

THE PEOPLE'S REPUBLIC OF BANGLADESH  
FLOOD PLAN COORDINATION ORGANIZATION

FEASIBILITY STUDY  
ON  
GREATER DHAKA PROTECTION PROJECT  
(STUDY IN DHAKA METROPOLITAN AREA)  
OF  
BANGLADESH FLOOD ACTION PLAN NO.8A

FAP 8A

SUPPORTING REPORT II

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## **ABBREVIATIONS**

ADB	Asian Development Bank
AIT	Asian Institute of Technology
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAAB	Civil Aviation Authority of Bangladesh
DIT	Dhaka Improvement Trust (now RAJUK)
DMAIUDP	Dhaka Metropolitan Area Integrated Urban Development Plan
DMC	Dhaka Municipal Corporation
DND Triangle	Dhaka - Narayanganj - Demra Triangle
DPHE	Department of Public Health Engineering
DOE	Department of Environment
DWASA	Dhaka Water and Sewerage Authority
ERD	External Resources Division Ministry of Finance
FAP	Flood Action Plan
FPCO	Flood Plan Coordination Organization
GDPP	Greater Dhaka Protection Project
GDFCD Project	Greater Dhaka Flood Control and Drainage Project
GOB	Government of Bangladesh
JICA	Japan International Cooperation Agency
MIWDFC	Ministry of Irrigation, Water Development and Flood Control
MPO	Master Plan Organization
PDB	Power Development Board
PHD	Public Health Department
PWD	Public Works Department
RHD	Roads and Highways Department



RAJUK	Rajdhani Unnayan Katripakkha (Capital Development Authority)
RRI	River Research Institute of the Ministry of Irrigation, Water Development and Flood Control
SOB	Survey of Bangladesh
SWMC	Surface Water Modelling Center
SPARRSO	Space Research and Remote Sensing
UNCHS	United Nations Center for Human Settlements
UNDP	United Nations Development Programme
WAPDA	Water and Power Development Authority
WASA	Water and Sewerage Authority
WMO	World Meteorological Organization





**SUPPORTING REPORT F**  
**PRELIMINARY DESIGN OF PROPOSED FACILITIES**

## SUPPORTING REPORT F : PRELIMINARY DESIGN OF PROPOSED FACILITIES

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## SUPPORTING REPORT F : PRELIMINARY DESIGN OF PROPOSED FACILITIES

### 1. Embankment, Road-Cum-Embankment and Sub-Embankment

#### 1.1 Design Condition and Criteria

##### (1) Topographical Conditions :

The proposed facilities are mostly located in the low-lying flat alluvial plain of which most parts are under water for over half year (Fig. F.1.1 to F.1.3).

##### (2) Geological Conditions :

The results of the geological survey conducted by the Study team are summarized in Table F.1.1.

Based on these results and the geological data obtained from the other studies, the geological profiles along the proposed alignments are produced and shown in Fig. F.1.1, It shows that a soft soil layer of N-values of less than 4 is developed close to the ground surface.

Relationships between the N-values of the standard penetration tests and the cohesions obtained by the uniaxial compression tests are shown in Fig. F.1.5.

The relationship between the cohesion "C" and the N-value is in general,  $C=1/8 \sim 1/2 N$ . However the relationship in the range of Depth <10m and N-values <10 which has a tendency to cause sliding, is assumed to be  $C=0.7 \times N$  according to the relationship enveloping the lowest limit of the soil test results.

##### (3) Embankment Material :

In general, the embankment material should have the following requirements :

- proper workability for compaction
- sufficient shear strength for stability
- low permeability for sufficient seepage resistance



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The embankment material should be obtained from nearby the construction site. Thus, soil samples have been taken from the riverside and tested at laboratory. The results were studied and analyzed. The relationship between moisture content, and dry density, compaction density (D-value), triaxial compression test results, and permeability test results are shown in Fig. F.1.6 to Fig. F.1.9.

The soil test results of embankment material revealed the following :

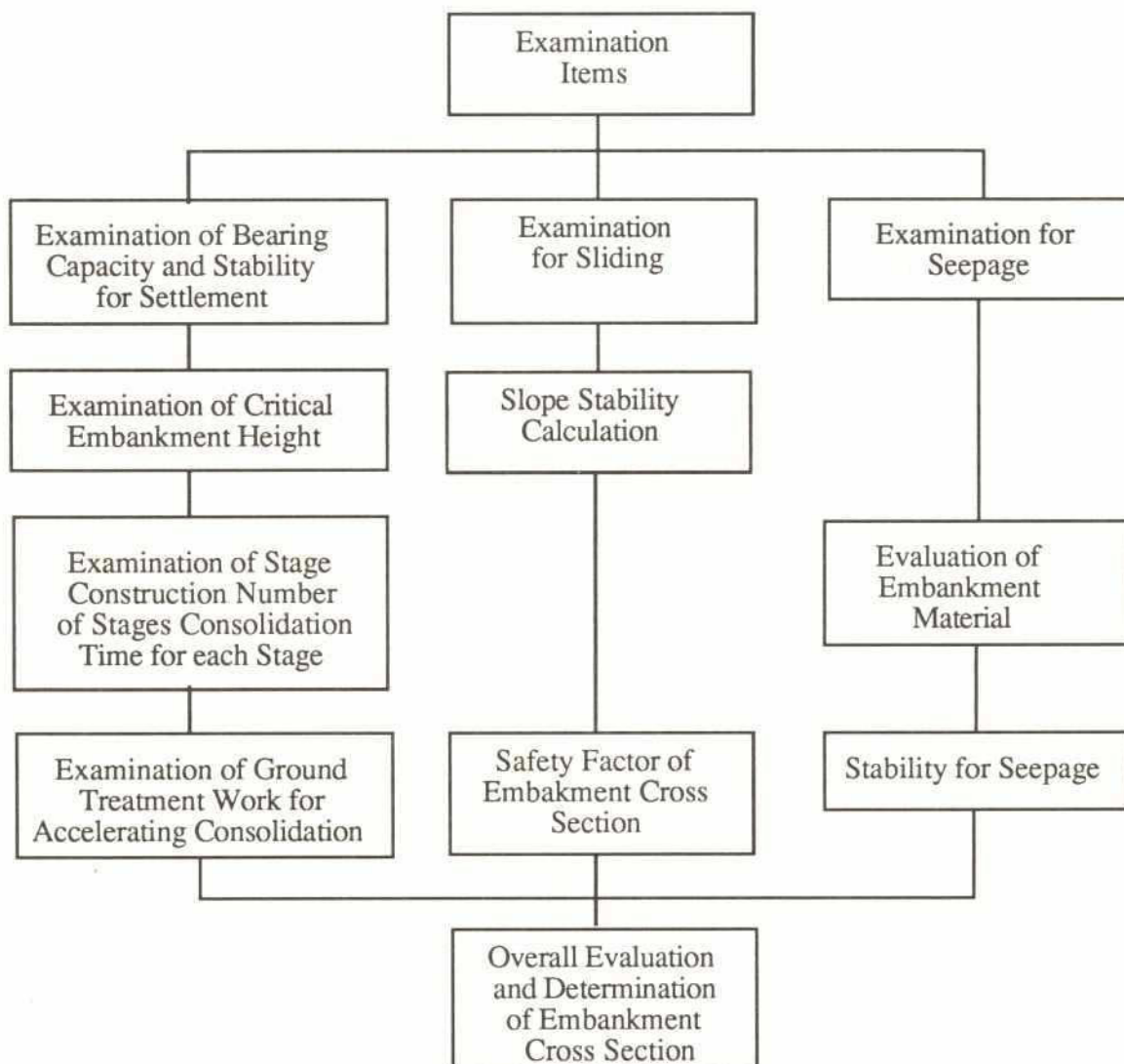
- The cohesion for shear strength can be estimated as  $4.0 \text{ t/m}^2$  under the condition of 90% wet side of its maximum dry density.
- The permeability is estimated as  $10^{-4} \text{ cm/s}$  under the same compaction condition.
- The natural moisture content is 10~15% under the wet side of its maximum density.

The soil can be used as material for constructing a uniform embankment.

#### (4) Embankment Stability Analysis

Embankment stability analysis will be conducted according to the following procedures:

Embankment Stability analysis Flow Chart



The stability analyses will be conducted at the following condition :

- Embankment stability after completion (long term)

The safety factor for the embankment stability is to be larger than 1.5 because of :

- As the bearing ground condition in the Project Area is poor because of the soft subsoil layer, the safety factors should have a certain allowance.
- The importance of protection area

#### 5) Construction Period :

The type of foundation treatment work for accelerating the consolidation of soft foundation has a close relationship with the embankment construction period.

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The embankment has better to be constructed by a step-by-step construction method according to the progress of the consolidation.

The construction period is determined based on the relationship between the foundation treatment work and the number of stages for embankment construction.

## 1.2 Standard Cross Sections of the Embankment

### 1.2.1 Embankment Type and Material :

The embankment type was decided upon based on available material, subsoil conditions, and the design flood water level.

The uniform embankment type was selected for the following reasons:

- Available material at sites is uniform
- As the subsoil is soft, flexible cross section and resistance against ground settlement are required.
- Construction cost is cheaper than other embankment types.

The standard embankment cross sections are shown in Fig. F.1.10.

### 1.2.2 Foundation Treatment :

There are various foundation treatment methods to be applied according to the construction type, the embankment type, the bearing capacity of the ground, etc. The proposed embankment will partly need to accelerate the subsoil's consolidation by foundation treatments in order to get a required stability.

#### 1) Ground's Bearing Capacity and the Critical Embankment Height

During the field survey period, the following two types of failures were observed at the existing embankments :

- Large settlement occurred when the embankment construction reached a certain height, and
- Sliding failure.



The critical embankment height was assumed by using the Taylor's Stability Analysis Chart as follows :

- Embankment's slope angle : 1:3.0, ( $B = 18.4^\circ$ )
- Depth coefficient :  $n_d = (\text{Embankment height} + \text{bearing ground depth}) + \text{Embankment height} = 3.5 \sim 6.0$
- Stability coefficient :  $N_s = 5.52$  (See Fig. F.1.11)
- Critical embankment height :  $H_{cr} = N_s \times C + r$

Table F.1.3 : Critical Embankment Height

Subsoil Condition		Critical Height : $H_{cr}$ (m)		
S. P. T. N	Cohesion $C=0.7N$	$F_s=1.0$	$F_s=1.1$	$F_s=1.2$
1.00	0.70	2.0	1.8	1.7
2.00	1.40	4.0	3.6	3.3
3.00	2.10	5.9	5.4	5.0
4.00	2.80	7.9	7.2	6.6
5.00	3.50	9.9	9.0	8.3
6.00	4.20	11.9	10.8	9.9
7.00	4.90	13.9	12.6	11.6
8.00	5.60	15.9	14.4	13.2
9.00	6.30	17.8	16.2	14.9
10.00	7.00	19.8	18.0	16.5
11.00	7.70	21.8	19.8	18.2
12.00	8.40	23.8	21.6	19.8

Note :  $H_{cr} = 5.52 \times C/r$  (m)

According to the above relationship, the ground's bearing strength of the proposed embankment of Greater Dhaka East, having an average N-value 2 to 4, is insufficient in a wide area for supporting the maximum height of 8.5 m and the average height of 5.5 m. If the embankment is constructed up to the design height by a rapid construction method, the embankment would be subject to a sudden settlement or bearing failure.

The ground's bearing strength would increase according to the progress of consolidation by applied loads. If a slow construction method will be applied, the critical height will increase.

In the Study Area, the ground's bearing strength is weak as described above. It would be necessary to construct the embankment by a stage construction method with some foundation treatment.

The embankment sections whose bearing ground must be treated in the Greater Dhaka East and the Narayanganj West are approximately 28.19 km (including 8.52 km of sub-embankments) and 0.80 km respectively and are summarized as follows (For details, see Fig. F.1.12 and Tables F.1.4(1) and (2)).

#### I. Greater Dhaka East

Embankment (Total Embankment length)	From	Station No. To	Distance for Treatment (km)
- Embankment (27.52km)	E. 7 E. 42+200 E. 60	E. 33 E. 59 E. 64+200 Sub-Total =	10.52 6.55 1.80 18.87
- Sub-embankment (SA) (6.40km)	SA. 5+200 SA. 10+200	SA. 8+200 Sa. 12+200 Sub-Total =	1.20 0.80 2.00
- Sub-embankment (SB) (4.71km)	SB. 0	SB. 7+200	2.96
- Sub-embankment (SC) (6.31km)	SC. 5+250	SC. 13	3.56
Total :			28.19 km

#### II. Narayanganj West

	From	Station No. To	Distance for Treatment (km)
Embankment (5.70km)	NE. 65 NE. 70	NE. 67 NE. 71 Sub-Total =	0.40 0.40 0.80

- 2) Examination of embankment height by the stage construction by taking into consideration the bearing ground's consolidation.

For normal clay, an increase in the bearing strength by consolidation can be expressed by the following equation :

$$C = C_0 + m \times 'U' \times P$$

Where, C = ground's cohesion after consolidation (t/m<sup>2</sup>)

C<sub>0</sub> = strength of original ground (t/m<sup>2</sup>)

$m$  = increase rate of strength, approximately 0.3

$U$  = consolidation rate (%)

$P$  = load ( $t/m^2$ )

Necessary stage embankment heights by the staged construction for different bearing strengths are shown in Tables F.1.4 (1) - (4).

### 3) Consolidation Period for a Step Embankment without Foundation Treatment

For the staged embankment construction, it is necessary to leave each embankment step settle for a certain time period until it reaches the required consolidation rate.

For untreated bearing ground, the time periods necessary for obtaining different consolidation rates were calculated as shown in the following Table F.1.5.

Table F.1.5 Consolidation time for Each Embankment Step

$C_v$ ( $m^2/day$ )	Drain Length (Lm)	95% Consoli- dation $T_v$	Time (day)	90% Consoli- dation $T_v$	Time (day)	80% Consoli- dation $T_v$	Time (day)
0.004	2.50	1.050	1641	0.848	1325	0.567	886
0.004	3.00	1.050	2363	0.848	1908	0.567	1376
0.004	4.00	1.050	4200	0.848	3392	0.567	2268
0.004	5.00	1.050	6563	0.848	5300	0.567	3544
0.004	7.50	1.050	14766	0.848	11925	0.567	7973
0.004	10.00	1.050	26250	0.848	21200	0.567	14175

Note : 1) Consolidation  $T_v$  : Coefficient of Consolidation time


According to the table, it will take approximately 10 years to obtain 80% consolidation of untreated soft bearing ground's top 5 m layer which affects the stability of the embankment. Thus, it is evident that adoption of a ground treatment method to accelerate consolidation will be necessary for those embankment sections that require the use of the staged embankment construction method.

### 4) Foundation Treatment for Accelerating Consolidation

There are the following bearing ground treatment methods :

- (a) A consolidation acceleration method to allow step embankment construction;



- 
- (b) A bearing ground strengthening method to allow embankment construction on soft ground;
  - (c) An embanking method using reinforcing materials;
  - (d) A method for replacing soft top layers :

The characteristics and application of each of the above methods are compared in Table F.1.6.

#### (1) Selection of Foundation Treatment Method

There are the following three consolidation acceleration methods :

- (a) Sand drain-pile method
- (b) Geotextile drain-pile method
- (c) Sand compaction pile method

Methods (a) and (b) adopt the same vertical draining method and are classified by their material types. Method (c) uses large diameter sand piles only for accelerating consolidation progress. Table F.1.7 lists the necessary features for accomplishing 80% consolidation of the bearing ground in the Study Area for a 7 to 9 month period under the load of an embankment step.

Table F.1.6 Comparison of Bearing Ground Treatment Methods

Method	Principle	Features	Applicability
Consolidation Acceleration Method  - Sand Drain  - Geotextile Drain (Wick Drain, Etc)	- To accelerate consolidation  - To increase ground's own strength	- Widely used  - A reliable method to increase entire ground's bearing strength  - A slow construction method is adoptable for step embankment construction  - A certain amount of consolidation can be accomplished during the construction period	O
Bearing Ground Straightening Method  - Sand Compaction	- To forcibly strengthen bearing ground	- Very effective method  - Possible to accelerate consolidation	O
Soil Reinforcing Method	- No bearing ground treatment  - To reinforce embankment soil	- Reliability of reinforcing soil's strength is required  - As bearing ground is untreated, progress of embankment settlement lasts a long period of time  - This method is questionable for an embankment's long-term stability in area having a large settlement (use flexible material & variable embankment type)	$\Delta$
Soil Replacement Method	- To replace weak soft soil with strong soil material	- Effective for a thin weak, soft soil layer  - Impossible to replace a deep soft soil layer Thus, embankment settlement will be caused by the deep soft soil	$\Delta$

Table F.1.7 Comparison of Accelerating Consolidation Methods

Method	Specifications	Cost per 100m <sup>2</sup> (Tk)	Applicability
Sand Drain	ø 400mm sand pile, 2.0m by 2.0m pitch	145,000	O
Geotextile Drain	100mm x 8mm, geotextile Drain 1.25m by 1.25m pitch	113,200	O
Sand Compaction	ø 700mm sand compaction pile, 2.5m by 2.5m pitch	173,000	Δ

The Sand Pile drain and Geotextile drain methods have a following merit and demerit

- Sand Pile Drain
  - (a) It is rather expensive than Geotextile Drain
  - (b) It is widely used and practised
  - (c) Locally available material is usable
  - (d) When the bearing ground is extremely soft and weak, a sand compaction pile method can be adopted by using the same machinery as for the sand drain pile method.
- Geotextile Drain
  - (a) It is inexpensive
  - (b) It is the latest technology
  - (c) The wick drain is being adopted in the western embankment of FAP-8B Project
  - (d) The material is not available locally

The above two methods are recommended in this stage.

The final selection should be made after the practice of the Geotextile Drain (wick drain) in the remedial work of western embankment in the FAP-8B Project.

## (2) Necessary drain Pile Pitch

The sand drain pile and geotextile drain pitches are calculated by the following equation and conditions.

- a) Equation :

$$T_h = \frac{C_h \cdot t}{d e^2}$$



Where,

- Th : Time factor (%)  
 Ch : Coefficient of consolidation : 0.004 m<sup>2</sup>/day  
 t : Consolidation time (day)  
 de : Effective drain pitch (m) (= 1.13 d)  
 d : Drain pitch (m)  
 dw : drain Diameter : Sand pile 0.4<sup>m</sup>, Geotext. Drain 0.07<sup>m</sup> (Nominal)  
 n : de / dw

b) Drain Pitch

The consolidation time is to be assumed at 7 to 9 months period which coincide with the suspended days of earth work for a year.

Based on the above condition and the relationships between drain pitches and consolidation time, the drain pitches are determined as follows :

- Sand pile drain : 2.00 m
- Geotextile pile drain : 1.25 m.

Table F.1.8 Necessary Sand Drain Pile and Geotextile Drain Pitch

Ch (m <sup>2</sup> /day)	Drain Pile Dia. (m)	Pitch (m)	Effective Pitch (m)	n	95% Consoli- dation Th	Time (day)	80% Consoli- dation Th	Time (day)
I. Sand Pile Drain								
0.004	0.400	1.00	1.130	2.825	0.200	64	0.100	32
0.004	0.400	1.50	1.695	4.237	0.300	215	0.150	108
0.004	0.400	1.75	1.978	4.944	0.400	391	0.200	196
0.004	0.400	2.00	2.260	5.650	0.500	368	0.200	255
0.004	0.400	2.50	2.825	7.062	0.550	1097	0.250	499
II. Geotextile Pile Drain								
0.004	0.07	0.5	0.57	8.14	0.6	48	0.3	24
0.004	0.07	1.0	1.13	16.14	0.8	255	0.40	128
0.004	0.07	1.25	1.41	20.14	0.9	447	0.45	224
0.004	0.07	1.5	1.70	24.29	1.0	723	0.50	362
0.004	0.07	2.0	2.26	32.3	1.2	867	0.60	434

Note : n, Th : See Fig.F.1.13 (Consolidation Curve and Table)

## 5) Stability of embankment Cross Section

### (1) Stability Against Sliding of Embankment

Stability against sliding of the embankment after completing construction work was examined by using the circular arc sliding method. The results shows that the safety factors of both shallow slope and deep-seated failure stability are 1.61 and 1.64 respectively (See Fig.F.1.14). For the study examination, a representative cross section of the embankment shown in Fig. F.1.10 was analyzed.

By the examination, it was confirmed that the embankment has the required stability ( $F_s > 1.5$ ) to prevent sliding over a long time period for the strength of the bearing ground and the embankment itself.

### (2) Stability Against Seepage

Seepage should be examined according to the characteristics of the embankment material and the bearing ground. Soil types of the embankment material and bearing ground in the Study area correspond to the type "ML" of the airfield Classification (Arthur Casagrande) System. The type "ML" soil is a relatively good embankment material. The permeability (K) of the soil material range around  $1 \times 10^{-4}$  to  $1 \times 10^{-5}$  cm/s on the natural moisture content (See Fig. F.1.8). Based on this soil characteristics and gentle slope of the embankment (1:3), it has been known that the embankment is within the range of safety side against seepage problem.

## 6) Quality Control of Embankment Material

In Bangladesh, embankment construction is carried out during dry season. Thus, there is a concern that the moisture content of the embankment material might be on the dry side.

In general, the embankment material's compaction density is maintained at more than 90% of the maximum dry density. It is necessary to maintain this density below the wet side in view of maintaining safety against seepage.

## 7) Land Width for Embankment

The embankment's cross section was decided upon as described in the previous Section. By taking into account the space required for drainage construction space, the land width to be procured for embankment construction was recommended to be the embankment base width plus 30 m (See Fig. F.1.10).

### 1.3 Associated Structures and Works

#### 1.3.1 Revetment Work

##### (1) Requirement for the Revetment Work

According to the existing embankment's slope failure conditions, the failures were mainly caused by waves but not the river flow's tractive force. Thus, wind directions are related to the embankment failures.

From a fluvial hydraulic viewpoint, the following aspects shall be taken into consideration for designing the revetment work:

##### a. River Characteristics :

A river's longitudinal character can be specified by dividing the river course into the following three segments :

- Segment 1 : alluvial fan area
- Segment 2 : Sedimentary dike area
- Segment 3 : Delta area

##### b. Scouring Factors

The Study Area is located in Segment 3 (delta area) and where the flood flow velocity is not great (approximately 1.0 to 1.5 m/s). Thus, its tractive force is not strong. River scouring is mainly to waves caused by wind and by navigating boats.

From a structural viewpoint, revetment work is classified into the following three types according to the locations where the revetment work is placed :



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- i) High-water revetment :
  - ii) Low-water channel revetment :
  - iii) Embankment revetment :

The planned embankment is at least 20 to 30 m away from the low-water river channel. Thus, a high-water revetment is to be adopted.

## (2) Reaches of Revetment Works

The revetment covered from foot of high water river bed to top of embankment is designed for the reaches where scouring by waves will be expected.

The high speed wind recorded during the monsoon season came from the North East side.

Based on the above condition, the revetment work is designed for the following reaches:

### a. Greater Dhaka East

- Sta. No. E 15 to E 21	: 3.20 km
- Sta. No. E 32 to E 39	: 3.05 km
- Sta. No. E 44 to E 52	: 3.77 km
- Sta. No. E 54 to E 60	: 2.80 km
<hr/>	
Total	12.82 km

### b. Narayanganj West

- Sta. No. NE 48-(1) R to NE 49	: 2.25 km
- Sta. No. NE 62 A - NE 87	: 6.90 km
<hr/>	
Total	9.15 km

The revetment is to be made of concrete block with brick chips and concrete foundation.

## 1.3.2 Sodding Work

Sodding is provided on the slope of embankment and berm on River side.

### 1.3.3 Brick Soling for Maintenance Road

The berm on country side of main embankment is used for operation and maintenance. While for sub-embankment, both berms are used for the operation and maintenance. This space is well compacted and paved by brick soiling in order to keep traffic ability in the rainy season. The above items and their work volumes are summarized in Table F.1.9.

## 2. Flood Wall

### 2.1 Design Condition and Criteria

#### 1) Topographical and Geological Conditions

Flood walls are basically planned at highly populated areas having relatively higher elevation and good bearing ground conditions.

The bearing capacity at foot portion of flood wall is assumed at more than 5 t/m<sup>2</sup> from boring data.

#### 2) Stability of Flood Wall

##### - I Type Wall

I type wall is assumed as a sheet pile type structure. This type structure is imprecisely known that when the embeded length is almost same with the free length, the structure is to be stable against over-turning and sliding provided that foot portion is not scoured or disturbed

Accordingly the foot protection is required in order to avoid the disturbance of foot portion of flood wall and enact the passive earth pressure.

Piping is examined by using Lane's approach and concluded satisfaction for the safety.

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- T Type Wall

The stability calculation results shows that the typical section of the flood wall satisfy the required safety factors ( $F_s > 1.5$ ) against the stability of overturning, sliding settlement and pumping.

Cut off structure is not required for the prevention of piping.

## 2.2 Standard Cross Section of the Flood Wall

### 1) Flood Wall Types and Material

It was decided upon to adopt inverted T-shaped flood walls (T Type Wall) for high wall portion by taking into account the safety. I-shaped flood walls were decided upon for narrow spaced housing areas. All flood walls are of reinforced concrete.

The standard Cross sections of rehabilitation work of existing flood wall and proposed flood wall are shown in Fig. F.2.1 and F.2.2.

### 2) Foundations

The ground's bearing strength for flood walls were examined. It was found that no special foundations would be required for the flood walls except at some inverted T-shaped sections. The inverted T-shaped flood walls on soft bearing ground will require pile foundations based on the further soil investigation.

### 3) Proposed Flood Wall Sections

The proposed length and sections of flood wall by area are summarized as follows :

#### I. Greater Dhaka East :

- New construction (I Type Wall) = 19.62 km (Sta. No. R.0 to R.22)

#### II. DND :

- New construction (I Type Wall) = 3.38 km

DN = 0.58 km (Sta. No. DN 0, DN 6, DN 22)

DE = 1.05 km ( Sta. No. DE 0, DE 13, DE 18, DE 26)

DS = 1.75 km (Sta. No. DS 0 to DS 6)

- Rehabilitation of Flood Wall = 7.60 km



### III. Narayanganj West :

- New construction (I Type & T Type Wall) = 11.49 km (St. NE 0 to NE 6, NE 55 to NE 62)

## 2.3 Stop Log Structure

Stop-log structure is designed at the openings of the flood walls. The location and number are tabulized below, while the general feature of stop-log structure is shown in Fig. F.2.3.

I. DND area : 58 places

II. Narayanganj : 17 places

The above items and their works volumes are summarized in Table F.2.1.

## 3. Sluice Gate

### 3.1 Design Condition and Criteria

Sluice gates are planned at crossing points of the existing drainage channels/khals and the proposed pump stations, however small drainage channels are to be combined with others in order to minimize the number of sluice gates.

A sluice gate of Box Culvert type is planned from economic and technical aspects of its lower cost for construction and easy operation and maintenance works.

The flow area of box culvert type of sluice gate is decided based on the design discharge and the design velocity of 2.5 m/s. However the minimum flow area is assumed to be more than 1.0 m<sup>2</sup> by taking account of maintenance work.

### 3.2 Standard Structure

Total of seven (7) sluice gates are proposed in the Greater Dhaka East. Four (4) sluice gates are attached with pump stations and others are independently allocated along the Balu river and sub-embankment (SA).



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For the DND area, one sluice gate attached with pump station is proposed.

For the Narayanganj West area, 14 sluice gates are proposed along the Lakhya river and the Dhaleswari river. Four (4) sluice gates are attached with pump stations (See Fig. F.1.3).

The proposed structural type are basically classified into two types. The one type is constructed at the embankment and others are at flood wall. However the structural shape is not different except operation and maintenance bridge (See Fig.F.3.1 and F.3.2).

The detailed information on the proposed structural features and dimensions of the sluice gates are also shown in Table F.3.1 and F.3.2.

The main features considered in the design are as follows :

- 1) To protect the gate structures from seepage, a cutoff wall made of steel sheet piles will be provided beneath and at both the sides of the sluice gate, in and outlet.
- 2) Bearing capacity of subsoils at the proposed locations are assumed to be 5 ~ 10 t/m<sup>2</sup> based on soil survey.

Since the gate structure has a 8 t/m<sup>2</sup> (Flood Wall Section) to 14 ton/m<sup>2</sup> (Embankment Section) of unit load, some pile foundation is required. The bearing piles shall be driven to soil layers, having more than N-value 30. The pile bearing capacity is calculated at 30 to 50 tons per pile for the embankment section and 20 tons for the flood wall section of Narayanganj West area.

- 3) The roller type gate is planned taking into account its easy operation and maintenance. The electrical hoisting devices are applied for the big gates which are more than 2 m x 2 m size per gate. While smaller gate is to be operated by manual.

The items and their work volumes are shown in Table F.3.1 and F.3.2.

Gate No.	Name of Khal	Sta. No.	Design Discharge (m <sup>3</sup> /s)	FL. of Outlet (m)	Remarks
I. Dhaka East					
14	KD-4	E. 68+150	22.57	+ 2.45	-
15	KD-3	E. 55	37.34	+ 2.45	-
16	Boalia Khal (KD-1)	E. 43+320	83.18	- 0.7	Pump Station (P5)
17	Jamair Khal (KD-5)	E. 28+150	114.61	- 1.0	Pump Station (P6)
18A	Begunbari Khal (KD-11)	E. 11+430	129.49	- 1.3	Pump Station (P7A)
18B	Dholai Khal	E. 8+90	140.67	- 1.3	Pump Station (P7B)
Sub-1	(KD-5)	S.A 11+100	83.2	+ 3.92	Sub-Embankment (SA)
II. DND					
20	K-4	DE. 10+300	143.5	- 1.4	Pump Station (P11)
III. N. West					
21	K-18	NE. 84+120	7.33	3.30	
22	K-19	NE. 77+160	16.72	0.0	Pump Station (P12)
23	K-20	NE. 69+100	—	3.21	Pump Station (P13)
24	K-22	NE. 49+100	21.90	2.63	
25	K-23	NE. 46+180	10.54	3.12	
26	K-23	NE. 40+170	10.31	3.11	
27	K-25	NE. 32	8.83	3.06	
28	K-26	NE. 26+150	9.18	3.04	
29	S-1	NE. 19	10.47	3.33	
30	S-2	NE. 8+50	6.17	3.00	
31	K-27	NE. 5+70	7.18	2.98	
32	S-3	NE. 1+150	3.89	3.25	
33A	K-28	NW. 23	26.97	0.50	Pump Station(NW) (P14A)
33B	K-30	NW. 14+190	43.15	0.50	Pump Station(NW) (P14B)



#### 4. Pumping Station

##### 4.1 Design Condition and Criteria

##### 4.1.1 Location and Soil Condition

Nine pumping stations, not including the existing Demra pumping station in the DND, are proposed to be constructed for the priority areas i.e, Greater Dhaka East, DND and Narayanganj West. Their locations are shown in Fig. F.4.1 and listed below.

Drainage Area	Sub-Drainage Area	No. of Pumping Station	Station No. of Embankment	Name of Khal
Greater Dhaka East	DC-1	P5	E 43+320	KD-1 (Boalia Khal)
	DC-2	P6	E 28+150	KD-5 (Jamair Khal)
	DC-3	P7A	E 11+340	KD-11(Begunbari Khal)
	DC-4	P7B	E 8+90	KD-14
DND	NA-1	P10(Demra PS)	DE 17+350	KN-1
	NA-2	P11	DE 10+300	KN-4
	NB-1	P12	NE 77+160	KN-19
Narayanganj West	NB-2	P13	NE 69+100	KN-20
	NB-4	P14A	NW 23	KN-28 (Shasongaen Khal)
	NB-5	P14B	NW 14+190	KN-31 (Mondal Para Khal)

Note : 1) Refer Fig. F.4.1

2) P10 is the existing Demra pumping station of BWDB

The soil investigation for the proposed pump stations were conducted by the study team from May to November 1991, the sub-soil conditions of them are summarized below ;

##### 1) Greater Dhaka East (P5, P6, P7A and P7B)

The sub-soil consists of the following three layers :

1) Greater Dhaka East (P5, P6, P7A and P7B)

The sub-soil consists of the following three layers :

Layer	Depth (m)	Thickness (m)	Material	N-Value	Solidity
Upper layer	0 ~ 20	5 ~ 20	Grey silt w /sand or clayey silt w/ sand	0 ~ 3	Very soft
Middle layer	5 ~ 25	5 ~ 7	Grey or brown silt w/ sand, or fine sand w/silt	5 ~ 20	Stiff
Lower layer	below 25	-	Grey or brown sand silt or fine sand	over 20	Very stiff

The lower layer, having N-values of over 20, is presumed to be a suitable soil layer to support the major structures. The suitable soil layers at P5, P6, P7A and P7B sites are presumed to be approx. 22.0, 28.0, 13.0 and 13.0 m in depth respectively. Their ground water levels are relatively high, approximately within 2.5 m deep.

The characteristics of the sub-soil within 10 m in depth are as follows :

- Natural Moisture Content (W<sub>n</sub>) : 26.5 ~ 53.7% (37.0%)
- Specific Gravity (G<sub>s</sub>) : 2.57 ~ 2.65 (2.61)
- Atterberg Limits : Liquid (L<sub>w</sub>) : 37.8 ~ 128.2 (68.3)
- Plastic (P<sub>w</sub>) : 21.4 ~ 99.9 (44.5)
- Density : Wet (rt) : 1.70 ~ 2.05 t/m<sup>3</sup> (1.86 t/m<sup>3</sup>)
- : Dry (rd) : 1.11 ~ 1.60 (1.37 t/m<sup>3</sup>)
- Cohesion (C) : 2.11 ~ 18.52 t/m<sup>2</sup> (7.50 t/m<sup>2</sup>)

2) DND (P11)

The sub-soil is basically the same as that of the Greater Dhaka East, however the depth or thickness of each layer is varied. The upper and middle layers are 8.0 and 5.0 m thick respectively. The lower layer which is presumed to be a suitable soil layer for foundation, seems 13.0 m in depth.

The characteristics of the sub-soil within 10 m in depth are as follows :

- Natural Moisture Content (Wn) : 25.9 ~ 39.4% (30.8%)
- Specific Gravity (Gs) : 2.61 ~ 2.65 (2.63)
- Atterberg Limits : Liquid (Lw) : 115.8 ~ 129.0 (122.0)  
: Plastic (Pw) : 83.1 ~ 102.5 (93.7)
- Density : Wet (rt) : 1.86 ~ 2.07 t/m<sup>3</sup> (1.96 t/m<sup>3</sup>)  
: Dry (rd) : 1.33 ~ 1.64 (1.50 t/m<sup>3</sup>)
- Cohesion (C) : 1.78 ~ 10.37 t/m<sup>2</sup> (6.67 t/m<sup>2</sup>)

### 3) Narayanganj West (P12, P13, P14A and P14B)

The sub-soil is also basically the same as that of the Greater Dhaka East. The suitable soil layer having N-values of over 20, seems 14 m to 16 m in depth.

The characteristics of the sub-soil within 10 m in depth are as follows ;

- Natural Moisture Content (Wn) : 22.1 ~ 46.9% (3728.1%)
- Specific Gravity (Gs) : 2.58 ~ 2.66 (2.61)
- Atterberg Limits : Liquid (Lw) : 37.7 ~ 60.4 (49.7)  
: Plastic (Pw) : 20.7 ~ 30.8 (25.8)
- Density : Wet (rt) : 1.77 ~ 2.08 t/m<sup>3</sup> (1.98 t/m<sup>3</sup>)  
: Dry (rd) : 1.21 ~ 1.67 (1.55 t/m<sup>3</sup>)
- Cohesion (C) : 4.45 ~ 12.98 t/m<sup>2</sup> (9.23 t/m<sup>2</sup>)

The sub-soil condition at each construction site is shown in Figs. F.4.2 (1) and (2).

### 4.1.2 Design Criteria

The preliminary designs of the proposed nine (9) pumping stations are carried out based on the followings.

#### 1) Pumping Capacity

The design pumping capacities (Q m<sup>3</sup>/s) are divided into the following four classes :

Q = 50 m<sup>3</sup>/s class : four stations (P6, P7A, P7B, P11)

Q = 25 m<sup>3</sup>/s class : one station (P5)

Q = 5 m<sup>3</sup>/s class : one station (P14B)

Q = 2 m<sup>3</sup>/s class : three stations (P12, P13, P14A)

The detailed pumping capacities are shown in Table F.4.1.



## 2) Design Water Levels

The design water levels of the river side and the land side are as follows :

- River side (Out side)
  - H.H.W.L : 100-year frequency flood water level
  - H.W.L : 2 - year frequency flood water level
  - L.W.L : Average water level at the beginning of June.
    - 3.00 m PWD (P5, P6, P7A, P11 and P14A)
    - 3.50 m PWD (P13 and P14B)
- Land side (In side)
  - H.W.L : 4.00 m PWD (P5, P6, P7A, P7B and P11)
    - 4.20 m PWD (P12)
    - 4.60 m PWD (P13, P14A and P14B)
  - L.W.L : 3.00 m PWD (P5, P6, P7A, P7B, P11, P12 and P14A)
    - 3.50 m PWD (P13 and P14B)

## 3) Pump Head

The static pump head (Hs) is estimated as follows:

Max. static pump head = H.H.W.L (river side) - L.W.L (land side)

Design static pump head = H.W.L (river side) - L.W.L (land side)

Min. static pump head = L.W.L (river side) - L.W.L (land side)

The total pump head (Ht) is estimated as follows :

$$H_t = H_s + H_l$$

Where, Ht : total pump head (m)

Hs : static pump head (m)

Hl : hydraulic losses of pump equipment, valves and sluice way (m)

The hydraulic losses of pump facilities including valves and sluice ways are roughly estimated to be 0.90 m and 0.60 m respectively.

The design static pump head and the total pump head of each station are shown in Table F.4.1.

#### 4) Pump Operation Period

The pump facilities are assumed to be intermittently operated for 5 months at least yearly from June to October, when the river stage is likely higher than 3.00 m PWD (L.W.L) as shown in Fig. E.3.13 in Supporting Report E.

The annual pump discharge volume of each station is estimated as follows :

P5	:	$27.2 \times 10^6 \text{ m}^3$	P6	:	$59.1 \times 10^6 \text{ m}^3$
P7A	:	$27.2 \times 10^6 \text{ m}^3$	P7B	:	$51.0 \times 10^6 \text{ m}^3$
P11	:	$54.3 \times 10^6 \text{ m}^3$	P12	:	$2.1 \times 10^6 \text{ m}^3$
P13	:	$2.4 \times 10^6 \text{ m}^3$	P14A	:	$2.9 \times 10^6 \text{ m}^3$
P14B	:	$5.7 \times 10^6 \text{ m}^3$			

#### 5) Ground Elevation at Pumping Station

The proposed pumping stations are located near the khals crossing the proposed embankments or flood walls, and the existing ground elevations are below the minimum required ground elevation of 4.50 m PWD.

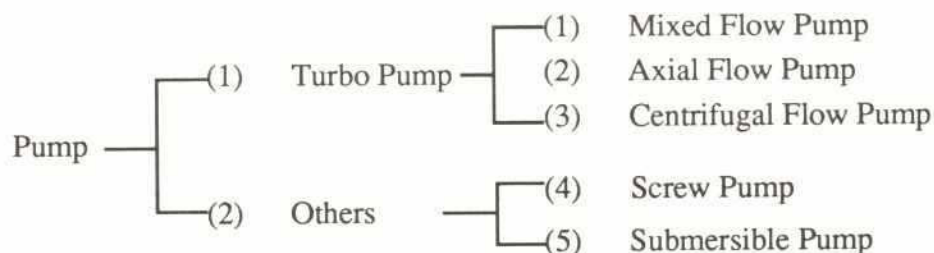
Based on the elevations of the existing roads nearby and the design flood water levels, the design elevation of each pump station yard is planned as follows ;

P5, P6, P7A, P7B and P11 stations : 5.20 m PWD  
P12, P13, P14A and P14B stations : 5.80 m PWD

### 4.2 Major Mechanical and Electric Equipment

#### 4.2.1 Pump Type Alternatives

The conventional pump applied for urban stormwater drainage systems is generally classified as follows:



Furthermore, mixed, axial and centrifugal flow pumps are divided into volute / diffuser types, single / double section types, and horizontal / vertical types.

Their applicable ranges in total pump head and bore size are summarized below.

Pump Type		Applicable Range in Total Pump Head (m)	Available Pump Dia. (mm)
Mixed Flow Pump	Horizontal	Less than 7 m	Less than ø 2,000
	Vertical	Less than 9 m	Less than ø 4,600
Centrifugal Flow Pump	Horizontal	More than 10 m	Less than ø 1,600
	Vertical	More than 10 m	Less than ø 2,000
Axial Flow Pump	Horizontal	Less than 3 m	Less than ø 2,000
	Vertical	Less than 5 m	Less than ø 4,600
Screw Pump		Less than 8 m	Less than ø 3,500
Submersible Pump		Less than 20 m	Less than ø 1,800

Submersible pump, screw pump and axial flow type pump will not be selected as pump type alternatives taking account of the following reasons :

(1) Submersible pump

- The big bore submersible pump has not yet been used for urban drainage in Bangladesh.
- As the electric motor is installed below the surface of water, strict and high technical operation and maintenance is required. O/M cost will be high.



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(2) Screw Pump

- The unit discharge capacity of pump is smaller than that of the other pump. For example, unit discharge capacity of 3,000 mm in dia. is only about 2.5 m<sup>3</sup>/s.
- In case of big pumping station, equipment and construction cost is high.

(3) Axial flow type pump

- The axial flow type pump is possible to operate under the design total pump head, however the maximum total pump head must not exceed 1.4 times of the design total pump head because of stall problem.
- The axial flow type is lower in reliability for a wide range of the pump head than the mixed flow type.

In consideration of the above the following three alternative pump types are considered.

- Alternative 1 : Vertical mixed flow pump
- Alternative 2 : Horizontal mixed flow pump
- Alternative 3 : Vertical mixed flow volute pump

For this project, the Alternative 1 'vertical mixed flow pump' is selected. The advantage and disadvantage of each pump type are described below:

(1) Alternative 1 : Vertical mixed flow pump

Advantage :

- It is more reliable over a wide range of flows and its operation and maintenance works are more easy in comparison with the horizontal mixed flow pump.
- The auxiliary equipment is not required much as the horizontal mixed flow pump, so the pump house space is smaller than that of the horizontal type.
- It is not necessary to pay any special attention for protection of motor driving unit from inundation, because it can be installed on the pump unit.

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Disadvantage :

- Though compared to the horizontal mixed flow type, this type saves about 10% in mechanical equipment costs, but requires an additional cost for civil works. The total construction cost is likely higher.

(2) Alternative 2 : Horizontal mixed flow pump

Advantage :

- Disassembly of the pump units for inspection and repair is simple and easy
- Required vertical clearance inside the pump house for installation or disassembly of the pump units is small.
- The total cost including equipment and civil works is less than that of the vertical mixed flow type.

Disadvantage :

- Many pre-operational activities are required prior to operate pumps as listed below:
  - (a) To start vacuum pump to fill water in intake casing
  - (b) To switch on main pump after completion of the above.
  - (c) To start discharge valve opening
  - (d) To stop vacuum pump operation

Due to these required pre-operational activities, the operational reliability of this type is lower than that of a vertical flow pump type.

- Inspection of the auxiliary equipment is required more in detail than that of the vertical flow pump type
- Protection of the pump floor from inundation shall be considered because a lot of electrical equipment, are arranged on the pump floor.

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(3) Alternative 3 : Vertical mixed flow volute pump

Advantage :

- This type is often available as a medium head pump (total head : 10 m to 20 m)
- Disassembly of the pump rotating parts for inspection or repairs is easy, because the pump casing can be easily lifted up.

Disadvantage :

- The structure of pump pit is more complicated and costly than the other alternatives.
- For pump installation works, the pump floor is necessary to be slightly wider than that of the vertical mixed flow pump.
- The protection works for electrical equipment from inundation, which is arranged outside of pump pit, must be considered.

#### 4.2.2 Number of Pump Unit and Its Bore

In general, by decreasing pump units, the construction cost will become lower, but the rate of risks in pump operation trouble will likely increase.

In this study, pump unit numbers and their bore sizes are planned based on the followings:

- The maximum pumping capacity per unit is decided to be below 10 m<sup>3</sup>/s based on the past experience in Bangladesh, considering easiness of operation and maintenance.
- The proposed nine (9) pumping stations are divided into 4 classes by their total pumping capacities. The pump unit numbers of each class are decided to be the same number.
- The pumping capacity per unit for a 25 m<sup>3</sup>/s class and a 50 m<sup>3</sup>/s class pumping stations is decided to be the same as possible, because of easiness and low costs for operation and maintenance, including of spare parts.

- 8D 8t
- The pump unit numbers for a 25 m<sup>3</sup>/s and a 50 m<sup>3</sup>/s classes pumping stations are decided to be more than 3 units based on their 2 to 3 stage implementation and to lower pump operational risks.
  - The minimum pump unit numbers are decided to be 2 units.

The proposed pump unit numbers and their pumping capacities and pump bore are as follows :

Pumping Station	Pumping Capacity (m <sup>3</sup> /s) Total	Unit	Number of unit	Bore of Pump (mm)
P5	25.6	8.53	3	ø 2,000
P6	54.6	9.10	6	ø 2,000
P7A	53.1	8.85	6	ø 2,000
P7B	47.2	7.87	6	ø 2,000
P11	50.2	8.37	6	ø 2,000
P12	2.0	1.00	2	ø 700
P14A	2.7	1.35	2	ø 800
P14B	5.3	2.65	2	ø 1,200

The above pump bore is estimated by the following formula ;

$$D = 1,000 \times (0.1 \sim 0.08) \times \sqrt{Q}$$

Where, D : Pump bore (mm)

Q : Unit pumping capacity (m<sup>3</sup>/s)

#### 4.2.3 Power Source of Pump Operation

For pump operation, the diesel engine driven type and the electric motor driven type were studied.

##### 1) Diesel Engine Driven Type

The diesel engine type is able to ensure pump operation in low cost for a limited time duration by supplying diesel fuel and cooling water from fuel and cooling water tanks in its pump yard.



In this project, a diesel engine, of which the capacity is estimated maximum of 770 PS for a 50 m<sup>3</sup>/s class pumping station, is to be required to run continuously for at least five months yearly during the flood season .

So, the diesel engine driven type requires regular and intensive operation and maintenance works through a year. Operation costs and capital investment costs would be costly.

## 2) Electric Motor Driven Type

When the electric motor driven type is adopted as the pump power source, the electricity has to be supplied from a 11KV power line. As the existing 11 KV power line by WAPDA, is located within max. 3.0 km from the proposed pump sites.

Considering the annual pump operation hours of 1,300 to 1,600 hr which are estimated at from the current operation records at Narinda and Demra pumping stations, and the maximum pump shaft break power of 580 KW for a 50 m<sup>3</sup>/s class pumping station, the capital investment costs, operation and maintenance costs of the electric motor driven type will be more economical than those of a diesel engine driven type.

A backup electric power source will, however, need to be provided to handle in case of emergency such emergencies as a power failure.

Taking account of the above, the electric motor driven type is planned as the pump power source. The maximum pump shaft break power of each pump station is estimated to be as follows :

P5 : 560 KW	P6 : 580 KW
P5 : 550 KW	P6 : 490 KW
P5 : 480 KW	P6 : 75 KW
P5 : 132 KW	P6 : 75 KW
P5 : 75 KW	

### 4.2.4 Gate of Sluice Way

The water gate is planned to be installed at the sluice way outlet in order to shut the culvert in case of emergency or repairing. The requirements for designing a sluice way gate are summarized below :

Pumping Station	Gate Size W (m) x H (m)	Design Water Depth (m)	
		Out side	In side
P5	2.3 x 2.3	6.15	1.00
P6	2.7 x 2.7	5.90	1.00
P7A	2.7 x 2.7	5.60	1.00
P7B	2.5 x 2.5	5.55	1.00
P11	2.5 x 2.0	5.10	1.00
P12	1.0 x 1.0	5.35	1.00
P13	1.0 x 1.0	4.75	1.00
P14A	1.1 x 1.1	5.20	1.10
P14B	1.5 x 1.5	5.10	1.60

Taking account of the above gate requirements, the following types are planned :

- Gates of P5, P6, P7A, P7B and P11  
gate type : steel roller gate  
hoist : pin-jack type with an electric motor
- Gates of P12, P13, P14A and P14B  
gate type : steel sluice gate  
hoist : manual pin-jack type

#### 4.2.5 Other Major Equipment

The other major equipment to be required for the installation, operation and maintenance works of the pumps are summarized as follows :

- Traveling overhead crane  
P5, P6, P7A, P7B and P11 : 40 t electric trolley type crane  
P14B : 13 t electric double rail hoist type crane  
P12, P13 and P14A : 7.5 t manual trolley type crane
- Screen  
P5, P6, P7a, P7B and P11 : automatic raking screen  
P12, P13 and P14A : manual raking screen
- Valve

In order to prevent flowing backward, a butterfly valve and a flap valve are to be installed at the middle and outlet of the pipe respectively.

### 4.3 Civil Works

The pumping station consists of intake channel, pump pit / pump house, discharge basin, outlet channel and other related structures. The civil works of these structures are composed of earth work, foundation work, reinforced concrete work, masonry and other works. The general layout of the proposed 9 pumping stations are shown in Figs. F.4.3 (1) to ( 5 ).

#### 4.3.1 Intake Channel

The intake channels convey flood water to the pump pits. The intake channel is designed to be a trapezoidal shape with 1:1 slope lined by brick protection as shown in Fig. F.5.1. and the flow velocity is designed to be less than 0.5 m/s at the maximum pump operation. The dimensions of each intake channel are summarized as follows :

Dimension of Intake Channel

No. of Pump Station	Length (m)	Cross Section			Brick Slope Protection (m <sup>2</sup> )
		Bottom Width(m)	Top Width(m)	Height (m)	
P5	175.0	21.4	25.8	2.2	1,090
P6	57.0	41.5	46.9	2.7	440
P7A	114.0	41.5	48.5	3.5	1,130
P7B	75.0	41.5	49.1	3.8	810
P11	62.0	41.5	50.1	4.3	760
P12	150.0	6.2	11.6	2.7	1,150
P13	140.0	6.2	9.8	1.8	720
P14A	67.0	6.7	10.3	1.8	350
P14B	135.0	9.2	15.6	3.2	1,230

#### 4.3.2 Pump Pit

The pump pit is a substructure for the pump station, which will be constructed with reinforced concrete. The pump pit is divided into pump cells of rigid frames, of which the width of each is planned to be 3 times of the pump bore. The top elevation of the pump pit (pump floor) is designed to be 10 cm higher than the proposed ground level of pump yard. The bottom elevation of the pump pit is designed to be more than three times deeper of the pump bore from the pump stop level.

As the bearing capacity of sub-soil is not enough for the spread foundation, the pump pit is planned to be supported by piles, of which the section size is 0.4 m x 0.4 m. The allowable bearing capacity per pile, pile length and required number of piles of pump pit at each pumping station are shown in Table F. 4.2.

A typical design of the pump pit is shown in Figs. F.4.4 (1) to ( 3 )

#### 4.3.3 Pump House

The pump house is a superstructure for the pump station, which is to be constructed with reinforced concrete frames and brick walls. The pump house of a 25 m<sup>3</sup>/s or a 50 m<sup>3</sup>/s class pumping station (P5, P6, P7A, P7B and P11) is of two stories and the others (P12, P13, P14A and P14B) are of one story.

The pump house is to have enough spaces and functions for the followings :

- Pump / motor equipment room
- Electrical panel room
- Operation control panel room
- Repair work shop
- Stores for tools, spare parts and others
- Office with toilet including water supply

The pump house should have the spaces and functions above, using the building space efficiently. The pump house projecting beyond the pump pits will be supported by independent footings with reinforced concrete piles.

A typical design of the pump house is shown in Figs. F.4.4 (1) to ( 3 ).

In addition, one storied administration building of approx. 100m<sup>2</sup> is planned for operations and administrative, staff and meeting rooms by taking account of continuous pump operation during the flood season.

#### 4.3.4 Discharge Basin

The discharge basin to where water is pumped out from pump pits, has a function to transmit the pumped water smoothly to sluice ways as surge tanks. The discharge basin is to be constructed with reinforced concrete of which the top elevation is designed to



be the same as that of the proposed embankment. The bottom elevation is designed to be able to install the outlet pipe with a flap valve below L.W.L. of the river side. The reinforced concrete pile foundation is planned. Their requirements are shown in Table F. 4.2.

A typical design of the discharge basin is shown in Figs. F. 4.4 (1) to ( 3 ).

#### 4.3.5 Sluice Way

The sluice way with a gate leaf at the outlet is planned with a reinforced concrete box culvert type through the flood embankment. As mentioned in section 3 (sluice gate), the maximum velocity, and the maximum size of the culvert are set at 2.5 m/s and 3.0 m x 3.0 m respectively. Accordingly the box culvert will be subdivided into necessary numbers of compartment based on the design pump discharge. The box culvert is also supported by reinforced concrete piles. Their requirements are shown in Table F.4.2.

The dimensions of the designed sluice ways are summarized below :

Dimension of Sluice Ways

No. of Pump Station	Design Discharge (m)	Cross Section			Length (m)
		Width (m)	Height (m)	No. of Compartment	
P5	25.6	2.3	2.3	2	76.7
P6	54.6	2.7	2.7	3	75.2
P7A	53.1	2.7	2.7	3	73.4
P7B	47.2	2.5	2.5	3	73.1
P11	50.2	2.5	2.0	4	61.4
P12	2.0	1.0	1.0	1	60.2
P13	2.2	1.0	1.0	1	56.6
P14A	2.7	1.1	1.1	1	59.3
P14B	5.3	1.5	1.5	1	58.7

Typical design of sluice way is shown in Figs. F.4.5 (1) and (2).

#### 4.3.6 Outlet Channel

The outlet channel is to convey pumped water from the sluice way to the river side. The design cross section is the same as that of the intake channel, which is designed to be a trapezoidal shape with 1:1 slope lined by brick protection as shown in Fig. F. 5.1.

The dimensions of the outlet channels are summarized below:

Dimension of Outlet Channel

No. of Pump Station	Length (m)	Cross Section			Brick Slope Protection (m <sup>2</sup> )
		Bottom Width(m)	Top Width(m)	Height (m)	
P5	130.0	16.0	25.0	4.5	1,660
P6	158.0	26.0	30.0	2.0	900
P7A	78.0	17.0	22.6	2.8	620
P7B	125.0	13.0	19.2	3.1	1,100
P11	130.0	9.0	16.2	3.6	1,330
P12	-	-	-	-	-
P13	-	-	-	-	-
P14A	-	-	-	-	-
P14B	-	-	-	-	-

## 5. Khal Improvement and Trunk Drain

### 5.1 Khal Section and Slope Protection

The khal improvement is based on the following two types

- Type (1) : Trapezoidal shape with 1:2 slope lined by sodding
- Type (2) : Trapezoidal shape with 1:1 slope lined by brick

Type (1) is applied for the khals situated in agricultural area where land cost is low and land acquisition is comparatively to be easy. Type (2) is proposed for the khals located in existing built-up areas where land acquisition is likely to be difficult.

Operation and maintenance roads with the minimum width of 4.0m, including its shoulders, are planned to the both banks of the khal. The typical cross sections of khal improvements are shown in Fig. F.5.1.

## 5.2 Bridge

### 5.2.1 General Features

According to the field investigation by the study team, there are 86 sites at where the khals to be improved are to cross roads, railways and irrigation canals. The locations are shown in Figs. F. 5.2. (1) and (2), summarized below :

Item	No. of Bridge (Place)			Total
	Greater Dhaka East	DND	Narayanganj West	
1. Road Bridge				
- Not to be reconstructed	5	9	4	18
- To be reconstructed	0	28	0	28
- To be newly constructed	12	6	11	29
Sub-Total	17	43	15	75
2. Railway Bridge				
- Not to be reconstructed	-	-	1	1
- To be reconstructed	1	4	0	5
- To be newly constructed	-	-	3	3
Sub-Total	1	4	4	9
3. Aqueduct				
- Not to be reconstructed	-	-	-	-
- To be reconstructed	-	2	-	2
- To be newly constructed	-	-	-	-
Sub-Total	-	2	-	2
Total :	18	49	19	86

Main features of the existing bridges are shown in Tables F. 5.1. (1) to (3).

### 5.2.2 Design Criteria

The preliminary design of the proposed bridges are based on the following main design criteria :

- Load
  - o for the internal road bridge : H-20
  - o for the highway bridge : H-20-S16
  - o for the railway bridge : M.L.
  - o for the aqueduct : water weight.
- Bridge width

The bridge width will be designed as the same width as the existing road or railway.

- Allowable reduction of the khal section

For deciding a bridge span, the allowable maximum reduction rate of the khal cross section is decided at 30% due to the BWDB design criteria.

### 5.2.3 Road Bridge

The road bridges are classified into the following three types based on their required spans.

- Type (1) : concrete slab bridge (span : below 5 m)
- Type (2) : concrete girder bridge (span: 5 m to 16 m)
- Type (3) : cantilever type concrete girder bridge (span : 16 m to 30 m)

Considering economic efficiency and construction easiness, abutments with wing walls and piers are planned with brick masonry and reinforced concrete respectively. If a spread foundation is not possible, the pile foundation with appropriate wooden or reinforced concrete piles are planned.

The necessary numbers of each type are summarized below :





(Unit : Place)

Bridge Type	Greater Dhaka East	DND	Narayanganj West	Total
Type (1)	-	6	8	14
Type (2)	11	27	3	41
Type (3)	1	1	-	2
Total :	12	34	11	57

Note : The road bridges which are not required to be reconstructed are not included in the table.

The main features of proposed bridges are shown in Tables F. 5.1 (1) to (3). Typical designs of the road bridge are shown in Figs. F.5.3 to F.5.4.

#### 5.2.4 Railway Bridge

Five railway bridges are planned to be reconstructed and three new bridges to be constructed.

A steel girder type bridge is proposed for reconstruction of the existing railway bridge because of the necessity to perform fast and safe construction without stopping trains.

The abutments and piers are planned with the same materials as that of the road bridge. Reinforced concrete piles are used as foundation of abutment or pier, if necessary.

The main features and typical designs of the proposed railway bridges are shown in Table F. 5.1 (1) to (3) and Fig. F.5.3 (2) respectively.

#### 5.2.5 Aqueduct

Only two aqueducts are planned at the khals crossings with the irrigation canals in the DND area. Considering the expected spans of 7 and 15 m in length, reinforced concrete U - type flume bridges are applied. Abutments are planned with brick masonry to economize the construction cost. A pile foundation by wood or reinforced concrete is applied, if necessary.

The main features and typical designs of the proposed aqueduct are shown in Table F. 5.1 (2) and Fig. F.5.4 respectively.

### 5.3 Trunk Drain

The trunk drain improvements in the Narayanganj town area are based on the following two covered channel types.

- Type (1) : Brick pipe
- Type (2) : Reinforced concrete box culvert

The brick pipe is commonly applied for sewerage and drainage in Dhaka because bricks can be supplied in low cost and many skilled masons are available. It is planned that the brick type pipe with a diameter of 1.5 to 3.0 m be used for the improvement of trunk drains.

The drainage pipes of more than 3.0 m in diameter and discharge capacities more than 10 m<sup>3</sup>/s, and being under heavy load conditions are planned to use a reinforced concrete box culvert type.

Typical designs of the proposed trunk drains are shown in Fig. F.5.5.

Table F.1.1 LABORATORY TEST DATA OF SOIL INVESTIGATION

	Sampl No.	Depth (m)	Po (t/m <sup>2</sup> )	SPT N	MOIS.C (Wn)	Gs (t/m <sup>3</sup> )	Lw	Pw	rt (t/m <sup>3</sup> )	rd (t/m <sup>3</sup> )	C (t/m <sup>2</sup> )	eo	Cc	Cv (cm <sup>2</sup> /s)
E-1	U-1	3.33	2.66	2.0	75.9	2.59	115.4	54.6	1.56	0.89	1.97	1.92	0.65	4.2 E-04
	U-2	6.33	5.06	2.0	111.1	2.58	111.4	50.0	1.40	0.66	1.48	2.89	1.00	1.5 E-03
	U-3	9.33	7.46	3.0	35.8	2.59	41.8	25.0	1.86	1.37	2.19	0.89	0.15	2.9 E-04
	U-4	12.33	9.86	15.0	21.6	2.60			2.11	1.73	9.78	0.50	0.07	6.9 E-04
	U-5	15.33	12.26	27.0	37.3	2.65	44.6	23.9	1.90	1.38	13.53	0.90	0.15	3.1 E-04
	U-6	18.33	14.66	29.0	26.1	2.65	36.7	22.2	1.96	1.56	12.23	0.70	0.13	6.8 E-04
E-2	U-1	3.33	2.66	2.0	36.7	2.59	47.8	25.9	1.86	1.36	6.45	0.89	0.11	1.7 E-03
	U-2	9.33	7.46	1.0	50.0	2.61	57.7	28.3	1.70	1.13	2.83	1.30	0.58	3.8 E-04
	U-3	12.33	9.86	1.0	52.9	2.63	50.0	27.5	1.70	1.11	3.22	1.37	0.50	3.5 E-04
	U-4	18.33	14.66	3.0	39.7	2.65	50.1	28.2	1.83	1.31	2.93	1.02	0.54	1.6 E-04
	U-5	21.33	17.06	42.0	35.5	2.67	49.3	26.2	1.82	1.35	3.71	0.98	0.24	2.9 E-04
	U-6	24.33	19.46	40.0	26.4	2.65			1.90	1.50	2.70	0.76	0.09	1.1 E-03
E-3	U-1	3.33	2.66	1.0	47.3	2.65	53.4	29.2	1.74	1.18	2.74	1.24	0.31	5 E-04
	U-2	6.33	5.06	1.0	76.7	2.60	119.5	62.5	1.53	0.87	3.29	1.98	0.77	2.1 E-04
	U-3	9.33	7.46	12.0	26.2	2.66			1.91	1.52	2.85	0.75	0.07	2.4 E-04
	U-4	12.33	9.86	12.0	25.6	2.68			1.88	1.49	2.63	0.79	0.06	1.9 E-04
	U-5	15.33	12.26	26.0	20.4	2.67			1.85	1.54	2.96	0.74	0.09	2.9 E-04
	U-6	18.33	14.66	32.0	18.9	2.68			1.81	1.52	2.42	0.77	0.10	1.7 E-04
E-4	U-1	3.33	2.66	2.0	113.2	2.55	119.7	106.2	1.39	0.65	3.37	2.91	0.94	1.5 E-04
	U-2	6.33	5.06	1.0	48.6	2.65	46.8	23.1	1.76	1.19	2.11	1.23	0.28	1.5 E-03
	U-3	9.33	7.46	2.0	53.7	2.63	49.0	25.4	1.71	1.11	2.24	1.35	0.40	2.9 E-04
	U-4	12.33	9.86	1.5	44.2	2.63	43.6	24.4	1.75	1.21	2.47	1.17	0.23	6.2 E-04
	U-5	15.33	12.26	3.0	49.4	2.62	43.3	23.4	1.76	1.18	2.83	1.22	0.24	3.1 E-04
	U-6	18.33	14.66	4.5	29.0	2.65	34.0	19.2	1.83	1.42	4.05	0.87	0.18	9.5 E-04
	U-7	24.33	19.46	13.0	18.8	2.65			2.15	1.81	3.98	0.46	0.11	2.1 E-04
	U-8	27.33	21.86	15.0	22.5	2.67			2.07	1.69	7.88	0.57	0.12	6.2 E-04
E-5	U-1	3.33	2.66	3.0	36.8	2.63	114.9	84.0	1.84	1.35	5.39	0.96	0.19	3 E-03
	U-2	6.33	5.06	2.0	52.5	2.64	109.2	76.6	1.87	1.23	2.69	1.30	0.29	7.2 E-05
	U-3	9.33	7.46	1.5	44.0	2.65	109.9	76.3	1.76	1.22	2.43	1.16	0.25	6.2 E-04
	U-4	12.33	9.86	2.0	39.9	2.66	110.9	79.3	1.78	1.27	2.74	1.10	0.26	1.3 E-03
	U-5	15.33	12.26	1.5	52.9	2.61	106.1	69.4	1.70	1.11	2.22	1.35	0.45	2.8 E-04
	U-6	18.33	14.66	2.0	48.8	2.62	109.2	73.4	1.75	1.18	1.45	1.23	0.33	1.1 E-04
E-6	U-1	3.33	2.66	8.0	30.9	2.57	117.3	89.6	1.88	1.44	14.41	0.80	0.11	1.1 E-03
	U-2	6.33	5.06	13.0	28.3	2.57	128.2	99.9	2.05	1.60	18.52	0.61	0.07	2.6 E-04
	U-3	9.33	7.46	18.0	26.5	2.63	122.4	96.8	1.96	1.55	12.02	0.69	0.10	9 E-04
	U-4	15.33	12.26	24.0	31.6	2.62	123.1	93.5	1.97	1.50	12.45	0.75	0.10	1.5 E-03
	U-5	18.33	14.66	20.0	25.2	2.59	128.2	102.4	2.05	1.64	8.80	0.58	0.32	3 E-05
	U-6	21.33	17.06	21.0	31.8	2.60	121.7	92.4	1.95	1.48	5.94	0.75	0.34	4.5 E-05
	U-7	24.33	19.46	15.0	29.3	2.63	124.9	96.6	2.00	1.55	9.43	0.70	0.18	6.2 E-04
	U-8	27.33	21.86	14.0	71.2	2.54	93.4	57.5	1.58	0.92	16.52	1.75	0.38	8.5 E-04
E-7	U-1	1.33	1.06	3.5	30.2	2.57	59.2	30.4	1.92	1.47	4.96	0.75	0.20	5.1 E-04
	U-2	3.33	2.66	4.5	36.8	2.63	45.0	24.6	1.84	1.35	4.94	0.96	0.24	1.7 E-04
	U-3	6.33	5.06	9.0	36.1	2.65	40.0	23.6	1.84	1.35	5.76	0.95	0.18	4 E-04
	U-4	9.33	7.46	8.0	28.8	2.65	37.8	21.4	1.94	1.51	8.24	0.76	0.14	4.8 E-03
	U-5	12.33	9.86	10.0	31.3	2.66			1.93	1.47	9.43	0.81	0.19	9.5 E-05
	U-6	15.33	12.26	28.0	21.0	2.64	48.1	24.6	2.08	1.72	21.09	0.54	0.12	2.5 E-03
	U-7	18.33	14.66	15.0	28.1	2.63	49.1	24.1	1.98	1.55	4.04	0.69	0.20	4 E-04
E-8	U-1	1.33	1.06	5.0	26.6	2.65	120.2	94.9	1.93	1.52	8.52	0.74	0.12	1 E-02
	U-2	3.33	2.66	5.0	31.1	2.63	123.3	94.1	1.98	1.51	6.00	0.75	0.14	1.1 E-02
	U-3	6.33	5.06	3.5	39.4	2.61	115.8	83.1	1.86	1.33	1.78	0.98	0.29	3.5 E-04
	U-4	9.33	7.46	11.0	25.9	2.62	129.0	102.5	2.07	1.64	10.37	0.60	0.13	1.7 E-03
	U-5	12.33	9.86	15.0	31.8	2.63	121.6	92.0	1.94	1.47	7.68	0.78	0.14	4.9 E-04
	U-6	15.33	12.26	80.0	28.5	2.62	121.6	94.6	1.95	1.52	17.12	0.73	0.13	8.5 E-04
		12.08	9.66	12.00	39.40	2.63	85.90	57.34	1.85	1.36	6.30	1.02	0.26	1.1 E-03
		27.33	21.86	80.00	113.20	2.68	129.00	106.20	2.15	1.81	21.09	2.91	1.00	1.1 E-02
		1.33	1.06	1.00	18.80	2.54	33.96	19.23	1.39	0.65	1.45	0.46	0.06	3 E-05



Table F.1.2 COMPACTION TEST AND MECHANICAL TEST DATA :  
DHAKA AND NARAYANGANJ WEST

Sampl No.	RD=95%						RD=95%					
	rd	w(%)	rw	c(t/m2)	Ø(deg)	k(cm/s)	rd	w(%)	rw	c(t/m2)	Ø(deg)	k(cm/s)
I. Dhaka East												
E-1-1	1.51	28.80	1.95	7.21	11.75	1.4 E-04	1.43	31.20	1.88	7.91	13.00	6.4 E-05
E-1-2	1.53	31.15	2.03	6.96	11.00	1.3 E-04	1.45	36.00	1.98	7.56	23.50	1.0 E-04
E-2-1	1.46	31.00	1.91	8.61	12.00	1.5 E-05	1.38	34.00	1.85	6.68	16.00	9.2 E-06
E-2-2	1.48	36.25	2.02	5.98	13.50	1.1 E-05	1.41	43.35	2.02	5.80	17.50	1.1 E-05
E-3-1	1.43	32.70	1.89	7.03	5.00	9.1 E-06	1.35	35.60	1.83	5.27	13.00	7.3 E-06
E-3-2	1.45	38.50	2.01	4.39	13.25	7.2 E-06	1.38	46.20	2.01	4.57	13.50	4.2 E-06
E-4-1	1.63	25.75	2.06	6.15	15.00	1.1 E-04	1.55	27.45	1.97	6.68	21.25	1.1 E-04
E-4-2	1.60	28.15	2.06	5.84	13.75	1.1 E-04	1.52	30.55	1.98	8.44	18.25	1.0 E-04
E-5-1	1.56	27.70	2.00	7.66	11.00	2.3 E-04	1.48	30.40	1.93	7.73	23.00	3.0 E-04
E-5-2	1.54	32.15	2.04	6.85	9.50	2.3 E-04	1.46	35.40	1.98	5.62	21.25	2.2 E-04
E-6-1	1.59	24.25	1.98	7.21	18.00	2.5 E-05	1.51	26.65	1.91	4.92	23.75	4.0 E-05
E-6-2	1.63	29.35	2.10	7.00	16.00	4.3 E-05	1.54	32.50	2.04	8.79	19.25	6.7 E-05
E-7-1	1.77	21.25	2.15	5.98	18.00	2.5 E-05	1.68	23.20	2.07	4.92	27.00	3.0 E-05
E-7-2	1.74	19.75	2.09	7.14	13.00	3.0 E-05	1.65	20.70	1.99	5.27	23.25	3.5 E-05
MEAN	1.57	29.13	2.02	6.71	12.91	8.0 E-05	1.49	32.37	1.96	6.44	19.54	7.9 E-05
MIN	1.43	19.75	1.89	4.39	5.00	7.2 E-06	1.35	20.70	1.83	4.57	13.00	4.2 E-06
MAX	1.77	38.50	2.15	8.61	18.00	2.3 E-04	1.68	46.20	2.07	8.79	27.00	3.0 E-04
II. Narayanganj West												
N-1	1.62	22.50	1.99	8.30	31.00	9.6 E-05	1.54	25.30	1.92	11.07	29.00	7.4 E-05
N-2	1.61	25.30	2.02	9.84	33.00	8.4 E-05	1.53	27.00	1.94	7.03	32.50	8.3 E-05
N-3	1.59	25.00	1.99	9.70	29.00	7.4 E-05	1.51	27.50	1.92	8.96	30.00	7.7 E-05
N-4	1.64	25.00	2.05	7.03	31.50	3.7 E-05	1.55	27.50	1.98	4.92	34.00	2.1 E-05
MEAN	1.62	24.40	2.01	8.72	31.13	7.3 E-05	1.53	26.80	1.94	8.00	31.38	6.4 E-05
MIN	1.59	22.50	1.99	7.03	29.00	3.7 E-05	1.51	25.30	1.92	4.92	29.00	2.1 E-05
MAX	1.64	25.30	2.05	9.84	33.00	9.6 E-05	1.55	27.50	1.98	11.07	34.00	8.3 E-05



Table F.1.4(1) : STAGE CONSTRUCTION OF EMBANKMENT : GREATER DHAKA EAST

Each Stage U = 80%										Remarks
Station No.	Distance (m)	Accumulative Distance(m)	Ground Elevation(m)	Top of Embankment(m)	Embankment Height(m)	Design N	1st Stage(m)	2nd Stage(m)	3rd Stage(m)	
E - 0	0.0	0.0	5.46	8.60	3.14	7.50	3.14			DC-4
1	400.0	400.0	5.46	8.62	3.16	7.50	3.16			
2	400.0	800.0	3.96	8.63	4.67	4.50	4.67			
3	400.0	1,200.0	3.96	8.65	4.69	4.50	4.69			
4	400.0	1,600.0	4.36	8.67	4.31	4.50	4.31			
5	400.0	2,000.0	4.36	8.69	4.33	4.50	4.33			
6	400.0	2,400.0	4.06	8.70	4.64	4.50	4.64			
7	400.0	2,800.0	4.26	8.72	4.46	4.50	4.46			
8	400.0	3,200.0	3.46	8.74	5.28	2.00	3.67	1.61		
9	400.0	3,600.0	2.96	8.76	5.8	2.00	3.67	2.13		
10	400.0	4,000.0	3.46	8.77	5.31	2.00	3.67	1.64		
11	400.0	4,400.0	3.96	8.79	4.83	2.00	3.67	1.16		DC-3
11+150	150.0	4,550.0	3.94	8.80	4.86	2.00	3.67	1.19		
12	250.0	4,800.0	3.92	8.81	4.89	2.00	3.67	1.22		
13	520.0	5,320.0	2.72	8.83	6.11	2.00	3.67	2.44		
14	400.0	5,720.0	2.65	8.85	6.2	2.00	3.67	2.53		
15	400.0	6,120.0	2.55	8.87	6.32	2.00	3.67	2.65		
16	400.0	6,520.0	3.06	8.88	5.82	2.00	3.67	2.15		
17	400.0	6,920.0	3.11	8.90	5.79	2.00	3.67	2.12		
18	400.0	7,320.0	3.11	8.92	5.81	2.00	3.67	2.14		
18+200	200.0	7,520.0	3.41	8.93	5.53	2.00	3.67	1.86		
19	200.0	7,720.0	3.70	8.94	5.24	2.00	3.67	1.57		DC-2
20	400.0	8,120.0	3.02	8.95	5.93	2.00	3.67	2.26		
21	400.0	8,520.0	2.94	8.97	6.03	2.00	3.67	2.36		
22	400.0	8,920.0	2.58	8.99	6.41	2.00	3.67	2.74		
23	400.0	9,320.0	2.48	9.01	6.53	2.00	3.67	2.86		
24	400.0	9,720.0	2.77	9.02	6.25	2.00	3.67	2.58		
25	400.0	10,120.0	2.68	9.04	6.36	2.00	3.67	2.69		
26	400.0	10,520.0	4.88	9.06	4.18	2.00	3.67	0.51		
27	400.0	10,920.0	5.00	9.08	4.08	2.00	3.67	0.41		
28	400.0	11,320.0	4.93	9.09	4.16	2.00	3.67	0.49		
29	400.0	11,720.0	4.93	9.11	4.18	2.00	3.67	0.51		
30	400.0	12,120.0	1.72	9.13	7.41	2.00	3.67	2.88	3.46	
31	400.0	12,520.0	1.73	9.15	7.42	2.00	3.67	2.88	3.48	
32	400.0	12,920.0	2.04	9.16	7.12	2.00	3.67	2.88	3.49	
33	400.0	13,320.0	4.37	9.18	4.81	2.00	3.67	1.14		DC-1
33+200	200.0	13,520.0	5.50	9.19	3.69	3.25	3.12			
34	200.0	13,720.0	6.63	9.20	2.57	4.50	2.57			
35	400.0	14,120.0	7.01	9.22	2.21	4.50	2.21			
36	400.0	14,520.0	4.38	9.23	4.85	4.50	4.85			
37	400.0	14,920.0	1.61	9.25	7.64	4.50	7.64			
38	400.0	15,320.0	2.78	9.27	6.49	4.50	6.49			
39	250.0	15,570.0	6.76	9.28	2.52	4.50	2.52			
40	400.0	15,970.0	6.96	9.30	2.34	4.50	2.34			
41	400.0	16,370.0	4.66	9.31	4.65	4.50	4.65			
42	400.0	16,770.0	5.46	9.33	3.87	4.50	3.87			
43	400.0	17,170.0	2.76	9.35	6.59	2.00	3.67	2.88	3.68	
44	400.0	17,570.0	1.96	9.37	7.41	2.00	3.67	2.88	3.70	
45	400.0	17,970.0	0.86	9.38	8.52	2.00	3.67	2.88	3.71	
46	400.0	18,370.0	1.06	9.40	8.34	2.00	3.67	2.88	3.73	
47	400.0	18,770.0	1.66	9.42	7.76	2.00	3.67	2.88	3.75	
48	400.0	19,170.0	1.76	9.44	7.68	2.00	3.67	2.88	3.77	
49	400.0	19,570.0	1.46	9.45	7.99	2.00	3.67	2.88	3.78	
50	500.0	20,070.0	2.16	9.48	7.32	2.00	3.67	2.88	3.81	
51	500.0	20,570.0	4.46	9.50	5.04	2.00	3.67	1.37		
52	370.0	20,940.0	3.09	9.51	6.42	2.00	3.67	2.75		
53	400.0	21,340.0	4.59	9.53	4.94	2.00	3.67	1.27		
54	400.0	21,740.0	5.06	9.55	4.49	2.00	3.67	0.82		
55	420.0	22,160.0	2.53	9.57	7.04	2.00	3.67	2.88	3.90	
56	160.0	22,320.0	2.08	9.57	7.49	2.00	3.67	2.88	3.90	
57	400.0	22,720.0	2.39	9.59	7.2	2.00	3.67	2.88	3.92	
58	400.0	23,120.0	2.37	9.61	7.24	2.00	3.67	2.88	3.94	
59	400.0	23,520.0	2.78	9.63	6.85	2.00	3.67	2.88	3.96	
60	400.0	23,920.0	7.26	9.64	2.38	7.50	2.38			
61	400.0	24,320.0	2.38	9.66	7.28	2.00	3.67	2.88	3.99	
62	400.0	24,720.0	4.73	9.68	4.95	2.00	3.67	1.28		
63	400.0	25,120.0	2.50	9.70	7.2	2.00	3.67	2.88	4.03	
64	400.0	25,520.0	2.95	9.71	6.76	2.00	3.67	2.88	4.04	
65	400.0	25,920.0	7.29	9.73	2.44	2.00				
66	400.0	26,320.0	7.55	9.75	2.2	4.50				
67	400.0	26,720.0	6.89	9.77	2.88	4.50				
68	400.0	27,120.0	7.01	9.78	2.77	4.50				
69	400.0	27,520.0	9.80	9.80	0	4.50				
				AVE	5.65	m		18870.0	7520.00	
				MAX	8.52	m		68.6%	27.3%	
				MIN	2.2	m				

Table F.1.4(2) : STAGE CONSTRUCTION OF SUB-EMBANKMENT : GREATER DHAKA EAST

Each Stage U = 80%

Station	Distance	Accumulative Distance	Ground Elevation	Top of Embankment(m)	Embankment Height(m)	Design N	1st Stage(m)	2nd Stage(m)	3rd Stage(m)	Remarks
SA 0	0.0	0.0	6.90	8.62	1.72	4.00	1.72			
1	400.0	400.0	7.61	8.62	1.01	4.00	1.01			
2	400.0	800.0	6.16	8.62	2.46	4.00	2.46			
3	400.0	1,200.0	6.53	8.62	2.09	4.00	2.09			
4	400.0	1,600.0	5.59	8.62	3.03	4.00	3.03			
5	400.0	2,000.0	4.44	8.62	4.18	4.00	4.18			
6	400.0	2,400.0	4.07	8.62	4.55	2.00	3.67	0.88		
7	400.0	2,800.0	4.54	8.62	4.08	2.00	3.67	0.41		
8	400.0	3,200.0	4.26	8.62	4.36	2.00	3.67	0.69		
9	400.0	3,600.0	6.44	8.62	2.18	4.00	2.18			
10	400.0	4,000.0	5.21	8.62	3.41	4.00	3.41			
11	400.0	4,400.0	4.09	8.62	4.53	2.00	3.67	0.86		
12	400.0	4,800.0	4.18	8.62	4.44	2.00	3.67	0.77		
13	400.0	5,200.0	5.63	8.62	2.99	2.00	2.99			
14	400.0	5,600.0	6.64	8.62	1.98	4.00	1.98			
15	400.0	6,000.0	6.35	8.62	2.27	4.00	2.27			
16	400.0	6,400.0	8.12	8.62	0.50	4.00	0.50			
				AVE	3.11	m		2000.0		
				MAX	4.55			0.3		
				MIN	0.50					

Station	Distance	Accumulative Distance	Ground Elevation	Top of Embankment	Embankment Height	Design N	1st Stage	2nd Stage	3rd Stage	
SB 0	0.0	0.0	3.87	8.33	4.46	2.00	3.67	0.79		
1	360.0	400.0	2.51	8.33	5.82	2.00	3.67	2.15		
2	400.0	760.0	2.30	8.33	6.03	2.00	3.67	2.36		
3	400.0	1,160.0	2.55	8.33	5.78	2.00	3.67	2.11		
4	400.0	1,560.0	1.57	8.33	6.76	2.00	3.67	2.88	0.21	
5	400.0	1,960.0	2.95	8.33	5.38	2.00	3.67	1.71		
6	400.0	2,360.0	3.70	8.33	4.63	2.00	3.67	0.96		
7	400.0	2,760.0	4.58	8.33	3.75	2.00	3.67	0.08		
8	350.0	3,160.0	4.91	8.33	3.42	2.00	3.42			
9	400.0	3,510.0	4.65	8.33	3.68	2.00	3.67	0.01		
10	400.0	3,910.0	5.39	8.33	2.94	5.00	2.94			
11	400.0	4,310.0	6.09	8.33	2.24	5.00	2.24			
12	400.0	4,710.0	6.57	8.33	1.76	7.50	1.76			
				AVE	4.72			3335.0	400.00	
				MAX	6.76			0.7	0.1	
				MIN	1.76					

