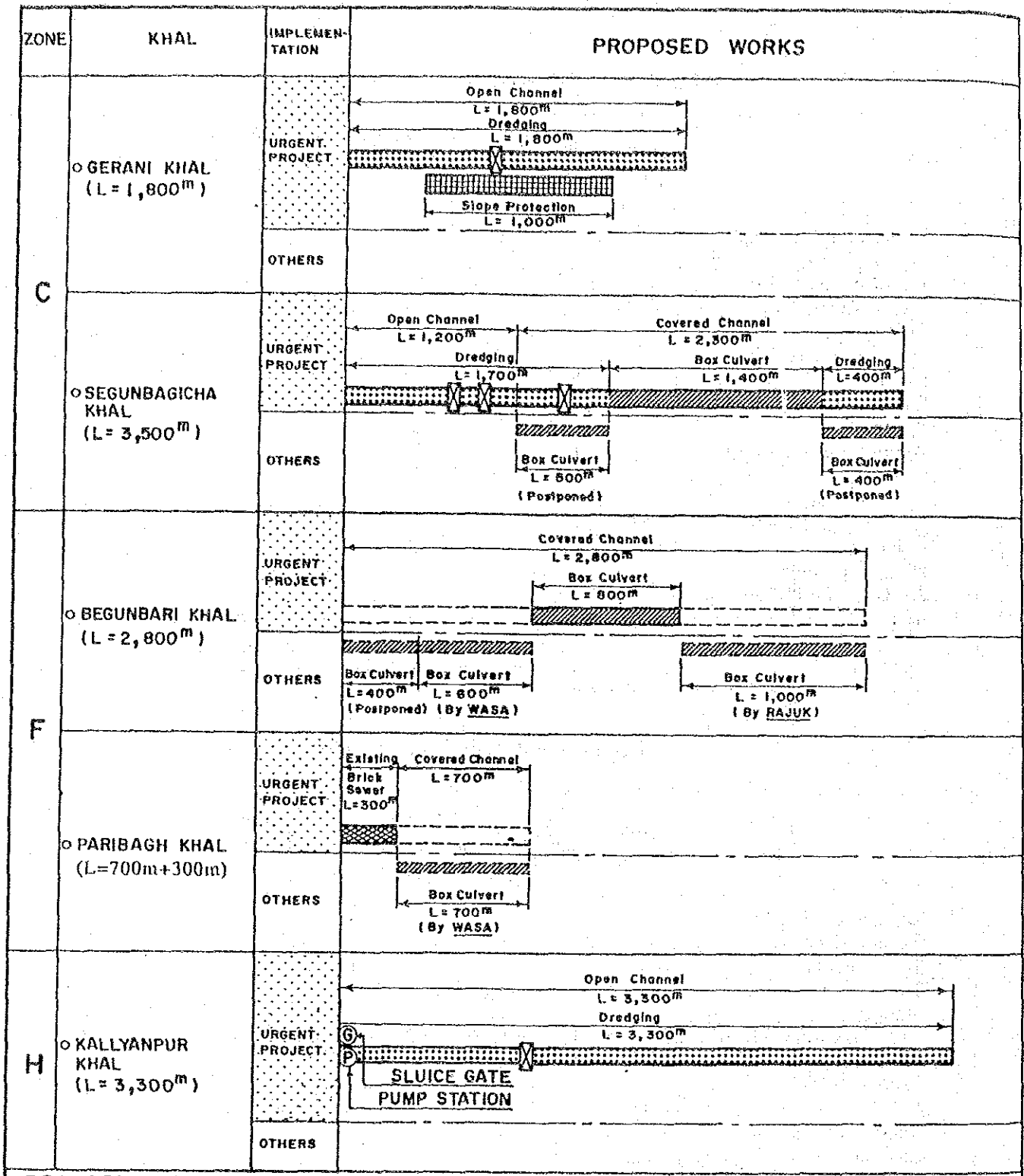


FIG. D. 1 IDENTIFICATION OF URGENT PROJECT

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

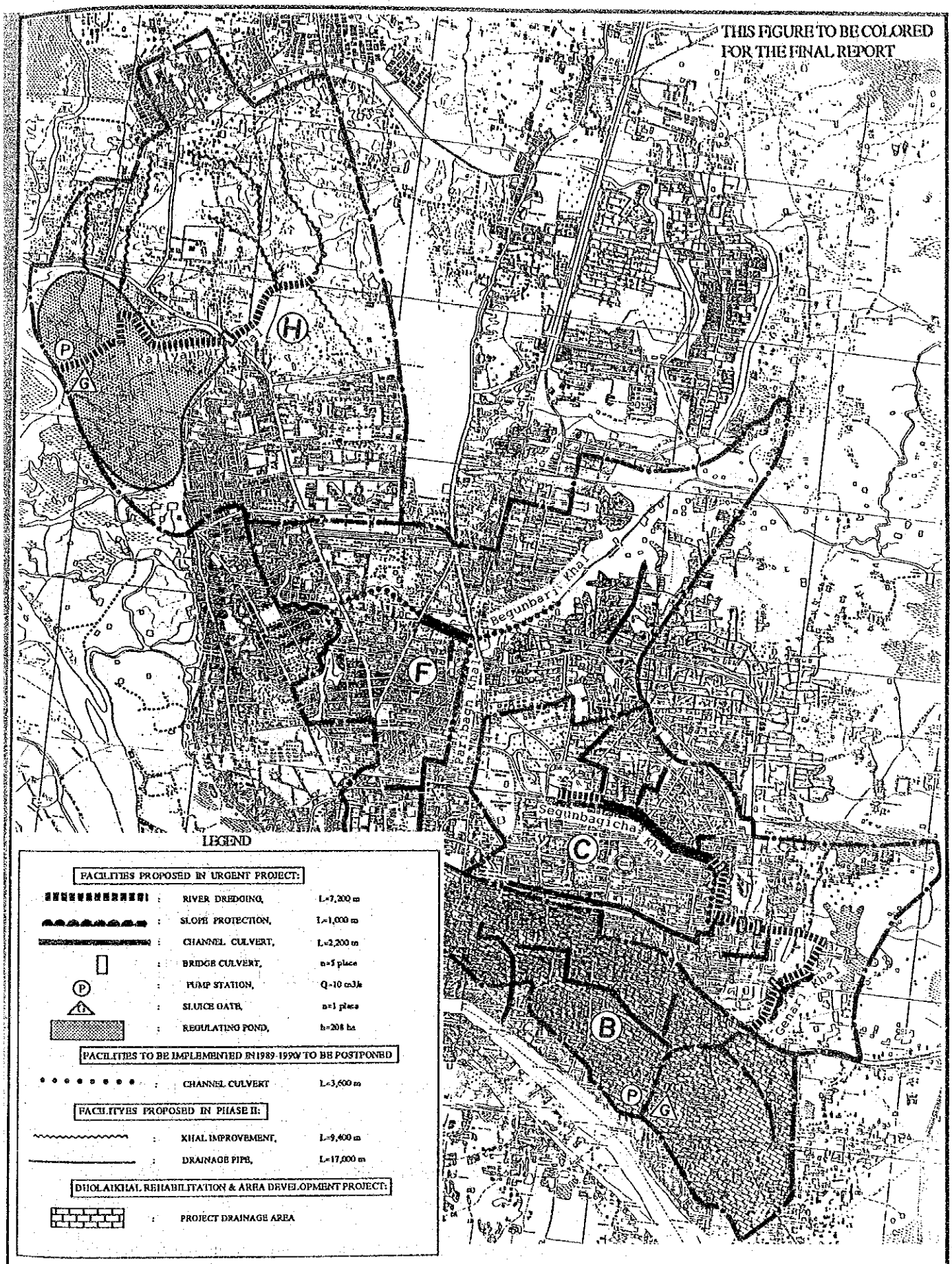
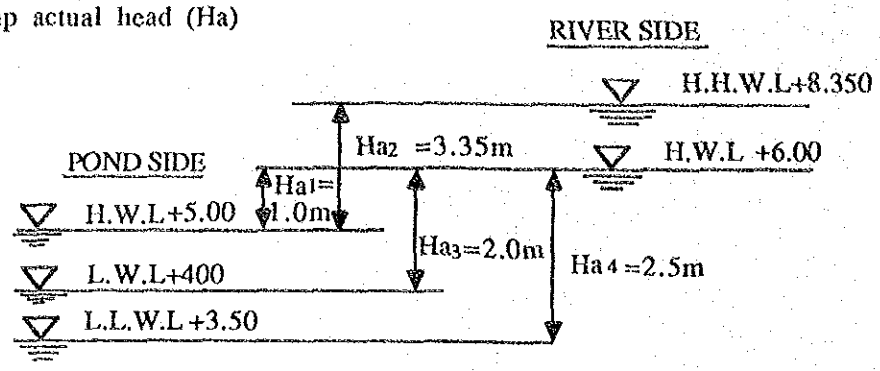


FIG. D. 2 LOCATIONS OF PROPOSED FACILITIES IN URGENT PROJECT

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

1. Pump actual head (Ha)



(a) Min. Ha=Ha 1=1.0m
(b) Design Ha=Ha 2=2.0m
(c) Max. Ha=Ha 3=3.35m(2.5m)

2. Loss head for pump discharge pipe

Capacity(m^3/s)	Diameter (mm)	Velocity (m/s)	Velocity head (m)
3.3/unit	ø 1,200	V_1 =2.92	$\frac{V_1^2}{2g}$ =0.434
3.3/unit	ø 1,500	V_2 =1.867	$\frac{V_2^2}{2g}$ =0.187

a)	ø1,200 Pipe	hf_1 =0.025 x $\frac{8}{1.2}$ x 0.434	= 0.072
b)	ø1,200 Butterfly valve	hf_2 = 0.18 x 0.434	= 0.078
c)	ø1,200 45° Bend, 2places	hf_3 = 0.284 x 0.434 x 2	= 0.247
d)	ø1,200 x ø1,500 Conical pipe	hf_4 = 0.25 x $\frac{(2.92-1.867)^2}{2g}$	= 0.014
e)	ø1,500 Flap valve	hf_5 = 0.5 x 0.187	= 0.089
f)	ø1,500 Velocity head	hf_6 =1.0 x 0.187	= 0.178
g)	TOTAL LOSS HEAD		≒0.7 m

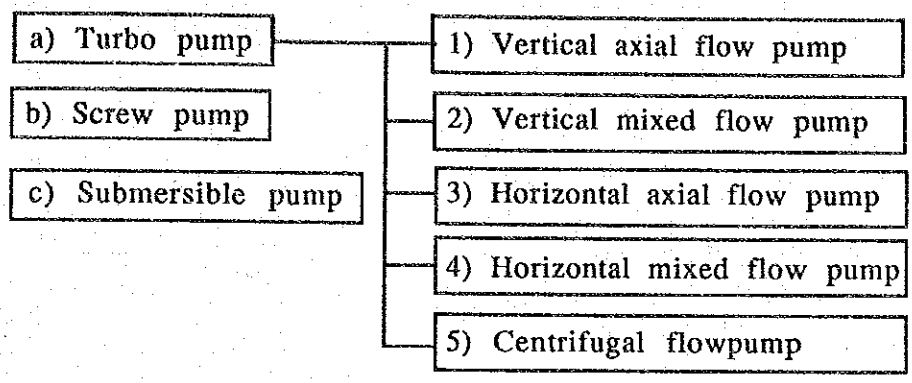
3. Total loss head

$$H = hf_s + hf_7 + hf_d + Ha = 0.3 + 0.7 + 0.4 + 2.0 = 3.4 \text{ m}$$

- hf_s : Screen loss (in case of hand raking, 0.3m)
- hf_7 : Pipe loss (as show in abow Section 2, 0.7m)
- hf_d : Sluice Gate loss (using 20 m^3/s of future discharge,0.40m)

FIG. D. 3 TOTAL LOSS HEAD FOR PUMPING

PUMP TYPE



APPLICABLE RANGE IN TOTAL PUMP HEAD AND PUMP DIA.

Pump type		Applicable range in Total Pump Head	Available Pump Dia.(mm)	Remarks
Axial flow	Horizontal	Less than 3 m	Less than 2,000 Ø	
	Vertical	Less than 5 m	Less than 4,600 Ø	
Mixed flow	Horizontal	Less than 7 m	Less than 2,200 Ø	
	Vertical	Less than 9 m	Less than 4,600 Ø	
Centrifugal flow pump	Horizontal	More than 10 m	Less than 1,600 Ø	
	Vertical	More than 10 m	Less than 2,000 Ø	
Secrew pump		Less than 8 m	Less than 3,500 Ø	
Submersible pump		Less than 20 m	Less than 1,800 Ø	

FIG. D. 4 PUMP TYPE SELECTION

P L A N

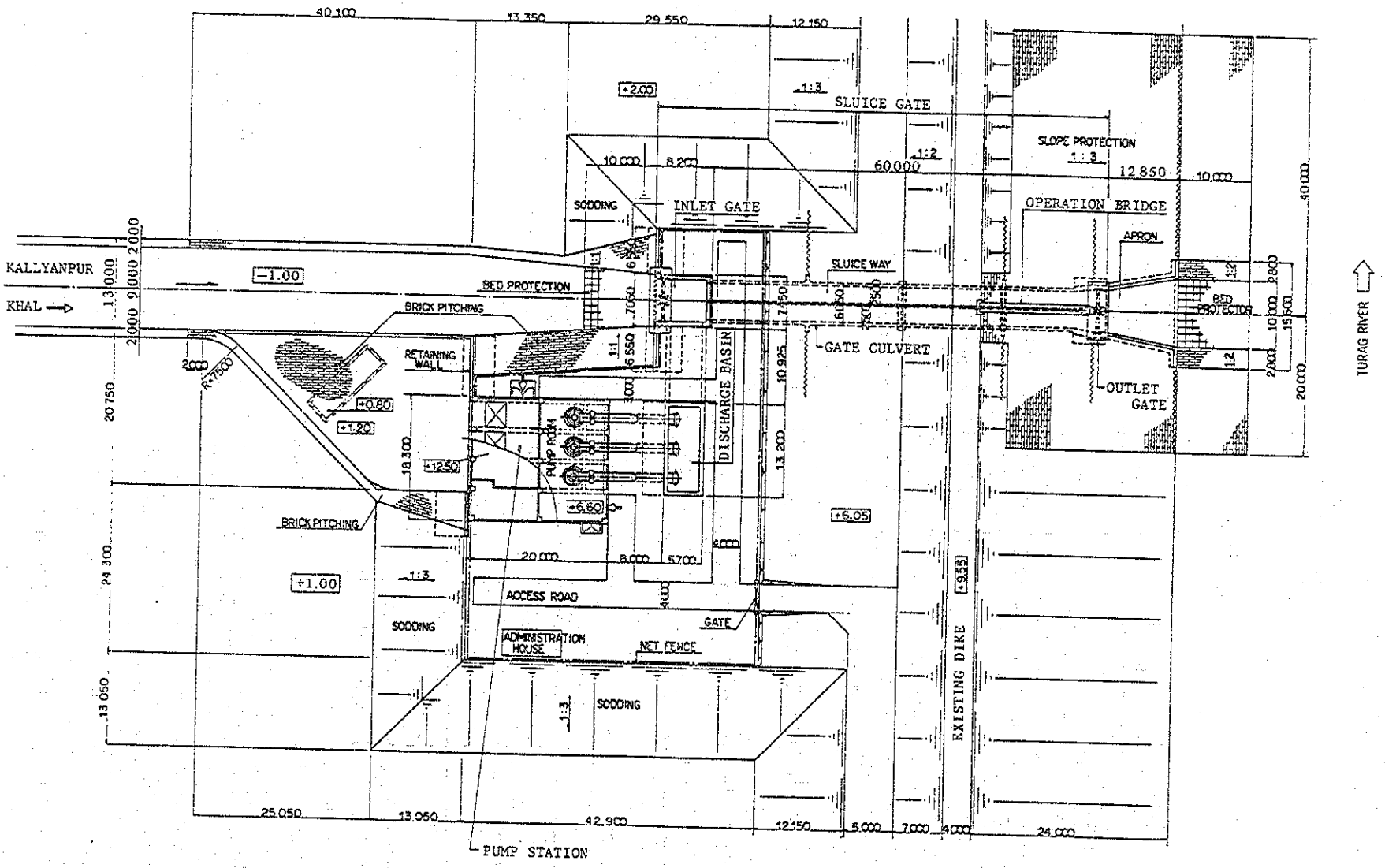
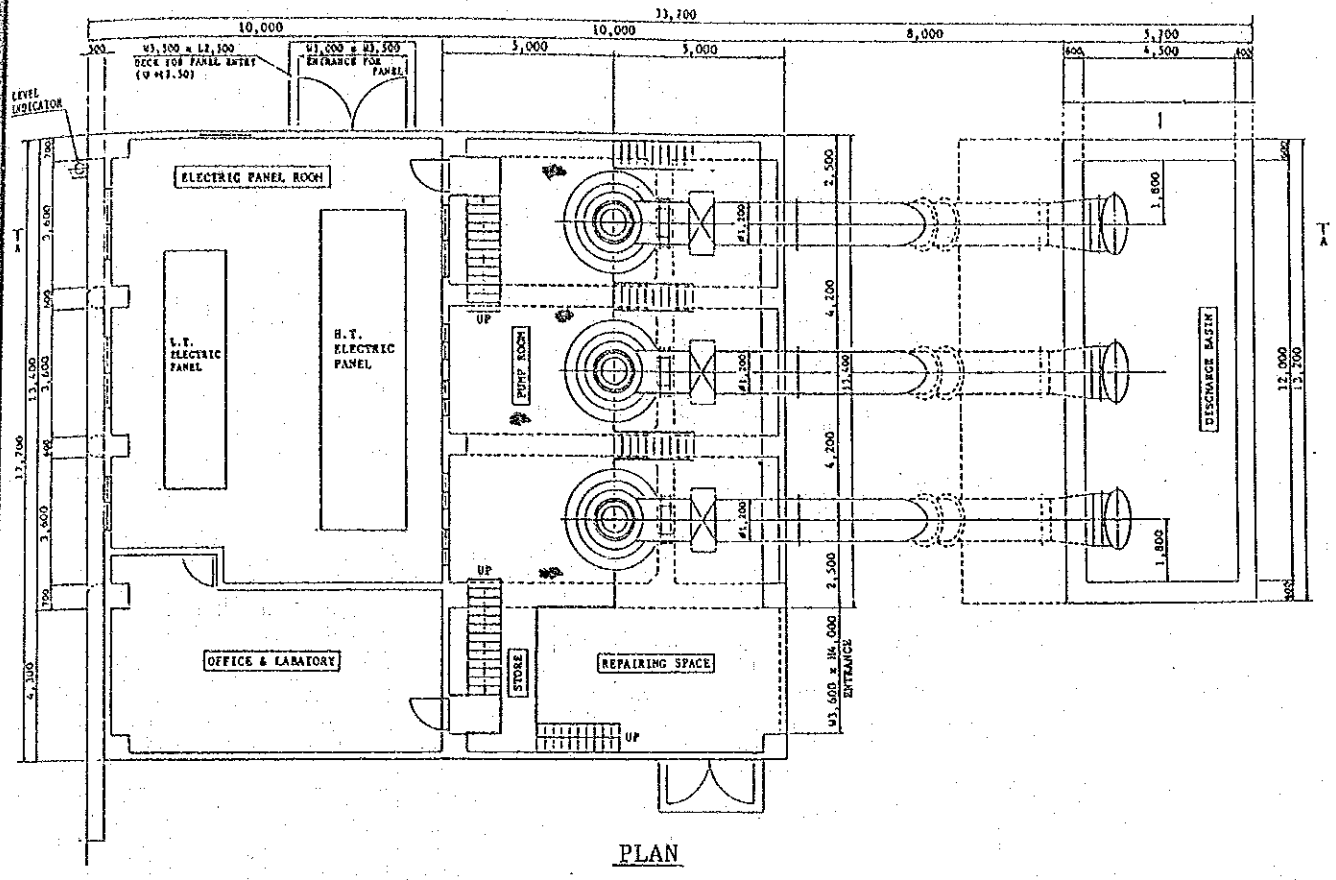
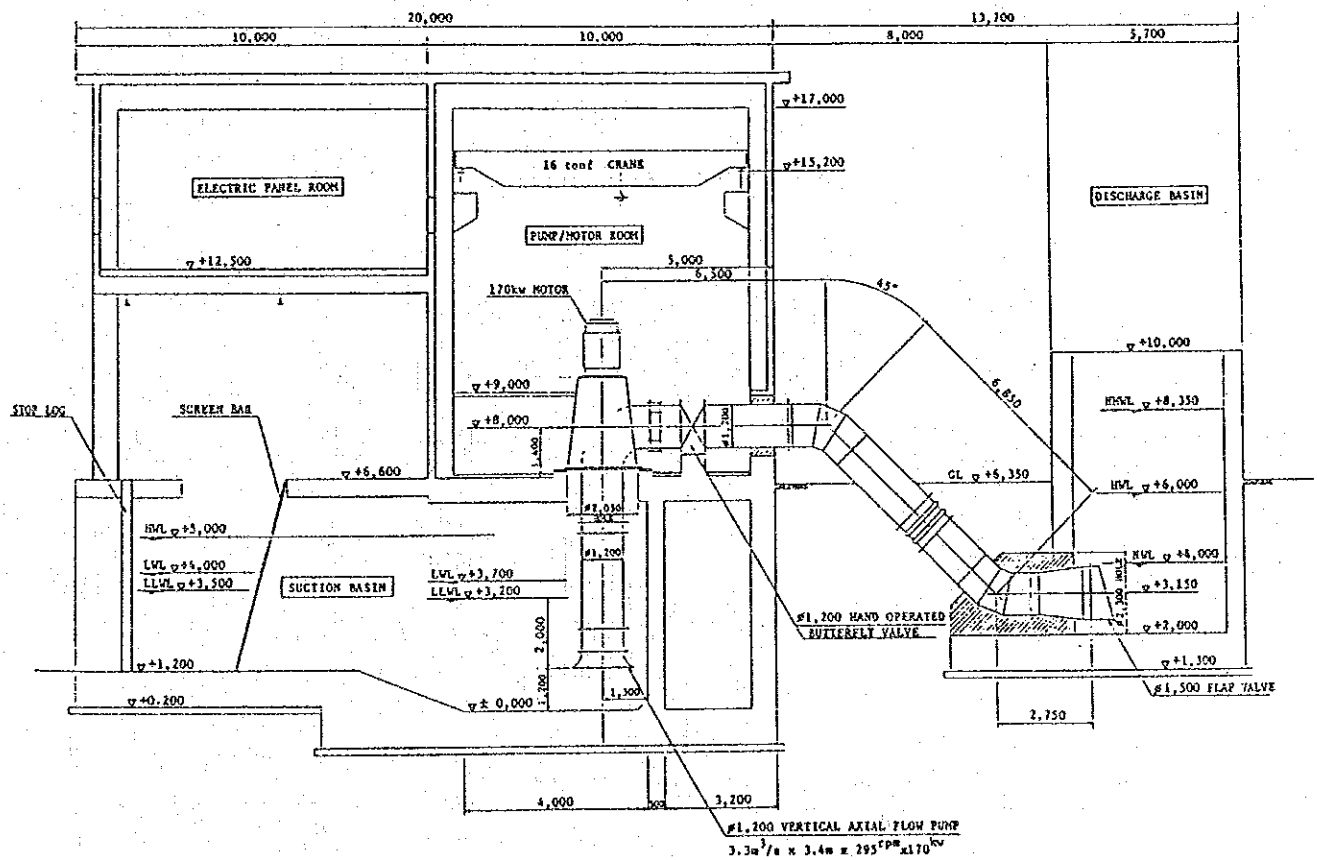


FIG. D. 5 GENERAL LAYOUT OF PUMP STATION AND SLUICE GATE

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



PLAN

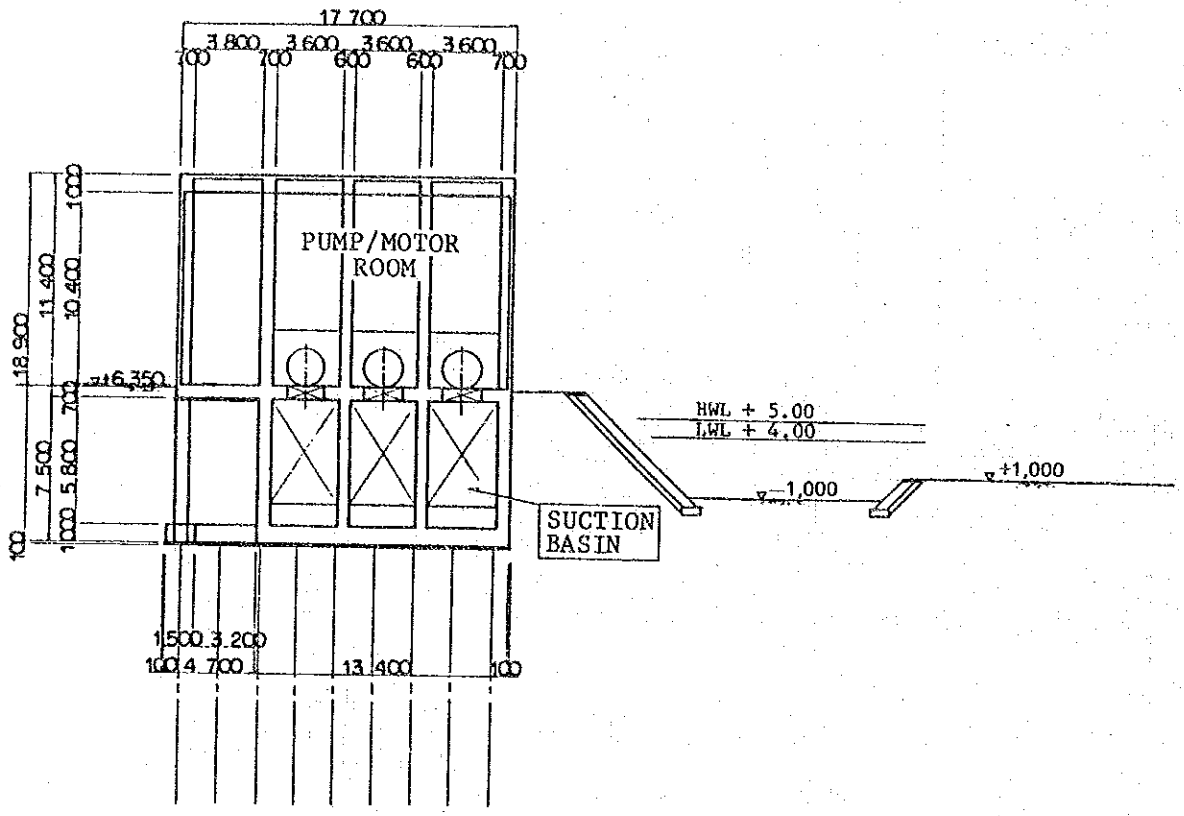


SECTION

FIG. D. 6 TYPICAL DESIGN OF PUMP STATION (1)

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

SECTION C – C



SECTION D – D

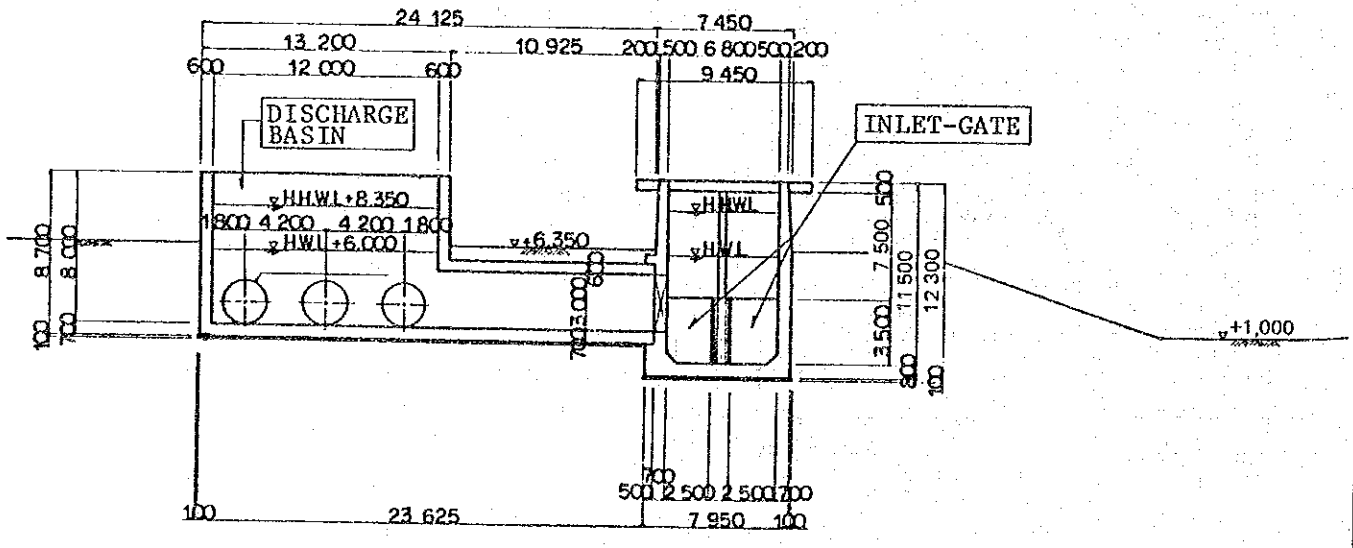


FIG. D. 7 | TYPICAL DESIGN OF PUMP STATION (2)

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

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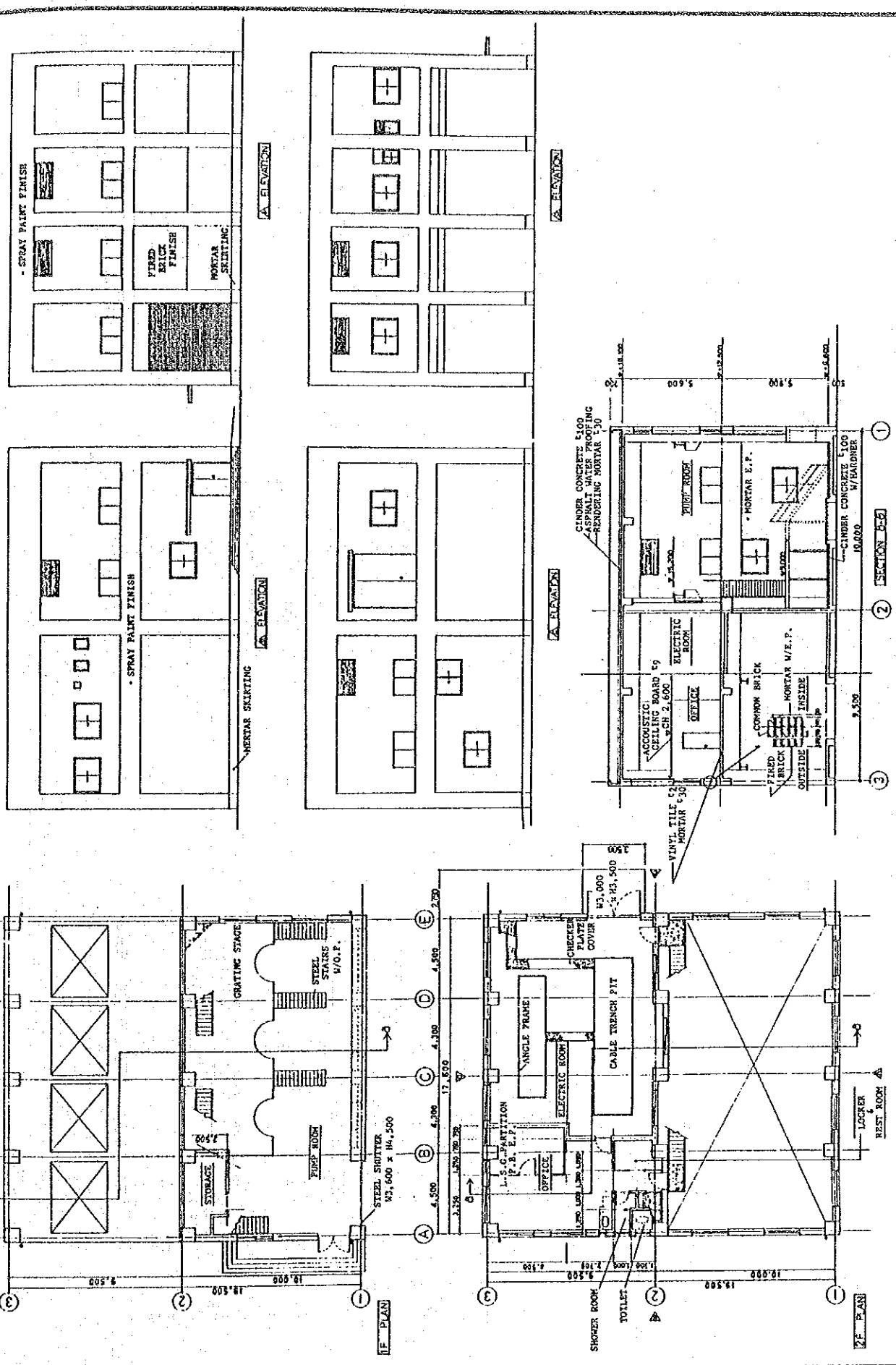
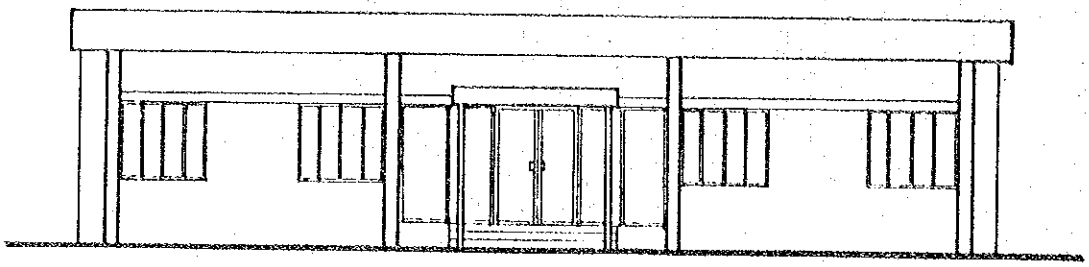
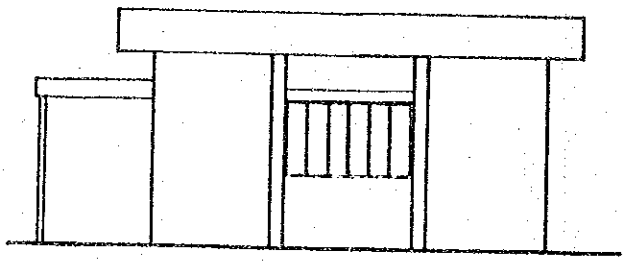


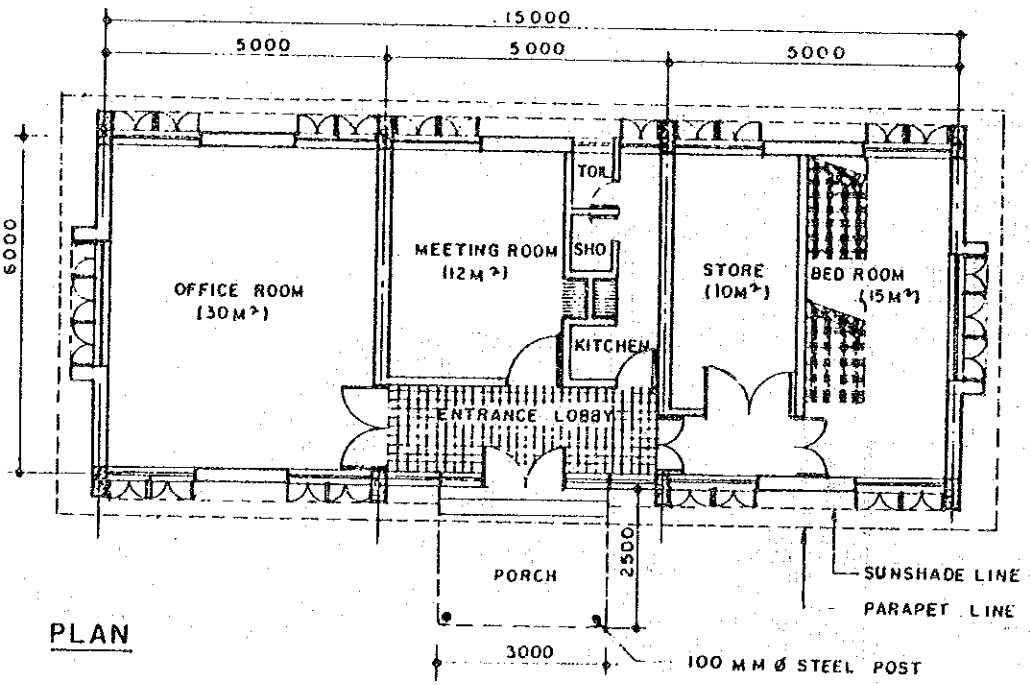
FIG. D. 8 TYPICAL DESIGN OF PUMP STATION (3)