Station	Distance	Accumulative Distance	Ground Elevation	Top of Embankment	Embankment Height	Design N	1st Stage	2nd Stage	3rd Stage	
SC 0	0.0	0.0	3.36	8.21	4.85	4.00	4.85			
1	500.0	500.0	2.76	8.21	5.45	4.00	5.45			
2	500.0	1,000.0	4.53	8.21	3.68	4.00	3.68			
3	500.0	1,500.0	4.09	8.21	4.12	4.00	4.12			
4	500.0	2,000.0	3.94	8.21	4.27	4.00	4.27			
5	500.0	2,500.0	4.29	8.21	3.92	4.00	3.92			
6	500.0	3,000.0	3.12	8.21	5.09	2.00	3.67	1.42		
7	500.0	3,500.0	2.83	8.21	5.38	2.00	3.67	1.71		
8	500.0	4,000.0	2.03	8.21	6.18	2.00	3.67	2.51		
9	500.0	4,500.0	2.58	8.21	5.63	2.00	3.67	1.96		
10	500.0	5,000.0	2.49	8.21	5.72	2.00	3.67	2.05		
11	500.0	5,500.0	2.66	8.21	5.55	2.00	3.67	1.88		
12	500.0	6,000.0	2.10	8.21	6.11	2.00	3.67	2.44		
13	310.0	6,310.0	2.92	8.21	5.29	2.00	3.67	1.62		
				AVE	5.48			3556.0		
				MAX	6.18			0.6		
				MIN	3.68					



Table 1.4 (3) : STAGE CONSTRUCTION OF EMBANKMENT : NARAYANGANJ WEST (NW)

Each Stage U = 80%										
Station No.	Distance (m)	Accumulative Distance (m)	Ground Elevation (m)	Top of Embankment (m)	Embankment Height (m)	Design N	1st Stage (m)	2nd Stage	3rd Stage	Remarks
NW 0	0.0	0.0	5.42	7.96	2.54	2.00	2.54			
1	39.0	39.0	6.26	7.96	1.70	2.00	1.70			
2	200.0	239.0	5.36	7.97	2.61	2.00	2.61			
3	200.0	439.0	5.25	7.98	2.73	2.00	2.73			
4	200.0	639.0	5.85	7.99	2.14	2.00	2.14			
5	200.0	839.0	6.51	8.00	1.49	2.00	1.49			
6	200.0	1,039.0	5.75	8.01	2.26	2.00	2.26			
7	200.0	1,239.0	5.49	8.01	2.52	2.00	2.52			
8	200.0	1,439.0	5.06	8.02	2.96	2.00	2.96			
9	200.0	1,639.0	6.91	8.03	1.12	2.00	1.12			
10	200.0	1,839.0	6.03	8.04	2.01	2.00	2.01			
11	200.0	2,039.0	5.09	8.05	2.96	2.00	2.96			
12	200.0	2,239.0	5.07	8.07	3.00	2.00	3.00			
12	200.0	2,439.0	6.75	8.09	1.34	2.00	1.34			
14	200.0	2,639.0	6.29	8.11	1.82	2.00	1.82			
15	200.0	2,839.0	5.02	8.13	3.11	2.00	3.11			
16	200.0	3,039.0	6.06	8.15	2.09	2.00	2.09			
17	200.0	3,239.0	6.31	8.17	1.86	2.00	1.86			
18	200.0	3,439.0	5.30	8.19	2.89	2.00	2.89			
19	200.0	3,639.0	4.77	8.21	3.44	2.00	3.44			
20	200.0	3,839.0	6.45	8.22	1.77	2.00	1.77			
21	200.0	4,039.0	6.55	8.24	1.69	2.00	1.69			
22	200.0	4,239.0	6.67	8.26	1.59	2.00	1.59			
23	200.0	4,439.0	6.09	8.28	2.19	2.00	2.19			
24	200.0	4,639.0	5.20	8.30	3.10	2.00	3.10			
25	200.0	4,839.0	5.27	8.32	3.05	2.00	3.05			
26	200.0	5,039.0	5.12	8.34	3.22	2.00	3.22			
27	200.0	5,239.0	5.22	8.36	3.14	2.00	3.14			
28	200.0	5,439.0	5.79	8.38	2.59	2.00	2.59			
29	200.0	5,639.0	6.86	8.40	1.54	2.00	1.54			
				AVE	2.43					
				MAX	3.44					
				MIN	1.12					

Table F.1.4(4) STAGE CONSTRUCTION OF EMBANKMENT : NARAYANGANJ WEST (NE)

Each Stage U = 80%										
Station No.	Distance (m)	Accumulative Distance (m)	Ground Elevation (m)	Top of Embankment (m)	Embankment Height (m)	Design N	1st Stage (m)	2nd Stage (m)	3rd Stage (m)	Remarks
NE 62	0.0	14,430.0	4.52	8.35	3.83	7.50	3.83			
62A	55.0	14,485.0	7.10	8.35	1.25	7.50	1.25			
63	200.0	14,685.0	6.76	8.36	1.60	7.50	1.60			
64	200.0	14,885.0	7.04	8.37	1.33	7.50	1.33			
65	200.0	15,085.0	4.29	8.38	4.09	2.00	3.67	0.42		
66	200.0	15,285.0	4.32	8.39	4.07	2.00	3.67	0.40		
67	200.0	15,485.0	4.79	8.40	3.61	2.00	3.61			
68	200.0	15,685.0	6.12	8.41	2.29	7.50	2.29			
69	200.0	15,885.0	4.86	8.42	3.56	7.50	3.56			
70	200.0	16,085.0	4.21	8.43	4.22	2.00	3.67	0.55		
71	200.0	16,285.0	7.80	8.44	0.64	7.50	0.64			
-(1	179.0	16,464.0	2.70	8.45	5.75	2.00	3.67	2.08		
-1	250.0	16,714.0	5.24	8.45	3.21	7.50	3.21			
-2	250.0	16,964.0	3.91	8.45	4.54	7.50	4.54			
-3	250.0	17,214.0	4.58	8.45	3.87	2.00	3.87			
3	296.0	17,510.0	3.50	8.45	4.95	2.00	4.95			
2	250.0	17,760.0	3.05	8.45	5.40	2.00	5.40			
1	250.0	18,010.0	5.32	8.45	3.13	7.50	3.13			
(1)	250.0	18,260.0	2.50	8.45	5.95	2.00	5.95			
72	69.0	18,329.0	7.44	8.45	1.01	7.50	1.01			
73	201.0	18,530.0	5.31	8.46	3.15	7.50	3.15			
74	200.0	18,730.0	6.35	8.47	2.12	7.50	2.12			
75	200.0	18,930.0	6.27	8.48	2.21	7.50	2.21			
76	200.0	19,130.0	6.57	8.49	1.92	7.50	1.92			
77	200.0	19,330.0	4.72	8.50	3.78	7.50	3.78			
78	200.0	19,530.0	5.47	8.51	3.04	7.50	3.04			
79	200.0	19,730.0	6.19	8.52	2.33	7.50	2.33			
80	200.0	19,930.0	6.15	8.53	2.38	7.50	2.38			
81	200.0	20,130.0	7.16	8.54	1.38	7.50	1.38			
82	200.0	20,330.0	6.41	8.55	2.14	7.50	2.14			
83	200.0	20,530.0	6.18	8.56	2.38	7.50	2.38			
84	200.0	20,730.0	6.54	8.57	2.03	7.50	2.03			
85	200.0	20,930.0	6.83	8.58	1.75	7.50	1.75			
86	200.0	21,130.0	6.91	8.59	1.68	7.50	1.68			
87	200.0	21,330.0	6.90	8.60	1.70	7.50	1.70			
AVE					2.92	814.50				
MAX					5.95	14.3%				
MIN					0.64					
--										



Table F.1.9 : MAIN FEATURE OF EMBANKMENT:DHAKA EAST & NARAYANGANJ WEST

	EMBANKMENT LENGTH(KM)	BANKING VOLUME(M3)	FOUNDATION TREATMENT(M2)	LAND ACQUISITION(M2)	REVTMENT (M2)	SODDING (M2)	BRICK SOLING(M2)	REMARKS
I.DHAKA EAST								
A.MAIN EMBANKMENT								
1.DC-1	14.00	1,898,550	458,697	1,067,422	190,276	337,756	70,000	
2.DC-2	6.00	760,123	290,755	484,110	43,325	202,835	30,000	
3.DC-3	2.97	371,481	151,451	247,301	39,270	85,015	14,850	
4.DC-4	4.55	400,032	81,881	323,271		132,521	22,750	
SUB TOTAL	27.52	3,430,186	982,784	2,122,104	272,871	758,127	137,600	
B.SUB-EMBANKMENT								
1.SA	6.40	273,402	70,080	348,860		100,400	38,400	
2.SB	4.71	405,920	145,766	324,481		138,956	28,260	
3.SC	6.31	664,850	189,072	474,322		261,820	37,860	
SUB TOTAL	17.42	1,344,172	404,918	1,147,663		501,176	104,520	
G.TOTAL	44.94	4,774,358	1,387,702	3,269,767	272,871	1,259,303	242,120	
II.NARAYANGANJ WEST								
1.NW	5.64	161,641		285,839		88,422	19,995	
2.NE	10.35	517,392	48,475	587,107	95,910	118,135	51,750	
G.TOTAL	15.99	679,033	48,475	872,946	95,910	206,557	71,745	

Table F.2.1 MAIN FEATURE OF FLOOD WALL/ WORKS:DHAKA EAST, DND & NARAYANGANJ WEST

	FLOOD WALL LENGTH(KM)	CONCRETE VOLUME(M3)	REHABILITATION WORKS		STOP LOG STRUCTURE(PLS)	REMARKS
			F.WALL RAISING	FOOT PROTECTION		
I.DHAKA EAST						
A.FLOOD WALL						
1.DC-1	5.85	1,255	-	-	-	
2.DC-2	4.85	1,410	-	-	-	
3.DC-3	2.50	900	-	-	-	
4.DC-4	8.07	1,966	-	-	-	
SUB TOTAL	21.27	5,531	-	-	-	
II.DND						
1.DW	-		-	3.60	14	
2.DN	0.58	206	4.40	5.60	17	
3.DS	1.75	790	-	-	-	
4.DE	1.05	240	3.20	8.40	27	
SUB TOTAL	3.38	1,236	7.60	17.60	58	
III.NARAYANGANJ WEST						
1.NW			-	-	0	
2.NE	11.48	16,384	-	-	17	
G.TOTAL	11.48	16,384	-	-	17	

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Table F.3.1(1): MAIN FEATURE OF SLUICE GATES :DHAKA EAST

No.	Sta. No.	Mark (Khal No.) Q(m3/s)	Dimensions of Culvert				Inlet			Outlet					O.Bridge	Khal Dimension (b1,b2,h1)	Remarks	
			B (m)	H (m)	L (m)	N	B1 (m)	L1 (m)	B2 (m)	B3 (m)	B4 (m)	B5 (m)	L2 (m)	L3 (m)	L4 (m)			
I. Greater Dhaka East																		
1	E68 + 150	14 (KD-4) 22.57	2.20	2.20	36.00	2	5.10	10.00	22.00	5.40	10.20	12.20	12.00	10.00	15.00	2.00		
																20.20 4.55		
2	E55	15 (KD-3) 37.34	2.20	2.20	34.00	3	8.00	10.00	25.00	8.60	13.40	15.40	12.00	10.00	15.00	5.00		23.20 4.55
3	E43 + 320	16 (KD-1) 83.18	3.00	3.00	45.00	4	14.10	10.00	43.00	15.00	19.80	21.80	12.00	10.00	20.00	20.00	20.00 40.80 5.20	With Pump P5 : (25.2 M3/s)
4	E28 + 150	17 (KD-5) 114.61	2.80	2.80	45.00	6	20.30	10.00	51.20	23.00	28.00	30.00	12.00	10.00	20.00	27.00	27.00 49.00 5.50	Pump P6 : (54.6 m3/s)
5	E11 + 340	18A (KD-11) 129.49	3.00	3.00	43.50	6	21.80	10.00	54.00	24.20	29.00	31.00	12.00	10.00	19.00	28.50	28.50 51.70 5.80	Pump P7A : (53.1 m3/s)
6	E8 + 90	18B (KD-14) 140.67	3.00	3.00	43.50	6	21.50	10.00	53.00	23.00	27.50	29.50	12.00	10.00	19.00	27.50	27.50 50.70 5.80	Pump P7B : (47.2 m3/s)
7	SA.11+100	Sub-1 (KD-5) 83.2	3.00	3.00	40.00	4	14.20	4.50	22.00	14.20	16.00	22.00	4.50	10.00	15.00	16.00	16.00 31.70 3.92	Sub Emb.SA

Table F.3.1(2) MAIN FEATURE OF SLUICE GATES :DHAKA EAST

Mark (Khal No.) Q(m <sup>3</sup> /s)	Concrete				Sheet Pile	R.C Pile			Bed.	Excavation	Backfill
	Inlet	Mainbox	Outlet	Total		Per No.	Total L.		Protection		
				m <sup>3</sup>	m <sup>2</sup>	No	m	m	m <sup>2</sup>	m <sup>3</sup>	m <sup>3</sup>
I. Greater Dhaka East		9.79									
		2.45									
14 (KD-4) 22.57	132.19	433.44	83.91	649.54	312.60	64	19.0	1216	322	1396	665
		9.57									
		2.45									
15 (KD-3) 37.34	149.99	577.32	106.95	834.26	358.20	95	18.9	1786	384	1670	637
		9.35									
		-0.70									
16 (KD-1) 83.18	259.59	1229.02	156.95	1645.56	506.40	202	19.0	3845	628	7597	2777
		9.10									
		-1.00									
17 (KD-5) 114.61	299.22	1699.50	214.34	2213.06	612.00	292	25.0	7300	792	10181	3024
		8.81									
		-1.30									
18A (KD-11) 129.49	321.13	1726.75	223.19	2271.07	640.80	304	8.0	2434	830	11022	3193
		8.74									
		-1.30									
18B (KD-14) 140.67	316.08	1726.02	213.39	2255.49	627.90	299	10.0	2986	805	10919	3193
		8.62									
		0.64									
Sub-1 (KD-5) 83.2	90.46	1082.40	54.33	1227.19	430.20	158	10.0	1585	380	4377	1428



Table F.3.2(1) : MAIN FEATURE OF SLUICE GATES :DND AND NARAYANGANJWEST

No.	Sta. No.	Mark (Khal No.) Q(m3/s)	Dimensions of Culvert				Inlet		Outlet							O.Bridge	Khal Dimension (b1,b2,h1)	Remarks
			B (m)	H (m)	L (m)	N	B1 (m)	L1 (m)	B2 (m)	B3 (m)	B4 (m)	B5 (m)	L2 (m)	L3 (m)	L4 (m)			
I.DND																		
1	DE.10+300	20	3.00	3.00	21.50	6	21.50	10.00	47.00	23.00	27.80	29.80	12.00	10.00	7.00	33.50	Pump/Wall	
		(KN-4) 143.5														45.30 5.90	P11 : (50.2 m3/s)	
2	DE.17+350	19	2.40	2.70	-	2	-	-	-	-	-	-	-	-	-		P 10 (existing Pump.)	
II. Narayanganj West																		
1	NE84 + 120	21	1.70	1.70	24.00	1	1.70	5.00	11.00	1.70	3.70	5.70	5.00	5.00	7.00	2.00	Emb	
		(KN-18) 7.23														9.40 3.70		
2	NE 77 + 160	22	2.60	2.60	39.30	1	2.60	10.00	23.20	3.30	8.00	10.00	12.00	10.00	15.50	2.00	Pump/Emb	
		(KN-19) 16.72														20.00 4.50	P12 : (2.0 m3/s)	
3	NE69 + 100	23	3.00	3.00	38.00	1	3.00	10.00	23.60	3.70	8.00	10.00	11.00	10.00	15.50	2.00	Pump/Emb	
		(KN-20) 20.04														20.00 4.50	P13 : (2.2 m3/s)	
4	NE49 + 100	24	2.20	2.20	24.00	2	5.10	5.00	14.00	5.40	7.40	9.40	5.00	5.00	No	4.50	Emb	
		(KN-22) 21.9														12.24 3.87		
5	NE46 + 180	25	2.00	2.00	7.00	1	2.00	1.50	11.00	2.00	3.50	5.50	1.50	5.00	No	2.50	F. Wall	
		(KN-23) 10.54														9.26 3.38		
6	NE40 + 170	26	2.00	2.00	7.00	1	2.00	1.50	11.00	2.00	3.50	5.50	1.50	5.00	No	2.50	F. Wall	
		(KN-24) 10.31														9.28 3.39		
7	NE32	27	2.00	2.00	7.00	1	2.00	1.50	11.00	2.00	3.50	5.50	1.50	5.00	No	2.00	F. Wall	
		(KN-25) 8.83														8.88 3.44		
8	NE26 + 150	28	2.00	2.00	7.00	1	2.00	1.50	11.00	2.00	3.50	5.50	1.50	5.00	No	2.00	F. Wall	
		(KN-26) 9.18														8.92 3.46		
9	NE19	29	3.00	3.00	7.00	1	3.00	1.50	5.00	3.00	4.50	6.50	1.50	5.00	No	Box Culvert	F. Wall	
		(S-1) 10.47														3.00 3.0mx3.0m		
10	NE8 + 50	30	2.50	2.50	7.00	1	2.50	1.50	5.00	2.50	4.00	6.00	1.50	5.00	No	Pipe Culvert	F. Wall	
		(S-2) 6.17														2.50 D=2.5m		
11	NES + 70	31	1.70	1.70	7.00	1	1.70	1.50	10.00	1.70	3.20	5.20	1.50	5.00	No	2.00	F. Wall	
		(KN-27) 7.18														8.04 3.02		
12	NE1 + 150	32	2.20	2.20	7.00	1	2.20	1.50	4.00	2.20	3.70	5.70	1.50	5.00	No	Pipe Culvert	F. Wall	
		(S-3) 3.89														2.20 D=2.2m		
13	NW23	33A	2.40	2.40	38.00	2	5.80	10.00	16.00	6.60	10.00	12.00	9.00	10.00	15.50	6.00	Pump/Emb	
		(KN-28) 26.97														14.00 4.00	P14A : (2.7 m3/s)	
14	NW14 + 190	33B	3.00	3.00	29.50	2	7.00	10.00	19.60	7.80	14.00	16.00	15.00	10.00	8.50	9.50	Pump/Emb	
		(KN-30) 43.15														17.50 4.00	P14B : (5.3 m3/s)	

Table 3.2(2) MAIN FEATURE OF SLUICE GATE :DND AND NARAYANGANJ WEST

Mark (Khal No.) Q(m3/s)	Concrete				Sheet Pile	R.C Pile			Bed.	Excavation	Backfill
	Inlet	Mainbox	Outlet	Total		Per No.	Total L		Protection		
				m3	m2	No	m	m	m2	m3	m3
20 (KN-4) 143.5 19		-1.40									
	288.18	797.10	214.55	1299.82	580.20	181	8.0	1444	748	6635	1955
III Narayanganj West											
21 (KN-18) 7.23		8.58									
		3.30									
	51.75	145.32	19.35	216.42	193.80	13	13.0	168	147	365	232
22 (KN-19) 16.72		8.54									
		0.00									
	141.89	313.43	70.37	525.69	297.90	37	13.0	485	312	2917	2012
23 (KN-20) 20.04		8.47									
		3.21									
	154.39	324.48	68.07	546.94	312.30	40	13.0	524	316	763	416
24 (KN-22) 21.9		8.30									
		2.63									
	66.02	288.41	31.47	385.90	254.40	38	13.0	491	214	788	369
25 (KN-23) 10.54		7.69									
		3.12									
	28.23	40.00	5.22	73.44	176.70	8	6.4	54	145	126	78
26 (KN-24) 10.31		7.65									
		3.11									
	28.23	39.94	5.22	73.38	176.70	8	6.1	51	145	127	79
27 (KN-25) 8.83		7.59									
		3.06									
	28.23	39.92	5.22	73.36	176.70	8	6.1	51	145	131	81
28 (KN-26) 9.18		7.55									
		3.04									
	28.23	39.88	5.22	73.32	176.70	8	6.1	51	145	133	83
29 (S-1) 10.47		7.52									
		3.33									
	11.18	51.34	6.58	69.09	182.70	13	6.0	75	95	123	66
30 (S-2) 6.17		7.47									
		3.00									
	11.35	45.85	5.90	63.10	170.70	10	6.0	63	90	145	85
31 (KN-27) 7.18		7.44									
		2.98									
	23.85	36.15	4.81	64.81	166.50	7	6.0	43	132	133	86
32 (S-3) 3.89		7.42									
		3.25									
	8.25	41.62	5.49	55.36	160.50	9	6.0	55	77	118	71
33A (KN-28) 26.97		8.30									
		0.50									
	113.17	484.89	67.69	665.76	306.60	72	16.0	1147	260	3057	1603
33B (KN-30) 43.15		8.17									
		0.50									
	141.19	441.80	136.36	719.35	324.00	81	11.0	889	336	2930	1418

TABLE F.4.1 DESIGN CRITERIA OF PUMPING STATION

Drainage Area Pumping Station		Greate Dhaka East					Narayanganj West			
Item		P5	P6	P7A	P7B	DND	P12	P13	P14A	P14B
(1) Pump Drainage Area (km2)		22.11	47.88	46.58	41.34	31.69	1.73	1.92	2.36	4.65
(2) Pump Capacity (m3/s)		25.6	54.6	53.1	47.2	50.2	2.0	2.2	2.7	5.3
(3) Design Water Level (m PWD)	H.H.W.L. (T = 1/100)	8.15	7.90	7.60	7.55	7.10	7.35	7.25	7.10	7.00
	H.W.L. (T = 1/2)	6.25	6.15	6.05	6.00	5.65	5.80	5.70	5.50	5.45
	L.W.L.	3.00	3.00	3.00	3.00	3.00	3.00	3.50	3.00	3.50
(4) Pump Actual Head (m)	H.W.L.	4.00	4.00	4.00	4.00	4.00	4.20	4.60	4.50	4.60
	L.W.L.	3.00	3.00	3.00	3.00	3.00	3.00	3.50	3.00	3.50
		5.15	4.90	4.60	4.55	4.10	4.35	3.75	4.10	3.50
(5) Pump Total Head (m)	Maximum	3.25	3.15	3.05	3.00	2.65	2.80	2.20	2.50	1.95
	Design	0.0	0	0	0	0	0	0	0	0
		6.65	6.40	6.10	6.05	5.60	5.85	5.25	5.60	5.00
(6) Pump Operating Period		4.75	4.65	4.55	4.50	4.15	4.30	3.70	4.00	3.45
(5 month)										
June to October										
(7) Ground Elevation at Pump yard (m PWD)	Existing	1.70	2.20	3.00	3.30	4.00	4.50	3.60	3.50	5.20
	Proposed	5.20	5.20	5.20	5.20	5.20	5.80	5.80	5.80	5.80



TABLE F.4.2 FOUNDATION PILE OF PUMPING STATION

Item	Pumping Station	Area of Bottom Slab (m <sup>2</sup> )	Weight W (t)	Soil Condition		Section B1(m)x B2(m)	Length l (m)	Precast Concrete Pile				Remarks
				Avg. N-Value of Supporting Layer C (t/m <sup>2</sup> )	Avg. N-Value of Middle Layer C (t/m <sup>2</sup> )			Allowable Bearing Cap. per Pile	Point Resistance	Frictional Force	Total	
Pump Pit Pump Hose	P5	752	11006	16	5	0.4 x 0.4	19	18.4	36.3	54.7	201	
	P6	1246	21191	24	5	0.4 x 0.4	25	28.8	47.9	76.7	276	
	P7A	1246	21154	28	5	0.4 x 0.4	8	32.9	15.7	48.6	435	
	P7B	1246	21010	25	5	0.4 x 0.4	10	29.2	19.5	48.7	431	
	P11	1246	21083	23	5	0.4 x 0.4	8	25.9	13.6	39.5	534	
	P12	209	3073	22	5	0.4 x 0.4	13	25.5	25.2	50.7	61	
	P13	209	3106	18	5	0.4 x 0.4	13	20.8	25.1	45.9	68	
	P14A	223	3331	23	5	0.4 x 0.4	16	26.6	30.9	57.5	58	
Discharge Basin	P14B	327	4050	24	5	0.4 x 0.4	11	26.8	21.4	48.2	84	
	P5	275	2954	16	5	0.4 x 0.4	20	18.3	38.2	56.6	52	
	P6	537	5791	24	5	0.4 x 0.4	26	27.6	49.8	77.4	75	
	P7A	537	5708	28	5	0.4 x 0.4	9	32.8	17.6	50.4	113	
	P7B	537	5694	25	5	0.4 x 0.4	11	29.2	21.4	50.5	113	
	P11	537	5570	23	5	0.4 x 0.4	9	26.9	15.6	42.5	131	
	P12	40	400	22	5	0.4 x 0.4	14	25.5	27.1	52.6	8	
	P13	40	373	18	5	0.4 x 0.4	14	20.8	27.0	47.8	8	
Sluice Way	P14A	44	426	23	5	0.4 x 0.4	17	26.6	32.8	59.4	7	
	P14B	73	675	24	5	0.4 x 0.4	12	27.9	23.3	51.2	13	
	P5	507	7213	16	5	0.4 x 0.4	20	18.3	38.2	56.6	128	
	P6	765	10930	24	5	0.4 x 0.4	26	27.6	49.8	77.4	141	
	P7A	748	10333	28	5	0.4 x 0.4	9	32.8	17.6	50.4	205	
	P7B	703	9844	25	5	0.4 x 0.4	11	29.2	21.4	50.5	195	
	P11	772	7534	23	5	0.4 x 0.4	9	26.9	15.6	42.5	177	
	P12	133	1005	22	5	0.4 x 0.4	14	25.5	27.1	52.6	19	
	P13	121	837	18	5	0.4 x 0.4	14	20.8	27.0	47.8	18	
	P14A	133	1021	23	5	0.4 x 0.4	17	26.6	32.8	59.4	17	
	P14B	218	1336	24	5	0.4 x 0.4	12	27.9	23.3	51.2	26	



TABLE F.5.1(1) KHAL IMPROVEMENT RELATED WORKS (BRIDGE/AQUEDUCT) - GREATER DHAKA EAST

Zone	Khal No.	Bridge No.	Existing		Required	Proposed			Remarks
			Type	Size (m x m)	Size (m x m)	Type	Size (m x m)	Width	
DC-1	KD-1-1	1	Cantilever	17.00 x 4.70	10.43 x 7.70	-	-	-	Road bridge
	KD-1-5	2	Girder bridge	6.58 x 4.70	6.58 x 4.70	-	-	-	" "
	KD-3-1	3	" "	11.50 x 6.50	9.10 x 5.00	-	-	-	" "
	KD-4	4	" "	6.00 x 5.10	7.00 x 5.00	-	-	-	" "
DC-2	KD-5-8	5	Deck-Rly	6.00 x 3.60	9.33 x 4.80	Deck Girder	9.4 x 4.80	1.7	Railway bridge
	KD-10-1	6	-	-	11.11 x 4.90	Girder bridge	11.2 x 4.90	3.66	Road bridge
	"	7	-	-	" "	" "	" "	"	" "
	"	8	-	-	" "	" "	" "	"	" "
	KD-10-2	9	-	-	6.98 x 4.80	" "	7.00 x 4.80	"	" "
	"	10	-	-	" "	" "	" "	"	" "
	"	11	-	-	" "	" "	" "	"	" "
	"	12	-	-	" "	" "	" "	"	" "
	"	13	-	-	" "	" "	" "	"	" "
DC-4	KD-14-2	14	-	-	24.92 x 5.30	Cantilever	25.00 x 5.30	3.66	" "
	KD-14-5	15	Girder bridge	11.00 x 5.30	9.50 x 5.30	-	-	-	" "
	"	16	-	-	9.88 x 5.20	Girder bridge	10.00 x 5.20	3.66	" "
	KD-17-2	17	-	-	9.59 x 5.20	" "	9.60 x 5.20	"	" "
	KD-20-1	18	-	-	8.17 x 5.30	" "	8.20 x 5.30	"	" "

TABLE F.5.1(2) KHAL IMPROVEMENT RELATED WORKS (BRIDGE) - DND

Zone	Khal No.	Bridge No.	Existing		Required Size (m x m)	Proposed			Remarks
			Type	Size (m x m)		Type	Size (m x m)	Width	
NA-1	KN-1-1	1	Girder bridge	12.50 x 5.00	6.65 x 5.00	-	-	-	Road bridge
	"	2	" "	8.40 x 5.00	6.50 x 5.00	-	-	-	" "
	KN-1-2	3	Box culvert	4.70 x 4.70	15.80 x 5.00	Girder bridge	15.8 x 5.00	40.00	Highway bridge
	KN-1-3	4	Girder bridge	11.00 x 3.00	14.75 x 5.00	" "	14.7 x 5.00	3.66	Road bridge
	KN-1-5	5	Box culvert	4.50 x 4.50	12.60 x 5.00	" "	12.6 x 5.00	40.00	Highway bridge
	KN-1-6	6	Slab bridge	4.85 x 2.30	11.32 x 4.90	" "	11.5 x 4.90	3.66	Road bridge
	KN-1-7	7	Deck-Rly.	11.00 x 4.88	6.26 x 4.88	-	-	-	Railway bridge
	"	8	Girder bridge	8.00 x 4.75	6.47 x 4.75	-	-	-	Road bridge
	NA-2-1	9	Aqueduct	4.00 x 0.61	6.68 x 0.61	Rect. Aqueduct	7.00 x 0.61	"	Rect. Aqueduct
	"	10	Pipe	0.91 x 2.00	6.68 x 4.95	Girder bridge	6.70 x 4.95	"	Road bridge
	"	11	Slab	1.09 x 1.57	6.77 x 4.90	" "	6.80 x 4.90	"	" "
	"	12	Pipe	0.91 x 1.00	6.77 x 4.90	" "	6.80 x 4.90	"	" "
	"	13	Slab	91.00 x 1.35	3.71 x 4.87	Slab bridge	3.80 x 4.87	"	" "
	KN-2-2	14	Pipe	0.91 x 1.00	3.94 x 4.65	" "	4.00 x 4.65	"	" "
	KN-3	15	-	-	6.73 x 4.90	Girder bridge	6.80 x 4.90	"	" "
	KN-13	16	-	-	6.69 x 5.00	" "	6.70 x 5.00	"	" "
	KN-14-3	17	-	-	2.96 x 4.70	Slab bridge	3.00 x 4.70	7.00	" "
	KN-15	18	-	-	4.92 x 4.80	" "	5.00 x 4.80	3.66	" "
NA-2	KN-4-1	19	Deck Rly.	18.3 x 7.00	26.18 x 5.20	Deck Girder	26.10 x 5.20	1.70	Railway bridge
	"	20	Pipe	0.45 x 2.00	29.18 x 5.20	Cantilever	26.10 x 5.20	3.66	Road bridge
	"	21	"	0.91 x 1.00	26.18 x 5.20	Deck Girder	26.10 x 5.20	1.70	Railway bridge
	KN-4-3	22	"	0.91 x 1.00	13.19 x 5.17	Girder bridge	13.20 x 5.20	3.66	Road bridge
	"	23	"	0.61 x 1.00	13.19 x 5.17	" "	13.20 x 5.20	"	" "
	KN-4-4	24	Girder bridge	5.50 x 3.70	9.37 x 5.10	" "	9.40 x 5.10	"	" "
	"	25	Arch bridge	4.50 x 4.85	9.50 x 5.04	" "	9.50 x 5.00	"	" "
	KN-4-5	26	Pipe	0.91 x 1.00	4.95 x 4.85	Slab bridge	5.00 x 4.90	"	" "
	"	27	"	"	5.02 x 4.80	girder bridge	5.10 x 4.80	"	" "
	"	28	"	"	5.09 x 4.75	" "	5.10 x 4.80	"	" "
	"	29	"	"	5.15 x 4.70	" "	5.20 x 4.70	"	" "
	KN-4-6	30	Box culvert	0.70 x 0.80	4.40 x 4.59	Deck Girder	4.40 x 4.60	1.70	Railway bridge
	KN-5-2	31	Girder bridge	13.00 x 5.00	13.30 x 5.00	-	-	-	Road bridge
	KN-6	32	" "	10.80 x 5.10	6.85 x 5.10	-	-	-	" "
	"	33	" "	7.00 x 5.20	6.85 x 5.20	-	-	-	" "
	"	34	" "	10.70 x 5.15	6.85 x 5.15	-	-	-	" "
	KN-7-1	35	Aqueduct	3.60 x 1.80	14.24 x 1.37	Rect. aqueduct	15.00 x 1.37	0.91	Rect. Aqueduct
	"	36	Slab bridge	2.40 x 2.50	14.24 x 5.17	Girder bridge	14.30 x 5.17	3.66	Road bridge
	KN-7-4	37	Pipe	0.91 x 2.00	5.26 x 5.07	" "	5.30 x 5.07	"	" "
	"	38	Slab bridge	0.95 x 1.65	5.28 x 5.05	" "	5.30 x 5.05	"	" "
	"	39	Pipe	0.61 x 1.00	5.35 x 5.00	" "	5.35 x 5.00	"	" "
	"	40	-	-	5.42 x 4.95	" "	5.45 x 4.95	"	" "
	"	41	Pipe	0.91 x 1.00	5.49 x 4.90	" "	5.50 x 4.90	"	" "
	"	42	Slab bridge	2.30 x 2.00	5.56 x 4.85	" "	5.56 x 4.85	"	" "
	KN-7-5	43	Pipe	0.45 x 1.00	3.47 x 4.72	Deck Girder	3.50 x 4.72	1.70	Railway bridge
	KN-9	44	Slab bridge	3.00 x 1.90	7.05 x 5.10	Girder	7.00 x 5.10	3.66	Road bridge
	"	45	Girder bridge	10.40 x 5.00	7.05 x 5.10	-	-	-	" "
	KN-10	46	Pipe	0.45 x 1.00	6.26 x 4.65	Girder bridge	6.30 x 4.60	3.66	" "
	"	47	"	0.45 x 2.00	6.26 x 4.65	" "	6.30 x 4.65	"	" "
	KN-12	48	Slab bridge	1.70 x 2.25	3.59 x 5.00	Slab bridge	3.60 x 5.00	"	" "
	KN-17	49	-	-	6.14 x 4.50	Girder bridge	6.20 x 4.50	"	" "

TABLE F.5.1(3)

KHAL IMPROVEMENT RELATED WORKS (BRIDGE) - NARAYANGANJ WEST

Zone	Khal No.	Bridge No.	Existing		Required Size (m x m)	Proposed			Remarks
			Type	Size (m x m)		Type	Size (m x m)	Width	
NB-1	KN-19	50	-	-	5.60 x 4.00	Girder bridge	5.6 x 4.00	-	Road bridge
NB-2	KN-21	51	-	-	2.60 x 4.00	Slab bridge	2.7 x 4.00	-	" "
	KN-22	52	-	-	5.25 x 4.00	Girder bridge	5.3 x 4.00	-	" "
	"	53	-	-	5.25 x 4.00	Deck girder	5.3 x 4.00	1.7	Railway bridge
NB-3	KN-23	54	-	-	3.50 x 3.50	" "	3.5 x 3.50	"	" "
	KN-24	55	-	-	3.50 x 3.50	" "	3.5 x 3.50	"	" "
	KN-25	56	Deck-Rly	6.10 x 6.10	3.15 x 3.50	-	-	-	" "
	"	57	Slab bridge	2x4.6 x 5.00	3.15 x 3.50	-	-	-	Road bridge
	KN-26	58	Box culvert	4.60 x 4.90	3.15 x 3.50	-	-	-	" "
	KN-27	59	Girder bridge	6.00 x 4.70	3.15 x 3.50	-	-	-	" "
NB-4	KN-29	60	-	-	3.50 x 4.00	Slab bridge	3.50 x 4.00	3.66	Road bridge
	"	61	-	-	3.50 x 4.00	" "	3.50 x 4.00	"	" "
NB-5	KN-30-1	62	-	-	8.75 x 4.00	Girder bridge	8.80 x 4.00	"	" "
	KN-30-2	63	Girder bridge	11.80 x 5.10	3.85 x 4.00	-	-	-	" "
	KN-31-1	64	-	-	5.95 x 4.00	Slab bridge	6.00 x 4.00	3.66	Road bridge
	KN-31-2	65	-	-	3.50 x 4.00	" "	3.50 x 4.00	"	" "
	"	66	-	-	3.50 x 4.00	" "	3.50 x 4.00	"	" "
	KN-32	67	-	-	3.85 x 4.00	" "	3.90 x 4.00	"	" "
	"	68	-	-	3.85 x 4.00	" "	3.90 x 4.00	"	" "



# GREATER DHAKA EAST

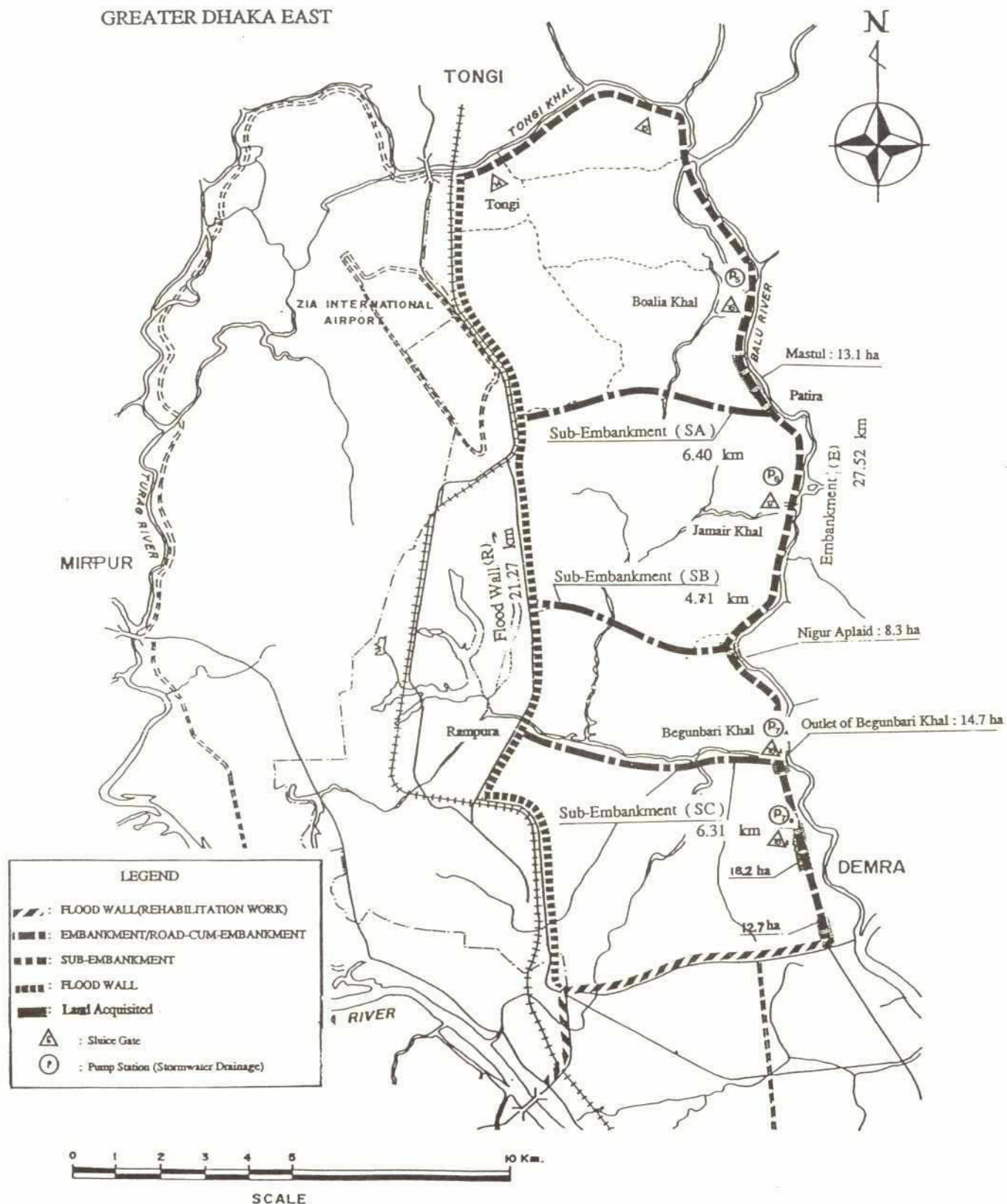


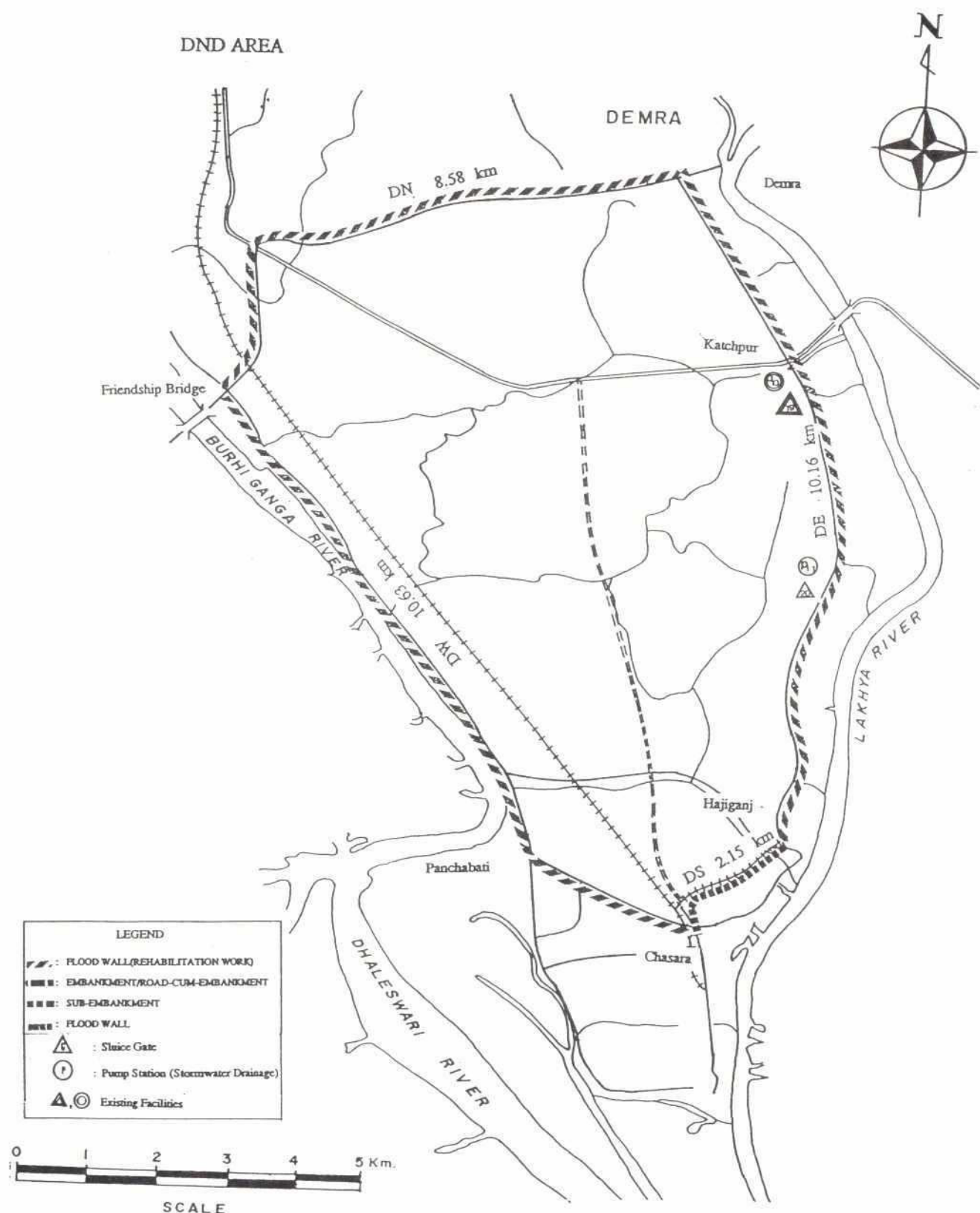
FIG. F.1.1

## PROPOSED LAYOUT OF FLOOD MITIGATION FACILITY : GREATER DHAKA EAST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



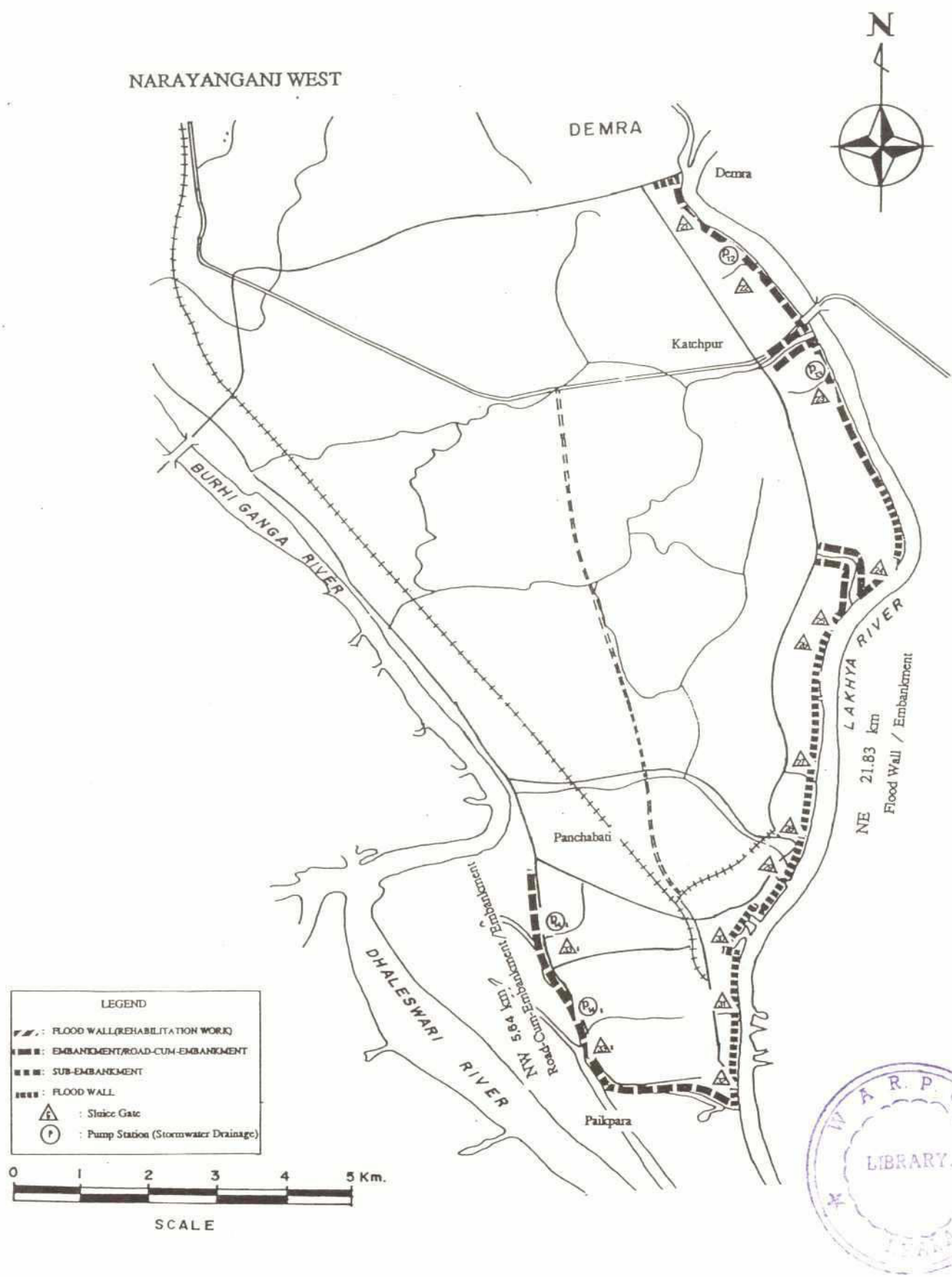
32



**FIG. F.1.2**

**PROPOSED LAYOUT OF FLOOD MITIGATION FACILITY : DND**

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



**FIG. F.1.3**

**PROPOSED LAYOUT OF FLOOD MITIGATION FACILITY :  
NARAYANGANJ WEST**

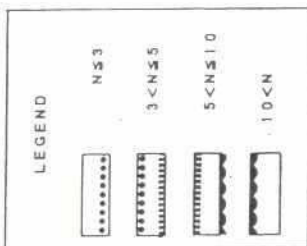
**GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH**

# Greater Dhaka East : Embankment (E)

96

Begunbari Khal

Demra ~ Tongi



10.0  
5.0  
0  
-5.0  
-10.0  
-15.0  
-20.0  
-25.0  
-30.0

P.W.D

STATION NO.	ACCUMULATED DISTANCE (M)	DISTANCE (M)	GROUND ELEVATION	DESIGNED	
				H.W.L	TOP OF EMBANKMENT
E-0	0	0	5.46	7.40	8.60
E-1	400.0	400.0	5.46	7.42	8.62
E-2	800.0	400.0	3.96	7.43	8.63
E-3	1200.0	400.0	3.96	7.45	8.65
E-4	1600.0	400.0	4.36	7.47	8.67
E-5	2000.0	400.0	4.46	7.49	8.69
E-6	2400.0	400.0	4.06	7.50	8.70
E-7	2800.0	400.0	4.26	7.52	8.72
E-8	3200.0	400.0	3.46	7.54	8.74
E-9	3600.0	400.0	2.96	7.56	8.76
E-10	4000.0	400.0	3.46	7.57	8.77
E-11	4400.0	400.0	3.96	7.59	8.79
E-12	4800.0	400.0	3.92	7.61	8.81
E-13	5200.0	520.0	2.72	7.63	8.83
E-14	5720.0	400.0	2.65	7.65	8.85
E-15	6120.0	400.0	2.55	7.67	8.87

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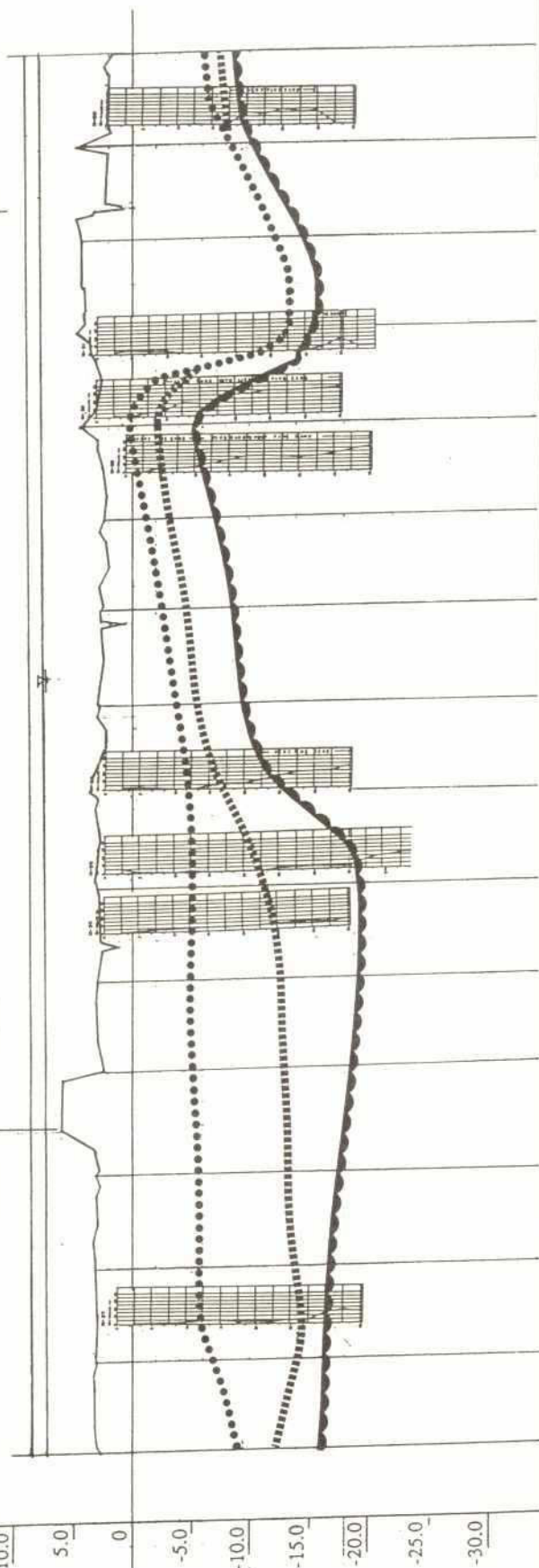
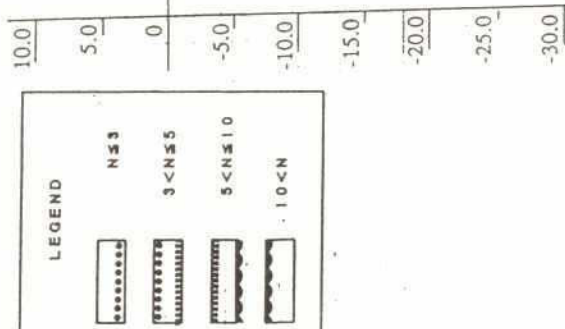
FIG. F.1.4(1)  
GEOLOGICAL PROFILES ALONG THE PROPOSED EMBANKMENT (E) (1)  
(GREATER DHAKA EAST)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



Jomir Khal

Sub-Embankment (SB)



P.W.D

STATION NO.	DESIGNED			GROUND ELEVATION	DISTANCE (M)	ACCUMULATED DISTANCE (M)	GRADIENT
	TOP OF EMBANKMENT	H.W.L					
E. 15	6120.0	400.0	2.55	7.67	8.87		
E. 16	6520.0	400.0	3.06	7.68	8.88		
E. 17	6920.0	400.0	3.11	7.70	8.90		
E. 18	7320.0	400.0	3.11	7.72	8.92		
E. 19	7720.0	400.0	5.96	7.74	8.94		
E. 20	8120.0	400.0	3.02	7.75	8.95		
E. 21	8520.0	400.0	2.94	7.77	8.97		
E. 22	8920.0	400.0	2.58	7.79	8.99		
E. 23	9320.0	400.0	2.48	7.81	9.01		
E. 24	9720.0	400.0	2.77	7.82	9.02		
E. 25	10120.0	400.0	2.68	7.84	9.04		
E. 26	10520.0	400.0	4.88	7.86	9.06		
E. 27	10920.0	400.0	5.00	7.88	9.08		
E. 28	11320.0	400.0	4.93	7.89	9.09		
E. 29	11720.0	400.0	4.93	7.91	9.11		
E. 30	12120.0	400.0	1.72	7.93	9.13		

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FIG. F.1.4(2)

GEOLOGICAL PROFILES ALONG THE PROPOSED EMBANKMENT (E) (2)

92

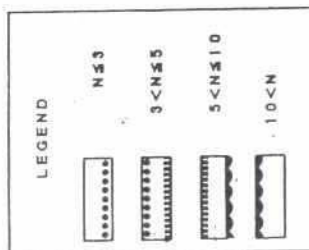
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



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Sub-Embankment (SA)

10.0  
5.0  
0  
-5.0  
-10.0  
-15.0  
-20.0  
-25.0  
-30.0



P.W.D

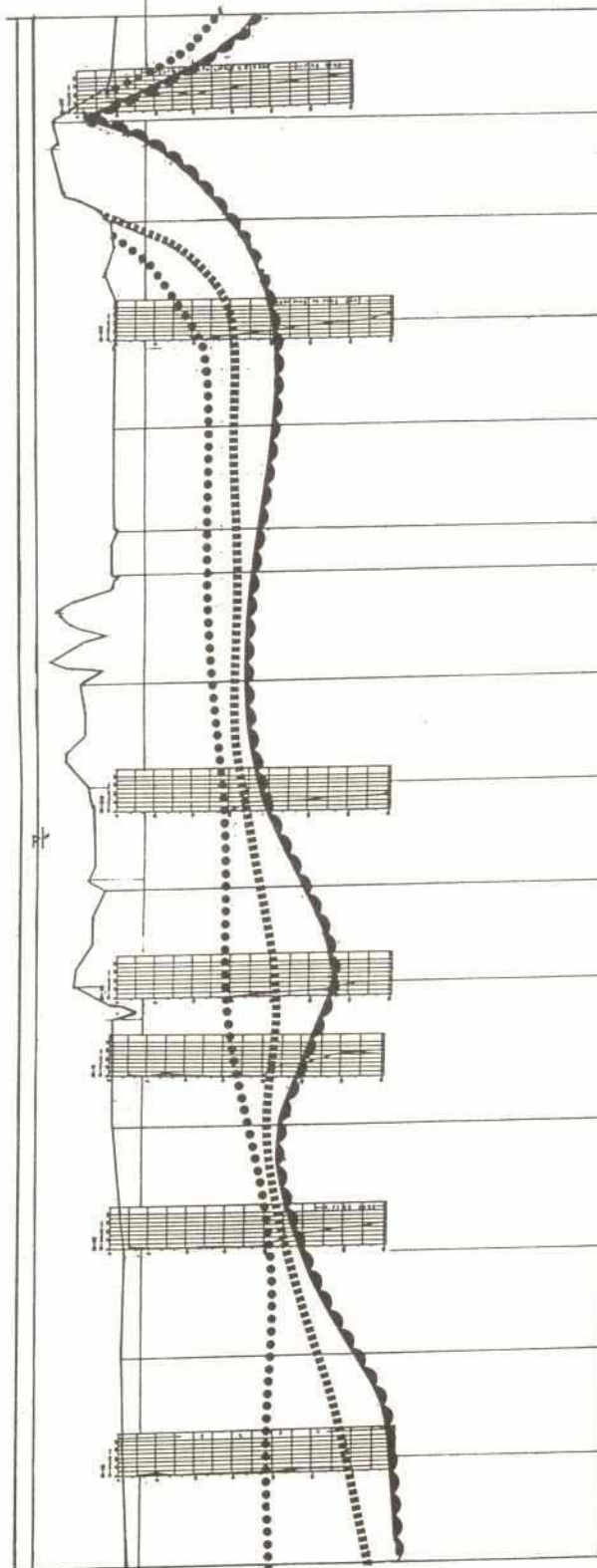
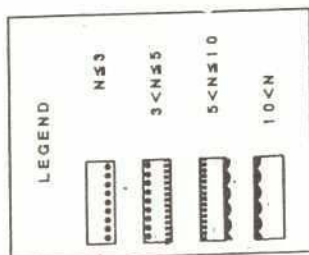
STATION NO.	DESIGNED		GRADIENT	TOP OF EMBANKMENT	H.W.L	GROUND ELEVATION	DISTANCE (M)	ACCUMULATED DISTANCE (M)	STATION NO.
E-30	12120.0	400.0	1.72	7.93	9.13				
E-31	12520.0	400.0	1.73	7.95	9.15				
E-32	12920.0	400.0	2.04	7.96	9.16				
E-33	13320.0	400.0	4.37	7.98	9.18				
E-34	13720.0	400.0	6.63	8.00	9.20				
E-35	14120.0	400.0	7.01	8.02	9.22				
E-36	14520.0	400.0	8.03	8.03	9.23				
E-37	14920.0	400.0	1.61	8.05	9.25				
E-38	15320.0	400.0	2.78	8.07	9.27				
E-39	15570.0	250.0	6.76	8.08	9.28				
E-40	15970.0	400.0	6.96	8.10	9.30				
E-41	16370.0	400.0	4.66	8.11	9.31				
E-42	16770.0	400.0	5.46	8.13	9.33				
E-43	17170.0	400.0	2.76	8.15	9.35				
E-44	17570.0	400.0	1.96	8.17	9.37				
E-45	17970.0	400.0	0.86	8.18	9.38				
E-46	18370.0	400.0	1.06	8.20	9.40				

FIG. F.1.4(3) GEOLOGICAL PROFILES ALONG THE PROPOSED EMBANKMENT (E) (3) (GREATER DHAKA EAST)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



10.0  
5.0  
0  
-5.0  
-10.0  
-15.0  
-20.0  
-25.0  
-30.0



P.W.D

STATION NO.	ACCUMULATED DISTANCE (M)	DISTANCE (M)	GROUND ELEVATION	DESIGNED	
				H.W.L	TOP OF EMBANKMENT
E. 46	18370.0	400.0	1.06	8.20	9.40
E. 47	18770.0	400.0	1.66	8.22	9.42
E. 48	19170.0	400.0	1.76	8.24	9.44
E. 49	19570.0	400.0	1.46	8.25	9.45
E. 50	20070.0	500.0	2.16	8.28	9.48
E. 51	20570.0	500.0	4.46	8.30	9.50
E. 52	20940.0	370.0	3.09	8.31	9.51
E. 53	21340.0	400.0	4.59	8.33	9.53
E. 54	21740.0	400.0	5.06	8.35	9.55
E. 55	22160.0	420.0	2.53	8.37	9.57
E. 56	22320.0	160.0	2.08	8.37	9.57
E. 57	22720.0	400.0	2.39	8.39	9.59
E. 58	23120.0	400.0	2.37	8.41	9.61
E. 59	23520.0	400.0	2.78	8.43	9.63
E. 60	23920.0	400.0	7.26	8.44	9.64
E. 61	24320.0	400.0	2.38	8.46	9.66

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FIG. F.1.4(4)

GEOLOGICAL PROFILES ALONG THE PROPOSED EMBANKMENT (E) (4)  
(GREATER DHAKA EAST)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

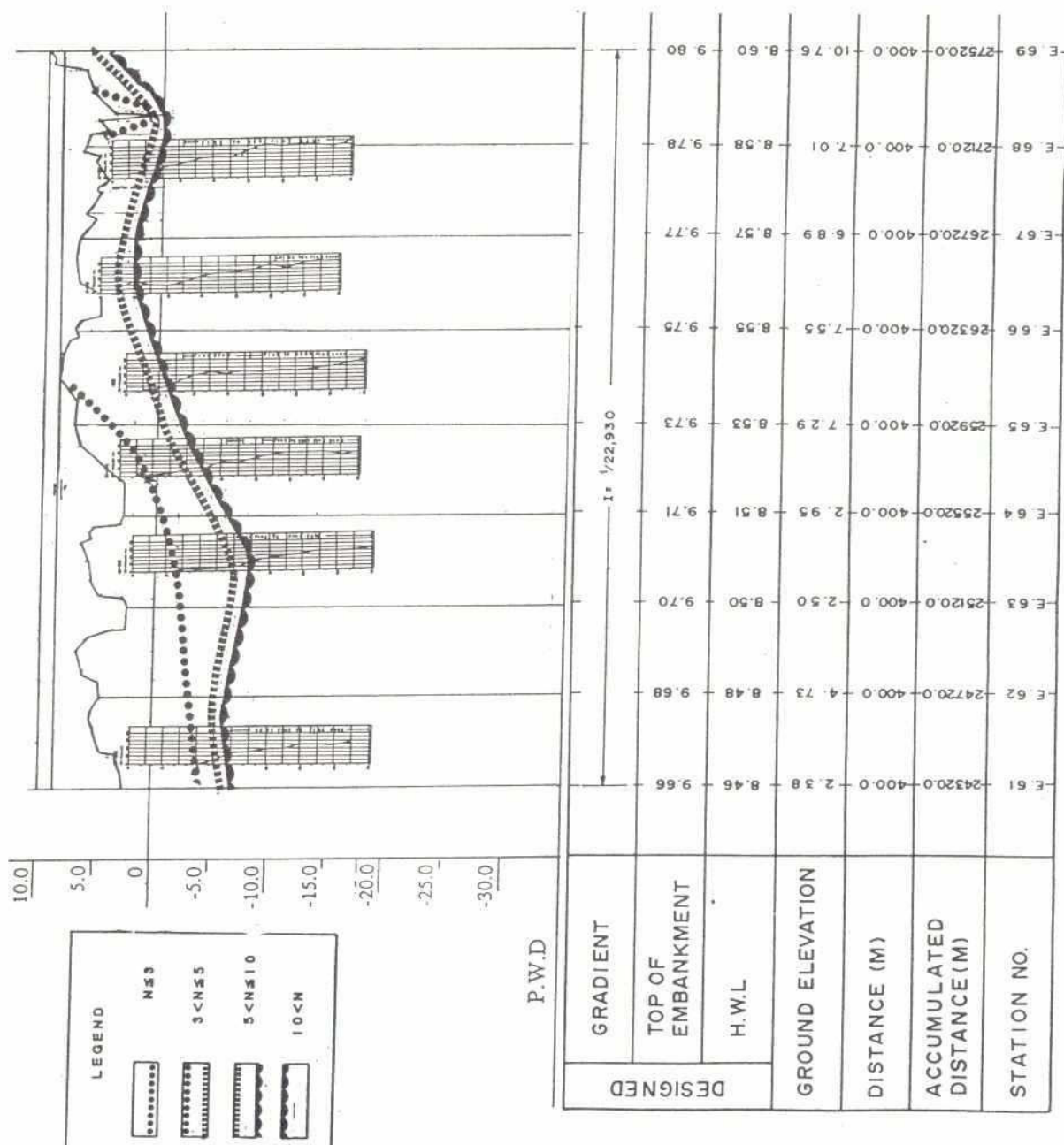


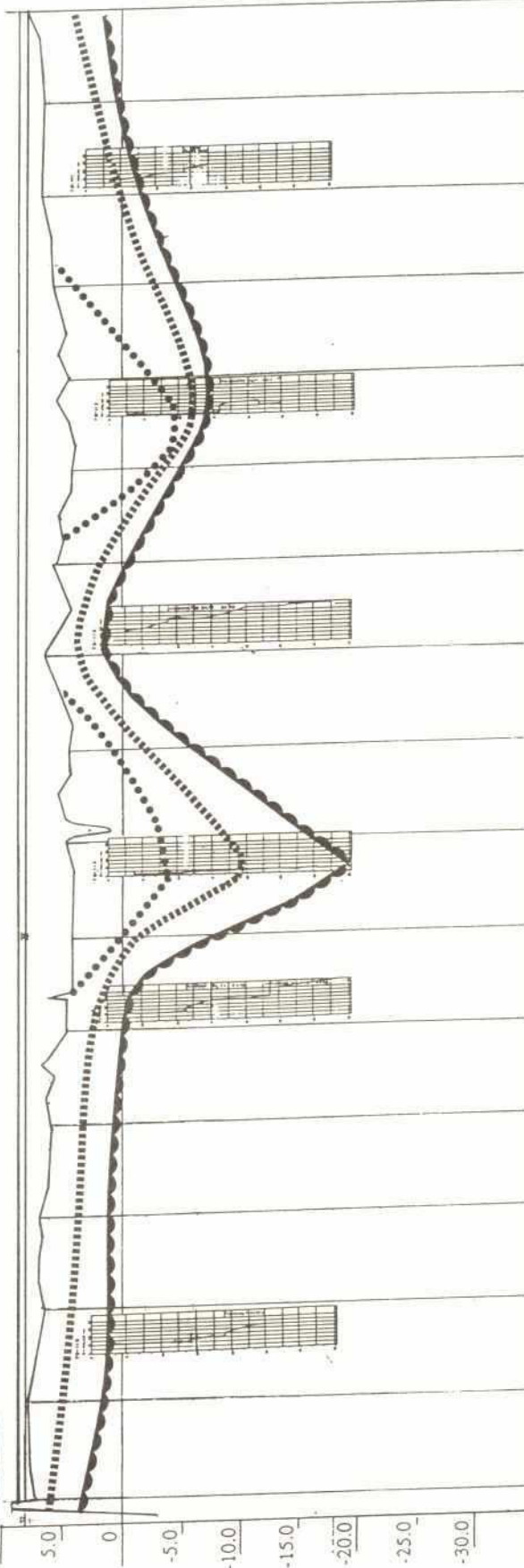
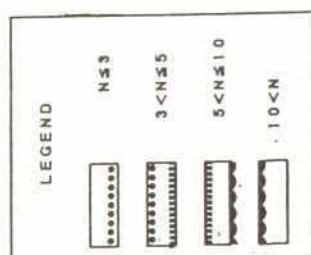
FIG. F.1.4(5) GEOLOGICAL PROFILES ALONG THE PROPOSED EMBANKMENT (E) (5)  
(GREATER DHAKA EAST)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



# Sub-Embankment (SA)

Balu River



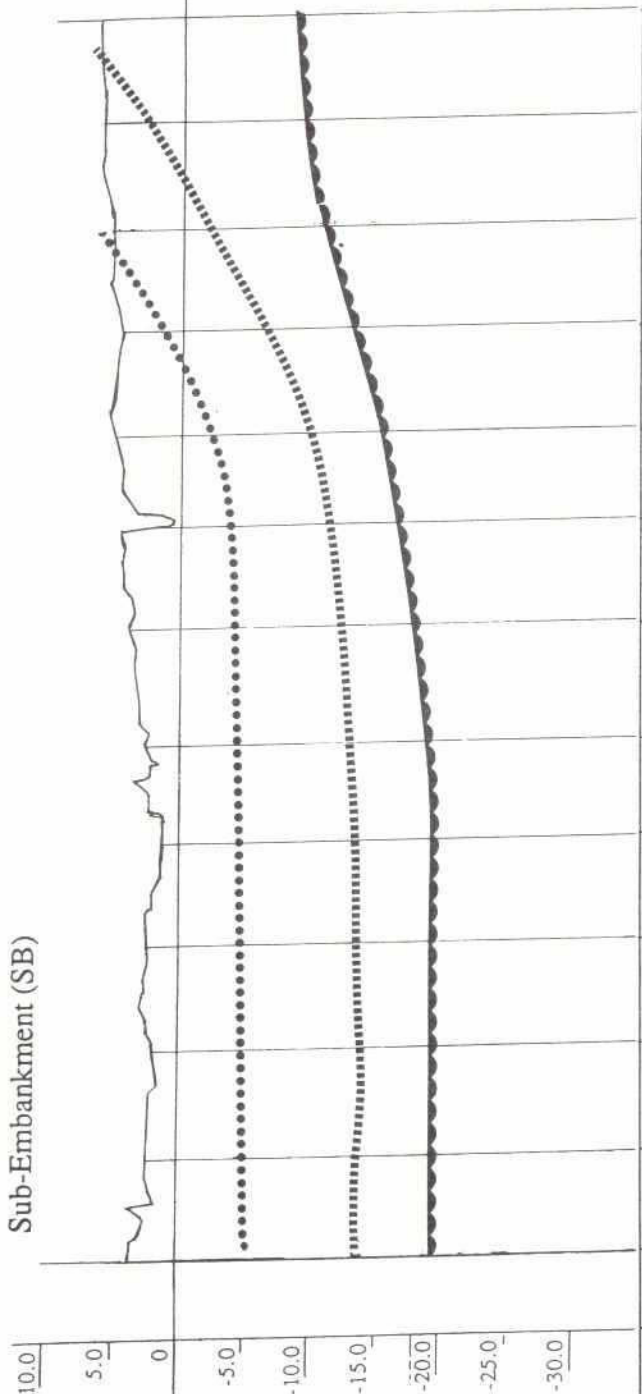
P.W.D.