FRONT VIEW



RIGHT SIDE VIEW



PLAN

FIG. D. 9 TYPICAL DESIGN OF ADMINISTRATION BUILDING

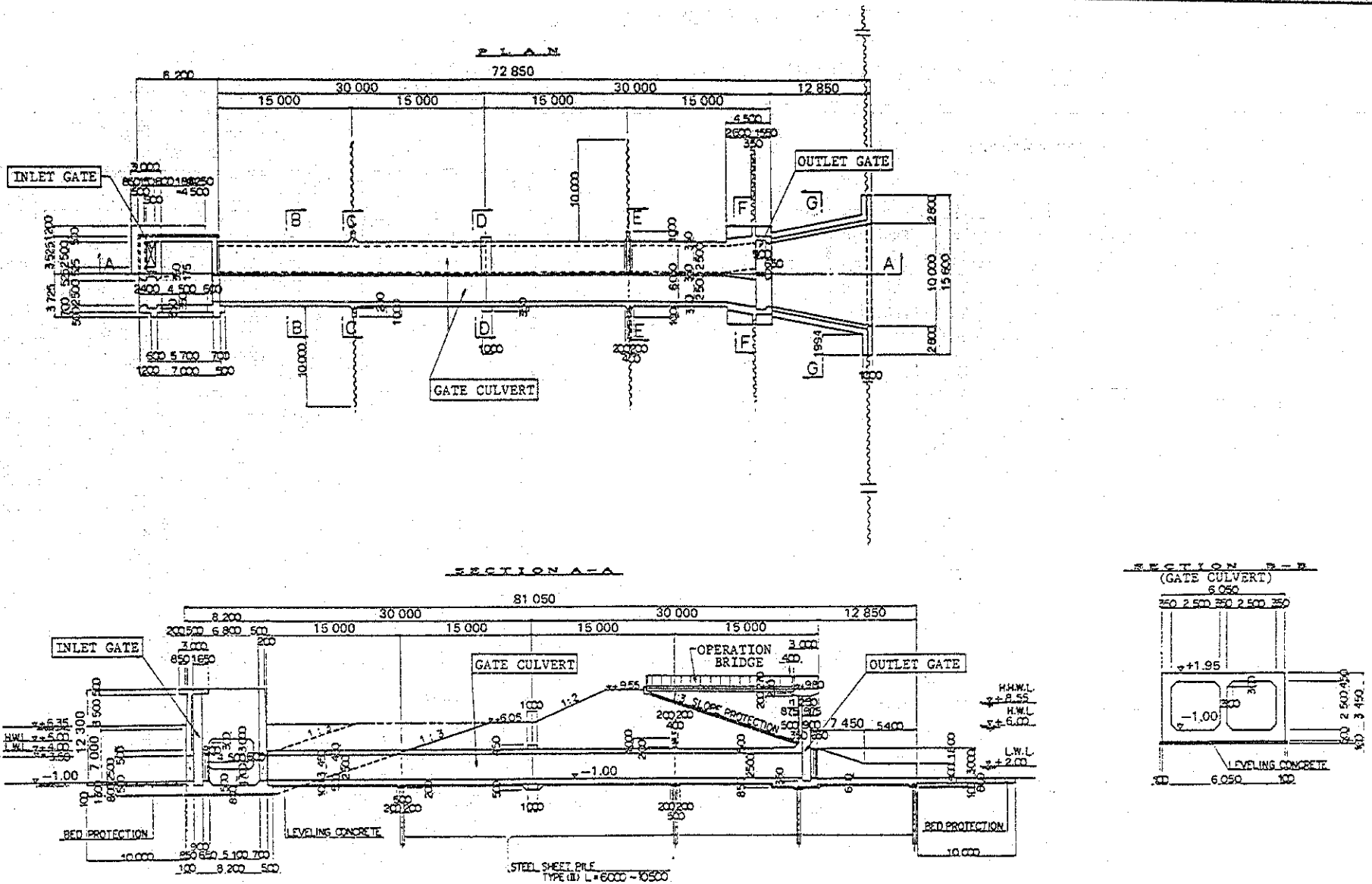


FIG. D. 10 TYPICAL DESIGN OF SLUICE GATE (1)

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

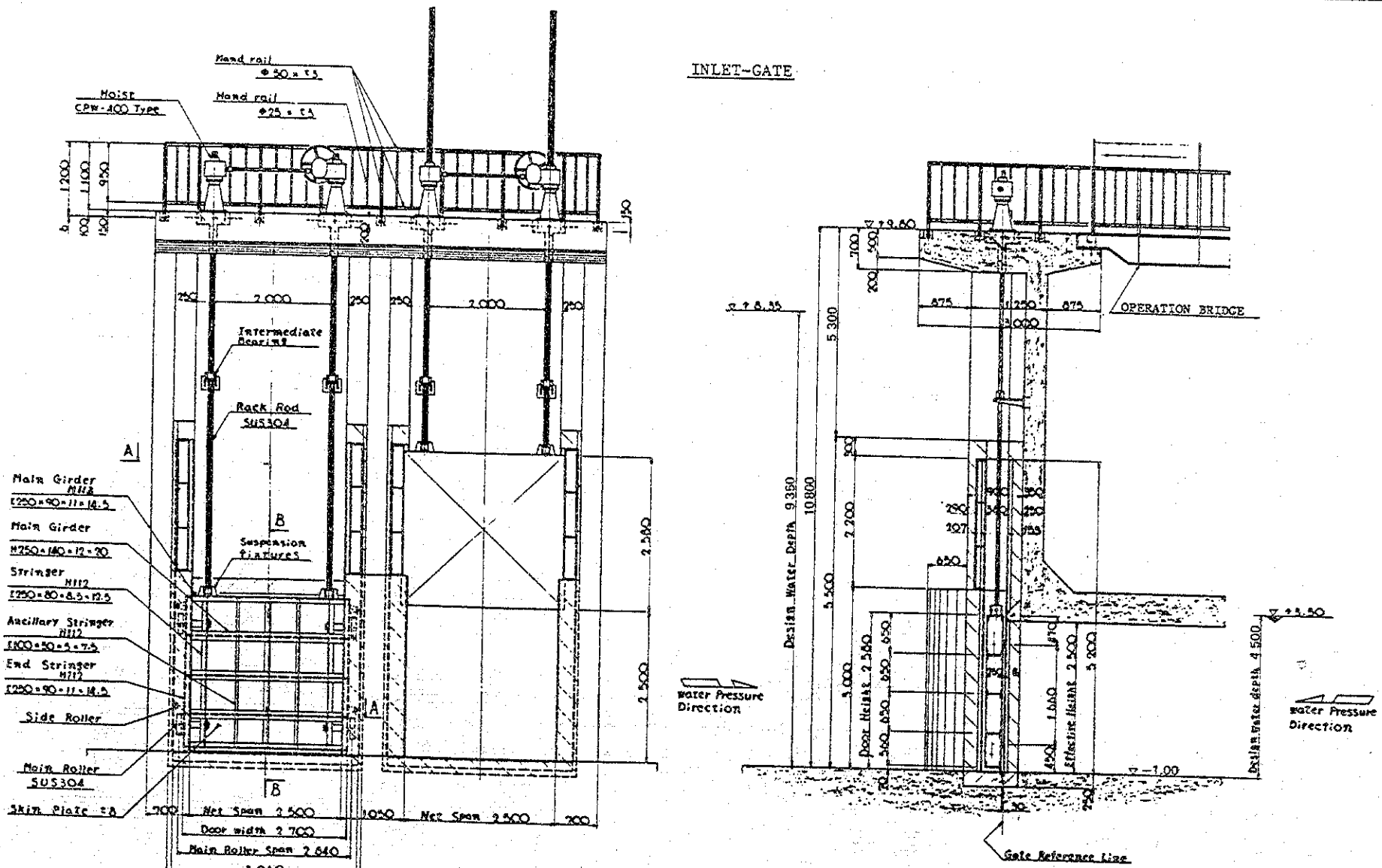
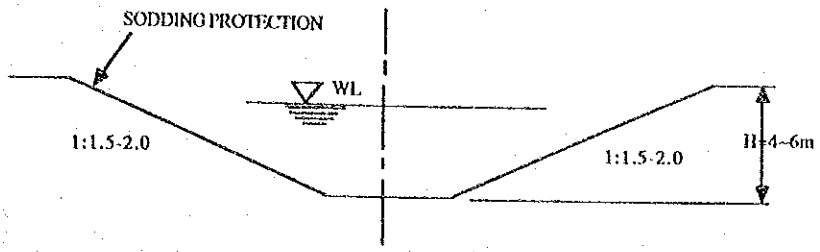


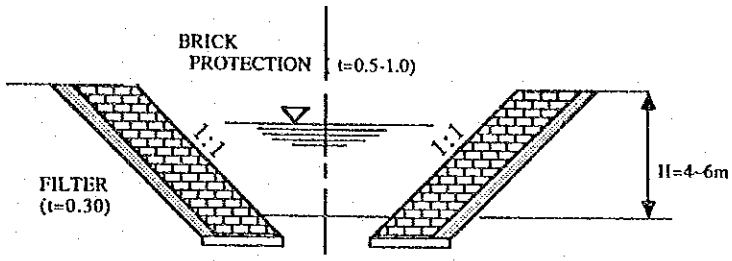
FIG. D. 11 TYPICAL DESIGN OF SLUICE GATE (2)

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

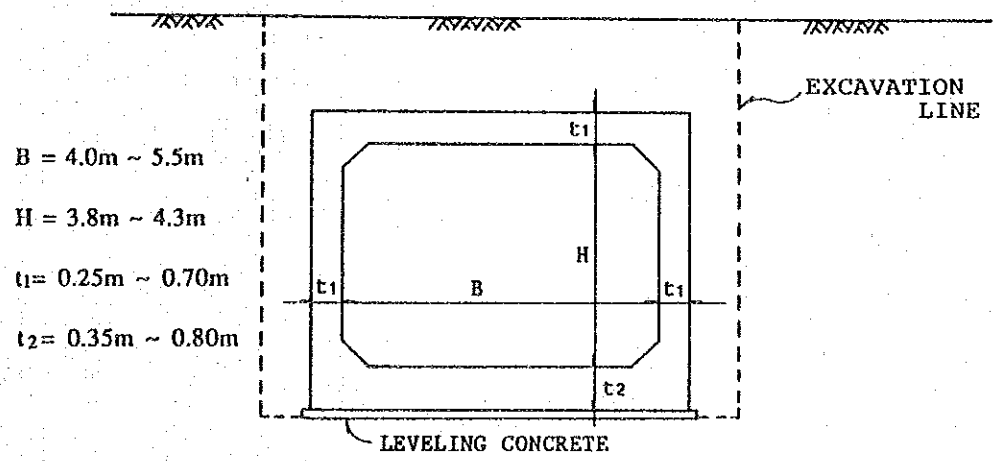
TYPE - 1 : TRAPEZOIDAL TYPE (1) - SODDING PROTECTION



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



TYPE - 3 SINGLE BOX CULVERT



TYPE - 4 DOUBLE BOX CULVERT

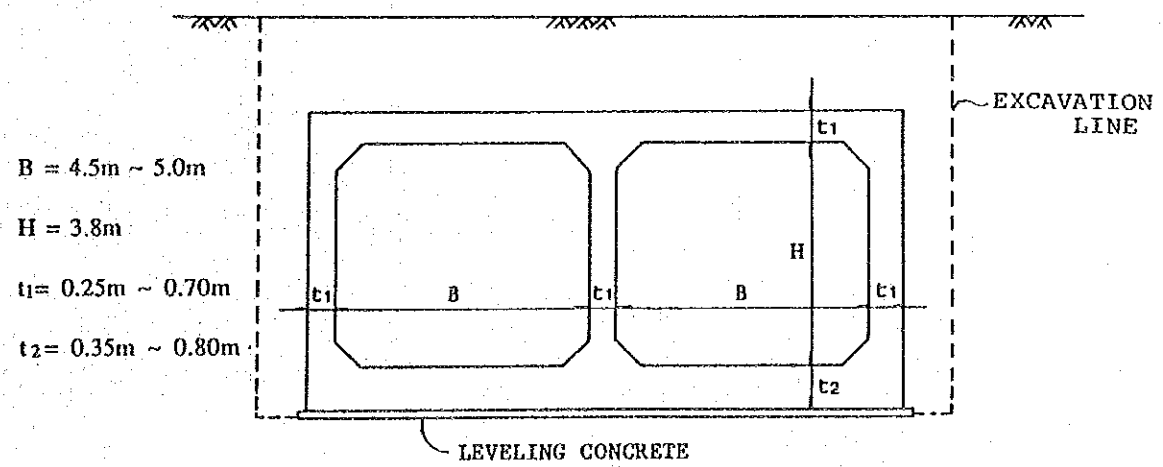
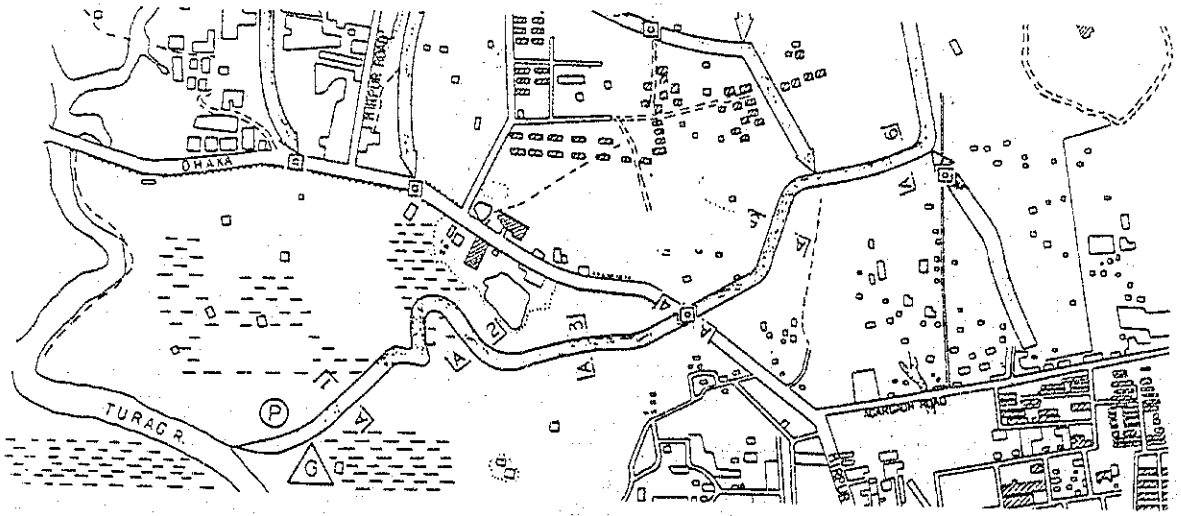


FIG. D. 12 TYPICAL SECTION OF KHAL IMPROVEMENT

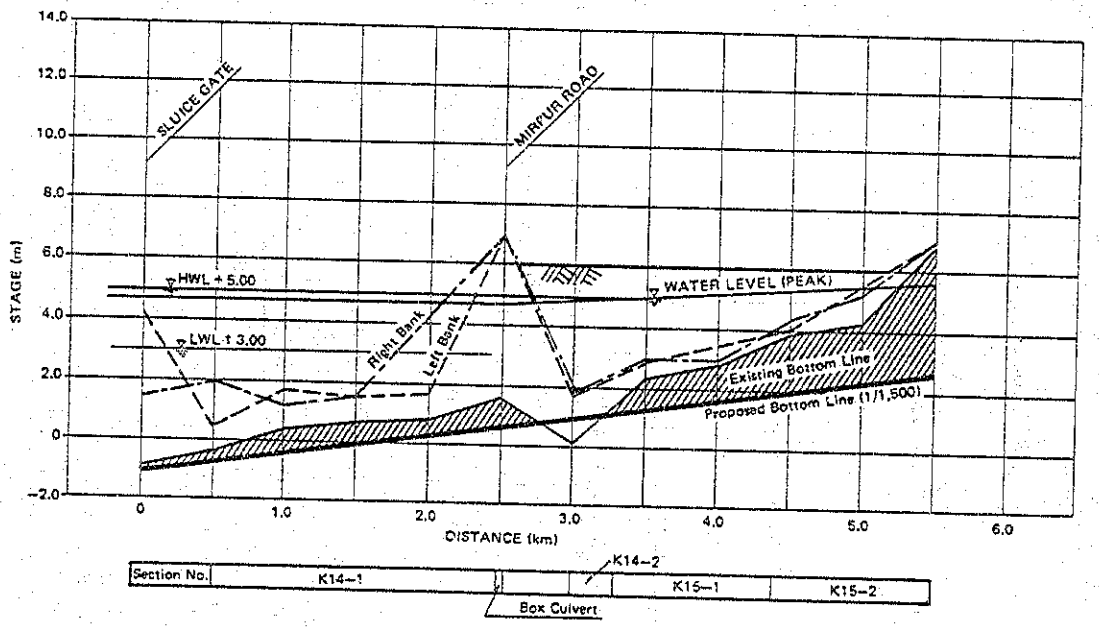
GENERAL VIEW OF KALLYANPUR KHAL

PLAN

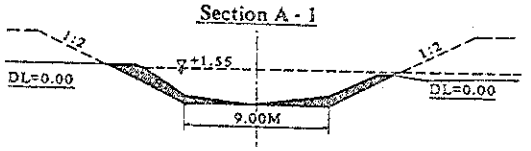
SCALE 1 : 20,000



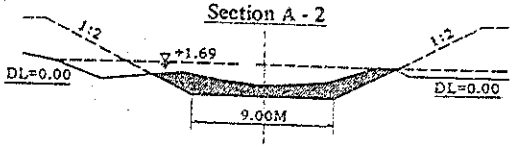
PROFILE



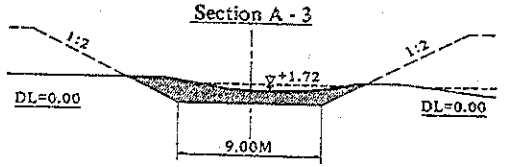
Section A - 1



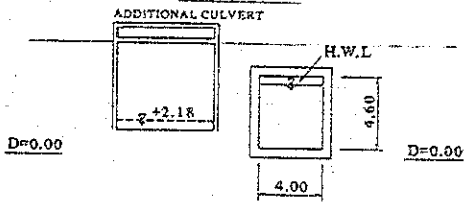
Section A - 2



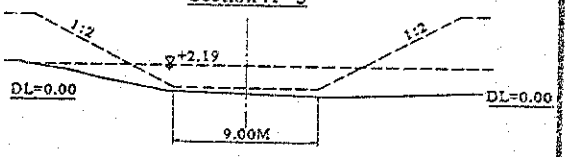
Section A - 3



Section A - 4



Section A - 5



Section A - 6

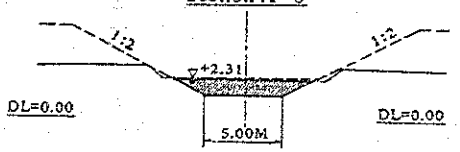
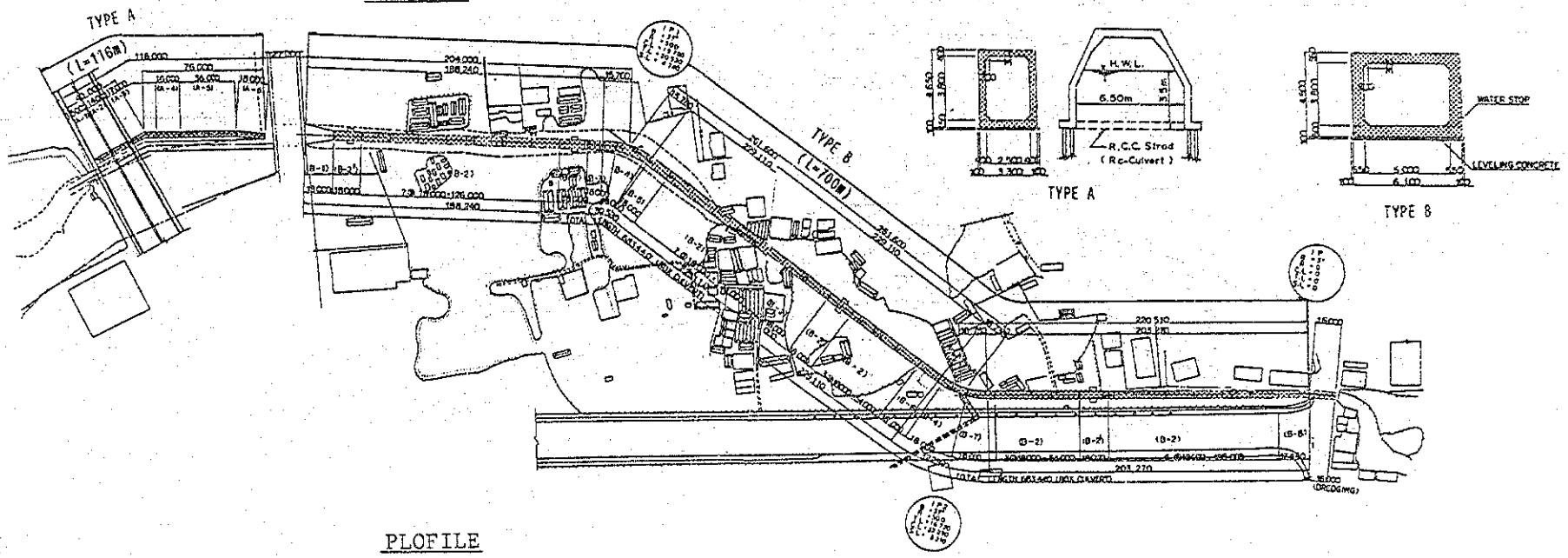


FIG. D. 13 (1) TYPICAL DESIGN OF KHAL IMPROVEMENT (1)
- KALLYANPUR KHAL IMPROVEMENT -

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

PLAN



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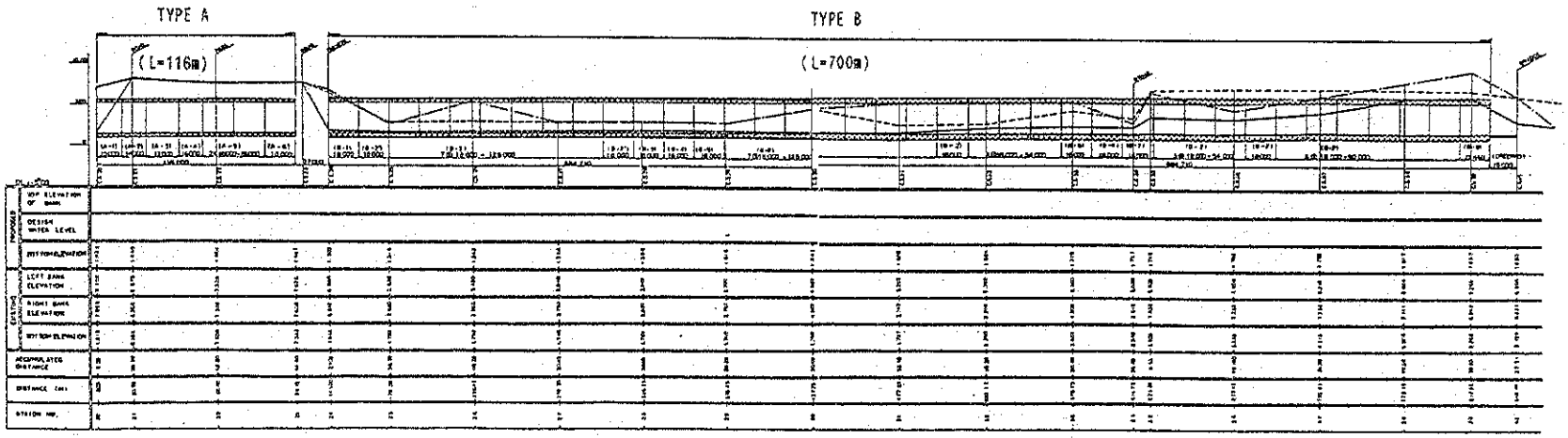


FIG. D. 13 (2)

TYPICAL DESIGN OF KHAL IMPROVEMENT (2)
- BOXCULVERT AT BEGUNBARI KHAL -

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

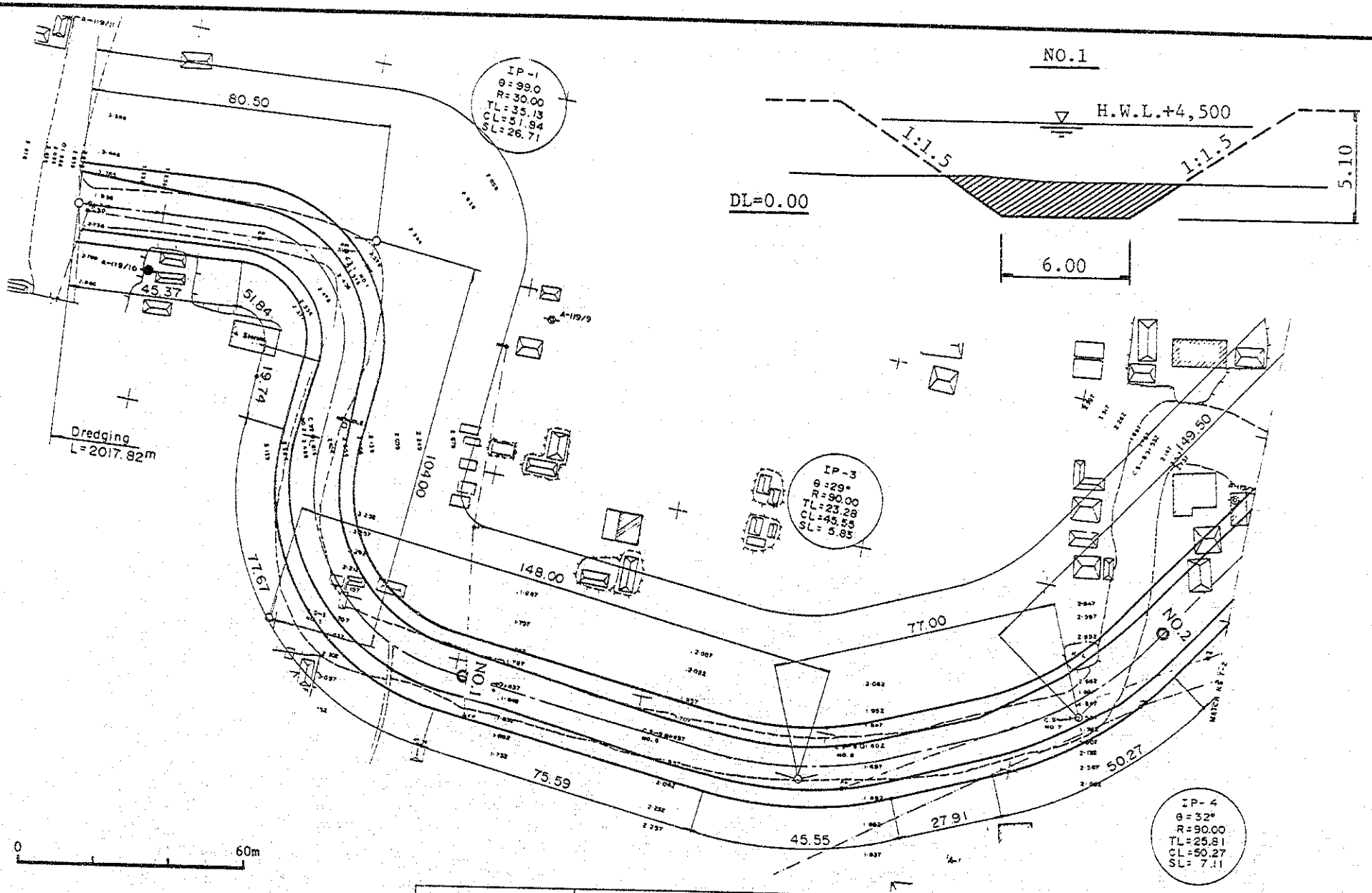
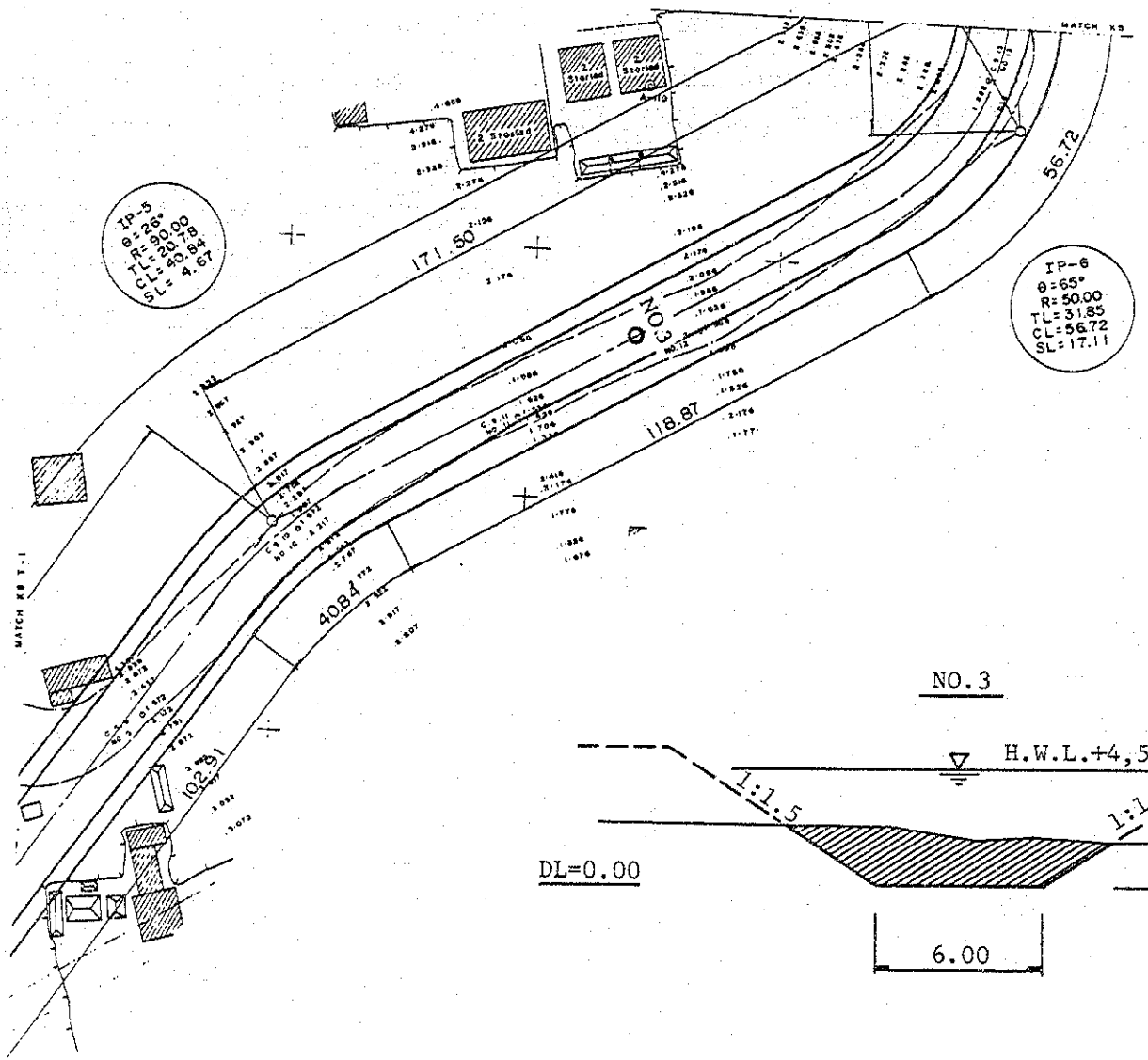


FIG. D. 13 (3) TYPICAL DESIGN OF KHAL IMPROVEMENT (3)
SEGUNBAGICHA KHAL (a)

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



0 60m

FIG. D. 13 (4)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (b)

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

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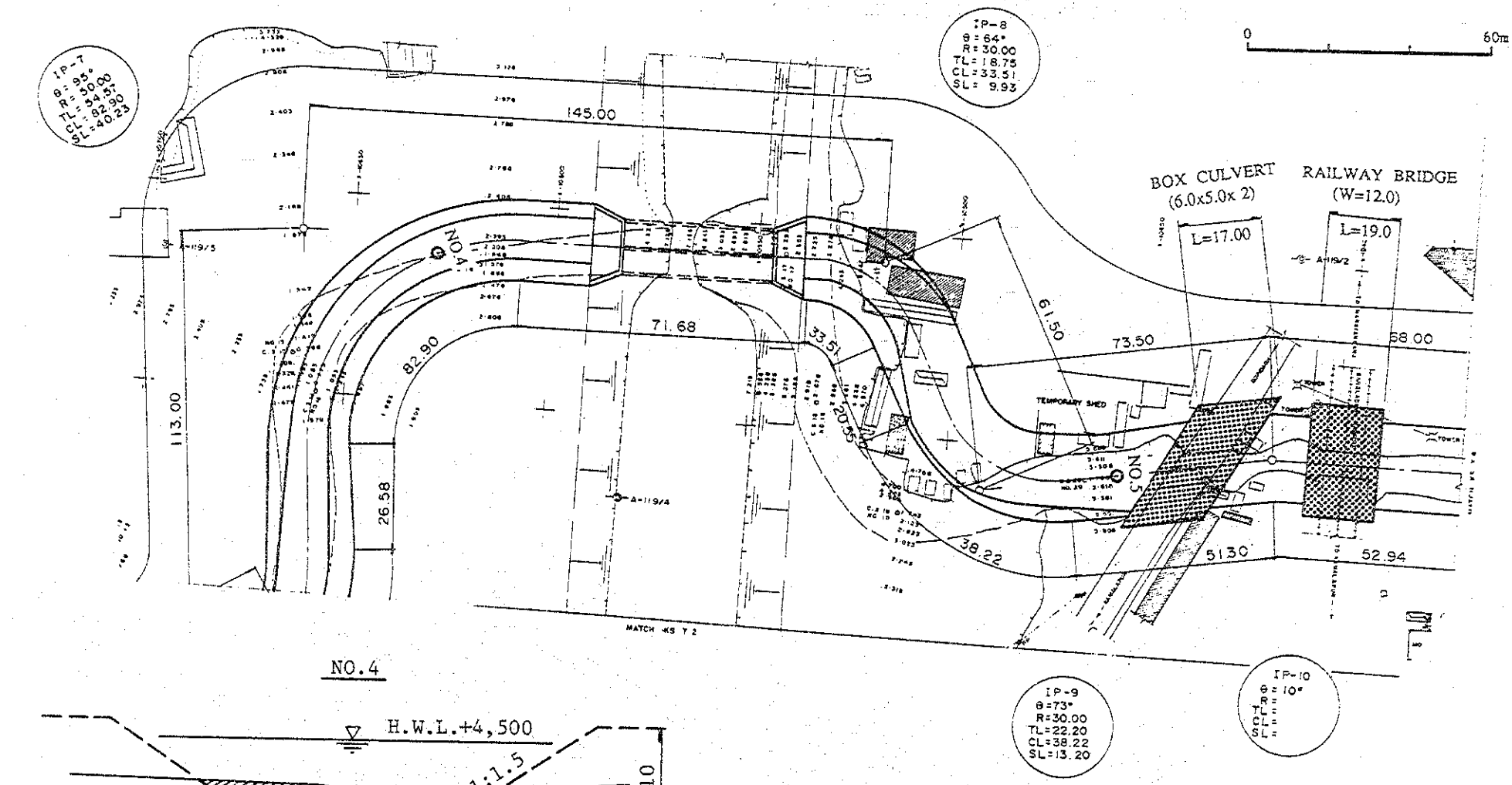
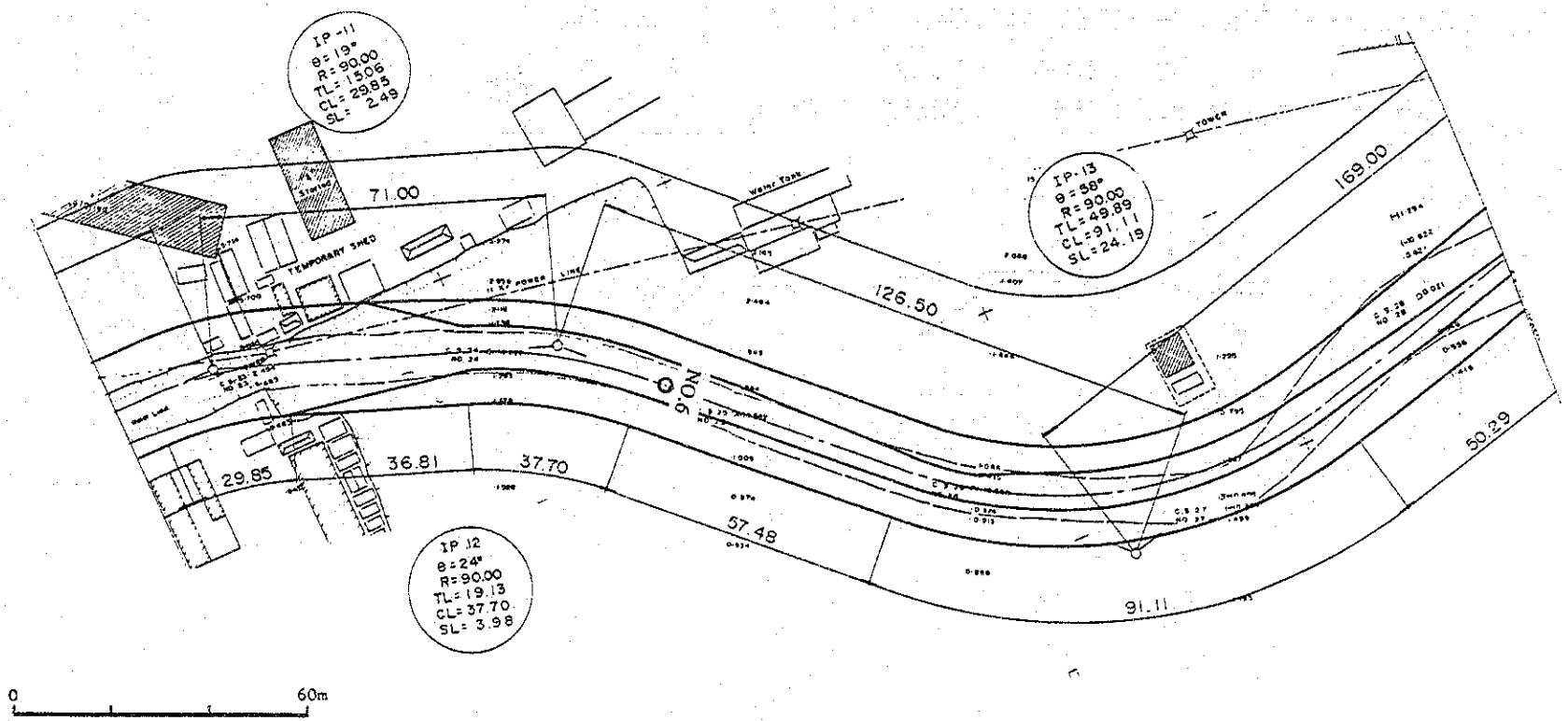