DESIGNED	LEVEL																
	GRADIENT	TOP OF FLOOD WALL / EMBANKMENT															
	H.W.L	H.O.L															
GROUND ELEVATION	SA.0	SA.1	SA.2	SA.3	SA.4	SA.5	SA.6	SA.7	SA.8	SA.9	SA.10	SA.11	SA.12	SA.13	SA.14	SA.15	SA.16
DISTANCE (M)	0	400.0	800.0	1200.0	1600.0	2000.0	2400.0	2800.0	3200.0	3600.0	4000.0	4400.0	4800.0	5200.0	5600.0	6000.0	6400.0
ACCUMULATED DISTANCE (M)	0	400.0	800.0	1200.0	1600.0	2000.0	2400.0	2800.0	3200.0	3600.0	4000.0	4400.0	4800.0	5200.0	5600.0	6000.0	6400.0
STATION NO.	SA.0	SA.1	SA.2	SA.3	SA.4	SA.5	SA.6	SA.7	SA.8	SA.9	SA.10	SA.11	SA.12	SA.13	SA.14	SA.15	SA.16

FIG. F.1.4(6) GEOLOGICAL PROFILES ALONG THE PROPOSED SUB-EMBANKMENT (SA) (GREATER DHAKA EAST)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8.A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

Sub-Embankment (SB)



LEGEND	
	$N \leq 3$
	$3 < N \leq 5$
	$5 < N \leq 10$
	$10 < N$

P.W.D

DESIGNED	LEVEL	
	GRADIENT	TOP OF FLOOD WALL / EMBANKMENT
H.W.L		
GROUND ELEVATION		
DISTANCE (M)		
ACCUMULATED DISTANCE (M)		
STATION NO.		
SB 0	10.0	10.0
SB 1	3.60	3.60
SB 2	2.30	2.30
SB 3	1.60	1.60
SB 4	1.57	1.57
SB 5	2.95	2.95
SB 6	3.70	3.70
SB 7	4.58	4.58
SB 8	4.91	4.91
SB 9	4.65	4.65
SB 10	5.39	5.39
SB 11	6.09	6.09
SB 12	6.57	6.57
	7.73	7.73
	8.33	8.33

**FIG. F.1.4(7)** GEOLOGICAL PROFILES ALONG THE PROPOSED SUB-EMBANKMENT (SB)  
(GREATER DHAKA EAST)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

**LEGEND**

- NS3
- 3 < NS ≤ 5
- 5 < NS ≤ 10
- 10 < NS

**Table 1: Station Data**

STATION NO.	ACCUMULATED DISTANCE (M)	DISTANCE (M)	GROUND ELEVATION	H.W.L	TOP OF FLOOD WALL / EMBANKMENT	GRADIENT
SC. 0	0	0	3.36			
SC. 1	500.0	2.76	500.0			
SC. 2	1000.0	4.53	500.0			
SC. 3	1500.0	4.09	500.0			
SC. 4	2000.0	3.94	500.0			
SC. 5	2500.0	4.29	500.0			
SC. 6	3000.0	3.12	500.0			
SC. 7	3500.0	2.83	500.0			
SC. 8	4000.0	2.03	500.0			
SC. 9	4500.0	2.38	500.0			
SC. 10	5000.0	2.49	500.0			
SC. 11	5500.0	2.66	500.0			
SC. 12	6000.0	2.10	500.0			
SC. 13	6310.0	2.91	310.0			



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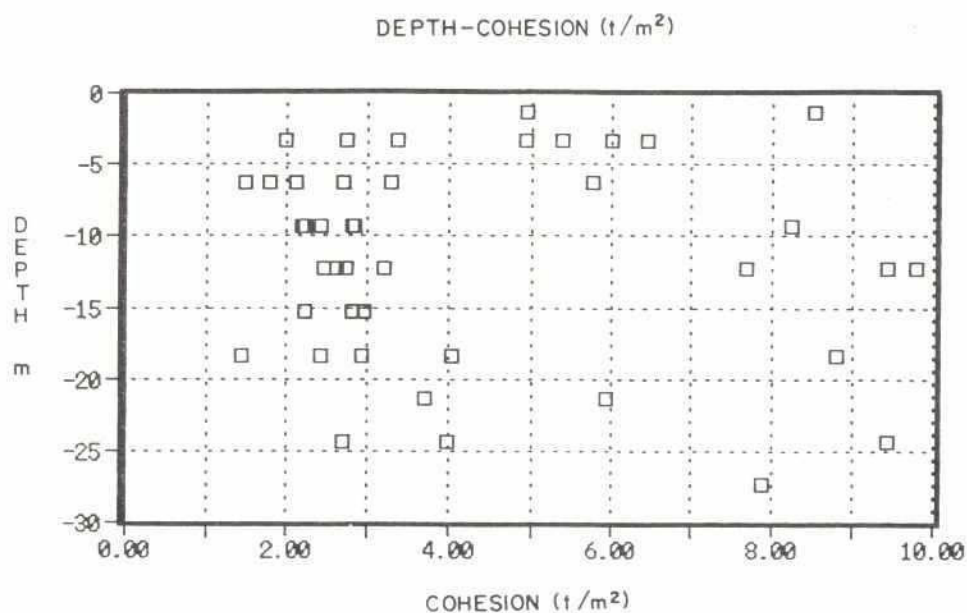
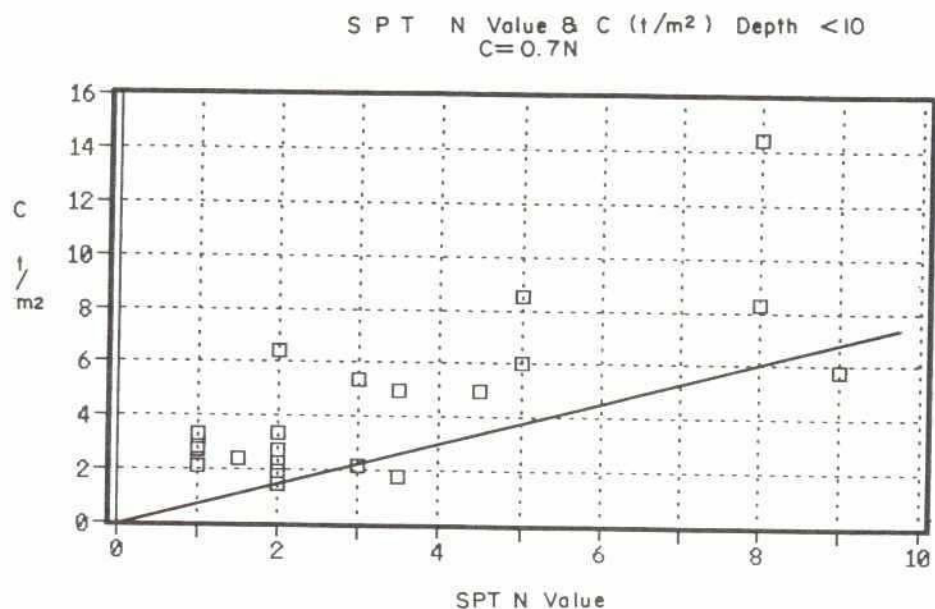
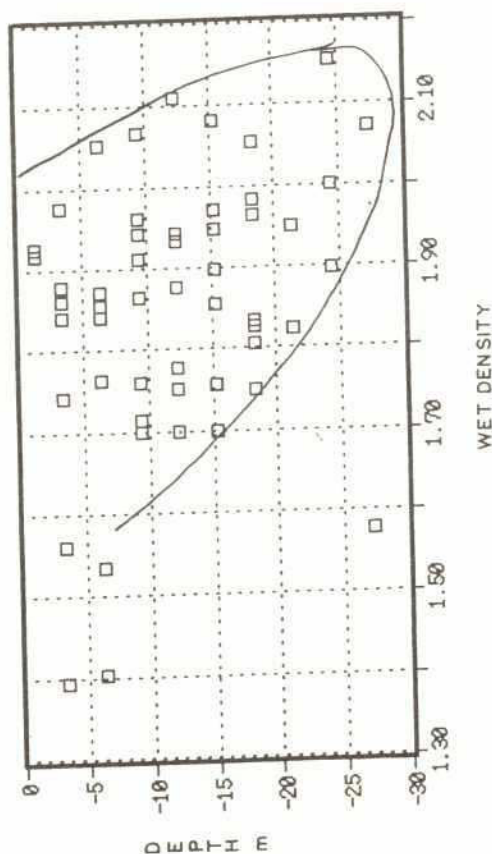


FIG. F.1.5

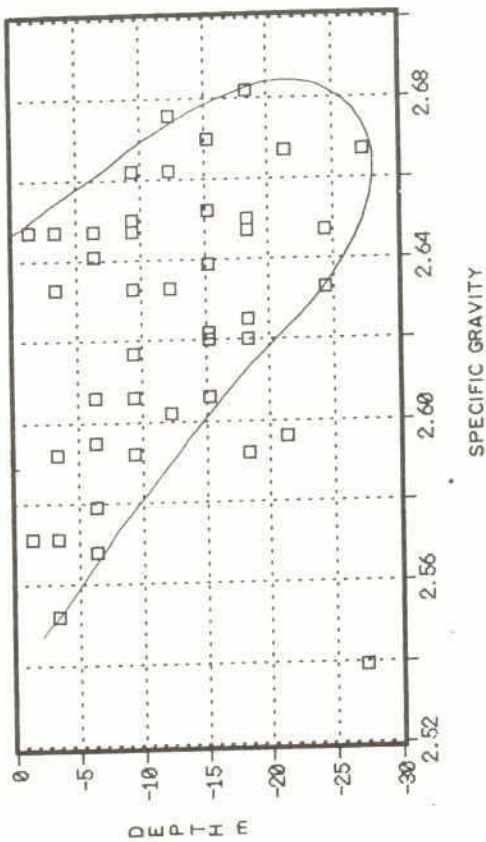
RELATIONSHIPS BETWEEN N-VALUES AND COHESION

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROLOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

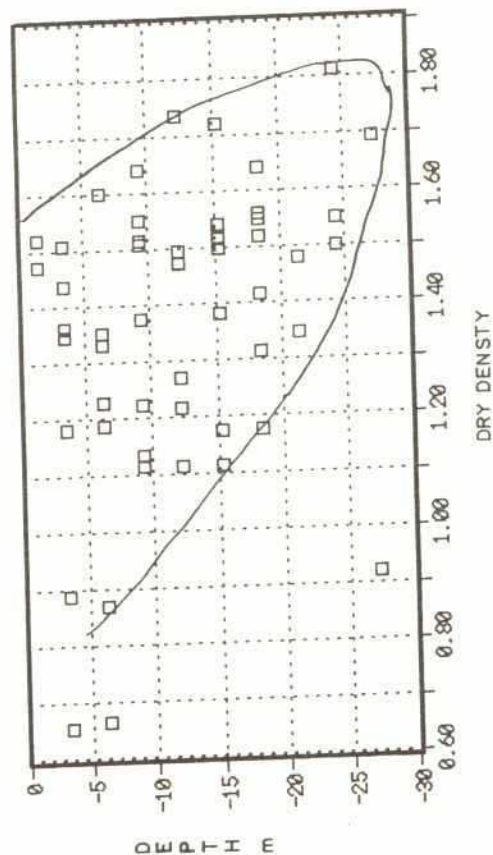
DEPTH - WET DENSITY



DEPTH - SPECIFIC GRAVITY



DEPTH - DRY DENSITY



DEPTH - NATURAL MOISTURE CONTENT %

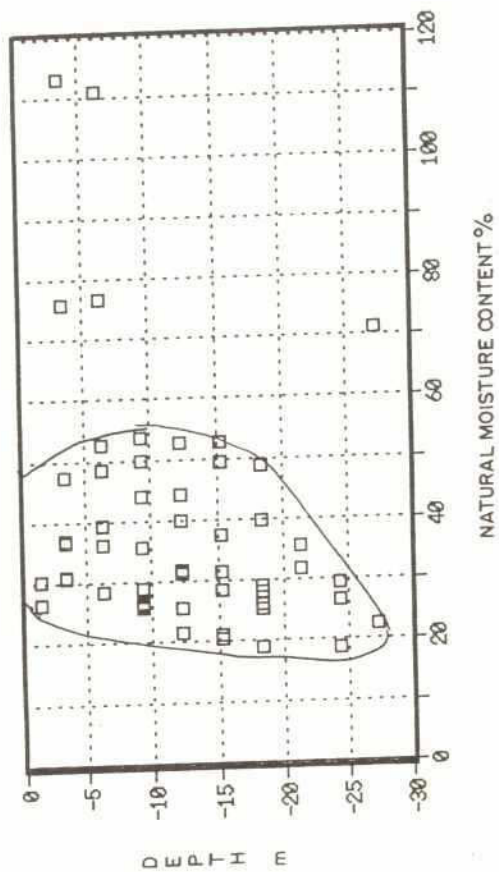
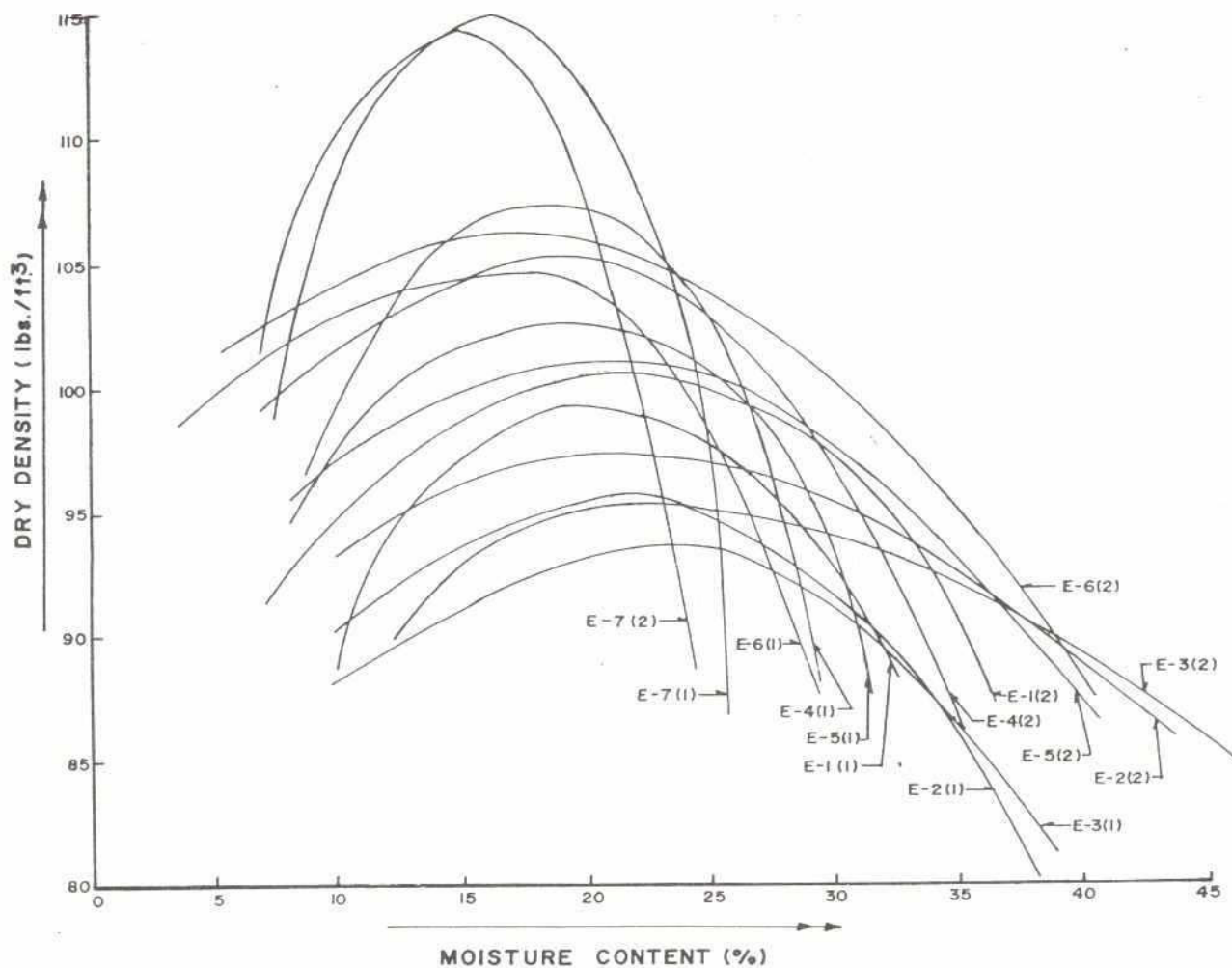


FIG. F.1.6

RELATIONSHIPS BETWEEN DEPTH AND SOIL FACTORS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



Compaction Curve of Embankment Material

FIG. F.1.7

COMPACTION CURVE OF EMBANKMENT MATERIAL

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



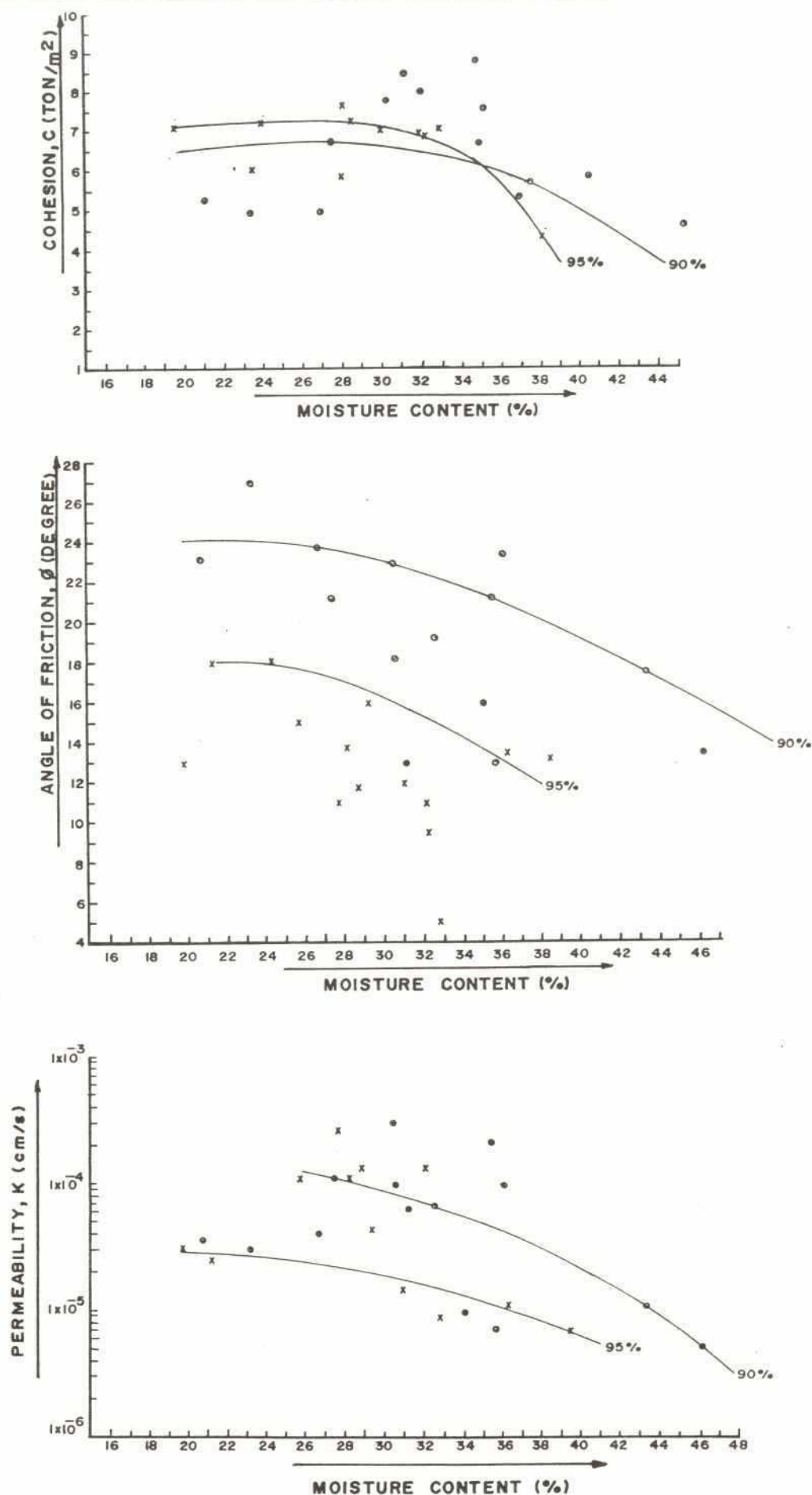


FIG. F.1.8

RELATIONSHIPS BETWEEN MOISTURE CONTENT AND MECHANICAL SOIL ELEMENTS (C,  $\phi$  AND K)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

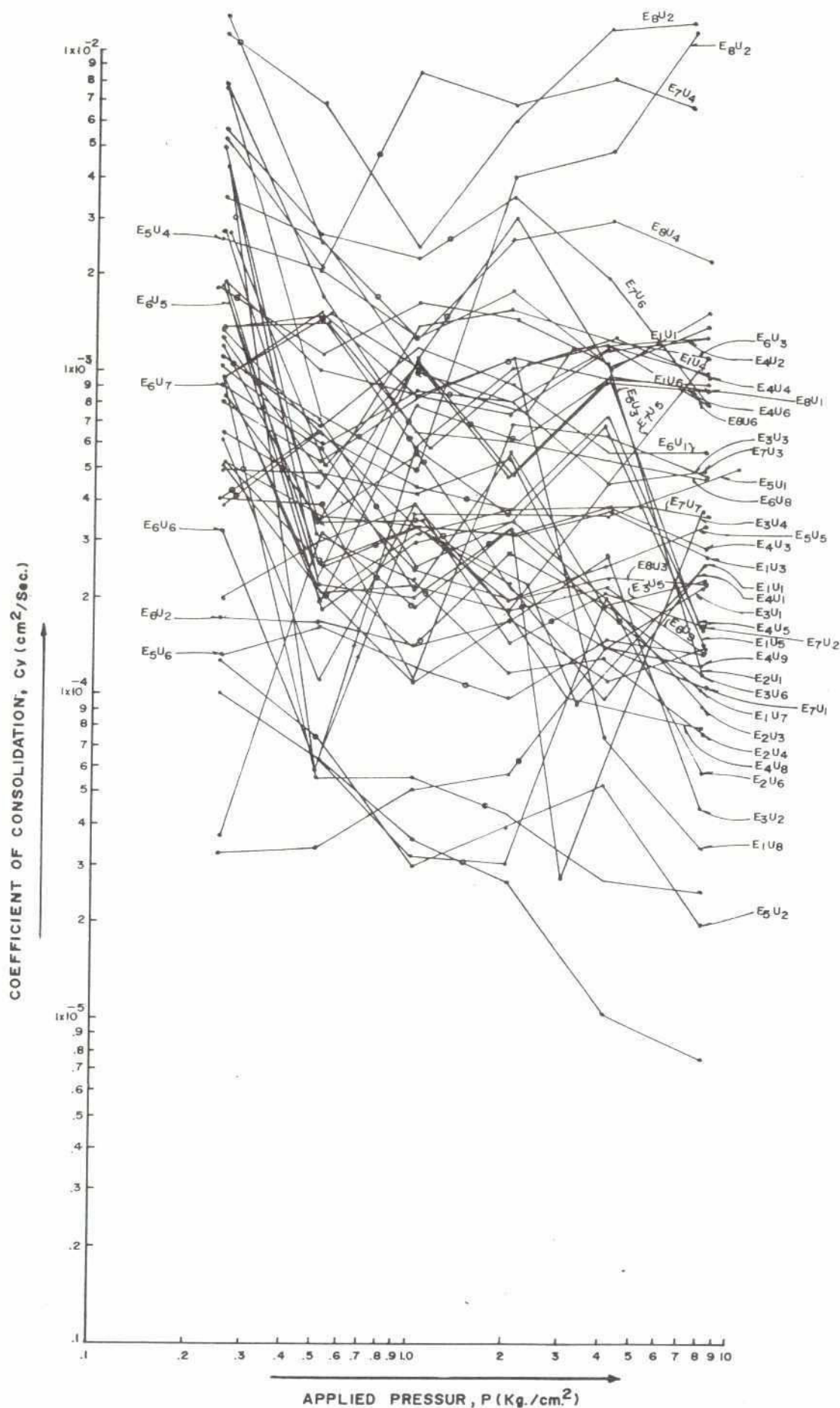
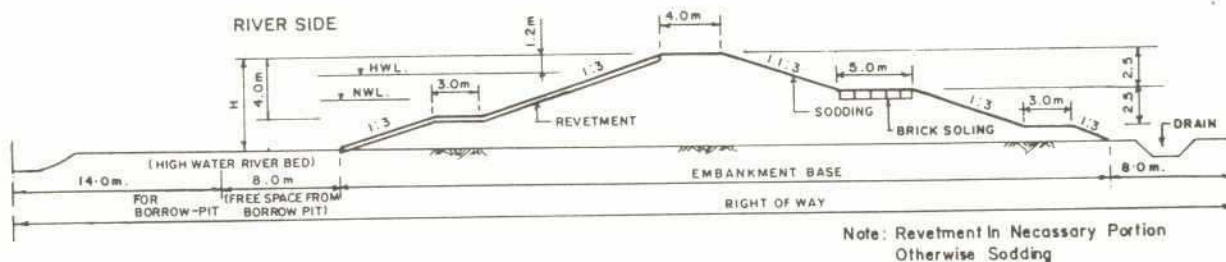


FIG. F.1.9

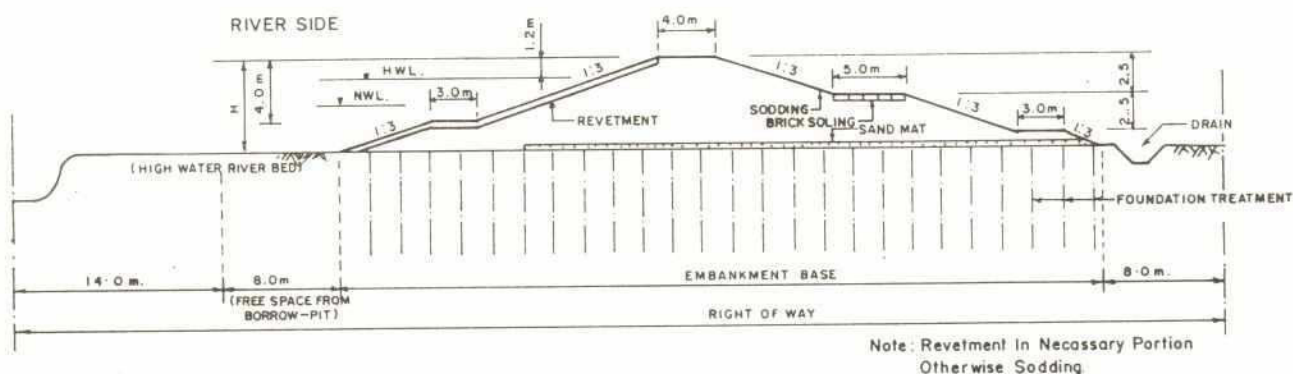
APPLIED PRESSURE (P) AND COEFFICIENT OF CONSOLIDATION (CV)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROLOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

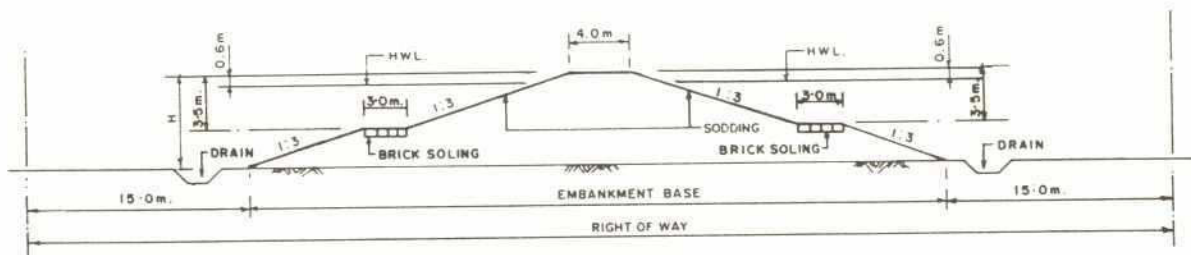
## TYPICAL SECTION OF EMBANKMENT



## TYPICAL SECTION OF EMBANKMENT WITH FOUNDATION TREATMENT



## TYPICAL SECTION OF SUB-EMBANKMENT



## TYPICAL SECTION OF SUB-EMBANKMENT WITH FOUNDATION TREATMENT

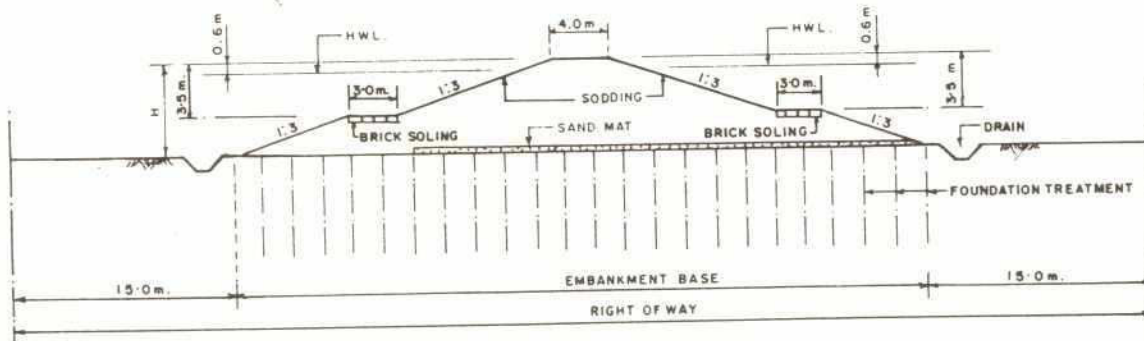
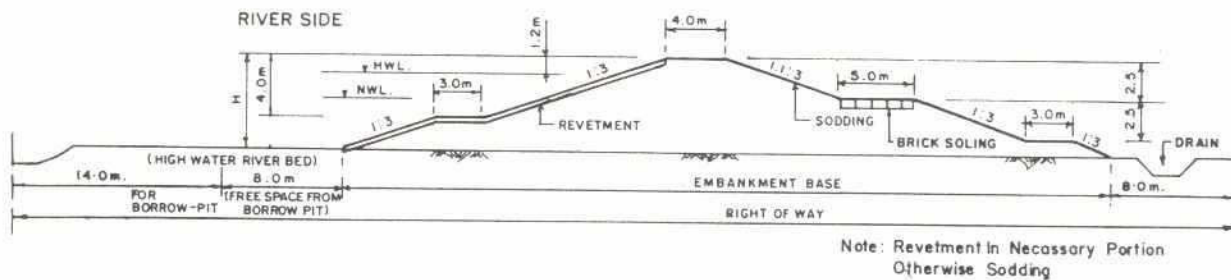


FIG. F.1.10(1) STANDARD CROSS SECTION OF EMBANKMENT : GREATER DHAKA EAST

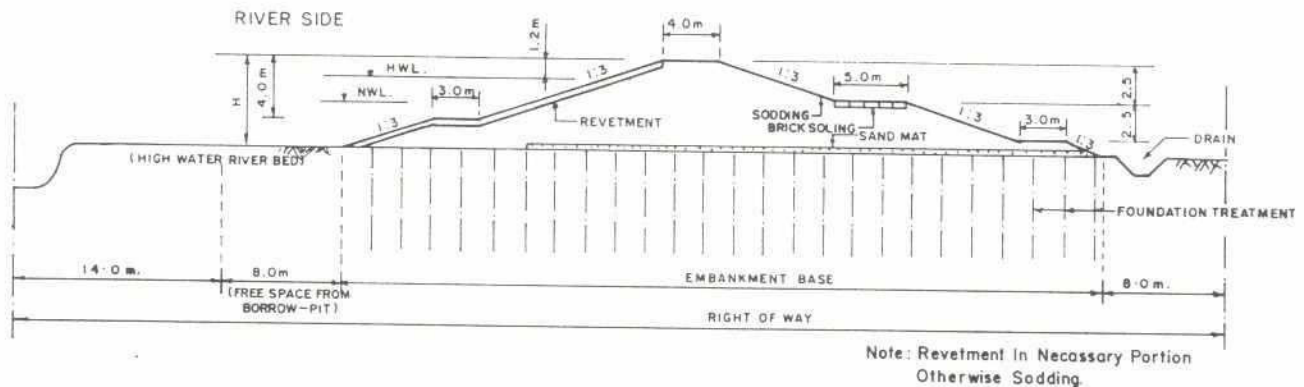
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



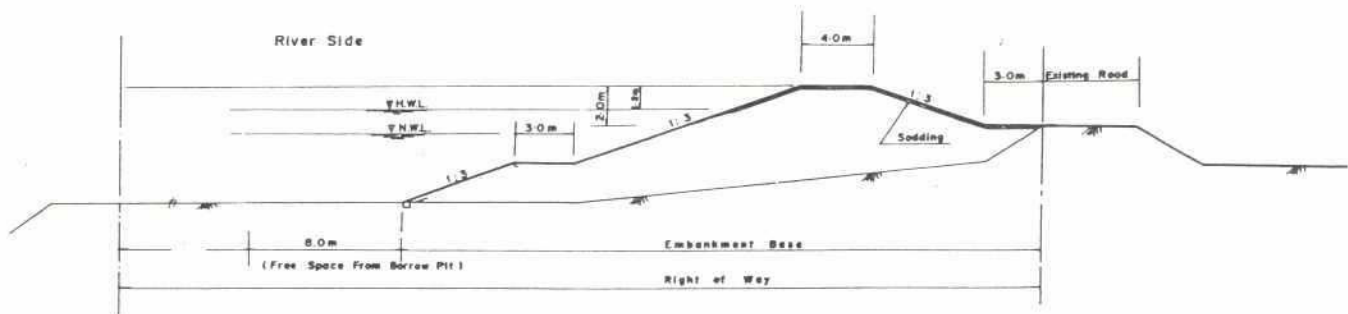
### TYPICAL SECTION OF EMBANKMENT



### TYPICAL SECTION OF EMBANKMENT WITH FOUNDATION TREATMENT



### TYPICAL SECTION OF ROAD-CUM EMBANKMENT



**FIG.F.1.10(2) STANDARD CROSS SECTION OF EMBANKMENT : NARAYANGANJ WEST**

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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# Taylor's Chart For Stability Analysis

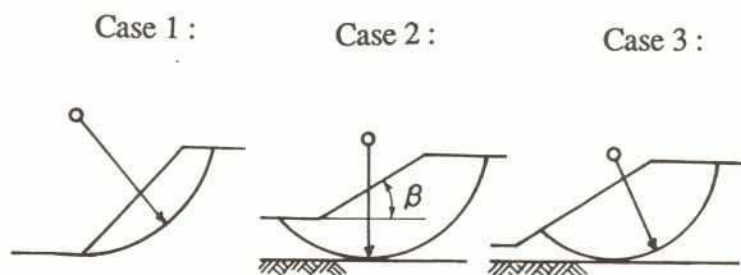
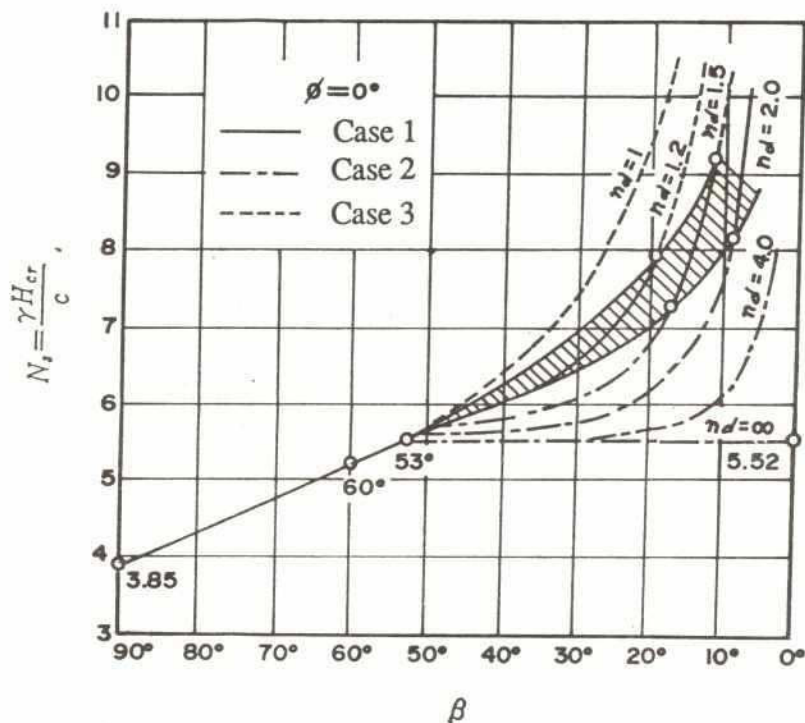


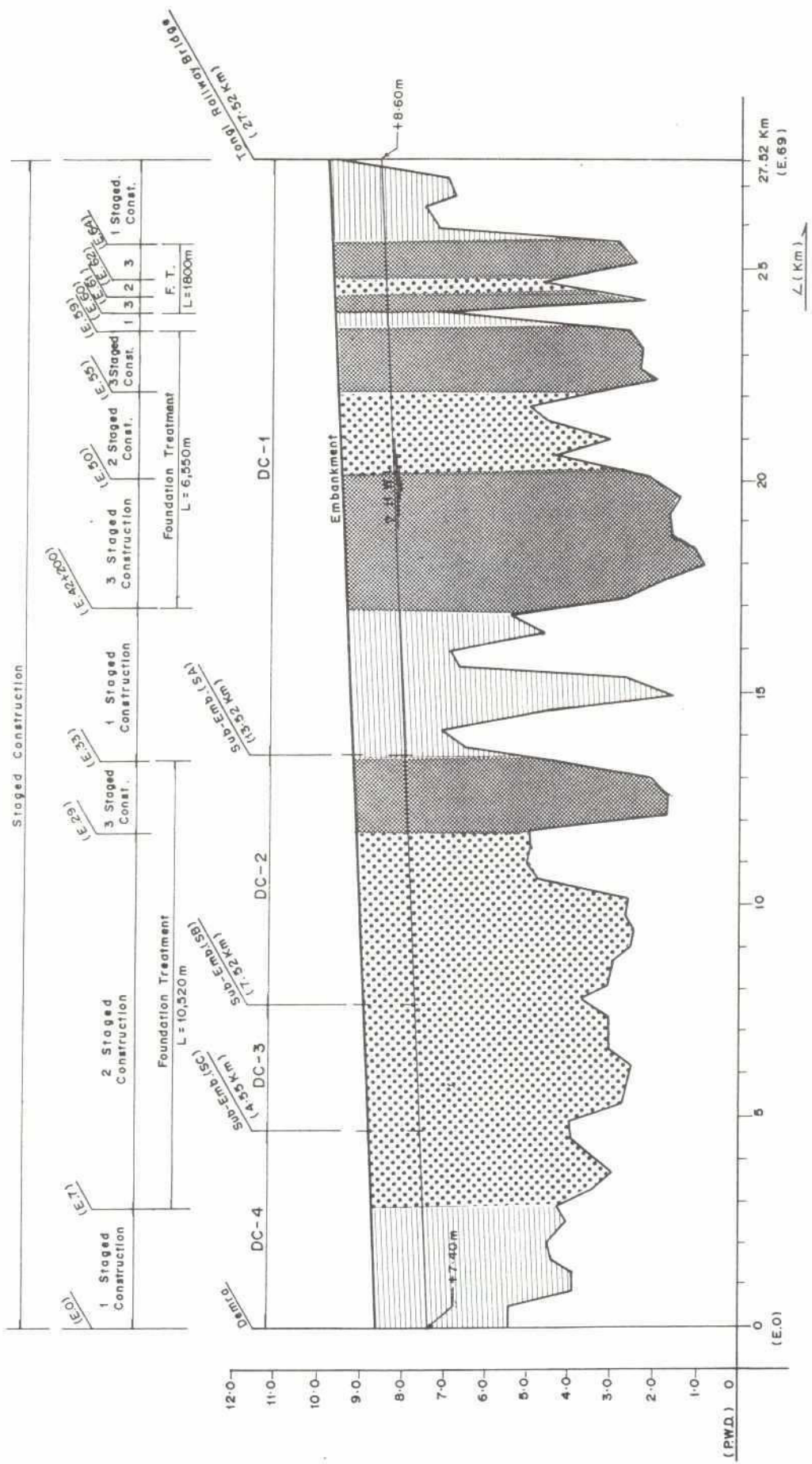
FIG. F.1.11

TAYLOR'S CHART FOR STABILITY ANALYSIS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROLOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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# STAGED CONSTRUCTION OF EMBANKMENT



## LEGEND

- 1st Staged Const.
- 2nd Staged Const.
- 3rd Staged Const.

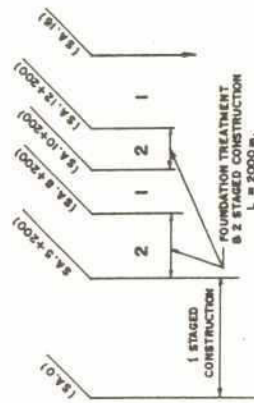
**FIG. F.1.12(1)** STAGED CONSTRUCTION OF EMBANKMENT : GREATER DHAKA EAST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

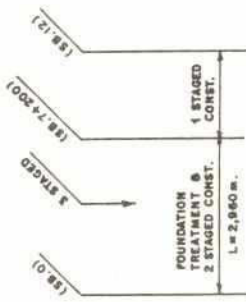




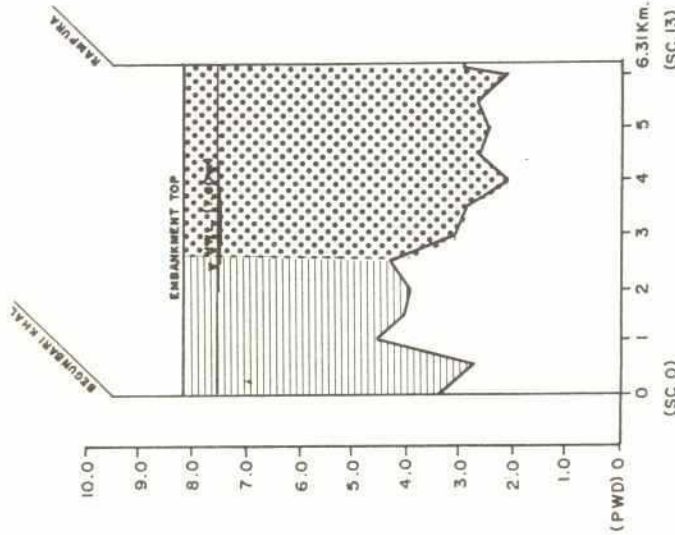
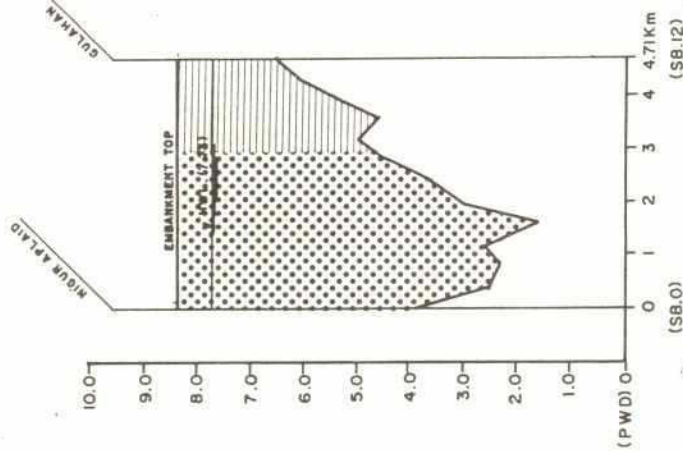
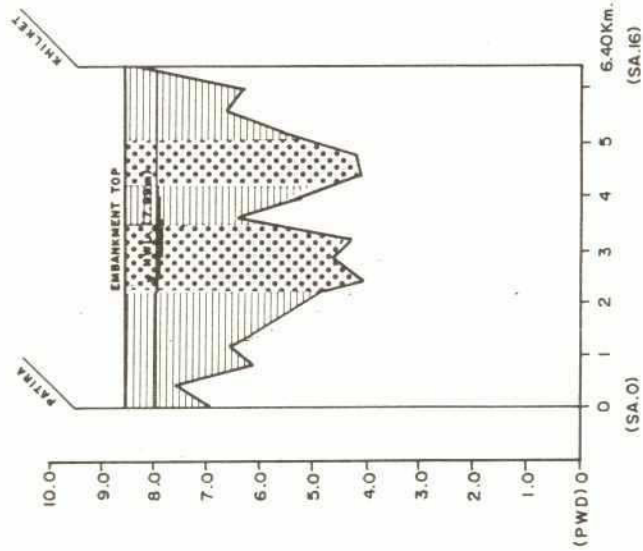
Sub-Embankment : SA



Sub-Embankment : SB



Sub-Embankment : SC



# LEGEND

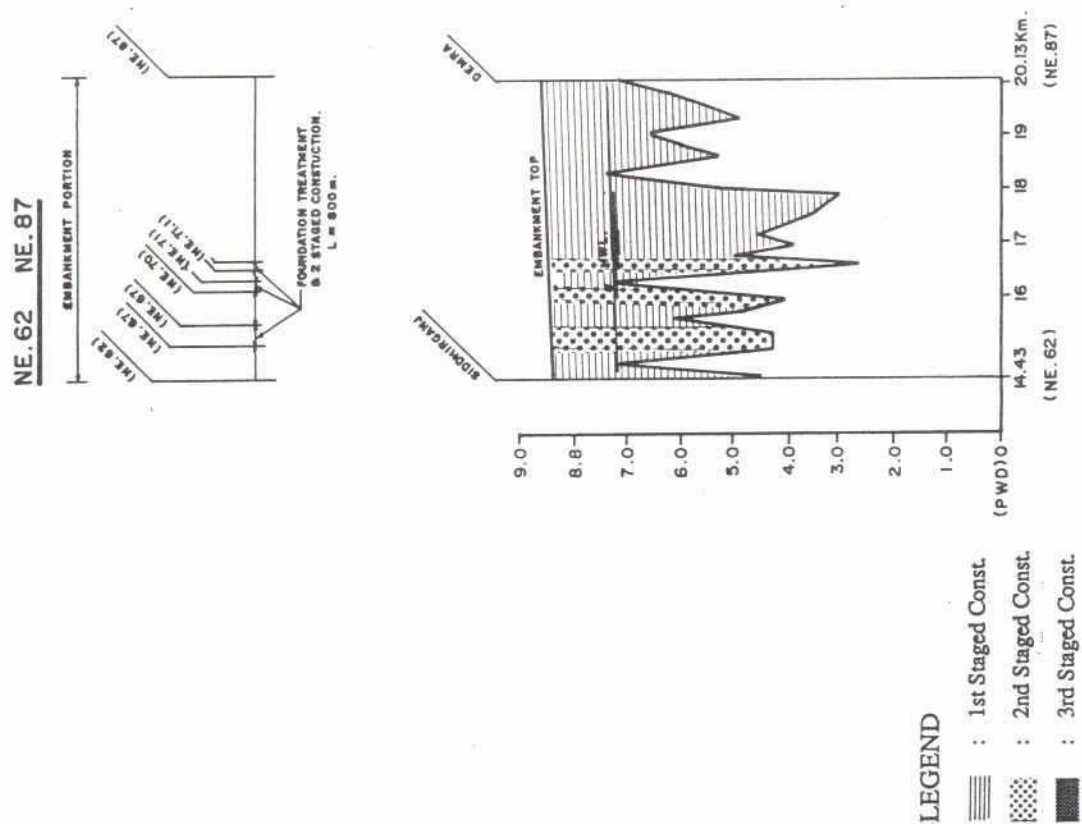
- : 1st Staged Const.
- : 2nd Staged Const.
- : 3rd Staged Const.

FIG. F.1.12(2)

STAGED CONSTRUCTION OF EMBANKMENT : GREATER DHAKA EAST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8.A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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**FIG. F.1.12(3)** STAGED CONSTRUCTION OF EMBANKMENT : NARAYANGANJ WEST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

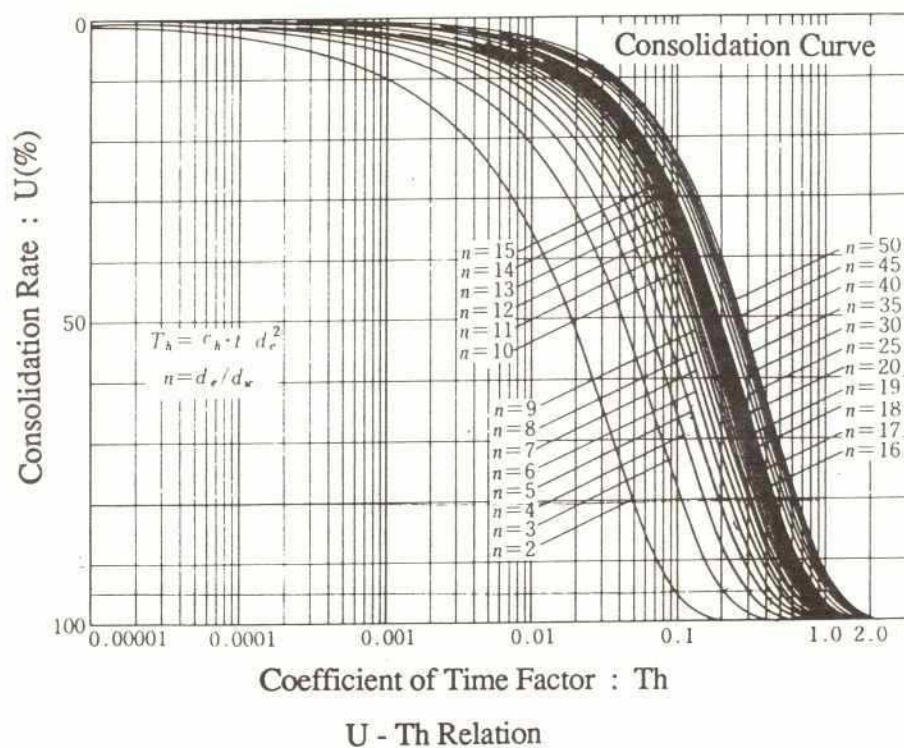
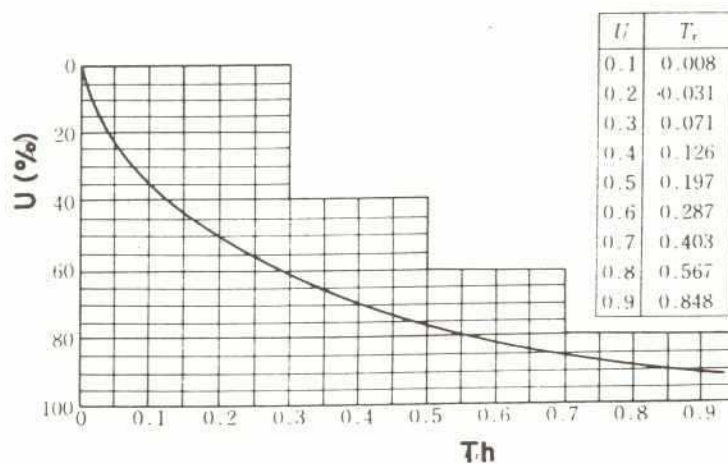


FIG. F.1.13

## CONSOLIDATION CURVE AND TABLE

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
 BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





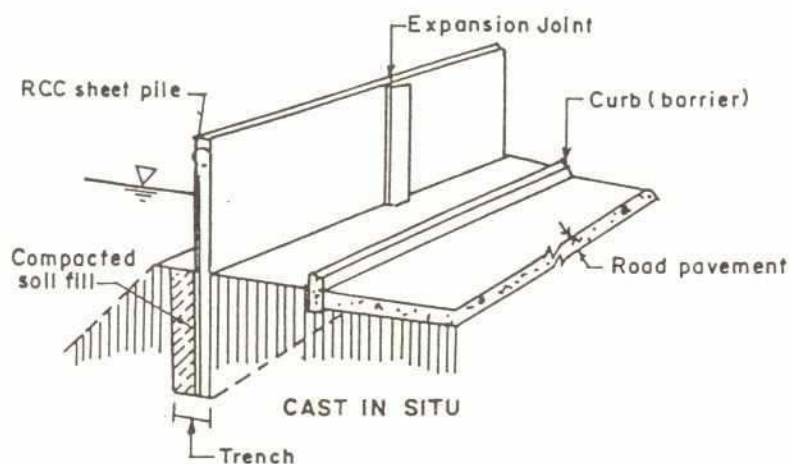
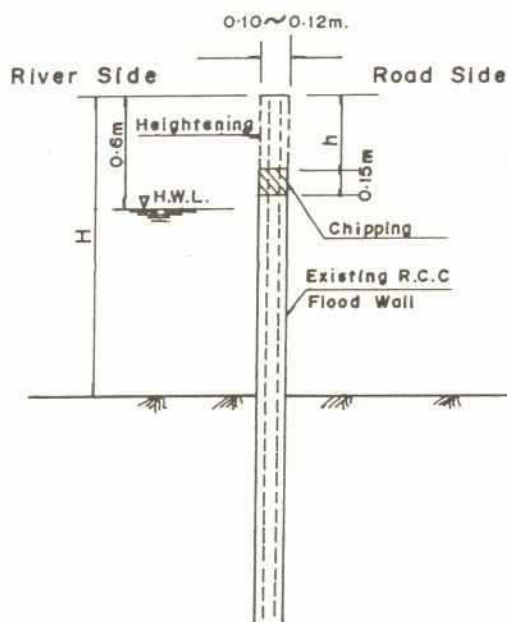
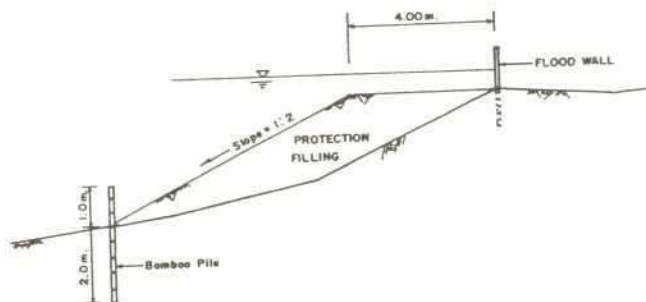
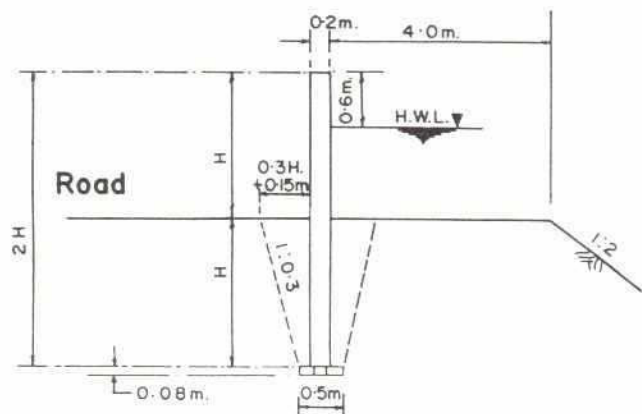


FIG. F.2.1

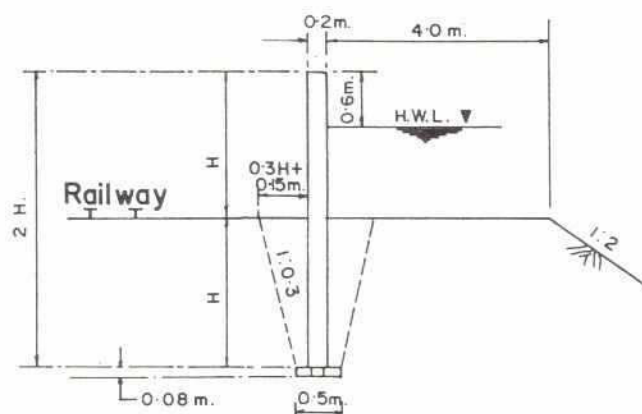
STANDARD CROSS SECTION OF EXISTING FLOOD WALL AND REHABILITATION WORKS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

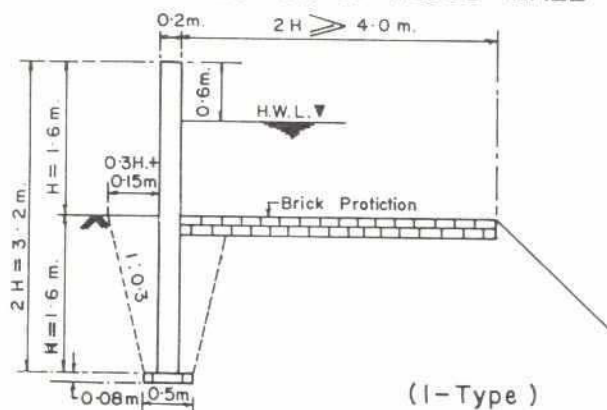
TYPICAL SECTION OF FLOOD WALL



TYPICAL SECTION OF FLOOD WALL

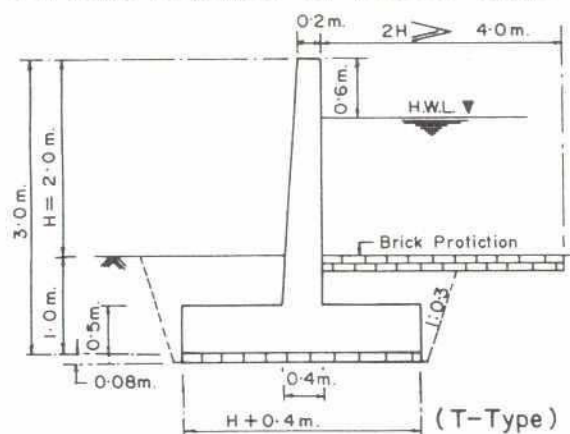


TYPICAL SECTION OF FLOOD WALL



(I-Type)

TYPICAL SECTION OF FLOOD WALL



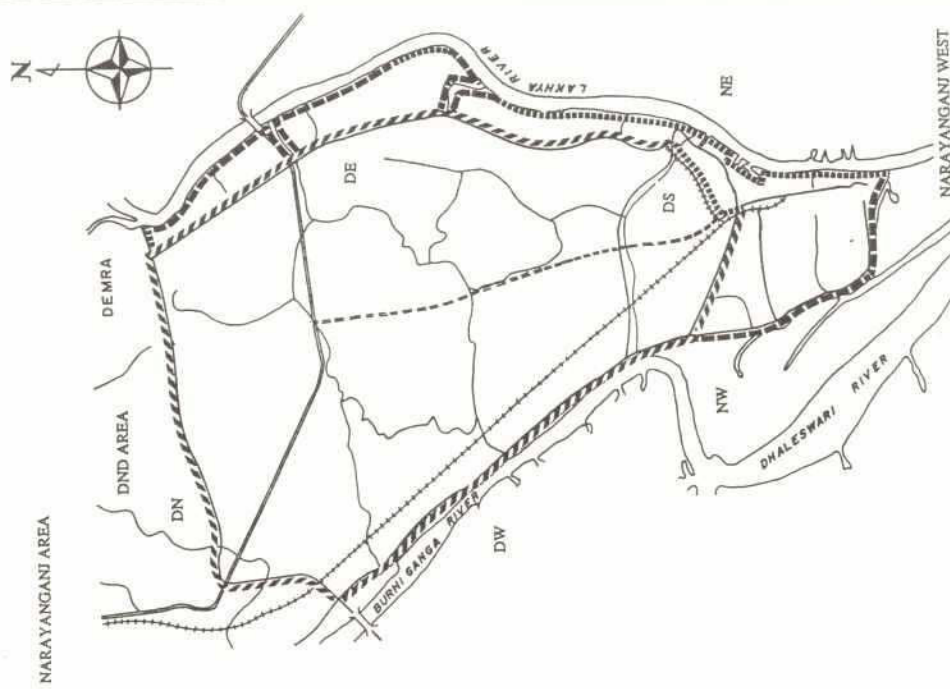
(T-Type)

FIG. F.2.2

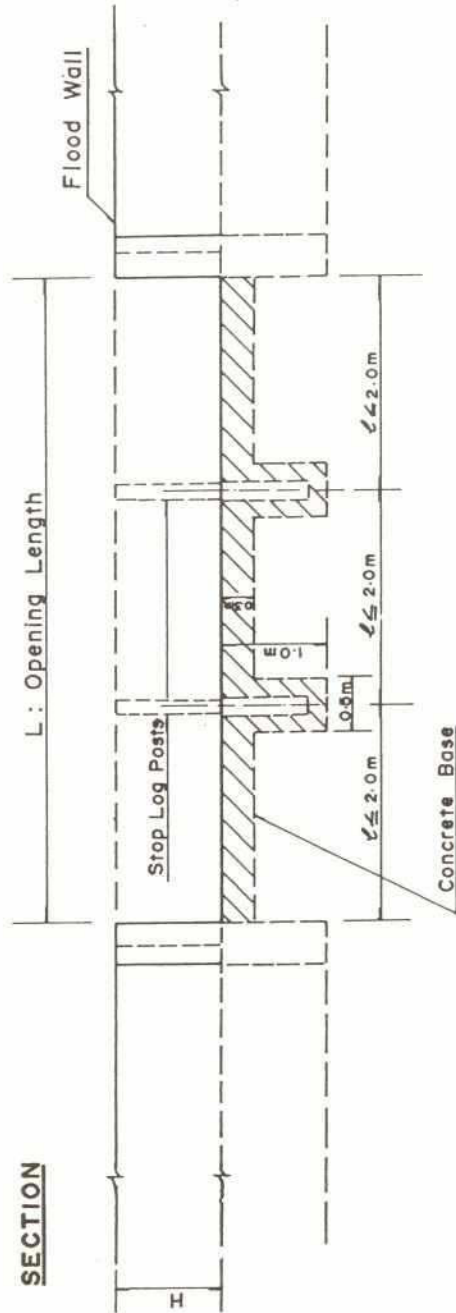
STANDARD CROSS SECTION OF PROPOSED FLOOD WALL

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





# STOP LOG STRUCTURE



## PLAN

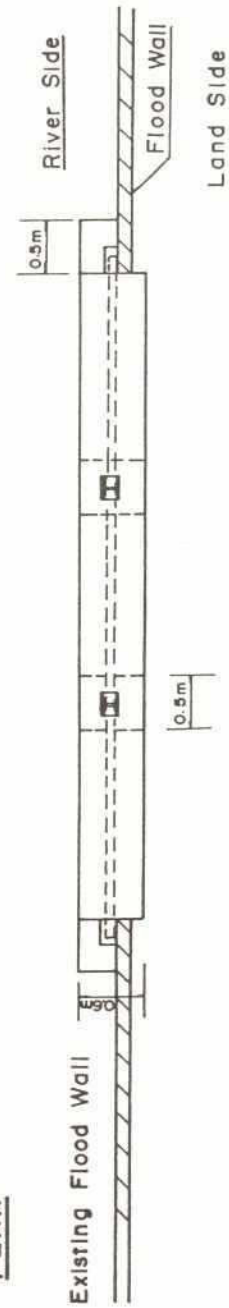


FIG. F.2.3 TYPICAL SECTION OF STOP LOG STRUCTURE

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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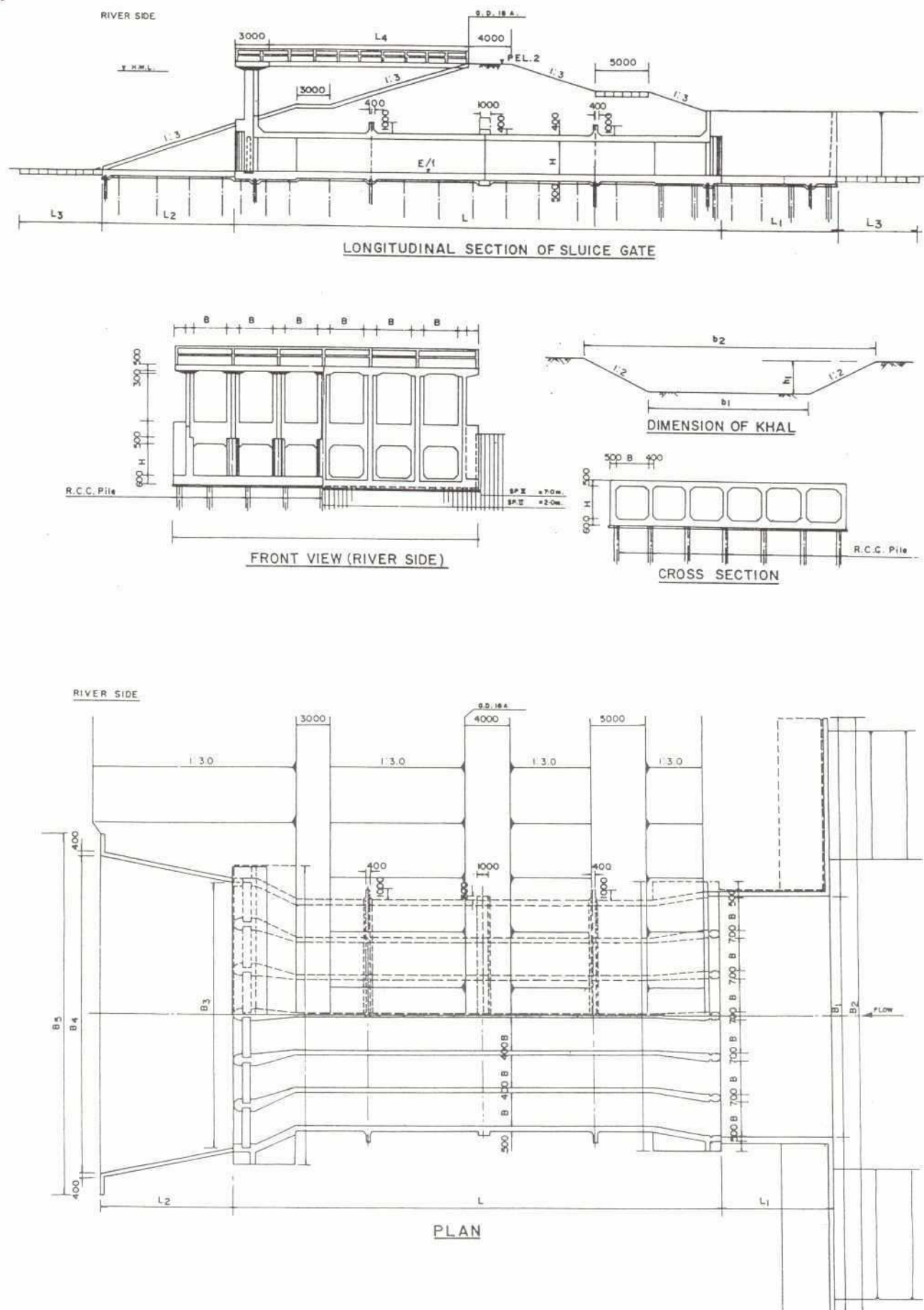


FIG. F.3.1

STANDARD SECTION OF SLUICE GATE APPLIED ON EMBANKMENT SECTION

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH









P5 Pump Station  
Boring No. E-2

P6 Pump Station  
Boring No. E-4

P7A Pump Station  
Boring No. E-6

P7B Pump Station  
Boring No. E-7

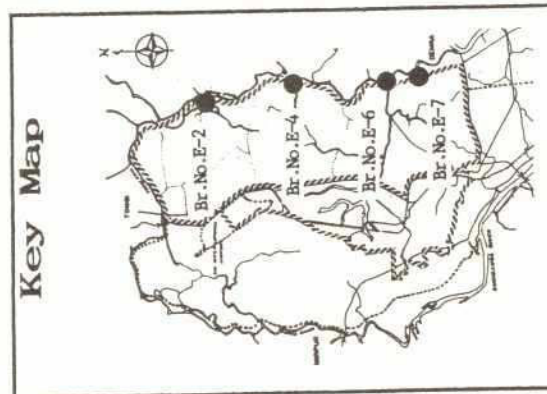
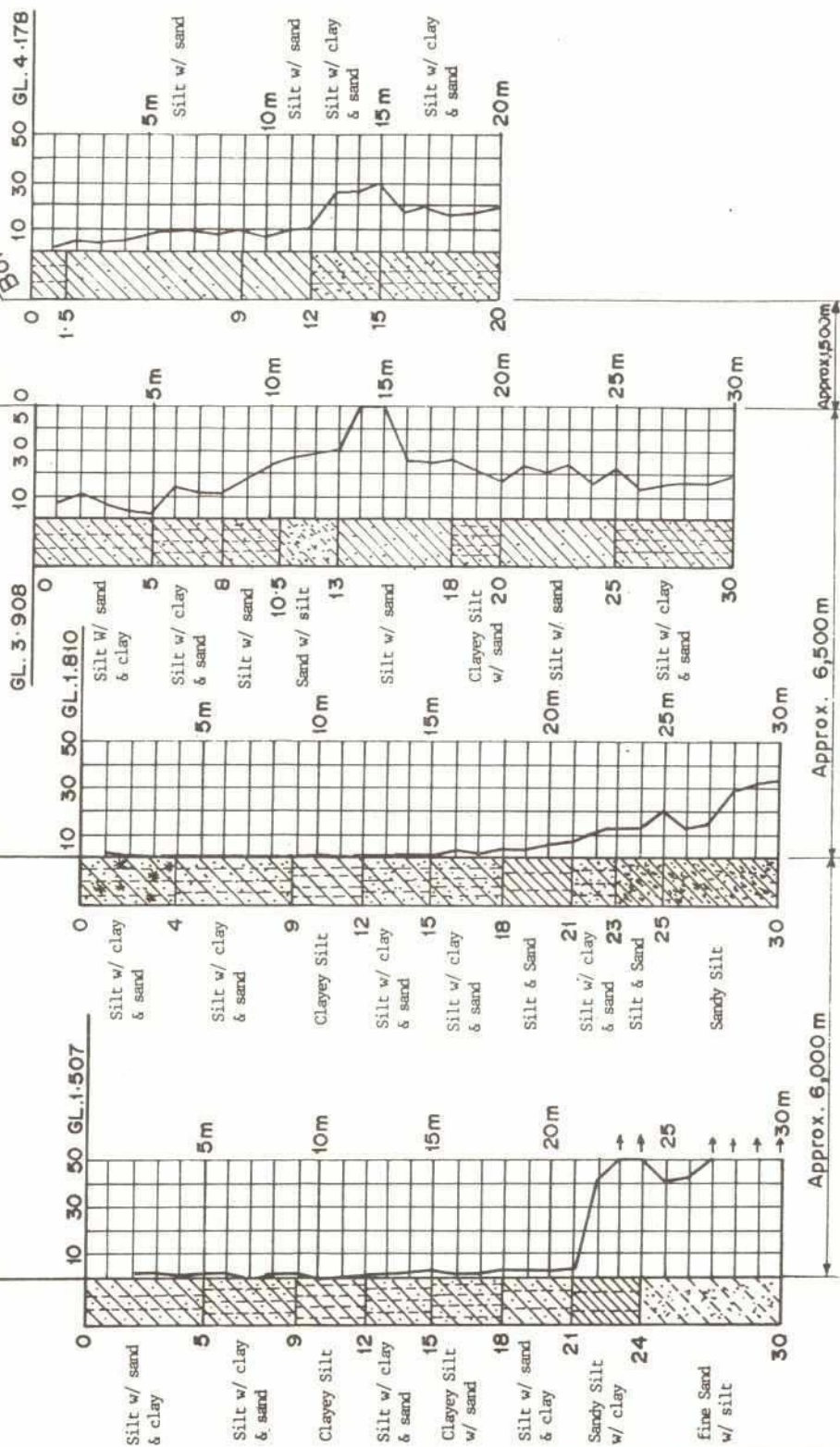
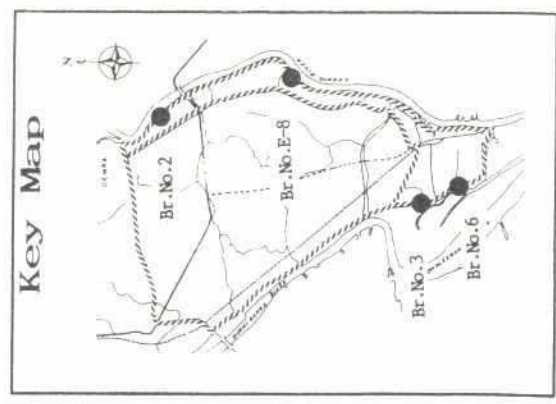
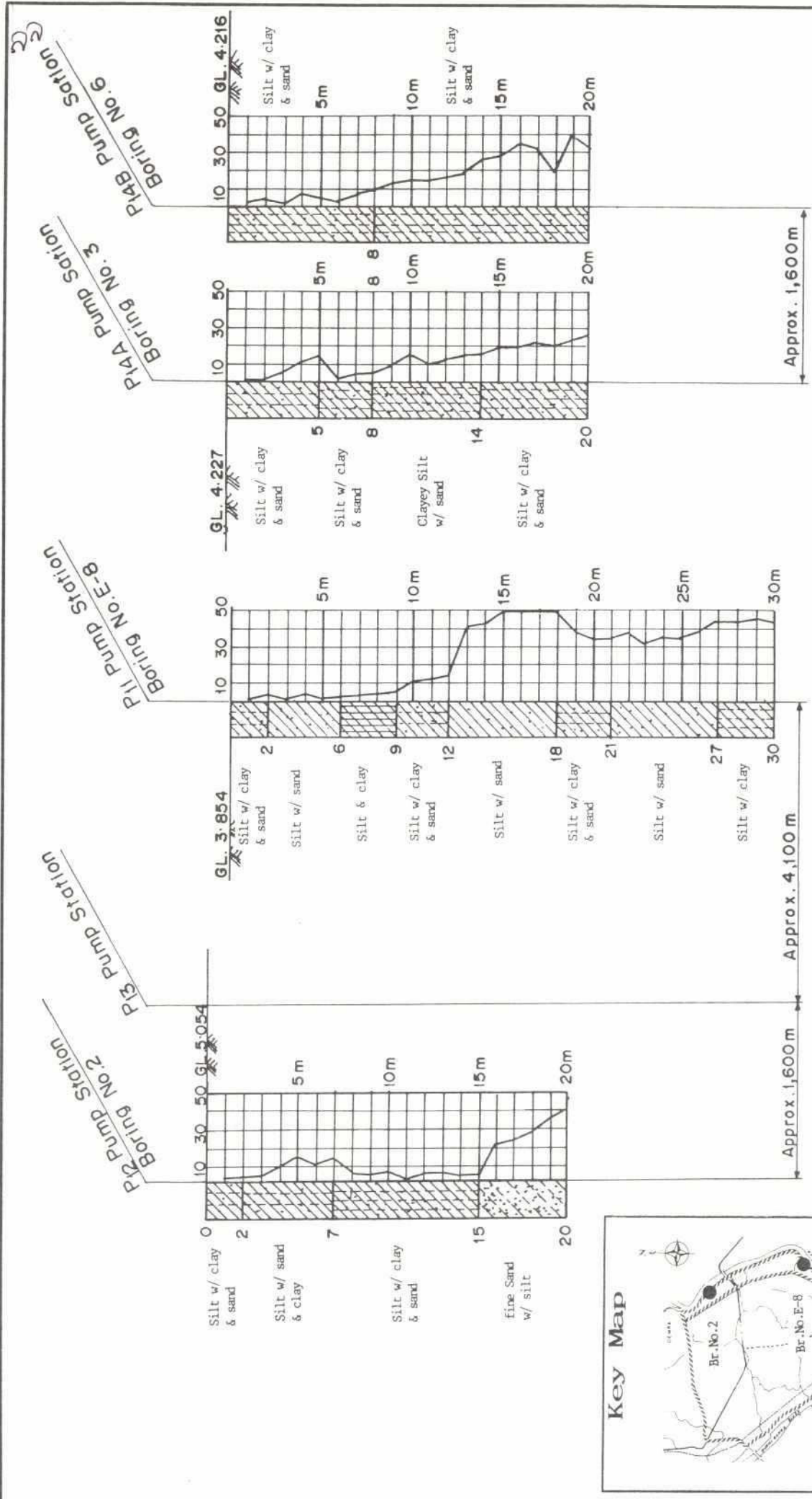


FIG. F.4.2(1) SOIL CONDITION AT PROPOSED PUMPING STATIONS :  
GREATER DHAKA EAST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



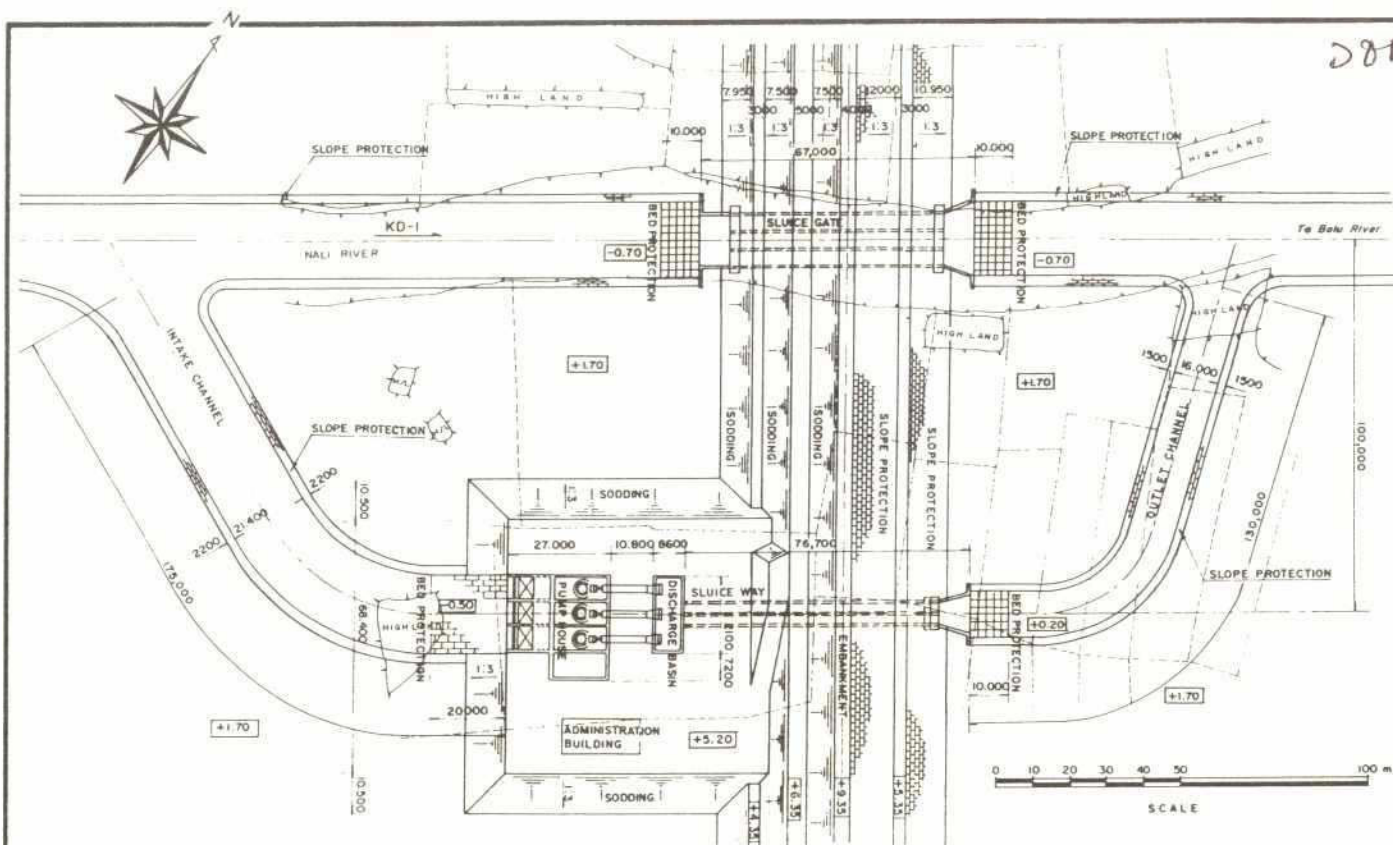


**FIG. F.4.2(2)** SOIL CONDITION AT PROPOSED PUMPING STATIONS :  
DND AND NARAYANGANJ WEST

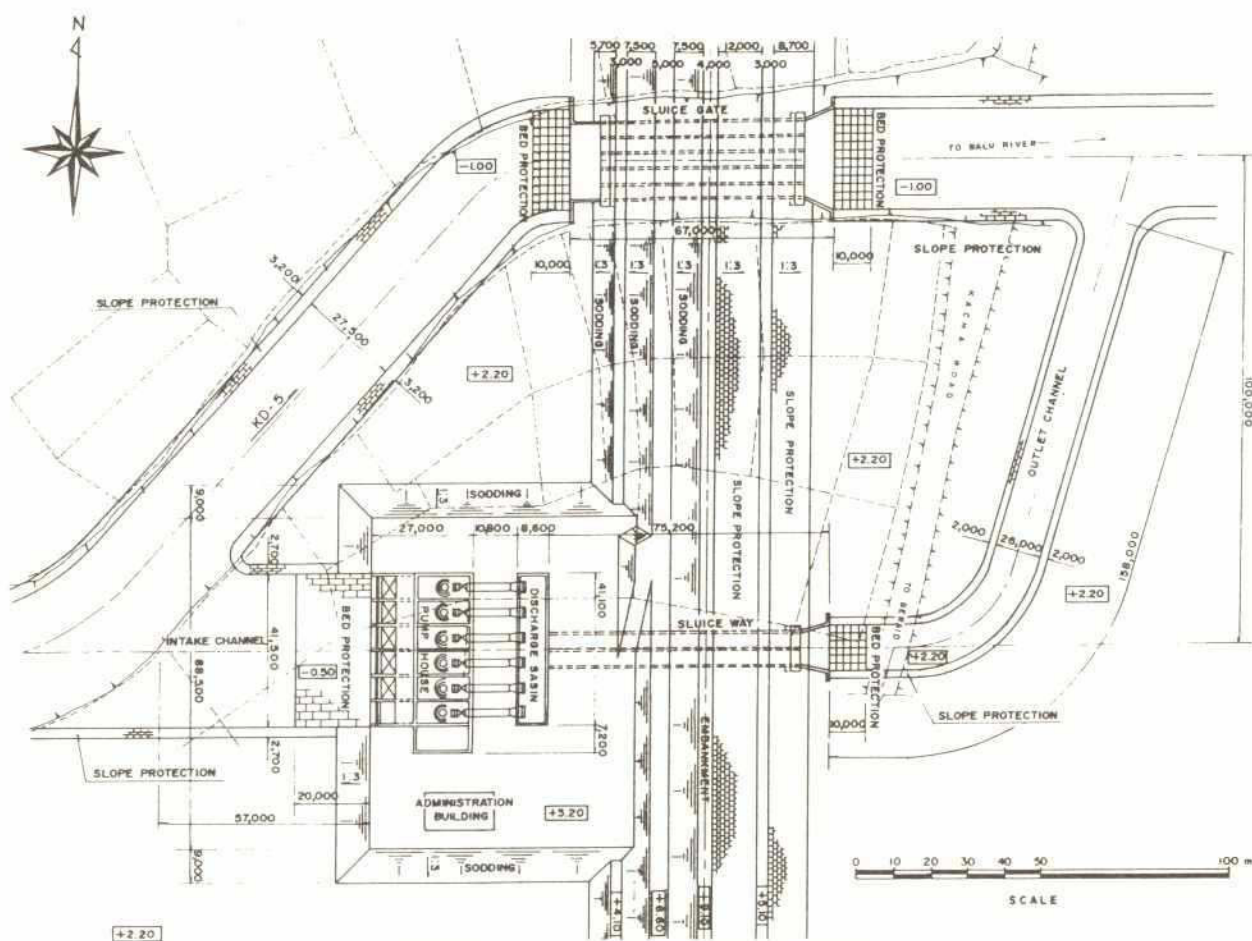
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH







P.5 Pumping Station ( $Q=25.6 \text{ m}^3/\text{s}$ )



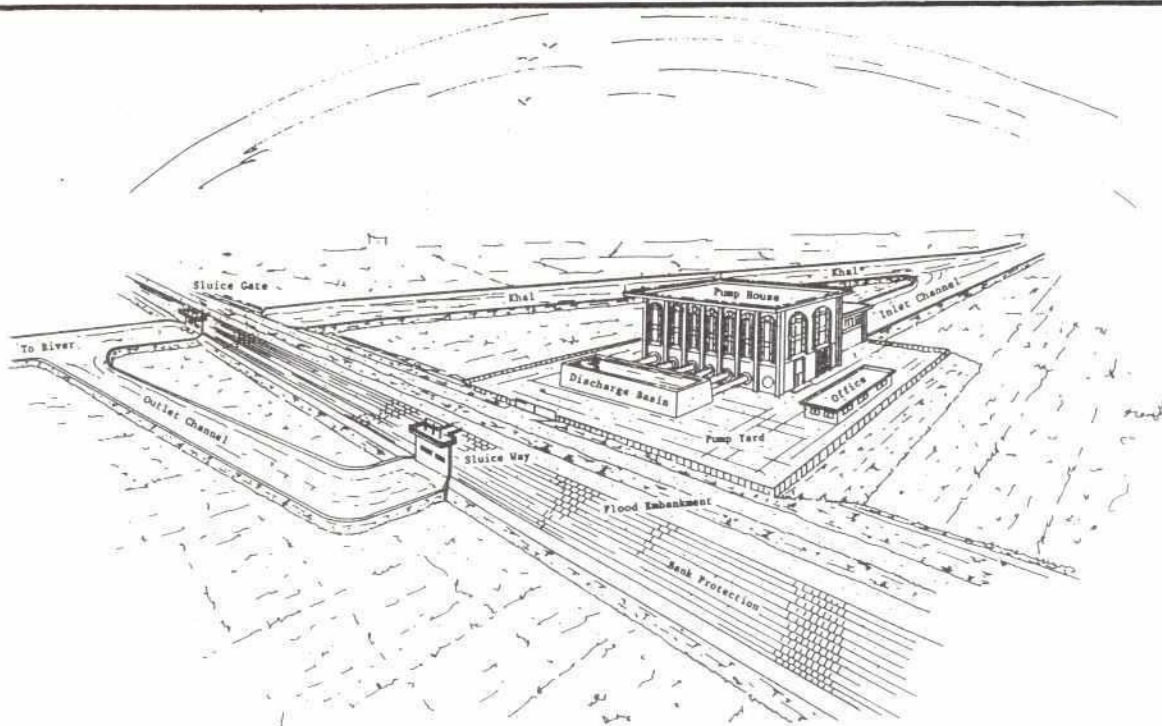
P.6 Pumping Station ( $Q=54.6 \text{ m}^3/\text{s}$ )

FIG. F.4.3(1)

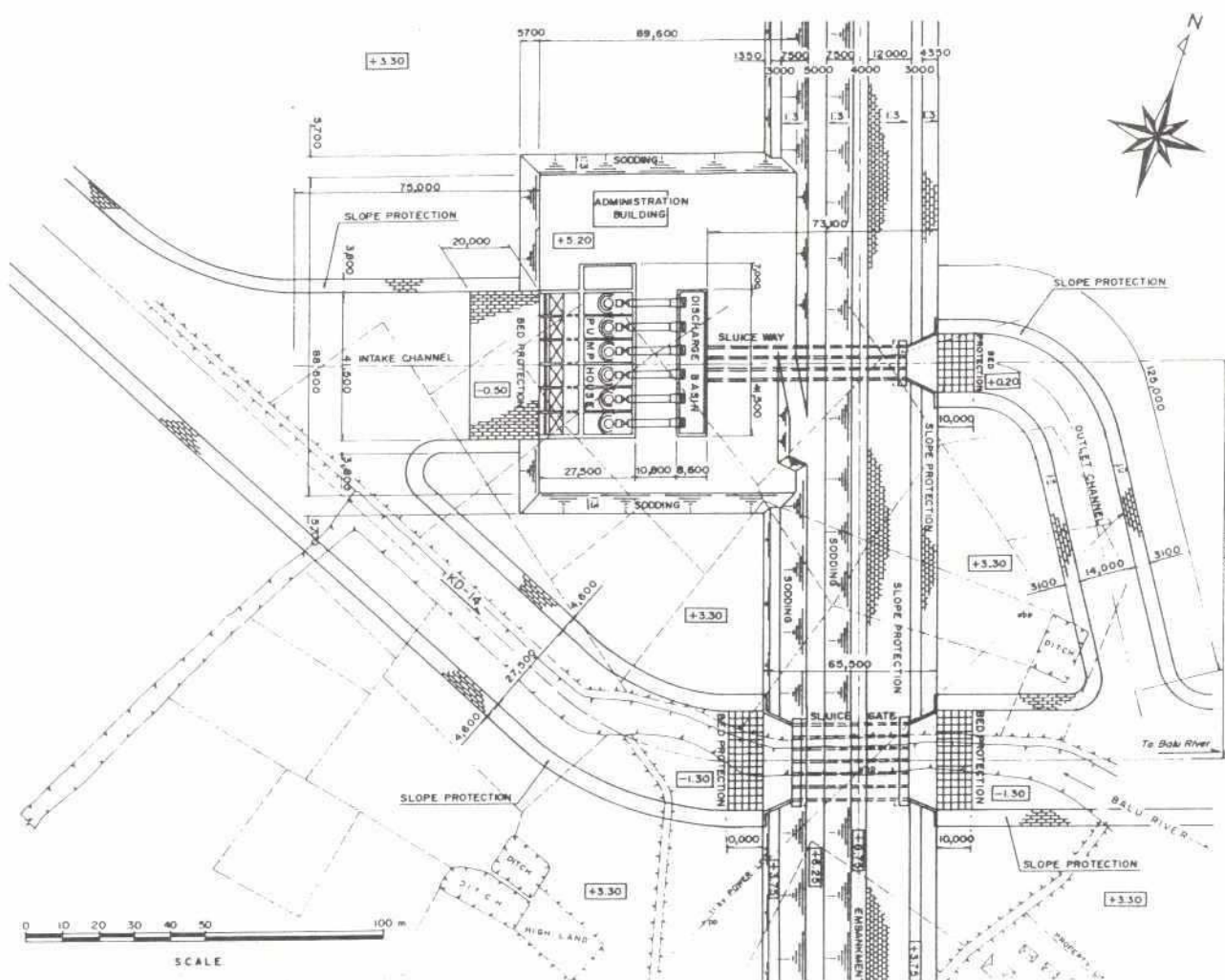
LAYOUT OF PROPOSED P5 AND P6 PUMPING STATIONS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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Perspective of Pumping Station