FIG. D. 13 (5) TYPICAL DESIGN OF KHAL IMPROVEMENT (3)
SEGUNBAGICHA KHAL (c)

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



NO.6

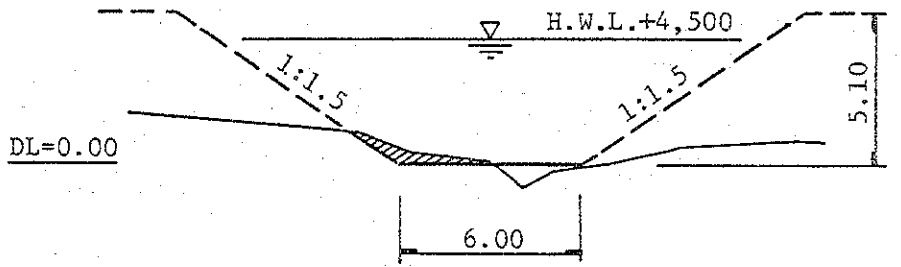
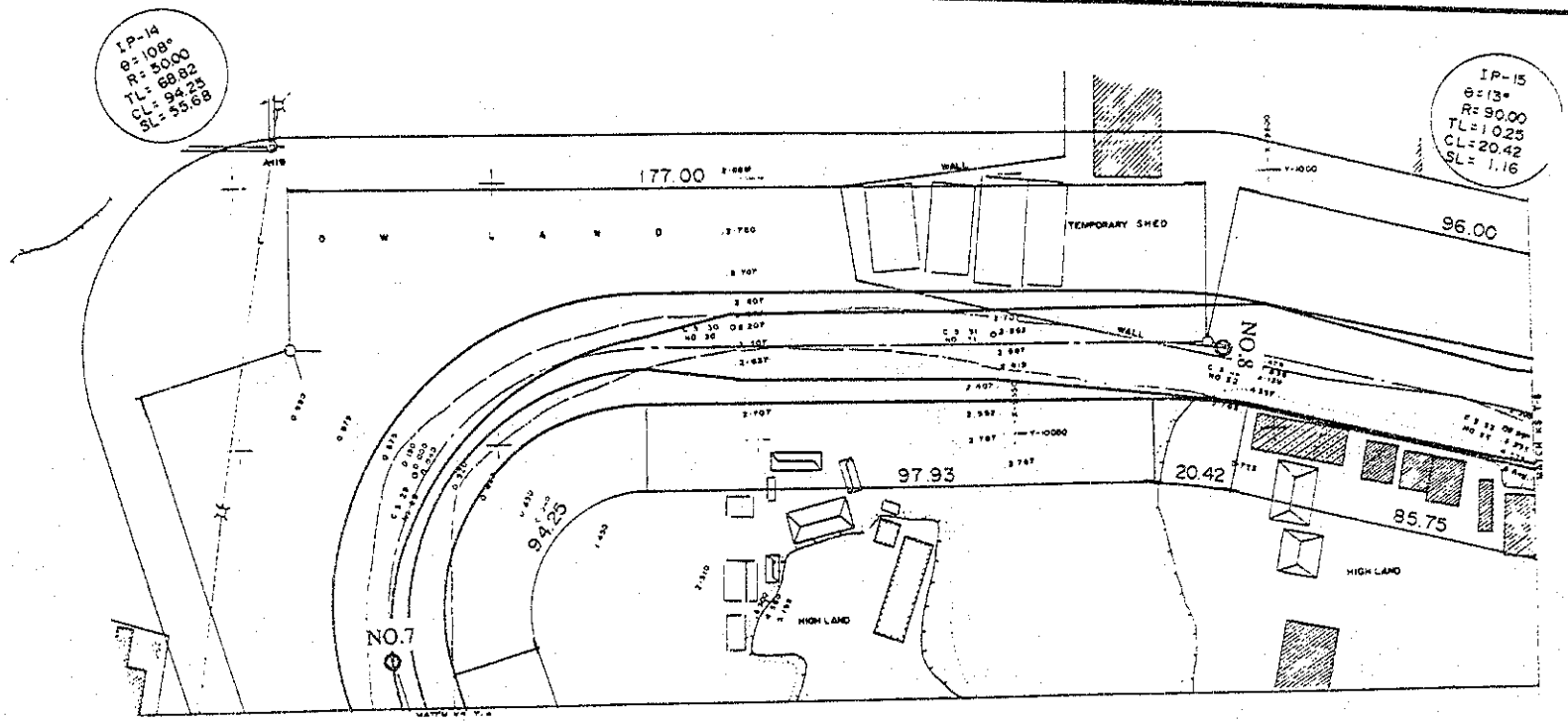


FIG. D. 13 (6)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (d)

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

JICA A.D 1990



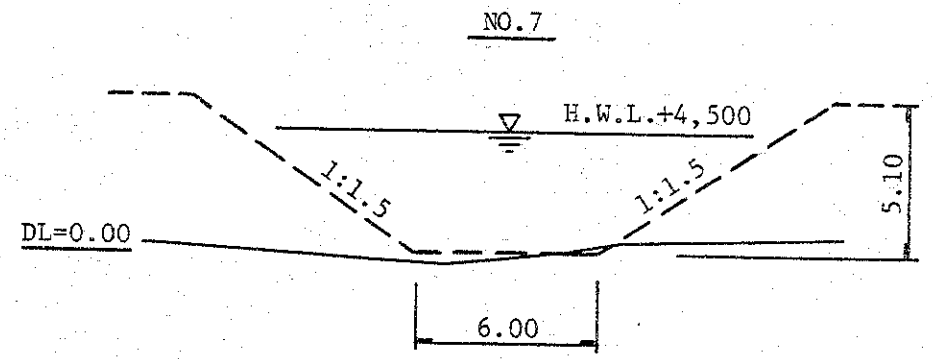


FIG. D. 13 (7)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (e)

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

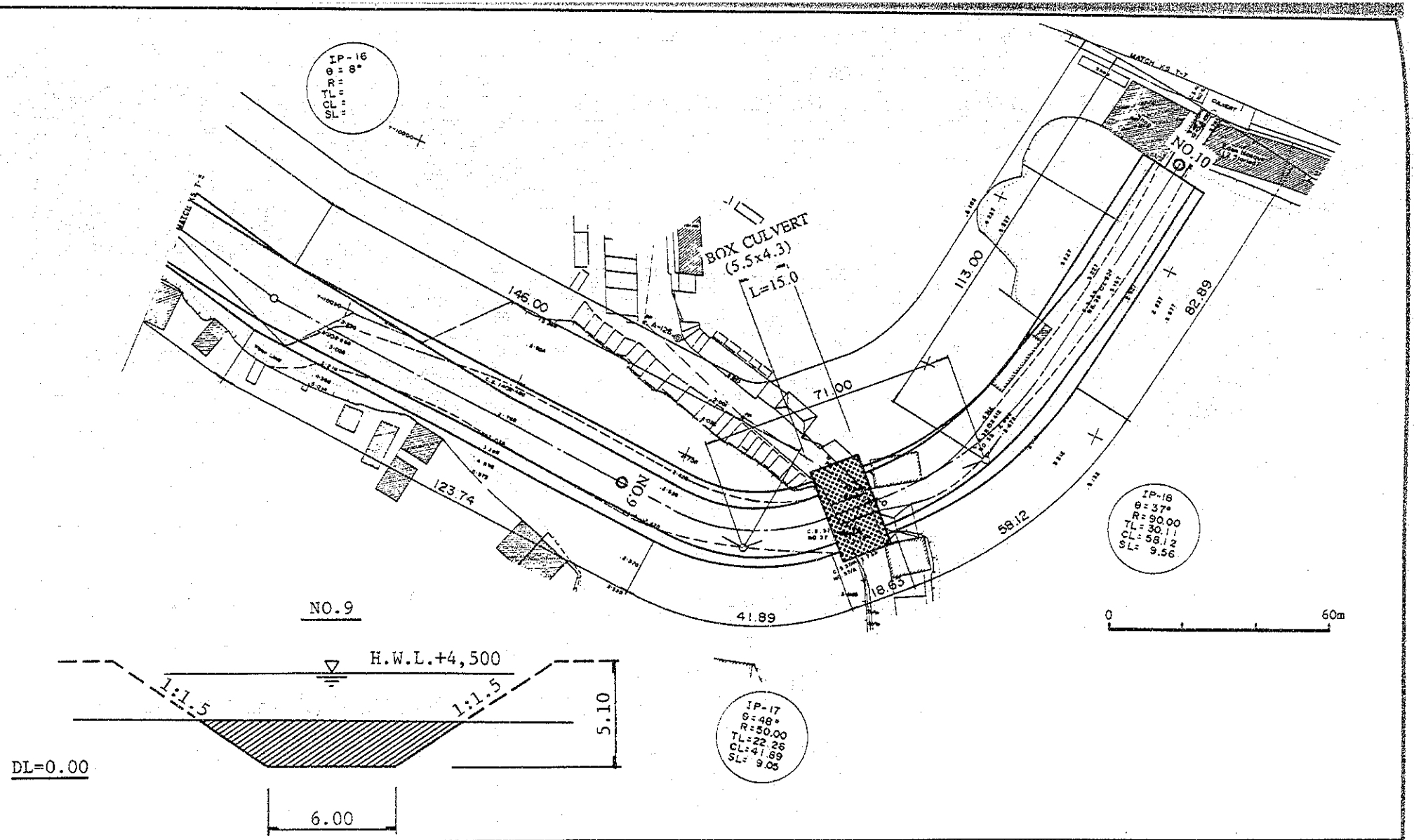


FIG. D. 13 (8)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (f)

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

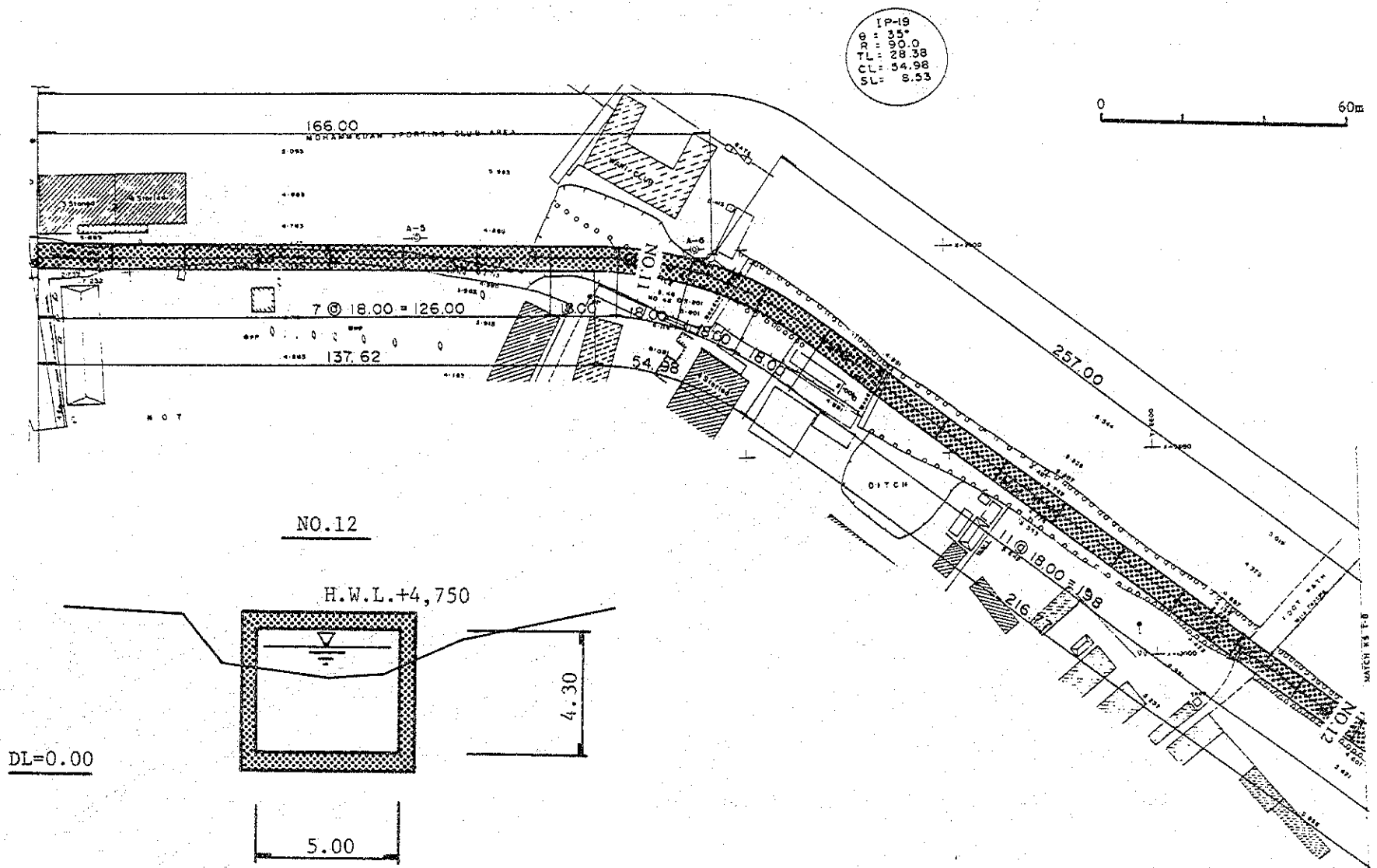


FIG. D. 13 (9)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (g)

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

JICA A.D 1990

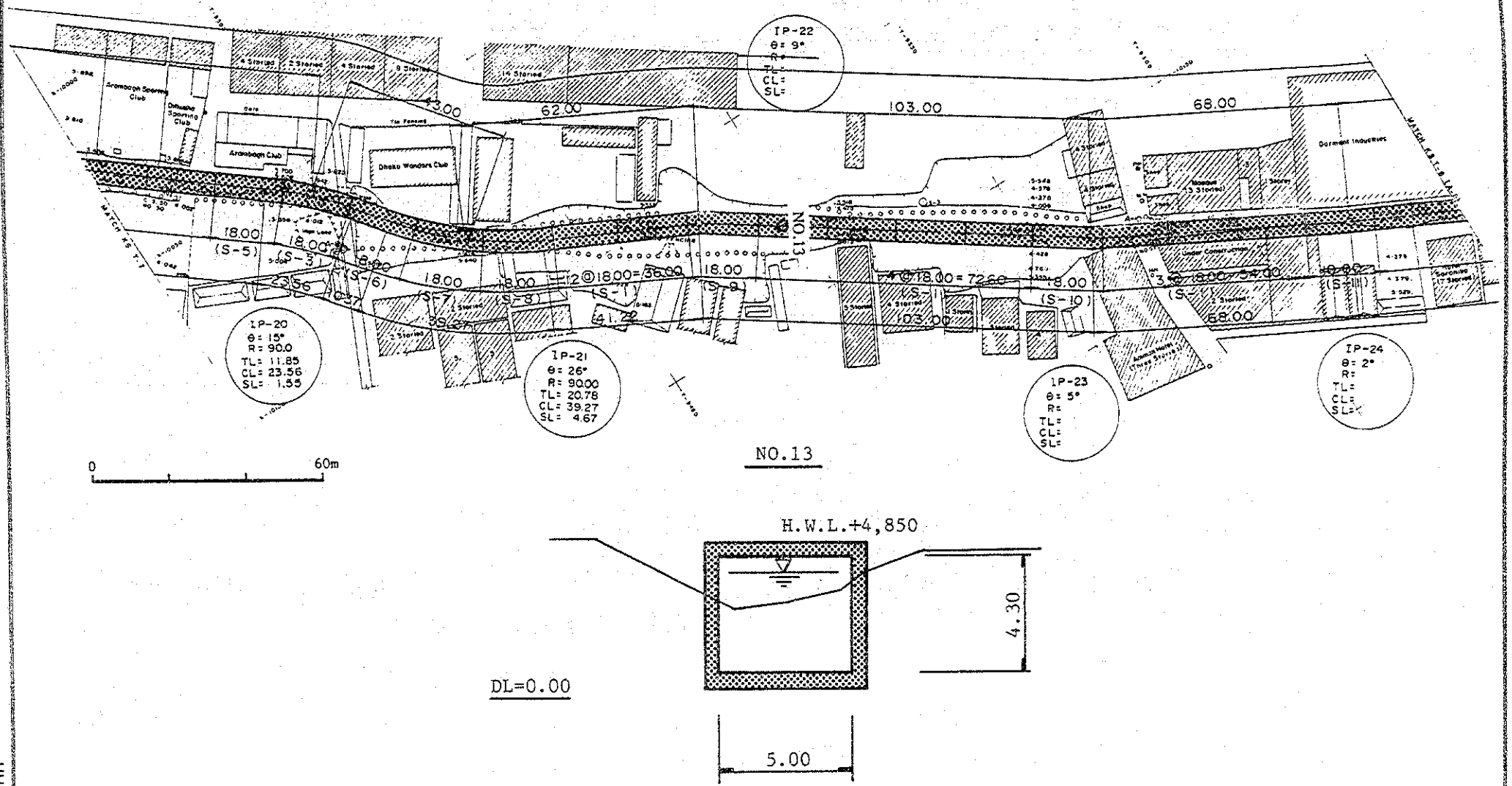
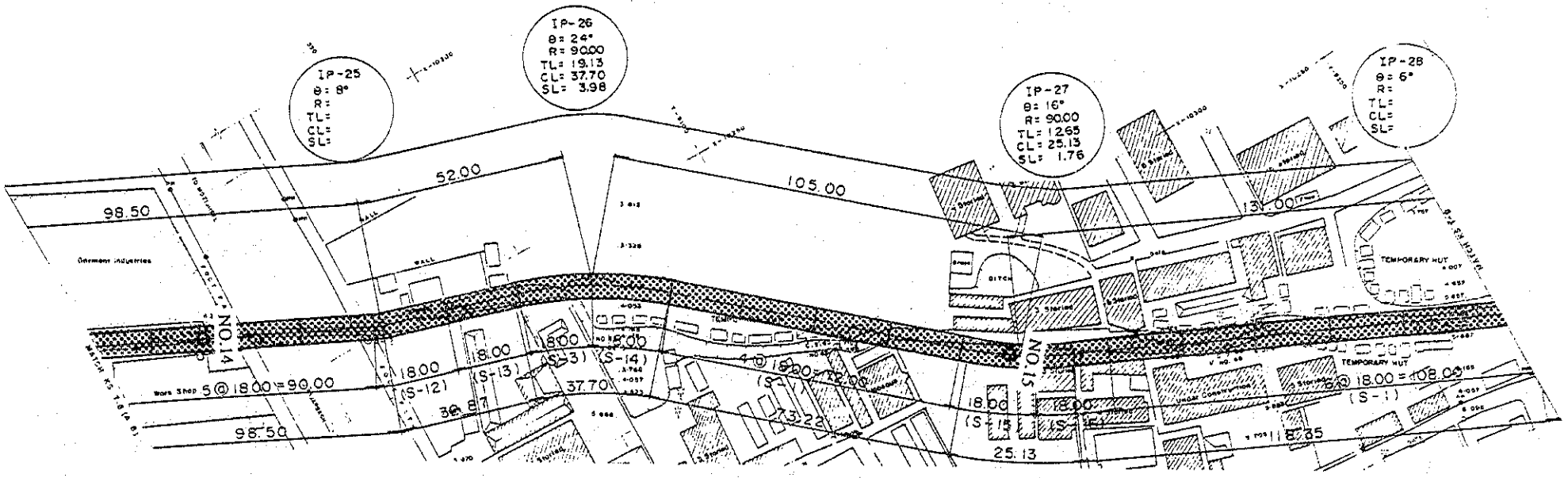


FIG. D. 13 (10)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (h)

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

JICA A.D 1990



NO.14

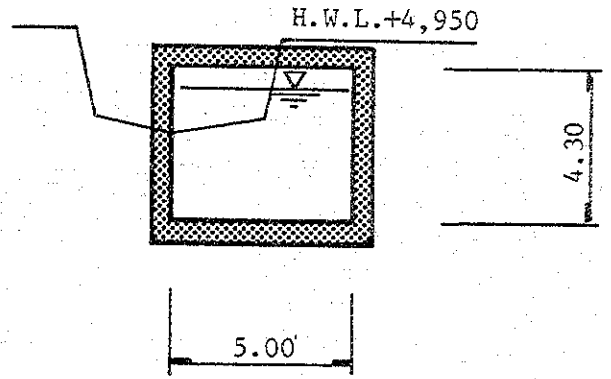


FIG. D. 13 (11)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (i)

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

JICA A.D 1990

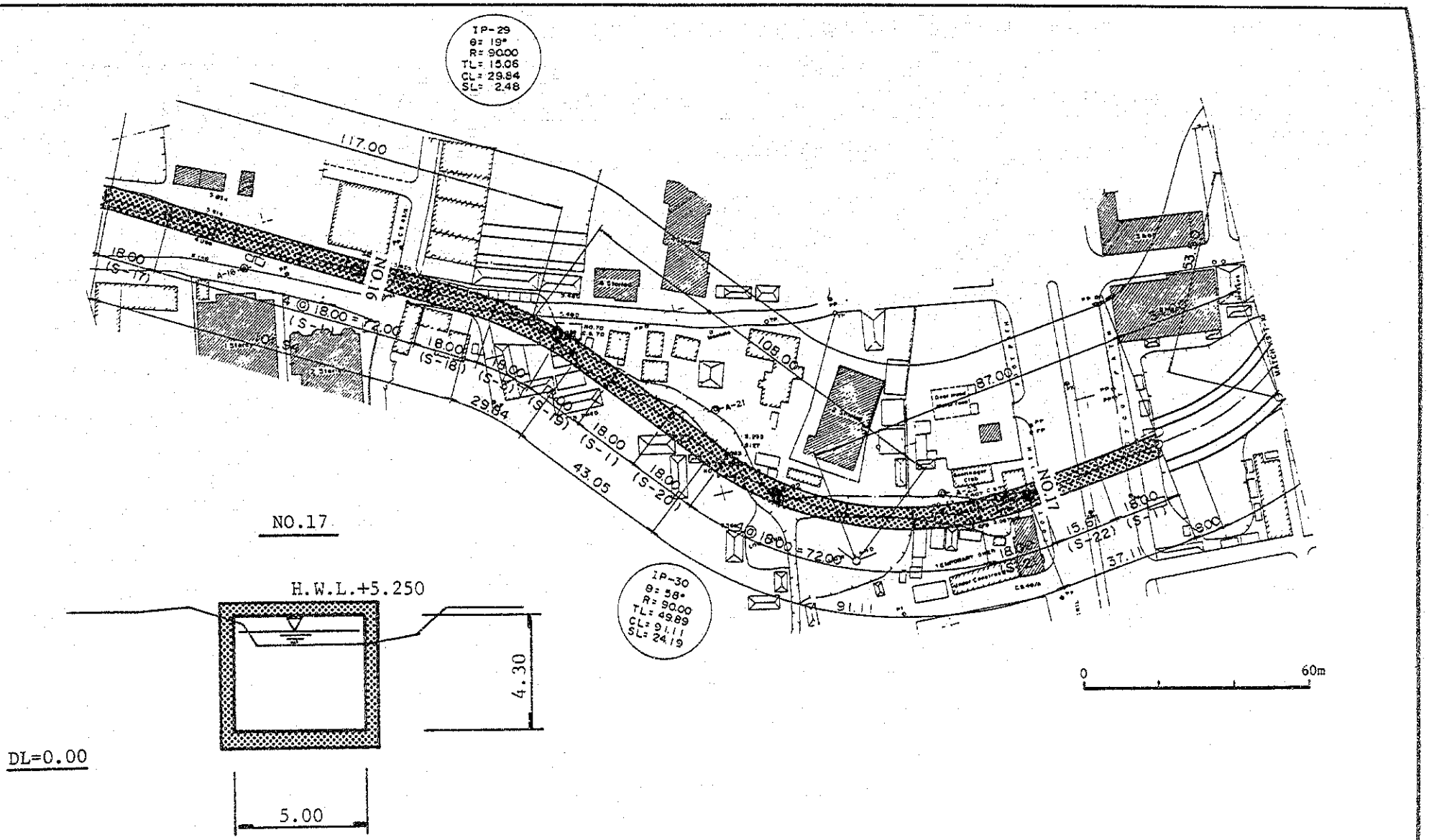


FIG. D. 13 (12)	TYPICAL DESIGN OF KHAL IMPROVEMENT (3) SEGUNBAGICHA KHAL (i)

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

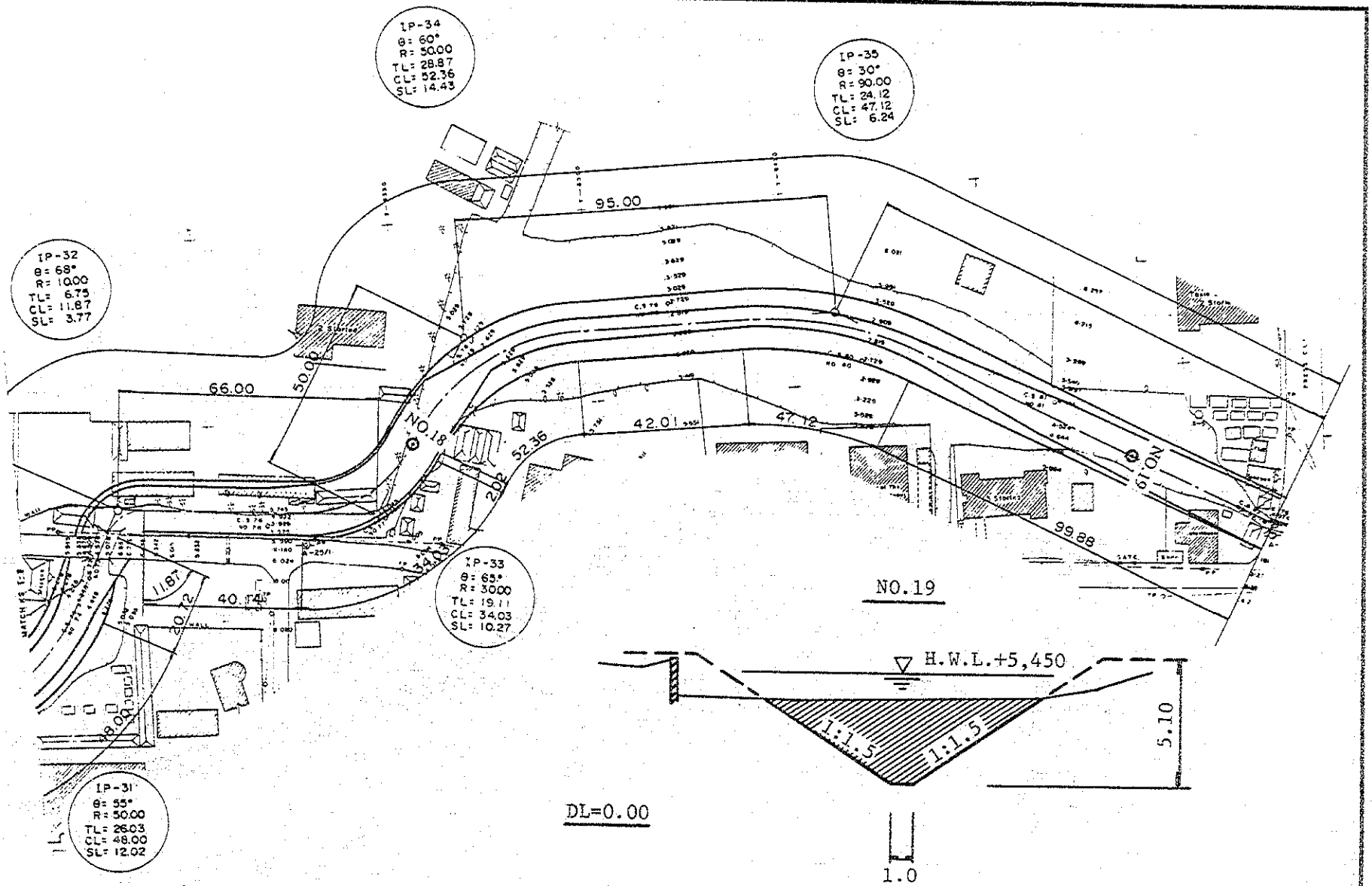
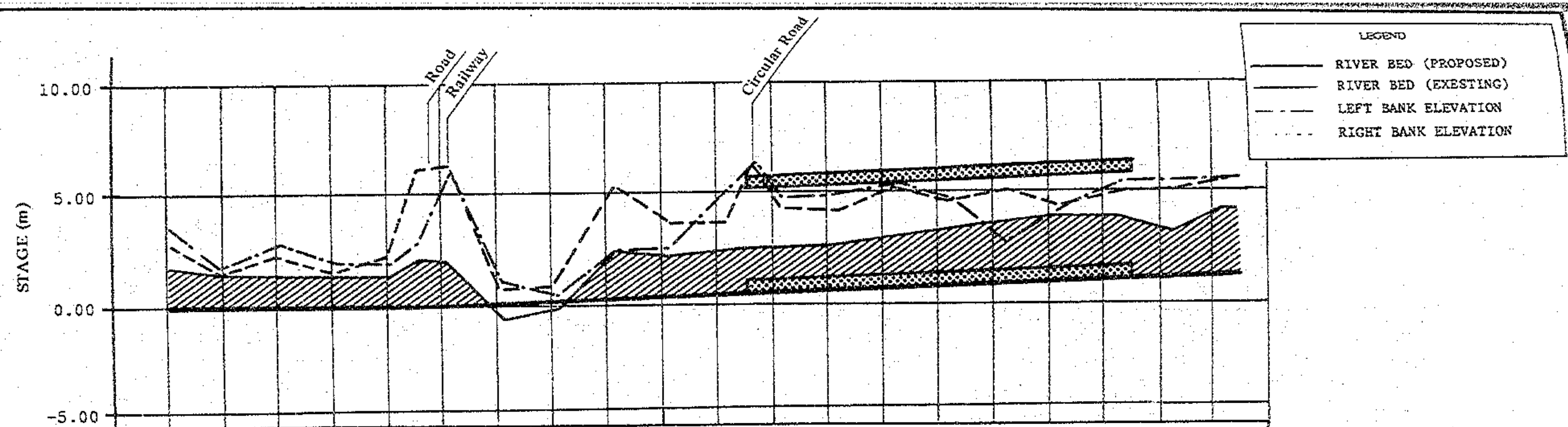


FIG. D. 13 (13) TYPICAL DESIGN OF KHAL IMPROVEMENT (3)
SEGUNBAGICHA KHAL (k)

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



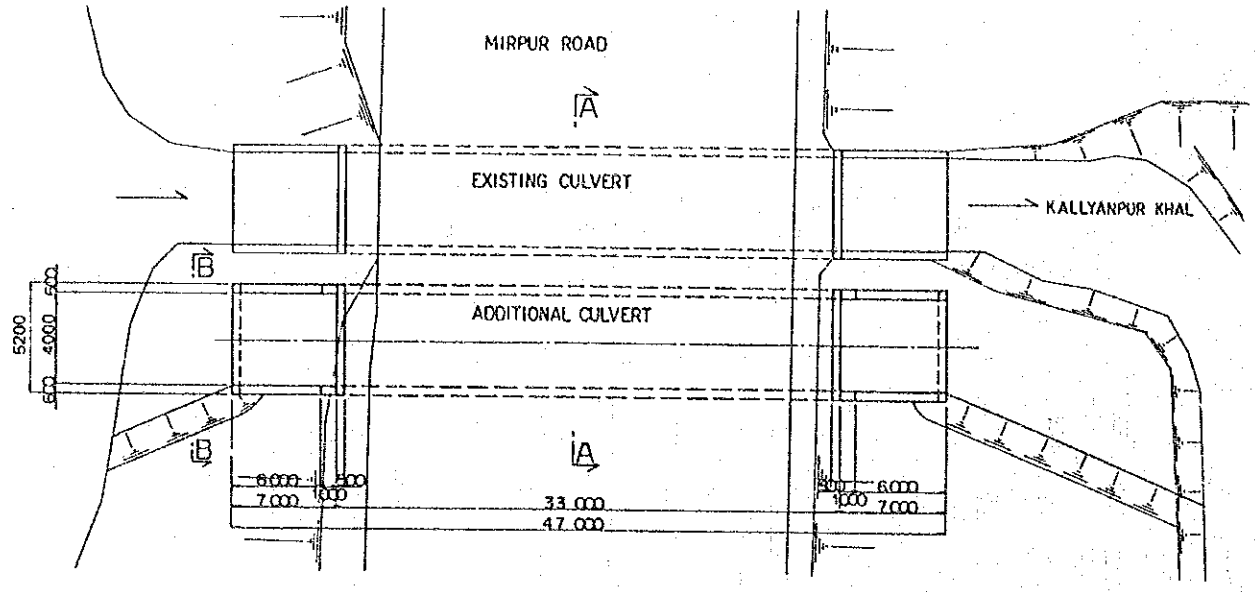
RIVER BED SLOP (PROPOSED): 0.00 — LEVEL — 0.00 — i = 0.05 o/oo — 1.47