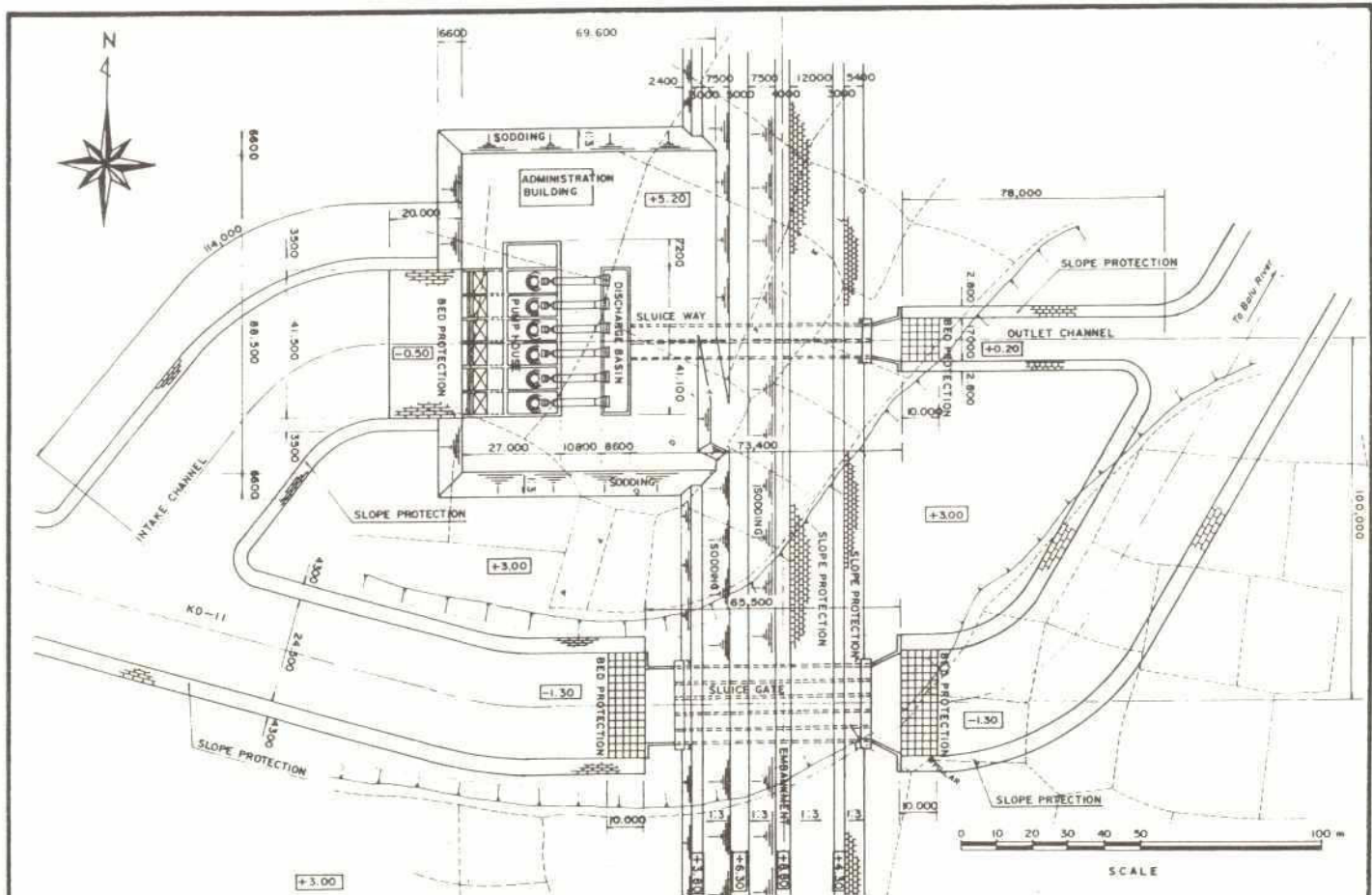
P.7B Pumping Station ( $Q=47.2 \text{ m}^3/\text{s}$ )

**FIG. F.4.3(2)**

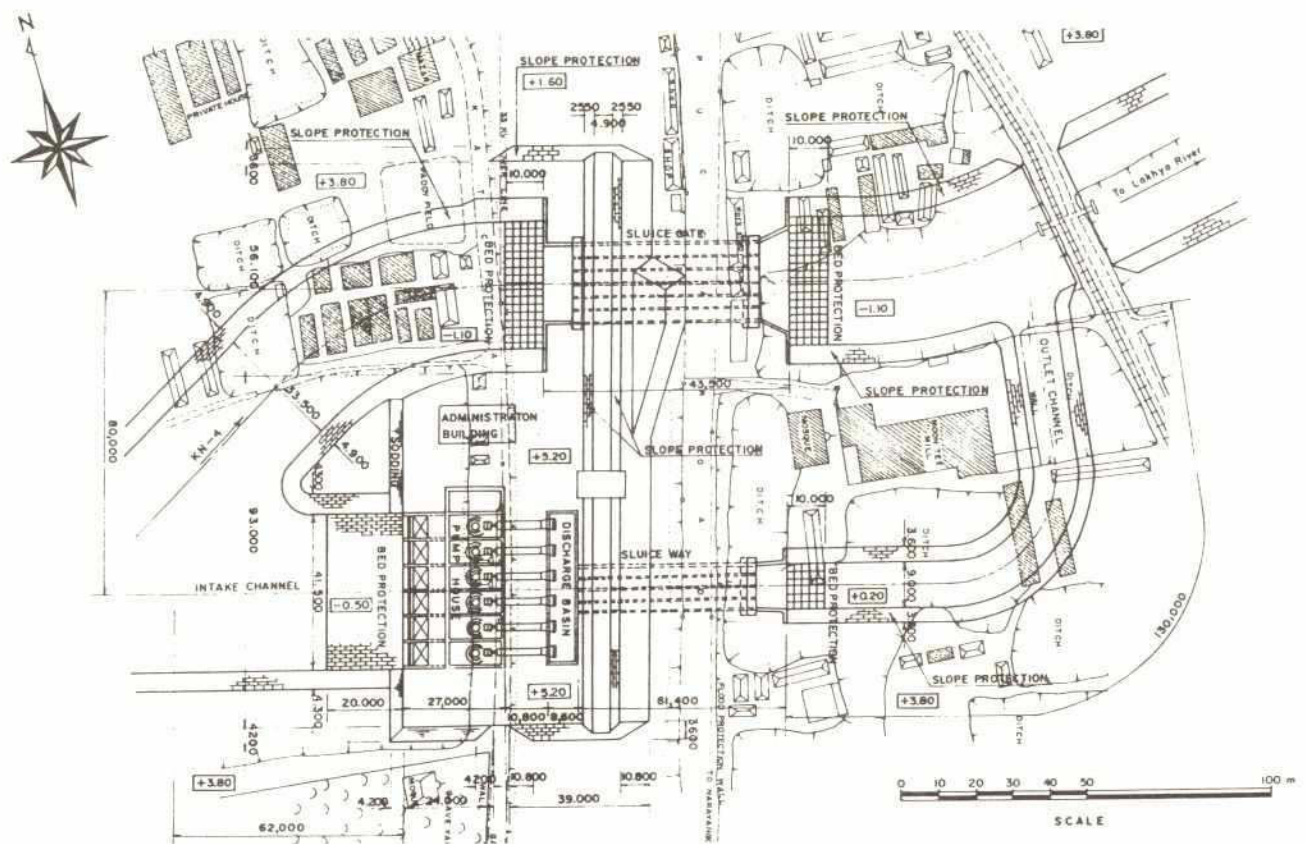
**LAYOUT OF PROPOSED P7B PUMPING STATION**

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





P.7A Pumping Station (Q=53.1 m<sup>3</sup>/s)



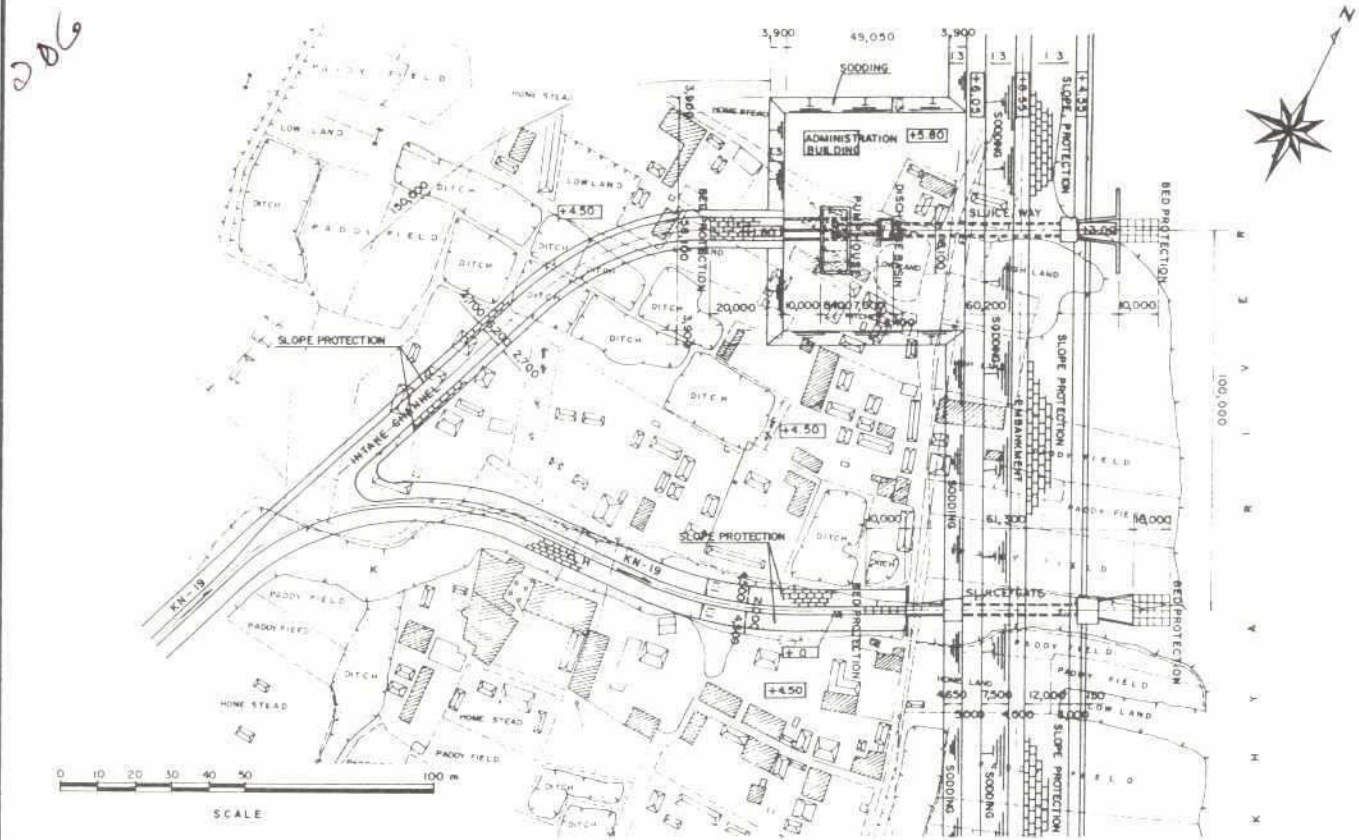
P.11 Pumping Station (Q=50.2 m<sup>3</sup>/s)

FIG. F.4.3(3)

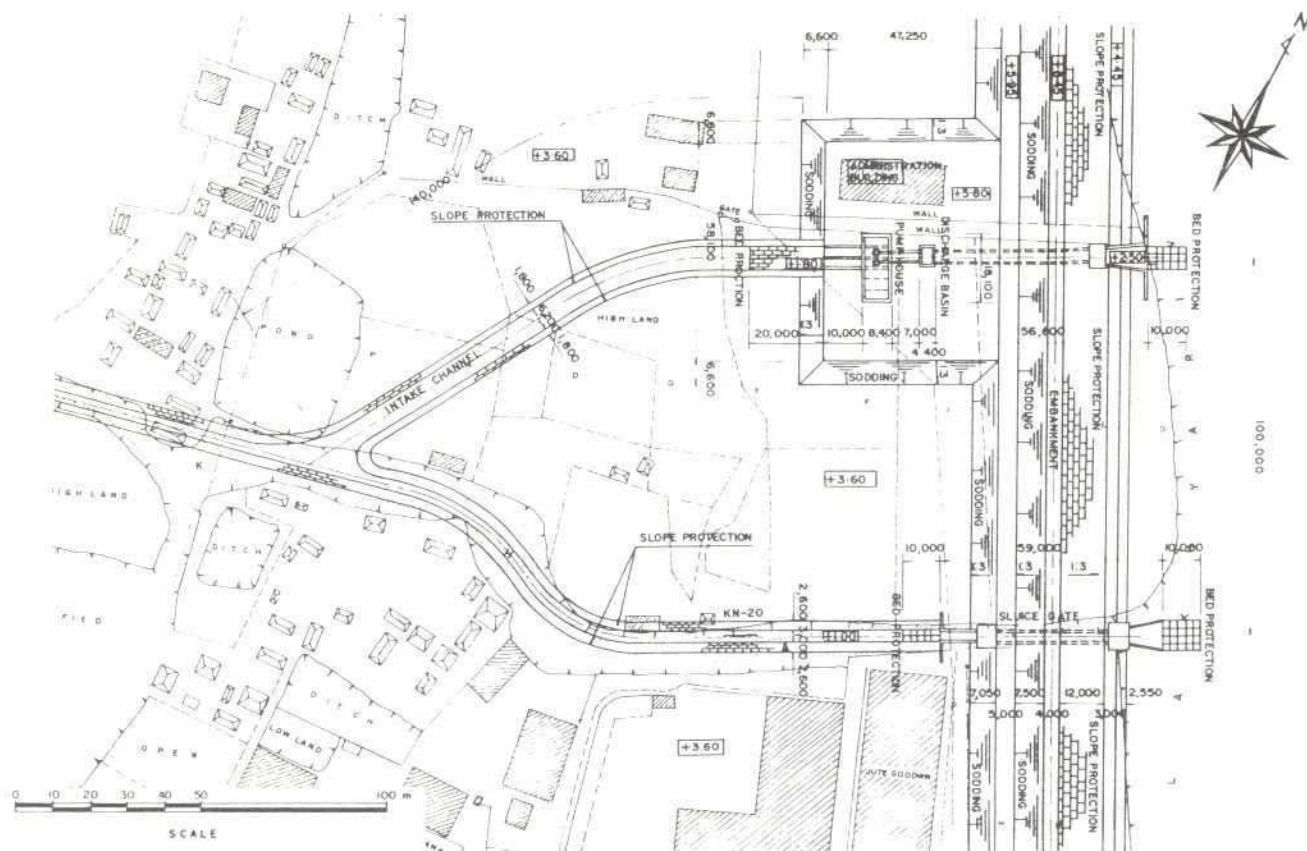
LAYOUT OF PROPOSED P7A AND P11 PUMPING STATIONS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





P.12 Pumping Station (Q=2.0 m³/s)



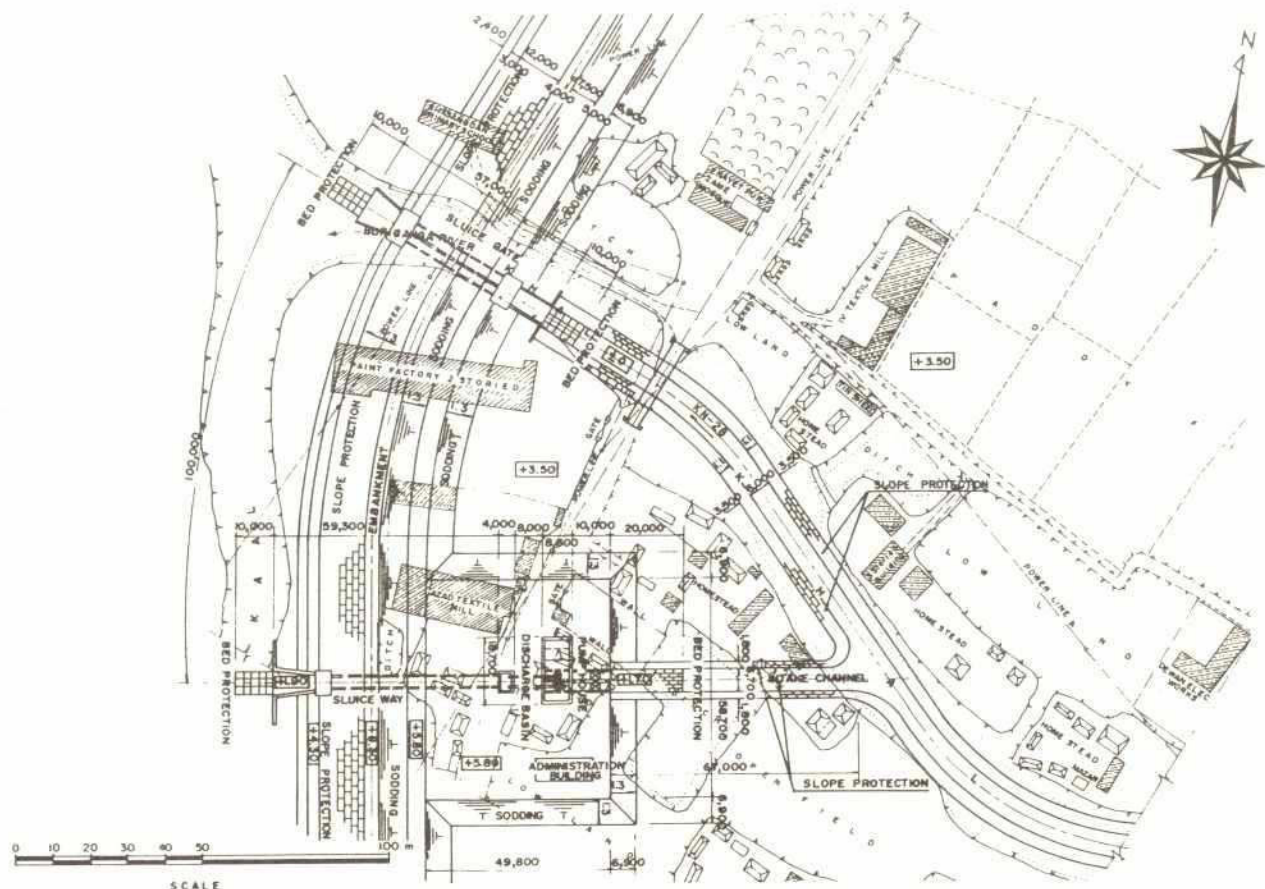
P.13 Pumping Station (Q=2.2 m³/s)

FIG. F.4.3(4)

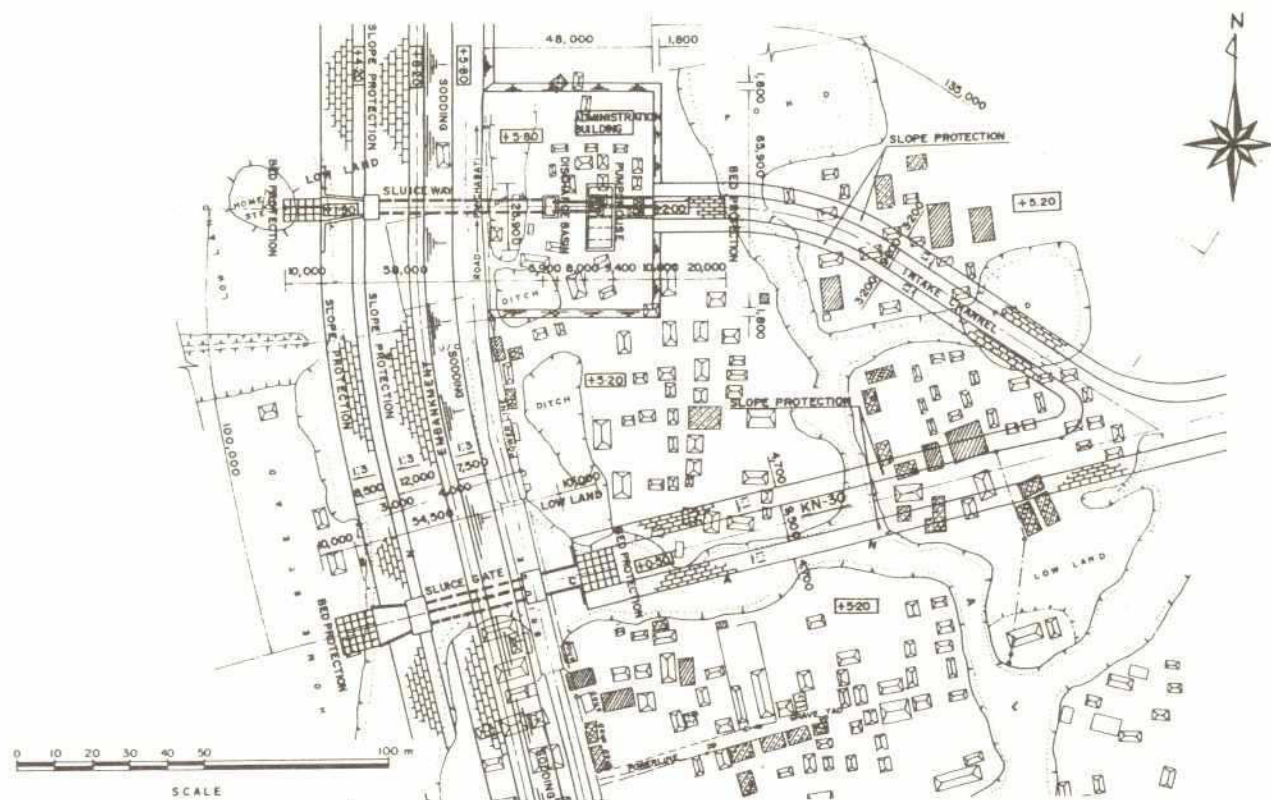
LAYOUT OF PROPOSED P12 AND P13 PUMPING STATIONS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





P.14A Pumping Station (Q=2.7 m<sup>3</sup>/s)



P.14B Pumping Station (Q=5.3 m<sup>3</sup>/s)

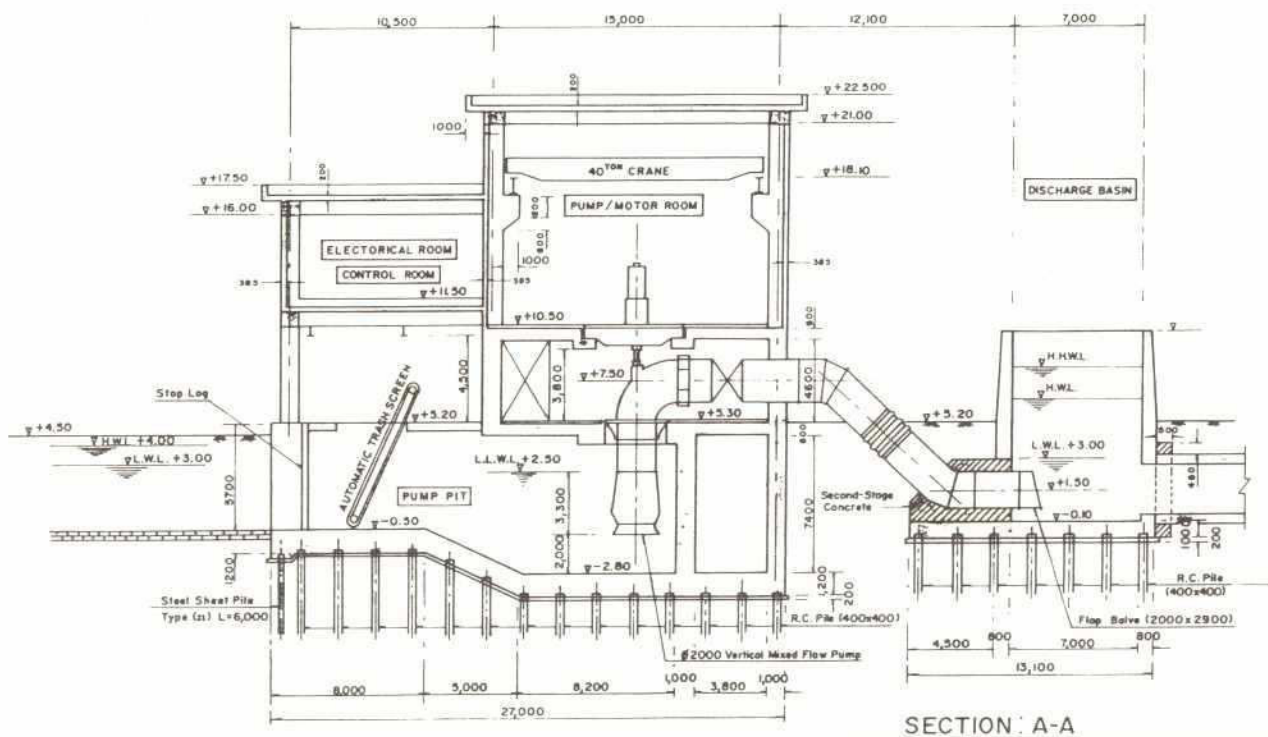
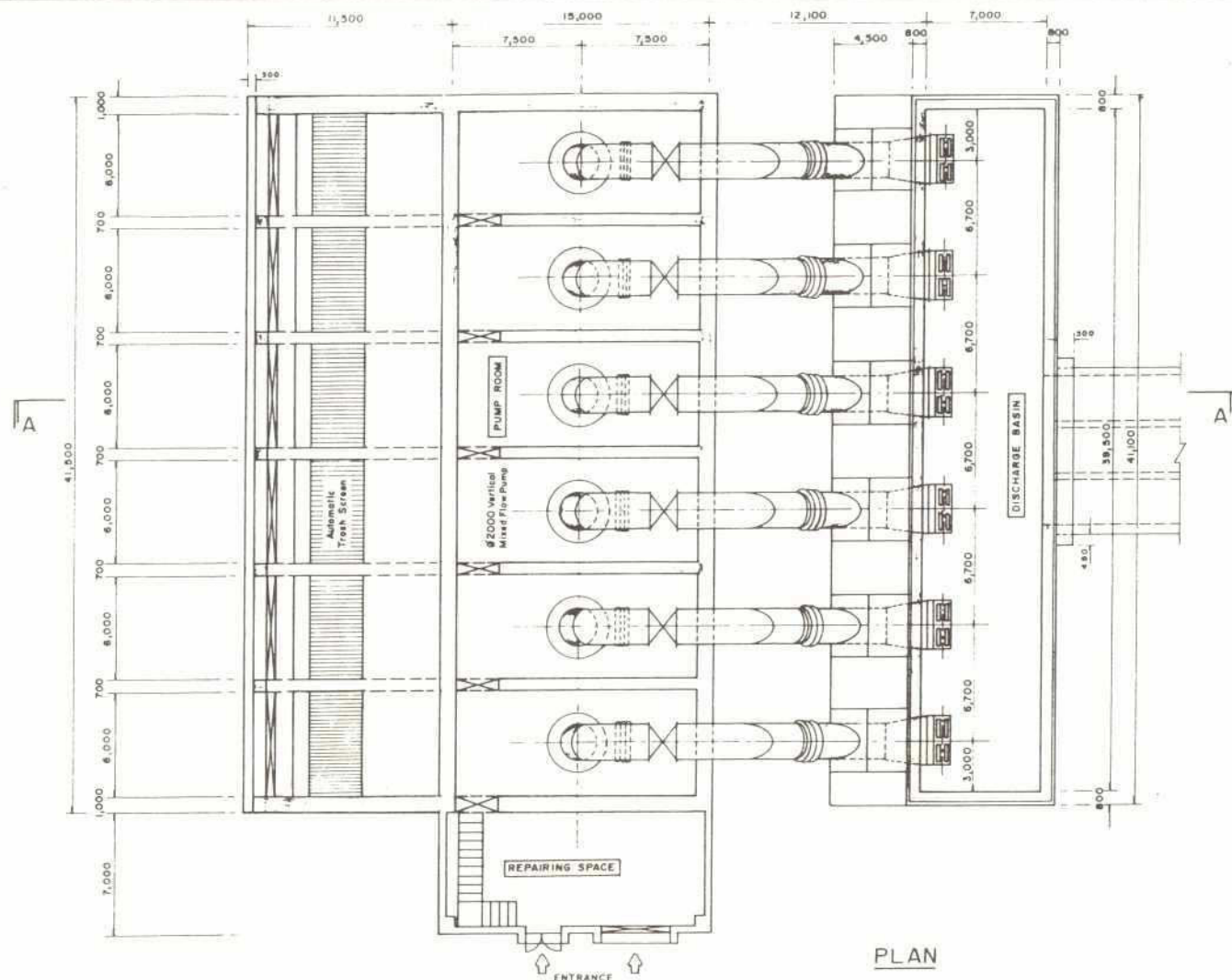
**FIG. F.4.3(5)**

**LAYOUT OF PROPOSED P14A AND P14B PUMPING STATIONS**

**GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH**



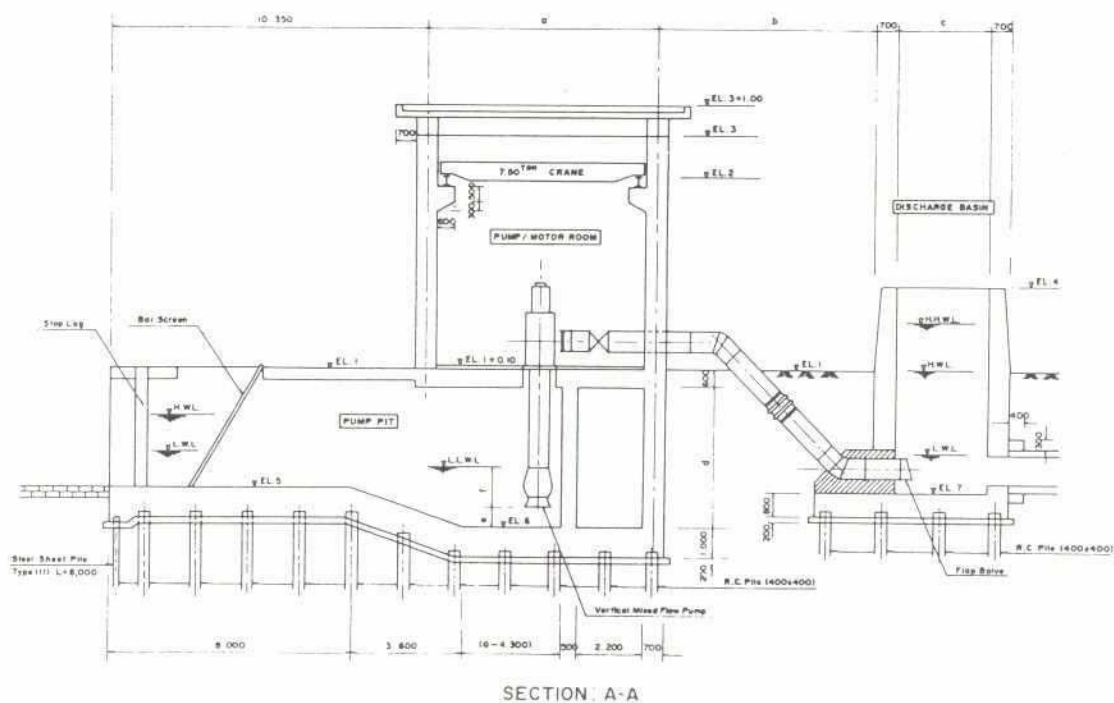
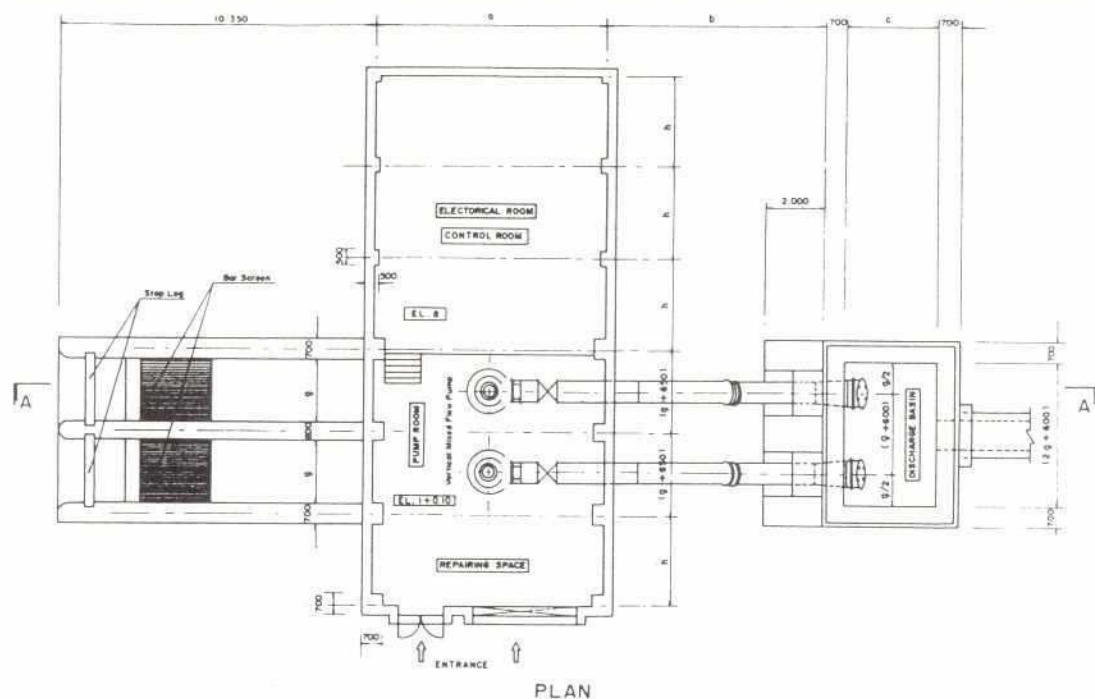




**FIG. F.4.4(2)**

**TYPICAL DESIGN OF PROPOSED 50 M<sup>3</sup>/S  
CLASS PUMPING STATION (P6, P7A, P7B AND P11)**

**GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH**



Main Feature of Pump Station

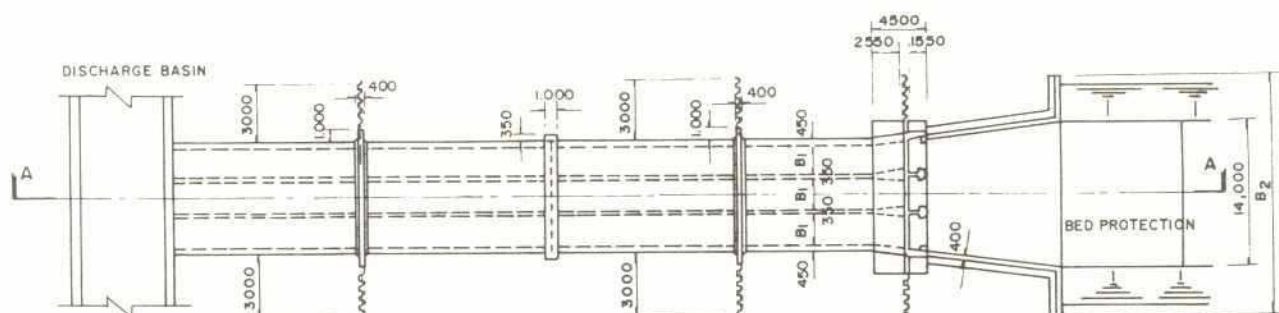
Pump No.	Dimension (mm)								Elevation							
	a	b	c	d	e	f	g	h	EL.1	EL.2	EL.3	EL.4	EL.5	EL.6	EL.7	EL.8
P.12	7,700	7,000	3,000	4,700	700	1,300	2,100	3,000	+5.80	+11.70	+13.10	+8.55	+1.80	+0.50	+1.70	+7.00
P.13	7,700	7,000	3,000	4,200	700	1,300	2,100	3,000	+5.80	+11.70	+13.10	+8.45	+1.80	+1.00	+2.20	+7.00
P.14A	7,900	8,000	3,000	4,900	800	1,400	2,400	3,000	+5.80	+12.20	+13.60	+8.30	+1.70	+0.30	+1.60	+6.70
P.14B	8,700	8,000	4,500	5,400	1,200	2,000	3,600	4,200	+5.80	+14.10	+16.30	+8.20	+2.00	-0.20	+1.60	+6.70

FIG. F.4.4(3)

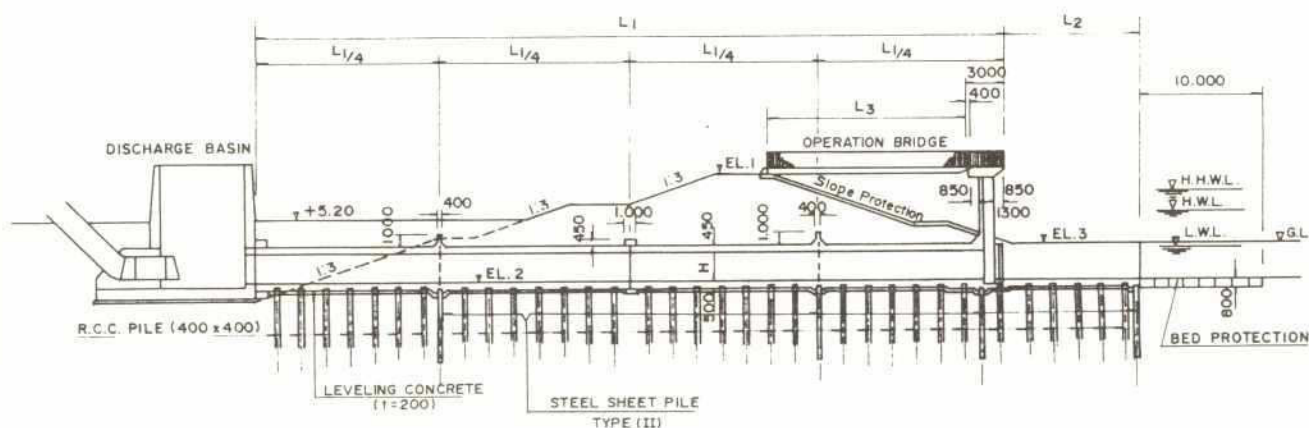
TYPICAL DESIGN OF PROPOSED 2 M<sup>3</sup>/S ~ 5 M<sup>3</sup>/S  
CLASS PUMPING STATION (P12, P13, P14A AND P14B)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

PLAN



SECTION A-A



Main Feature of Sluice Way

Pump No.	Culvert				Outlet		0.Bridge	Elevation		
	B1 (mm)	H1 (mm)	L1 (mm)	n (Nos.)	B2 (mm)	L2 (mm)	L3 (mm)	EL.1	EL.2	EL.3
P.5	2,300	2,300	62,000	2	19,000	14,700	14,850	+9.35	+0.20	+1.70
P.6	2,700	2,700	61,200	3	20,000	14,000	14,800	+9.10	+0.20	+2.20
P.7A	2,700	2,700	60,000	3	21,600	13,400	14,500	+8.80	+0.20	+3.00
P.7B	2,500	2,500	60,000	3	22,200	13,100	14,650	+8.75	+0.20	+3.30
P.11	2,500	2,000	48,400	4	23,200	13,000	9,500	+8.00	+0.20	+3.80

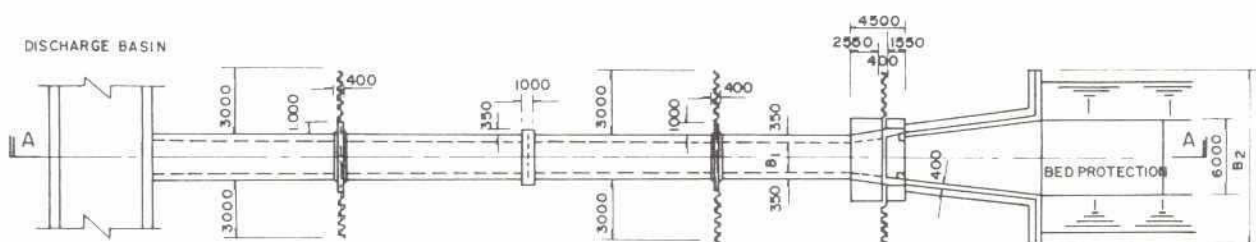
FIG. F.4.5(1)

TYPICAL DESIGN OF PROPOSED SLUICE WAY FOR 25 M<sup>3</sup>/S ~ 50 M<sup>3</sup>/S CLASS PUMPING STATION (P5, P6, P7A, P7B AND P11)

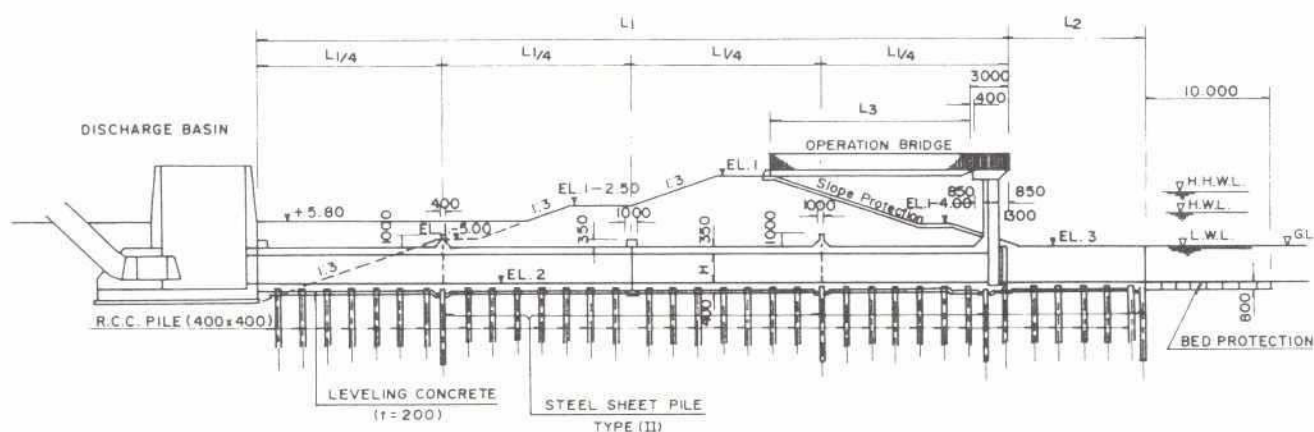
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



# PLAN



# SECTION A-A



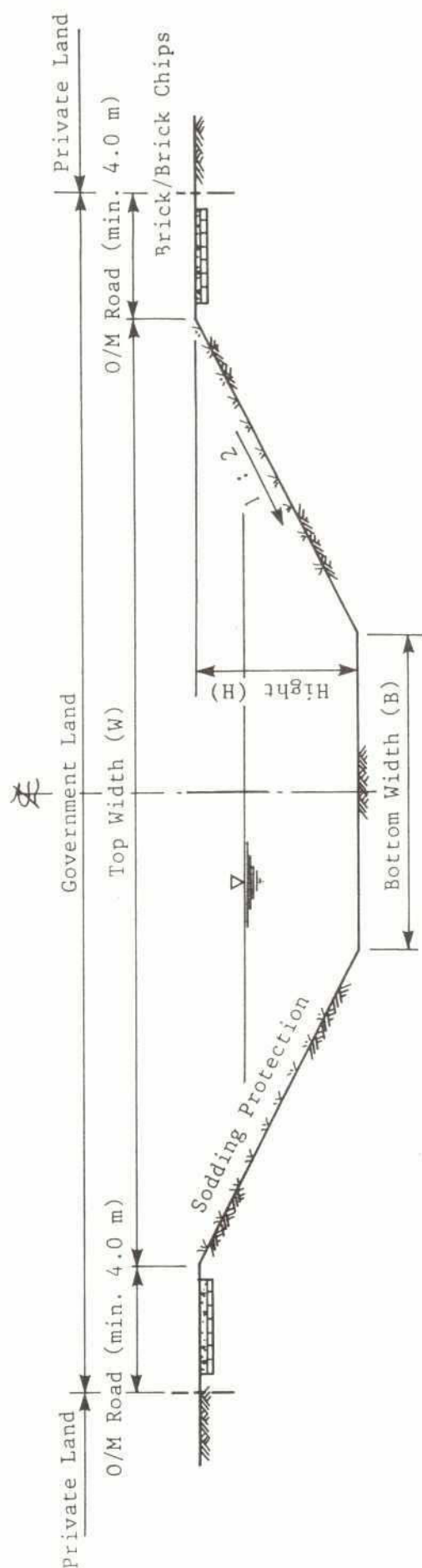
# Main Feature of Sluice Way

Pump No.	Culvert				Outlet		0. Bridge	Elevation		
	B1 (mm)	H1 (mm)	L1 (mm)	n (Nos.)	B2 (mm)	L2 (mm)	L3 (mm)	EL.1	EL.2	EL.3
P.12	1,000	1,000	52,000	1	13,400	8,200	13,250	+8.55	+2.00	+4.50
P.13	1,000	1,000	50,000	1	11,600	6,600	13,050	+8.45	+2.50	+3.60
P.14A	1,100	1,100	52,400	1	15,000	6,900	14,100	+8.30	+1.90	+3.50
P.14B	1,500	1,500	44,800	1	14,400	13,900	6,800	+8.20	+1.90	+5.20

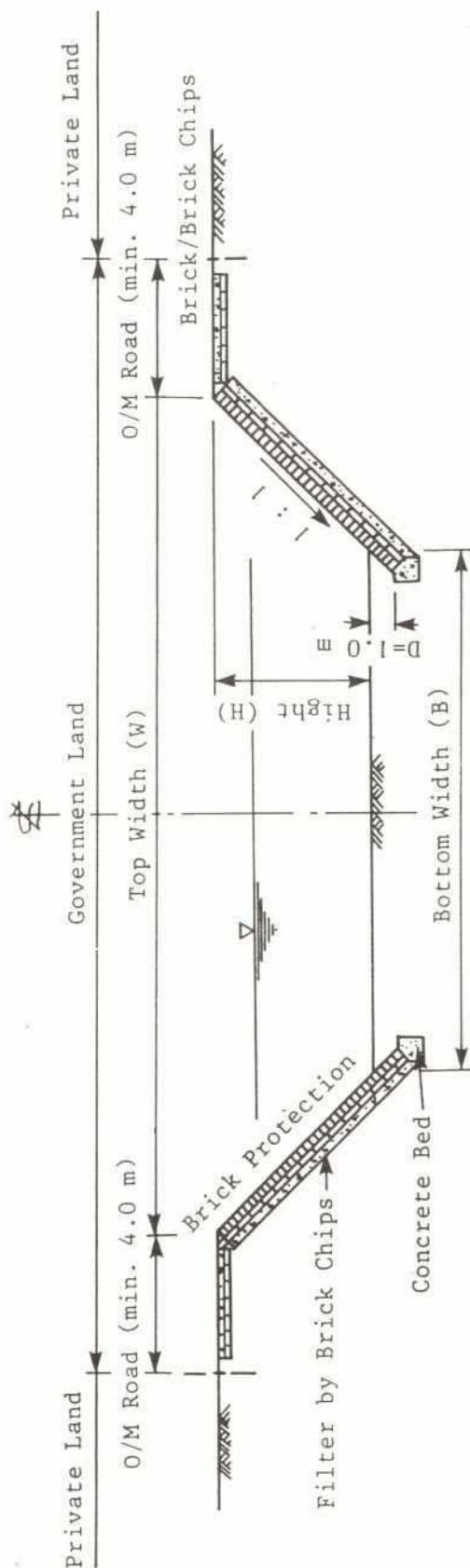
FIG. F.4.2(5)

TYPICAL DESIGN OF PROPOSED SLUICE WAY FOR 2 M<sup>3</sup>/S ~ 5 M<sup>3</sup>/S CLASS PUMPING STATION (P12, P13, P14A AND P14B)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



TYPE (1) : TRAPEZOIDAL SHAPE WITH 1 : 2 SLOPE PROTECTION BY SODDING



TYPE (2) : TRAPEZOIDAL SHAPE WITH 1 : 1 SLOPE PROTECTED BY BRICK

FIG. F.5.1

TYPICAL SECTION OF PROPOSED KHAL IMPROVEMENT

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



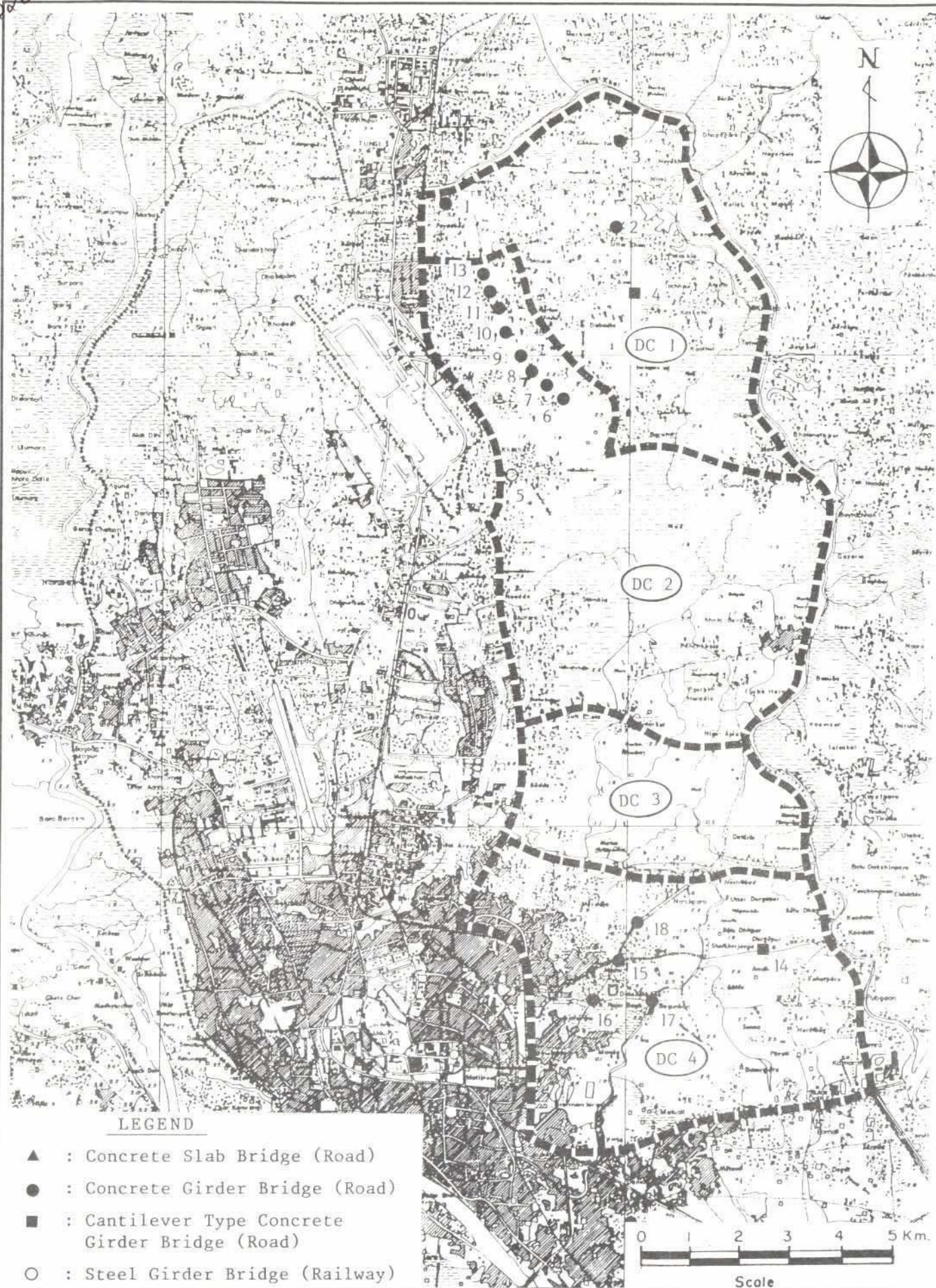


FIG. F.5.2(1)

LOCATION OF PROPOSED BRIDGES : GREATER DHAKA EAST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



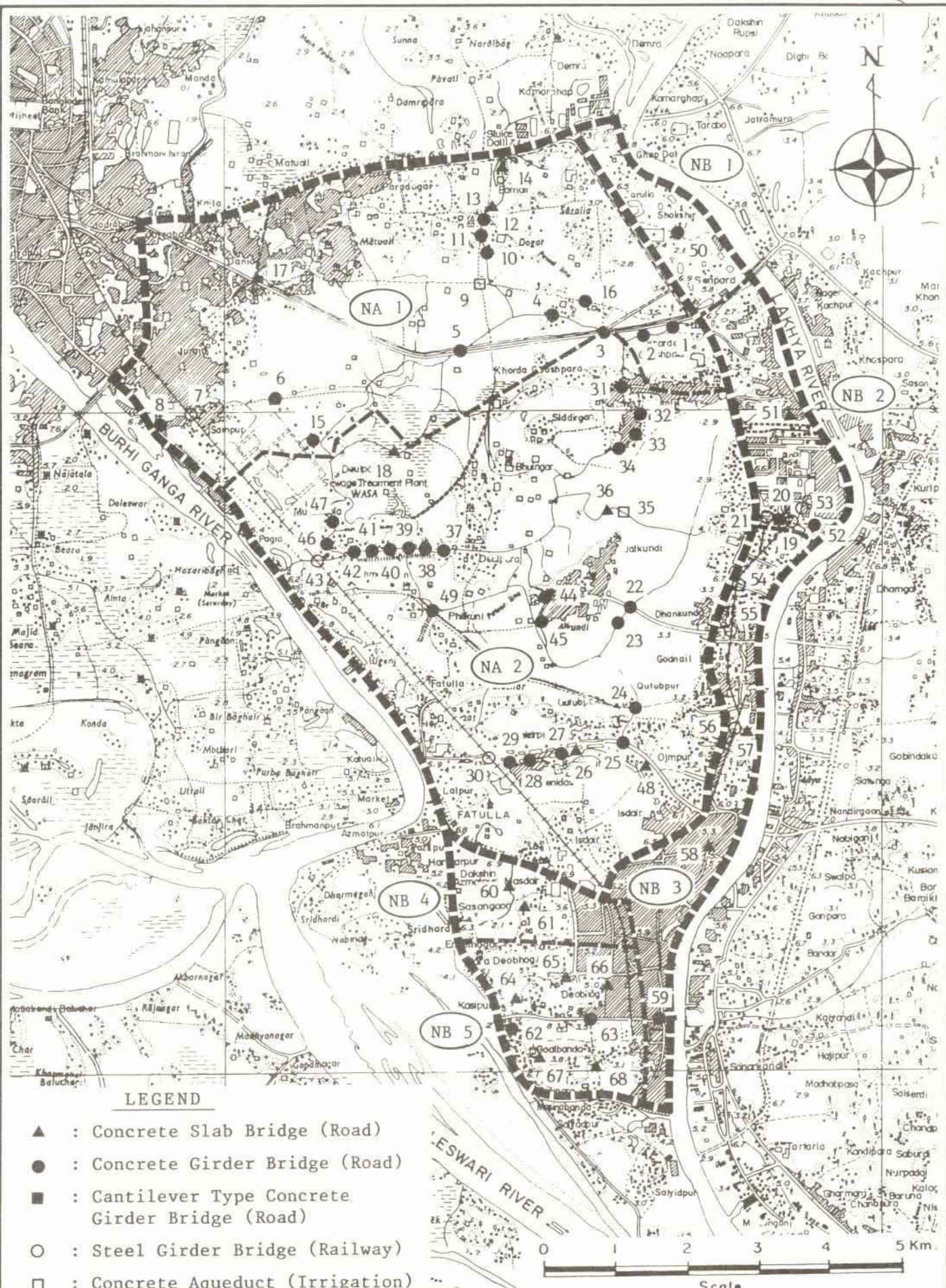


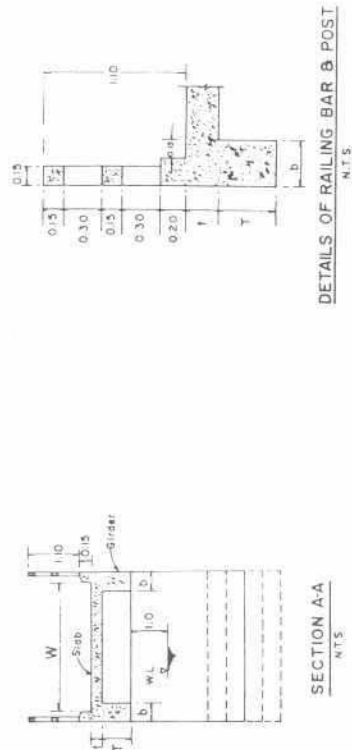
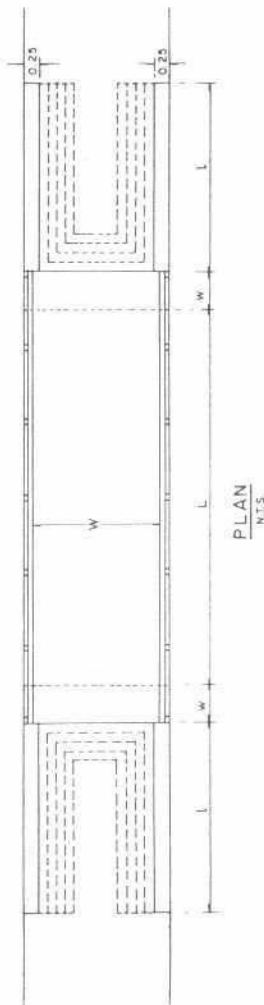
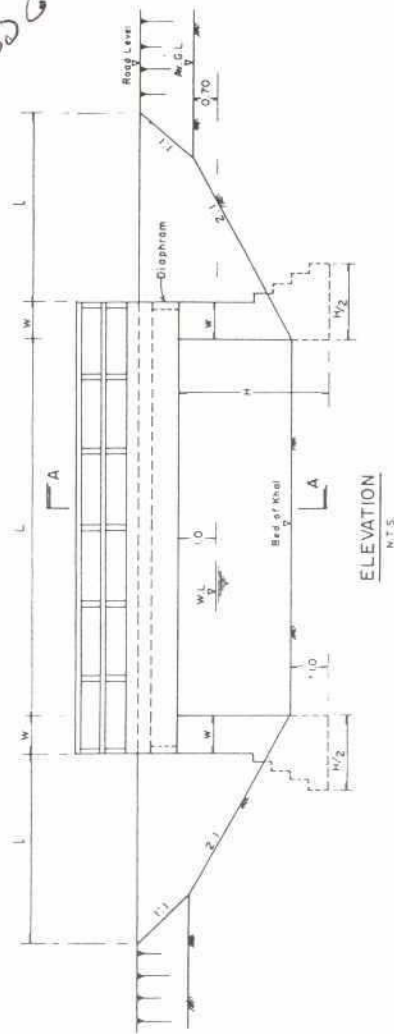
FIG. F.5.2(2)

LOCATION OF PROPOSED BRIDGES AND AQUEDUCT :  
DND AND NARAYANGANJ WEST

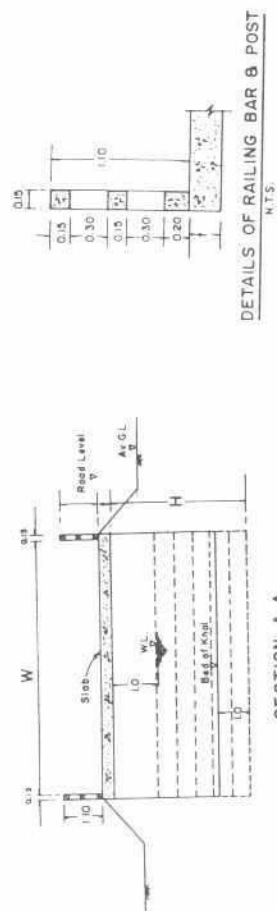
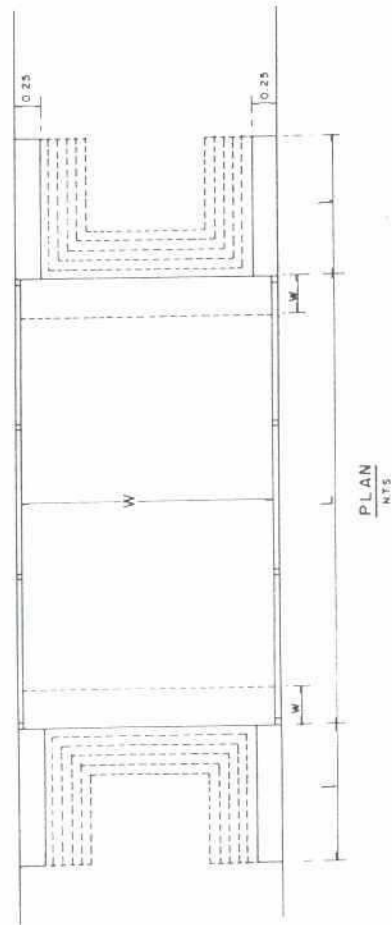
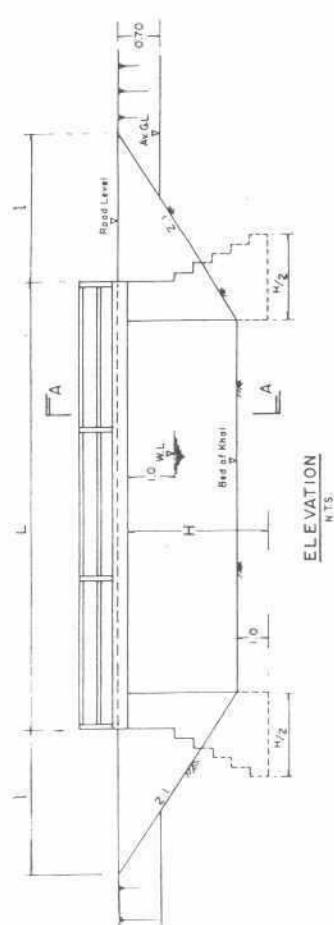
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



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TYPE (2) : CONCRETE GIRDER BRIDGE  
( Span : 5.0 m to 15.0 m )



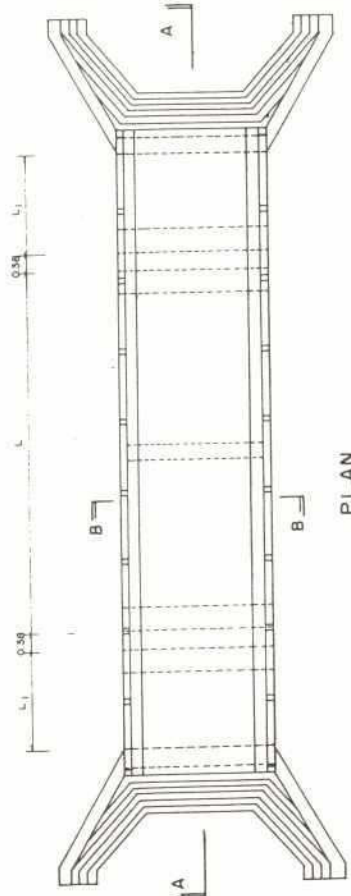
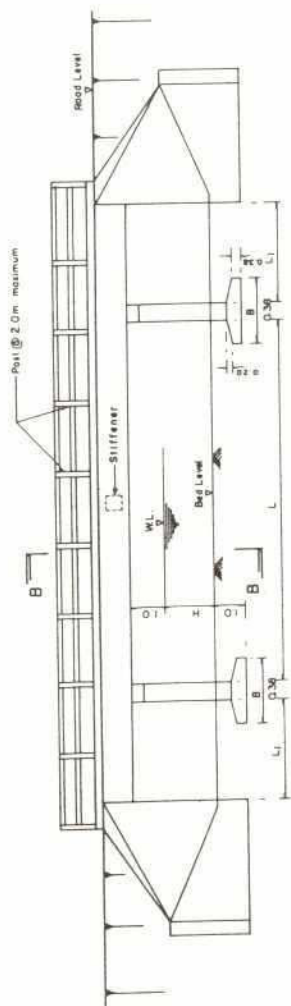
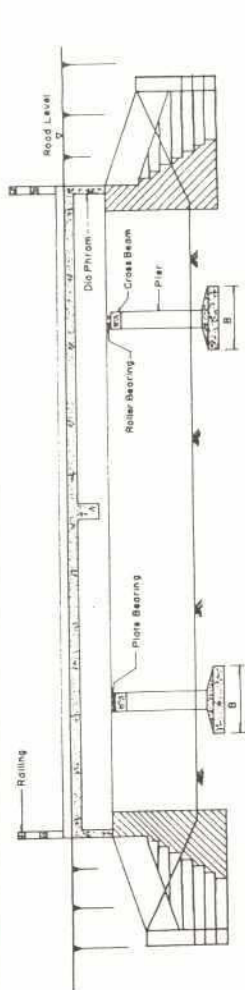
TYPE (1) : CONCRETE SLAB BRIDGE  
( Span : Below 5.0 m )

**FIG. F.5.3(1)**

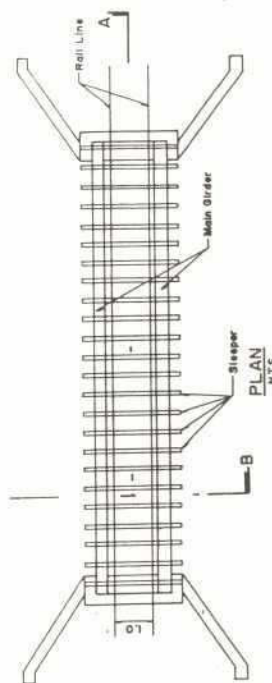
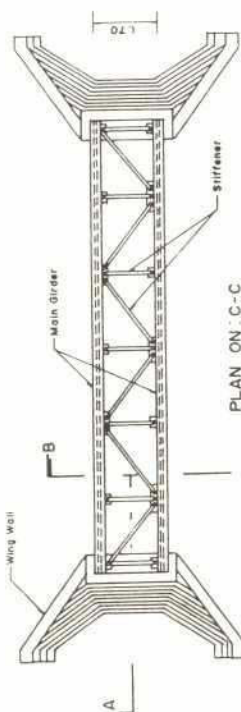
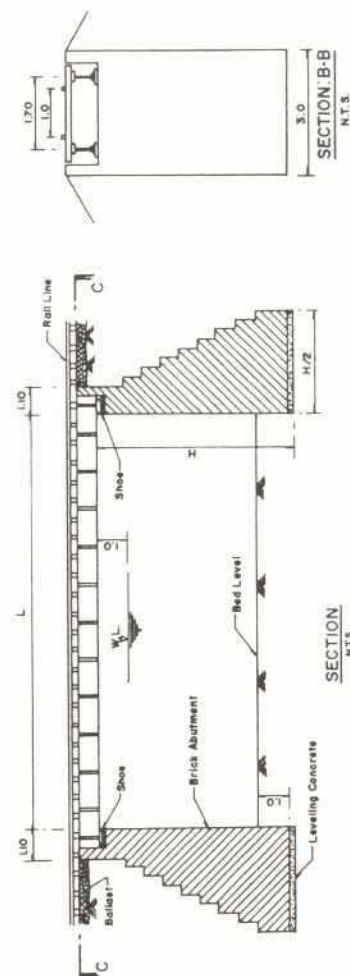
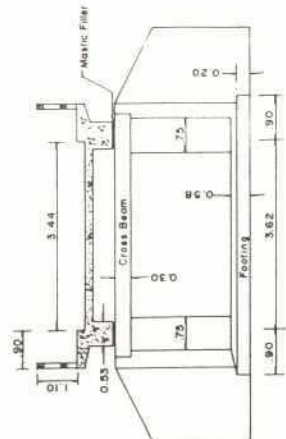
**TYPICAL DESIGN OF PROPOSED BRIDGE (1)**

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





TYPE (3) :  
CANTILEVER TYPE  
CONCRETE GIRDER BRIDGE  
(Span : 15.0 m to 30 m)



TYPE (4) : STEEL GIRDER RAILWAY BRIDGE

FIG. F.5.3(2)

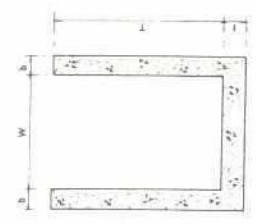
TYPICAL DESIGN OF PROPOSED BRIDGE (2)

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF  
BANGLADESH FLOOD ACTION PLAN NO.8.A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

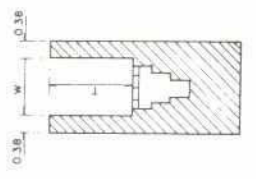


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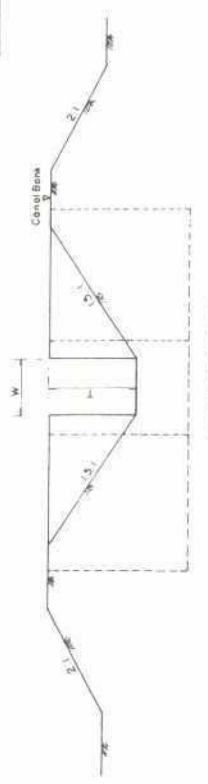
**AQUEDUCT**



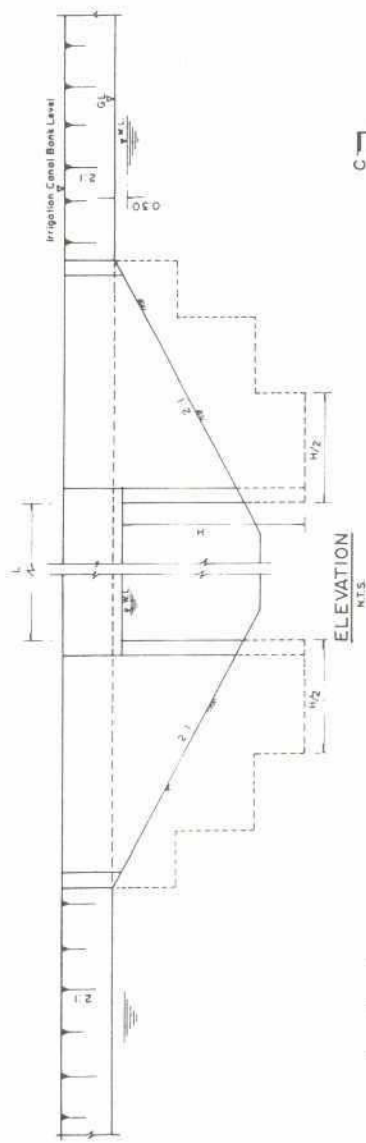
SECTION A-A  
NTS



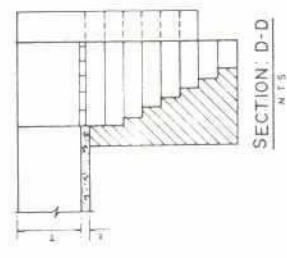
SECTION B-B  
NTS



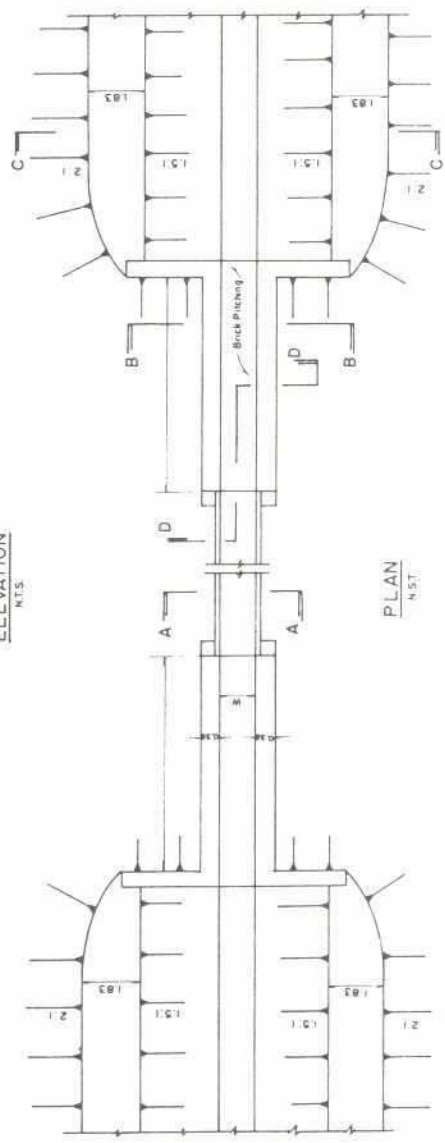
SECTION C-C  
NTS



ELEVATION  
NTS



SECTION D-D  
NTS



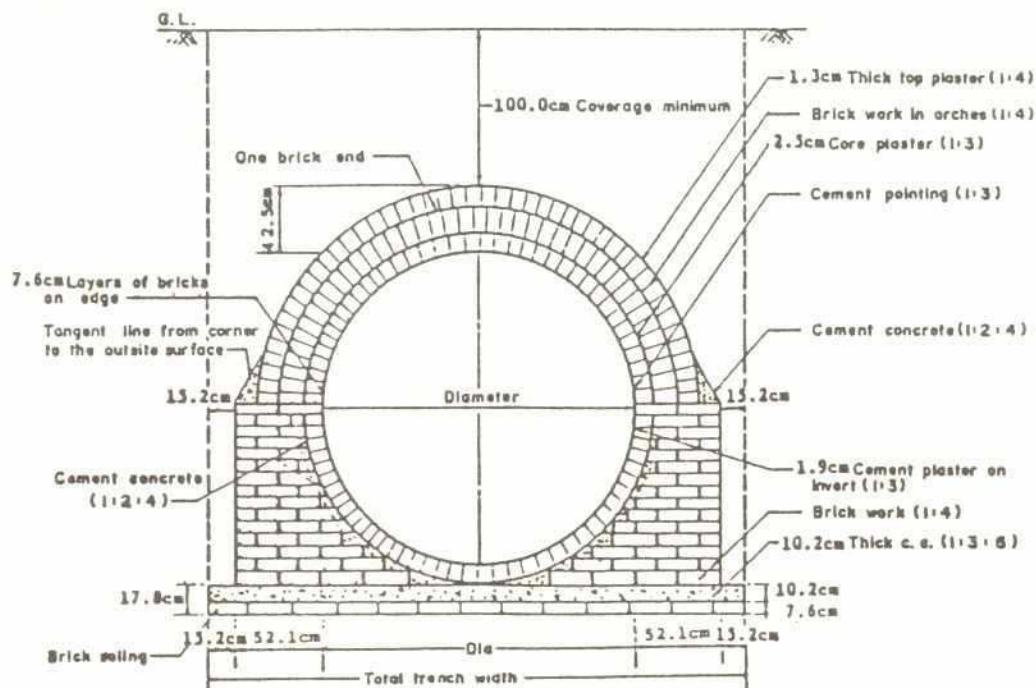
PLAN  
NTS

**FIG. F.5.4**

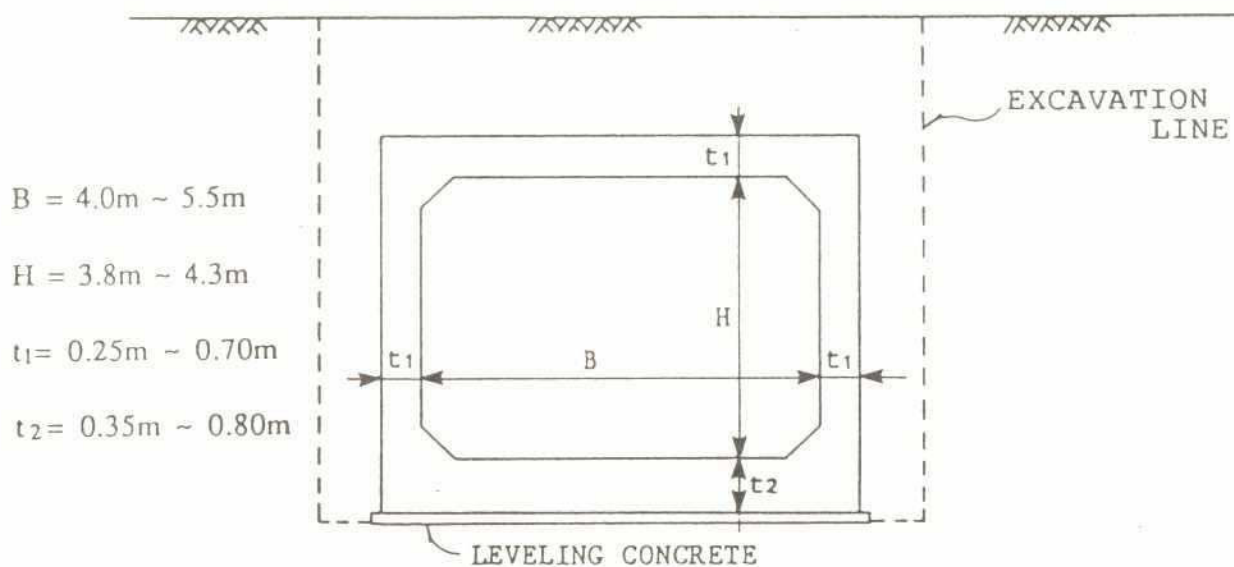
**TYPICAL DESIGN OF PROPOSED AQUEDUCT**

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





TYPE (1) : BRICK PIPE (Blow  $\phi 3,000$  m/m)



TYPE (2) : SINGLE BOX CULVERT

FIG. F.5.5

TYPICAL DESIGN OF PROPOSED TRUNK DRAIN

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

**SUPPORTING REPORT G**  
**OPERATION/MAINTENANCE**



## SUPPORTING REPORT G : OPERATION AND MAINTENANCE

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## SUPPORTING REPORT G OPERATION AND MAINTENANCE

### 1. General

The operation and maintenance (O & M) measures of the project are routine activities to get the expected benefits with the project. The flood mitigation and drainage improvement facilities, once completed, will encourage people to settle in areas where formerly they would not have settled because of a high risk of flooding. Accordingly inadequate O & M activities could lead to even a high risk of greater damage to life and property than without the project. The proper O & M activities will be indispensable for achievement of the project goals.

The poor quality of maintenance activities of infrastructure likely results partly from lack of finance, partly from lack of proper O&M programs and partly from absence of public participation in either operating practice or maintenance.

An optimum O & M program should be prepared by BWDB, before implementation of the project.

### 2. Basic Concept

Basic O & M demands for the flood mitigation and drainage improvement facilities are summarized as follows :

- (1) The tasks and responsibilities of the O & M divisions of BWDB, DWASA and Narayanganj Municipality which are in charge of the O & M activities of the project, should be defined clearly.
- (2) An active local participation should be considered in field level O & M activities or routine maintenance works. It will likely enhance a sense of public duty among local people and also increase employment opportunities for low income or landless people.
- (3) Practical O & M manuals and routine programs should be prepared by the BWDB engineer concerned for the project before implementation of the project.
- (4) Periodical training programs should be prepared for the GOB staff in supervision of the construction works of flood mitigation facilities and their O & M.



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- (5) Collaboration and coordination among the operating and the implementing agencies and other government agencies, should be improved in order to minimize adverse impacts and avoid operating conflicts.
  - (6) The budget constraints should be solved before implementation of the project. Everyone in Dhaka Metropolitan area would get benefit from flood protection measures. Everyone should in principal contributed towards cost.

### 3. O & M Demands for Major Facilities

#### 3.1 Greater Dhaka East

##### 3.1.1 Responsibilities for O & M

The responsible agencies for O & M activities are :

Facility	Responsible Agency	Assisting group
Flood Embankment / Flood wall	BWDB	Local participants
Drainage Pump / Sluice	BWDB	Local participants
Khal / Drainage channel	DWASA	Local participants

The O & M divisions of BWDB should be fully responsible to required O & M activities for flood mitigation facilities including drainage pumps, sluices and retarding areas. Similarly the O & M divisions of DWASA have a full responsibility to O & M to drainage channels and pipes. Local people who live in unions or wards wherein facilities locate, had better be involved in routine O & M activities as assisting groups.

In general, people who share a common interest in O & M activities of flood mitigation facilities would participate in the creation of associations which will enable them to better deal with their water related problems at the bottom level.

Their responsibilities would cover both operation of the sluices and routine maintenance of the embankments / khals serving them.

### 3.1.2 Tasks and Responsibilities

#### 1) Tasks and Responsibilities of BWDB and DWASA

They are :

- to employ and organize O & M assisting groups of local people through the unions or wards wherein facilities locate,
- to prepare an optimum O & M manual and a routine O & M program,
- to provide local participants with proper training and guidance,
- to carry out major actions including repairing where necessary, according to the field reports.
- to operate pumps and sluices according to an operation manual which should be prepared during the detailed study stage.

#### 2) Tasks and Responsibilities of Assisting Groups are :

- to carry out year - round maintenance of embankments and their O & M roads including repair patching of surface, side slopes and wheel cuts created by vehicles under the guidance of BWDB's field staff.
- to operate and maintain sluices according to the guideline prepared by BWDB,
- to report conditions of embankments, damages, erosion, sliding, failures etc.

### 3.1.3 Routine O & M Activities

The routine O & M demands for the major facilities are as follows :

#### (1) Embankment

- Inspection and repairing of damaged parts
- Inspection of land use according to the regulations
- Inspection and prohibition of any harmful activities to the embankments.

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(2) Flood Wall

- Inspection and repairing to ensure structural stability
- Inspection of adjacent land use according to the regulations.

(3) Sluice

- Inspection and repairing of sluices,
- Operation according to a operation manual,
- Maintenance activities.

(4) Drainage Channel / pipe

- Inspection and cleaning of channels / pipes,
- Inspection and repairing of channels / pipes,
- Inspection of land use according to the regulations,
- Inspection and prohibition of any harmful activities to the drainage channels.

(5) Pump Station

- Operation and maintenance activities of pump facilities
- Operation according to a operation manual.

(6) Retarding Area

- Inspection of land use according to the regulations,
- Inspection and prohibition of any harmful activity.

3.1.4 Guidelines for Operation of Pumps and Sluices

For flood mitigation purposes, the pumps and sluices are planned to be operated according to the following concepts :

- (1) The sluices along the Balu River, i.e. G. 16, G. 17, G. 18A and B, are planned to be closed for approximately five (5) months from June through October, when the river stage is higher than 3.00 m (PWD).



The river stage normally starts to rise in March, 3.00 m (PWD) around May to June, 5.00 m to 6.00 m in August to September, starts to fall in September, 3.00 m in approximately in November, and becomes the lowest stage in February.

- (2) The pumps along the Balu River, i.e. P. 5, P. 6, P. 7A and B, are planned to control the water levels in land side between 3.00 m and 4.00 m (PWD) during the flood season. The pumps are designed to have a capacity to meet the flood stage of a 100-year flood frequency.

The pumps are planned to start operation when the water levels in land side start to rise due to the flood runoff from their own catchment areas.

The concept is based on flood mitigation and drainage improvement purposes. Then the proposed guideline might be reviewed and revised, if necessary, according to the results of further studies on productive uses of water resources in future.

### 3.1.5 Required O & M Organization

For O & M activities, the executive engineer's office and sub-divisional engineer's offices which are planned to be established for implementation of the project, will be shifted to O & M offices after completion of the works.

The required O & M offices are planned to be as follows :

- (1) The O & M activities for embankments and related facilities, are conducted under the executive engineer's office of Dhaka II (BWDB), through two new sub-divisional engineer's offices in the field. The field level routine activities are to be conducted by crews of local participants.
- (2) The O & M activities for drainage channels, are conducted under the executive engineer's office of DWASA, through a new sub-divisional engineer's office in the field. The field level routine activities are also be conducted by crews of local participants.
- (3) For O & M activities of pumps and sluices

It is necessary to establish one superintending engineer's office, executive engineer's office and four new sub-divisional engineer's offices.

pa  
The proposed O & M organization for Greater Dhaka East is shown in Fig. G.1 and required crew of each office are shown in Tables G. 1 to 4.

### 3.1.6 Required O & M Equipment

Required O & M equipment is listed as follows :

- Inspection vehicles :
- Trucks for minor repairing works / sludge transportation
- Tamping machine
- Pumps

## 3.2 DND

### 3.2.1 Responsibilities for O & M

The O & M divisions of BWDB should have a full responsibility for the flood mitigation and drainage improvement facilities, and local people should be involved in routine O & M activities as an assisting group.

### 3.2.2 Tasks and Responsibilities

The tasks and responsibilities of the government agencies and the local assisting groups are the same as those of the Greater Dhaka East.

### 3.2.3 Routine O & M Activities

They are the same as those for the Greater Dhaka East

### 3.2.4 Guidelines for Operation of Pumps and Sluices

For flood mitigation purposes, the pumps and sluices are planned to operated according the following concepts :

- (1) The sluices i.e. G. 19 and G. 20, are planned to be closed when the river stage is higher than 3.00 m (PWD),

- ২২৭
- (2) The pumps are planned to control the water level in land side between 3.00 and 4.00 m (PWD).

### 3.2.5 Required O & M Organization

The sub-divisional engineer's office for implementation of the project, will be turned to the O & M office.

For O & M activities for the pump drainage system, the existing sub-divisional office is to be reinforced, up to the same scale as that of Table G. 4. O & M activities for embankment and drainage channels are to be done by local participants under the guidance of the sub-divisional engineer's office of Dhaka II which is planned for the Greater Dhaka East (Fig. G.2).

### 3.2.6 Required O & M Equipment

- Inspection vehicles
- Trucks for minor repairing works / sludge transportation
- Pumps
- Tamping machine

## 3.3 Narayanganj West

### 3.3.1 Responsibilities for O & M

The O & M division of BWDB should have a full responsibility for the flood mitigation facilities, including pumps, sluices and stop logs. Narayanganj municipality should have a full responsibility for drainage channels. Local people should be involved in routine O & M activities as assisting groups.

### 3.3.2 Tasks and Responsibilities

The tasks and responsibilities of the government agencies and the local assisting groups are the same as those for the Greater Dhaka East.

### 3.3.3 Routine O & M Activities

They are the same as those for the Greater Dhaka East.



### 3.3.4 Guide line for Operation of Pumps and Sluices

For flood mitigation purposes, the pumps and sluices are planned to be operated according to the following concepts :

- (1) The sluice of G. 21 and G. 22 are planned to be closed when the river stage is higher than 3.00 m (PWD), but the sluices of G. 23 ~ g. 32, G. 32A and are to be closed at the river stage higher than 3.50 m (PWD),
- (2) The pumps of P. 12 and P. 13 are planned to control the water level in land side between 3.00 and 4.00 m, but the pumps of P. 14A and B are planned to control the water level between 3.50 m and 4.50 m (PWD).

### 3.3.5 Required O & M Organization

The sub-divisional engineer's office for implementation of the project will be turned to the O & M office.

For O & M activities for pumps and sluices, on sectional office will be required (Table G. 5).

Routine O & M activities for embankments and flood walls are to be conducted by local participants under the guidance of the sub-divisional engineer's office of Dhaka - II.

But O & M activities for drainage channels are to be conducted by local participants under Narayanganj Municipality's office (Table G. 6 and Fig. G.2).

### 3.3.6 Required O & M Equipment

- Inspection vehicles
- Trucks for minor repairing works / sludge transportation
- Pumps
- Tamping machine

Table G. 1 O & M Executive Engineer's Office and Sub-divisional Engineer's Office for Drainage Channels (DWASA)

	Executive Engr's Office	Sub-divisional Engr's Office
1. Executive Engineer	1	-
2. Sub-divisional Engineer	1	1
3. Sub-Assistant Engineer	1	2
4. Head Assistant	1	-
5. Estimator	1	-
6. Assistant Accountant	1	-
7. Draftsman	1	-
8. Surveyor	-	2
9. Cashier	1	-
10. LDA Cum Typist	1	-
11. Work Assistant	-	6
12. Line Cleaner	-	6
13. Driver	-	1
14. Night guard	1	1
15. MLSS	1	1
16. Sweeper	-	1
Total :	11	21

Note : 1) Annual expense for each Executive engr's office: Tk. 884,200  
Sub-divisional engr's office : Tk.1,366,900  
(including personnel expenses, office expenditure)

Table G. 2 O & M Executive Engineer's Office and Sub-divisional Engineer's Office for Embankment (BWDB)

	Executive Engr's Office	Sub-divisional Engr's Office
1. Executive Engineer	1	-
2. Sub-divisional Engineer	1	1
3. Sub-Assistant Engineer	1	2
4. Surveyor	-	2
5. Draftsman	1	-
6. Tracer	1	-
7. LDA Cum Typist	2	1
8. Senior Accountant	1	-
9. Accountant Assistant Cum Typist	1	1
10. Driver	-	1
11. Guard	-	1
12. MLSS	1	1
13. Messenger	-	1
14. Sweeper	-	1
Total :	10	12

Note: 1. Executive Engr's office : one  
 2. Sub-divisional Engr's office : two  
 3. Annual expense for each Executive Engr's office : Tk. 736,500  
 Sub-divisional engr's office Tk. 700,100

Table G. 3 O & M Sub-divisional for the Pump drainage System of Pump Station, P5

(BWDB)	Sub-divisional Engineer's
1. Sub-divisional Engineer	1
2. Sub-Assistant Engineer (Mech.)	2
3. Sub-Assistant Engineer (Elect.)	1
4. Foreman (Mechanical)	1
5. Mechanic	2
6. Electrician	2
7. Helper	2
8. Sub-divisional Clerk	1
9. Account Clerk	1
10. Typist	1
11. Office Peon	1
12. Pump Operator	3
13. Driver	1
14. Sweeper Cum Mali	1
15. Security Guard	3
15. Khalasi / Labour	3
Total :	26

Note : 1) Annual expenses : Tk. 1,331,700 (not including operation cost)



Table G. 4 O & M Sub-divisional Engineer's Office for the Pump drainage System of Pump Station, P6 (m)

(BWDB)		Sub-divisional Engineer's
1.	Sub-divisional Engineer	1
2.	Sub-Assistant Engineer (Mech.)	2
3.	Sub-Assistant Engineer (Elect.)	2
4.	Foreman (Mechanical)	1
5.	Mechanic	1
6.	Assistant Mechanic	1
7.	Assistant Mechanic	1
8.	Electrician	1
9.	Assistant Electrician	1
10.	Assistant Electrician	1
11.	Pump Operator	4
12.	Helper	4
13.	Khalashi / Labour	6
14.	Security Guard	6
15.	Sub-divisional Clerk	1
16.	Account Clerk	1
17.	Store Keeper	1
18.	Typist	1
19.	Driver	1
20.	Office Peon	1
21.	Sweeper Cum Mali	1
22.	Barkan door	1
Total :		40

Remark : 1) Apply for pump capacity is 47 to 54 m<sup>3</sup>/s  
 2) This is also applied to pump stations, P.7A and B.  
 3) Annual expenses : Tk. 1,901,000 (not including operation cost)

Table G. 5 O & M Sectional Officer's Office for Pump Drainage Systems Narayanganj West

Sub-Assistant Engineer (Mech.)	1
Mechanic	1
Electrician	1
Assistant Electrician	1
Pump Operator	3
Helper	2
Khalasi / Labour	3
Sweeper Cum Mali	1
Security Guard	3
Total :	16

Note : 1) Annual expenses : Tk. 1,331,700 (not including operation cost)

Table G.6 O & M Executive Engineer's Office and Sub-divisional Engineer's Office  
Narayanganj Municipality

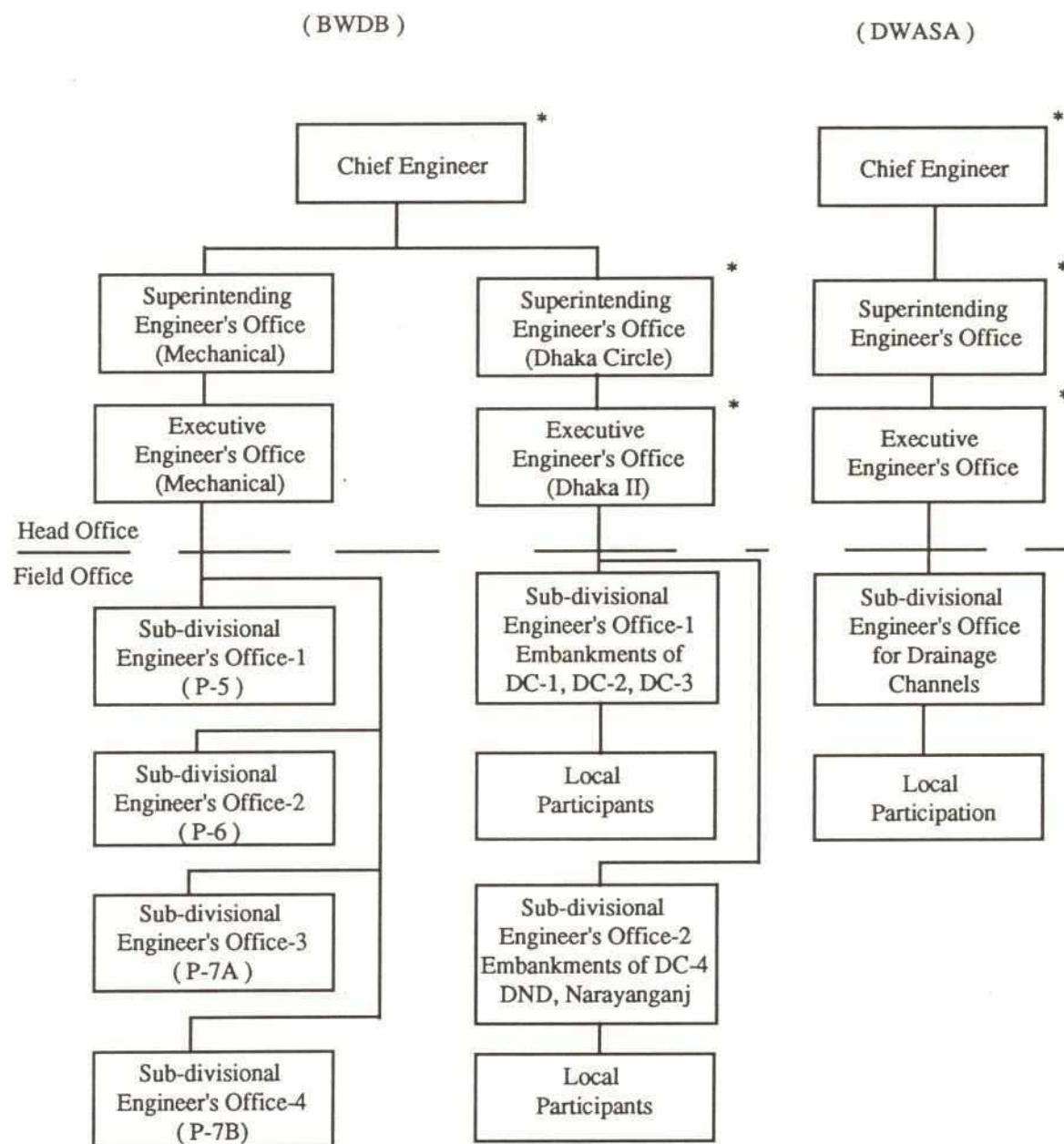
	Executive Engr's Office	Sub-divisional Engr's Office
1. Executive Engineer	1	-
2. Sub-divisional Engineer	1	1
3. Sub-Assistant Engineer	1	2
4. Accounts Assistant Cum Clerk	1	1
5. LDA Cum Typist	1	1
6. Line Cleaner	-	4
7. Driver	-	1
8. Sweeper	-	1
9. MLSS cum Messenger	1	2
10. Night Guard	-	1
Total :	6	14

Note: 1. Annual expenses

Executive engr's office : Tk. 516,800

Sub-divisional engr's office: Tk. 730,000

## Required O&amp;M Organization for Greater Dhaka East



Note : \* Existing Office

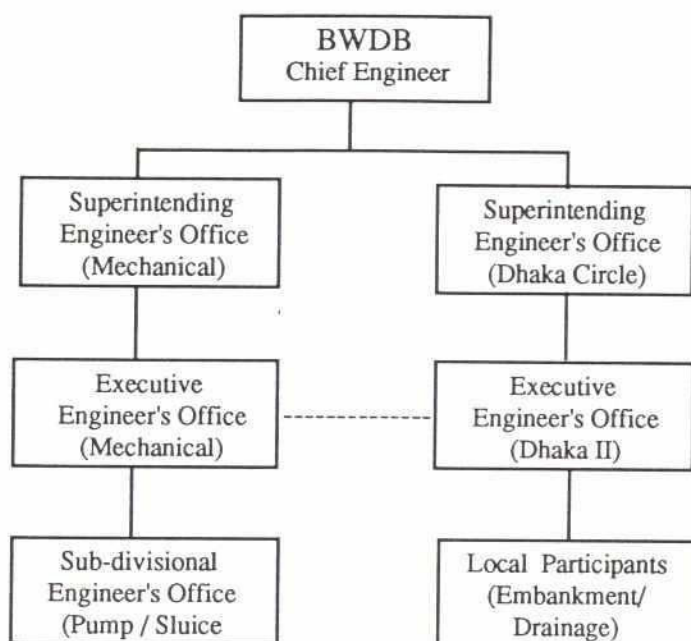
FIG. G.1

REQUIRED O&M ORGANIZATION FOR GREATER DHAKA EAST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



### O&M Organization for DND



### O&M Organization for Narayanganj West

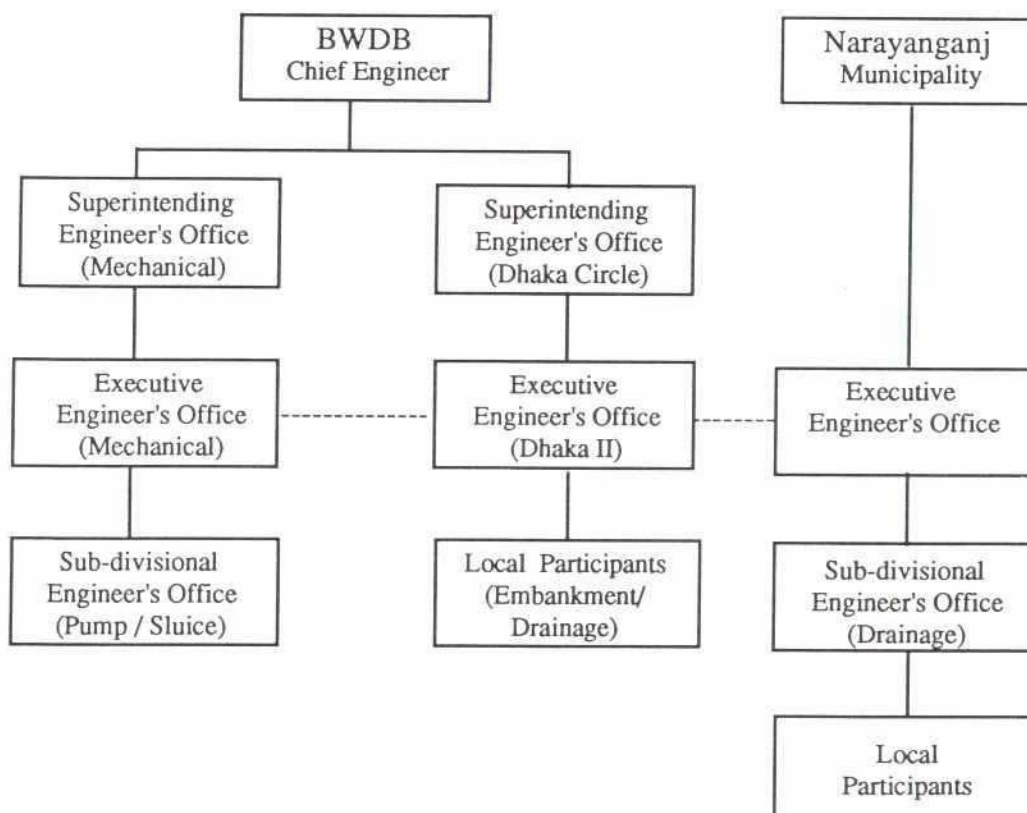


FIG. G.2

O&M ORGANIZATION FOR DND AND NARAYANGANJ WEST

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

**SUPPORTING REPORT H**  
**CONSTRUCTION PLAN, COST ESTIMATE**  
**AND IMPLEMENTATION PROGRAM**



SUPPORTING REPORT H : CONSTRUCTION PLAN,  
COST ESTIMATE AND IMPLEMENTATION PROGRAM

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## SUPPORTING REPORT H : CONSTRUCTION PLAN, COST ESTIMATE AND IMPLEMENTATION PROGRAM

### 1. General

This report deals with the construction plan, construction schedule and cost estimate of the identified priority areas of the feasibility study.

The construction works consist mainly of embankment, concrete flood wall, sluice gate, pump station, Khal improvement, and bridge works for flood mitigation and stormwater drainage works.

### 2. Construction Plan

#### 2.1 Basic Conditions

For the construction planning and scheduling, the following considerations have been taken as the basic concept of construction works.

##### 2.1.1 Block-wise Implementation

The Greater Dhaka East was divided into four (4) compartments from view-points of 1) flood mitigation policy on risk disparagement from embankment breach, 2) project implementation scale in construction cost and area size aspects, and 3) the different characteristics of area development tendency and its urgent need of flood protection measures.

While, the Narayanganj area is divided into two (2) sub-divisions i.e DND and Narayanganj West areas as described in the Master Plan Study.

Accordingly the construction plan and cost estimate are prepared based on the above compartments and sub-divisions.

##### 2.1.2 Mode of Construction

The construction shall be carried out by contractors selected through international competitive bidding.

### 2.1.3 Workable Days and Working Hours

Annual workable days for respective works are estimated based on the rainfall records, water levels, national holidays and experience of similar works in and around the area. The annual workable days for earthen works is set at 160 days and 130 days concrete works on higher land (see Table H.2.1, Fig.H.2.1). Daily working hours is set at 9 hours with 1-hour overtime by considering the local working system in the area.

### 2.1.4 Availability of Construction Plant and Equipment

The Major construction work shall be carried out by applying heavy equipment due to limited construction period and keeping good quality of construction.

### 2.1.5 Construction Materials

Most of basic construction materials are available in this country. While, the processed steel, such as sheet pile, H - shaped steel, angle, and other particular materials, are to be procured from outside.

### 2.1.6 Pattern of Construction method

Main work comprises of earth work and concrete work. The Earth work is planned to be carried out mainly by construction machinery in combination with manpower. While, the concrete work is to be mixing plant and or conventional way.

## 2.2 Major Work of Construction

The construction consists of the following two major item of works.

- |                       |                         |
|-----------------------|-------------------------|
| 1) Flood Mitigation   | 2) Storm Water Drainage |
| a. Embankment         | a. Pump Station         |
| b. Flood Wall         | b. Khal Improvement     |
| c. Sluice Gate        | c. Bridge & others      |
| d. Related Structures |                         |

The work is covered both new construction and rehabilitation for existing facilities include temporary works, surveying, coffering, scaffolding etc.

The construction methods for the major works are planned as follows :

### 2.2.1 Flood Mitigation Facilities

#### 1) Embankment / Sub-Embankment / Road-Cum-Embankment

##### (1) Foundation Treatment and Stage Construction

###### - Greater Dhaka East -

About 18.9 km (69%) out of 27.5 km of the main embankment is designed to be constructed on the poor sub-soil ( $N < 4$ ) condition. The foundation treatment by Geotextile drain/Sand drain is to be selected based on the practicality on the west bank proposed by FAP 8B.

The embankment work by this foundation treatment needs certain period of the consolidation time for poor sub-soil.

The consolidation time closely relate the consolidation co-efficient of sub-soil and the pitch of sand piles.

From the view-point of the possible workable days for the embankment work, the consolidation time per one stage embankment construction is planned to be six (6) to nine (9) months.

Based on the above condition and the proposed maximum embankment height of 8.5 m, 3 staged (3 year) embankment construction is required for 7.5 km in distance. While, one and two staged construction embankment distances are designed for 9.4 km and 10.6 km respectively.

For Sub-Embankment portion, most of sections are designed for 2 staged (2 year) construction work.

###### - DND Area -

Rehabilitation works for existing flood wall is to be carried out and no embankment work is proposed in this area.

###### - Narayanganj West -

For the Road-Cum-Embankment between Panchabati to Narayanganj via Paikpara on the western side of Narayanganj West, the sub-soil condition is classified as poor soil. However, no staged embankment construction is required due to lower embankment height.



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For the eastern part of embankment along Lakhya river, two staged (2 year) embankment work is required for the distance of 8.1 km (14%) out of total embankment length 20.1 km.

The banking for the Embankment / Road-Cum-Embankment is to be principally carried out with the suitable materials from borrow pit nearby the embankment site, except in the special case where the materials is not suitable for the embankment.

The banking is principally carried out by bulldozer, compactor for spreading and compaction. While, transportation and hauling of the earth materials is carried out by dump track and manpower.

The excavation from borrow pit is to be carried out by using bulldozer/ swampdozer, backhore and manpower.

In case of excavation for low-lying portion width wetted condition swampdozer is mainly used. The excavation by dredging is also considered for underwater excavation.

In the dry season, water tanker may be required to adjust the water content of the earth materials for quality control.

Furthermore for the smooth and effective operation of the work, supporting equipment and temporary coffering, etc, are required.

## 2) Flood Wall

Reinforced concrete and mass concrete are used for flood wall both new construction and rehabilitation work. The concrete works are planned to be carried out by using conventional method.

The rehabilitation work; heightening, repairing of existing flood wall, foot protection requires relatively small amount of concrete and earth volume.

Accordingly the rehabilitation work is to be used the conventional construction method.

## 3) Sluice Gate

Construction of sluice gate requires earth work, concrete work, foundation work, metal work and installation of Mechanical & Electrical facilities.

In most of the site, design level is below ground water. Civil work is needed coffering with earth banking and or steel sheet piling. Concrete mixing plant is to be installed at the site. Foundation is principally to be treated by concrete piling. Regarding to mechanical facilities, Fabrication shall be done in authorized factory.

#### 4) Stop Log Structure

Structure is required reinforcement concrete works. Stop log (metal) is to be fabricated in authorized factory.

#### 5) Revetment

The revetment is designed on the river side slope of the embankment, inlet and out let of sluice gate and other designed portions. The material is composed of concrete with brick in the factory base. The revetment is mostly constructed by man power. Coffering is also required for the construction under water portion.

### 2.2.2 Stormwater Drainage

#### 1) Pump Station

The construction of pump station comprises the civil work, building work, mechanical and electrical works. The major work items of the civil work are excavation, banking, backfill, foundation work and concrete works. The civil work is planned to be carried out with the same manner described in the "sluice gate".

The pumping equipment, such as, pump, main motor, pipe and valve, and other facilities are to be imported.

#### 2) Khal Improvement

The main work item of the Khal improvement composed of excavation some revetment and sodding works.

#### 3) Bridge

The renewal of bridge involves almost the same work items of the sluice gate. The construction machinery is also assumed to be the same.

### 3. Cost Estimate

#### 3.1 Basis of Cost Estimate

The construction cost for the projects is estimated on the basis of the design, construction plan and the following conditions.

##### 3.1.1 Basic Conditions for Major Item of Works

###### 1) Banking for embankment

###### - Material

A half volume of embankment material is to be obtained from nearby the embankment, and the remained half is to be brought from outside.

###### - Equipment

Heavy construction machinery i.e. Backhoe, Bulldozers and Dump tracks are used due to the big scale of embankment work.

###### 2) Dredging for Khal Improvement

###### - Equipment

Dredger and manpower are to be used for the excavation of Khal. The dredger is mainly used for the portion of below the ground water, while manpower is used for the above water.

###### 3) Concrete Work

###### - Material

Most materials are to be procured at the site. Aggregates are graded by manpower.

###### - Equipment

Batching plant is used due to produce large volume of concrete and its quality control. The concrete is transported by transit mixer and placed by using concrete pump car.



4) Backfilling with Compaction.

- Backfilling by Equipment.

The construction of big structures i.e. pump stations and sluice gates, generally involve large volume of backfilling at lower portion.

For these structures, machinery work for backfilling and compaction by using backhoe, bulldozer and tamper are applied.

- Backfilling by manpower

For the backfilling and compaction of flood wall and other related structures, the work is to be carried out by manpower and handy type tamper.

5) Compaction of Maintenance Roads

Compaction work with material for the Maintenance roads of Khal and Embankment are to be carried out by using compaction roller and bulldozer.

6) Excavation by Equipment

Excavation work for pump stations, and sluice gates are mostly to be carried out by using Backhoe, Bulldozer.

The Bulldozer is used for the transportation of the excavated soil to the designated places.

7) Excavation by Manpower

Excavation work for flood wall and other small scale structures which generally involves small scale of the excavation work is to be carried out by manpower.

8) Reinforcement Bar Arrangement and Formworks

Bending and arrangement of steel bar are conducted at the site. The formwork is to be classified into two categories base on the height of work place and complexity of the structure. The tall structure requires truck crane for lifting the formwork panel, while low height structure is not required. Metal form is to be used for keeping work quality and efficiency.

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9) Brickworks and Concrete Block Works

Brickworks for Khal improvement and concrete block works for revetment are carried out mainly by manpower. Truck crane is used for the transportation and lifting the materials.

10) R.C Pile and Steel Sheet Pile Driving

For the driving work of R.C and Steel Sheet piles, crawler crane with Diesel hammer / vibration hammer is used. Generator is associated for the main equipment.

11) Foundation Treatment

Geotextile drain driving method is accepted for soft foundation treatment. One unit of equipment for this purpose is composed of base machine (driving & inserting material), front casing, generator, recorder. Sand mat is uniformly placed with 0.60 m thickness after treated.

12) Special consideration, on construction of project offices, quarters, warehouses, workshops, water supply system, electric power supply system communication system, etc., is not considered due to availability of these facilities nearby the construction site.

3.1.2 Component of the Project Cost

The project cost is composed of "direct cost", "indirect cost" and contingency. They are:

- 1) Direct cost : - Construction work  
- Procurement and Installation of equipment,
- 2) Indirect cost : - Land acquisition and compensation cost for house resettlement,  
- Administration cost,  
- Engineering cost,
- 3) Contingency : - Physical contingency.

3.1.3 Price Level and Unit Cost

The unit cost is based mainly market price prevailing in Dhaka in October 1991, and referring to BWDB's Schedule of Rates.

### 3.1.4 Mode of Contract

All the construction works are to be contracted by general contractors in international tendering process.

### 3.1.5 Currency Portion

The cost is divided into foreign and local currency portions.

They are :

#### 1) The Foreign currency portion :

- Imported equipment, materials and supplies
- Overhead for contractors
- Expense of expatriate personnel

#### 2) The Local currency portion :

- The construction materials which are available in the local market.
- Land Acquisition and Compensation
- The salary and wages for local personnel
- Overhead for local firms
- Tariff & Tax

### 3.1.6 Exchange Rate

The exchange rates of foreign currencies are as follows: US \$ 1 = 36 Tk. = ¥ 137

### 3.1.7 Indirect Cost

Indirect cost is based on the following assumptions :

- |    |                      |   |                          |
|----|----------------------|---|--------------------------|
| a) | Administration Cost  | : | 3% of construction cost  |
| b) | Engineering Service  | : | 10% of construction cost |
| c) | Physical contingency | : | 15% of construction cost |

The land acquisition and compensation cost are estimated by using the collected data.



### 3.2 Unit Price

The unit prices of labor, materials and equipment are determined based on the data collected from BWDB and other agencies concerned.

The unit prices of the construction material are divided into two components of foreign and local currencies based on the current data applied to similar project.

#### 3.2.1 Material Price

The unit price of construction materials were estimated by means of BWDB data and prevailing market price. The price of import material which are not available here are converted from prevailing market price in Japan to local currency by using the exchange rate.

The unit price list of the materials is shown in Table H.3.1.

#### 3.2.2 Wages

Labour wage of common labour, skilled labour, operator / driver, etc are estimated in consideration with the "Schedule of Rates" of BWDB, the prevailing labour wages, in a similar works in the area.

The list of unit price is shown in Table H.3.2.

#### 3.2.3 Equipment Cost and Production Rate

The hourly equipment cost consist of depreciation, maintenance and repair and other administration cost mentioned in Tables H.3.3, H.34(1) and (2). Major equipment and its production rate, is referred to Table H.3.5.

#### 3.2.4 Land Acquisition and Compensation Cost

The unit price of land acquisition and compensation of house resettlement are estimated based on the "Schedule of Rates" of BWDB and prevailing market price.

The list of unit price is shown in Table H.3.6.

#### 3.2.5 Unit Construction Cost

The unit construction cost is estimated by applying the unit prices of labour, construction materials, equipment cost.

The unit construction cost is composed of construction cost, site expenses, overhead and profit including tax.

The rate are assumed as follows :

- (1) Construction cost
- (2) Site expenses : 15% of (1)
- (3) Contractor's overhead profit and tax : 10% of ((1) + (2))

The unit construction cost of general items are summarized in Table H.37. Their breakdown are shown in Tables H.3.8(1) to (13).

### 3.3 Estimate of Project Cost

The total project costs consisting of direct cost, indirect cost and physical contingency is estimated as follows :

#### 3.3.1 Greater Dhaka East

Unit Million Tk.(1991 Price)				
	Item	F/C	L/C	Total
A.	Construction Cost	7,558	3,358	10,916
	1) Flood Mitigation	3,732	1,964	5,696
	2) Storm Water Drainage	3,826	1,394	5,220
B.	Physical Contingency	1,134	501	1,635
C.	Engineering	869	387	1,256
D.	Administration	0	328	328
E.	Land Acquisition/compensation	0	1,487	1,487
F.	C.D.S.T.& Tax	0	2,674	2,674
	Total	9,561	8,735	18,296

The construction is to be implementation by dividing with four phases, DC-1, DC-2, DC-3, DC-4.

Detail information of cost is mentioned on Tables H.3.9 to H.3.19.



### 3.3.2 Narayanganj DND

Unit Million Tk.(1991 Price)

Item	F/C	L/C	Total
A. Construction Cost	1,742	914	2,656
1) Flood Mitigation	82	32	115
2) Storm Water Drainage	1,660	882	2,542
B. Physical Contingency	261	137	398
C. Engineering	200	105	305
D. Administration	0	80	80
E. Land Acquisition/compensation	0	400	400
F. C.D.S.T.& Tax	0	755	755
Total	2,203	2,391	4,594

Construction costs and their breakdown are shown in Tables 3.20 to H.3.28.

### 3.3.3 Narayanganj West

Unit Million Tk.(1991 Price)

Item	F/C	L/C	Total
A. Construction Cost	1,420	633	2,053
1) Flood Mitigation	756	302	1,059
2) Storm Water Drainage	663	331	994
B. Physical Contingency	213	94	307
C. Engineering	163	73	236
D. Administration	0	62	62
E. Land Acquisition/compensation	0	1,082	1,082
F. C.D.S.T.& Tax	0	336	336
Total	1,796	2,280	4,096

Construction costs and their breakdown are shown in Tables 3.29 to H.3.40.

### 3.4 O & M Cost

O & M costs consist of routine O & M costs, operation and maintenance costs for equipment, and civil works.



Routine O & M costs are estimated based on a crew month basis for required O & M activities, according to the proposed O & M organization. They are estimated as below :

Office	Number	Annual Cost (Million Tk.)
Executive Engr's Office (DWASA)	1	0.9
Sub-divisional Engr's Office (DWASA)	1	1.4
Executive Engr's Office (BWDB)	2	1.4
Sub-divisional Engr's Office (BWDB) for embankment etc.	2	1.4
Sub-divisional Engr's Office (BWDB) for Pump-(25 m <sup>3</sup> /s)	1	1.4
Sub-divisional Engr's Office (BWDB) for Pump-(47 to 54 m <sup>3</sup> /s)	3	5.7
Sectional Engr's Office (BWDB)	1	1.4
Executive Engr's Office (N.M)	1	0.6
Sub-divisional Engr's Office (N.M)	1	0.7
Total	13	14.8

Annual operation costs are estimated at Tk. 269,000/m<sup>3</sup>/s, based on the followings :

1. Electric charge based on "Power consumption charge", "Demand charge", service charge" and "Government duty".
2. Maintenance costs based on "Periodical maintenance", "annual maintenance" and "particular maintenance".
3. Operation hours based on the average rainfall amount of from May to October; 1,459 mm (1,824 mm x 80%)

Annual O & M costs are summarized as follows :

(Unit : Million Tk.)

Area	Routine O&M	Operation
DC - 1	2	6.9
DC - 2	3	14.3
DC - 3	3	14.3
DC - 4	3	12.7
DND	2	13.5
Narayanganj West	2	3.3
Total	15	65.8

Civil works will be estimated at 0.5 to 1.0% of the capital investment cost .

#### 4. Implementation Program

##### 4.1 General

The construction works consist of embankment, flood wall, sluice gate, pump station, Khal improvement, box culvert, bridge works etc. for flood mitigation and stormwater drainage improvement works. It is assumed that the detailed designs and construction works will be executed by international competitive bidding basis and completed by the target year of 2010.

The implementation program for the project is based on :

- (1) The proposed flood mitigation and stormwater drainage improvement works will be complete by the target year of 2010.
- (2) The phased implementation programs proposed in the Master Plan Study, was reviewed from economical efficiency, social and environmental aspects, and modified in order to get a higher economic efficiency and to avoid adverse social impacts as much as possible.
- (3) The other on-going project or committed projects, if any, will be considered to ensure consistency with the proposed phased implementation programs.

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- (4) Though three project components of the Greater Dhaka East, the DND and the Narayanganj West, were identified in the Master Plan Study for F/S areas, the Greater Dhaka East is divided into four compartments, considering effectiveness against floods, and easiness for O & M and economic efficiency.

The Greater Dhaka East is divided into the following four compartments :

1. Northern Compartment
2. Central Compartment
3. Southern - 1 Compartment
4. Southern - 2 Compartment

## 4.2 Implementation Schedule

### 4.2.1 Greater Dhaka East

The implementing agency for flood mitigation and related facilities such as pumps and sluices will be BWDB, while DWASA will be responsible for Khal and drainage improvements.

The Greater Dhaka East is divided into four compartments and planned to be implemented in phases compartment by compartment with progressing urbanization. However the entire projects will be completed by the target year of 2010.

The proposed implementation program is composed of four stages i.e. preparation stage, construction stage, monitoring stage and completion stage.

The proposed construction schedule is arranged to avoid likely adverse effects caused by implementation of the proposed works as much as possible and also to conform the priority sequence. The area, which has a high development pressure and a high economic efficiency, is given a high priority for early implementation.



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The construction schedule is based on the following assumptions :

- (1) Financial and required arrangements shall be complete by the end of 1993.
- (2) Detailed design shall be commenced in 1994 and completed within a period of 18 months.
- (3) The construction works of southern compartments-2 shall be commenced in 1996 and completed within a construction period of four years.
- (4) The construction works of Northern compartment, southern compartment-1 and central compartment shall be commenced in 2001, 2002 and 2007 respectively. However 60 to 70% of the proposed pump capacity shall be installed in the first stage.
- (5) After completion of the first stage construction of each compartment, the drainage system shall be monitored and checked whether there are any gaps between the actual conditions and the assumed conditions.
- (6) Before the completion stage of 2007 to 2010, the proposed plans shall be reviewed and modified, if necessary, based on the analyses of monitored data.


The proposed implementation schedule is shown in Fig.H.4.1.

#### 4.2.2 DND

The implementing agency for the Project will be BWDB.

The construction schedule is based on the following assumptions :

- (1) Financial and required arrangements shall be completed by the end of 1995.
- (2) Detailed design shall be commenced in 1996 and completed within a period of 12 months.
- (3) The construction works shall be commenced in 1997 and completed within three years. however about pump facilities, 60 to 70% of the proposed capacity shall only be installed in this stage.

- 
- (4) After completion of the works, the drainage system should be monitored, to check whether there are any gaps between the actual conditions and the assumption.
  - (5) During the final stage, the proposed facilities shall be reviewed and modified, if necessary, according to the monitored data.
  - (6) If it is possible for GOB to implement the flood mitigation measures for the Narayanganj West, the flood mitigation works for the DND may be deferred.

The proposed implementation schedule is shown in Fig.H.4.1.

#### 4.2.3 Narayanganj West

The implementing agency for flood mitigation and related facilities will be BWDB, while that for drainage facilities will be Narayanganj Municipality.

The construction schedule is based on the following assumptions ;

- (1) Implementation arrangement shall be completed by the end of 1996
- (2) Detailed design shall be commenced in 1999 and completed within a period of 12 months.
- (3) The construction works shall be commenced in 2000 and completed within five years.

The proposed implementation schedule is shown in Fig.H.4.1.

#### 4.3 Disbursement Schedule

The disbursement schedule of each project is shown in Table H.4.1.

Table H.2.1 ANNUAL WORKABLE DAYS

Rainfall Data : Dhaka Sta. (1980-1989)

Month	Precipitation	0 mm	<5 mm	5 - 9 mm	10 - 20 mm	>20 mm	Calendar day	Amount, work suspend days	Holidays	Workable days Earth Work	Concrete Works
January	Rainy day (days)	29.6	1.1	0.3	-	-	31	0	4+(0)=4	27	27
February	Rainy day (days)	25.7	1.0	1.0	0.4	0.3	28	2	4+(1)=5	21	21
March	Rainy day (days)	26.6	1.3	0.7	1.1	1.3	31	4	5+(1)=6	21	21
April	Rainy day (days)	20.0	2.8	1.6	2.4	3.2	30	9	4+(#5)=9	12	12
May	Rainy day (days)	14.7	4.8	1.8	2.7	7.0	31	17	5+(1)=6	0(*8)	8
June	Rainy day (days)	10.2	6.4	3.2	4.3	5.9	30	17	4+(2)=6	0(*7)	7
July	Rainy day (days)	8.1	7.5	4.7	4.4	6.3	31	17	4+(1)=5	0(*9)	0(*9)
August	Rainy day (days)	10.3	9.2	3.4	3.9	4.2	31	13	5+(0)=5	0(*13)	0(*13)
September	Rainy day (days)	11.4	6.3	3.1	3.8	5.4	30	15	4+(1)=5	0(*10)	0(*10)
October	Rainy day (days)	23.1	2.7	1.3	1.4	2.5	31	7	4+(1)=5	0(*19)	19
November	Rainy day (days)	28.8	0.3	0.3	0.2	0.4	30	3	5+(1)=6	21	21
December	Rainy day (days)	30.0	0.5	0.1	0.2	0.2	31	2	4+(1)=5	24	24

\* <10 mm : No work suspend  
 10 - 20 mm : Work suspend on that date  
 <20 mm : Work suspend on that date plus the next day  
 ( )/(#) : National Holiday/Muslim Religious Holiday  
 (\*) : Work Suspended Day

Total=

106

365

Total=

126

Assumed 130 days

160

160 days



Table H.3.1 UNIT PRICES OF TYPICAL MATERIALS

Unit: Tk ( 1991 Price)

Item	Description	Unit	Price (TK)	Foreign Currency(%)	Local Currency(%)
Earth Material	Use for banking	m3	150	15	85
Sodding		m2	60	0	100
Bricks	1st class	1000 Peaces	3,100	20	80
Ready mixed concrete (1:3:5)	160 kg/cm2	m3	2,900	40	60
Ready mixed concrete (1:2:4)	210 kg/cm2	m3	3,100	45	55
Cement (50 kg/bag)	Portland	bag	250	60	40
Sand	Use for concrete	m3	500	15	85
Crushed Stone		m3	1,300	15	85
Riprap (Gravel)	50-150 mm	m3	1,200	15	85
Brick Chips		m3	1,200	15	85
Deformed Bar	SD 30	t	31,000	50	50
Steel sheet pile		t	31,000	100	0
Structural Steel		t	26,000	100	0
Timber	Low Class	m3	15,000	0	100
Timber	High Class	m3	25,000	20	80
Gasoline		L	15.0	90	10
Diesel oil		L	14.5	90	10

Table H.3.2 LABOUR WAGES

Unit :TK (1991 Price)

Type of Labour	Labour Wage (TK) (1991 Price)
1. Common Labour	80
2. Mason and Plasterer	175
3. Reinforcement Worker	145
4. Concrete Worker	120
5. Pavement Worker	130
6. Carpenter	175
7. Painter	140
8. Welder	200
9. Foreman	225
10. Chief Foreman	340
11. Car Driver and Operator	150
12. Heavy Equipment Operator	270
13. Boat Man	115
14. Boat Captain	190
15. Mechanic	210
16. Electrician	210
17. Plumber	230
18. Surveyor	260

Table H.3.3 HOURLY COST OF EQUIPMENT

Unit: TK(1991 Price)

No.	Equipment	Capacity	Base Cost (J.Y) (1000 Yen)	Freight ton	CIF Site Delivery Cost (1000TK)	Life Year <1	Operation Hr/Year	Operation Days/Year	Mobil.etc Days/Year	Yearly Rate of Mainte. (%)	Yearly Rate of Manage- ment (%)	Operation cost per hr. (TK)	Site Cost Per hr (TK)	Hourly Cost (7+8) (TK)	Assumed Hourly Cost
1.	Backhoe	1.2m3	28400	70	9294	5	845	130	330	35	7	1760	1760	3520	3520
2.	Backhoe	0.6 m3	14100	50	5011	5	1040	160	330	35	7	771	771	1542	1540
3.	Swamp bulldozer	16 t	15500	35	4989	6	845	130	330	45	7	886	856	1742	1740
4.	Bulldozer	21t	24000	35	7226	6	845	130	330	45	7	1283	1240	2523	2520
5.	Dump truck	11t	8530	65	3935	5	845	130	330	60	10	978	885	1863	1860
6.	Dump truck(*)	6 t	5630	50	2782	5	1040	160	330	60	10	562	508	1070	1070
7.	Clamshell	0.8 m3	34500	50	10379	8	845	130	330	45	7	1382	1551	2933	2930
8.	Sand pile driver crane	27 t	64500	100	19574	6	845	130	330	40	7	3282	3359	6640	6640
9.	Diesel pile hammer	2.5 t	7930	10	2347	5	845	130	330	35	7	444	444	889	890
10.	Vibration hammer	45 kw	6890	10	2073	6	845	130	330	40	7	348	356	703	700
11.	Concrete Plant(*)	30m3/hr	27900	200	12542	6	1040	160	330	60	7	2110	1749	3859	3860
12.	Air Compressor	10.5m3/min	5020	10	1581	6	1040	160	330	50	5	241	190	431	430
13.	Tracter Shovel	0.8m3	6400	50	2984	5	845	130	330	45	7	636	565	1201	1200
14.	D. generator(*)	200 kva	6520	15	2106	7	1040	160	330	45	5	260	231	492	490
15.	Concrete pump car(*)	45 m3/h	11500	55	4456	5	1040	160	330	60	7	900	686	1585	1590
16.	Concrete Track Mixer(*)	6m3	10400	60	4297	5	1040	160	330	45	7	744	661	1405	1400
17.	Water tanker	6 kl	5660	40	2529	6	845	130	330	45	7	449	434	883	880
18.	Workshop car	6 t	3350	20	1402	6	1040	160	330	45	7	202	195	398	400
19.	Truck Crane(*)	10 t	14500	50	5116	8	1040	160	330	45	7	553	621	1174	1170
20.	Crawler Crane	35 t	33100	100	11311	7	845	130	330	45	7	1721	1797	3518	3520
21.	Compaction Roller	10 t	7020	30	2627	8	845	130	330	35	7	311	393	703	700

Note <1 : The life time was estimated based on data by Ministry of construction in Japan.

<2 : Yearly management cost of 5% to 10% was applied. The management cost comprises the insurance, tax, interest and other expenses for the equipment management.

<3 : (1)=(B)/3.8+Vol\*TK13000\*2/1000

<4 : (3)=6.5hr/day\*Workable days per Year

<5 : (7) = (1) x (0.45 + (5)/(2)) / (3)

<6 : (8) = (1) x (0.45/(2) + (6)/(3))

<7 : (\*):Mainly for concrete work,etc

<8 : Exchange Rate 1\$ = 36 Tk. = 137 Yen



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Table H.3.4 (1) FREIGHT FOR TYPICAL ITEMS

Unit : TK/Freight Ton (1991 Price)

Item	Unit Price /F. Ton (1)	Packing (2)	Shipping (3)	Ocean Freight(4)	Unloading (5)	Land Transport(6)	Insurance (7)	Total (2)-(7)
Sheet Pile	31000	1570	1840	5970	160	2760	79	12379
Pump Equipment	950000	2960	1840	5970	160	2760	5297	18987
Gate Equipment	850000	2470	1840	5970	160	2760	4744	17944
Construction Machinery	108000	1570	1840	5970	160	2760	662	12962
Miscellaneous Goods	108000	2960	1840	5970	160	2760	787	14477

Note :

- 1). Unit Price : Average Price/F. ton
- 2). F. Ton : Freight ton
- 3). Insurance :  $(1+2+3+4+5+6) \times 0.0055$
- 4). Miscellaneous Goods : Small Water Pump, Tamper Tools, etc.

Table H.3.4(2) CDST & TAX FOR IMPORTED MATERIALS

ITEMS	Unit Price(CIF)	Custum Duty	BAT	LF	CDST & Tax	Remarks
	1	(%).2	$3=(1+2) \times 15\%$	(%)	$2+3+4$ (%)	
1.Steel Sheet Pile	100	100	30	5	135 Say=140%	
2.Pump equipment	100	100	30	5	135 Say=140%	
3.Gate Equipment	100	60	24	5	89 Say 90%	
4. Construction Machinery	100	100	100	5	135 Say=140%	

Note:

- 1).BAT :Value Added Tax
- 2).L.F :Licence Fee Etc.

Table H.3.5 MAJOR EQUIPMENT AND ITS PRODUCTION RATE

Work Item	Equipment	Capacity	Production Rate	Remarks	
A. EARTH WORKS					
1.EXCAVATION	a. BACKHOE	1.2m3	85m3/hr	Main for emb.	
	b. BACKHOE	0.6m3	45m3/hr		
	c. CLAMSHELL	0.8m3	25m3/hr		
	d. DREDGER(*)	-	-		
2.TRANSPORTATION	a. DAMPTRACK	11t	20m3/hr	Main for emb.	
	b. S. BULLDOZER	16t	30m3/hr		
3.SPREDING & COMPACTION	a. BULLDOZER	21t	60m3/hr	Main for emb.	
	b. S. BULLDOZER	16t	45m3/hr		
4.GEOTEXT. DRAIN /SAND DRAIN PILING	a. DRAIN PILE DRIVER	50kw	60m/hr	Foundation treatment	
	b. AIR COMPRESSOR	10.5m3/min			
	c. GENERATOR	200kva			
	d. TRACTAR SHOVEL(S.DRAIN)	1.2m3			
	* SAND PILING CAPACITY		100 m/hr		L=10m
	** PAPER DRIN PILING		260 m/hr		L=10m
B. CONCRETE WORK					
1.CONCRETE	a. CONCRETE PLANT	30m3/hr	30m3/hr	For Pump sta. etc	
	b. CONCRETE PUMP CAR	45m3/hr	45m3/hr		
	c. CONCRETE MIXER	6m3			
	d. CONCRETE MIXER(*)	0.4m3			
2.R.C.PILE DRIVE	a. DIESEL HAMMER	2.5t		For Structures	
	b. CLAWLER CLANE	35t			
	* PILING CAPACITY		1 hr/Nos 1.5hr/Nos		L=10m L=20m
C. REVETMENT,ETC	a. TRACK CLANE	10t			
	b. COMPACTION ROLLER	10t			

Note :

S. Bulldozer : Swamp Bulldozer

(\*) :Available at Site

Main :Main Equipment

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Table H.3.6 UNIT PRICE OF LAND

Unit: TK (1991 Price)

Projec Area	Flood Mitigation Facility	Storm Water Drainage	Remarks
1. Greater Dhaka East			
1) DC - 1	280	230	* 235/190
2) DC - 2	280	230	* 150/120
3) DC - 3	280	230	* 275/220
4) DC - 4	280	230	* 210/170
2. DND	740	310	
3. Narayanganj West			
1) Western Part	740	310	
2) Eastern Part	740/**1230	740	**Commercial Area

Note: 1) \* Surveyed Price : Flat/low land price in 1989/90 collected from the office of the Deputy Commissioner of Dhaka

2) Unit Price (Dhaka): Average surveyed price(1989/1990) x 1.3 (Price escalation, etc

3) Unit Price (DND/Narayanganj.W) : Surveyed price at site in 1991



Table H.3.7 UNIT CONSTRUCTION COST OF GENERAL ITEMS

Unit :TK(1991 Price)						
Item	Description	Unit	Price (TK)	Foreign Portion(%)	Local Portion(%)	Remarks
Banking	By Equipment	m3	509	70	30	Ref.Table H.3.8(1)
Excavation	By Equipment	m3	324	80	20	Ref.Table H.3.8(2)
	By Man power	m3	159	20	80	Ref.Table H.3.8(3)
Dredging	By Dreagder & ManPower	m3	196	40	60	Ref.Table H.3.8(1)
Back filling	By Equipment	m3	299	90	10	Ref.Table H.3.8(2)
	By Man power (With Tamper)	m3	118	50	50	Ref.Table H.3.8(4)
Foundation For Emb.	Pile With Mat	m2	1,132	55	45	Ref.Table H.3.8(5)
Concrete work (1:3:5)	160 kg/cm2	m3	3,777	60	40	do
Concrete work (1:2:4)	210 kg/cm2	do.	4,786	60	40	Ref.Table H.3.8(6)
Reinforcement work		t	44,717	60	40	do
Formwork(Compl. Struct)	Metal Form	m2	761	80	20	Ref.Table H.3.8(7)
Formwork(Simple Struct.)	do	m2	614	80	20	do
Brick Protection work	Brick (t=35cm)	m2	1,579	40	60	Ref.Table H.3.8(3)
Brick Works	Brick	m3	3,614	40	60	Ref.Table H.3.8(8)
Revetment Work	Concrete Blockt=20cm)	m2	1,635	70	30	Ref.Table H.3.8(9)
Maintenance Road	t=30cm	m2	588	90	10	Ref.Table H.3.8(8)
Sodding		m2	60	20	80	Ref.Table H.3.8(9)
Steel Sheet Pile	Type II	m2	6,117	60	40	Ref.Table H.3.8(10)
Concrete pile	0.4x0.4m	m	3,262	60	40	Ref.Table H.3.8(11)
Bed Protection	1x1x0.8m	m2	4,613	50	50	Ref.Table H.3.8(12)
Operation Bridge	B=1.2m	m2	65,400	55	45	do

Note:

1.Emb:Embankment

2.Simple Struct: Flood Wall,Etc

3.Compli.struct.:Complicated shaped structures

Table H.3.8 UNIT COST OF CONSTRUCTION WORKS

Table H.3.8 (1) :Unit Cost of Construction Works

No:1

Work Banking (Embankment)

m3						
Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.03	225	7	
b.Operator		"	0	270	0	
c.Assistant		"	0.15	150	23	
d.Labour		"	0	80	0	
					29	
2.Equipment						
a.Backhoe	1.2m3	m3	0.5	52	26	
b.Dump Truck	11t	m3	1	116	116	
c.Bulldozer	21t	m3	1	56	56	
d.Tamper	100kg	day	0.03	1101	33	
					231	
3.Material						
a.Earth Material		m3	0.5	150	75	50% from Outside
					75	
4.Miscellaneous		LS	1		67	20%
5.Sub-Total					402	
6.Site Expences		LS	1		60	
7.Overhead		LS	1		46	
8.Unit Cost	Perm3				509	
			L/C=	163	F/C=	346
			(%)	32	F/C=	68

No:2

Work Excavation (Machine+Manpower)

m3						
Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						0.5m3
a.Foreman		Man/day	0.2	225	45	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	0.5	80	40	
					85	
2.Equipment						
a.dreadger	Leased	m3	0.5	115	58	0.5m3
					58	
3.Material						
					0	
4.Miscellaneous		LS	1		13	
5.Sub-Total					155	
6.Site Expences		LS	1		23	
7.Overhead		LS	1		18	
8.Unit Cost	Perm3				196	
			L/C=	107	F/C=	89
			(%)	54	F/C=	46

Table H.3.8(2) Unit Cost of Construction Works

No:1

Work Excavation By Equipment(m3)

TK

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.02	225	5	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	0.08	80	6	
					11	
2.Equipment						
a.Backhoe	1.2m3	m3	1	52	52	
b.S.Bulldozer	16t	m3	2	80	160	
					212	
3.Material						
					0	
4.Miscellaneous		LS	1		33	
5.Sub-Total					256	
6.Site Expences		LS	1		38	
7.Overhead		LS	1		29	
8.Unit Cost	Per m3				324	
			L/C=	58	F/C=	267
			(%)	18	F/C=	82

No:2

Work Backfill By Equipment

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.02	225	5	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	0.08	80	6	
					11	
2.Equipment						
a.Backhoe	0.6m3	m3	1	85	85	
b.Bulldozer	16t	m3	1	80	80	
c.Tamper		Day	0.027	1101	30	
					195	
3.Material						
					0	
4.Miscellaneous		LS			31	
5.Sub-Total					236	
6.Site Expences		LS			35	
7.Overhead		LS			27	
8.Unit Cost	Per m3				299	
			L/C=	34	F/C=	265
			(%)	11	F/C=	89



Table H.3.8(3) Unit Cost of Construction Works

No:1

Work Excavation By Manpower(m3)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.2	225	45	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	0.8	80	64	
					109	
2.Equipment						
					0	
3.Material						
					0	
4.Miscellaneous		L.S	1		16	
5.Sub-Total					125	
6.Site Expences		L.S	1		19	
7.Overhead		L.S	1		14	
8.Unit Cost					159	
			L/C=	130	F/C=	29
			(%)	82	F/C=	18

No:2

Work Brick Protection(m2)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						Per 10m2
a.Foreman		Man/day	0.2	225	45	
b.Oprater		"	0.7	270	189	
c.Assistant		"	0	150	0	
d.Labour		"	1.2	80	96	
					330	
2.Equipment						Per 10m2
a.Track Clane	10t	Hr	0.8	1584	1267	
					1267	
3.Material						Per 10m2
a.Brick	0.21*10	pcs	1000	3.1	3100	
b.Brick Chips	0.15*10	m3	1.5	1200	1800	
c.Base Concrete	0.5*0.5	m3	0.5	4786	2393	
d.Reinforcement	60kg/m3	kg	30	45	1350	
e.Formwork		m2	1	614	614	
					9257	
4.Miscellaneous		L.S	1		1628	
5.Sub-Total					12482	
6.Site Expences		L.S	1		1872	
7.Overhead		L.S	1		1435	
8.Unit Cost	Per m2				1579	/10
			L/C=	956	F/C=	623
			(%)	61	F/C=	39

Table H.3.8(4) Unit Cost of Construction Works

No:1

Work Backfilling&Compaction (m3)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.50	225	113	
b.Oprater		"	0.00	270	0	
c.Assistant		"	0.00	150	0	
d.Labour		"	5.00	80	400	
					513	
2.Equipment						
a.Tanper		Day	0.27	1101	297	
					297	
3.Material						
					0	
4.Miscellaneous		LS	1		121	
5.Sub-Total					931	
6.Site Expences		LS	1		140	
7.Overhead		LS	1		107	
8.Unit Cost	Per m3				118	/10
			L/C=	63	F/C=	54
			(%)	54	F/C=	46

No:2

Work Cutting slope By Manpower(m2)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.7	225	158	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	5.3	80	424	
					582	
2.Equipment						
					0	
3.Material						
					0	
4.Miscellaneous		LS	1		87	
5.Sub-Total					669	
6.Site Expences		LS	1		100	
7.Overhead		LS	1		77	
8.Unit Cost					8	/100
			L/C=	7	F/C=	2
			(%)	82	F/C=	18

Table H.3.8(5) Unit Cost of Construction Works

No:1

Work Geotext /Wick Drain Driving (L=10m)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						Per Day
a.Foreman		Man/day	3.75	225	844	
b.Oprater		"	3.75	270	1013	
c.Assistant		"	3	150	450	
d.Labour		"	4.2	80	336	
					2642	
2.Equipment/Oil						
a.Piling Driver	45kw	Hr	6.5	6500	42250	1690m/ day
b.Oil		l	101	14.5	1465	
c.bulldozer		Hr	2.5	2520	6300	
					50015	
3.Material						Per Day
a.Geotext Drain		L.s	1	61600	61600	*
b.Geotext Mat		m2	264.063	45	11883	*
c.sand Mat		m3	158.438	500	79219	
					152702	
4.Miscellaneous		L.S	1		30839	
5.Sub-Total					236197	
6.Site Expences		L.S	1		35430	
7.Overhead		L.S	1		27163	
8.Unit Cost	Per m2				1132	
	Per10m/No				1768	/169
			L/C=	800	F/C=	968
			(%)	45	F/C=	55

No:2

Work Concrete(1:3:5) m3

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.02	225	5	
b.Oprater		"	0.04	270	11	
c.Assistant		"	0	150	0	
d.Labour		"	0.04	80	3	
					19	
2.Equipment						
a.Concrete Plant	30m3/hr	Hr	0.03	4489	135	
b.Concret Mixer	6m3	Hr	0.07	1834	128	
c.Punp Car	45m3/hr	Hr	0.024	1960	47	
d.Crusing		LS	1		31	10%
					341	
3.Material						
a.Cement	50kg/bag	bag	5	250	1250	
b.Sand		m3	0.33	500	165	
c.Crushed Stone		m3	0.55	1300	715	
d.Admixture,etc		LS	1		107	5%
					2237	
4.Miscellaneous		L.S	1		389	
5.Sub-Total					2986	
6.Site Expences		L.S	1		448	
7.Overhead		L.S	1		343	
8.Unit Cost	Perm3				3777	
			L/C=	1597	F/C=	2180
			(%)	42	F/C=	58



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Table H.3.8(6) Unit Cost of Construction Works

No:1

Work Concrete(1:2:4)m3

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.02	225	5	
b.Oprater		"	0.04	270	11	
c.Assistant		"	0	150	0	
d.Labour		"	0.06	80	5	
					20	
2.Equipment						
a.Concrete Plant	30m3/hr	Hr	0.04	4489	180	
b.Concrete Mixer	6m3	Hr	0.07	1834	128	
c.Pump Car	45m3/hr	hr	0.024	1960	47	
d.Clasing		LS	1		35	
					390	
3.Material						
a.Cement	50kg/bag	bag	7	250	1750	
b.Sand		m3	0.32	500	160	
c.Crushed Stone		m3	0.64	1300	832	
d.Admixture,etc		LS	1		137	5%
					2879	
4.Miscellaneous		LS	1		493	
5.Sub-Total					3783	
6.Site Expences		LS	1		567	
7.Overhead		LS	1		435	
8.Unit Cost	Per m3				4786	
			L/C=	1978	F/C=	2808
			(%)	41	F/C=	59

No:2

Work Reinforcement Bar Arrangement with Material(t)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.5	225	113	
b.Oprater		"	2.4	270	648	
c.Assistant		"	0	150	0	
d.Labour		"	1.9	80	152	
					913	
2.Equipment						
a.Track Clane	10t	day	0.08	10296	824	
					824	
3.Material						
a.Deformed Bar		t	1.03	31000	31930	
					31930	
4.Miscellaneous		LS	1		1683	5%
5.Sub-Total					35349	
6.Site Expences		LS	1		5302	
7.Overhead		LS	1		4065	
8.Unit Cost	Per Ton				44717	
			L/C=	19003	F/C=	25714
			(%)	42	F/C=	58



Table H.3.8(7) Unit Cost of Construction Works

No:1

Work Form Work For Compl. Structure

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						For 100 m2
a.Foreman		Man/day	3.1	225	698	
b.Plumber		"	5	230	1150	
c.Carpenter		"	16.4	175	2870	
d.Labour		"	16.4	80	1314	
e.Operator		"	1.0	270	270	
					6301	
2.Equipment						
a.Truck Crane	10t	day	1	10296	10296	
					10296	
3.Material						For 100 m2
a.Metal		m2	100	360	36000	
					36000	
4.Miscellaneous		LS	1		7600	
5.Sub-Total					60197	
6.Site Expences		LS	1		9029	
7.Overhead		LS	1		6923	
8.Unit Cost	Per m2				761	/100
			L/C=	121	F/C=	640
			(%)	16	F/C=	84

No:2

Work Formwork For Simple Struct.(m2)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						Per100m2
a.Foreman		Man/day	3.1	225	698	
b.Plumber		"	5	230	1150	
c.Carpenter		"	16.4	175	2870	
d.Labour		"	16.4	80	1314	
					6031	
2.Equipment						
					0	
3.Material						Per100m2
a.Metal Form		m2	100	360	36000	
					36000	
4.Miscellaneous		LS	1		6305	
5.Sub-Total					48336	
6.Site Expences		LS	1		7250	
7.Overhead		LS	1		5559	
8.Unit Cost	Per m2				611	/100
			L/C=	140	F/C=	472
			(%)	23	F/C=	77

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Table H.3.8(8) Unit Cost of Construction Works

No:1

Work Maintenance Road(Compaction With Material(m2))

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						Per100 m2
a.Foreman		Man/day	0.6	225	135	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	3.00	80	240	
					375	
2.Equipment						Per100 m2
a.Compaction Roller	10t	Hr	1.5	1094	1641	
b.Bulldozer		Hr	1	2406	2406	
					4047	
3.Material						Per100 m2
a.Brickchips		m3	30	1200	36000	
					36000	
4.Miscellaneous		L.S	1		6063	
5.Sub-Total					46485	
6.Site Expences		L.S	1		6973	
7.Overhead		L.S	1		5346	
8.Unit Cost	Per m2				588	/100
			L/C=	54	F/C=	534
			(%)	9	F/C=	91

No:2

Work Brick Works(m3)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						Per 10m3
a.Foreman		Man/day	0.6	225	135	
b.Oprater		"	2.1	270	567	
c.Assistant		"	0	150	0	
d.Labour		"	3.6	80	288	
			0		990	
2.Equipment			0			Per 10m3
a.Track Clane	10t	Hr	2.4	1584	3802	
					3802	
3.Material						Per 10m3
a.Brick		pcs	4762	3.1	14762	
b.Mortal,Etc		m3	1.4	3777	5288	
					20050	
4.Miscellaneous		L.S	1		3726	
5.Sub-Total					28568	
6.Site Expences		L.S	1		4285	
7.Overhead		L.S	1		3285	
8.Unit Cost	Per m2				3614	/10
			L/C=	2125	F/C=	1489
			(%)	59	F/C=	41



Table H.3.8(9) Unit Cost of Construction Works

No:2

Work Revetment (Plain Block m2)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						Per 10m2
a.Foreman		Man/day	0.2	225	45	
b.Oprater		"	0.4	270	108	
c.Assistant		"	0	150	0	
d.Labour		"	0.9	80	72	
					225	
2.Equipment						Per 10m2
a.Truck Clane	10t	Hr	0.8	1584	1267	
					1267	
3.Material						Per 10m2
a.Concrete	.5*.5*.2	m3	0.5	4786	2393	
b.Brick Chips	.25*10	m3	2.5	1200	3000	
c.Base Concrete	0.5*0.5	m3	0.5	4786	2393	
d.Reinfocement	60kg/m3	kg	30	45	1350	
e.Formwork		m2	1	614	614	
					9750	
4.Miscellaneous		L.S	1		1686	
5.Sub-Total					12929	
6.Site Expences		L.S	1		1939	
7.Overhead		L.S	1		1487	
8.Unit Cost	Per m2				1635	/10
			L/C=	562	F/C=	1073
			(%)	34	F/C=	66

No:1

Work Sodding(m2)

(Tk.)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.6	225	135	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	6.4	80	512	
					647	
2.Equipment						
					0	
3.Material						
a.Grass for sodding		m2	100	35	3500	
					3500	
4.Miscellaneous		L.S	1		622	
5.Sub-Total					4769	
6.Site Expences		L.S	1		715	
7.Overhead		L.S	1		548	
8.Unit Cost	Per m2				60	/100
			L/C=	49	F/C=	11
			(%)	82	F/C=	18

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Table H.3.8(10) Unit Cost of Construction Works

No:1

Work Steel Sheet Pile (L=6m)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						For 10sheets
a.Foreman		Man/day	0.23	225	52	
b.Oprater		"	0.23	270	62	
c.Assistant		"	0	150	0	
d.Labour		"	0.46	80	37	
					151	
2.Equipment						For 10sheets
a.Vibro Hummer	45kw	Hr	1.7	907	1542	
b.Clawler Clane	30t	Hr	1.7	4127	7016	
c.Generator	200kva	Day	0.23	8132	1870	
					10428	
3.Material						
a.Steel Sheet		No	1	89280	89280	*
					89280	
4.Miscellaneous		LS	1		14979	
5.Sub-Total					114838	
6.Site Expences		LS	1		17226	
7.Overhead		LS	1		13206	
8.Unit Cost	Per Sheet				14527	/10
			L/C=	5723	F/C=	8804
			(%)	39	F/C=	61

No:2

Work Steel Sheet Pile(10m)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						For 10 sheets
a.Foreman		Man/day	0.46	225	104	
b.Oprater		"	0.46	270	124	
c.Assistant		"	0	150	0	
d.Labour		"	0.92	80	74	
					301	
2.Equipment						For 10 sheets
a.Vibro Hummer	45kw	Hr	3.4	907	3084	
b.Clawer Clane	30t	Hr	3.4	4127	14032	
c.Generator	200kva	Day	0.46	8132	3741	
					20856	
3.Material						
a.SteelSheet Pile		No	10	14880	148800	*
					148800	
4.Miscellaneous		LS	1		25494	
5.Sub-Total					195451	
6.Site Expences		LS	1		29318	
7.Overhead		LS	1		22477	
8.Unit Cost	Per Sheet				24725	/10
			L/C=	9618	F/C=	15107
			(%)	39	F/C=	61

Table H.3.8(11) Unit Cost of Construction Works

No:2

Work R.C Pile Driving 10m/No

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.16	225	36	
b.Oprater		"	0.32	270	86	
c.Assistant		"	0	150	0	
d.Labour		"	0.16	80	13	
					135	
2.Equipment						
a.Diesel hummer	2.5t	Hr	1	1166	1166	
b.Clawer Clane	30t	Hr	1	4127	4127	
c.Generator	200kva	Day	0.16	8132	1301	
					6594	
3.Material						
a.R.C Pile Concrete	.4*.4*10	m3	1.6	4890	7824	
b.Reinforcement	100kg/m3	kg	160	45	7200	
c.Formwork,Etc		LS	1		1502	10%
					16526	
4.Miscellaneous		LS	1		3488	
5.Sub-Total					26744	
6.Site Expences		LS	1		4012	
7.Overhead		LS	1		3076	
8.Unit Cost	Per No				33831	
			L/C=	12538	F/C=	21294
			(%)	37	F/C=	63

No:1

Work R.C Pile Driving 20m/No

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.24	225	54	
b.Oprater		"	0.48	270	130	
c.Assistant		"	0	150	0	
d.Labour		"	0.48	80	38	
					222	
2.Equipment						
a.Diesel Hummer	2.5t	Hr	1.5	1166	1749	
b.Clawer Clane	30t	Day	1.5	4127	6191	
c.Generator	200kva	Day	0.24	8132	1952	
					9891	
3.Material						
a.R.C Pile	.4*.4*20	m3	3.2	4890	15648	
b.Reinforcement	100kg/m3	kg	320	45	14400	
c.Formwork,Etc		LS	1		3005	10%
					33053	
4.Miscellaneous		LS	1		6475	
5.Sub-Total					49641	
6.Site Expences		LS	1		7446	
7.Overhead		LS	1		5709	
8.Unit Cost	Per No				62796	
			L/C=	24315	F/C=	38480
			(%)	39	F/C=	61



Table H.3.8(12) Unit Cost of Construction Works

No:1

Work Bed Protection ( Block m2)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						Per 10m2
a.Foreman		Man/day	0.2	225	45	
b.Oprater		"	0.4	270	108	
c.Assistant		"	0	150	0	
d.Labour		"	0.9	80	72	
					225	
2.Equipment						Per 10m2
a.Truck Crane	10t	Hr	0.8	1584	1267	
					1267	
3.Material						Per 10m2
a.Concrete	1*1*0.8	m3	8	3777	30216	
					30216	
4.Miscellaneous		L.S	1		4756	
5.Sub-Total					36464	
6.Site Expences		L.S	1		5470	
7.Overhead		L.S	1		4193	
8.Unit Cost	Per m2				4613	/10
			L/C=	2210	F/C=	2403
			(%)	48	F/C=	52

No:2

Work Operation Bridge(m2)

(Tk.)