SECTION NUMBER	SECTION DISTANCE (M)	CUMULATIVE DISTANT (M)	EXSTING RIVER BED ELEVATION (M)	EXSTING RIGHT BANK ELEVATION (M)	EXSTING LEFT BANK ELEVATION (M)	PROPOSED RIVER BED ELEAVATION (M)	PROPOSED FLOOD WATER LEVEL (M)	PROPOSED BANK ELEVATION
NO.0	0.0	0.0	1.72	2.82	3.40	0.00		
NO.1	200.0	200.0	1.65	1.80	1.90	0.00		
NO.2	200.0	400.0	1.60	2.42	2.66	0.00		
NO.3	200.0	600.0	1.61	1.71	2.11	0.00		
NO.4	200.0	800.0	1.50	2.40	2.08	0.00		
	100.0	900.0	2.28	6.29	3.07	0.00		
NO.5	100.0	1000.0	2.12	6.55	6.21	0.05		
NO.6	200.0	1200.0	-0.41	0.91	1.21	0.15		
NO.7	200.0	1400.0	0.01	0.94	0.65	0.25		
NO.8	200.0	1600.0	2.86	5.50	2.86	0.35		
NO.9	200.0	1800.0	2.46	3.91	2.82	0.45		
NO.10	200.0	2000.0	2.52	3.96	5.70	0.55		
	104.3	2104.3	2.52	7.02	7.02	0.58		
NO.11	95.7	2200.0	3.08	4.68	5.24	0.65		
NO.12	200.0	2400.0	3.10	4.53	5.29	0.75		
NO.13	200.0	2600.0	3.35	5.50	5.60	0.85		
NO.14	200.0	2800.0	3.57	5.10	5.31	0.95		
NO.15	200.0	3000.0	4.02	5.52	4.70	1.05		
NO.16	200.0	3200.0	4.30	4.77	5.75	1.15		
NO.17	200.0	3400.0	4.26	5.40	4.40	1.25		
	36.3	3436.3						
NO.18	163.7	3600.0	3.55	5.48	5.80	1.35		
NO.19	200.0	3800.0	4.49	5.85	6.01	1.45		
	42.6	3842.6	4.58	6.17	6.17	1.47		

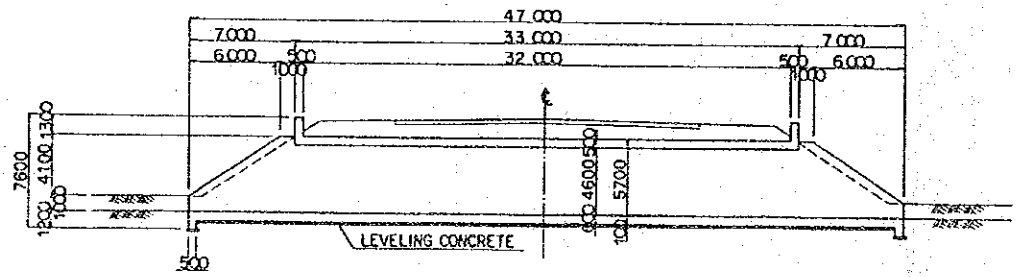
FIG. D.13 (14) LONGITUDINAL SECTION OF SEGUNBAGICHA KHAL

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

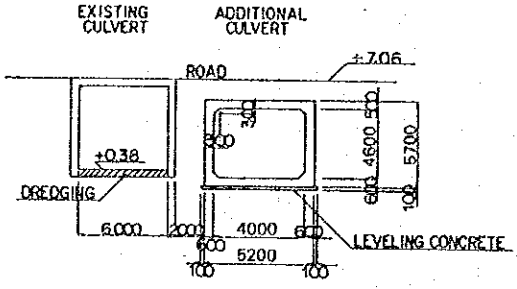
P L A N



LONGITUDINAL SECTION



SECTION A-A



SECTION B-B

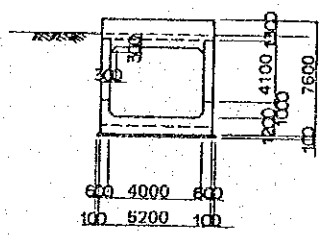


FIG. D. 14 TYPICAL DESIGN OF BRIAGE CULVERT AT KALLANPUR KHAL

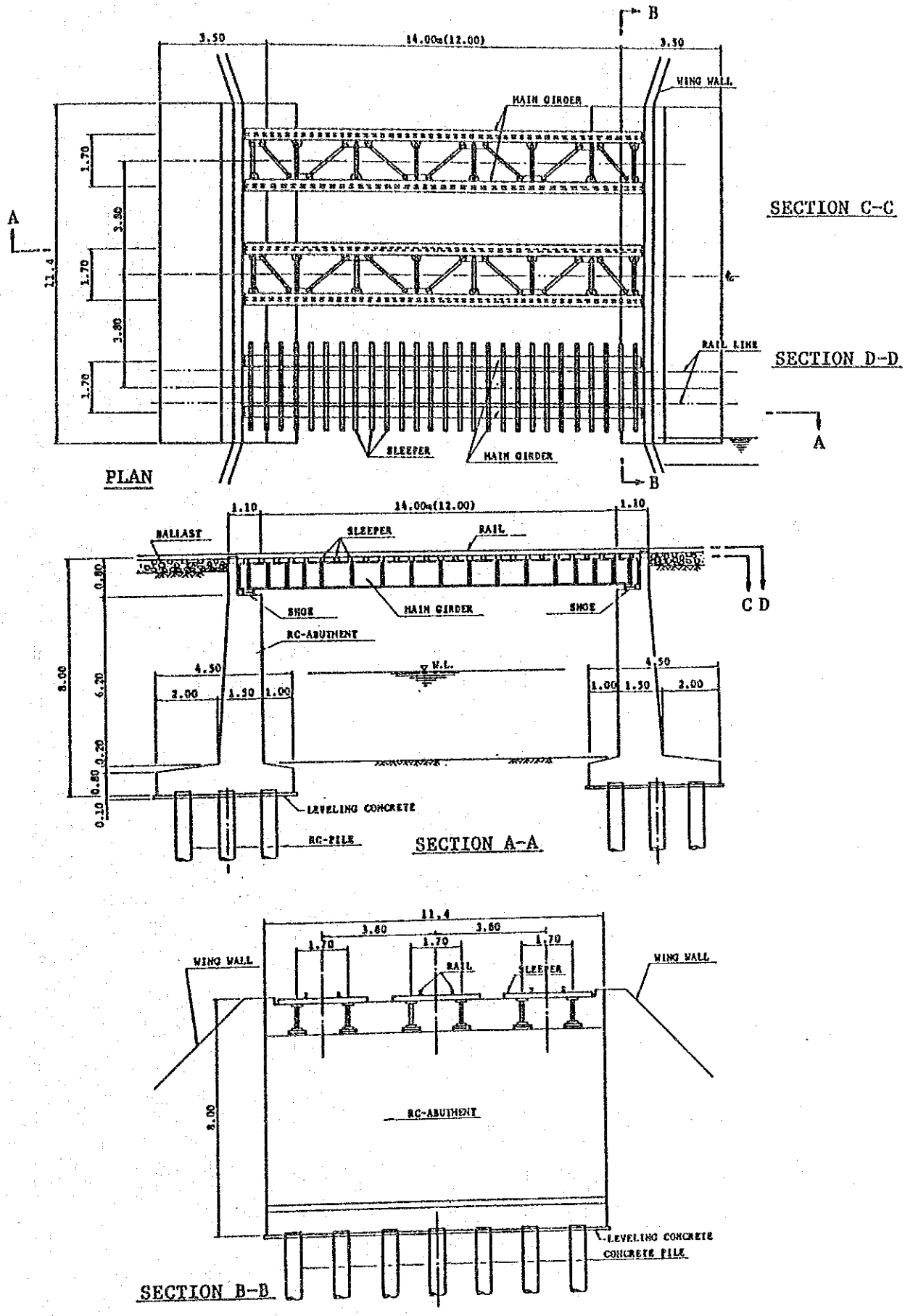


FIG. D. 15 TYPICAL DESIGN OF RAILWAY BRIDGE

BUCKET MACHINE

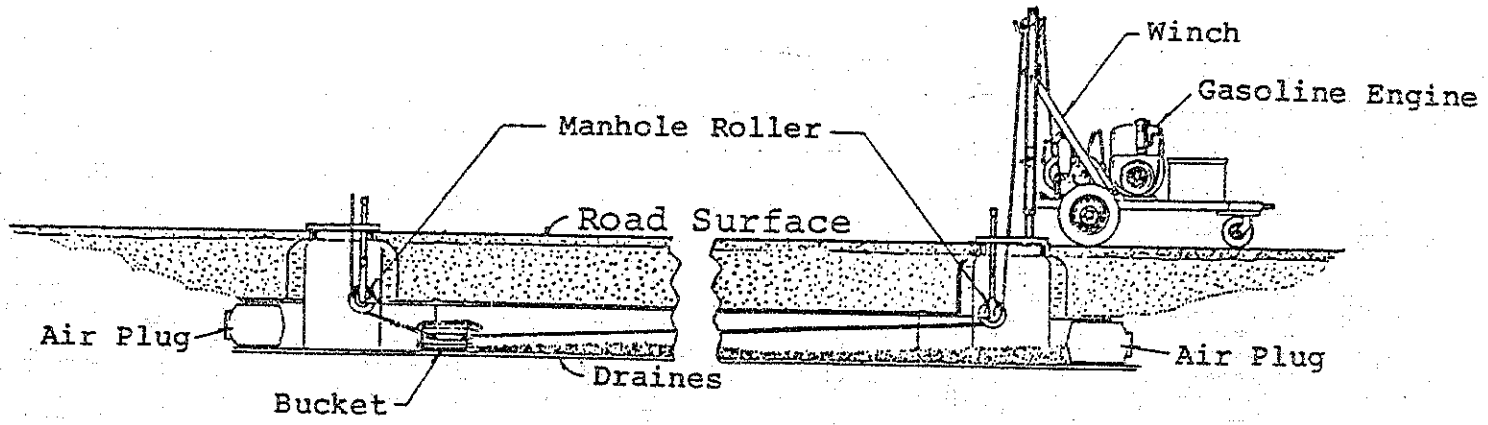
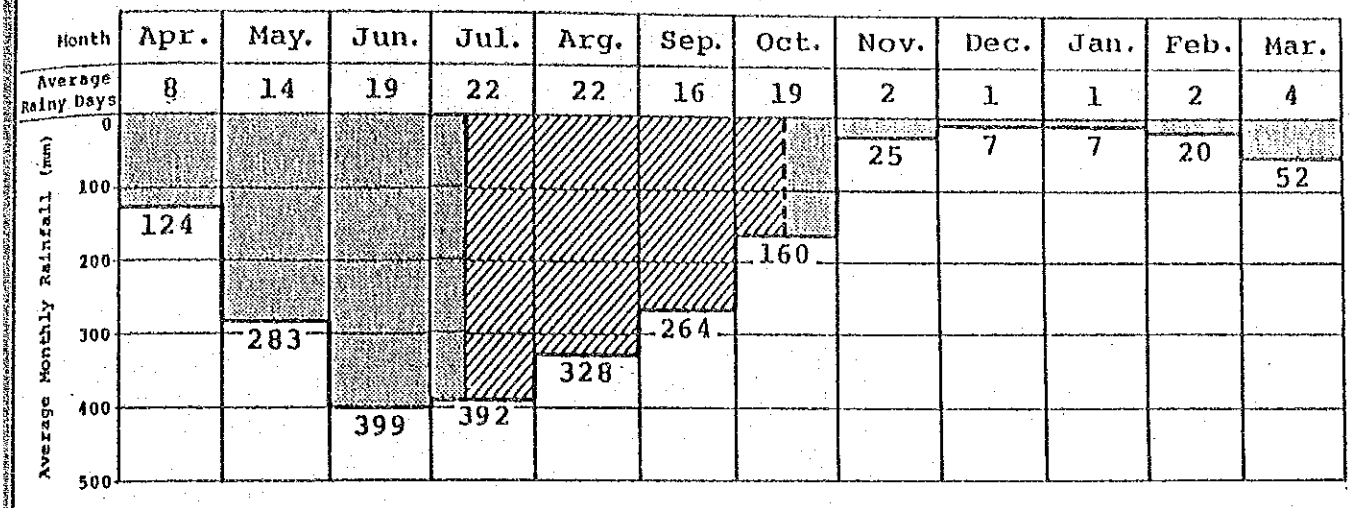


FIG. D. 16	DRAINAGE PIPE CLEANING MACHINE

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

AVERAGE MONTHLY RAINFALL AND RAINY DAYS



SEASONAL VARIATION OF BURIGANGA RIVER WATER LEVEL AT MILL BARRACK STATION

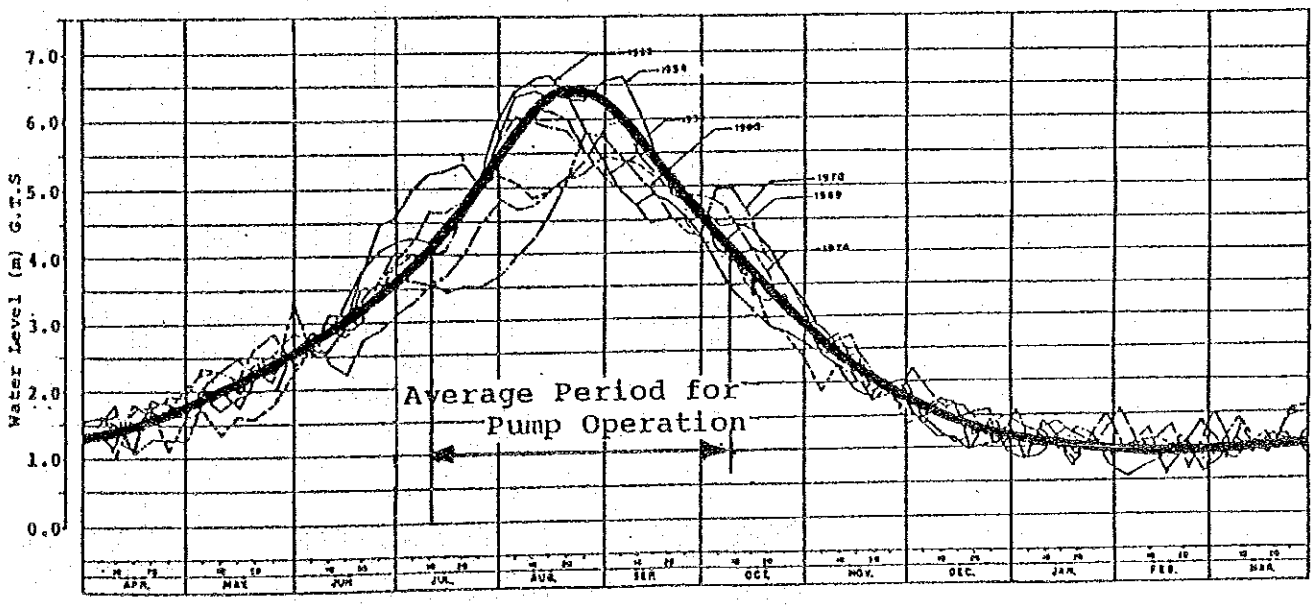
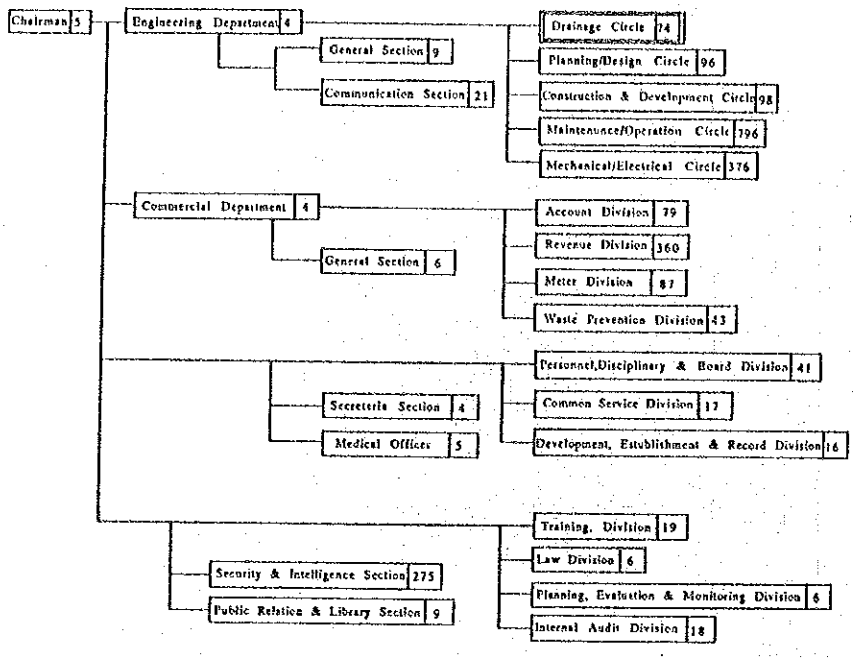


FIG. D. 17 SEASONAL VARIATION OF BURIGANGA RIVER WATER LEVEL AND AVERAGE MONTHLY RAINFALL

A . PRESENT ORGANIZATION OF DHAKA WASA (1989)



Note 1) : Figure Shows Number Of Staff.
2) : Total Staff is 2474 Persons.