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0	225	0	
b.Oprater		"	0	270	0	
c.Assistant		"	0	150	0	
d.Labour		"	0	80	0	
					0	
2.Equipment						
					0	
3.Material						
					0	
					0	
4.Miscellaneous		L.S	1		0	
5.Sub-Total					0	
6.Site Expences		L.S	1		0	1286000*(1.04)^2
7.Overhead		L.S	1		0	/17.7/1.2=
						65400/m2
8.Unit Cost	Per m2				65400	Ref.JICA Study
			L/C=	0	F/C=	65400
			(%)	55	F/C=	45

Table H.3.8(13) Unit Cost of Construction Works

No:1

Work (Reference) Sand F 10m/No

Item	Spec.	Unit	Quantity	Unit Price	Cost	Remarks
1.Manpower						
a.Foreman		Man/day	0.09	225	20	
b.Oprater		"	0.09	270	24	
c.Assistant		"	0	150	0	
d.Labour		"	0.18	80	14	
					59	
2.Equipment						
a.Sand Pile Driver	50kw	Hr	0.15	7313	1097	
b.Air Compressor	10.5m3	Day	0.03	5311	159	
c.Generator	200 KVA	Day	0.03	8132	244	
d.Tracter Shovel	0.8m3	Hr	0.15	1648	247	
					1747	
3.Material						
a.Sand Pile	D=0.4m	m3	1.6	500	800	
b.Geotex		m2	4	45	180	*
c.Sand mat	d=0.6m	m3	2.4	500	1200	
					2180	
4.Miscellaneous		L.S	1		598	
5.Sub-Total					4584	
6.Site Expences		L.S	1		688	
7.Overhead		L.S	1		527	
8.Unit Cost	Per No				5799	
			L/C=	2479	F/C=	3321
			(%)	43		57

Table H.3.9 Total Project Cost of G.Dhaka East

Unit : Million TK (1991Price)

Phase	Construction Cost (x10 <sup>6</sup> )					Remarks
Project Area	F/C	%	L/C	%	Total	
A.Construction Cost	7,558	69	3,358	31	10,916	
1.Flood Mitigation	3,732	66	1,964	34	5,696	
1).DC-1	1,675	66	852	34	2,527	Ref. H.3.10(1)
2) DC-2	658	65	362	35	1,020	Ref. H.3.10(2)
3) DC-3	664	65	361	35	1,025	Ref. H.3.10(3)
4) DC-4	735	65	389	35	1,124	Ref. H.3.10(4)
2.Storm Water Drainage	3,827	73	1,393	27	5,220	
1).D-C 1	657	70	275	30	932	
2) DC-2	1,047	76	324	24	1,371	
3) DC-3	1,003	77	300	23	1,303	
4) DC-4	1,120	69	494	31	1,614	
B.Physical Contingency	1,134	69	501	31	1,635	Ax15%
C.Engineering	869	69	387	31	1,256	(A+B)x10%
D.Administration		0	327	100	327	Ax3%
E.Land Aquisition & Compensation		0	1,487	100	1,487	Ref. H.3.12
F. C.D.S.T & Tax		0	2,674	100	2,674	Ref. H.3.13
Total	9,561	52	8,734	48	18,296	





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Table H.3.10(1) Project Cost of Dhaka East (DC-1)

Unit : Million TK (1991Price)				
Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	2,332	1,127	3,459	
1.Flood Mitigation	1,675	852	2,527	
1).Embankment	1,541	800	2,340	Ref. H.3.13
2). Flood Wall	15	8	22	Ref. H.3.14
3).Sluice Gate	120	45	165	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	657	275	932	
1).Pump Sta.	513	121	634	Ref. H.3.17(1)
2).Khal Improve.	136	144	280	Ref. H.3.18
3).Bridge,Etc	7	10	17	Ref. H.3.19
B.Physical Contingency	349	169	518	Ax15%
C.Engineering	268	130	398	(A+B)x10%
D.Administration	0	104	104	Ax3%
E.Land Aquisition & Compensation	0	565	565	Ref. H.3.11
F. CDST & Tax	0	572	572	Ref. H.3.12
Total	2,949	2,667	5,616	

Table H.310(2) Project Cost: Dhaka East (DC-2)

Unit : Million TK (1991Price)				
Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	1,705	686	2,391	
1.Flood Mitigation	658	362	1,020	
1).Embankment	576	328	905	Ref. H.3.13
2). Flood Wall	16	8	24	Ref. H.3.14
3).Sluice Gate	66	26	92	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	1,047	324	1,371	
1).Pump Sta.	946	218	1,163	Ref. H.3.17(1)
2).Khal Improve.	101	106	208	Ref. H.3.18
3).Bridge,Etc	0	0	0	Ref. H.3.19
B.Physical Contingency	256	102	358	Ax15%
C.Engineering	196	79	275	(A+B)x10%
D.Administration	0	72	72	Ax3%
E.Land Aquisition & Compensation	0	272	272	Ref. H.3.11
F. CDST & Tax	0	706	706	Ref. H.3.12
Total	2,157	1,917	4,074	

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Table H.3.10(3) Project Cost of Dhaka East (DC-3 )

Phase Project Area	Construction Cost (x10 <sup>6</sup> )			Remarks
	F/C	L/C	Total	
A.Construction Cost	1,667	661	2,328	
1.Flood Mitigation	664	361	1,025	
1).Embankment	594	335	930	Ref. H.3.13
2). Flood Wall	10	5	16	Ref. H.3.14
3).Sluice Gate	60	20	80	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	1,002	300	1,303	
1).Pump Sta.	927	206	1,133	Ref. H.3.17(1)
2).Khal Improve.	76	94	170	Ref. H.3.18
3).Bridge,Etc	0	0	0	Ref. H.3.19
B.Physical Contingency	250	98	348	Ax15%
C.Engineering	192	76	268	(A+B)x10%
D.Administration	0	70	70	Ax3%
E.Land Aquisition & Compensation	0	238	238	Ref. H.3.11
F. CDST & Tax	0	709	709	Ref. H.3.12
Total	2,109	1,852	3,961	

Table H.3.10(4) Project Cost: Dhaka East (DC-4)

Phase Project Area	Construction Cost (x10 <sup>6</sup> )			Remarks
	F/C	L/C	Total	
A.Construction Cost	1,854	884	2,738	
1.Flood Mitigation	735	389	1,124	
1).Embankment	655	359	1,013	Ref. H.3.13
2). Flood Wall	19	10	29	Ref. H.3.14
3).Sluice Gate	61	20	81	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	1,120	495	1,614	
1).Pump Sta.	914	208	1,121	Ref. H.3.17(1)
2).Khal Improve.	202	282	484	Ref. H.3.18
3).Bridge,Etc	4	5	9	Ref. H.3.19
B.Physical Contingency	279	132	411	Ax15%
C.Engineering	213	102	315	(A+B)x10%
D.Administration	0	82	82	Ax3%
E.Land Aquisition & Compensation	0	412	412	Ref. H.3.11
F. CDST & Tax	0	687	687	Ref. H.3.12
Total	2,347	2,298	4,645	

Table H.3.11 Summary of Land Acquisition and Cost: G.Dhaka East

Unit : Million TK (1991 Prince)

Project Area	Land Acquisition			Compensation			Total
	Flood Mitigation	Storm Water Drainage	Sub-Total	Flood Mitigation	Storm Water Drainage	Sub-Total	
1).DC-1	396.6	133.6	530.2	26.4	8.0	34.4	564.6
2) DC-2	135.6	114.6	250.2	19.7	2.0	21.7	271.9
3) DC-3	160.1	64.0	224.1	6.3	7.3	13.6	237.7
4) DC-4	223.3	157.0	380.3	16.2	15.0	31.2	411.5
Total	915.6	469.2	1,384.8	68.6	32.3	100.9	1,485.7

Table H.3.12 Summary of C.D.S.T. & Tax : G.Dhaka East

Unit : Million TK (1991 Prince)

Project Area	Flood Mitigation			Storm Water Drainage			Total
	Embankment	Sluice Gate	Sub-Total	Pump Station	Khal Improvement	Sub-Total	
1).DC-1	206.2	67.6	273.8	297.9	0.3	298.2	572.0
2) DC-2	113.4	32.2	145.6	560.1	0.0	560.1	705.7
3) DC-3	115.9	36.6	152.5	556.7	0.0	556.7	709.2
4) DC-4	105.7	36.5	142.2	545.2	0.0	545.2	687.4
Total	541.2	172.9	714.1	1,959.9	0.3	1,960.2	2,674.3



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Table H.3.13 CONSTRUCTION COST OF EMBANKMENT: DHAKA EAST

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks (Tk1.05)
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS	-			1	160,280	86,759	247,038	5%
II. Direct Construction Cost									
DC-1:									
1. Excavation	m3	324	80	20	53,600	13,893	3,473	17,366	
2. Banking	m3	509	70	30	2,171,952	773,866	331,657	1,105,524	
3. Foundation	m2	1,132	55	45	528,776	329,216	269,358	598,574	
4. Revetment Work	m2	1,635	70	30	190,276	217,771	93,330	311,101	
5. Maint.Road	m2	588	90	10	108,400	57,365	6,374	63,739	
6. Sodding	m2	60	20	80	438,156	5,258	21,031	26,289	
7. Miscellaneous	LS				1	69,868	36,261	106,130	
Sub-Total						1,467,238	761,486	2,228,724	(2,340mill.)
DC-2:									
1. Excavation	m3	324	80	20	12,000	3,110	778	3,888	2000m3/km
2. Banking	m3	509	70	30	760,123	270,832	116,071	386,903	
3. Foundation	m2	1,132	55	45	290,755	181,024	148,111	329,135	
4. Revetment Work	m2	1,635	70	30	43,325	49,585	21,251	70,836	
5. Maint.Road	m2	588	90	10	30,000	15,876	1,764	17,640	
6. Sodding	m2	60	20	80	202,835	2,434	9,736	12,170	
7. Miscellaneous	LS				1	26,143	14,885	41,029	
Sub-Total						549,005	312,595	861,600	(905 mill.)
DC-3:									
1. Excavation	m3	324	80	20	24,740	6,413	1,603	8,016	
2. Banking	m3	509	70	30	777,401	276,988	118,709	395,697	
3. Foundation	m2	1,132	55	45	297,217	185,047	151,402	336,450	
4. Revetment Work	m2	1,635	70	30	39,270	44,945	19,262	64,206	
5. Maint.Road	m2	588	90	10	43,110	22,814	2,535	25,349	
6. Sodding	m2	60	20	80	223,971	2,688	10,751	13,438	
7. Miscellaneous	LS				1	26,945	15,213	42,158	
Sub-Total						565,839	319,475	885,314	(930 mill.)
DC-4:									
1. Excavation	m3	324	80	20	34,340	8,901	2,225	11,126	
2. Banking	m3	509	70	30	1,064,882	379,417	162,607	542,025	
3. Foundation	m2	1,132	55	45	270,953	168,695	138,023	306,719	
4. Revetment Work	m2	1,635	70	30	0				
5. Maint.Road	m2	588	90	10	60,610	32,075	3,564	35,639	
6. Sodding	m2	60	20	80	394,341	4,732	18,928	23,660	
7. Miscellaneous	LS				1	29,691	16,267	45,958	
Sub-Total						623,512	341,616	965,127	(1,013mill.)
Total (II)						3,205,593	1,735,172	4,940,765	
Total(I+II)						3,365,873	1,821,931	5,187,804	
						0.65	0.35	1	
Total:									
I. Preparation of Work	LS	-			1	160,280	86,759	247,038	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	124,680	32,317	8,079	40,396	
2. Banking	m3	509	70	30	4,774,358	1,701,104	729,044	2,430,148	
3. Foundation	m2	1,132	55	45	1,387,701	863,983	706,895	1,570,878	
4. Revetment Work	m2	1,635	70	30	272,871	312,301	133,843	446,144	
5. Maint.Road	m2	588	90	10	242,120	128,130	14,237	142,367	
6. Sodding	m2	60	20	80	1,259,303	15,112	60,447	75,558	
7. Miscellaneous	LS				4	152,647	82,627	235,275	
Sub-Total (II)						3,205,593	1,735,172	4,940,765	
Total (I+II)						3,365,873	1,821,931	5,187,804	
III Land Aquisition									
DC-1	m2	280		100	1,416,282		396,559	396,559	
DC-2	m2	280		100	484,110		135,551	135,551	
DC-3	m2	280		100	571,782		160,099	160,099	
DC-4	m2	280		100	797,593		223,326	223,326	
Total					3,269,767		915,535	915,535	

Note : 1) Unit Construction costs are shwon in Table H.3.7

2) Bill of Quanties are shown in Data Book

Table H.3.14 CONSTRUCTION COST OF FLOOD WALL:G.DHAKA EAST

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks (Itx1.05)
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1	2,848	1,475	4,324	5%
II. Direct Construction Cost									
1).DC-1									
1. Excavation	m3	159	20	80	2,400	76	305	382	
2. Backfill &Filling	m3	118	50	50	24,249	1,431	1,431	2,861	
3. Concrete	m3	4,786	60	40	1,255	3,604	2,403	6,006	
4. Form	m2	614	80	20	11,580	5,688	1,422	7,110	
5. Re. Bar	t	44,717	60	40	88	2,357	1,571	3,928	
6. Miscellaneous	LS				1	658	357	1,014	
<b>Subtotal</b>						13,814	7,489	21,302	(22 mill.)
2).DC-2									
1. Excavation	m3	159	20	80	3,020	96	384	480	
2. Backfill &Filling	m3	118	50	50	12,790	755	755	1,509	
3. Concrete	m3	4,786	60	40	1,410	4,049	2,699	6,748	
4. Form	m2	614	80	20	13,640	6,700	1,675	8,375	
5. Re. Bar	t	44,717	60	40	99	2,648	1,765	4,414	
6. Miscellaneous	LS				1	712	364	1,076	
<b>Subtotal</b>						14,960	7,642	22,602	(24 mill.)
3).DC-3									
1. Excavation	m3	159	20	80	1,000	32	127	159	
2. Backfill &Filling	m3	118	50	50	13,975	825	825	1,649	
3. Concrete	m3	4,786	60	40	900	2,584	1,723	4,307	
4. Form	m2	614	80	20	8,600	4,224	1,056	5,280	
5. Re. Bar	t	44,717	60	40	63	1,690	1,127	2,817	
6. Miscellaneous	LS				1	468	243	711	
<b>Subtotal</b>						9,823	5,101	14,924	(16 mill.)
4).DC-4									
1. Excavation	m3	159	20	80	3,778	120	481	601	
2. Backfill &Filling	m3	118	50	50	2,754	162	162	325	
3. Concrete	m3	4,786	60	40	1,966	5,646	3,764	9,409	
4. Form	m2	614	80	20	16,024	7,871	1,968	9,839	
5. Re. Bar	t	44,717	60	40	138	3,692	2,462	6,154	
6. Miscellaneous	LS				1	875	442	1,316	
<b>Subtotal</b>						18,366	9,278	27,644	(29 mill)
<b>Total</b>						59,811	30,985	90,796	
Total									
I. Preparation of Work					1	2,848	1,475	4,324	
II. Direct Construction Cost									
1. Excavation	m3	159	20	80	10,198	324	1,297	1,621	
2. Backfill &Filling	m3	118	50	50	53,768	3,172	3,172	6,345	
3. Concrete	m3	4,786	60	40	5,531	15,883	10,589	26,471	
4. Form	m2	614	80	20	49,844	24,483	6,121	30,604	
5. Re. Bar	t	44,717	60	40	387	10,388	6,925	17,313	
6. Miscellaneous	LS				4	2,713	1,405	4,118	
<b>Subtotal</b>						56,963	29,509	86,473	
<b>Total</b>						59,811	30,985	90,796	
Land Aquisition									
1).DC-1	m2	280		100	0			0	
2).DC-2	m2	280		100	0			0	
3).DC-3	m2	280		100	0			0	
4).DC-4	m2	280		100	0			0	
<b>Total</b>									

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Table H.3.15 Summary of Construction Cost of Sluice Gate (DC-1~4)

Unit : Million Tk. (1991 Price)

Area	No. Sluice	Construction Cos (x1000)			Remarks
		F/C	L/C	Total	
DC - 1	Gate No. 14	15,860	7,107	22,967	Ref. Table H.3.16 (1)
	Gate No. 15	21,412	9,133	30,545	Ref. Table H.3.16 (2)
	Gate No. 16	46,851	17,738	64,589	Ref. Table H.3.16 (3)
	SG:(Sub-1)	35,701	10,812	46,513	Ref. Table H.3.16 (7)
	Sub-Total	119,824	44,790	164,614	
DC - 2	Gate No. 17	65,916	26,272	92,188	Ref. Table H.3.16 (4)
DC - 3	Gate No. 18A	59,951	19,875	79,826	Ref. Table H.3.16 (5)
DC - 4	Gate No. 18B	60,880	20,496	81,376	Ref. Table H.3.16 (6)
Total (DC-1~4)	Total	306,571	111,433	418,004	



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Table H.3.16(1) CONSTRUCTION COST OF SLUICE GATE : Gate No. 14

Const. Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	755	338	1094	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	1396.00	362	90	452	
2. Backfill	m3	299	90	10	665.00	179	20	199	
3. Sheet Pile	m2	6117	60	40	313.00	1149	766	1915	
4. R.C Pile	m	3264	60	40	1216.00	2381	1588	3969	
5. Concrete	m3	4786	60	40	650.00	1867	1244	3111	
6. Form	m2	761	80	20	1430.00	871	218	1088	
7. Re. Bar	t	44717	60	40	58.50	1570	1046	2616	
8. Bed Protection	m2	4613	50	50	322.00	743	743	1485	
9. Operation Bridge	m2	65400	55	45	18.00	647	530	1177	
10. Miscellaneous	LS				1.00	488	312	801	
<b>Subtotal</b>						10256	6557	16813	
III. Gate Leaf & equipment									
1. Gate Leaf, Sheet	m2	264000	100		9.68	2556		2556	
2. Hoist Machine	m2	176000	100		9.68	1704		1704	
3. Installation	LS	44000	90	10	1.00	383	43	426	
4. Miscellaneous	LS	38720	55	45	1.00	206	169	375	
<b>Subtotal</b>						4849	211	5060	
<b>Total</b>						15860	7107	22967	
						0.69	0.31	1	

Table H.3.16(2) CONSTRUCTION COST OF SLUICE GATE : Gate No.15

Const. Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	1020	435	1455	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	1670.00	433	108	541	
2. Backfill	m3	299	90	10	637.00	171	19	190	
3. Sheet Pile	m2	6117	60	40	358.00	1314	876	2190	
4. R.C Pile	m	3264	60	40	1796.00	3517	2345	5862	
5. Concrete	m3	4786	60	40	834.00	2395	1597	3992	
6. Form	m2	761	80	20	1834.80	1117	279	1396	
7. Re. Bar	t	44717	60	40	75.06	2014	1343	3356	
8. Bed Protection	m2	4613	50	50	384.00	886	886	1771	
9. Operation Bridge	m2	65400	55	45	18.00	647	530	1177	
10. Miscellaneous	LS				1.00	625	399	1024	
<b>Subtotal</b>						13119	8381	21500	
III. Gate Leaf & equipment									
1. Gate Leaf, Sheet	m2	264000	100		14.52	3833		3833	
2. Hoist Machine	m2	176000	100		14.52	2556		2556	
3. Installation	LS	44000	90	10	1.00	575	64	639	
4. Miscellaneous	LS	38720	55	45	1.00	309	253	562	
<b>Subtotal</b>						7273	317	7590	
<b>Total</b>						21412	9133	30545	

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Table H.3.16(3) CONSTRUCTION COST OF SLUICE GATE :Gate No.16

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	2231	845	3076	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	7597.00	1969	492	2461	
2. Backfill	m3	299	90	10	2777.00	747	83	830	
3. Sheet Pile	m2	6117	60	40	506.00	1857	1238	3095	
4. R.C Pile	m	3264	60	40	3845.00	7530	5020	12550	
5. Concrete	m3	4786	60	40	1646.00	4727	3151	7878	
6. Form	m2	761	80	20	3621.20	2205	551	2756	
7. Re. Bar	t	44717	60	40	148.14	3975	2650	6624	
8. Bed Protection	m2	4613	50	50	628.00	1448	1448	2897	
9. Operation Bridge	m2	65400	55	45	24.00	863	706	1570	
10. Miscellaneous	LS				1.00	1266	767	2033	
<b>Subtotal</b>						26587	16107	42695	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		36.00	9504		9504	
2. Hoist Machine	m2	176000	100		36.00	6336		6336	
3. Installation	LS	44000	90	10	1.00	1426	158	1584	
4. Miscellaneous	LS	38720	55	45	1.00	767	627	1394	
<b>Subtotal</b>						18032	786	18818	
<b>Total</b>						46851	17738	64588	

Table H.16(4) CONSTRUCTION COST OF SLUICE GATE :Gate No.17

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	3139	1251	4390	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	10181.00	2639	660	3299	
2. Backfill	m3	299	90	10	3024.00	814	90	904	
3. Sheet Pile	m2	6117	60	40	612.00	2246	1497	3744	
4. R.C Pile	m	3264	60	40	7300.00	14296	9531	23827	
5. Concrete	m3	4786	60	40	2213.00	6355	4237	10591	
6. Form	m2	761	80	20	4868.60	2964	741	3705	
7. Re. Bar	t	44717	60	40	199.17	5344	3563	8906	
8. Bed Protection	m2	4613	50	50	792.00	1827	1827	3653	
9. Operation Bridge	m2	65400	55	45	24.00	863	706	1570	
10. Miscellaneous	LS				1.00	1867	1143	3010	
<b>Subtotal</b>						39215	23994	63209	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		47.04	12419		12419	
2. Hoist Machine	m2	176000	100		47.04	8279		8279	
3. Installation	LS	44000	90	10	1.00	1863	207	2070	
4. Miscellaneous	LS	38720	55	45	1.00	1002	820	1821	
<b>Subtotal</b>						23562	1027	24589	
<b>Total</b>						65916	26272	92188	
						0.72	0.28	1	



Table H.3.16(5) CONSTRUCTION COST OF SLUICE GATE :Gate No.18A

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	2855	946	3801	
II. Direct Construction Cost									
1. Excavation	m <sup>3</sup>	324	80	20	11022.00	2857	714	3571	
2. Backfill	m <sup>3</sup>	299	90	10	3193.00	859	95	955	
3. Sheet Pile	m <sup>2</sup>	6117	60	40	641.00	2353	1568	3921	
4. R.C Pile	m	3264	60	40	2434.00	4767	3178	7945	
5. Concrete	m <sup>3</sup>	4786	60	40	2271.00	6521	4348	10869	
6. Form	m <sup>2</sup>	761	80	20	4996.20	3042	760	3802	
7. Re. Bar	t	44717	60	40	204.39	5484	3656	9140	
8. Bed Protection	m <sup>2</sup>	4613	50	50	830.00	1914	1914	3829	
9. Operation Bridge	m <sup>2</sup>	65400	55	45	22.80	820	671	1491	
10. Miscellaneous	LS				1.00	1431	845	2276	
<b>Subtotal</b>						30048	17750	47798	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m <sup>2</sup>	264000	100		54.00	14256		14256	
2. Hoist Machine	m <sup>2</sup>	176000	100		54.00	9504		9504	
3. Installation	LS	44000	90	10	1.00	2138	238	2376	
4. Miscellaneous	LS	38720	55	45	1.00	1150	941	2091	
<b>Subtotal</b>						27048	1178	28227	
<b>Total</b>						59951	19875	79826	

Table H.16(6) CONSTRUCTION COST OF SLUICE GATE :Gate No.18.B

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	2899	976	3875	
II. Direct Construction Cost									
1. Excavation	m <sup>3</sup>	324	80	20	10919.00	2830	708	3538	
2. Backfill	m <sup>3</sup>	299	90	10	3193.00	859	95	955	
3. Sheet Pile	m <sup>2</sup>	6117	60	40	628.00	2305	1537	3841	
4. R.C Pile	m	3264	60	40	2986.00	5848	3899	9746	
5. Concrete	m <sup>3</sup>	4786	60	40	2255.00	6475	4317	10792	
6. Form	m <sup>2</sup>	761	80	20	4961.00	3020	755	3775	
7. Re. Bar	t	44717	60	40	202.95	5445	3630	9075	
8. Bed Protection	m <sup>2</sup>	4613	50	50	805.00	1857	1857	3713	
9. Operation Bridge	m <sup>2</sup>	65400	55	45	22.80	820	671	1491	
10. Miscellaneous	LS				1.00	1473	873	2346	
<b>Subtotal</b>						30933	18341	49274	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m <sup>2</sup>	264000	100		54.00	14256		14256	
2. Hoist Machine	m <sup>2</sup>	176000	100		54.00	9504		9504	
3. Installation	LS	44000	90	10	1.00	2138	238	2376	
4. Miscellaneous	LS	38720	55	45	1.00	1150	941	2091	
<b>Subtotal</b>						27048	1178	28227	
<b>Total</b>						60880	20496	81376	



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Table H.3.16(7) CONSTRUCTION COST OF SLUICE GATE :Gate N0:Sub-1

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	1700	515	2215	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	4377.00	1135	284	1418	
2. Backfill	m3	299	90	10	1428.00	384	43	427	
3. Sheet Pile	m2	6117	60	40	430.00	1578	1052	2630	
4. R.C Pile	m	3264	60	40	1585.00	3104	2069	5173	
5. Concrete	m3	4786	60	40	1227.00	3523	2349	5872	
6. Form	m2	761	80	20	2699.40	1643	411	2054	
7. Re. Bar	t	44717	60	40	110.43	2963	1975	4938	
8. Bed Protection	m2	4613	50	50	190.00	438	438	876	
9. Operation Bridge	m2	65400	55	45	18.00	647	530	1177	
10. Miscellaneous	LS				1.00	552	361	913	
<b>Subtotal</b>						15968	9512	25480	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		36.00	9504		9504	
2. Hoist Machine	m2	176000	100		36.00	6336		6336	
3. Installation	LS	44000	90	10	1.00	1426	158	1584	
4. Miscellaneous	LS	38720	55	45	1.00	767	627	1394	
<b>Subtotal</b>						18032	786	18818	
<b>Total</b>						35701	10812	46513	

Table H.3.17(1) : Construction Cost of Pump Station : G.Dhaka East

1) DC-1: P.5 (Q=25.60m3/s)

Item	Unit	(1991 Price)				Quantity	Construction Cost (1000TK)		
		Unit Cost (TK)		L/C(%)	F/C		L/C	Total	
		Total	F/C(%)						
I. Preparation Work	LS	30,200,188	81	19	1	24,436	5,765	30,200	
II. Civil Work									
1. Excavation	m3	324	80	20	23780	6,164	1,541	7,705	
2. Embankment	m3	509	70	30	18221	6,492	2,782	9,274	
3. Backfill	m3	118	50	50	4546	268	268	536	
4. R.C. Pile (0.4x0.4)	m	3,262	60	40	7735	15,140	10,093	25,233	
5. Sheet Pile (Type II)	m2	6,117	60	40	264	967	645	1,612	
6. Leveling Concrete	m2	3,777	60	40	328	742	495	1,237	
7. Concrete	m3	4,786	60	40	4627	13,288	8,859	22,146	
8. Form	m2	761	80	20	8666	5,276	1,319	6,595	
9. Reinforcement Bar	t	44,717	60	40	455	12,198	8,132	20,331	
10. Slope Protection	m2	1,579	40	60	1439	909	1,363	2,271	
11. Bed Protection (Concrete Block)	m2	4,613	50	50	168	387	387	775	
12. Bed Protection (brick)	m2	1,579	40	60	449	284	426	710	
13. Sodding	m2	60	20	80	2380	29	114	143	
14. Operation Bridge	m2	65,400	55	45	18	647	530	1,177	
15. Building Works	LS	63,500,000	40	60	1	25,400	38,100	63,500	
16. Miscellaneous	LS	16,324,545	54	46	1	8,819	7,505	16,325	
17. Coffor Dam	LS	35,913,999	54	46	1	19,402	16,512	35,914	
Subtotal			54	46		116,412	99,072	215,484	
III. Mechanical & Electrical Work									
1. #2000 Pump	Place	156,000,000	100	0	1	156,000	0	156,000	
2. 560 kw Main Motor	Place	50,736,842	100	0	1	50,737	0	50,737	
3. Pipe and Valve	Place	37,263,158	100	0	1	37,263	0	37,263	
4. Electrical Facilities	LS.	40,000,000	100	0	1	40,000	0	40,000	
5. Crane and Spare Parts	LS.	10,800,000	100	0	1	10,800	0	10,800	
6. Automatic Trash Screen	LS.	27,136,842	100	0	1	27,137	0	27,137	
7. Gate Leaf and Sheet	LS.	3,060,000	100	0	1	3,060	0	3,060	
8. Hoist Machine	LS.	2,040,000	100	0	1	2,040	0	2,040	
9. Installation	LS.	32,703,684	90	10	1	29,433	3,270	32,704	
10. Miscellaneous	LS	28,779,242	55	45	1	15,829	12,951	28,779	
Subtotal			96	4		372,299	16,221	388,520	
Total			81	19		513,147	121,057	634,204	

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

2) DC-2: P.6 (Q=54.60m3/s)

Item	Unit	Unit Cost (TK)		Quantity	Construction Cost (1000TK)			
		Total	F/C(%)		L/C(%)	F/C	L/C	Total
I. Preparation Work	LS	55,401,864	81	19	1	45,038	10,364	55,402
II. Civil Work								
1. Excavation	m3	324	80	20	33574	8,702	2,176	10,878
2. Embankment	m3	509	70	30	17882	6,371	2,731	9,102
3. Backfill	m3	118	50	50	6868	405	405	810
4. R.C. Pile (0.4x0.4)	m	3,262	60	40	13063	25,567	17,045	42,612
5. Sheet Pile (Type II)	m2	6,117	60	40	332	1,218	812	2,030
6. Leveling Concrete	m2	3,777	60	40	544	1,233	822	2,054
7. Concrete	m3	4,786	60	40	8492	24,387	16,258	40,645
8. Form	m2	761	80	20	15776	9,605	2,401	12,006
9. Reinforcement Bar	t	44,717	60	40	837	22,453	14,969	37,421
10. Slope Protection	m2	1,579	40	60	1332	842	1,262	2,104
11. Bed Protection (Concrete Block)	m2	4,613	50	50	126	291	291	581
12. Bed Protection (brick)	m2	1,579	40	60	872	550	826	1,376
13. Sodding	m2	60	20	80	2060	25	99	124
14. Operation Bridge	m2	65,400	55	45	18	647	530	1,177
15. Building Works	LS	122,100,000	40	60	1	48,840	73,260	122,100
16. Miscellaneous	LS	28,501,982	53	47	1	15,114	13,388	28,502
17. Coffor Dam	LS	62,704,360	53	47	1	33,250	29,455	62,704
Subtotal			53	47		199,499	176,728	376,226
III. Mechanical & Electrical Work								
1. #2000 Pump	Place	312,000,000	100	0	1	312,000	0	312,000
2. 560 kw Main Motor	Place	103,705,263	100	0	1	103,705	0	103,705
3. Pipe and Valve	Place	74,526,316	100	0	1	74,526	0	74,526
4. Electrical Facilities	LS	56,000,000	100	0	1	56,000	0	56,000
5. Crane and Spare Parts	LS	10,800,000	100	0	1	10,800	0	10,800
6. Automatic Trash Screen	LS	49,978,947	100	0	1	49,979	0	49,979
7. Gate Leaf and Sheet	LS	5,395,263	100	0	1	5,395	0	5,395
8. Hoist Machine	LS	3,596,842	100	0	1	3,597	0	3,597
9. Installation	LS	61,600,263	90	10	1	55,440	6,160	61,600
10. Miscellaneous	LS	54,208,232	55	45	1	29,815	24,394	54,208
Subtotal			96	4		701,257	30,554	731,811
Total			81	19		945,794	217,645	1,163,439

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



**Table H.3.17(2) : Construction Cost of Pump Station : G.Dhaka East**

3) DC-3: P.7A (Q=53.10m<sup>3</sup>/s)

Item	Unit	Unit Cost (TK)		Quantity	Construction Cost (1000TK)	
		Total	F/C(%)		F/C	L/C
		Total	F/C(%)		F/C	L/C
I. Preparation Work	LS	53,949,712	82	18	44,124	9,826
II. Civil Work						
1. Excavation	m <sup>3</sup>	324	80	48931	12,683	3,171
2. Embankment	m <sup>3</sup>	509	70	13026	4,641	1,989
3. Backfill	m <sup>3</sup>	118	50	9126	538	1,077
4. R.C. Pile (0.4x0.4)	m	3,262	60	6540	12,801	8,534
5. Sheet Pile (Type II)	m <sup>2</sup>	6,117	60	332	1,218	812
6. Leveling Concrete	m <sup>2</sup>	3,777	60	540	1,223	815
7. Concrete	m <sup>3</sup>	4,786	60	8443	24,245	16,163
8. Form	m <sup>2</sup>	761	80	15679	9,545	2,386
9. Reinforcement Bar	t	44,717	60	833	22,340	14,893
10. Slope Protection	m <sup>2</sup>	1,579	40	1715	1,083	1,624
11. Bed Protection (Concrete Block)	m <sup>2</sup>	4,613	50	126	291	291
12. Bed Protection (brick)	m <sup>2</sup>	1,579	40	872	550	826
13. Sodding	m <sup>2</sup>	60	20	1499	18	72
14. Operation Bridge	m <sup>2</sup>	65,400	55	17	611	500
15. Building Works	LS	122,100,000	40	60	48,840	73,260
16. Miscellaneous	LS	26,650,382	53	47	14,063	12,588
17. Coffor Dam	LS	58,630,841	53	47	30,938	27,693
Subtotal			53	47	185,629	166,156
III. Mechanical & Electrical Work						
1. ø2000 Pump	Place	312,000,000	100	0	312,000	0
2. 560 kw Main Motor	Place	100,673,684	100	0	100,674	0
3. Pipe and Valve	Place	74,526,316	100	0	74,526	0
4. Electrical Facilities	LS	55,157,895	100	0	55,158	0
5. Crane and Spare Parts	LS	10,800,000	100	0	10,800	0
6. Automatic Trash Screen	LS	49,978,947	100	0	49,979	0
7. Gate Leaf and Sheet	LS	5,395,263	100	0	5,395	0
8. Hoist Machine	LS	3,596,842	100	0	3,597	0
9. Installation	LS	61,212,895	90	10	55,092	6,121
10. Miscellaneous	LS	53,867,347	55	45	29,627	24,240
Subtotal			96	4	696,848	30,362
Total			82	18	926,601	206,343
						1,132,944

4) DC-4: P.7B (Q=47.20m<sup>3</sup>/s)

Item	Unit	Unit Cost (TK)		Quantity	Construction Cost (1000TK)	
		Total	F/C(%)		F/C	L/C
		Total	F/C(%)		F/C	L/C
I. Preparation Work	LS	53,387,818	81	19	43,505	9,883
II. Civil Work						
1. Excavation	m <sup>3</sup>	324	80	20	12,027	3,007
2. Embankment	m <sup>3</sup>	509	70	11246	4,007	1,717
3. Backfill	m <sup>3</sup>	118	50	10072	594	594
4. R.C. Pile (0.4x0.4)	m	3,262	60	7975	15,608	10,405
5. Sheet Pile (Type II)	m <sup>2</sup>	6,117	60	330	1,210	807
6. Leveling Concrete	m <sup>2</sup>	3,777	60	531	1,204	803
7. Concrete	m <sup>3</sup>	4,786	60	8377	24,055	16,037
8. Form	m <sup>2</sup>	761	80	15535	9,458	2,364
9. Reinforcement Bar	t	44,717	60	826	22,171	14,781
10. Slope Protection	m <sup>2</sup>	1,579	40	1810	1,143	1,715
11. Bed Protection (Concrete Block)	m <sup>2</sup>	4,613	50	126	291	291
12. Bed Protection (brick)	m <sup>2</sup>	1,579	40	872	550	826
13. Sodding	m <sup>2</sup>	60	20	1336	16	64
14. Operation Bridge	m <sup>2</sup>	65,400	55	45	647	530
15. Building Works	LS	122,100,000	40	60	48,840	73,260
16. Miscellaneous	LS	26,902,238	53	47	14,182	12,720
17. Coffor Dam	LS	59,184,925	53	47	31,201	27,984
Subtotal			53	47	187,205	167,904
III. Mechanical & Electrical Work						
1. ø2000 Pump	Place	312,000,000	100	0	312,000	0
2. 560 kw Main Motor	Place	90,694,737	100	0	90,695	0
3. Pipe and Valve	Place	74,526,316	100	0	74,526	0
4. Electrical Facilities	LS	53,684,211	100	0	53,684	0
5. Crane and Spare Parts	LS	10,800,000	100	0	10,800	0
6. Automatic Trash Screen	LS	49,978,947	100	0	49,979	0
7. Gate Leaf and Sheet	LS	4,912,105	100	0	4,912	0
8. Hoist Machine	LS	3,274,737	100	0	3,275	0
9. Installation	LS	59,987,105	90	10	53,988	5,999
10. Miscellaneous	LS	52,788,653	55	45	29,034	23,755
Subtotal			96	4	682,893	29,754
Total			81	19	913,603	207,541
						1,121,144

Note : Bill of Quantities are shown in Table H.0

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



Tble H.3.18 Construction Cost of Khal Improvement : G. Dhaka East

Zone	Khal	Channel Works			Maintenance Road			Banking			Dredging			Total		
		F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
DC-1	KD-1-1	63	251	314	1,588	176	1,764	826	826	1,652	798	3,193	3,991	3,275	4,447	7,721
	KD-1-2	239	954	1,193	6,033	670	6,703	3,139	3,139	6,278	1,073	4,694	5,867	10,584	9,457	20,041
	KD-1-3	289	1,155	1,444	7,303	811	8,114	3,800	3,800	7,599	2,197	8,389	10,486	13,489	14,155	27,644
	KD-1-4	213	854	1,067	5,398	600	5,998	2,808	2,808	5,617	1,027	4,109	5,136	9,447	8,371	17,818
	KD-1-5	126	502	628	3,175	353	3,528	1,652	1,652	3,304	728	2,913	3,641	5,681	5,420	11,101
	KD-2	171	684	855	4,445	494	4,939	2,313	2,313	4,626	59	237	296	6,988	3,728	10,716
	KD-3-1	176	706	882	4,128	459	4,586	2,148	2,148	4,295	0	0	0	6,452	3,312	9,764
	KD-3-2	190	760	950	4,445	494	4,939	2,313	2,313	4,626	0	0	0	6,948	3,567	10,515
	KD-4	10,719	16,078	26,797	3,810	423	4,234	1,982	1,982	3,965	123	491	614	16,634	18,975	35,609
	KD-5-6	132	529	662	3,175	353	3,528	1,652	1,652	3,304	1,030	4,121	5,152	5,990	6,656	12,645
DC-2	KD-5-7	181	722	903	4,445	494	4,939	2,313	2,313	4,626	598	2,391	2,989	7,536	5,920	13,457
	KD-10-1	258	1,032	1,290	6,350	706	7,056	3,304	3,304	6,608	1,251	5,004	6,255	11,163	10,045	21,209
	KD-10-2	17,257	25,885	43,142	6,668	741	7,409	3,469	3,469	6,938	4,905	19,621	24,526	32,299	49,716	82,015
	Sub-Total	30,013	50,115	80,128	60,964	6,774	67,738	31,718	31,718	63,437	13,791	55,162	68,953	136,486	143,769	280,255
	KD-5-1	339	1,358	1,697	7,938	882	8,820	4,130	4,130	8,260	4,720	18,881	23,601	17,128	25,251	42,378
	KD-5-2	95	380	475	2,223	247	2,470	1,156	1,156	2,313	1,573	6,293	7,866	5,047	8,076	13,123
	KD-5-3	190	760	950	4,445	494	4,939	2,313	2,313	4,626	2,538	10,152	12,690	9,486	13,719	23,205
	KD-5-4	272	1,086	1,358	6,350	706	7,056	3,304	3,304	6,608	2,598	10,392	12,990	12,524	15,488	28,012
	KD-5-5	299	1,195	1,493	6,985	776	7,762	3,634	3,634	7,269	1,941	7,763	9,704	12,859	13,368	26,228
	KD-6	238	953	1,191	5,715	635	6,350	2,974	2,974	5,947	433	1,732	2,166	9,360	6,294	15,655
DC-3	KD-7-1	217	869	1,086	5,080	564	5,645	2,643	2,643	5,286	880	3,521	4,401	8,821	7,597	16,418
	KD-7-2	284	1,135	1,419	6,985	776	7,762	3,634	3,634	7,269	744	2,976	3,721	11,648	8,522	20,170
	KD-8	238	953	1,191	5,715	635	6,350	2,974	2,974	5,947	220	879	1,099	9,147	5,441	14,588
	KD-9	132	529	662	3,175	353	3,528	1,652	1,652	3,304	51	202	253	5,010	2,737	7,747
	Sub-Total	2,305	9,218	11,523	54,613	6,068	60,682	28,414	28,414	56,829	15,698	62,792	78,490	101,030	106,493	207,523
	KD-11-1	321	1,284	1,605	6,985	776	7,762	3,634	3,634	7,269	4,319	17,275	21,593	15,260	22,970	38,229
	KD-11-2	394	1,576	1,970	8,573	953	9,526	4,460	4,460	8,921	4,960	19,838	24,798	18,387	26,827	45,214
	KD-11-3	237	946	1,183	5,398	600	5,998	2,808	2,808	5,617	3,521	14,085	17,606	11,964	18,439	30,403
	KD-12-1	155	619	774	3,810	423	4,234	1,982	1,982	3,965	1,203	4,811	6,013	7,150	7,836	14,986
	KD-12-2	146	582	728	4,128	459	4,586	2,148	2,148	4,295	1,141	4,565	5,707	7,562	7,754	15,316
DC-4	KD-13-1	257	1,026	1,283	5,715	635	6,350	2,974	2,974	5,947	471	1,884	2,355	9,417	6,519	15,935
	KD-13-2	167	668	835	3,810	423	4,234	1,982	1,982	3,965	128	510	638	6,087	3,584	9,671
	Sub-Total	1,676	6,703	8,378	38,420	4,269	42,689	19,989	19,989	39,978	15,742	62,967	78,709	75,827	93,928	169,755
	KD-14-1	73	292	365	1,588	176	1,764	826	826	1,652	5,057	20,230	25,287	7,544	21,524	29,068
	KD-14-2	277	1,109	1,386	6,033	670	6,703	3,139	3,139	6,278	4,875	19,500	24,375	14,324	24,418	38,742
	KD-14-3	146	584	730	3,175	353	3,528	1,652	1,652	3,304	3,722	14,887	18,609	8,695	17,476	26,171
	KD-14-4	6,628	9,942	16,569	2,223	247	2,470	1,156	1,156	2,313	1,436	5,743	7,179	11,442	17,088	28,530
	KD-14-5	13,934	20,901	34,835	4,763	529	5,292	2,478	2,478	4,956	3,549	14,194	17,743	24,724	38,103	62,826
	KD-15-1	171	684	855	3,810	423	4,234	1,982	1,982	3,965	1,958	7,830	9,788	7,921	10,920	18,842
	KD-15-2	171	684	855	4,445	494	4,939	2,313	2,313	4,626	2,755	11,021	13,776	9,684	14,512	24,196
DC-5	KD-16	208	831	1,039	5,398	600	5,998	2,808	2,808	5,617	2,512	10,046	12,558	10,926	14,285	25,211
	KD-17-1	88	350	438	1,905	212	2,117	991	991	1,982	204	814	1,018	3,187	2,367	5,555
	KD-17-2	306	1,225	1,531	6,985	776	7,762	3,634	3,634	7,269	2,604	10,415	13,019	13,530	16,050	29,580
	KD-17-3	348	1,393	1,741	8,573	953	9,526	4,460	4,460	8,921	3,752	15,008	18,760	17,134	21,814	38,948
	KD-18-1	306	1,225	1,531	6,985	776	7,762	3,634	3,634	7,269	1,785	7,141	8,926	12,711	12,776	25,487
	KD-18-2	113	452	565	2,858	318	3,175	1,487	1,487	2,974	630	2,519	3,148	5,087	4,775	9,862
	KD-19	226	903	1,129	6,033	670	6,703	3,139	3,139	6,278	450	1,801	2,251	9,848	6,513	16,361
	KD-20-1	157	627	784	3,493	388	3,881	1,817	1,817	3,634	1,507	6,029	7,537	6,974	8,862	15,836
	KD-20-2	11,844	17,766	29,610	4,128	459	4,586	2,148	2,148	4,295	1,094	4,376	5,470	19,213	24,748	43,961
	KD-20-3	11,612	17,418	29,030	4,128	459	4,586	2,148	2,148	4,295	1,470	5,882	7,352	19,358	25,906	45,263
	Sub-Total	46,607	76,385	122,993	76,522	8,502	85,025	39,813	39,813	79,626	39,359	157,437	196,796	202,302	282,138	484,440
	Total	80,601	142,421	223,022	230,520	25,613	256,133	119,935	119,935	239,870	84,589	338,358	422,947	515,645	626,328	1,141,973

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Table H.3.19 Construction Cost of Bridge/Aqueduct : G.Dhaka East

Zone	Khal No.	Bridge No.	Length (m)	Type	Area (m2)	Unit Cost (TK)			Construction Cost (1000TK)			C.D.S.T. (1000Tk)	Remarks
						Total	F/C(%)	L/C(%)	F/C	L/C	Total		
DC-1	KD-5-7	BD-5	9.40	Deck Girder	-	-	-	-	724	730	1,454	315	Railway bridge
	KD-10-1	BD-6	11.20	Girder bridge	40.99	52.00	40	60	853	1,279	2,131	-	Road bridge
	"	BD-7	11.20	" "	40.99	52.00	40	60	853	1,279	2,131	-	" "
	"	BD-8	11.20	" "	40.99	52.00	40	60	853	1,279	2,131	-	" "
	KD-10-2	BD-9	7.00	" "	25.62	72.00	40	60	738	1,107	1,845	-	" "
	"	BD-10	7.00	" "	25.62	72.00	40	60	738	1,107	1,845	-	" "
	"	BD-11	7.00	" "	25.62	72.00	40	60	738	1,107	1,845	-	" "
	"	BD-12	7.00	" "	25.62	72.00	40	60	738	1,107	1,845	-	" "
	"	BD-13	7.00	" "	25.62	72.00	40	60	738	1,107	1,845	-	" "
	Sub Total						41	59	6,971	10,101	17,072	315	
DC-4	KD-14-2	BD-14	25.00	Cantilever	91.50	30.10	47	53	1,294	1,460	2,754	-	Road bridge
	KD-14-5	BD-16	10.00	Girder bridge	36.60	56.00	40	60	820	1,230	2,050	-	" "
	KD-17-2	BD-17	9.60	" "	35.14	57.00	40	60	801	1,202	2,003	-	" "
	KD-20-1	BD-18	8.20	" "	30.01	64.00	40	60	768	1,152	1,921	-	" "
	Sub Total						42	58	3,684	5,044	8,727	0	
Total							41	59	10,655	15,144	25,799	315	

Table H.3.20 Project Cost of DND Area

Unit : Million TK (1991Price)

Phase	Construction Cost (x10 <sup>6</sup> )			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	1,742	914	2,656	
1.Flood Mitigation	82	32	114	
1) Flood.Wall Works	32	18	50	Ref. H.3.23
2)Sluice Gate	49	13	62	Ref. H.3.24
3)Related.Struc.Etc	2	1	3	Ref. H.3.25
2.Storm Water Drainage	1,660	882	2,542	
1).Pump Sta.	1,144	219	1,363	Ref. H.3.26
2).Khal Improve.	467	593	1,059	Ref. H.3.27
3).Bridge,Etc	49	70	119	Ref. H.3.28
B.Physical Contingency	261	137	398	Ax15%
C.Engineering	200	105	305	(A+B)x10%
D.Administration	0	80	80	Ax3%
E.Land Aquisition & Compensation	0	400	400	Ref. H.3.21
F. CDST & Tax		755	755	Ref. H.3.22
Total	2,203	2,392	4,594	



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Table H.3.21 Summary of Land Acquisition and Compensation Cost : DND Area

Project Area	Land Acquisition			Compensation			Total
	Flood Mitigation	Storm Water Drainage	Sub-Total	Flood Mitigation	Storm Water Drainage	Sub-Total	
DND	0.0	338.7	338.7	0.0	61.7	61.7	400.4

Table H.3.22 Summary of C.D.S.T. & Tax : DND Area

Project Area	Flood Mitigation			Storm Water Drainage			Total
	Embankment	Sluice Gate	Sub-Total	Pump Station	Khal Improvement	Sub-Total	
DND	0.0	36.3	36.3	717.0	2.0	719.0	755.3

Table H.3.23 :CONSTRUCTION COST OF FLOOD WALL AND REHABILITATION WORKS : DND AREA

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks (IIx1.05)
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1	1,518	873	2,391	
II. Direct Construction Cost									
1).DW.0-27 (L=10625 m)									
1. Excavation	m3	159	20	80	0	0	0	0	
2. Backfill / Filling	m3	118	50	50	31,040	1,831	1,831	3,663	
3. Concrete	m3	4,786	60	40	0	0	0	0	
4. Form	m2	614	80	20	0	0	0	0	
5. Re. Bar	t	44,717	60	40	0	0	0	0	
6. Brick Solling	m2	588	90	10	0	0	0	0	
7. Sodding	m2	60	20	80	22,424	269	4	273	
8. Miscellaneous	LS				1	92	92	183	
<b>Subtotal</b>						2,192	1,927	4,119	
2).DN.0-22 (L= 8580m)									
1. Excavation	m3	159	20	80	424	13	54	67	
2. Backfill / Filling	m3	118	50	50	69,445	4,097	4,097	8,195	
3. Concrete	m3	4,786	60	40	422	1,212	808	2,020	
4. Form	m2	614	80	20	4,888	2,401	600	3,001	
5. Re. Bar	t	44,717	60	40	30	793	19	812	
6. Brick Solling	m2	588	90	10	145	77	1	77	
7. Sodding	m2	60	20	80	44,428	533	9	542	
8. Miscellaneous	LS				1	426	279	705	
<b>Subtotal</b>						9,552	5,866	15,418	
3).DE.0-26 (L=10155 m)									
1. Excavation	m3	159	20	80	453	14	58	72	
2. Backfill / Filling	m3	118	50	50	75,068	4,429	4,429	8,858	
3. Concrete	m3	4,786	60	40	370	1,062	708	1,771	
4. Form	m2	614	80	20	3,870	1,901	475	2,376	
5. Re. Bar	t	44,717	60	40	26	695	17	712	
6. Brick Solling	m2	588	90	10	263	139	1	140	
7. Sodding	m2	60	20	80	44,734	537	9	545	
8. Miscellaneous	LS				1	405	284	689	
<b>Subtotal</b>						9,183	5,981	15,164	
4).DS.0-6 (L= 2150 m)									
1. Excavation	m3	159	20	80	1,682	53	214	267	
2. Backfill / Filling	m3	118	50	50	13,090	772	772	1,545	
3. Concrete	m3	4,786	60	40	790	2,269	1,512	3,781	
4. Form	m2	614	80	20	7,880	3,871	968	4,838	
5. Re. Bar	t	44,717	60	40	55	1,484	36	1,519	
6. Brick Solling	m2	588	90	10	838	443	4	447	
7. Sodding	m2	60	20	80	10,166	122	2	124	
8. Miscellaneous	LS				1	422	175	598	
<b>Subtotal</b>						9,437	3,683	13,120	
<b>Total</b>						31,881	18,331	50,212	(50 mill.)
Total (Flood Wall)									
I. Preparation of Work					1	1,518	873	2,391	
II. Direct Construction Cost									
1. Excavation	m3	159	20	80	2,559	81	326	407	
2. Backfill / Filling	m3	118	50	50	188,643	11,130	11,130	22,260	
3. Concrete	m3	4,786	60	40	1,582	4,543	3,029	7,571	
4. Form	m2	614	80	20	16,638	8,173	2,043	10,216	
5. Re. Bar	t	44,717	60	40	111	2,971	71	3,042	
6. Brick Solling	m2	588	90	10	1,246	659	6	665	
7. Sodding	m2	60	20	80	121,752	1,461	23	1,484	
8. Miscellaneous	LS				4	1,345	830	2,175	
<b>Subtotal</b>						30,363	17,458	47,821	
<b>Total</b>						31,881	18,331	50,212	

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Table H.3.24 CONSTRUCTION COST OF SLUICE GATE :Gate No.20

Const.Cost Unit : x1000 (TK) (1991 Price)									
Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1	2317	641	2959	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	6635	1720	430	2150	
2. Backfill	m3	299	90	10	1955	526	58	585	
3. Sheet Pile	m2	6117	60	40	580	2129	1419	3548	*
4. R.C Pile	m	3264	60	40	1444	2828	1885	4713	
5. Concrete	m3	4786	60	40	1381	3966	2644	6609	
6. Form	m2	761	80	20	3038	1850	462	2312	
7. Re. Bar	t	44717	60	40	124	3335	2223	5558	
8. Bed Protection	m2	4613	50	50	748	1725	1725	3451	
9. Operation Bridge	m2	65400	55	45	8	302	247	549	
10. Miscellaneous	LS		50	50	1	919	555	1474	
Subtotal						19299	11649	30948	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		54	14256		14256	*
2. Hoist Machine	m2	176000	100		54	9504		9504	*
3. Installation	LS	44000	90	10	1	2138	238	2376	
4. Miscellaneous	LS	38720	55	45	1	1150	941	2091	
Subtotal						27048	1178	28227	
Total						48665	13469	62134	

Table H.3.25 CONSTRUCTION COST OF STOP LOG STRUCTURE

Const.Cost Unit : x1000 (TK) (1991 Price)									
Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1	1.3	0.7	2	
II. Direct Construction Cost									
Per One Place									
1. Excavation	m3	159	20	80	5.9	0.2	0.8	1	
2. Backfill	m3	118	50	50	3.7	0.2	0.2	0	
3. Concrete	m3	4786	60	40	3.0	8.6	5.7	14	
4. Form	m2	614	80	20	19.0	9.3	2.3	12	
5. Re. Bar	t	44717	60	40	0.3	7.2	4.8	12	
6. Miscellaneous	LS		50	50	1	1.3	0.7	2	
Subtotal						26.9	14.6	41	
Total						28.2	15.3	44	
Total (58 Places)									
I. Preparation of Work	LS				1	77.9	42.2	120	
II. Direct Construction Cost									
1. Excavation	m3	159	20	80	342.2	10.9	43.5	54	
2. Backfill	m3	118	50	50	214.6	12.7	12.7	25	
3. Concrete	m3	4786	60	40	174.0	499.7	333.1	833	
4. Form	m2	614	80	20	1102.0	541.3	135.3	677	
5. Re. Bar	t	44717	60	40	15.7	420.2	280.1	700	
6. Miscellaneous	LS		50	50	1	74.2	40.2	114	
Subtotal						1558.9	845.0	2404	
Total						1636.8	887.2	2524	



Table H.3.26 : CONSTRUCTION COST OF PUMP STATION : DND Area

B. DND

1) NA-1: P.10 (Q=14.50m<sup>3</sup>/s)1) NA-2: P.11 (Q=50.20m<sup>3</sup>/s)

Item	Unit	Unit Cost (TK)		Quantity	Construction Cost (1000TK)	
		Total	F/C(%)		F/C	Total
I. Preparation Work	LS	11,370,156	96	1	10,895	475
II. Mechanical & Electrical Work						
1. ø1200 Pump	Place	86,947,365	100	0	86,947	0
2. 170 kw Main Motor	Place	33,078,145	100	0	33,078	0
3. Pipe and Valve	Place	23,729,889	100	0	23,730	0
4. Electrical Facilities	LS.	40,000,000	100	0	40,000	0
5. Crane and Spare Parts	LS.	3,500,000	100	0	3,500	0
6. Gate Leaf and Sheet	LS.	2,496,823	100	0	2,497	0
7. Hoist Machine	LS.	1,664,548	100	0	1,665	0
8. Installation	LS.	19,141,677	90	10	17,228	1,914
9. Miscellaneous	LS	16,844,676	55	45	9,265	7,580
Subtotal			96	4	217,909	9,494
Total			96	4	228,804	9,969

(1991 Price)

(1991 Price)

Item	Unit	Unit Cost (TK)		Quantity	Construction Cost (1000TK)	
		Total	F/C(%)		F/C	Total
I. Preparation Work	LS	53,553,249	81	19	43,602	9,951
II. Civil Work						
1. Excavation	m <sup>3</sup>	324	80	20	14,047	3,512
2. Embankment	m <sup>3</sup>	509	70	30	6,660	2,854
3. Backfill	m <sup>3</sup>	118	50	50	881	881
4. R.C. Pile (0.4x0.4)	m	3,262	60	40	14,207	9,471
5. Sheet Pile (Type II)	m <sup>2</sup>	6,117	60	40	1,241	827
6. Leveling Concrete	m <sup>2</sup>	3,777	60	40	1,244	830
7. Concrete	m <sup>3</sup>	4,786	60	40	23,971	15,980
8. Form	m <sup>2</sup>	761	80	20	15,496	39,951
9. Reinforcement Bar	t	44,717	60	40	823	2,358
10. Slope Protection	m <sup>2</sup>	1,579	40	60	22,087	14,724
11. Bed Protection (Concrete Block)	m <sup>2</sup>	4,613	50	50	1,402	2,103
12. Bed Protection (brick)	m <sup>2</sup>	1,579	40	60	339	339
13. Sodding	m <sup>2</sup>	60	20	80	550	826
14. Operation Bridge	m <sup>2</sup>	65,400	55	45	8	30
15. Building Works	LS	122,100,000	40	60	11	396
16. Miscellaneous	LS	27,362,496	53	47	48,840	73,260
17. Coffor Dam	LS	60,197,492	53	47	14,531	12,832
Subtotal			53	47	31,967	28,230
					191,803	169,382
III. Mechanical & Electrical Work						
1. ø2000 Pump	Place	312,000,000	100	0	312,000	0
2. 560 kw Main Motor	Place	89,305,263	100	0	89,305	0
3. Pipe and Valve	Place	74,526,316	100	0	74,526	0
4. Electrical Facilities	LS.	53,684,211	100	0	53,684	0
5. Crane and Spare Parts	LS.	10,800,000	100	0	10,800	0
6. Automatic Trash Screen	LS.	49,978,947	100	0	49,979	0
7. Gate Leaf and Sheet	LS.	4,348,421	100	0	4,348	0
8. Hoist Machine	LS.	2,898,947	100	0	2,899	0
9. Installation	LS.	59,754,211	90	10	53,779	5,975
10. Miscellaneous	LS	52,583,705	55	45	28,921	23,663
Subtotal			96	4	680,242	29,638
Total			81	19	915,647	208,971
						1,124,618

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

**Tble H.3.27 Construction Cost of Khal Improvement : DND Area**

Zone	Khal	Channel Works			Maintenance Road			Banking			Dredging			Total		
		F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
NA-1	KN-1-1	18,758	28,136	46,894	6,668	741	7,409	3,469	3,469	6,938	708	2,833	3,541	29,603	35,179	64,782
	KN-1-2	95	380	475	2,223	247	2,470	1,156	1,156	2,313	1,095	4,381	5,476	4,569	6,164	10,734
	KN-1-3	136	543	679	3,175	332	3,528	1,652	1,652	3,304	1,368	5,472	6,840	6,331	8,020	14,351
	KN-1-4	81	326	407	1,905	212	2,117	991	991	1,982	378	1,514	1,892	3,356	6,399	10,351
	KN-1-5	244	978	1,222	5,715	635	6,350	2,974	2,974	5,947	2,445	9,779	12,224	11,378	14,365	25,743
	KN-1-6	185	741	927	4,445	494	4,939	2,313	2,313	4,626	1,586	6,342	7,928	8,529	9,890	18,419
	KN-1-7	138	554	692	3,810	423	4,234	1,982	1,982	3,965	938	3,754	4,692	6,870	6,713	13,583
	KN-1-8	4,395	6,592	10,987	1,905	212	2,117	991	991	1,982	188	752	940	7,479	8,547	16,025
	KN-2-1	212	847	1,059	5,080	564	5,645	2,643	2,643	5,286	1,093	4,371	5,463	9,028	8,425	17,453
	KN-2-2	12,862	19,293	32,156	5,080	564	5,645	2,643	2,643	5,286	678	2,712	3,390	21,264	25,213	46,477
	KN-3	225	900	1,125	5,398	600	5,998	2,808	2,808	5,617	534	2,134	2,668	8,965	6,443	15,408
	KN-13	159	635	794	3,810	423	4,234	1,982	1,982	3,965	1,251	5,005	6,257	7,203	8,046	15,249
	KN-14-1	199	794	993	4,763	529	5,292	2,478	2,478	4,956	1,532	6,128	7,661	8,971	9,930	18,901
	KN-14-2	193	774	967	4,763	529	5,292	2,478	2,478	4,956	1,154	4,617	5,772	8,589	8,398	16,987
	KN-14-3	11,719	17,579	29,298	5,080	564	5,645	2,643	2,643	5,286	880	3,521	4,401	20,323	24,307	44,630
	KN-15	174	695	869	5,080	564	5,645	2,643	2,643	5,286	372	1,487	1,859	8,269	5,390	13,659
	KN-16	18,472	27,708	46,179	6,985	776	7,762	3,634	3,634	7,269	1,369	5,475	6,843	30,460	37,593	68,053
	Sub-Total	68,247	107,475	175,723	75,887	8,432	84,319	39,483	39,483	78,966	17,569	70,277	87,846	201,186	225,667	426,853
NA-2	KN-4-1	16,721	25,082	41,803	5,715	635	6,350	2,974	2,974	5,947	7,300	29,200	36,500	32,710	57,890	90,600
	KN-4-2	185	741	927	4,128	459	4,586	2,148	2,148	4,295	3,774	15,096	18,870	10,235	18,444	28,678
	KN-4-3	171	684	855	3,810	423	4,234	1,982	1,982	3,965	1,960	7,842	9,802	7,924	10,932	18,856
	KN-4-4	204	815	1,018	4,763	529	5,292	2,478	2,478	4,956	2,351	9,404	11,755	9,795	13,226	23,021
	KN-4-5	14,792	22,188	36,979	5,715	635	6,350	2,974	2,974	5,947	792	3,169	3,961	24,273	28,965	53,237
	KN-4-6	6,145	9,218	15,363	2,540	282	2,822	1,322	1,322	2,643	661	2,646	3,307	10,669	13,468	24,136
	KN-5-1	250	1,002	1,252	5,715	635	6,350	2,974	2,974	5,947	8,171	32,685	40,857	17,111	37,296	54,407
	KN-5-2	8,932	13,398	22,330	3,175	353	3,528	1,652	1,652	3,304	2,138	8,552	10,690	15,897	23,955	39,852
	KN-6	122	489	611	2,858	318	3,175	1,487	1,487	2,974	586	2,346	2,932	5,053	4,639	9,692
	KN-7-1	342	1,369	1,711	7,620	847	8,467	3,965	3,965	7,930	6,240	24,960	31,201	18,168	31,140	49,308
	KN-7-2	114	456	570	2,540	282	2,822	1,322	1,322	2,643	1,349	5,395	6,743	5,324	7,455	12,779
	KN-7-3	10,933	16,399	27,332	3,810	423	4,234	1,982	1,982	3,965	789	3,157	3,946	17,515	21,962	39,477
	KN-7-4	11,755	17,632	29,387	4,445	494	4,939	2,313	2,313	4,626	1,091	4,363	5,454	19,604	24,802	44,405
	KN-7-5	6,288	9,432	15,721	2,540	282	2,822	1,322	1,322	2,643	277	1,107	1,383	10,427	12,143	22,570
	KN-8	139	557	696	3,175	353	3,528	1,652	1,652	3,304	653	3,266	4,613	5,620	5,174	10,794
	KN-9	181	724	905	4,128	459	4,586	2,148	2,148	4,295	996	3,984	4,980	7,452	7,314	14,766
	KN-10	220	880	1,100	5,715	635	6,350	2,974	2,974	5,947	636	3,840	4,800	9,545	7,032	16,577
	KN-11	195	779	974	4,445	494	4,939	2,313	2,313	4,626	960	3,840	4,800	7,913	7,426	15,339
	KN-12	13,148	19,722	32,870	5,080	564	5,645	2,643	2,643	5,286	285	1,140	1,425	21,157	24,070	45,226
	KN-17	178	713	891	4,763	529	5,292	2,478	2,478	4,956	1,505	6,019	7,524	8,924	9,739	18,663
	Sub-Total	91,016	142,279	233,295	86,683	9,631	96,314	45,100	45,100	90,199	42,515	170,060	212,575	265,314	367,070	632,384
	Total	159,263	249,755	409,018	162,570	18,063	180,634	84,582	84,582	169,165	60,084	240,337	300,421	466,500	592,737	1,059,237

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Table H.3.28 Construction Cost of Bridge/Aqueduct : DND Area

													(1991 Price)
Zone	Khal No.	Bridge No.	Length (m)	Type	Area (m2)	Unit Cost (TK)			Construction Cost (1000TK)			C.D.S.T. (1000Tk)	Remarks
						Total	F/C(%)	L/C(%)	F/C	L/C	Total		
NA-1	KN-1-2	BN-3	15.80	Girder bridge	632.00	43.00	40	60	10,870	16,306	27,176	-	Highway bridge
	KN-1-3	BN-4	14.70	" "	53.80	45.00	40	60	968	1,453	2,421	-	Road bridge
	KN-1-5	BN-5	12.60	" "	504.00	48.00	40	60	9,677	14,515	24,192	-	Highway bridge
	KN-1-6	BN-6	11.50	" "	42.09	52.00	40	60	875	1,313	2,189	-	Road bridge
	NA -2-1	BN-9	7.00	Rect. Aqueduct	-	-	-	-	629	1,010	1,639	-	Rect. Aqueduct
	"	BN-10	6.70	Girder bridge	24.52	74.00	40	60	726	1,089	1,814	-	Road brige
	"	BN-11	6.80	" "	24.89	73.00	40	60	727	1,090	1,817	-	" "
	"	BN-12	6.80	" "	24.89	73.00	40	60	727	1,090	1,817	-	" "
	KN-2-2	BN-13	3.80	Slab bridge	13.91	112.40	40	60	625	938	1,563	-	" "
	"	BN-14	4.00	" "	14.64	112.30	40	60	658	986	1,644	-	" "
	KN-3	BN-15	6.80	Girder bridge	24.89	73.00	40	60	727	1,090	1,817	-	" "
	KN-13	BN-16	6.70	" "	24.52	74.00	40	60	726	1,089	1,814	-	" "
	KN-14-3	BN-17	3.00	Slab bridge	21.00	113.50	40	60	953	1,430	2,384	-	" "
	KN-15	BN-18	5.00	" "	18.30	111.50	40	60	816	1,224	2,040	-	" "
	Sub Total						40	60	29,705	44,623	74,328	0	
NA-2	KN-4-1	BN-19	26.10	Deck Girder	-	-	-	-	1,430	1,092	2,522	878	Railway birdge
	"	BN-20	26.10	Cantilever	95.53	29.30	47	53	1,316	1,483	2,799	-	Road bridge
	"	BN-21	26.10	Deck Girder	-	-	-	-	1,430	1,092	2,522	878	Railway birdge
	KN-4-3	BN-22	13.20	Girder birdge	48.31	47.00	40	60	908	1,362	2,271	-	Road bridge
	"	BN-23	13.20	" "	48.31	47.00	40	60	908	1,362	2,271	-	" "
	KN-4-4	BN-24	9.40	" "	34.40	58.00	40	60	798	1,197	1,995	-	" "
	"	BN-25	9.50	" "	34.77	57.50	40	60	800	1,200	1,999	-	" "
	KN-4-5	BN-26	5.00	Slab bridge	18.30	111.50	40	60	816	1,224	2,040	-	" "
	"	BN-27	5.10	Girder birdge	18.67	90.00	40	60	672	1,008	1,680	-	" "
	"	BN-28	5.10	" "	18.67	90.00	40	60	672	1,008	1,680	-	" "
	"	BN-29	5.20	" "	19.03	89.00	40	60	677	1,016	1,694	-	" "
	KN-4-6	BN-30	4.40	Deck Girder	-	-	-	-	420	464	884	147	Railway bridge
	KN-7-1	BN-35	15.00	Rect. Aqueduct	-	-	-	-	999	1,554	2,553	-	Rect. Aqueduct
	"	BN-36	14.30	Girder Bridge	52.34	46.00	40	60	963	1,445	2,408	-	Road bridge
	KN-7-4	BN-37	5.30	" "	19.40	87.00	40	60	675	1,013	1,688	-	" "
	"	BN-38	5.30	" "	19.40	87.00	40	60	675	1,013	1,688	-	" "
	"	BN-39	5.35	" "	19.58	86.00	40	60	674	1,010	1,684	-	" "
	"	BN-40	5.45	" "	19.95	85.00	40	60	678	1,017	1,696	-	" "
	"	BN-41	5.50	" "	20.35	84.00	40	60	684	1,026	1,709	-	" "
	"	BN-42	5.56	" "	20.35	83.50	40	60	680	1,020	1,699	-	" "
	Kn-7-5	BN-43	3.50	Deck Girder	-	-	-	-	367	420	787	117	Railway bridge
	KN-9	BN-44	7.00	Girder	25.62	72.00	40	60	738	1,107	1,845	-	Road bridge
	KN-10	BN-46	6.30	Girder bridge	23.06	77.00	40	60	710	1,065	1,776	-	" "
	"	BN-47	6.30	" "	23.06	77.00	40	60	710	1,065	1,776	-	" "
	KN-12	BN-48	3.60	Slab bridge	13.18	112.70	40	60	594	891	1,485	-	" "
	KN-17	BN-49	6.20	Girder bridge	22.69	78.00	40	60	708	1,062	1,770	-	" "
		Sub Total						42	58	20,703	28,217	48,920	2,020
	Total						41	59	50,407	72,841	123,248	2,020	



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**Table H.3.29 Project Cost of Narayanganj West**

Unit : Million TK (1991Price)

Phase	Construction Cost (x10 <sup>6</sup> )			Remarks
Project Area	F/C	L/C	Total	
A. Construction Cost	1,421	633	2,054	
1. Flood Mitigation	757	302	1,060	
1). Embankment	478	208	686	Ref. H.3.32
2). Flood Wall	159	52	211	Ref. H.3.33
3). Sluice Gate	120	42	162	Ref. H.3.34
4). Related Struc. Etc	1	0	1	Ref. H.3.36
2. Storm Water Drainage	663	331	994	
1). Pump Sta.	440	96	536	Ref. H.3.37
2). Khal Improve.	216	223	439	Ref. H.3.39
3). Bridge, Etc	8	12	19	Ref. H.3.40
B. Physical Contingency	213	94	307	Ax15%
C. Engineering	163	73	236	(A+B)x10%
D. Administration	0	62	62	Ax3%
E. Land Acquisition & Compensation	0	1,082	1,082	Ref. H.3.30
F. CDST & Tax	0	356	356	Ref. H.3.31
Total	1,797	2,299	4,097	

Table H.3.30 Summary of Land Acquisition and Compensation Cost : Narayanganj West

Project Area	Land Acquisition			Compensation			Total
	Flood Mitigation	Storm Water Drainage	Sub-Total	Flood Mitigation	Storm Water Drainage	Sub-Total	
N. West	703.8	212.5	916.3	126.3	39.2	165.5	1,081.8

Table H.3.31 Summary of C.D.S.T. & Tax : Narayanganj West

Project Area	Flood Mitigation			Storm Water Drainage			Total
	Embankment	Sluice Gate	Sub-Total	Pump Station	Khal Improvement	Sub-Total	
N. West	18.9	82.4	101.3	254.1	0.4	254.5	355.8

Table H. 3.32 CONSTRUCTION COST OF EMBANKMENT :NARAYANGANJ WEST

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS	-			1	22,752	9,917	32,668	
II. Direct Construction Cost									
1). Sta.NW.0-29:									
1. Excavation	m3	324	80	20	11,278	2,923	731	3,654	
2. Banking	m3	509	70	30	161,641	57,593	24,683	82,275	
3. Foundation	m2	1,132	60	40	0				
4. Revetment Work	m2	1,635	70	30	0				
5. Maint.Road	m2	588	90	10	19,995	10,581	1,176	11,757	
6. Sodding	m2	60	20	80	88,422	1,061	4,244	5,305	
7. Miscellaneous	LS				1	3,608	1,542	5,150	
<b>Sub-Total</b>						75,766	32,375	108,141	
2).Sta.NE.48-55									
1. Excavation	m3	324	80	20	6,900	1,788	447	2,236	
2. Banking	m3	509	70	30	196,783	70,114	30,049	100,163	
3. Foundation	m2	1,132	60	40	0				
4. Revetment Work	m2	1,635	70	30	24,971	28,579	12,248	40,828	
5. Maint.Road	m2	588	90	10	17,250	9,129	1,014	10,143	
6. Sodding	m2	60	20	80	50,565	607	2,427	3,034	
7. Miscellaneous	LS				1	5,511	2,309	7,820	
<b>Sub-Total</b>						115,728	48,495	164,223	
3).Sta.NE.62-87									
1. Excavation	m3	324	80	20	13,800	3,577	894	4,471	
2. Banking	m3	509	70	30	320,609	114,233	48,957	163,190	
3. Foundation	m2	1,132	60	40	48,475	32,924	21,949	54,874	
4. Revetment Work	m2	1,635	70	30	70,939	81,190	34,796	115,985	
5. Maint.Road	m2	588	90	10	34,500	18,257	2,029	20,286	
6. Sodding	m2	60	20	80	67,570	811	3,243	4,054	
7. Miscellaneous	LS				1	12,550	5,593	18,143	
<b>Sub-Total</b>						263,542	117,462	381,003	
<b>Total (II)</b>						455,036	198,332	653,367	
<b>Total (I+II)</b>						477,788	208,248	686,036	
						1	0	1	
Total:									
I. Preparation of Work	LS	-			1	22,752	9,917	32,668	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	31,978	8,289	2,072	10,361	
2. Banking	m3	509	70	30	679,033	241,939	103,688	345,628	
3. Foundation	m2	1,132	60	40	48,475	32,924	21,949	54,874	
4. Revetment Work	m2	1,635	70	30	95,910	109,769	47,044	156,813	
5. Maint.Road	m2	588	90	10	71,745	37,967	4,219	42,186	
6. Sodding	m2	60	20	80	206,557	2,479	9,915	12,393	
7. Miscellaneous	LS				3	21,668	9,444	31,113	
<b>Total (II)</b>						455,036	198,332	653,367	
<b>Total (I+II)</b>						477,788	208,248	686,036	
III Land Acquisition									
1). Sta.NW.0-29	m2	740		100	285,839		211,521		
2). Sta.NE.48-55	m2	740		100	201,763		149,305		
3). Sta.NE.62-87	m2	740		100	385,344		285,155		
<b>Total</b>					872,946		645,980		





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Table H.3.33 CONSTRUCTION COST OF FLOOD WALL :NARAYANGANJ WEST

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1	7,570	2,455	10,025	
II. Direct Construction Cost									
1).NE.0-48 (L=9600m)									
1. Excavation	m3	159	20	80	26,204	833	3,333	4,166	
2. Backfill & Filling	m3	118	50	50	16,135	952	952	1,904	
3. Concrete	m3	4,786	60	40	14,129	40,573	27,049	67,621	
4. Form	m2	614	80	20	65,321	32,086	8,021	40,107	
5. Re. Bar	t	44,717	60	40	989	26,536	637	27,173	
6. Foot Protection	m2	588	90	10	43,415	22,975	207	23,182	
7. Miscellaneous	LS				1	5,049	2,000	7,049	
<b>Subtotal</b>						129,004	42,198	171,202	
2).NE.55-62 (L=1580 m)									
1. Excavation	m3	159	20	80	3,850	122	490	612	
2. Backfill & Filling	m3	118	50	50	2,361	139	139	279	
3. Concrete	m3	4,786	60	40	2,080	5,973	3,982	9,955	
4. Form	m2	614	80	20	10,180	5,000	1,250	6,251	
5. Re. Bar	t	44,717	60	40	146	3,906	94	4,000	
6. Foot Protection	m2	588	90	10	7,100	3,757	34	3,791	
7. Miscellaneous	LS				1	757	298	1,055	
<b>Subtotal</b>						19,656	6,286	25,942	
3).NE.87-88 (L=500 m)									
1. Excavation	m3	159	20	80	325	10	41	52	
2. Backfill & Filling	m3	118	50	50	250	15	15	30	
3. Concrete	m3	4,786	60	40	175	503	335	838	
4. Form	m2	614	80	20	1,500	737	184	921	
5. Re. Bar	t	44,717	60	40	12	329	8	337	
6. Foot Protection	m2	588	90	10	2,000	1,058	10	1,068	
7. Miscellaneous	LS				1	80	29	109	
<b>Subtotal</b>						2,731	622	3,353	
<b>Total</b>						158,960	51,562	210,522	
<b>Total</b>									
I. Preparation of Work						7,570	2,455		
II. Direct Construction Cost									
1. Excavation	m3	159	20	80	30,379	966	3,864	4,830	
2. Backfill & Filling	m3	118	50	50	18,746	1,106	1,106	2,212	
3. Concrete	m3	4,786	60	40	16,384	47,048	31,366	78,414	
4. Form	m2	614	80	20	77,001	37,823	9,456	47,279	
5. Re. Bar	t	44,717	60	40	1,147	30,771	739	31,510	
6. Foot Protection	m2	588	90	10	52,515	27,791	250	28,041	
7. Miscellaneous	LS				3	5,886	2,326	8,212	
<b>Subtotal</b>						151,391	49,107	200,498	
<b>Total</b>						158,960	51,562	210,522	
<b>Total</b>									
Land Acquisition									
1).Commercial Area	m2	1,230		100	34,975		43,019	43,019	
2).Non Commercial	m2	740		100	20,000		14,800	14,800	
<b>Total</b>					54,975		57,819	57,819	

Table H.3.34 Summary of Construction Cost of Sluice Gate

Unit : Million Tk. (1991 Price)

No. of sluice Gate	Construction Cos (x1000)			Remarks
	F/C	L/C	Total	
21	6,266	2,775	9,041	Ref.H.3.35(1)
22	12,612	5,566	18,178	Ref.H.3.35(2)
23	13,006	5,605	18,611	Ref.H.3.35(3)
24	10,878	3,869	14,747	Ref.H.3.35(4)
25	4,943	1,379	6,322	Ref.H.3.35(5)
26	4,944	1,379	6,323	Ref.H.3.35(6)
27	4,945	1,380	6,325	Ref.H.3.35(7)
28	4,947	1,380	6,327	Ref.H.3.35(8)
29	6,436	1,354	7,790	Ref.H.3.35(9)
30	4,871	1,205	6,076	Ref.H.3.35(10)
31	3,925	1,239	5,164	Ref.H.3.35(11)
32	3,961	1,061	5,022	Ref.H.3.35(12)
33A	17,391	7,113	24,504	Ref.H.3.35(13)
33B	20,467	7,067	27,534	Ref.H.3.35(14)
<b>Total</b>	<b>119,592</b>	<b>42,372</b>	<b>161,964</b>	

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Table H.3.35 (1) BREAKDOWN OF CONSTRUCTION COST OF SLUICE GATE :GATE NO.21

Const.Cost Unit : x1000 (TK) (1991 Price)									
Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	298	132	431	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	365.00	95	24	118	
2. Backfill	m3	299	90	10	232.00	62	7	69	
3. Sheet Pile	m2	6117	60	40	194.00	712	475	1187	
4. R.C Pile	m	3264	60	40	168.00	329	219	548	
5. Concrete	m3	4786	60	40	216.00	620	414	1034	
6. Form	m2	761	80	20	475.20	289	72	362	
7. Re. Bar	t	44717	60	40	19.44	522	348	869	
8. Bed Protection	m2	4613	50	50	147.00	339	339	678	
9. Operation Bridge	m2	65400	55	45	18.00	647	530	1177	
10. Miscellaneous	LS				1.00	181	121	302	
Subtotal						3797	2548	6345	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	396000	100		2.89	1144		1144	
2. Hoist Machine	m2	264000	100		2.89	763		763	
3. Installation	LS	66000	90	10	1.00	172	19	191	
4. Miscellaneous	LS	58080	55	45	1.00	92	76	168	
Subtotal						2171	95	2266	
Total						6266	2775	9041	

Table H.3.35 (2) BREAKDOWN OF CONSTRUCTION COST OF SLUICE GATE :GATE NO.22

Const.Cost Unit : x1000 (TK) (1991 Price)									
Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	601	265	866	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	2917.00	756	189	945	
2. Backfill	m3	299	90	10	2012.00	541	60	602	
3. Sheet Pile	m2	6117	60	40	298.00	1094	729	1823	
4. R.C Pile	m	3264	60	40	485.00	950	633	1583	
5. Concrete	m3	4786	60	40	526.00	1510	1007	2517	
6. Form	m2	761	80	20	1157.20	705	176	881	
7. Re. Bar	t	44717	60	40	47.34	1270	847	2117	
8. Bed Protection	m2	4613	50	50	312.00	720	720	1439	
9. Operation Bridge	m2	65400	55	45	18.60	669	547	1216	
10. Miscellaneous	LS				1.00	411	245	656	
Subtotal						8626	5154	13779	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		6.76	1785		1785	
2. Hoist Machine	m2	176000	100		6.76	1190		1190	
3. Installation	LS	44000	90	10	1.00	268	30	297	
4. Miscellaneous	LS	38720	55	45	1.00	144	118	262	
Subtotal						3386	148	3534	
Total						12612	5566	18178	



Table H.3.35(3) CONSTRUCTION COST OF SLUICE GATE :GATE NO.23

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	619	267	886	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	763.00	198	49	247	
2. Backfill	m3	299	90	10	416.00	112	12	124	
3. Sheet Pile	m2	6117	60	40	312.00	1145	763	1909	
4. R.C Pile	m	3264	60	40	524.00	1026	684	1710	
5. Concrete	m3	4786	60	40	547.00	1571	1047	2618	
6. Form	m2	761	80	20	1203.40	733	183	916	
7. Re. Bar	t	44717	60	40	49.23	1321	881	2201	
8. Bed Protection	m2	4613	50	50	316.00	729	729	1458	
9. Operation Bridge	m2	65400	55	45	18.60	669	547	1216	
10. Miscellaneous	LS				1.00	375	245	620	
<b>Subtotal</b>						7878	5141	13020	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		9.00	2376		2376	
2. Hoist Machine	m2	176000	100		9.00	1584		1584	
3. Installation	LS	44000	90	10	1.00	356	40	396	
4. Miscellaneous	LS	38720	55	45	1.00	192	157	348	
<b>Subtotal</b>						4508	196	4704	
<b>Total</b>						13006	5605	18611	

Table H.3.35(4) CONSTRUCTION COST OF SLUICE GATE :GATE NO.24

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	518	184	702	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	788.00	204	51	255	
2. Backfill	m3	299	90	10	369.00	99	11	110	
3. Sheet Pile	m2	6117	60	40	254.00	932	621	1554	
4. R.C Pile	m	3264	60	40	491.00	962	641	1603	
5. Concrete	m3	4786	60	40	386.00	1108	739	1847	
6. Form	m2	761	80	20	849.20	517	129	646	
7. Re. Bar	t	44717	60	40	34.74	932	621	1553	
8. Bed Protection	m2	4613	50	50	214.00	494	494	987	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	262	165	428	
<b>Subtotal</b>						5511	3473	8984	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		9.68	2556		2556	
2. Hoist Machine	m2	176000	100		9.68	1704		1704	
3. Installation	LS	44000	90	10	1.00	383	43	426	
4. Miscellaneous	LS	38720	55	45	1.00	206	169	375	
<b>Subtotal</b>						4849	211	5060	
<b>Total</b>						10878	3869	14747	

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Table H.3.35(5) BREAKDOWN OF CONSTRUCTION COST OF SLUICE GATE :GATE NO..25

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	235	66	301	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	126.00	33	8	41	
2. Backfill	m3	299	90	10	78.00	21	2	23	
3. Sheet Pile	m2	6117	60	40	177.00	650	433	1083	*
4. R.C Pile	m	3264	60	40	51.00	100	67	166	
5. Concrete	m3	4786	60	40	73.00	210	140	349	
6. Form	m2	761	80	20	160.60	98	24	122	
7. Re. Bar	t	44717	60	40	6.57	176	118	294	
8. Bed Protection	m2	4613	50	50	145.00	334	334	669	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	81	56	137	
<b>Subtotal</b>						1702	1183	2885	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	396000	100		4.00	1584		1584	*
2. Hoist Machine	m2	264000	100		4.00	1056		1056	*
3. Installation	LS	66000	90	10	1.00	238	26	264	
4. Miscellaneous	LS	58080	55	45	1.00	128	105	232	
<b>Subtotal</b>						3005	131	3136	
<b>Total</b>						4943	1379	6322	

Table H.3.35(6) BREAKDOWN OF CONSTRUCTION COST OF SLUICE GATE :GATE NO.26

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	235	66	301	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	127.00	33	8	41	
2. Backfill	m3	299	90	10	79.00	21	2	24	
3. Sheet Pile	m2	6117	60	40	177.00	650	433	1083	*
4. R.C Pile	m	3264	60	40	51.00	100	67	166	
5. Concrete	m3	4786	60	40	73.00	210	140	349	
6. Form	m2	761	80	20	160.60	98	24	122	
7. Re. Bar	t	44717	60	40	6.57	176	118	294	
8. Bed Protection	m2	4613	50	50	145.00	334	334	669	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	81	56	137	
<b>Subtotal</b>						1703	1183	2886	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	396000	100		4.00	1584		1584	*
2. Hoist Machine	m2	264000	100		4.00	1056		1056	*
3. Installation	LS	66000	90	10	1.00	238	26	264	
4. Miscellaneous	LS	58080	55	45	1.00	128	105	232	
<b>Subtotal</b>						3005	131	3136	
<b>Total</b>						4944	1379	6323	



Table H.3.35(7) BREAKDOWN OF CONSTRUCTION COST OF SLUICE GATE :GATE NO.27

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	235	66	301	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	131.00	34	8	42	
2. Backfill	m3	299	90	10	81.00	22	2	24	
3. Sheet Pile	m2	6117	60	40	177.00	650	433	1083	*
4. R.C Pile	m	3264	60	40	51.00	100	67	166	
5. Concrete	m3	4786	60	40	73.00	210	140	349	
6. Form	m2	761	80	20	160.60	98	24	122	
7. Re. Bar	t	44717	60	40	6.57	176	118	294	
8. Bed Protection	m2	4613	50	50	145.00	334	334	669	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	81	56	138	
<b>Subtotal</b>						1705	1183	2888	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	396000	100		4.00	1584		1584	*
2. Hoist Machine	m2	264000	100		4.00	1056		1056	*
3. Installation	LS	66000	90	10	1.00	238	26	264	
4. Miscellaneous	LS	58080	55	45	1.00	128	105	232	
<b>Subtotal</b>						3005	131	3136	
<b>Total</b>						4945	1380	6325	

Table H.3.35(8) BREAKDOWN OF CONSTRUCTION COST OF SLUICE GATE :Gate No.28

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	236	66	301	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	133.00	34	9	43	
2. Backfill	m3	299	90	10	83.00	22	2	25	
3. Sheet Pile	m2	6117	60	40	177.00	650	433	1083	*
4. R.C Pile	m	3264	60	40	51.00	100	67	166	
5. Concrete	m3	4786	60	40	73.00	210	140	349	
6. Form	m2	761	80	20	160.60	98	24	122	
7. Re. Bar	t	44717	60	40	6.57	176	118	294	
8. Bed Protection	m2	4613	50	50	145.00	334	334	669	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	81	56	138	
<b>Subtotal</b>						1706	1183	2889	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	396000	100		4.00	1584		1584	*
2. Hoist Machine	m2	264000	100		4.00	1056		1056	*
3. Installation	LS	66000	90	10	1.00	238	26	264	
4. Miscellaneous	LS	58080	55	45	1.00	128	105	232	
<b>Subtotal</b>						3005	131	3136	
<b>Total</b>						4947	1380	6327	



Table H.3.35(9) CONSTRUCTION COST OF SLUICE GATE :GATE NO.29

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	306	64	371	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	123.00	32	8	40	
2. Backfill	m3	299	90	10	66.00	18	2	20	
3. Sheet Pile	m2	6117	60	40	183.00	672	448	1119	*
4. R.C Pile	m	3264	60	40	75.00	147	98	245	
5. Concrete	m3	4786	60	40	69.00	198	132	330	
6. Form	m2	761	80	20	151.80	92	23	116	
7. Re. Bar	t	44717	60	40	6.21	167	111	278	
8. Bed Protection	m2	4613	50	50	95.00	219	219	438	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	77	52	129	
<b>Subtotal</b>						1622	1093	2715	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		9.00	2376		2376	*
2. Hoist Machine	m2	176000	100		9.00	1584		1584	*
3. Installation	LS	44000	90	10	1.00	356	40	396	
4. Miscellaneous	LS	38720	55	45	1.00	192	157	348	
<b>Subtotal</b>						4508	196	4704	
<b>Total</b>						6436	1354	7790	

Table H.3.35(10) CONSTRUCTION COST OF SLUICE GATE :GATE NO.30

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	232	57	289	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	145.00	38	9	47	
2. Backfill	m3	299	90	10	85.00	23	3	25	
3. Sheet Pile	m2	6117	60	40	171.00	628	418	1046	*
4. R.C Pile	m	3264	60	40	63.00	123	82	206	
5. Concrete	m3	4786	60	40	63.00	181	121	302	
6. Form	m2	761	80	20	138.60	84	21	105	
7. Re. Bar	t	44717	60	40	5.67	152	101	254	
8. Bed Protection	m2	4613	50	50	90.00	208	208	415	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	72	48	120	
<b>Subtotal</b>						1508	1011	2520	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		6.25	1650		1650	*
2. Hoist Machine	m2	176000	100		6.25	1100		1100	*
3. Installation	LS	44000	90	10	1.00	248	28	275	
4. Miscellaneous	LS	38720	55	45	1.00	133	109	242	
<b>Subtotal</b>						3131	136	3267	
<b>Total</b>						4871	1205	6076	

Table H.3.35(11) CONSTRUCTION COST OF SLUICE GATE :GATE NO.31

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	187	59	246	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	133.00	34	9	43	
2. Backfill	m3	299	90	10	86.00	23	3	26	
3. Sheet Pile	m2	6117	60	40	167.00	613	409	1022	*
4. R.C Pile	m	3264	60	40	43.00	84	56	140	
5. Concrete	m3	4786	60	40	65.00	187	124	311	
6. Form	m2	761	80	20	143.00	87	22	109	
7. Re. Bar	t	44717	60	40	5.85	157	105	262	
8. Bed Protection	m2	4613	50	50	133.00	307	307	614	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	75	52	126	
<b>Subtotal</b>						1567	1085	2652	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	396000	100		2.89	1144		1144	*
2. Hoist Machine	m2	264000	100		2.89	763		763	*
3. Installation	LS	66000	90	10	1.00	172	19	191	
4. Miscellaneous	LS	58080	55	45	1.00	92	76	168	
<b>Subtotal</b>						2171	95	2266	
<b>Total</b>						3925	1239	5164	

Table H.3.35(12) CONSTRUCTION COST OF SLUICE GATE :GATE NO.32

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	189	51	239	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	118.00	31	8	38	
2. Backfill	m3	299	90	10	71.00	19	2	21	
3. Sheet Pile	m2	6117	60	40	161.00	591	394	985	*
4. R.C Pile	m	3264	60	40	55.00	108	72	180	
5. Concrete	m3	4786	60	40	54.00	155	103	258	
6. Form	m2	761	80	20	118.80	72	18	90	
7. Re. Bar	t	44717	60	40	4.86	130	87	217	
8. Bed Protection	m2	4613	50	50	77.00	178	178	355	
9. Operation Bridge	m2	65400	55	45					
10. Miscellaneous	LS				1.00	64	43	107	
<b>Subtotal</b>						1348	905	2252	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		4.84	1278		1278	*
2. Hoist Machine	m2	176000	100		4.84	852		852	*
3. Installation	LS	44000	90	10	1.00	192	21	213	
4. Miscellaneous	LS	38720	55	45	1.00	103	84	187	
<b>Subtotal</b>						2424	106	2530	
<b>Total</b>						3961	1061	5022	



Table H.3.35(13) CONSTRUCTION COST OF SLUICE GATE :GATE NO.33A

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	828	339	1167	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	3057.00	792	198	990	
2. Backfill	m3	299	90	10	1603.00	431	48	479	
3. Sheet Pile	m2	6117	60	40	307.00	1127	751	1878	
4. R.C Pile	m	3264	60	40	1147.00	2246	1498	3744	
5. Concrete	m3	4786	60	40	666.00	1912	1275	3187	
6. Form	m2	761	80	20	1465.20	892	223	1115	
7. Re. Bar	t	44717	60	40	59.94	1608	1072	2680	
8. Bed Protection	m2	4613	50	50	260.00	600	600	1199	
9. Operation Bridge	m2	65400	55	45	18.60	669	547	1216	
10. Miscellaneous	LS				1.00	514	311	825	
<b>Subtotal</b>						10792	6523	17315	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		11.52	3041		3041	
2. Hoist Machine	m2	176000	100		11.52	2028		2028	
3. Installation	LS	44000	90	10	1.00	456	51	507	
4. Miscellaneous	LS	38720	55	45	1.00	245	201	446	
<b>Subtotal</b>						5770	251	6022	
<b>Total</b>						17391	7113	24504	

Table H.3.35(14) CONSTRUCTION COST OF SLUICE GATE :GATE NO.33.B

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1.00	975	337	1311	
II. Direct Construction Cost									
1. Excavation	m3	324	80	20	2930.00	759	190	949	
2. Backfill	m3	299	90	10	1418.00	382	42	424	
3. Sheet Pile	m2	6117	60	40	324.00	1189	793	1982	
4. R.C Pile	m	3264	60	40	889.00	1741	1161	2902	
5. Concrete	m3	4786	60	40	719.00	2065	1376	3441	
6. Form	m2	761	80	20	1581.80	963	241	1204	
7. Re. Bar	t	44717	60	40	64.71	1736	1157	2894	
8. Bed Protection	m2	4613	50	50	336.00	775	775	1550	
9. Operation Bridge	m2	65400	55	45	10.20	367	300	667	
10. Miscellaneous	LS				1.00	499	302	801	
<b>Subtotal</b>						10476	6337	16813	
III. Gate Leaf & equipment									
1. Gate Leaf,Sheet	m2	264000	100		18.00	4752		4752	
2. Hoist Machine	m2	176000	100		18.00	3168		3168	
3. Installation	LS	44000	90	10	1.00	713	79	792	
4. Miscellaneous	LS	38720	55	45	1.00	383	314	697	
<b>Subtotal</b>						9016	393	9409	
<b>Total</b>						20467	7067	27534	



Table H.3.36 CONSTRUCTION COST OF STOP LOG.STRUCTURE:N.WEST

Const.Cost Unit : x1000 (TK) (1991 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (x1000)			Remarks
		Total	F/C(%)	L/C(%)		F/C	L/C	Total	
I. Preparation of Work	LS				1	1.6	0.9	2	
II. Direct Construction Cost									
Per One Place									
1. Excavation	m3	159	20	80	7.0	0.2	0.9	1	
2. Backfill	m3	118	50	50	4.5	0.3	0.3	1	
3. Concrete	m3	4786	60	40	3.5	10.1	6.7	17	
4. Form	m2	614	80	20	23.0	11.3	2.8	14	
5. Re. Bar	t	44717	60	40	0.3	8.5	5.6	14	
6. Miscellaneous	LS		50	50	1	1.5	0.8	2	
<b>Subtotal</b>						31.8	17.1	49	
<b>Total</b>						33.4	18.0	51	
Total ( 17 Places)									
I. Preparation of Work	LS				1	27.0	14.6	42	
II. Direct Construction Cost									
1. Excavation	m3	159	20	80	119.0	3.8	15.1	19	
2. Backfill	m3	118	50	50	76.5	4.5	4.5	9	
3. Concrete	m3	4786	60	40	59.5	170.9	113.9	285	
4. Form	m2	614	80	20	391.0	192.1	48.0	240	
5. Re. Bar	t	44717	60	40	5.4	143.7	95.8	239	
6. Miscellaneous	LS		50	50	1	25.7	13.9	40	
<b>Subtotal</b>						540.6	291.2	832	
<b>Total</b>						567.7	305.8	873	

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Table H.3.37 Summary of Construction Cost of Pump Station : Narayanganj West

Unit : Million Tk. (1991 Price)

No. of sluice Gate	Construction Cos (x10 <sup>6</sup> )			Remarks
	F/C	L/C	Total	
P12	98	22	120	Ref. Table H.3.38 (1)
P13	97	21	118	Ref. Table H.3.38 (1)
P14A	103	22	125	Ref. Table H.3.38 (2)
P14B	142	31	173	Ref. Table H.3.38 (2)
<b>Total</b>	<b>440</b>	<b>96</b>	<b>536</b>	

**Table H.3.38(1) : Breakdown of Construction Cost of Pump Station : Narayananj West**

1) NB-1: P:12 (Q=2.00m<sup>3</sup>/s)

Item	Unit	(1991 Price)				Quantity	Construction Cost (1000TK)		
		Unit Cost (TK)		Total	F/C		L/C	Total	
		F/C(%)	L/C(%)						
I. Preparation Work	LS	5,683,201	82	18	1	4,654	1,029	5,683	
II. Civil Work									
1. Excavation	m3	324	80	20	11418	2,960	740	3,699	
2. Embankment	m3	509	70	30	4338	1,546	662	2,208	
3. Backfill	m3	118	50	50	4000	236	236	472	
4. R.C. Pile (0.4x0.4)	m	3,262	60	40	1221	2,390	1,593	3,983	
5. Sheet Pile (Type II)	m2	6,117	60	40	209	767	511	1,278	
6. Leveling Concrete	m2	3,777	60	40	89	202	135	337	
7. Concrete	m3	4,786	60	40	925	2,656	1,771	4,427	
8. Form	m2	761	80	20	1760	1,071	268	1,339	
9. Reinforcement Bar	t	44,717	60	40	90	2,423	1,615	4,038	
10. Slope Protection	m2	1,579	40	60	1203	760	1,140	1,900	
11. Bed Protection (Concrete Block)	m2	4,613	50	50	63	145	145	291	
12. Bed Protection (brick)	m2	1,579	40	60	130	82	123	206	
13. Sodding	m2	60	20	80	652	8	31	39	
14. Operation Bridge	m2	65,400	55	45	16	576	471	1,046	
15. Building Works	LS	6,460,000	40	60	1	2,584	3,876	6,460	
16. Miscellaneous	LS	3,172,424	58	42	1	1,841	1,332	3,172	
17. Coffer Dam	LS	6,979,334	58	42	1	4,049	2,930	6,979	
Subtotal			58	42		24,296	17,580	41,876	
III. Mechanical & Electrical Work									
1. ø700 Pump	Place	15,073,684	100	0	1	15,074	0	15,074	
2. 75 kw Main Motor	Place	4,294,737	100	0	1	4,295	0	4,295	
3. Pipe and Valve	Place	3,284,211	100	0	1	3,284	0	3,284	
4. Electrical Facilities	LS	34,526,316	100	0	1	34,526	0	34,526	
5. Crane and Spare Parts	LS	2,421,053	100	0	1	2,421	0	2,421	
6. Gate Leaf and Sheet	LS	496,579	100	0	1	497	0	497	
7. Hoist Machine	LS	331,053	100	0	1	331	0	331	
8. Installation	LS	6,042,763	90	10	1	5,438	604	6,043	
9. Miscellaneous	LS	5,317,632	55	45	1	2,925	2,393	5,318	
Subtotal			96	4		68,791	2,997	71,788	
Total			82	18		97,741	21,607	119,347	

2) NB-2: P:13 (Q=2.20m<sup>3</sup>/s)

Item		Unit	Unit Cost (TK)		Quantity	(1991 Price)			
			Total	F/C(%)		L/C(%)	F/C	L/C	Total
I. Preparation Work		LS	5,619,455	82	18	1	4,613	1,006	5,619
II. Civil Work									
1. Excavation	m3		324	80	20	8783	2,277	569	2,846
2. Embankment	m3		509	70	30	7342	2,616	1,121	3,737
3. Backfill	m3		118	50	50	3077	182	182	363
4. R.C. Pile (0.4x0.4)	m		3,262	60	40	1302	2,548	1,699	4,247
5. Sheet Pile (Type II)	m2		6,117	60	40	209	767	511	1,278
6. Leveling Concrete	m2		3,777	60	40	87	197	132	329
7. Concrete	m3		4,786	60	40	861	2,472	1,648	4,121
8. Form	m2		761	80	20	1639	998	249	1,247
9. Reinforcement Bar	t		44,717	60	40	84	2,254	1,502	3,756
10. Slope Protection	m2		1,579	40	60	749	473	709	1,182
11. Bed Protection (Concrete Block)	m2		4,613	50	50	63	145	145	291
12. Bed Protection (brick)	m2		1,579	40	60	130	82	123	206
13. Sodding	m2		60	20	80	1104	13	53	66
14. Operation Bridge	m2		65,400	55	45	16	576	471	1,046
15. Building Works	LS		6,460,000	40	60	1	2,584	3,876	6,460
16. Miscellaneous	LS		3,117,523	58	42	1	1,818	1,299	3,118
17. Coffer Dam	LS		6,858,550	58	42	1	4,000	2,858	6,859
Subtotal				58	42		24,002	17,149	41,151
III. Mechanical & Electrical Work									
1. ø700 Pump	Place		14,694,737	100	0	1	14,695	0	14,695
2. 75 kw Main Motor	Place		4,294,737	100	0	1	4,295	0	4,295
3. Pipe and Valve	Place		3,200,000	100	0	1	3,200	0	3,200
4. Electrical Facilities	LS		34,526,316	100	0	1	34,526	0	34,526
5. Crane and Spare Parts	LS		2,421,053	100	0	1	2,421	0	2,421
7. Gate Leaf and Sheet	LS		496,579	100	0	1	497	0	497
8. Hoist Machine	LS		331,053	100	0	1	331	0	331
9. Installation	LS		5,996,447	90	10	1	5,397	600	5,996
10. Miscellaneous	LS		5,276,874	55	45	1	2,902	2,375	5,277
Subtotal				96	4		68,264	2,974	71,238
Total				82	18		96,879	21,129	118,009

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



Table H.3.38(2) : Breakdown of Construction Cost of Pump Station : Narayananj West

3) NB-4: P.14A (Q=2.70m<sup>3</sup>/s)

Item		Unit	Unit Cost (TK)		Quantity	(1991 Price)			
			Total	F/C(%)		L/C(%)	F/C	L/C	Total
I. Preparation Work		LS	5,961,408	82	18	1	4,902	1,059	5,961
II. Civil Work									
1. Excavation	m3		324	80	20	8490	2,201	550	2,751
2. Embankment	m3		509	70	30	7675	2,735	1,172	3,907
3. Backfill	m3		118	50	50	2974	175	175	351
4. R.C. Pile (0.4x0.4)	m		3,262	60	40	1395	2,731	1,821	4,552
5. Sheet Pile (Type II)	m2		6,117	60	40	213	782	522	1,304
6. Leveling Concrete	m2		3,777	60	40	97	219	146	365
7. Concrete	m3		4,786	60	40	967	2,777	1,851	4,628
8. Form	m2		761	80	20	1844	1,123	281	1,403
9. Reinforcement Bar	t		44,717	60	40	95	2,535	1,690	4,226
10. Slope Protection	m2		1,579	40	60	358	226	339	565
11. Bed Protection (Concrete Block)	m2		4,613	50	50	63	145	145	291
12. Bed Protection (brick)	m2		1,579	40	60	141	89	133	222
13. Sodding	m2		60	20	80	1153	14	55	69
14. Operation Bridge	m2		65,400	55	45	17	611	500	1,112
15. Building Works	LS		7,120,000	40	60	1	2,848	4,272	7,120
16. Miscellaneous	LS		3,286,529	58	42	1	1,921	1,365	3,287
17. Coffor Dam	LS		7,230,363	58	42	1	4,227	3,004	7,230
Subtotal				58	42		25,359	18,023	43,382
III. Mechanical & Electrical Work									
1. ø800 Pump	Place		17,473,684	100	0	1	17,474	0	17,474
2. 75kw Main Motor	Place		4,294,737	100	0	1	4,295	0	4,295
3. Pipe and Valve	Place		4,210,526	100	0	1	4,211	0	4,211
4. Electrical Facilities	LS.		34,526,316	100	0	1	34,526	0	34,526
5. Crane and Spare Parts	LS.		2,421,053	100	0	1	2,421	0	2,421
6. Gate Leaf and Sheet	LS.		550,263	100	0	1	550	0	550
7. Hoist Machine	LS.		366,842	100	0	1	367	0	367
8. Installation	LS.		6,384,342	90	10	1	5,746	638	6,384
9. Miscellaneous	LS		5,618,221	55	45	1	3,090	2,528	5,618
Subtotal				96	4		72,679	3,167	75,846
Total				82	18		102,941	22,249	125,190

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

4) NB-5: P.14B (Q=5.30m<sup>3</sup>/s)

(1991 Price)

Item	Unit	Unit Cost (TK)		Quantity	Construction Cost (1000TK)			
		F/C(%) L/C(%)			F/C	L/C	Total	
		Total						
I. Preparation Work	LS	8,243,386	82	18	1	6,784	1,460	8,243
II. Civil Work								
1. Excavation	m3	324	80	20	13468	3,491	873	4,364
2. Embankment	m3	509	70	30	2002	713	306	1,019
3. Backfill	m3	118	50	50	4717	278	278	557
4. R.C. Pile (0.4x0.4)	m	3,262	60	40	1448	2,834	1,889	4,723
5. Sheet Pile (Type II)	m2	6,117	60	40	236	867	578	1,445
6. Leveling Concrete	m2	3,777	60	40	139	314	209	523
7. Concrete	m3	4,786	60	40	1229	3,528	2,352	5,880
8. Form	m2	761	80	20	2349	1,430	357	1,787
9. Reinforcement Bar	t	44,717	60	40	120	3,212	2,141	5,353
10. Slope Protection	m2	1,579	40	60	1283	810	1,216	2,026
11. Bed Protection (Concrete Block)	m2	4,613	50	50	63	145	145	291
12. Bed Protection (brick)	m2	1,579	40	60	193	122	183	305
13. Sodding	m2	60	20	80	301	4	14	18
14. Operation Bridge	m2	65,400	55	45	8	288	235	523
15. Building Works	LS	13,130,000	40	60	1	5,252	7,878	13,130
16. Miscellaneous	LS	4,194,347	56	44	1	2,329	1,866	4,194
17. Coffor Dam	LS	9,227,564	56	44	1	5,123	4,104	9,228
Subtotal		56	44			30,740	24,625	55,365
III. Mechanical & Electrical Work								
1. ø1200 Pump	Place	34,778,947	100	0	1	34,779	0	34,779
2. 132 kw Main Motor	Place	10,273,684	100	0	1	10,274	0	10,274
3. Pipe and Valve	Place	8,673,684	100	0	1	8,674	0	8,674
4. Electrical Facilities	LS	33,473,684	100	0	1	33,474	0	33,474
5. Crane and Spare Parts	LS	3,452,632	100	0	1	3,453	0	3,453
6. Gate Leaf and Sheet	LS	912,632	100	0	1	913	0	913
7. Hoist Machine	LS	608,421	100	0	1	608	0	608
8. Installation	LS	9,217,368	90	10	1	8,296	922	9,217
9. Miscellaneous	LS	8,111,284	55	45	1	4,461	3,650	8,111
Subtotal			96	4		104,931	4,572	109,502
Total			82	18		142,454	20,657	173,111

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

**Tble H.3.39 Construction Cost of Khal Improvement : Narayanganj West**

(Unit: 1000Tk.,1991 Price)

Zone	Khal	Channel Works			Maintenance Road			Banking			Dredging			Total		
		F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
NB-1	KN-18	2,501	3,752	6,253	1,270	141	1,411	661	661	1,322	176	702	878	4,607	5,256	9,863
	KN-19	122	489	611	3,810	423	4,234	1,982	1,982	3,965	949	3,797	4,746	6,864	6,691	13,555
	Sub-Total	2,623	4,240	6,863	5,080	564	5,645	2,643	2,643	5,286	1,125	4,499	5,624	11,471	11,947	23,418
NB-2	KN-20	76	305	382	2,858	318	3,175	1,487	1,487	2,974	269	1,076	1,345	4,690	3,186	7,876
	KN-21	8,754	13,130	21,884	4,445	494	4,939	2,313	2,313	4,626	855	3,422	4,277	16,367	19,359	35,726
	KN-22	5,717	8,575	14,291	2,540	282	2,822	1,322	1,322	2,643	313	1,252	1,565	9,891	11,430	21,322
NB-3	Sub-Total	14,546	22,011	36,557	9,843	1,094	10,937	5,121	5,121	10,242	1,437	5,749	7,187	30,948	33,975	64,923
	KN-23	3,752	5,627	9,379	1,905	212	2,117	991	991	1,982	248	992	1,240	6,896	7,822	14,718
	KN-24	4,377	6,565	10,942	2,223	247	2,470	1,156	1,156	2,313	356	1,425	1,781	8,112	9,393	17,505
NB-4	KN-25	2,501	3,752	6,253	1,270	141	1,411	661	661	1,322	0	0	0	4,432	4,553	8,985
	KN-26	3,752	5,627	9,379	1,905	212	2,117	991	991	1,982	0	0	0	6,648	6,830	13,478
	KN-27	1,876	2,814	4,689	953	106	1,058	496	496	991	57	229	286	3,381	3,644	7,025
NB-5	S-1	45,701	30,467	76,168	-	-	-	-	-	-	-	-	-	45,701	30,467	76,168
	S-2	3,873	4,547	8,420	-	-	-	-	-	-	-	-	-	3,873	4,547	8,420
	S-3	2,348	2,757	5,105	-	-	-	-	-	-	-	-	-	2,348	2,757	5,105
NB-4	Sub-Total	68,179	62,156	130,335	8,256	917	9,173	4,295	4,295	8,590	661	2,646	3,307	81,391	70,014	151,405
	KN-28-1	92	367	458	2,858	318	3,175	1,487	1,487	2,974	326	1,304	1,630	4,762	3,475	8,237
	KN-28-2	48	190	238	1,588	176	1,764	826	826	1,652	138	551	688	2,599	1,743	4,342
NB-5	KN-29	10,004	15,006	25,010	4,445	494	4,939	2,313	2,313	4,626	1,126	4,503	5,629	17,888	22,316	40,203
	Sub-Total	10,143	15,563	25,706	8,891	988	9,878	4,626	4,626	9,251	1,589	6,357	7,947	25,249	27,534	52,782
	KN-30-1	2,144	3,216	5,359	953	106	1,058	496	496	991	430	1,720	2,150	4,022	5,537	9,559
NB-5	KN-30-2	10,719	16,078	26,797	4,763	529	5,292	2,478	2,478	4,956	435	1,739	2,174	18,394	20,824	39,218
	KN-31-1	81	326	407	2,540	282	2,822	1,322	1,322	2,643	725	2,900	3,625	4,668	4,830	9,498
	KN-31-2	9,289	13,934	23,224	4,128	459	4,586	2,148	2,148	4,295	1,059	4,236	5,295	16,624	20,776	37,400
NB-5	KN-32	12,862	19,293	32,156	5,715	635	6,350	2,974	2,974	5,947	1,196	4,783	5,978	22,747	27,685	50,432
	Sub-Total	35,096	52,847	87,943	18,099	2,011	20,110	9,416	9,416	18,833	3,844	15,377	19,222	66,455	79,652	146,106
	Total	130,587	156,816	287,404	50,168	5,574	55,742	26,102	26,102	52,203	8,657	34,629	43,286	215,514	223,121	438,636

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Table H.3.40 Construction Cost of Bridge/Aqueduct : Narayanganj West

(1991 Price)

Zone	Khal No.	Bridge No.	Length (m)	Type	Area (m2)	Unit Cost (TK)			Construction Cost (1000TK)			C.D.S.T. (1000Tk)	Remarks
						Total	F/C(%)	L/C(%)	F/C	L/C	Total		
NB-1	KN-19	BN-50	5.60	Girder bridge	20.50	83.00	40	60	681	1,021	1,702	-	Road bridge
	Sub Total						40	60	681	1,021	1,702	0	
NB-2	KN-21	BN-51	2.70	Slab bridge	9.88	114.00	40	60	451	676	1,126	-	Road bridge
	KN-22	BN-52	5.30	Girder bridge	19.40	87.00	40	60	675	1,013	1,688	-	" "
	"	BN-53	5.30	Deck Girder	-	-	-	-	473	509	982	178	Railway bridge
	Sub Total						42	58	1,599	2,197	3,796	178	
NB-3	KN-23	BN-54	3.50	" "	-	-	-	-	367	420	787	117	Railway bridge
	KN-24	BN-55	3.50	" "	-	-	-	-	367	420	787	117	" "
	Sub Total						47	53	734	840	1,574	234	
NB-4	KN-29	BN-60	3.50	Slab bridge	12.81	112.80	40	60	578	867	1,445	-	Road bridge
	"	BN-61	3.50	" "	12.81	112.80	40	60	578	867	1,445	-	" "
	Sub Total						40	60	1,156	1,734	2,890	0	
NB-5	KN-30-1	BN-62	8.80	Girder bridge	32.21	61.00	40	60	786	1,179	1,965	-	Road bridge
	KN-31-1	BN-64	6.00	Slab bridge	21.96	110.90	40	60	974	1,461	2,435	-	" "
	KN-31-2	BN-65	3.50	" "	12.81	112.80	40	60	578	867	1,445	-	" "
	"	BN-66	3.50	" "	12.81	112.80	40	60	578	867	1,445	-	" "
	KN-32	BN-67	3.90	" "	14.27	112.30	40	60	641	962	1,603	-	" "
	"	BN-68	3.90	" "	14.27	112.30	40	60	641	962	1,603	-	" "
	Sub Total						40	60	4,198	6,297	10,495	0	
	Total						41	59	8,367	12,089	20,457	412	



Table H.4.1 Proposed Disbursement Schedule

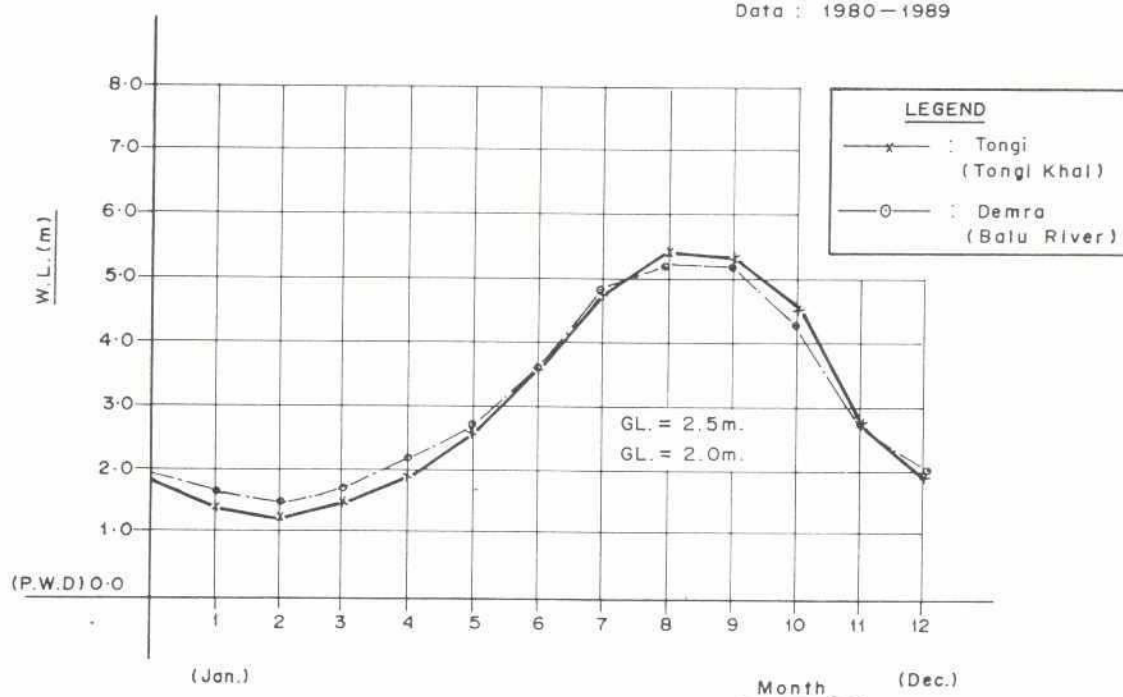
Unit : Million Tk.

Year	'94	'95	'96	'97	'98	'99	2000	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	Total Project Cost
I G. Dhaka East																		
1. DC - 1 (Total)						498	499	900	1,181	1,181	1,179					3	175	5,616
(F/C)						134	134	506	702	703	696						74	2,949
(L/C)						364	365	394	479	478	483					3	101	2,667
2. DC - 2 (Total)												284	285	745	1,141	636	983	4,074
(F/C)												98	98	392	691	362	516	2,157
(L/C)												186	187	353	450	274	467	1,917
3. DC - 3 (Total)							263	263	746	1,118	607	610			6	348		3,961
(F/C)							96	96	395	678	346	348				150		2,109
(L/C)							167	167	351	440	261	262			6	198		1,852
4. DC - 4 (Total)	375	378	620	1,098	1,102	727								5	340			4,645
(F/C)	106	107	314	639	641	395									146			2,348
(L/C)	269	271	306	459	461	332								5	194			2,297
II DND																		
Total			723	1,191	1,192	1,143									5	340		4,594
(F/C)			200	630	631	592										150		2,203
(L/C)			521	533	533	523										87		2,197
III Narayanganj West																		
Total						717	799	1,047	745	389	400							4,097
(F/C)						163	294	459	462	208	211							1,797
(L/C)						554	505	588	283	181	189							2,300

# Monthly Mean Water Level

: Dhaka East ( Tongi & Demra )

Data : 1980-1989



# Monthly Mean Water Level

: Narayanganj Area ( Narayanganj & Hariharpara )

Data : 1980-1989

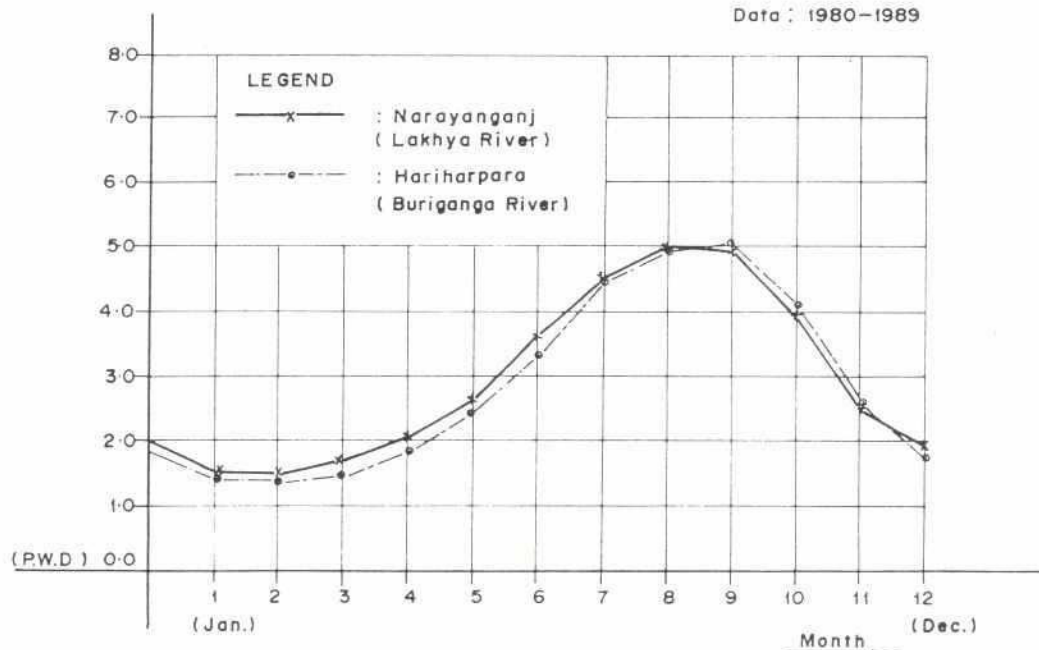


FIG. H.2.1

## MONTHLY MEAN WATER LEVEL

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROLOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



Phase	'92	'93	'94	'95	'96	'97	'98	2000	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	Remarks
Preparation Stage by GOB																			
G.Dhaka East																			
1.NORTHERN COMPT.(DC-1)																			
A.Project Preparation																			
B.Flood Mitigation																			Including Sub-Emb.SA
C.Storm Water Drainage																			
2. CENTRAL COMPT.(DC-2)																			
A.Project Preparation																			
B.Flood Mitigation																			
C.Storm Water Drainage																			
3.SOUTHERN COMPT.-1(DC-3)																			
A.Project Preparation																			Including Sub-Emb.SB
B.Flood Mitigation																			
C.Storm Water Drainage																			
4.SOUTHERN COMPT.-2(DC-4)																			
A.Project Preparation																			Including Sub-Emb.SC
B.Flood Mitigation																			
C.Storm Water Drainage																			
Narayanganj																			
1.DND																			
A.Project Preparation																			
B.Flood Mitigation																			
C.Storm Water Drainage																			
2.Narayanganj West																			
A.Project Preparation																			
B.Flood Mitigation																			
C.Storm Water Drainage																			

Note:

- 1).Preparation stage by GOB :Including development study, etc.
- 2).Sub-Emb:Sub-Embment.

FIG.

PROPOSED IMPLEMENTATION SCHEDULE

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



**SUPPORTING REPORT I**  
**PROJECT EVALUATION**



## SUPPORTING REPORT I: PROJECT EVALUATION

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## SUPPORTING REPORT I: PROJECT EVALUATION

### 1. General

Project evaluation will be done by comparing the flood damages in the "with" and "without project" situations.

To make an overall evaluation of the project, not only the economic aspect, but also the socio-economic and environmental aspects were taken into account. The JICA Study team tried to express the socio-economic impacts of the project in quantitative terms as much as possible. But, environmental impacts are very hard to be quantitatively estimated. Therefore, qualitative analysis was employed for assessment of environmental aspects.

For project evaluation the Study Area was divided into 6 projects, i.e. Greater Dhaka East (or DC) -1, -2, -3, -4, Narayanganj DND and Narayanganj West Projects. For the sake of reference the combined total of the 4 Dhaka projects was also subjected to evaluation.

The period of project life was assumed basically to be 30 years. The opportunity cost of capital (OCC) is assumed as 12%. These are based on the "FAP: Guidelines of Economic (Micro) Analysis".

The estimation of NPVR(2) and the sensitivity analysis using such variables as the increase of capital costs, the increase of O&M costs and the reduction of benefits were done in accordance with the "Guidelines".

Financial analysis were also done, centering on the ways and means to get financial resources for O&M costs.

### 2. Estimation of Benefits and Costs

#### 2.1 Estimation of Benefits

In the "with" situation flood damages expected under the "without" situation will be virtually avoided. That is to say, flood damages under the "without" situation just turn into project benefits in the "with" situation.

Economic losses deriving from floods and inundations are manifold and profound. They range from direct damages to houses, establishments, institutions, agricultural crops, infrastructures, etc., to income losses of households, to sales losses of private and public enterprises and to traffic damages in the form of reduced sales, more operating cost and more operating hours.

They have been estimated by project area, by type/scale of floods for 1990 and 2010 in "B Flood and Flood Damage" of this report. Ultimately they were converted into "average annual flood damages", that is, average flood damages to be expected annually, which were estimated based on probability theory. In the "with" situation they just become project benefits. (Refer to Table I.1).

Project benefits are summarized as follows :

(Unit : Tk. Million)

Project	1990	2010
DC - 1	43.2	648.4
DC - 2	26.4	176.7
DC - 3	195.1	628.5
DC - 4	293.0	791.3
Greater Dhaka East	557.7	2,244.9
Narayanganj DND	153.4	639.9
Narayanganj West	113.4	395.3
Total	824.5	3,280.1

## 2.2 Estimation of Costs

Costs are divided into capital cost which is required to install/construct necessary equipment/facilities concerned, and operation and maintenance (O&M) cost which is required annually after the implementation of a project. Capital cost is further divided into initial cost and replacement cost. Replacement cost is required to replace pumping equipment.

In performing economic analysis costs were converted into economic costs. To convert capital cost into economic cost, a conversion factor was employed for a specific type of work.

Conversion factors employed are 89.8% for embankment, 85.2% for flood wall, 97.2% for sluice gate, 95.1% for pump station and 88.0% for khal improvement.

Land acquisition cost was valued as a stream of annual net benefits of production foregone.

Replacement cost is assumed to be required every 15 years.

Economic costs are summarized below. (For more details refer to Table I.2).

(Unit : Tk. Million)

Project	Costs		
	Capital	NBOPF*	O&M
DC - 1	4,955	2.3	37
DC - 2	2,991	1.1	30
DC - 3	3,457	1.0	29
DC - 4	3,920	1.7	32
Greater Dhaka East	15,323	6.1	128
Narayanganj DND	4,088	1.2	28
Narayanganj West	2,858	1.4	21
Total	22,269	8.7	177

Note : NBOPF = Annual Net Benefits of Production Foregone

The annual O&M cost corresponds to 0.79% of capital cost on total average basis.

In performing economic analysis, a part of the costs of the ADB project now under way under FAP 8B were incorporated into the costs of DC-3 and DC-4 Projects because beneficiary areas of the two projects encompass some of the ADB project areas.

The costs of the JICA drainage project now on-going were also incorporated into the costs of the DC-3 Project. Further, the costs of the raising of roads and the construction



of flood walls around DND were incorporated into the costs of the Narayanganj DND Project. The above table does not take into account these costs.

### 3. Economic Evaluation

Results of economic analysis on the 6 projects are described in the followings. The case where the Narayanganj DND Project and the Narayanganj West Project are combined together is additionally taken up and economically evaluated in Supplementary Study. Also, an additional economic analysis applying the standard conversion factor (SCF) to the benefits was performed.

#### 3.1 Calculation of EIRR and Other Decision Criteria

In accordance with the implementation schedule, initial costs were distributed over years for each of the 6 projects. Also, based on the initial cost distribution O&M and replacement costs were determined and allotted over years.

Benefits of each of the intermediate years between 1990 and 2010 and beyond were calculated based on the estimated benefits for 1990 and 2010 employing a simple equation. Benefits during the project implementation period were assumed to be realized in proportion to the extent of project implementation.

In this way cost benefit streams for the 6 projects were prepared. (Refer to Table I.3).

Using those cost benefit streams economic internal rate of return (EIRR), net present value (NPV) and benefit cost ratio (B/C) were calculated. In addition, NPVR (2) was calculated. It is given by NPV divided by the present value of capital and O&M costs. The results are shown under.

Project	EIRR (%)	NPV (Tk. Mln.)	B/C	NPVR (2)
DC - 1	14.8	274	1.22	0.162
DC - 2	8.0	- 98	0.74	-0.155
DC - 3	13.9	263	1.19	0.147
DC - 4	18.9	1,032	1.55	0.416
Greater Dhaka East	15.8	1,501	1.31	0.228
Narayanganj DND	14.5	371	1.21	0.151
Narayanganj West	14.3	152	1.18	0.110

The DC-4 Project has the highest EIRR of 18.9%. The EIRR's of the DC-1, Narayanganj DND, Narayanganj West and DC-3 Projects are not much different, being all distributed in the surroundings of 14%. All of these five projects have the EIRR's exceeding the OCC of 12%.

The DC-2 Project has the EIRR of 8.0%. This project is marginal so far as economic evaluation is concerned.

In terms of NPV, the DC-4 Project is the biggest with Tk. 1,032 million. The second place goes to the Narayanganj DND Project with Tk. 371 million, followed by the DC-1 and DC-3 Projects with Tk. 274 million and Tk. 263 million, respectively. The Narayanganj West Project is placed fifth with the NPV of Tk. 152 million. The DC-2 Project has the negative NPV of Tk. -98 million.

The highest B/C of 1.55 is held by the DC-4 Project. The B/C's of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are not much different, being all distributed in the surroundings of 1.2. The DC-2 Project has the B/C of less than one with 0.74.

Turning to NPVR (2), the DC-4 Project has the highest value of 0.416. It is expected that the project will contribute to the increase of national income by the amount corresponding to 41.6% of project costs. The NPVR (2)'s of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are mutually not widely apart, all ranging between 0.1 and 0.2. The DC-2 Project has the negative NPVR (2) with -0.155.

It is to be noted regarding priority order that the DC-4 Project is placed first in all the decision criteria, the DC-1 Project is placed second except in NPV where it is the third, the Narayanganj DND Project is placed third except in NPV where it is the second, the DC-3 Project is placed fourth except in EIRR where it is the fifth and the Narayanganj West Project is placed fifth except in EIRR where it is the fourth. The DC-2 Project is always placed sixth.

As seen in the above, the five projects, namely the DC-4, DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are judged to be economically feasible, while the DC-2 Project is marginal so far as economic evaluation is concerned. However, in case of social projects such as this one the EIRR's of over 7% have proved to be on the high side.

Moreover, if the four Greater Dhaka East projects are combined together and treated as one entity (the Greater Dhaka East Project), which is reasonable because of their geographical, economic and social connections and interrelations, then the project has the EIRR of 15.8, NPV of Tk. 1,501 million, B/C of 1.31 and NPVR (2) of 0.228.

These values are the highest among the three projects. Viewed in this way, the implementation of the DC-2 Project is justified.

### 3.2 Sensitivity Analysis

Sensitivity analysis was conducted to see whether the projects can maintain their viability and robustness, when placed under unfavorable circumstances during and after implementation.

In conducting sensitivity analysis, the "Guidelines" was referred to.

In Case A the 15% increase of capital costs compared with the base case was assumed. In Case B the 100% increase of O&M costs was assumed. In Cases C and D the 15% reduction of benefits and one and a half year delays in achieving benefits were respectively assumed.

The sensitivity analysis on the reduction of incremented net value of agricultural and fisheries production was not done because this is essentially not an agricultural development project and the sensitivity to such a variable is minimal.

In Case E the switching values of capital cost increase were estimated. Likewise, in Case F the switching values of benefit reduction were estimated.

The results of sensitivity analysis are shown below. The decision criterion employed is EIRR.

Case	Greater Dhaka East					(Unit : %)	
	DC-1	DC-2	DC-3	DC-4	Combined	Narayanganj DND	West
Base Case	14.8	8.0	13.9	18.9	15.8	14.5	14.3
Case A	12.9	6.6	12.5	16.6	13.9	12.8	12.4
Case B	14.2	6.7	13.4	18.2	15.1	13.9	13.6
Case C	12.5	6.1	12.2	16.1	13.5	12.4	12.1
Case D	12.7	6.9	12.5	16.2	13.7	12.6	12.4
Case E	22.7	-28.0	20.0	58.6	33.5	22.1	18.7
Case F	17.7	-35.0	15.9	35.4	22.8	17.4	15.1



As the table shows, in all the cases of A, B, C and D all the five above - OCC projects maintain their viability.

When the four Greater Dhaka East projects are combined together and treated as one entity, then this project stay viable in all the cases of A, B, C and D.

In Case E the switching value of the DC-4 Project is calculated at 58.6%, that is to say, it may still stay viable, supposing the capital cost overrun reaches 58.6%. Likewise, the switching values of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are calculated at 22.7%, 22.1%, 20.0% and 18.7%, respectively.

In Case F the switching value of the DC-4 Project works out at 35.4%, that is, it may still remain viable, supposing the benefits turn out to be less by 35.4%. Similarly, the switching values of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects work out at 17.7%, 17.4%, 15.9% and 15.1%, respectively.

The switching value of the combined Greater Dhaka East Project is 33.5% in Case E and 22.8% in Case F.

It follows from the above that the five above-OCC projects will all stay robust under any conceivable adverse circumstances. Also, the combined Greater Dhaka East Project will maintain its viability under any conceivable unfavorable conditions.

As regard the DC-2 Project, the 28% reduction of costs or the 35% addition of benefits will be necessary if it is to be feasible. It was found out also as a result of simulation that the implementation of the project should be started in 2015 (10 year postponement) if we are to make it feasible.

#### 4. Socio-Economic Impact Assessment

As negative social impacts of the project, one can cite people to be displaced from locations they have inhabited by the construction of flood protection facilities, people earning a livelihood by inland water fisheries and transportation to be affected by the depletion of flood water and farmers whose agricultural land will be acquired by the government for the sake of the project or be purchased by developers, thus their traditional form of earning being threatened.

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On the other hand, as positive social impacts, one can quote the vast population and area to be saved from inundation, creation of employment and jobs during and after project implementation, reduction of water-borne diseases which are apt to break out especially accompanying a big and protracted flood, the removal of psychological burden people are habitually forced to bear and its beneficial effects on their attitude to life, and elevation of the use of flood protected land, thus accelerating its urbanization.

#### 4.1 Negative Impacts

##### 1) Displacement of People

It is estimated that the number of people to be displaced by the construction of embankments and khal improvement will reach 7,053. It is broken down to 1,337 for DC-1, 734 for DC-2, 433 for DC-3, 1,127 for DC-4, 1,783 for Narayanganj DND and 1,639 for Narayanganj West. Also, compensation for building demolition accompanying displacement is estimated to amount to Tk. 328.1 million. It is broken down to 34.4, 21.7, 13.6, 31.2, 61.7 and 165.5 in millions of Taka for the areas in the above order, respectively. (For detailed information on compensation refer to Table I.4).

The JICA Study Team conducted the sampling questionnaire survey to grasp socio-economic aspects of the people to be displaced. The survey was done in December, 1991 towards people to be affected by the construction of the embankments along the Balu River. The number of samples was 61 houses. (Refer to Table I.5).

The profile of the sampled subjects is that the average number of household members is 8.3; 62.3% are engaged in agriculture more or less, 11.5% in boating and 4.9% in fisheries; average monthly income is Tk. 6,266; 72.1% got either primary schooling or no schooling whatsoever.

As the results of the survey it was revealed that the average price of a house on demand basis is Tk. 210 thousand, the average area of land possessed by a house is .776 ha and the average price of land possessed by a house is Tk. 1,202 thousand.

It was also revealed that 70.5% of the respondents agree to be displaced and remove to other locations. The average compensation demanded per house is Tk. 882 thousand for land, Tk. 245 thousand for the house building, Tk. 39 thousand for removing and Tk. 39 thousand for life support and training, totaling Tk. 1,205 thousand. Concerning mental attitude toward displacement, 34.4% replied that resettlement was a good chance

to start a new life with compensation, topping other replies. Secondly placed was "If I get sufficient compensation, I agree to displacement." with 27.9%. But, the third with 21.3% was a negative reply saying that "It is difficult to change my occupation as a farmer". The attitude of resignation was expressed by 9.8% voicing "I cannot resist government order". There was none who appealed to difficulty in changing the present occupation as a fisherman/boatman.

As an overall assessment it can be said that the people concerned have on the whole positive mental attitudes towards resettlement, that proper amount of compensation is the central and crucial issue, and that proper job retraining/ reorientation is a "must". According to the surveys conducted on the people already displaced in such circumstances, the living standard of most of them deteriorated after the displacement. Systematic, detailed and long-term approach to this problem is, therefore, the most important and essential.

## 2) Adverse Effects on Boating and Fishing People

There are many people who are earning their livelihood by inland water fishing and boating in the Greater Dhaka East area. When embankments are constructed along the Balu River and other protective measures are taken, the vast areas which are now under water in the rainy season will be saved from inundation. Then, those people who are making their living by transportation and fisheries will be threatened to lose their trade.

The JICA Study Team carried out the interview survey towards boating people to know the extent and scale of this age-old, traditional occupation and the effects of the embankment on them.

The eleven (11) centers that are bazars, haats (weekly markets) or transshipment points were selected for the survey as shown under :

Tongi, Rampura Ghat, Madartek, Khilkhet, Shahjadpur, Mainertek, Kaskura, Kaetpara, Patira, Bora Beraid and Meradia.

The locations of the above terminals are shown in Fig. I.1. It was revealed as a result of the survey that the Greater Dhaka East area could be divided into three navigational zones as described below.





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(1) Tongi and Balu River Zone

This area incorporates six (6) terminals, namely Tongi, Mainertek, Kaskura, Patira, Bora Beraid and Kaetpara. Navigational activities in this area will be little affected by the construction of the embankment.

(2) Begunbari and Madartek Zone

This area covers three (3) terminals of Rampura, Meradia and Madartek. This area will be most affected by the construction of embankment since it acts as a major transshipment point and both rural and urban produce are exchanged there. The Begunbari Khal along with the Naral River and the Naral Khal represents the only all season accessible waterway in the Greater Dhaka East area.

(3) Central Zone

This zone will be totally affected by the flood protection embankment. It includes Khilkhet and Shahjadpur. Once the embankment is put up, they will be completely isolated from the rest of the navigation network.

The total number of boats operating around the 11 terminals comes to 1,050. Since a boat is estimated to be owned/operated on average by 2.5 persons, the total number of people engaged in boating business works out at 2,625. The total sales earned by those boats and people are estimated at Tk. 53.3 million per year. (Refer to Table I.6).

The total number of people yearly transported by boats is calculated at 2.8 million. Also, the total value of the commodities transported by this navigational means would reach Tk. 573.7 million per annum. (Refer to Tables I.7 and I.8).

The total employment and household income in the Greater Dhaka East area in 1990 are estimated at 193,925 and Tk. 4,274.6 million, respectively. Therefore, the people and their earnings to be more or less affected by the construction of the embankment account for 1.4% and 1.2% of the total labor force and their earnings in the Greater Dhaka East area, respectively.

Actually, as mentioned above, only 5 terminals are directly affected by the embankment. The boating people and their earnings connected with those terminals are calculated at 573 and Tk. 18.1 million, respectively. They occupy 0.3% and 0.4% of the total labour force and their earnings in the Greater Dhaka East area, respectively.

It can be said from the above that the socio-economic impacts of the construction of the eastern embankment along the Balu River on the boating trade are not so much in comparative terms.

Moreover, although the boating business is an age-old, traditional occupation that has given employment to a substantial number of people and has benefited millions of customers, it is not an efficient service both for the suppliers and the customers compared with land transport. Although utmost care and measures should be taken so that the people to be directly affected can redirect their occupation or find a new locations for their trade, the transfer of the transport mode from inland water navigation to land transport is the demand of the modern times. Land transport is bound to be developed where boating was the sole transport means, which is more economic and more contributory to the socio-economic development of the Greater Dhaka East area in long terms.

It is said that over 756 households are involved with different intensity in fishing activities in the Study Area. More than 90% of them are occasional fishermen, the balance being constituted essentially by part-time fishermen. Full-time fishermen have proved to be scarce. Under these circumstances the impacts of the project on fishing people should not be exaggerated.

### 3) Loss of Farm Land and Occupation as Farmers

To make way for embankments many people living on the left bank of the Balu River will have to part with their farm land and be evacuated. Or, after the construction of the embankments farm land inside the embankments will be gradually bought up by the developers for residential and other uses. All this means that farmers will gradually lose their ancestral farm land and along with it they will lose their own traditional way of earning.

As Table C.1 shows, agricultural area in the Greater Dhaka East, Narayanganj DND and Narayanganj West was in 1990 8,814 ha, 3,173 ha and 464 ha, respectively. It is forecast that in 2010 agricultural area in the 3 project areas will be reduced to 1,310 ha, 532 ha and 8 ha in the above order, respectively.

The money they will get in return for their farm land will not necessarily make their new life easier. Rather past examples tend to depict the opposite picture. Farmers whose land is lost will usually fail to reorient their occupation to a higher plane, ending

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up as squatters and so forth. Systematic, long-term approach and programs by the government are sought for to avoid or alleviate such a situation. One such approach is the provision of alternative farmlands, that remain unaffected in the surrounding flood plains of the priority area.

## 4.2 Positive Impacts

### 1) Population to be Saved from Inundation

In the "with" situation people living in the flood prone areas will be no longer affected by inundations.

It is estimated in the "without" situation that supposing the 1988-scale flood hit the Study Area in 2010, population to be affected would be 665,996 for DC-1, 261,856 for DC-2, 847,139 for DC-3, 1,218,397 for DC-4, 2,993,388 for Narayanganj DND and 981,873 for Narayanganj West, totaling 5,326,040. In the "with" situation the same number of people would be saved from inundation.

### 2) Area to be Saved from Inundation

In the "with" case areas which are habitually or in time of big floods inundated will be free from such natural influences.

It is estimated in the "without" case that supposing the 1988-scale flood hit the Study area in 2010, built-up area to be affected would be 3,036 ha for DC-1, 1,146 ha for DC-2, 2,977 ha for DC-3, 2,635 ha for DC-4, 4,270 ha for Narayanganj DND and 1,720 ha for Narayanganj West, totaling 15,784 ha. In the "with" case the same area would be saved from inundation.

### 3) Creation of Employment

The implementation of the project will accompany the recruitment of a great number of labour force.

The project will provide employment during construction works to 10,693 people for DC-1, 8,616 people for DC-2, 5,968 people for DC-3, 13,637 people for DC-4, 19,974 people for Narayanganj DND and 7,625 people for Narayanganj West, totaling 66,513 people on man-year basis.



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After project implementation permanent jobs will be created for the operation and maintenance of equipment/facilities.

#### 4) Reduction of Water-Borne Diseases

Water-borne epidemics such as dysentery, diarrhoea, malaria, typhoid and cholera tend to break out following the visits of floods, especially, big and protracted ones. According to Statistical Yearbook of Bangladesh 1990, 144,521 more cases of dysentery, 8,930 more cases of diarrhoea and 25,533 more cases of malaria were recorded in 1988 compared with 1987 in the Region of Dhaka. Connection with the 1988 flood is suspected for this unusual happening.

The JICA Study Team conducted the field survey to know about the incidence of water-borne diseases as well as medical costs of those diseases in the Study Area.

According to the survey results the incidence of water-borne diseases in the Study Area abruptly went up in the two flood years of 1987 and 1988: in normal years the annual number of cases works out at 17,789 on average, while it was 31,955 and 41,607 in 1987 and 1988, respectively. It means that one witnessed 14,166 more cases in 1987 and 23,818 more cases in 1988. Such cases of water-borne diseases will increase with increasing population in future.

Medical costs of such diseases are calculated at Tk. 3,178 per case on average. It means the additional loss of Tk. 45.0 million and Tk. 75.7 million in 1987 and 1988 respectively to the economy of the Study Area. (Such a loss will increase with increasing population). These amounts correspond to 0.3% and 0.5% of the estimated GDP of the Study Area in 1987 and 1988, respectively.

Supposing the higher incidence of water-borne diseases in 1987 and 1988 was primarily due to floods, such economic losses as estimated above are likely to be avoided in the "with" situation.

#### 5) Removal of Psychological Burden

People of Bangladesh more or less suffer from psychological burden associated with the threats of floods. Once the flood protection and drainage project is realized in the Study Area, people there will be virtually freed from the inner load they are now forced to bear. It will surely affect their attitude toward life. They may get more positive and more active in their socio-economic activities.

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## 6) Elevation of Land Use

After the project the existing low land mainly used for agriculture will be gradually developed and urbanized. It will be gradually converted into built-up areas. That is to say, houses, shops, factories and institutions will make their appearance, grow in number and finally get congested.

In the process more capital will be invested in the land for a higher use of it. It means that the value of the land will gradually go up, which will be reflected in a higher land price. This impact on the value of land can be enormous.

## 5. Environmental Impact Assessment

The project is aimed at protecting from flooding the existing and future urban area of Dhaka and Narayanganj. The population in the Study Area is projected to increase by 2.2 times from 3,068,927 in 1990 to 6,710,661 in 2010. It means a massive amount of wastewater, solid waste, etc. more than doubling the present level will be generated in future. (For more details refer to 3.3 of Supporting Report C). Unless proper vigilance and measures are taken most of the water courses crisscrossing the Study Area are going to be polluted as happened in so many other countries. In order that such things may not happen, regular monitoring of water quality in major water courses is recommended. (Refer to 4. of Supporting Report C).

Possible environmental impacts taken up and described hereunder except "possible change of river courses" and "possible breach of embankments" pertain to agriculture and related fields. As mentioned already, agricultural land in the Study Area is bound to be greatly reduced after the construction of embankments. Therefore, possible negative impacts on agriculture should be viewed against this background. In other words, such impacts should not be inordinately exaggerated.

Environmental factors to be considered for possible negative impacts on them by a flood protection and drainage project include quality of surface water, fauna and flora related to surface water, overall ecological balance, quality of soil, courses of rivers and possible breach of embankment.

### 1) Adverse Effect on Water Quality and Its Far-Reaching Implications

Water in canals and ponds will be depleted and its free intercourse with river water outside the embankment will be obstructed after the project. This may lead to the

stagnation of surface water. Besides, farmers will be encouraged to grow HYV more as there will be no floodings any more. But, HYV are more prone to pests and farmers will resort to more use of pesticide.

These things along with a more concentration of population are likely to pollute the water of canals and ponds and adversely affect fish and plant concerned. This can cause chain reactions in the overall ecological system in the Study Area.

## 2) Adverse Effects on Soil Quality

Annual floodings in the rainy season in the low land areas bring with them fertile soil made up of organic matters and crops in the dry season are benefited by them. This way of things has continued from the time immemorial. but, once the circumstances are created where there are no more such floodings crops may not grow as before unless farmers take remedial steps.

Farmers will be encouraged to grow HYV because there will be no floodings in the farm land any more. It will lead to a more use of chemical fertilizer as the growing of HYV and the use of fertilizer are inseparable. This situation may contribute to the deterioration of soil quality.

## 3) Possible Change of River Courses

Environmentalists argue about the possible change of river courses as a result of the empoldering of a certain area and its possible adverse effects on the natural and social environments concerned.

## 4) Possible Breach of Embankments

Should an embankment fail and the bulged water surge into the erstwhile protected area, the resultant damages to properties, human life and farm land would be enormous. This is a man-made disaster that is not allowed to happen.



## 6. Financial Analysis

### 6.1 General

The implementation of the flood protection and drainage project will save the vast Study Area from inundations by floods.

Those lands which are now flood plains will be no longer inundated and majority of them will be developed for urban uses. That is to say, they will be raised with additional soil and infrastructures such as roads, bridges, electric lines, telecommunication lines, water supply, gas and sewerage pipes will be constructed there so that they can be used for residential, commercial, industrial and institutional purposes. This land development will be basically public undertakings. The costs of land development will reach an enormous amount.

Those areas which are already built up will also be no longer inundated.

The total capital costs of the flood protection and drainage project are estimated at Tk. 26,987 million. In addition, to maintain and operate the flood protection and drainage facilities recurrent costs amounting to Tk. 177 million will be annually required.

Through flood protection, drainage and land development majority of lands in the Study Area will turn into urban areas. In parallel with it the value, that is, price of land will go up to a great extent.

It follows from the above that land owners in the Study Area will be a major beneficiary of the project. However, the degree of benefits they will get will be different between those who now own flood plains and those who own already built-up areas. Also, it will be different between those who own commercial areas with high population density and those who own residential areas with low population density.

The JICA Study Team proposes that the authorities impose Land Development Tax on landowners to recover O&M costs.

### 6.2 Land Development Tax

As Table I.9 shows, the built-up area in Greater Dhaka East is estimated to increase from 6,675 ha in 1990 by 98.4% to 13,245 ha in the target year of 2010. Likewise, the

built-up area in Narayanganj is estimated to increase from 3,487 ha in 1990 by 71.8% to 5,990 ha in 2010. In total, the built-up area in the Study Area will go up from 10,162 ha in 1990 by 89.3% to 19,235 ha in 2010.

It is assumed that Dhaka and Narayanganj have their own, separate jurisdictions for the collection of Land Development Tax rates. It implies that the tariff will be different between the two areas.

As mentioned above, the built-up area in Greater Dhaka East and Narayanganj is estimated in 2010 to reach 13,245 ha and 5,990 ha, respectively, while annual O&M costs of the project for the two areas in the same years are estimated at Tk. 128 million and Tk. 49 million, respectively. That is to say, to recover O&M costs annual rates of Tk. 9,664 and Tk. 8,180 per ha will be levied on landowners in Greater Dhaka East and Narayanganj, respectively. Supposing collection efficiency is 70%, their respective annual rates will be Tk. 13,806 and Tk. 11,686 per ha.

Using the local measure, Tk. 39 and Tk. 33 per decimal will be annually levied in Greater Dhaka East and Narayanganj, respectively. Supposing collection efficiency is 70%, their respective annual rates will be Tk. 56 and Tk. 47 per decimal.

Table I.10 shows the amount of Land Development Tax, O&M costs, cash flow and cumulative cash flow by year and by project area. As it presents, cumulative cash flow is mostly negative in DC-1 and DC-2, but mostly positive in DC-3 and DC-4, combinedly showing a certain positiveness in the long run. Also, cumulative cash flow is positive in Narayanganj DND, but negative in Narayanganj West, combinedly showing a certain positiveness.

As already mentioned, actually the tariff should be structured in such a way that rates will be different depending on various factors. For instance, they will be different between the land which is now agricultural and the land which is now already urban, and also between the highly built-up area and the built-up area with low population density. Rates will be determined partly in accordance with the level/intensity of infrastructural investments per unit area of land and partly in accordance with the convenience/utility of locations. They will all be reflected in the price of land.

If a uniform tariff is applied in both Greater Dhaka East and Narayanganj, average annual rates work out at Tk. 9,202 per ha or Tk. 37 per decimal. Supposing collection efficiency is 70%, the rates come to Tk. 13,146 per ha or Tk. 53 per decimal.

## 7. Conclusions

As already mentioned, the DC-4, DC-1, Narayanganj DND, Narayanganj West and DC-3 Projects with their respective EIRR's of 18.9%, 14.8%, 14.5%, 14.3% and 13.9% can be judged to be economically feasible .

Regarding this kind of project with a strong social nature, the EIRR's of over 7% have proved to be on the high side. In this light the DC-2 Project with the EIRR of 8.0% can also be judged to be feasible. Moreover, the 4 compartments of the Greater Dhaka East area are geographically, socially and economically interdependent and inseparable. In this meaning the EIRR of 15.8% for the 4 Dhaka projects combined justifies the implementation of the DC-2 Project.

Values of other decision criteria and results of sensitivity analysis support the above evaluation.

In terms of socio-economic impacts of the projects, supposing the 1988-scale flood hit the Study Area in 2010, 5,660,700 people or 84.4% of the total population and 15,784 ha or 82.1% of the total built-up area would be saved from inundation. The projects will provide employment opportunities reaching 66,513 man-years. (Refer to Table I.11).

They will surely reduce the breakout of water-borne diseases by tens of thousands of cases, saving the economic losses running into Tk. fifty to one hundred million. They will remove psychological burden and stresses from people's mind, nurturing positive attitude to life. Most importantly, the enormous and vast area of land will be set free from inundation, enabling it to be developed and used for human habitation and economic activity.

The resettlement and boating trade issues must be treated with the utmost care as the livelihood of people is involved. However, they are transitory in nature and an inescapable friction from the standpoint of overall economic development.

Regarding environmental issues, it is indispensable and essential to concentrate all the human efforts to prevent, stop and lessen the negative environmental impacts of the project. The prime targets are living environment improvement and water pollution control measures as illustrated in Supporting Report C.



## 8. Supplementary Study

### 8.1 Economic Analysis of Integrated Narayanganj Project

Economic analysis was performed on the assumptions that the Narayanganj DND Project and the Narayanganj West Project are integrated into one entity. In this case the two projects will start simultaneously and also, the rehabilitation costs of flood walls in the Narayanganj DND Project will become unnecessary.

Subsequently, the results of economic analysis was compared between this integrated case and the separated case.

#### 1) Implementation Schedule

The implementation schedule of this case is as follows:

Item	1996	1997	1998	1999	2000	2001	2001
1. Narayanganj DND							
A. Project Preparation	_____						
B. Storm Water Drainage		_____					
2. Narayanganj West							
A. Project Preparation	_____						
B. Flood Mitigation		_____					
C. Storm Water Drainage			_____				
Item	2003	2004	2005	2006	2007	2008	2009
1. Narayanganj DND							
A. Project Preparation						_____	
B. Storm Water Drainage							_____
2. Narayanganj West							
A. Project Preparation							
B. Flood Mitigation							
C. Storm Water Drainage							

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## 2) Results of Economic Analysis

### (1) Cost Benefit Streams

Based on the implementation schedule the cost benefit streams were prepared as shown in Table I.12.

### (2) Calculation of Decision Criteria

Based on the cost benefit streams economic analysis was performed. The results are shown and compared with the separated case below.

Case	EIRR (%)	NPV (Tk.Mln.)	B/C	NPVR(2)
Combined Case	14.0	473	1.16	0.109
Separated Case				
1. Narayanganj DND	14.5	371	1.21	0.151
2. Narayanganj West	14.3	152	1.18	0.110

It is apparent from the above that the separated case is better in economic viability than the combined case.

## 8.2 SCF Based Economic Analysis

Additional economic analysis including sensitivity analysis was performed, applying the standard conversion factor (SCF) of 0.87 to the benefits excluding those related to agriculture.

The SCF value of 0.87 is based on the final report of "Estimation of Economic Prices of Selected Commodities for Use in FAP Planning Studies" by Q. Shahabuddin and K. Mustahidur Rahman dated April 15, 1992.

Agricultural benefits have already been converted in economic terms in accordance with the "Guidelines".

1) Project Benefits

Annual, 1987 - scale and 1988 - scale external flood damages and annual and worst internal damages were recalculated for each of the 6 areas and for both 1990 and 2010 conforming the SCF as above. The results are shown in Table I.13.

Based on Table I.13 average annual flood damages were calculated as presented in Table I.14. The below table summarises Table I.14.

Project Benefits

Project	(Unit: Tk. Million)	
	1990	2010
DC-1	39.8	564.3
DC-2	25.1	154.4
DC-3	171.2	546.8
DC-4	260.2	688.4
Greater Dhaka East	496.3	1,953.9
Narayanganj DND	135.0	556.8
Narayanganj West	99.2	343.8
Total	730.5	2,854.5

2) Calculation of EIRR and Other Decision Criteria

Employing the project benefits in Table I.14, economic analysis was newly conducted. The results are tabulated below.

Project	EIRR (%)	NPV (Tk. Min.)	B/C	NPVR(2)
DC-1	12.8	74	1.06	0.044
DC-2	6.4	-134	0.65	-0.212
DC-3	12.5	55	1.04	0.031
DC-4	16.6	660	1.35	0.266
Greater Dhaka East	13.8	685	1.14	0.104
Narayanganj DND	12.7	96	1.05	0.039
Narayanganj West	12.4	21	1.02	0.015



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As the above table shows, the DC-4 Project has the highest EIRR of 16.6%. The EIRR's of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are almost the same, being 12.8%, 12.7%, 12.5% and 12.4%, respectively. All these five projects have the EIRR's exceeding the OCC of 12.0%

The EIRR of the DC-2 Project is 6.4%, which is low compared with OCC.

With regard to NPV, the DC-4 Project has the biggest value of Tk. 660 million. The second place goes to the Narayanganj DND Project with Tk. 96 million, followed by the DC-1, DC-3 and Narayanganj West Projects with Tk. 74 million, Tk. 55 million and Tk. 21 million, respectively. The DC-2 Project has the negative NPV of Tk. -134 million.

In terms of B/C, the DC-4 Project leads others with 1.35. The B/C's of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are not much different, being 1.06, 1.05, 1.04 and 1.02, respectively. The B/C of the DC-2 Project is 0.65, which is less than one (1).

Turning to NPVR (2), the DC-4 Project has the highest value of 0.266. The DC-1, Narayanganj DND and DC-3 Projects have similar values of 0.044, 0.039 and 0.031, respectively. The Narayanganj West Project is placed fifth with 0.015. The DC-2 Project has the negative NPVR (2) of -0.212.

It is to be noted that regarding priority order the DC-4 Project is placed first in all the decision criteria. The DC-1 Project is placed second except in NPV where it is the third. The Narayanganj DND Project is placed third except in NPV where it is the second. The DC-3 Project is placed fourth. The Narayanganj West Project is placed fifth and the DC-2 Project is placed sixth.

As seen in the above, the five projects, namely the DC-4, DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are judged to be economically feasible, while the DC-2 Project appears problematic so far as economic evaluation is concerned.

However, one thing to be noted and remembered is that in a project with a strongly social nature such as this one the EIRR of 7% has proved to be on a high side.

Furthermore, the DC-2 Project is an integral part of the Greater Dhaka East Project combining the four compartments, which has the EIRR of 13.8%, NPV of Tk. 685 million, B/C of 1.14 and NPVR (2) of 0.104. These values are the highest among the three projects. Because of these reasons the implementation of the DC-2 Project is justified.

### 3) Sensitivity Analysis

Sensitivity analysis was conducted to see whether the projects can maintain their viability, when placed under unfavorable circumstances during and after implementation. In conducting sensitivity analysis, GPA was referred to.

In case A the 15% increase of capital costs compared with the base case was assumed. In Case B the 100% increase of O&M costs was assumed. In Cases C and D the 15% reduction of benefits and one and a half year delays in achieving benefits were respectively assumed.

The sensitivity analysis on the reduction of incremented net value of agricultural and fisheries production was not done because this is not an agricultural development project and the sensitivity to such a variable is minimal.

In Case E the switching values of capital cost increase were estimated. Likewise, in Case F the switching values of benefit reduction were estimated.

The results of sensitivity analysis are shown below. The decision criteria employed is EIRR.

Case	Greater Dhaka East					Narayanganj	
	DC-1	DC-2	DC-3	DC-4	Combined	DND	West
Base Case	12.8	6.4	12.5	16.6	13.8	12.7	12.4
Case A	11.1	5.0	11.1	14.4	12.0	11.1	10.7
Case B	12.1	5.0	11.9	15.8	13.1	12.1	11.7
Case C	10.7	4.6	10.8	14.0	11.6	10.7	10.3
Case D	11.0	5.4	11.2	14.3	12.0	11.0	10.8
Case E	6.1	-38.5	4.2	37.5	15.7	5.7	2.6
Case F	5.5	-55.0	3.8	26.0	11.6	5.2	2.4

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As the table shows, in Case A out of the five above-OCC projects only the DC-4 Project stays viable. In Case B the DC-4, DC-1 and Narayanganj DND Projects stay viable. In cases C and D only the DC-4 Project stays viable as in Case A.

When the four Greater Dhaka East projects are combined together and treated as one entity, then this project maintain its viability in case A, B and D.

In case E the switching value of the DC-4 Project is calculated at 37.5%, that is to say, it may stay viable, supposing the capital cost overrun reaches 37.5%. Likewise, the switching values of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are calculated at 6.1%, 5.7%, 4.2% and 2.6%, respectively.

In Case F the switching value of the DC-4 Project works out at 26.0%, that is to say, it may remain viable, supposing the benefits turn out to be less by 26%. Similarly, the switching values of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects work out at 5.5%, 5.2%, 3.8% and 2.4%.

The switching value of the combined Greater Dhaka East Project is 15.7% in Case E and 11.6% in Case F.

It follows from the above that the DC-4 Project will keep its robustness under any conceivable adverse circumstances, that the other four above-OCC projects will be vulnerable to unfavorable circumstances in one way or another and also that the combined Greater Dhaka East Project will virtually stay viable under any adverse circumstances.

As regard the DC-2 Project, the 38.5% reduction of costs or the 55% addition of benefits will be required if it is to be feasible.

It might be added that the EIRR's of all the five above-OCC projects stay above the 10% line in all the cases of A, B, C and D.



Table I.1 Average Annual Flood Damages by Area by Year

(Unit : Tk. Million)

Area	Average Annual Flood Damages		
	External Flood	Internal Flood	Total
1. 1990			
Dhaka East - 1	40.7	2.5	43.2
Dhaka East - 2	25.4	1.0	26.4
Dhaka East - 3	121.0	74.1	195.1
Dhaka East - 4	195.5	97.5	293.0
Dhaka East (Sub-Total)	382.6	175.1	557.7
Narayanganj DND	116.0	37.4	153.4
Narayanganj West	88.5	24.9	113.4
Total	587.1	237.4	824.5
2. 2010			
Dhaka East - 1	634.5	13.9	648.4
Dhaka East - 2	169.3	7.4	176.7
Dhaka East - 3	480.4	148.1	628.5
Dhaka East - 4	631.9	159.4	791.3
Dhaka East (Sub-Total)	1,916.1	328.8	2,244.9
Narayanganj DND	483.8	156.1	639.9
Narayanganj West	318.8	76.5	395.3
Total	2,718.7	561.4	3,280.1

Source : JICA

Table I.2 (1) Economic Costs by Project

1. Capital Cost

(Unit : Tk. Million)

Item	Greater Dhaka East					Narayanganj		Total
	DC-1	DC-2	DC-3	DC-4	Sub-Total	DND	West	
<b>A. Project Preparation</b>								
1) Administration	85	59	57	67	268	66	51	385
2) Engineering	326	226	220	258	1,030	250	194	1,474
3) Compensation	34	22	14	31	101	62	166	329
<b>Sub-Total</b>	445	307	291	356	1,399	378	411	2,188
<b>B. Flood Mitigation</b>								
1) Embankment	2,101	813	835	910	4,659	0	616	5,275
2) Flood Wall	19	20	14	25	78	43	180	301
3) Sluice Gate	160	89	78	79	406	60	157	623
4) Related Struc.etc.	0	0	0	0	0	3	1	4
<b>Sub-Total</b>	2,280	922	927	1,014	5,143	106	954	6,203
<b>C. Storm Water Drainage</b>								
1) Pump Station	1,156	553	1,077	1,066	3,852	1,296	510	5,658
2) Khal Improvement	246	183	150	426	1,005	932	386	2,323
3) Bridge etc.	14	0	0	8	22	101	16	139
<b>Sub-Total</b>	1,416	736	1,227	1,500	4,879	2,329	912	8,120
<b>D. Physical Contingency</b>	425	294	285	337	1,341	326	253	1,920
<b>E. Replacement</b>	389	732	727	713	2,561	949	328	3,838
<b>Total</b>	4,955	2,991	3,457	3,920	15,323	4,088	2,858	22,269

Table I.2 (2) Economic Costs by Project

## 2. Annual Net Benefits of Production Foregone

(Unit : Tk. Million)

Item	Greater Dhaka East					Narayanganj		Total
	DC-1	DC-2	DC-3	DC-4	Sub-Total	DND	West	
Land Acquisition (ha)	197.9	96.2	83.1	146.3	523.5	107.1	121.2	751.8
Annual Net Benefits of Production Foregone	2.28	1.11	0.96	1.68	6.02	1.23	1.39	8.65

## 3. Annual Operating and Maintenance Cost

(Unit : Tk. Million)

Item	Greater Dhaka East					Narayanganj		Total
	DC-1	DC-2	DC-3	DC-4	Sub-Total	DND	West	
O & M Cost	37	30	29	32	128	28	21	177

Source : JICA





Table I.3(1) Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits  
CF=Cash Flow (=BF - CS)

## 1. Greater Dhaka East - 1 Project

(Unit:Tk Million)					
NO. YEAR	CC	OM	CS	BF	CF
1 1992	0	0	0	0	0
2 1993	0	0	0	0	0
3 1994	0	0	0	0	0
4 1995	0	0	0	0	0
5 1996	0	0	0	0	0
6 1997	0	0	0	0	0
7 1998	0	0	0	0	0
8 1999	195	0	195	0	-195
9 2000	196	0	196	0	-196
10 2001	692	0	692	73	-619
11 2002	952	0	952	188	-764
12 2003	952	0	952	320	-632
13 2004	948	0	948	467	-481
14 2005	2	36	38	497	459
15 2006	2	36	38	527	489
16 2007	2	36	38	558	519
17 2008	157	36	193	588	395
18 2009	157	36	193	618	425
19 2010	247	36	283	648	366
20 2011	2	37	39	679	639
21 2012	90	37	127	709	582
22 2013	2	37	39	739	700
23 2014	2	37	39	769	730
24 2015	2	37	39	800	760
25 2016	2	37	39	830	791
26 2017	2	37	39	860	821
27 2018	2	37	39	890	851
28 2019	299	37	336	921	584
29 2020	2	37	39	951	912
30 2021	2	37	39	981	942
31 2022	2	37	39	1012	972
32 2023	2	37	39	1042	1003
33 2024	2	37	39	1072	1033
34 2025	94	37	131	1102	971
35 2026	2	37	39	1133	1093
36 2027	2	37	39	1163	1124
37 2028	2	37	39	1193	1154
38 2029	2	37	39	1223	1184
39 2030	2	37	39	1394	1355

Table I.3(2) Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits  
CF=Cash Flow (=BF - CS)

## 2. Greater Dhaka East - 2 Project

(Unit:Tk Million)					
NO. YEAR	CC	OM	CS	BF	CF
1 1992	0	0	0	0	0
2 1993	0	0	0	0	0
3 1994	0	0	0	0	0
4 1995	0	0	0	0	0
5 1996	0	0	0	0	0
6 1997	0	0	0	0	0
7 1998	0	0	0	0	0
8 1999	0	0	0	0	0
9 2000	0	0	0	0	0
10 2001	0	0	0	0	0
11 2002	0	0	0	0	0
12 2003	0	0	0	0	0
13 2004	0	0	0	0	0
14 2005	132	0	132	0	-132
15 2006	134	0	134	0	-134
16 2007	544	0	544	44	-500
17 2008	760	0	760	111	-649
18 2009	299	13	312	142	-169
19 2010	301	15	316	177	-140
20 2011	1	25	26	184	158
21 2012	88	25	113	192	78
22 2013	1	30	31	199	168
23 2014	1	30	31	207	176
24 2015	1	30	31	214	183
25 2016	1	30	31	222	191
26 2017	1	30	31	229	198
27 2018	1	30	31	237	206
28 2019	1	30	31	244	213
29 2020	1	30	31	252	221
30 2021	1	30	31	259	228
31 2022	1	30	31	267	236
32 2023	1	30	31	274	243
33 2024	1	30	31	282	251
34 2025	549	30	579	289	-289
35 2026	1	30	31	297	266
36 2027	185	30	215	304	90
37 2028	1	30	31	312	281
38 2029	1	30	31	319	289
39 2030	1	30	31	327	296
40 2031	1	30	31	335	304
41 2032	1	30	31	342	311
42 2033	1	30	31	350	319
43 2034	1	30	31	357	326
44 2035	1	30	31	365	334
45 2036	1	30	31	592	561

Table I.3(3) Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits  
CF=Cash Flow (=BF - CS)

## 3. Greater Dhaka East - 3 Project

(Unit: Tk Million)					
NO. YEAR	CC	OM	CS	BF	CF
1 1992	439	0	439	19	-420
2 1993	180	0	180	28	-152
3 1994	82	0	82	34	-49
4 1995	1	4	5	35	30
5 1996	0	4	4	36	32
6 1997	0	4	4	38	33
7 1998	0	4	4	39	35
8 1999	0	4	4	41	36
9 2000	125	4	130	42	-88
10 2001	126	4	130	43	-87
11 2002	544	4	548	183	-365
12 2003	894	4	898	337	-562
13 2004	432	17	449	425	-24
14 2005	436	17	453	520	67
15 2006	6	29	35	542	507
16 2007	175	29	204	563	359
17 2008	1	33	34	585	551
18 2009	1	33	34	607	573
19 2010	1	33	34	629	594
20 2011	1	33	34	650	616
21 2012	1	33	34	672	638
22 2013	1	33	34	694	659
23 2014	1	33	34	715	681
24 2015	1	33	34	737	703
25 2016	1	33	34	759	724
26 2017	1	33	34	780	746
27 2018	1	33	34	802	768
28 2019	1	33	34	824	789
29 2020	545	33	578	845	267
30 2021	1	33	34	867	833
31 2022	184	33	217	889	671
32 2023	1	33	34	910	876
33 2024	1	33	34	932	898
34 2025	1	33	34	954	919
35 2026	1	33	34	975	941
36 2027	1	33	34	997	963
37 2028	1	33	34	1019	984
38 2029	1	33	34	1040	1006
39 2030	1	33	34	1062	1028
40 2031	1	33	34	1302	1268

Table I.3(4) Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits  
CF=Cash Flow (=BF - CS)

## 4. Greater Dhaka East - 4 Project

(Unit: Tk Million)					
NO. YEAR	CC	OM	CS	BF	CF
1 1992	163	0	163	9	-154
2 1993	167	0	167	19	-148
3 1994	8	3	11	20	10
4 1995	158	3	160	21	-140
5 1996	434	3	436	108	-329
6 1997	877	3	879	249	-631
7 1998	880	3	882	405	-478
8 1999	539	20	558	517	-41
9 2000	2	32	33	542	509
10 2001	2	32	33	567	534
11 2002	2	31	32	592	559
12 2003	2	31	32	617	584
13 2004	2	31	32	642	609
14 2005	2	31	32	667	634
15 2006	2	31	32	692	659
16 2007	2	31	32	717	684
17 2008	7	31	37	741	704
18 2009	172	31	202	766	564
19 2010	2	35	36	791	755
20 2011	2	35	36	816	780
21 2012	2	35	36	841	805
22 2013	2	35	36	866	830
23 2014	536	35	570	891	320
24 2015	2	35	36	916	879
25 2016	2	35	36	941	904
26 2017	2	35	36	966	929
27 2018	2	35	36	991	954
28 2019	2	35	36	1016	979
29 2020	2	35	36	1040	1004
30 2021	2	35	36	1065	1029
31 2022	2	35	36	1090	1054
32 2023	2	35	36	1115	1079
33 2024	181	35	215	1140	925
34 2025	2	35	36	1474	1438

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Table I.3(5) Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits  
CF=Cash Flow (=BF - CS)

5. Greater Dhaka East Project

(Unit:Tk Million)					
NO. YEAR	CC	OM	CS	BF	CF
1 1992	602	0	602	28	-574
2 1993	347	0	347	48	-300
3 1994	90	3	93	54	-39
4 1995	158	7	166	56	-110
5 1996	434	7	441	144	-297
6 1997	877	7	884	287	-597
7 1998	880	7	887	444	-443
8 1999	734	24	758	558	-200
9 2000	323	36	360	584	225
10 2001	820	36	856	684	-172
11 2002	1498	35	1533	964	-569
12 2003	1848	35	1883	1273	-610
13 2004	1382	48	1430	1533	103
14 2005	572	84	656	1684	1027
15 2006	144	96	240	1761	1521
16 2007	723	96	819	1882	1063
17 2008	925	100	1025	2025	1000
18 2009	629	113	742	2134	1392
19 2010	551	119	670	2245	1575
20 2011	6	130	136	2329	2193
21 2012	181	130	311	2414	2103
22 2013	6	135	141	2498	2357
23 2014	540	135	675	2582	1907
24 2015	6	135	141	2667	2526
25 2016	6	135	141	2751	2610
26 2017	6	135	141	2835	2694
27 2018	6	135	141	2920	2779
28 2019	303	135	438	3004	2566
29 2020	550	135	685	3089	2404
30 2021	6	135	141	3173	3032
31 2022	189	135	324	3257	2933
32 2023	6	135	141	3342	3201
33 2024	185	135	320	3426	3106
34 2025	646	135	781	3820	3039
35 2026	4	100	104	2405	2300
36 2027	188	100	288	2464	2176
37 2028	4	100	104	2524	2419
38 2029	4	100	104	2583	2479
39 2030	4	100	104	2783	2679
40 2031	2	63	65	1636	1571
41 2032	2	63	65	1442	1377
42 2033	2	63	65	1471	1406
43 2034	2	63	65	1718	1653
44 2035	1	30	31	365	334
45 2036	1	30	31	592	561

Table I.3(6) Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits  
CF=Cash Flow (=BF - CS)

5. Narayanganj DND Project

(Unit:Tk Million)					
NO. YEAR	CC	OM	CS	BF	CF
1 1992	234	0	234	0	-234
2 1993	0	0	0	0	0
3 1994	0	0	0	0	0
4 1995	0	0	0	0	0
5 1996	328	0	328	0	-328
6 1997	895	0	895	110	-786
7 1998	896	0	896	236	-660
8 1999	850	14	864	372	-492
9 2000	1	25	26	397	370
10 2001	1	25	26	421	395
11 2002	1	25	26	445	419
12 2003	1	25	26	470	443
13 2004	1	25	26	494	468
14 2005	1	25	26	518	492
15 2006	1	25	26	543	516
16 2007	1	24	25	567	542
17 2008	5	24	29	591	562
18 2009	171	24	195	616	420
19 2010	1	28	29	640	611
20 2011	1	28	29	664	635
21 2012	1	28	29	689	659
22 2013	1	28	29	713	684
23 2014	1	28	29	737	708
24 2015	771	28	799	762	-38
25 2016	1	28	29	786	757
26 2017	1	28	29	810	781
27 2018	1	28	29	835	805
28 2019	1	28	29	859	830
29 2020	1	28	29	883	854
30 2021	1	28	29	907	878
31 2022	1	28	29	932	903
32 2023	1	28	29	956	927
33 2024	180	28	208	980	772
34 2025	1	28	29	1005	976
35 2026	1	28	29	1390	1360



Table I.3(7) Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits  
CF=Cash Flow (=BF - CS)

## 7. Narayananj West Project

NO. YEAR	(Unit: Tk Million)			
	CC	OM	CS	BF
1 1992	0	0	0	0
2 1993	0	0	0	0
3 1994	0	0	0	0
4 1995	0	0	0	0
5 1996	0	0	0	0
6 1997	0	0	0	0
7 1998	0	0	0	0
8 1999	369	0	369	0
9 2000	376	0	376	44
10 2001	603	0	603	121
11 2002	606	0	606	207
12 2003	286	16	302	256
13 2004	295	16	311	311
14 2005	1	21	22	302
15 2006	1	21	22	317
16 2007	1	21	22	339
17 2008	1	21	22	353
18 2009	1	21	22	367
19 2010	1	21	22	381
20 2011	1	21	22	395
21 2012	1	21	22	409
22 2013	1	21	22	423
23 2014	1	21	22	438
24 2015	1	21	22	452
25 2016	1	21	22	466
26 2017	1	21	22	480
27 2018	1	21	22	494
28 2019	329	21	350	508
29 2020	1	21	22	522
30 2021	1	21	22	536
31 2022	1	21	22	550
32 2023	1	21	22	564
33 2024	1	21	22	579
34 2025	1	21	22	593
35 2026	1	21	22	607
36 2027	1	21	22	621
37 2028	1	21	22	635
38 2029	1	21	22	649
				772
				750

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Table I.4 Resettlement Compensation Cost for Buildings

(Unit : Tk. Million)

Project Area	Embankment			Compensation Cost	Drainage		Total Compensation Cost
	No. of House Buildings (units)	Floor Area of Other Bldgs (sq.m)	Floor Area of Other Bldgs (sq.m)		No. of House Buildings (units)	Compensation Cost	
Dhaka East - 1	310	2,800	26.4	200	0	8.0	34.4
Dhaka East - 2	230	2,100	19.7	50	0	2.0	21.7
Dhaka East - 3	70	700	6.3	95	700	7.3	13.6
Dhaka East - 4	230	1,400	16.2	200	1,400	15.0	31.2
Dhaka East (Sub-Total)	840	7,000	68.6	545	2,100	32.3	100.9
Narayanganj DND	0	0	0.0	680	6,900	61.7	61.7
Narayanganj West	195	23,700	126.3	430	4,400	39.2	165.5
Total	1,035	30,700	194.9	1,655	13,400	133.2	328.1

Notes : 1) The unit cost of compensation for house buildings is Tk. 40,000/ building. (Source : WDB and JICA)  
 2) The unit cost of compensation for other buildings is Tk. 5,000 / sq.m of floor area. (Source : PWD)

Source : JICA

Table I.5 Summary of Questionnaire Survey on People to be Displaced

1. Average No. of Household Members : 8.33
5. Average House Price : Tk. 209,980
6. Average Land Area : 0.776 ha
7. Average Land Price : Tk. 1,202,110
8. Agree to Remove ? : Yes = 70.5%, No = 29.5%

Occupation	Share (%)
1) Business & Agriculture	29.50
2) Agriculture	16.39
3) Service & Agriculture	11.48
4) Boating	11.48
5) Service	11.47
6) Business	6.56
7) Fishing	4.92
8) Agriculture & Fishing	4.92
9) Service & Business	3.28
Total	100.00

9. Average Compensation Demanded

(Unit : Tk.)			
Land	House	Remove	Others
881,540	245,340	39,030	39,330
			Total
			1,205,240

3. Average Monthly Income : Tk. 6,266
- 10.

Education	Share (%)
1) Primary	37.70
2) No Schooling	34.43
3) Secondary	24.59
4) College	3.28
5) University	-
6) Others	-
Total	100.00

Mental Attitude toward Displacement	Share (%)
1) Good chance to start a new life with compensation	34.42
2) If I get sufficient compensation, I agree to displacement.	27.87
3) Difficult to change my occupation as a farmer	21.31
4) I can not resist government order.	9.84
5) Others	6.56
6) Difficult to change my occupation as a fisherman / boatman	-
Total	100.00



Table I.6 Sales by Boating in Dhaka East Area

Boat Terminals	Boat - Days								Average Sales per Boat per Day	Sales by Boating			Share (%)
	Wet Season				Dry Season					Wet Season F1=D1xE	Dry Season F2=D2xE	Total G=F1+F2	
	No. of Boats A1	No. of Months B1	No. of Opera- ting Days per Month C1	Boat-Days D1= A1xB1xC1	No. of Boats A2	No. of Months B2	No. of Opera- ting Days per Month C2	Boat-Days D2 = A2xB2xC2					
Rampura	85	7	30	17,850	18	5	30	2,700	350	6,247,500	945,000	7,192,500	13.50
Meradia	11	7	4	308					350	107,800	0	107,800	0.20
	3	7	26	546					350	191,100	0	191,100	0.36
Madartek	60	7	30	12,600	18	5	30	2,700	350	4,410,000	945,000	5,355,000	10.06
Shahjadpur	23	7	30	4,830					325	1,569,750	0	1,569,750	2.95
Khilkhet	47	7	30	9,870					375	3,701,250	0	3,701,250	6.95
Tongi	275	7	30	57,750	75	5	30	11,250	375	21,656,250	4,218,750	25,875,000	48.57
Mainer Tek	11	7	30	2,310	6	5	30	900	250	577,500	225,000	802,500	1.51
Kaskura	8	7	30	1,680					175	294,000	0	294,000	0.55
Patira	75	7	8	4,200	35	5	8	1,400	350	1,470,000	490,000	1,960,000	3.68
	8	7	22	1,232	8	5	22	880	350	431,200	308,000	739,200	1.39
Bora Beraid	75	7	4	2,100	60	5	4	1,200	350	735,000	420,000	1,155,000	2.17
	8	7	26	1,456	8	5	26	1,040	350	509,600	364,000	873,600	1.64
Kaetpara	350	7	4	9,800	125	5	4	2,500	225	2,205,000	562,500	2,767,500	5.20
	11	7	26	2,002	8	5	26	1,040	225	450,450	234,000	684,450	1.28
Total	1,050			128,534	361			25,610		44,556,400	8,712,250	53,268,650	100.00

Note : Results of the interview survey towards boatmen.