B . PRESENT ORGANIZATION OF DRAINAGE CIRCLE (1989)

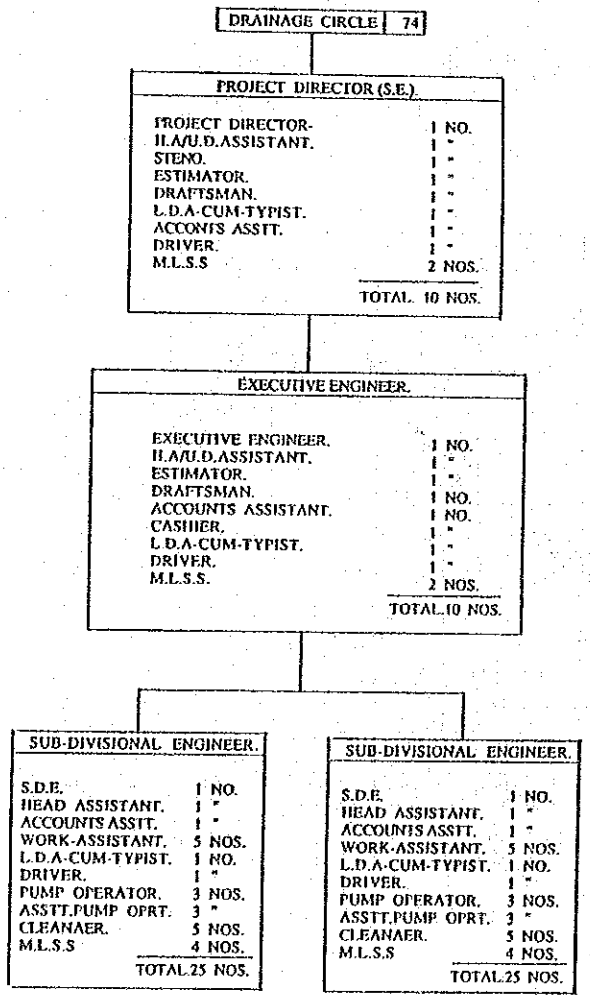
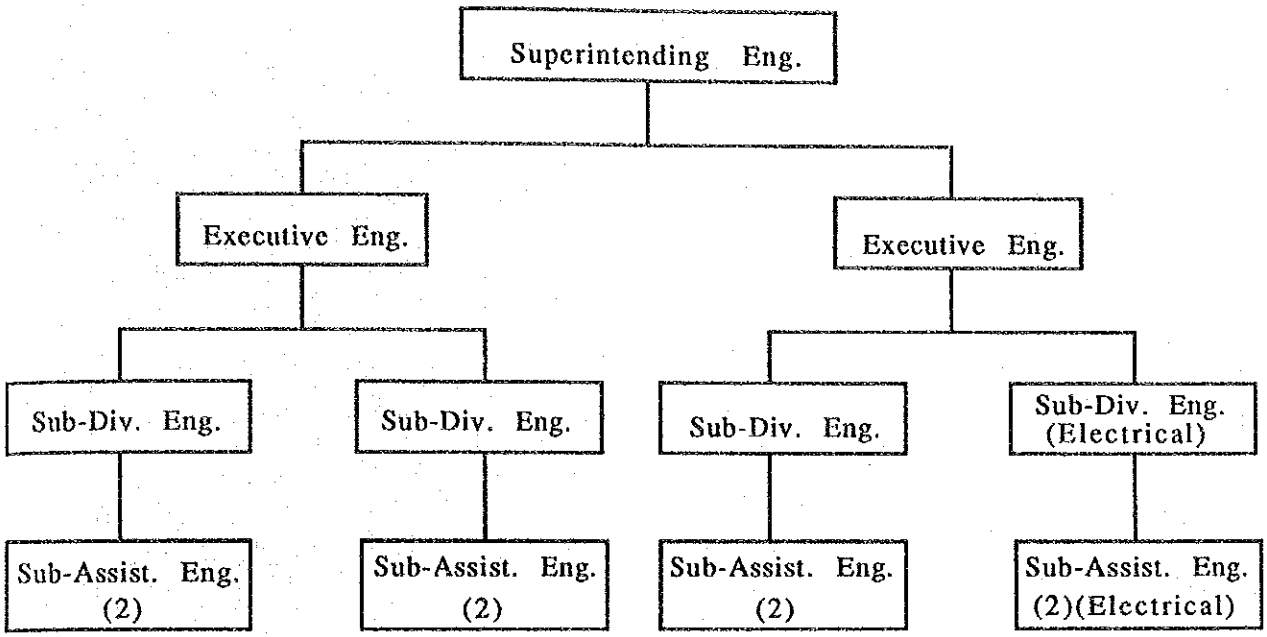


FIG. D . 1 8 PESENT ORGANIZATION OF DHAKA WASA AND DRAINAGE CIRCLE

(1) PROPOSED ORGANIZATION FOR CONSTRUCTION
(DRAINAGE CIRCLE DIVISION, DWASA)



(2) PROPOSED ORGANIZATION FOR OPEARATION AND MAINTENACE
(DRAINAGE CIRCLE DIVISION, DWASA)

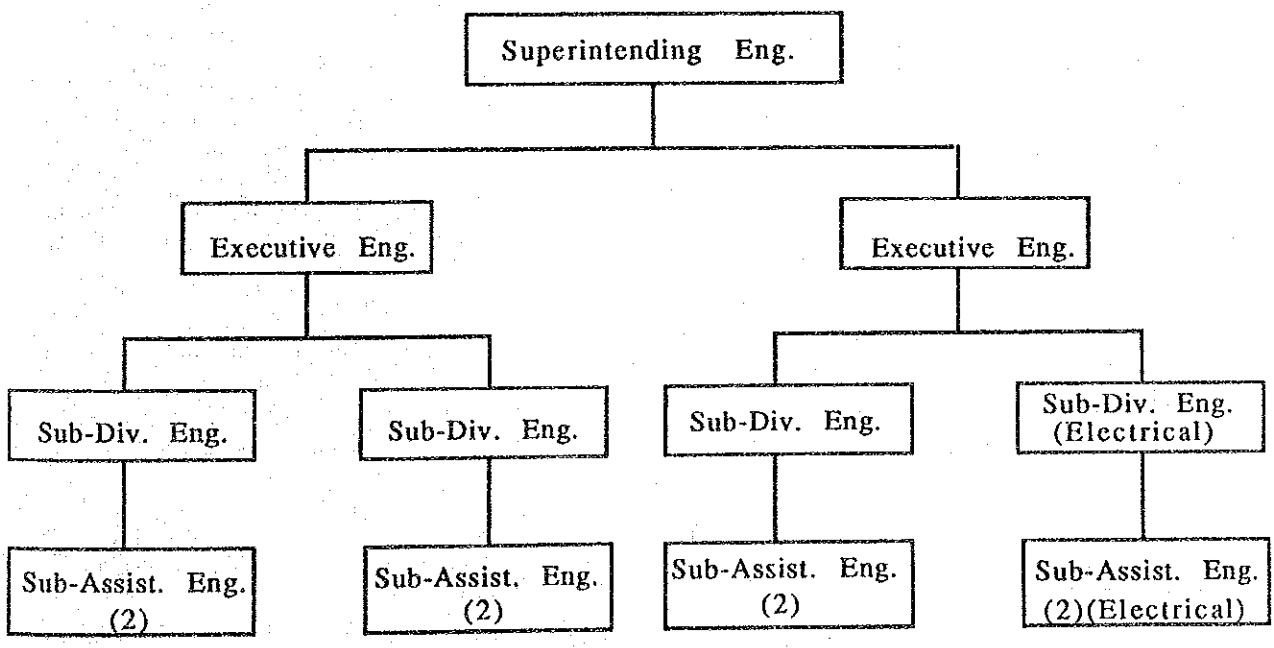


FIG. D. 19 PROPOSED ORGANIZATION FOR CONSTRUCTION, OPERATION AND MAINTENANCE

SUPPORTING REPORT - E -

PROJECT COST AND CONSTRUCTION SCHEDULE

SUPPORTING REPORT E
PROJECT COST AND CONSTRUCTION SCHEDULE

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LIST OF FIGURES

SUPPORTING REPORT E
PROJECT COST AND CONSTRUCITON SCHEDULE

1. General

The project cost is estimated for the assessment of economic and financial viability, and preparation of a funding schedule for the Government.

The costs are estimated based on the current prices of construction materials, equipment, and labor rates prevailing in Dhaka.

The cost data was obtained from government agencies and from the private sector. The collected data was compared, evaluated, and updated to establish a current cost data base that is applicable to the Project.

2. 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 were made on the assumption that all construction works 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, based on the following:

The foreign currency portions include the costs of:
- Imported equipment, materials, and supplies,
- Domestic materials for which the country is a net importer,
- Wages of expatriate personnel, and

- Overhead and profit of foreign firms.

The local currency portions contain the costs of:

- Domestic materials and supplies for which the country is a net exporter,
- Wages of local personnel,
- Land acquisition and house resettlement compensation,
- Overhead and profit of local firms, and
- Taxes.

(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 are earmarked at 20% of the total construction costs.

3. Estimation of Unit Cost

The unit cost estimated in the previous study is updated on the current prices prevailing in Dhaka. The escalation of construction material prices over the past three years (ranging from 140% to 170%) greatly affects the unit cost.

Unit costs, by work item, are calculated from the material cost, labor cost, and equipment cost by analyzing the data of similar work implemented in recent years as well as by taking into consideration the local conditions in Dhaka. The unit costs calculated by work item are as listed in Table E.11. The unit construction cost for each type of facility is shown in Table E.11 to E. 16.

4. Land Acquisition Costs

The price of land varies depending upon its location and geographical condition. The unit land costs shown below are given for two typical land usages, i.e., urbanized area and non-urbanized area. Those costs are approximately ten times higher than the previous costs. The breakdown of the acquisition cost of each facility is shown in Table E.2.

Unit Cost for Land Acquisition

Area	Land Cost
Lowland in Urbanized Area	4,800 Tk/m^2
Lowland in Non-urbanized Vicinity Area	1,200 Tk/m^2

Source: DWASA

5. Direct CDST

Most construction materials are available locally: they can be used for construction of drainage facilities. However, particular equipment and material, such as pumps and gates with accessories, sheet piles and testing apparatus, must be imported. It is considered that the CDST (customs duty and sales taxes) for this equipment and material will be borne by the Bangladesh Government and will be exempted from the contractor's contract because it is being funded by a foreign aid program. The costs for CDST, as of 1989, are estimated on a lump sum basis as shown in Table E.6.

Construction machinery and equipment that is to be temporarily imported for the execution of work and reexported after the work is completed are assumed to be exempted from CDST, considering that the Bangladesh Gazette No. SRD 542-L/84/886/CUS, issued by the National Board of Revenue (NBR), specifies the CDST exemption of reexported goods. Other taxes, such as income tax, excise tax, and CDST of raw materials for local industrial products are included in the prices of goods or wages when paid for on the local market.

6. 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 following table. The breakdown of the estimated project cost are shown in Tables E.1 to E.5.

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

7. 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 Box Culvert	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	
Total	13.0	

Note: Breakdown of the personnel expense and office accommodation cost is shown in Table E.19.

8. Construction 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			Package II for zone C		
(1)	Pump station:	1 place	(1)	Channel culvert:	1.4 km
(2)	Sluice gate:	1 place	(2)	Bridge culvert:	3 place
(3)	Channel culvert:	0.8 km	(3)	Railway bridge:	1 place
(4)	Bridge culvert:	1 place	(4)	Brick protection:	1.0 km
(5)	Dredging:	3.3 km	(5)	Dredging:	3.9 km

In view of proposed approximately 2.5 year construction period for each package, the construction schedule is prepared as shown in Fig. E.1.

Major considerations for the construction sequence of the proposed facilities are as follows:

1) In order to lower the flood water level of the inner area, top priority will be given in package I for the construction of the pump station with sluice gate at Kallyanpur, in association with the flood protection dike constructed by the GDFCD project. Lowering of the inner flood water level will facilitate the internal drainage through the drains.

2) The construction of the approximately 200 m upstream culvert of the Begunbari khal between Green and Sonargaon roads, will also be given priority in package I for removing the khal flow bottleneck and improving the flow capacity.

3) The construction of a 1.4 km culvert is given priority in package II for improving the flow capacity and to facilitate the secondary drainage through the drains.

4) The remaining bridge-culverts and dredging will be constructed stage by stage in consideration of the yearly disbursement capacity of finance.

5) Land acquisition and house resettlement compensation are required prior to the commencement of construction work.

5) Land acquisition and house resettlement compensation are required prior to the commencement of construction work.

TABLE E.1 SUMMARY OF CONSTRUCTION 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	2.5x2.5x2x60.0(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 E.2 COST FOR LAND ACQUISITION

(1989 Price)

	Item	Zone	Area (ha)	Unit Price (Million TK)	Land Acquisition (Million TK)
A.	Pump Station				
	P1	H	1.0	12.0	12.0
B.	Khal Improvement				
	K4	C	1.1	16.0	17.6
	K5-1	C	0.3	16.0	4.8
	K5-2	C	0.4	16.0	6.4
	K5-3	C	0.2	64.0	12.8
	K5-4	C	0.4	64.0	25.6
	K5-5	C	0.2	64.0	12.8
	Subtotal		2.6		80.0
	K10-1	F	0.2	48.0	9.6
	Subtotal		0.2		9.6
	K14-1	H	3.2	12.0	38.4
	K14-2	H	1.1	16.0	17.6
	Subtotal		4.3		56.0
	Total		8.1		157.6

TABLE E.3 CONSTRUCTION COST OF KHAL IMPROVEMENT

Unit : Million Tk. 1989 Price

Zone	Khal No.	Protection Work			Bridge & Box Culvert			Dredging			Total
		F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	
C	K4	10.7	26.8	37.5	2.7	2.2	4.9	6.5	4.3	10.8	53.2
	K5-1	0.0	0.4	0.4				3.1	2.1	5.2	5.6
	K5-2	0.0	0.3	0.3	17.1	6.9	24.0	2.4	1.6	4.0	28.3
	K5-3	0.0	0.3	0.3	1.9	1.6		3.6	2.4	6.0	9.8
	K5-4	164.9	134.9	299.7				4.7	3.1	7.8	307.5
	K5-5		0.2	0.2				2.3	1.5	3.8	4.0
	Subtotal	175.6	162.9	338.4	21.7	10.7	32.4	22.6	15.0	37.6	408.4
F	K10-1	83.6	68.4	152.0				1.0	0.6	1.6	153.6
	Subtotal	83.6	68.4	152.0				1.0	0.6	1.6	153.6
H	K14-1		1.8	1.8	6.6	0.5	12.1	4.5	3.0	7.5	21.4
	K14-2		0.2	0.2				1.4	1.0	2.4	2.6
	Subtotal	0.0	2.0	2.0	6.6	0.5	12.1	5.9	4.0	9.9	24.0
	Total	259.2	233.2	492.4	28.3	16.2	44.5	11.5	37.6	49.1	586.0

TABLE E.4 CONSTRUCTION COST OF KHAL IMPROVEMENT WORK

Unit : 1,000Tk 1989 Price

Zone	Khal	Section No	Length m	Net Length m	Protection Works								Cost For Dredging			
					Type	Length m	Unit Construction Cost			Construction Cost			Volume (1000m3)	F/C	L/C	Total
							Total	F/C(%)	L/C(%)	F/C	L/C	Total				
C	K4		1,800	1,790	Brick Protection	1,000	37.0	29	71	10,730	26,270	37,000	30.0	3,600	2,400	6,000
					Sodding	790	0.6	0	100		474	474	24.0	2,880	1,920	4,800
	K5	1	700	700	Sodding	700	0.6	0	100		420	420	25.9	3,108	2,072	5,180
		2	500	464	do	464	0.6	0	100		278	278	20.0	2,400	1,600	4,000
		3	500	500	do	500	0.6	0	100		300	300	30.0	3,600	2,400	6,000
		4	1,400	1,400	Box Culvert	1,400	214.1	55	45	164,857	134,883	299,740	39.0	4,680	3,120	7,800
		5	400	400	Sodding	400	0.6	0	100		240	240	19.2	2,304	1,536	3,840
		Subtotal	5,300					52	48	175,587	162,865	338,452	188.1	22,572	15,048	37,620
F	K10	1	816	816	Box Culvert	700	194.0	55	45	74,690	61,110	135,800	7.0	840	560	1,400
					do	116	139.9	55	45	8,925	7,303	16,228	1.0	120	80	200
		Subtoral	816					55	45	83,615	68,413	152,028	8.0	960	640	1,600
H	K14	1	3,000	2,953	Sodding	2,953	0.6	0	100		1,772	1,772	37.5	4,500	3,000	7,500
		2	300	300	do	300	0.6	0	100		180	180	12.0	1,440	960	2,400
		Subtotal	3,300					0	100		1,952	1,952	49.5	5,940	3,960	9,900
		Total	9,416					53	47	259,202	233,230	492,432	245.6	29,472	19,648	49,120

TABLE E.5 CONSTRUCTION COST OF KHAL IMPROVEMENT WORK - BRIDGE AND BOX CULVERT (I)

Size : Width x Height x Units Unit : 1,000 Tk. 1989 Price

ZONE	KHAL NO.	(TYPE)	Proposed (Size) m x m	Length m	Unit Construction Cost			Construction Cost			Remarks
					Total	F/C(%)	L/C(%)	F/C	L/C	Total	
C	K4	Box Culvert	6.0 x 5.0 x 2	10.0	489.7	55	45	2,693	2204	4,897	
	K5-2	do	6.0 x 5.0 x 2	17.0	489.7	55	45	4,579	3746	8,325	
	K5-2	Bridge	L=12.0m	19.0	L.S.	80	20	12,541	3135	15,676	
	K5-3	Box Culvert	5.5 x 4.3	15.0	233.2	55	45	1,924	1574	3,498	
	Subtotal							21,737	10659	32,396	
H	K14-1	Box Culvert	4.0 x 4.6	47.0	256.5	45	45	6,631	5425	12,056	
	Subtotal							6,631	5425	12,056	
	Total					64	36	28,368	16084	44,452	

TABLE E.6 CUSTOMS DUTY & SALES TAX (CDST) FOR IMPORTED MATERIAL & EQUIPMENT

Unit : 1,000TK, 1986 Price

Item	Unit	Amount	Unit Price (C.I.F)	Total Price	RATE			Customs Duty & Tax
					CD	ST	LF	
A. Steel Sheel Pile Foundation	t	125	26	3,250	100	20	5	4,063
B. Gate Leaf & Hoist Machine	L.S	1	12,096	12,096	50	20	5	9,072
C. Equipment for Pump Station	L.S	1	132,490	132,490	50	20	5	99,368
D.Girder for Railway Bridge L=12m (11t)	L.S	3	1,100	3,300	50	20	5	2,475
TOTAL								114,978

Note : CD : Customs Duty
ST : Sales Tax
LF : Licence Fee and Surcharge

Table E.7 LABOUR WAGES

Type of Labour	Labour Wage (TK) (1989 Price)
1. Common Labourer	65
2. Mason and Plasterer	160
3. Reinforcement Worker	130
4. Concrete Worker	90
5. Pavement Worker	125
6. Carpenter	160
7. Painter	120
8. Welder	160
9. Foreman	210
10. Chief Forman	320
11. Car Driver and Operator	130
12. Heavy Equipment Operator	180
13. Boat Man	95
14. Boat Captain	145
15. Mechanic	175
16. Electrician	175
17. Plumber	215
18. Surveyer	210