Source : JICA

Table I.7 No. of Passengers Transported by Boats

(Unit : Persons)

Boat Terminals	Boat - Days per Year		Average No. of Trips per Day	Share of Passenger Terminal Services	Average No. of Passengers per Trip	No. of Passengers			Share (%)
	Wet Season	Dry Season				Wet Season	Dry Season	Total	
	A1	A2	B	C	D	E1 = A1xBxCxD	E2 = A2xBxCxD	F = E1+E2	(%)
Rampura	17,850	2,700	1.5	50%	20	267,750	40,500	308,250	10.94
Meradia	308 546	0 0	11.0 11.0	80% 80%	10 10	27,104 48,048	0 0	27,104 48,048	0.96 1.71
Madartek	12,600	2,700	2.5	50%	20	315,000	67,500	382,500	13.57
Shahjadpur	4,830	0	3.0	90%	20	260,820	0	260,820	9.25
Khilkhet	9,870	0	2.0	90%	20	355,320	0	355,320	12.60
Tongi	57,750	11,250	1.0	40%	20	462,000	90,000	552,000	19.58
Mainer Tek	2,310	900	11.0	90%	10	228,690	89,100	317,790	11.27
Kaskura	1,680	0	1.0	90%	20	30,240		30,240	1.07
Patira	4,200 1,232	1,400 880	3.5 3.5	30% 30%	20 20	88,200 25,872	29,400 18,480	117,600 44,352	4.17 1.57
Bora Beraid	2,100 1,456	1,200 1,040	2.5 2.5	50% 50%	20 20	52,500 36,400	30,000 26,000	82,500 62,400	2.93 2.21
Kaetpara	9,800 2,002	2,500 1,040	1.5 1.5	50% 50%	20 20	147,000 30,030	37,500 15,600	184,500 45,630	6.55 1.62
Total	128,534	25,610				2,374,974	444,080	2,819,054	100.00

Note : Results of the interview survey towards boatmen.

Source : JICA

Table I.8 Amount of Commodities Transported by Boats

Boat Terminals	Boat - Days per Year		Average No. of Trips per Day	Share of Commodity Transport Services	Total No. of Trips for Commodity Transport Services		Share by Size of Boats				Value of Commodities per Trip		Valut of Commodities			Share (%)
	Wet Season	Dry Season			Wet Season	Dry Season	Wet Season	Dry Season	Small Boat	Big Boat	Wet Season	Dry Season	Total			
A1	A2	B	C	D1=A1xBxC	D2=A2xBxC	E11	E12	E21	E22	F1	F2	G1 = D1x(E11xF1+ E12xF2)	G2 = D2x(E21xF1+ E22xF2)	H = G1+G2		
Rampura	17,850	2,700	1.5	50%	13,388	2,025	0.65	0.35	0.25	0.75	1,000	10,000	55,558,125	15,693,750	71,251,875	12.42
Meradia	308	0	11.0	20%	678	0	0.33	0.67	0.25	0.75	1,000	10,000	4,743,200	0	4,743,200	0.83
	546	0	11.0	20%	1,201	0	0.33	0.67	0.25	0.75	1,000	10,000	8,408,400	0	8,408,400	1.47
Madartek	12,600	2,700	2.5	50%	15,750	3,375	1.00	0.00	1.00	0.00	1,000	10,000	15,750,000	3,375,000	19,125,000	3.33
Shahjampur	4,830	0	3.0	10%	1,449	0	0.00	1.00	1.00	0.00	1,000	10,000	14,490,000	0	14,490,000	2.53
Khilkhet	9,870	0	2.0	10%	1,974	0	0.00	1.00	1.00	0.00	1,000	10,000	19,740,000	0	19,740,000	3.44
Tongi	57,750	11,250	1.0	60%	34,650	6,750	0.45	0.55	0.00	1.00	1,000	10,000	204,750,000	39,150,000	243,900,000	42.50
Mainer Tek	2,310	900	11.0	10%	2,541	990	1.00	0.00	1.00	0.00	1,000	10,000	2,541,000	990,000	3,531,000	0.62
Kaskura	1,680	0	1.0	10%	168	0	1.00	0.00	1.00	0.00	1,000	10,000	168,000	0	168,000	0.03
Patira	4,200	1,400	3.5	70%	10,290	3,430	0.53	0.47	1.00	0.00	1,000	10,000	53,508,000	18,865,000	72,373,000	12.61
	1,232	880	3.5	70%	3,018	2,156	0.53	0.47	1.00	0.00	1,000	10,000	15,695,680	11,858,000	27,553,680	4.80
Bora Beraid	2,100	1,200	2.5	50%	2,625	1,500	0.53	0.47	1.00	0.00	1,000	10,000	13,650,000	8,250,000	21,900,000	3.82
	1,456	1,040	2.5	50%	1,820	1,300	0.53	0.47	1.00	0.00	1,000	10,000	9,464,000	7,150,000	16,614,000	2.90
Kaetpara	9,800	2,500	1.5	50%	7,350	1,875	0.64	0.36	1.00	0.00	1,000	10,000	30,975,000	8,906,250	39,881,250	6.95
	2,022	1,040	1.5	50%	1,517	780	0.64	0.36	1.00	0.00	1,000	10,000	6,327,750	3,705,000	10,032,750	1.75
Total	128,554	25,610											455,769,155	117,943,000	573,712,155	100.00

Note : Results of the interview survey towards boatmen.

Source : JICA



Table I.9 Built-up Area by Year and by Project Area

Year						(Unit: ha)	
	Greater Dhaka East					Narayanganj	
	DC-1	DC-2	DC-3	DC-4	Combined	DND	West
1990	1,253	341	3,164	1,917	6,675	2,175	1,312
1991	1,339	380	3,197	1,979	6,894	2,288	1,348
1992	1,430	423	3,229	2,043	7,125	2,407	1,385
1993	1,528	470	3,263	2,109	7,370	2,533	1,423
1994	1,632	524	3,296	2,177	7,630	2,665	1,462
1995	1,744	583	3,330	2,248	7,905	2,804	1,502
1996	1,863	649	3,364	2,321	8,197	2,950	1,543
1997	1,990	723	3,399	2,396	8,508	3,103	1,586
1998	2,126	804	3,434	2,473	8,838	3,265	1,629
1999	2,272	896	3,469	2,553	9,190	3,435	1,674
2000	2,427	997	3,505	2,636	9,565	3,614	1,720
2001	2,558	1,042	3,553	2,717	9,870	3,675	1,720
2002	2,697	1,089	3,602	2,801	10,188	3,737	1,720
2003	2,843	1,139	3,651	2,887	10,518	3,799	1,720
2004	2,996	1,190	3,701	2,975	10,862	3,863	1,720
2005	3,158	1,244	3,751	3,067	11,220	3,928	1,720
2006	3,329	1,300	3,803	3,161	11,593	3,994	1,720
2007	3,509	1,359	3,855	3,258	11,981	4,062	1,720
2008	3,699	1,421	3,907	3,358	12,385	4,130	1,720
2009	3,899	1,485	3,961	3,462	12,806	4,199	1,720
2010	4,110	1,552	4,015	3,568	13,245	4,270	1,720

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Table I.10(1) O&M Cost Recovery Cash Flow

1. DC-1

(Unit: Tk. Million)				
Year	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0
2004	29.0	36.0	-7.0	-7.0
2005	30.5	36.0	-5.5	-12.5
2006	32.2	36.0	-3.8	-16.3
2007	33.9	36.0	-2.1	-18.4
2008	35.7	36.0	-0.3	-18.7
2009	37.7	36.0	1.7	-17.0
2010	39.7	37.0	2.7	-14.3
2011	39.7	37.0	2.7	-11.6
2012	39.7	37.0	2.7	-8.8
2013	39.7	37.0	2.7	-6.1
2014	39.7	37.0	2.7	-3.4
2015	39.7	37.0	2.7	-0.7
2016	39.7	37.0	2.7	2.0
2017	39.7	37.0	2.7	4.7

Table I.10(2) O&M Cost Recovery Cash Flow

2. DC-2

(Unit: Tk. Million)				
Year	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0
2004	0.0	0.0	0.0	0.0
2005	0.0	0.0	0.0	0.0
2006	0.0	0.0	0.0	0.0
2007	13.1	13.0	0.1	0.1
2008	13.7	15.0	-1.3	-1.1
2009	14.3	25.0	-10.7	-11.8
2010	15.0	25.0	-10.0	-21.8
2011	15.0	30.0	-15.0	-36.8
2012	15.0	30.0	-15.0	-51.8
2013	15.0	30.0	-15.0	-66.8
2014	15.0	30.0	-15.0	-81.8
2015	15.0	30.0	-15.0	-96.8
2016	15.0	30.0	-15.0	-111.8
2017	15.0	30.0	-15.0	-126.8

Table I.10(3) O&amp;M Cost Recovery Cash Flow

## 3. DC-3

(Unit: Tk. Million)

Year	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0
2004	0.0	0.0	0.0	0.0
2005	0.0	0.0	0.0	0.0
2006	36.7	13.0	23.7	23.7
2007	37.3	13.0	24.3	48.0
2008	37.8	25.0	12.8	60.8
2009	38.3	25.0	13.3	74.0
2010	38.8	29.0	9.8	83.8
2011	38.8	29.0	9.8	93.6
2012	38.8	29.0	9.8	103.4
2013	38.8	29.0	9.8	113.2
2014	38.8	29.0	9.8	123.0
2015	38.8	29.0	9.8	132.8
2016	38.8	29.0	9.8	142.6
2017	38.8	29.0	9.8	152.4

Table I.10(4) O&amp;M Cost Recovery Cash Flow

## 4. DC-4

(Unit: Tk. Million)

Year	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	23.9	17.0	6.9	6.9
1999	24.7	29.0	-4.3	2.6
2000	25.5	29.0	-3.5	-0.9
2001	26.3	28.0	-1.7	-2.7
2002	27.1	28.0	-0.9	-3.6
2003	27.9	28.0	-0.1	-3.7
2004	28.8	28.0	0.8	-3.0
2005	29.6	28.0	1.6	-1.3
2006	30.5	28.0	2.5	1.2
2007	31.5	28.0	3.5	4.7
2008	32.5	28.0	4.5	9.2
2009	33.5	32.0	1.5	10.6
2010	34.5	32.0	2.5	13.1
2011	34.5	32.0	2.5	15.6
2012	34.5	32.0	2.5	18.1
2013	34.5	32.0	2.5	20.5
2014	34.5	32.0	2.5	23.0
2015	34.5	32.0	2.5	25.5
2016	34.5	32.0	2.5	28.0
2017	34.5	32.0	2.5	30.5



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Table I.10(5) O&M Cost Recovery Cash Flow

5. Narayanganj DND

Year	(Unit: Tk. Million)			
	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	26.7	14.0	12.7	12.7
1999	28.1	25.0	3.1	15.8
2000	29.6	25.0	4.6	20.4
2001	30.1	25.0	5.1	25.4
2002	30.6	25.0	5.6	31.0
2003	31.1	25.0	6.1	37.1
2004	31.6	25.0	6.6	43.7
2005	32.1	25.0	7.1	50.8
2006	32.7	24.0	8.7	59.5
2007	33.2	24.0	9.2	68.7
2008	33.8	24.0	9.8	78.5
2009	34.4	28.0	6.4	84.9
2010	34.9	28.0	6.9	91.8
2011	34.9	28.0	6.9	98.7
2012	34.9	28.0	6.9	105.6
2013	34.9	28.0	6.9	112.6
2014	34.9	28.0	6.9	119.5
2015	34.9	28.0	6.9	126.4
2016	34.9	28.0	6.9	133.4
2017	34.9	28.0	6.9	140.3

Table I.10(6) O&M Cost Recovery Cash Flow

6. Narayanganj West

Year	(Unit: Tk. Million)			
	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0
2001	14.1	16.0	-1.9	-1.9
2002	14.1	16.0	-1.9	-3.9
2003	14.1	21.0	-6.9	-10.8
2004	14.1	21.0	-6.9	-17.7
2005	14.1	21.0	-6.9	-24.6
2006	14.1	21.0	-6.9	-31.6
2007	14.1	21.0	-6.9	-38.5
2008	14.1	21.0	-6.9	-45.4
2009	14.1	21.0	-6.9	-52.4
2010	14.1	21.0	-6.9	-59.3
2011	14.1	21.0	-6.9	-66.2
2012	14.1	21.0	-6.9	-73.2
2013	14.1	21.0	-6.9	-80.1
2014	14.1	21.0	-6.9	-87.0
2015	14.1	21.0	-6.9	-93.9
2016	14.1	21.0	-6.9	-100.9
2017	14.1	21.0	-6.9	-107.8

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Table I.10(7) O&M Cost Recovery Cash Flow

7. Greater Dhaka East Combined

(Unit: Tk. Million)				
Year	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	23.9	17.0	6.9	6.9
1999	24.7	29.0	-4.3	2.6
2000	25.5	29.0	-3.5	-0.9
2001	26.3	28.0	-1.7	-2.7
2002	27.1	28.0	-0.9	-3.6
2003	27.9	28.0	-0.1	-3.7
2004	57.7	64.0	-6.3	-10.0
2005	60.2	64.0	-3.8	-13.9
2006	99.5	77.0	22.5	8.6
2007	115.8	90.0	25.8	34.4
2008	119.7	104.0	15.7	50.1
2009	123.8	118.0	5.8	55.8
2010	128.0	123.0	5.0	60.8
2011	128.0	128.0	0.0	60.8
2012	128.0	128.0	0.0	60.8
2013	128.0	128.0	0.0	60.8
2014	128.0	128.0	0.0	60.8
2015	128.0	128.0	0.0	60.8
2016	128.0	128.0	0.0	60.8
2017	128.0	128.0	0.0	60.8

Table I.10(8) O&M Cost Recovery Cash Flow

8. Narayanganj Combined

(Unit: Tk. Million)				
Year	Land Development Tax	O&M Costs	Cash Flow	Cumulative Cash Flow
1998	26.7	14.0	12.7	12.7
1999	28.1	25.0	3.1	15.8
2000	29.6	25.0	4.6	20.4
2001	44.1	41.0	3.1	23.5
2002	44.6	41.0	3.6	27.1
2003	45.2	46.0	-0.8	26.3
2004	45.7	46.0	-0.3	26.0
2005	46.2	46.0	0.2	26.2
2006	46.7	45.0	1.7	27.9
2007	47.3	45.0	2.3	30.2
2008	47.9	45.0	2.9	33.1
2009	48.4	49.0	-0.6	32.5
2010	49.0	49.0	0.0	32.5
2011	49.0	49.0	0.0	32.5
2012	49.0	49.0	0.0	32.5
2013	49.0	49.0	0.0	32.5
2014	49.0	49.0	0.0	32.5
2015	49.0	49.0	0.0	32.5
2016	49.0	49.0	0.0	32.5
2017	49.0	49.0	0.0	32.5

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Table I. 11 Project Evaluation

Item	Greater Dhaka East					Narayanganj		Remarks
	DC-1	DC-2	DC-3	DC-4	Combined	DND	West	
<b>1. Economic Evaluation</b>								
1) EIRR (%)	14.8	8.0	13.9	18.9	15.8	14.5	14.3	
2) NPV (Tk. million)	274	-98	263	1,032	1,501	371	152	
3) B/C	1.22	0.74	1.19	1.55	1.31	1.21	1.18	
4) NPVR (2)	0.162	-0.155	0.147	0.416	0.228	0.151	0.110	
<b>2. Socio - Economic Impacts</b>								
1) Population to be Saved from Inundation by 1988 - Scale Flood in 2010	665,996	261,856	847,139	1,218,397	2,993,388	1,685,439	981,873	
2) Area to be Saved from Inundation by 1988-Scale Flood in 2010 (ha)	3,036	1,146	2,977	2,635	9,794	4,270	1,720	
3) Labour Force to be Employed during Construction (man-years)	10,693	8,616	5,968	13,637	38,914	19,974	7,625	
4) Resettlement								
(1) No. of People to be Displaced	1,337	734	433	1,127	3,631	1,783	1,639	
(2) Compensation (Tk. million)	34.4	21.7	13.6	31.2	100.9	61.7	165.5	
5) Boating Trade to be Affected								
(1) No. of Boatmen to be Affected	853 118	415 -	1,207 305	150 150	2,625 573	- -	- -	....Seriously
(2) Annual Sales to be Affected (Tk.)	30,675,750 3,701,250	4,727,800 -	12,513,100 9,061,150	5,355,000 5,355,000	53,268,650 18,117,400	- -	- -	....Seriously

Source : JICA



Table I.12 Cost Benefit Streams of Integrated Narayanganj DND  
and West Projects

CC=Capital Costs; OM=O/M Costs; CS=Costs  
BF=Benefits; CF=Cash Flow (=BF - CS)

(Unit: Tk Million)

NO.	YEAR	CC	OM	CS	BF	CF
1	1992	234	0	234	0	-234
2	1993	0	0	0	0	0
3	1994	0	0	0	0	0
4	1995	0	0	0	0	0
5	1996	698	0	698	0	-698
6	1997	1220	0	1220	144	-1075
7	1998	1447	0	1447	334	-1113
8	1999	1457	14	1471	548	-922
9	2000	288	41	329	616	288
10	2001	297	41	338	689	352
11	2002	3	46	49	728	679
12	2003	3	46	49	766	718
13	2004	3	46	49	805	756
14	2005	3	46	49	843	794
15	2006	3	46	49	882	833
16	2007	3	45	48	920	872
17	2008	7	45	52	958	907
18	2009	173	45	218	997	779
19	2010	3	49	52	1035	984
20	2011	3	49	52	1074	1022
21	2012	3	49	52	1112	1060
22	2013	3	49	52	1150	1099
23	2014	3	49	52	1189	1137
24	2015	773	49	822	1227	406
25	2016	331	49	380	1266	886
26	2017	3	49	52	1304	1253
27	2018	3	49	52	1343	1291
28	2019	3	49	52	1381	1329
29	2020	3	49	52	1419	1368
30	2021	3	49	52	1458	1406
31	2022	3	49	52	1496	1445
32	2023	3	49	52	1535	1483
33	2024	182	49	231	1573	1342
34	2025	3	49	52	1612	1560
35	2026	3	49	52	2120	2068

Table I.13 Summary of Flood Damages with SCF Applied

Area	(Unit: Tk. Million)				
	External Flood			Internal Flood	
	Annual	1987-Scale	1988-Scale	Annual	Worst
1. 1990					
DC-1	2.4	84.2	262.8	1.6	5.8
DC-2	1.2	52.1	209.6	0.6	2.4
DC-3	18.5	194.8	1,103.6	57.9	145.3
DC-4	18.1	324.3	2,071.2	77.7	186.7
Dhaka East	40.2	655.4	3,647.2	137.8	340.2
Narayanganj DND	1.3	162.4	1,862.2	33.6	61.1
Narayanganj West	5.3	113.9	1,441.3	19.1	49.9
Total	46.8	931.7	6,950.7	190.5	451.2
2. 2010					
DC-1	65.9	1,232.2	3,060.0	8.7	33.5
DC-2	29.4	282.7	1,242.1	4.4	18.3
DC-3	87.0	750.9	4,129.4	112.1	300.6
DC-4	97.9	973.4	6,079.6	123.4	316.0
Dhaka East	280.2	3,239.2	14,511.1	248.6	668.4
Narayanganj DND	13.1	601.0	8,478.4	139.7	255.3
Narayanganj West	22.5	344.3	6,011.2	59.6	150.3
Total	315.8	4,184.5	29,000.7	447.9	1,074.0

Note: SCF of 0.87 was applied to the flood damages excluding agricultural damages.

Table I.14 Average Annual Flood Damages with SCF Applied

(Unit: Tk. Million)			
Area	Average Annual Flood Damages		
	External Flood	Internal Flood	Total
1. 1990			
DC-1	37.7	2.1	39.8
DC-2	24.2	0.9	25.1
DC-3	106.7	64.5	171.2
DC-4	175.4	84.8	260.2
Dhaka East	344.0	152.3	496.3
Narayanganj DND	102.4	32.6	135.0
Narayanganj West	77.6	21.6	99.2
Total	524.0	206.5	730.5
2. 2010			
DC-1	552.2	12.1	564.3
DC-2	148.0	6.4	154.4
DC-3	418.0	128.8	546.8
DC-4	549.7	138.7	688.4
Dhaka East	1,667.9	286.0	1,953.9
Narayanganj DND	421.0	135.8	556.8
Narayanganj West	277.3	66.5	343.8
Total	2,366.2	488.3	2,854.5



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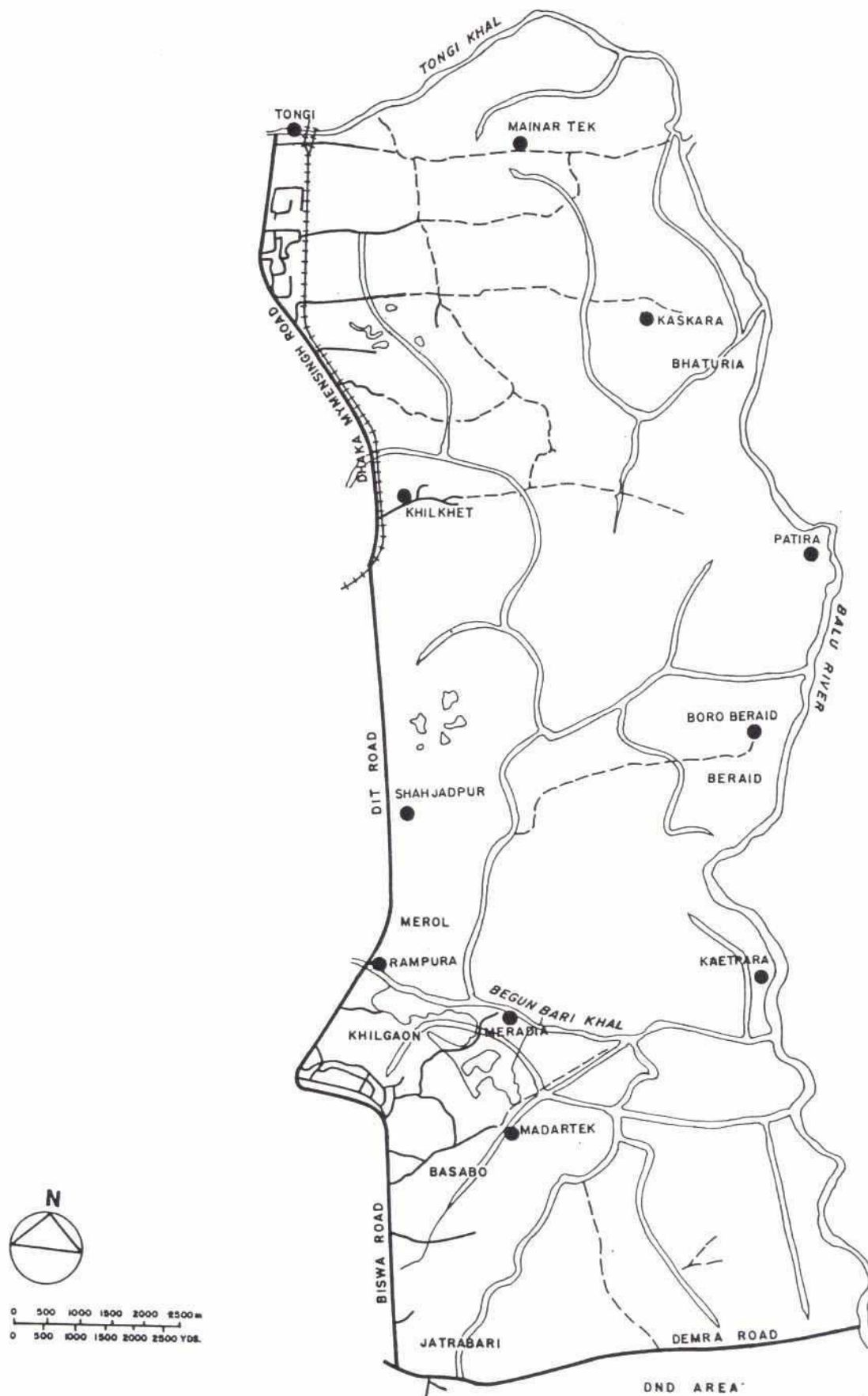


FIG. I.1

# LOCATIONS OF MAJOR EXISTING BOATING CENTERS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

**SUPPORTING REPORT J**  
**SUPPLEMENTAL SURVEYS AND**  
**WATER LEVEL GAUGE INSTALLATION**



SUPPORTING REPORT J : SUPPLEMENTARY SURVEY  
AND WATER LEVEL GAUGE INSTALLATION

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## SUPPORTING REPORT J : SUPPLEMENTARY SURVEY AND WATER LEVEL GAUGE INSTALLATION

### 1. General

Supplementary surveys and investigations have been carried out for the identified priority areas. The surveys for Greater Dhaka and DND were conducted from May 1991, and but for Narayanganj West from September 1991. They are explained as follows :

- (1) Ground survey on the existing embankment, the proposed flood mitigation and stormwater drainage improvement facilities
- (2) Soil investigation on the proposed facilities
- (3) Environmental survey
- (4) Installation of two water-level gauges

### 2. Ground Survey

#### 2.1 Greater Dhaka

##### 1) Longitudinal and Cross Sectional Survey

The survey was conducted for the following flood mitigation and stormwater drainage improvement facilities :

- (1) Embankment and Flood Wall
- Existing west embankment and flood wall : L = 38.5 km.
- Existing road-cum-embankment : L = 21.0 km
- Proposed east embankment : L = 30.0 km
- Proposed sub-embankment : L = 10.0 km

---

Total : L = 99.5 km

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(2) River and Khal

- Dhaleswari River : L = 13.0 km
- Buriganga River : L = 3.0 km
- Turag River : L = 12.0 km
- Lakhya River : L = 7.0 km
- Balu River : L = 1.0 km
- Khal : L = 103.5 km

---

Total : L = 139.5 km

2) Topographic Survey

Topographic surveys were conducted at the proposed pumping stations

Each survey location is shown in Fig. 3.1

2.2 DND

Longitudinal and cross sectional surveys, and topographical surveys were conducted for the following flood mitigation and stormwater drainage improvement facilities:

- Existing DND embankment : L = 31.0 Km
- Khal : L = 37.5Km
- Topographic survey at the proposed pumping stations

Each survey location is shown in Fig. 3.2

### 2.3 Narayanganj West

Longitudinal and cross sectional surveys, and topographical surveys were conducted for the following flood mitigation and stormwater drainage improvement facilities :

- Proposed embankment and road-cum embankment : L=13.0 km
- Proposed concrete flood wall : L=14.0 km
- Proposed Khal improvement : L=7.5 km

Each survey location is shown in Fig. 3.2.

## 3. Soil Investigation

### 3.1 Greater Dhaka

Soil investigations were carried out for the existing embankment of Greater Dhaka West, the proposed east embankment and flood wall of Greater Dhaka East. The main items of the work are as follows :

#### (1) Machine boring

- Existing west embankment : 4 sites
- Proposed east embankment : 4 sites
- Proposed pumping station : 3 sites

#### (2) Standard penetration test with split-barrel sampling in order to obtain N-values of all foundations and for soil classification, laboratory test and unconfined compression test.

#### (3) Thin walled tube sampling ( undisturbed core sampling for foundation sub-soil)

#### (4) Sampling for embankment material test.

Each location is shown in Fig. 3.3.



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### 3.2 Narayanganj

The soil investigation was carried out for the proposed embankment, flood wall and pumping stations of Narayanganj DND and West.

- (1) Machine boring at six sites, in order to get subsoil conditions for proposed facilities,
- (2) Standard penetration test with split-barrel sampling in order to obtain N-values of sub-soil and split-barrel sampling for soil classification, laboratory test and unconfined compression test.
- (3) Thin-walled tube sampling ( undisturbed core sampling ) for foundation sub-soil, and
- (4) Sampling for embankment material test.

The locations of soil investigation are shown in Figs. 3.4.

### 4. Environmental Survey

The survey is consisting of the followings :

- (1) Comprehensive ecological survey

A comprehensive ecological survey is carried out aiming at facilitating comprehensive environmental assessment by the implementation of flood control and drainage works and subsequent urbanization on the ecological elements of fauna and flora, and agricultural and aquacultural resources.

- (2) Water Quality Survey

Water quality sampling and analysis at fifteen (15) sites specified in the proposed retarding areas of the F/S area was carried out in flood season (September to October, 1991) and will be done in dry season ( January to February to February, 1991).

(3) Supplementary Living Environmental Survey

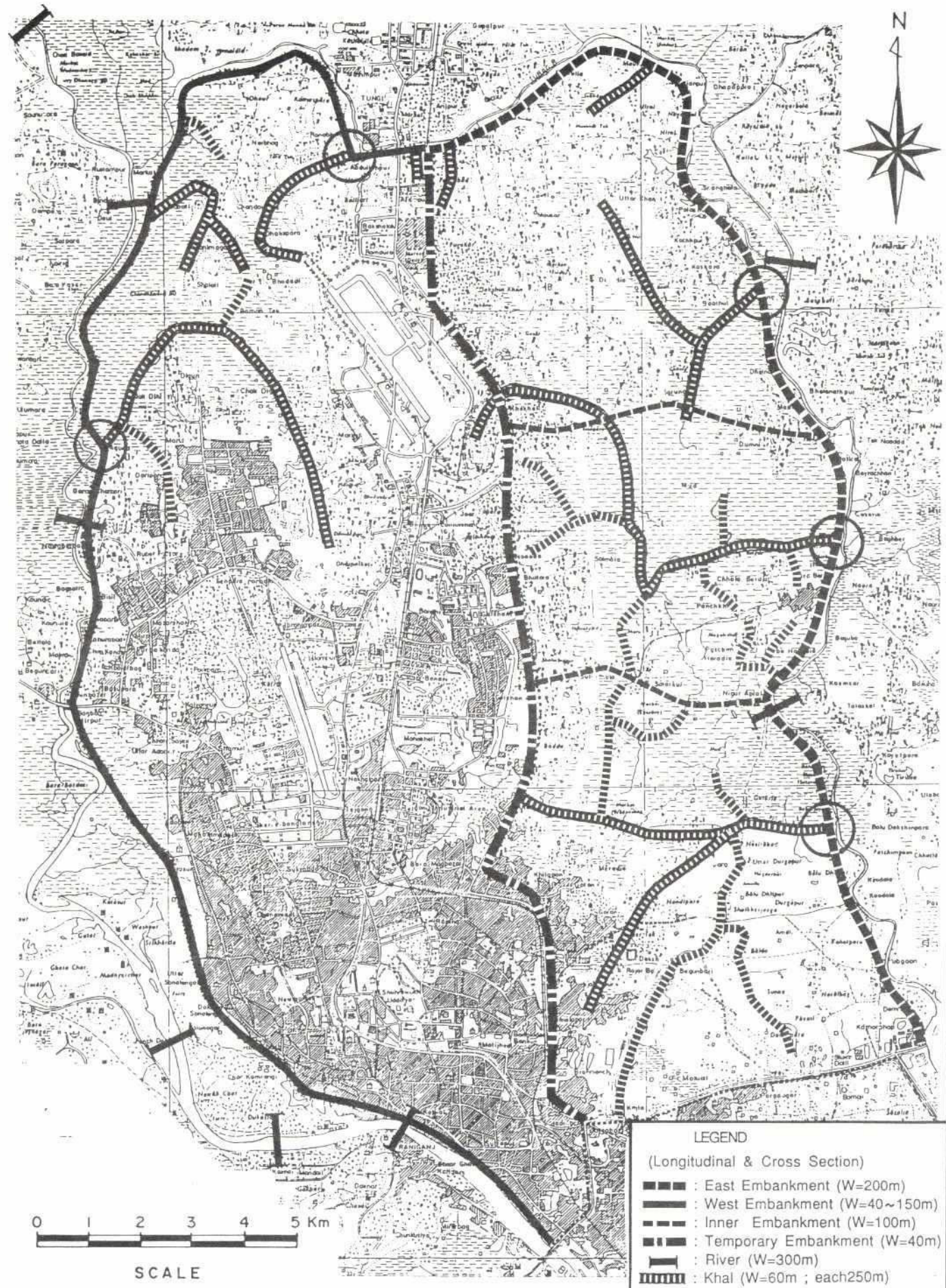
The survey consists of additional data collection of living environmental parameters at water supply, sewerage/sanitation and solid waste management. In addition determination of resettlement population due to embankment / Khal construction/ improvement and the survey to determine necessity of navigational provision be carried out.

5 Installation of Water Level Gauges

Automatic water level gauges are installed at Demra (BWDB St. 179) of the Lakhya River and Kalagachia ( BWDB St. 71) near the confluence of the Meghna River to the Dhaleswari River, shown in Fig. 3.5. The gauges are designed to obtain data through year.



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LEGEND

(Longitudinal & Cross Section)

- ■ ■ ■ : East Embankment (W=200m)
- — — — : West Embankment (W=40~150m)
- - - - : Inner Embankment (W=100m)
- ▤ ▤ ▤ ▤ : Temporary Embankment (W=40m)
- ▬ ▬ ▬ ▬ : River (W=300m)
- ||||| : Khal (W=60m ; each 250m)
- ||||| : Khal (W=60m ; each 500m)

(Topographic & Cross Section)

- : Pump Station (200m x 200m)

FIG. J.1

LOCATION OF GROUND SURVEY  
: GREATER DHAKA

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



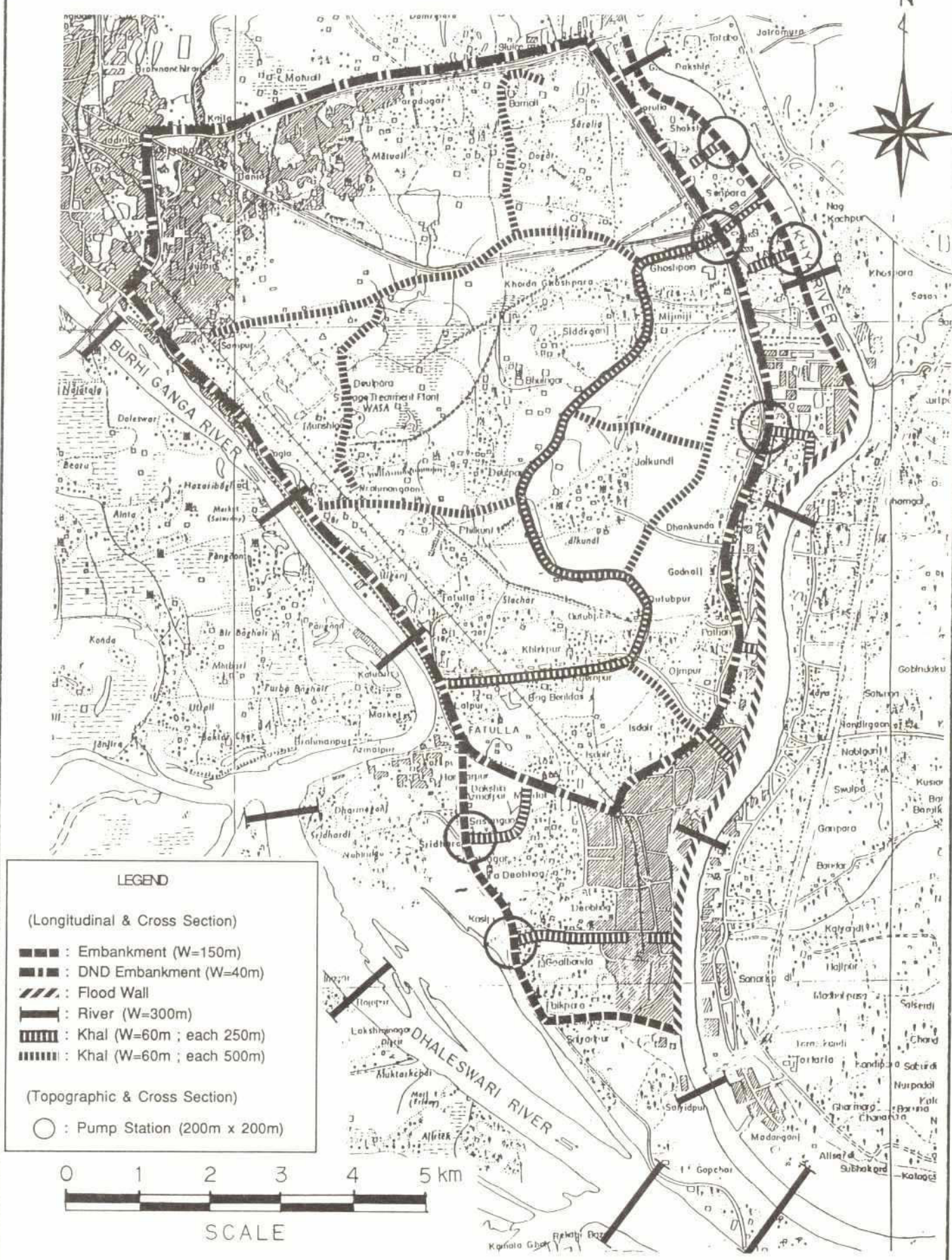


FIG. J.2

LOCATION OF GROUND SURVEY : NARAYANGANJ

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



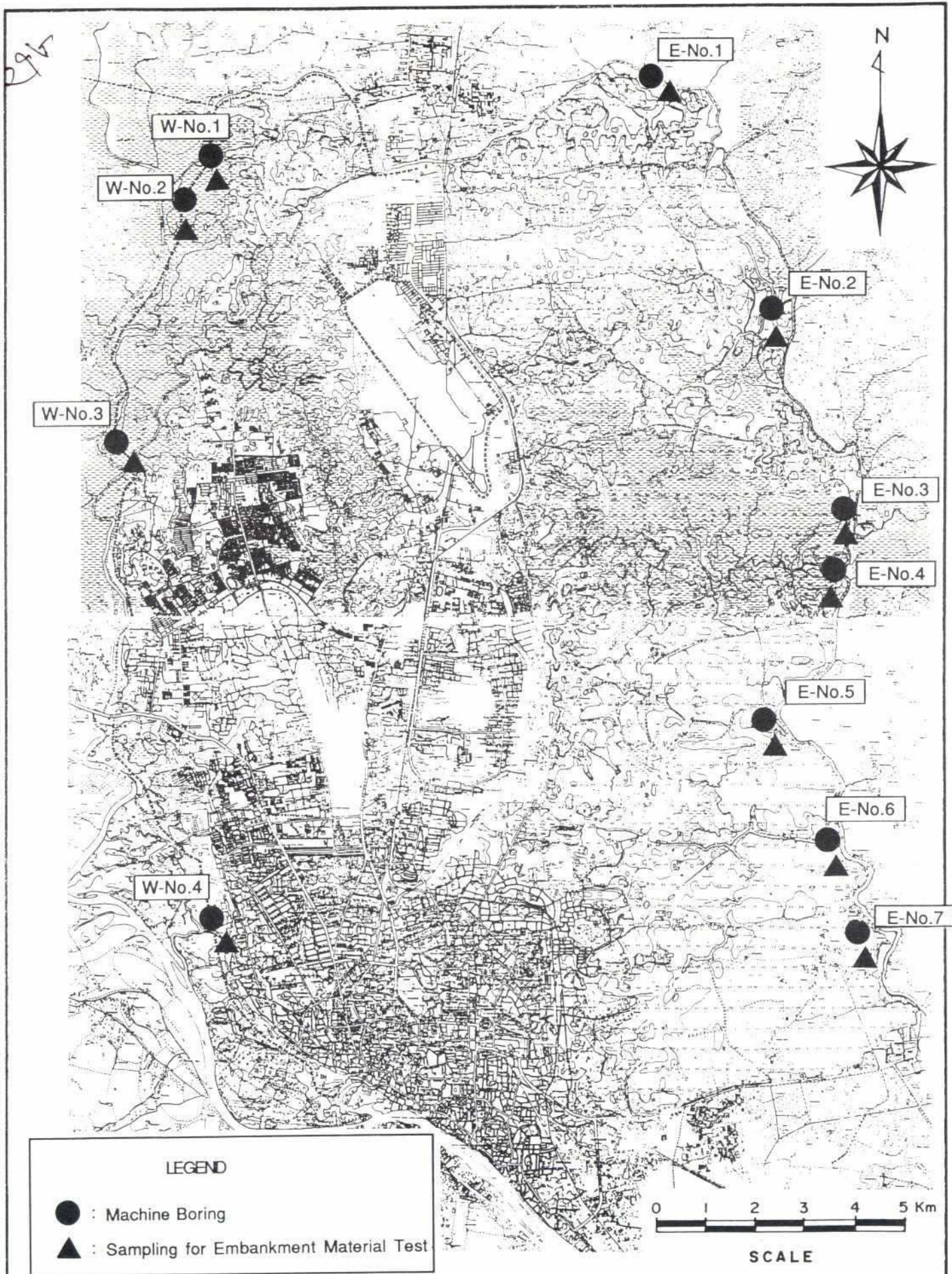


FIG. J.3

LOCATION OF SOIL INVESTIGATION : GREATER DHAKA

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



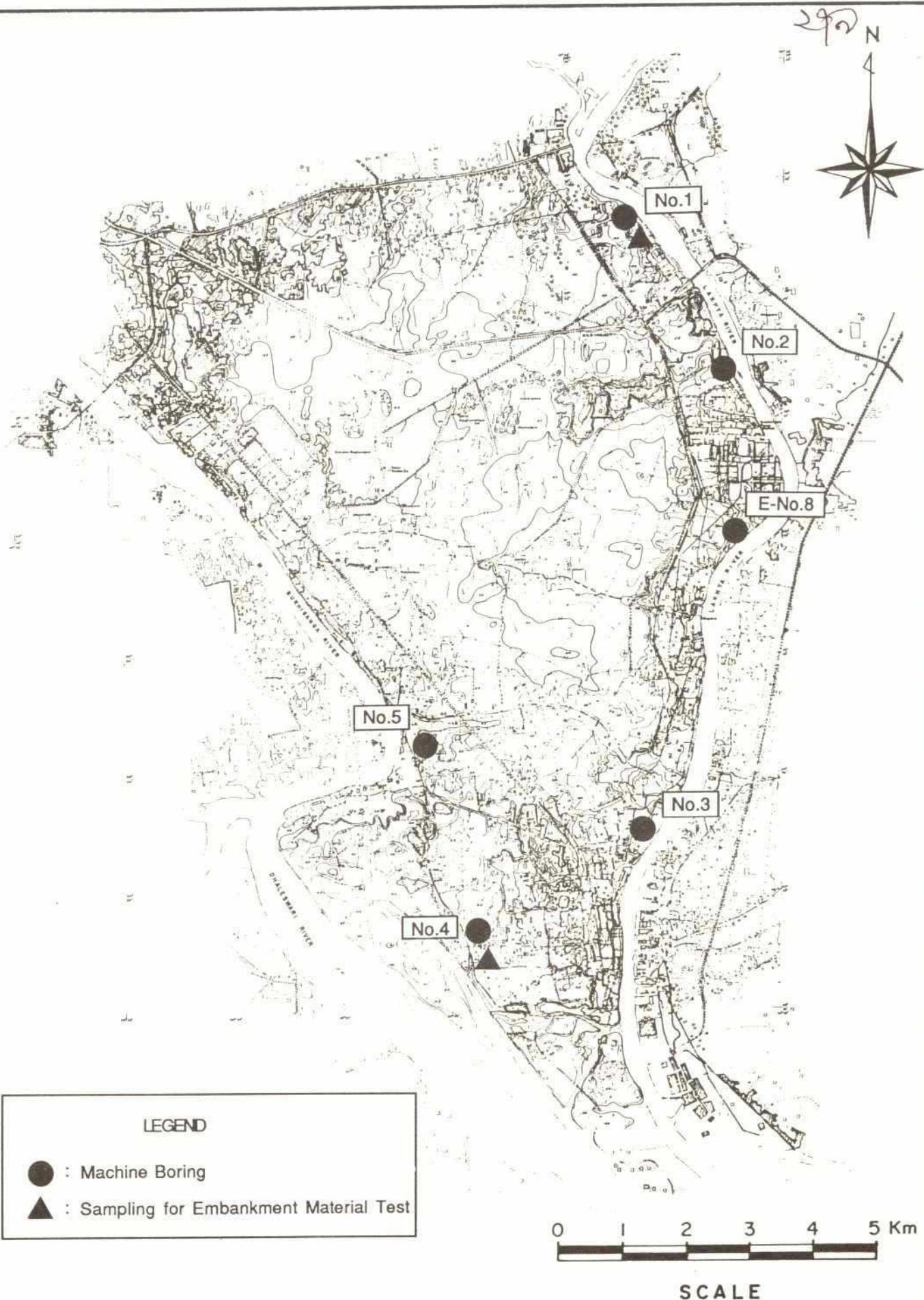


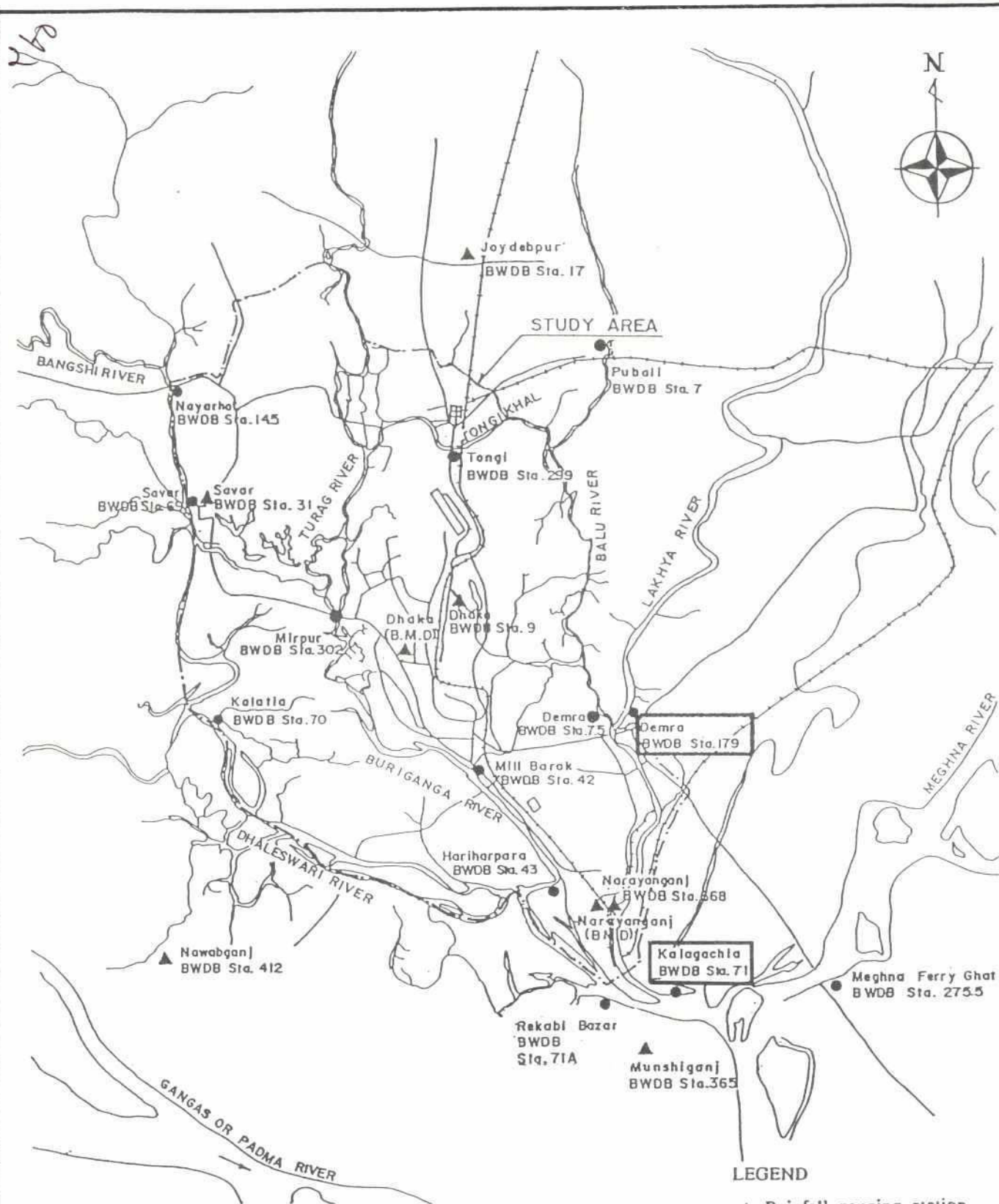
FIG.

J.4

LOCATION OF SOIL INVESTIGATION : NARAYANGANJ

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH





#### LEGEND

- ▲ Rainfall gauging station
- Water level gauging station

#### Notes :

- 1) Narayanganj Rainfall Station (B.M.D.) was closed in 1979.

FIG. J.5

LOCATION OF DEMRA AND KALAGACHIA WATER LEVEL GAGING STATIONS NEWLY INSTALLED BY JICA STUDY TEAM

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

**SUPPORTING REPORT K**  
**SCOPE OF WORK AND MINUTES OF MEETING**

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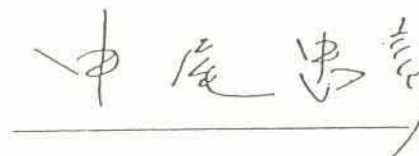
SCOPE OF WORK  
FOR  
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA)  
OF  
BANGLADESH FLOOD ACTION PLAN NO. 8A  
IN  
THE PEOPLE'S REPUBLIC OF BANGLADESH

AGREED UPON BETWEEN  
JAPAN INTERNATIONAL COOPERATION AGENCY  
AND  
FLOOD PLAN COORDINATION ORGANIZATION

DHAKA, BANGLADESH, JUNE 21, 1990

  
21.6.90

HR. A. H. M. NURUL HUQ  
CHIEF ENGINEER  
FLOOD PLAN  
COORDINATION ORGANIZATION  
THE PEOPLE'S REPUBLIC  
OF BANGLADESH



HR. TADAHIKO NAKAO  
LEADER OF  
PRELIMINARY SURVEY TEAM,  
JAPAN INTERNATIONAL  
COOPERATION AGENCY



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## I. INTRODUCTION

In response to the request of the Government of the People's Republic of Bangladesh (hereinafter referred to as "the Government of Bangladesh") the Government of Japan decided to conduct the Study on Greater Dhaka Protection Project for Dhaka Metropolitan Area in the People's Republic of Bangladesh of Flood Action Plan No. 8A (hereinafter referred to as "the Study"). in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Bangladesh.

The present document sets forth the Scope of Work with regard to the Study.

## II. OBJECTIVES OF THE STUDY

The objectives of the Study are as follows;

1. to formulate a Master Plan on a comprehensive flood control and stormwater drainage for Dhaka Metropolitan Area.
2. to conduct a feasibility study on a flood control and stormwater drainage for the priority area identified in the Master Plan.

## III. STUDY AREA

The Study area will cover Dhaka Metropolitan area (approximately 850 km<sup>2</sup>), consisting of Greater Dhaka area (approximately 260km<sup>2</sup>), Tongi, Savar, Keraniganj and Marayanganj.

2)

N.T.

#### IV. OUTLINE OF THE STUDY

##### 1. Study Framework

The Study Comprises of the following three (3) phases

Phase 1: Preliminary Review

Phase 2: Master Plan Study on a comprehensive flood control and stormwater drainage in the Dhaka Metropolitan area

Phase 3: Feasibility study for priority area identified in the Master Plan

##### 2. Study Items

###### 2-1 Phase 1: Preliminary Review

2-1-1 Collection, collation and updating of available data and informations as described below:

- a. topographic map, aerial photograph and related drawings,
- b. soil, geological and geographical data,
- c. population, land use and regional development plans,
- d. existing road network,
- e. hydrological and hydraulic conditions,
- f. existing flood control and stormwater drainage facilities,
- g. past floods and flood damages,
- h. related institutions, and
- i. other related data and information.

2-1-2 Review of the relevant previous studies, reports and plans including ongoing projects

2-1-3 Carrying out of the following field surveys and investigations:

- a. field reconnaissance,
- b. supplemental topographic survey for preparation of accurate base map,
- c. longitudinal and cross sectional survey for drainage channels and rivers,
- d. supplemental geo-technical survey for proposed major flood control and drainage facilities,
- e. flood and flood damage survey, and
- f. water quality test.

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2-1-4 Review of existing urban development plans and projections of population distribution and land use pattern/distribution, in order to assess the future flood control and stormwater drainage requirement.

2-2 Phase 2: A Master Plan Study on a comprehensive flood control and stormwater drainage in the Dhaka Metropolitan area  
for this purpose, the following studies and analysis shall be conducted:

- a. assessment of the present conditions for the existing flood control and stormwater drainage works,
- b. target year, design rainfall and flood water level,
- c. hydraulic simulation with mathematical modelling using Hike 11 of the Surface Water Modelling Centre for the 850 km<sup>2</sup> area with a view to formulate and optimise planning and design aspects at the Master Plan and its priority projects considering various options for flood control and drainage,
- d. alternative studies for external flood protection and internal drainage improvement plans, and recommendation of optimum plan in consideration to capital cost, operation/maintenance, environmental and financial aspects, and
- e. preparation of phased implementation programme and identification of priority projects.

2-3 Phase 3: A feasibility study for the priority projects identified in the Master Plan Study

A feasibility study for the identified priority projects shall incorporate, the following aspects:

- a. the necessary supplementary data collection, field surveys and analysis,
- b. alternative project concepts and selection of the optimum ones considering technical, economic and operational aspects,
- c. preliminary designs of the proposed facilities, with due attention to appropriate technology and taking into account prevailing conditions in Bangladesh,
- d. time schedules for subsequent detailed design, tendering and construction, with estimated dates for putting the proposed facilities into service.



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- e. approximate land acquisition plans,
  - f. cost estimates for construction, operation and maintenance of the proposed projects,
  - g. economic and financial evaluation of the proposed projects, including their social and environmental impacts,
  - h. proposals for institutional arrangements for operation and maintenance,

#### V. SCHEDULE OF THE STUDY

The Study will be performed in accordance with the tentative study schedule shown in the appendix.

#### VI. REPORTS

JICA will prepare and submit the following reports in English to the Government of Bangladesh.

##### 1. Inception Report (50 copies)

This report is to be submitted at the commencement of the first field survey in Bangladesh and to describe the overall approach and implementation programme of the Study.

##### 2. Preliminary Review Report (50 copies)

This report is to be submitted at the end of the Preliminary Review phase.

It shall present a compilation and analysis of all collected relevant data on the basis of which a precise description of the required Master Plan Study and of the related details of study programme

It will include a proposal for the development of the project area that will form the basis for the desired master plan. The Government of Bangladesh will offer his decision on this proposal within 1 month after submission of the Report; agreed development plan will be the basis of the Master Plan to be prepared.

##### 3. Interim Report (50 copies)

This report is to be submitted four (4) months after the commencement of the Master Plan Study.

It shall present all findings in field survey, preliminary results of analysis and confirmation of basic idea, criteria and standard for formulation of the Master Plan.

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4. Draft Master Plan Report (50 copies)

This report is to be submitted seven (7) months after the commencement of the Master plan Study.

It shall review all options assessed and propose the preferred Master Plan for flood control and drainage for the Dhaka Metropolitan Area.

The report shall make firm recommendation for the priority project(s) to be taken up for the subsequent feasibility study. Final proposals for detailed terms of reference for the feasibility study will be submitted separately.

The Government of Bangladesh will offer his decision and give its comments on this report within one (1) month after submission of the Report.

5. Master Plan Report (100 copies)

This report is to be submitted within two (2) months after receipt of the comments from the Government of Bangladesh on the Draft Master Plan Report.

6. Draft Final Report (50 copies)

This report is to be submitted six (6) months after the commencement of the Feasibility Study.

It will confirm viability of priority projects.

The Government of Bangladesh shall provide JICA with its comments within one (1) month after the receipt of the Draft Final Report.

7. Final Report (100 copies)

This report is to be submitted within one (1) month after receipt of the comments from the Government of Bangladesh on the Draft Final Report.

V. UNDERTAKINGS OF THE GOVERNMENT OF BANGLADESH

1. To facilitate smooth conduct of the Study, the Government of Bangladesh shall take necessary measures:

- (1) to secure the safety of the Japanese Study Team for the Study (hereinafter referred to as "the Team").

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- (2) to permit the members of the Team to enter, leave and stay in Bangladesh for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees,
  - (3) to exempt the members of the Team from taxes, duties and other charges on equipment, machinery and other materials brought into and out of Bangladesh for the implementation of the Study,
  - (4) to exempt the members of the Team from income tax and other charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Team for their services in connection with the implementation of the Study,
  - (5) to provide necessary facilities to the Team for the remittance as well as the utilization of the funds introduced into Bangladesh from Japan in connection with the implementation of the Study,
  - (6) to secure permission for entry into private properties or restricted areas for the conduct of the Study,
  - (7) to provide and to secure permission for the Team to take all data and documents (including photographs and maps) related to the Study to Japan,
  - (8) to provide medical services as needed, its expenses will be chargeable on members of the Team.
2. The Government of Bangladesh shall bear claims, if any arises against the members of the Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.
3. Flood Plan Coordination Organization (hereinafter referred to as "FPCO"), Ministry of Irrigation, Water Development and Flood Control, shall be the executing agency of the Study and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study. FPCO will review and monitor the Study.

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4. FPCO shall, at its own expense, provide the Team with the followings, in cooperation with other relevant organizations concerned :

- (1) counterpart personnel necessary for the Study,
- (2) credentials or identification cards.

#### VI. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures:

1. to dispatch, at its own expense, the Team to Bangladesh,
2. to perform technology transfer to the Bangladesh counterpart personnel in the course of the Study.

#### IX. CONSULTATION

JICA and FPCO shall consult each other in respect of any matter that may arise from or in connection with the Study.

#### X. VALIDITY OF THIS SCOPE OF WORK

This Scope of Work comes into effect as of the date when a formal request with Technical Assistance Project Proposal would be made through the diplomatic channel.

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# Appendix I

## TENTATIVE WORK SCHEDULE

Phase	Phase 1			Phase 2								Phase 3								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Month in Order																				
Works in Bangladesh	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	<div></div>																			
Works in Japan	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	<div></div>																			
Reports	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	Ic/R		PR/R					It/R		DWP/R			WP/R				DF/R		F/R	


(Remarks)

Ic/R : Inception Report  
 PR/R : Preliminary Review Report  
 It/R : Interim Report  
 DMP/R : Draft Master Plan Report  
 WP/R : Master Plan Report  
 DF/R : Draft Final Report  
 F/R : Final Report

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MINUTES OF MEETING  
FOR  
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA)  
OF  
BANGLADESH FLOOD ACTION PLAN NO. 8A  
IN  
THE PEOPLE'S REPUBLIC OF BANGLADESH

DHAKA, BANGLADESH, JUNE 21, 1990



21.6.90

HR. A. K. H. HURUL HUQ  
CHIEF ENGINEER  
FLOOD PLAN  
COORDINATION ORGANIZATION  
THE PEOPLE'S REPUBLIC  
OF BANGLADESH



HR. TADAHIKO NAKAO  
LEADER OF  
PRELIMINARY SURVEY TEAM,  
JAPAN INTERNATIONAL  
COOPERATION AGENCY



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A Preliminary Survey Team (the Team) of Japan International Cooperation Agency (JICA), headed by Mr. Tadahiko Nakao visited Bangladesh from June 15 to June 22, 1990 to discuss the Scope of Work for the study on Greater Dhaka Protection Project for Dhaka Metropolitan Area in the People's Republic of Bangladesh of Flood Action Plan No. 8A (the Study).

The Team carried out field surveys of the study area and held series of discussions with officials of Flood Plan Coordination Organization (FPCO) and the authorities concerned of the Government of Bangladesh (GOB). A list of those who attended the meetings is shown in the attached sheet.

A final meeting was held on June 21, 1990 at the Conference Room of FPCO, in Dhaka. Mr. A. H. H. Nurul Huq, Chief Engineer of FPCO, presided over the meeting on behalf of FPCO. Main issues discussed on the Scope of Work are as follows:

1. It was confirmed that the Terms of Reference (T/R) for the Study was approved by the Technical Committee for FAP and GOB will request technical cooperation on the above Study to the Government of Japan through diplomatic channel, as soon as the Technical Assistance Project Proposal (TAPP) be approved, for the formality.

2. GOB understood that the responsibility of consultants as specified in Section 9 of T/R was primarily to JICA, therefore, provisions under section 9 were not applicable to the Study to be carried out under the Technical Cooperation Scheme of JICA.

3. In reference to II., III., and IV. in S/W, it was confirmed that further details and clarification should be referred to relevant section in the said T/R as guideline of the Study.

4. In reference to V. SCHEDULE OF THE STUDY in S/W, although it was agreed that part of work is done in Japan in accordance with normal procedure under JICA, GOB requested the Team to consider further that work be done in Bangladesh as much as possible, for keeping continuous consultation and coordination with FPCO, Panel of Experts and other FAP activities.

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5. In reference to VI. of REPORT in S/W, it was confirmed that progress report will be prepared and submitted quaterly to GOB.

6. In reference to VI. of UNDERTAKING OF THE GOVERNMENT OF BANGLADESH in S/W, the following points were raised and confirmed:

- 1) Implementation arrangement for the study should be the same as for the Dhaka Integrated Flood Protection Project of FAP No.8B, otherwise agreed in S/W
- 2) GOB agreed to assign Bangladesh counterpart personnel as project director (full time), engineers from BWDB, DHC, RIID, DWASA, RAJUK, DOE, SOB and other organizations concerned, for the smooth execution of the Study.

7. In reference to VI. of UNDERTAKING OF JICA in S/W, GOB requested the Team;

- 1) to respect the policy of GOB to utilize availability of local consultant as much as possible for the Study.
- 2) to provide survey equipment and vehicles for the Study and donate them with customs and other duties borne by FPCO, after the completion of the Study.
- 3) to accept Bangladesh counterpart personnel for technical training in Japan.
- 4) to secure intimate communication among the Study team and organizations concerned.
- 5) to provide office with equipment borne by JICA, due to the budgetary constraint of FPCO.

8. For the smooth and effective implementation of the Study, it was agreed;

- 1) GOB should provide all data and information required in the initial stage of the Study.
- 2) GOB should make decision and give it's comments on provisional Preliminary Review Report and Draft Master Plan Report on schedule in accordance with the work schedule.

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attendants listBangladesh Side

1.Mr.Md. Nurul Huda	Chairman, Local Panel of Experts, FPCO
2.Mr.A.M.M. Nurul Huq	Chief Engineer, FPCO
3.Mr.K.B.M.Shafiuddin	Superintending Engineer, FPCO
4.Mr.Emaduddin Ahmad	Executive Engineer, FPCO
5.Mr.Md.M.Delwar Hossain	Chief Engineer, RAJUK
6.Mr.Zakir Hossain	Dhaka Town Planner, RAJUK
7.Mr.Emdadul Islam	Executive Engineer
8.Mr.R. Nurul Hasan	Superintending Engineer, LGEB
9.Mr.Md. Morsed Alam	Senior Water Resources Specialist, LGEB
10.Mr.A.Quader Chondhuy	Superintending Engineer of Drainage, DWASA
11.Mr.Shafiul Islam	Additional Chief Engineer, DMC
12.Mr.Md. Afazuddin	Chief Engineer, NEZ, WDB

Japanese Side

1.Mr.Tadahiko Nakao	Team Leader
2.Mr.Tomoki Sato	Member(Cooperation Policy)
3.Mr.Muneo Sato	Member(Cooperation Planning)
4.Mr.Ryosuke Kikuchi	Member(River Planning)
5.Mr.Motoharu Sekizawa	Member(River Protection & Drainage)
6.Mr.Mitsuru Suemori	Member(Project Planning)
7.Mr.Itsu Adachi	Member(Coordinator)
8.Mr.Hitoshi Baba	Embassy of Japan
9.Mr.Takeshi Naruse	JICA Bangladesh Office

Panel of Experts

1.Mr.W.Van Allen	Panel of Expert
2.Mr.Hidetomi OI	Panel of Expert

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MINUTES OF MEETING  
FOR  
GREATER DHAKA PROTECTION PROJECT  
(STUDY IN DHAKA METROPOLITAN AREA)  
OF  
BANGLADESH FLOOD ACTION PLAN NO 8A  
IN  
THE PEOPLE'S REPUBLIC OF BANGLADESH

DHAKA, BANGLADESH, OCTOBER 25, 1990



K. B. M. SHAFIUDDIN  
SUPERINTENDING ENGINEER  
FLOOD PLAN  
COORDINATION ORGANIZATION  
THE PEOPLE'S REPUBLIC  
OF BANGLADESH



HAJIME TANAKA  
TEAM LEADER  
JICA STUDY TEAM  
JAPAN INTERNATIONAL  
COOPERATION AGENCY

Witness



EMADUDDIN AHMAD  
EXECUTIVE ENGINEER  
FPCO



DR. HIROYOSHI SHIIGAI  
CHAIRMAN  
ADVISORY COMMITTEE, JICA

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Minutes of the Meeting for Greater Dhaka Protection Project  
(Study in Dhaka Metropolitan Area) of Bangladesh Flood Action  
Plan No. 8A. between JICA and FPCO on 25th October, 1990.

An Advisory Committee of Japan International Cooperation Agency headed by Dr. Hiroyoshi Shiigai and the members of the Study Team on Greater Dhaka Protection Project : FAP 8A discussed with the officials of Flood Plan Coordination Organization, (FPCO) BWDB, DMC, RAJUK, DOE, DWASA, LGEB on the draft Inception Report of the study from 23rd Oct. 90 to 25th Oct. 90 in Dhaka, Bangladesh. A list of the personnel attended the discussions are shown in annexure I. During discussions, the following points were raised and confirmed.

- 1) Agreed comments on the draft Inception report for incorporating changes at places are shown in Annexure II. The revised Inception Report will be prepared by JICA Study Team before 31st Oct. 1990 in the light of the discussion.
- 2) FPCO requested JICA to modify the tentative study schedule (shown in Fig. 3) to accommodate the important activities to be performed in Bangladesh in the spirit of sl. 4 of the minutes of the meeting on 21st June between FPCO & JICA. JICA agreed to consider the issue.
- 3) FPCO agreed to provide GOB personnel as per TAPP at the shortest possible time.
- 4) FPCO recalled the article 7 (1) of the minutes of meeting of 21st June '90 between FPCO and JICA and requested JICA study team to engage local Consultant. JICA agreed to engage local consultants and the consolidated assignment schedule will be submitted to FPCO at the earliest.
- 5) FPCO requested JICA to initiate the process of procurement of vehicles and equipment (as per list shown in TOR) under temporary importation policy through Project Pass Book (as per clause 7/2 of 21st June, 1990 minutes of the study) and keep FPCO informed. At the end of the Study JICA will donate the vehicles and equipments and GOB will make necessary arrangement of payment of Custom duty and Sales-Tax. JICA will inform on the procurement of vehicles and equipment after discussion with JICA headquarter.
- 6) FPCO & JICA jointly reconfirmed to abide by the clauses of Scope of Works and Minutes of Meeting signed on 21st June, 1990 of the study.

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APPENDIX - I

MEMBERS ATTENDED IN THE MEETING:

GOB TEAM

	Name	Designation	Organization
1.	M. N. Huda	Chairman Local Specialist Panel	FPCO
2.	Prof. Ainun Nishat	Member PoE	FPCO
3.	K. B. M. Shafiuddin	SE	FPCO
4.	Abdul Quader Choudhury	SE	DWASA
5.	Md. Mehedi Ali Khan	SE	DMC
6.	Emaduddin Ahmad	EE	FPCO
7.	Emdadul Islam	EE	RAJUK
8.	A.K.M. Halimur Rahman	EE	BWDB
9.	Md. Moksed Alam	EE	LGEB
10.	Abu Taleb Khandaker	DD	DOE

JICA TEAM

1.	Dr. Hiroyoshi Shiigai	Chairman Advisory Committee	JICA
2.	Itsu Adachi	Member	JICA
3.	Atsushi Suzuki	Member	JICA
4.	Takeshi Naruse	Deputy Rep.	JICA Dhaka
5.	Hajime Tanaka	Team Leader	JICA Study team
6.	Toshiaki Tokumasu	Deputy Team Leader	-do-
7.	Isao Misono	Member	-do-
8.	Takashi Furukawa	Member	-do-
7.	J. R. Jones	Member	-do-



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## ANNEXURE II

### Comments on the Draft Inception Report of Greater Dhaka Protection Project, FAP-8A.

- Page 1 2nd line from bottom  
Insert "in general" after "area"
- Page 2 3rd para, 2nd line  
May be rephrased as "several plans were prepared until 1987"
- Page 2 last para 4th line  
Add after 'disaster'.

Government of Bangladesh established a "Committee for Flood Control and Drainage of Greater Dhaka" and approved a major flood protection scheme in March 1989. Pending assistance from donors and in view of the urgent need for flood protection, the Government has undertaken some flood protection works in the western part of the metropolis (some 155 sq. km) involving construction of embankment/flood wall, regulators, road raising etc. from internal resources.

- Page 2 last para 4th line after "studies" add "of the International agencies"

- Page 3 5th line from top  
add after 'January 1990'

The ADB financed "Dhaka City Integrated Flood Protection Project" (FAP-8B) includes 260 sqkm area covering current DMA area and the area in its immediate vicinity undergoing fast urbanization. It involves in the preparation of a feasibility for priority investments not covered under ongoing flood protection program comprising embankment roads, pumping station/sluices and improvement of drainage, slum areas, solid waste management and sanitation. ADB study will take into account the recommendations and conclusions of JICA master planning for flood control and drainage as well as pilot investment projects.

It is thus necessary that JICA assisted study will maintain close contact with ADB study and vice versa and the two teams will keep access for each other in their findings through FPCO.

- Page 7 2.2 1st line  
add 'available' after 'All'
- Sl.(1) 'Aerial, photographs in 1:50,000'

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- Page 8 bottom  
Add sl (10) Any other relevant studies
- Page 10  
Add above the last three lines  
long term effect of the flood damage both  
quantifiable and unquantifiable
- Page 11 (3) preparation of Topo Maps, 8th line delete the  
remaining after "carried out"  
4th para delete
- Page 11 (5) Survey for Environmental Aspects EIA based on mainly  
secondary data  
Add after environmental aspects "including slums"
- Page 13 (1) Target year  
target year will be 2020
- Page 13 4th & 3rd line from bottom rephrase as  
"peak level of 1988 or storm with 100 year return period  
or any other appropriate return period."
- Page 20 Sl.(3) delete 'living' and insert 'impact' after  
'Environmental'
- Page 20 End of Economic evaluation Para  
Add "The study team will also consider the proposed  
special Economic Evaluation guide lines if available."
- Page 24 concerned agency may be replaced by 'GOB Study Team' with  
note on the compositions.
- Page 25 last para 2nd line delete 'together'  
3rd and 4th line  
delete and replace by "The GOB counterpart team will  
supervise, review, monitor and coordinate the study while  
the JICA expatriate and local consultants will implement  
the study as per agreed documents of scope of work and  
TOR. The schedule of GOB input is shown in Fig.5."
- Page 26 Final printing of Feasibility Report will be done in  
May'92 in Japan.
- Page 34 List of data to be collected (Add as may be available)
- Page 36 Sl.(8)  
Add after "(O&M)" "flood protection and" delete "of"

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Minutes of the Meeting  
for  
Greater Dhaka Protection Project  
(Study in Dhaka Metropolitan Area)  
of Bangladesh Flood Action Plan No. 8A  
between JICA and FPCO on 20th December, 1990

The Advisory Committee of Japan International Cooperation Agency headed by Dr. Hiroyoshi Shiigai and the members of the Study Team on Greater Dhaka Protection Project: FAP 8A, discussed with the officials of Flood Plan Coordination Organization (FPCO), BWDB, DMC, RAJUK, DOE, DWASA, LGEB and SOB on a Draft Copy of Preliminary Review Report of the study from 19th Dec. 1990 to 20th Dec. 1990 in Dhaka, Bangladesh. A list of the personnel attended the discussion, are shown in Annex I.


Draft copy of Preliminary Review Report was submitted by the JICA Study Team to the meeting. Mr. H. TANAKA, the Team leader of JICA study Team, explained the outline of the report and stressed the importance on timely selection of master plan study area.

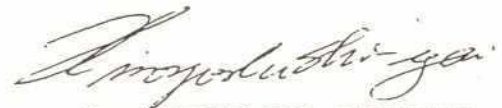
After discussions and comments, the draft report was received by FPCO. It was agreed by GOB counterpart team to furnish comments on the report by 23.12.90.

JICA will submit the final copy which will be made shortly with some changes incorporating the comments.

FPCO will send comments on this report to JICA collecting opinions of various Ministries and Agencies of GOB by the end of January, 1991.

This minutes of meeting has been signed on 20th December, 1990

  
9 / 20.12.90  
A.M.M. NURUL HUQ  
Chief Engineer  
Flood Plan  
Coordination Organization

  
Dr. HIROYOSHI SHIIGAI  
Chairman  
Advisory Committee  
Japan International  
Cooperation Agency



MEMBERS ATTENDED IN THE MEETING :

APPENDIX - I

GOB TEAM

Name	Designation	Organization.
1. M.N.Huda	Chairman, Local Specialist Panel.	FPCO
2. Prof. M.A.Hannan.	Member, PoE	FPCO
3. Prof. Ainun Nishat	Member PoE	FPCO
4. Mr. A.M.M.Nurul Huq	Chief Engineer.	FPCO
5. Mr. K.B.M.Shafiuddin	S.E.	FPCO
6. Mr. Farhad Hussain.	Executive Engineer.	RHD
7. Mr. Emaduddin Ahmad	Executive Engineer	FPCO
8. Mr. Emdadul Islam	Executive Engineer	RAJUK
9. Mr. A.K.M.Halimur Rahman.	Executive Engineer.	BWDB.
10. Md. Harun	Executive Engineer.	BWDB
11. Mr. Abu Taleb Khandaker	Dy. Director.	DOE

JICA TEAM :

1. Dr. Hiroyoshi Shiigai	Chairman Advisory Committee	JICA
2. Mr. Hidetomi Ol	Panel of Expert.	
3. Hiroshi Enomoto	Coordinator	JICA.
4. Mr. Hitoshi Baba	Embassy of Japan.	
5. Takeshi Naruse	Deputy Rep.	JICA Dhaka.
6. Mr. Hajime Tanaka	Team Leader	JICA Study Team
7. Toshiaki Tokumasu	Deputy Team Leader	-do-
8. Isao Misono	Member	-do-
9. J.R.Jones	Member	-do-

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Minutes of the meeting for Greater Dhaka Protection Project of Bangladesh Flood Action Plan No.8A between JICA and FPCO on 21st March, 1991.

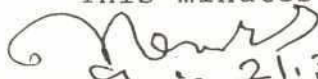
The Advisory Team of Japan International Co-operation Agency headed by Mr. HIDE TOMI OI and the members of the Study Team on Greater Dhaka Protection Project: FAP-8A, discussed with the officials of Flood Plan Co-ordination Organisation (FPCO) PoE(L&E), BWDB, RAJUK, UDD, DoE, RHD, HSD and consultants of FAP-8B on the Interim Report (summary and main report) of the study on 20th March and 21st March, 1991 in Dhaka, Bangladesh. A list of personnel attended the discussion meeting are shown in Annex-I.

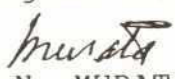
Interim Report was presented by Mr. Naohito MURATA, the Team Leader of JICA Study Team. He explained the main part of the report and pointed out the basic idea, standard and criteria for formulation of the Master Plan of the study area.

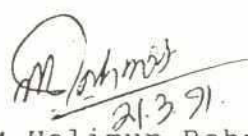
During discussions various points were raised on Interim report from representatives of various organisations, PoE(L&E) and consultants of FAP-8B. Finally it was agreed that comments from different Ministries & Agencies will be collected very soon, JICA Study Team will submit the final copy within a short time incorporating the comments received from GOB side.

GOB side pointed out that some of the members of the JICA Study Team should work in Bangladesh during April & May, 91. JICA Advisory Team informed that they will take up the matter with Head office in Tokyo.

This minutes of the meeting has been signed on 21st March, 1991.

  
( A.M.M. Nurul Haq )  
Chief Engineer  
Flood Plan Co-ordination  
Organisation.

  
( N. MURATA )  
Team Leader  
JICA Study Team  
Greater Dhaka Protection Project-

  
Witness : (A.K.M. Halimur Rahman)  
Superintending Engineer,  
Flood Plan Co-ordination  
Organisation.

  
Witness : (HIDE TOMI OI )  
Member  
JICA Advisory Team.

<u>Name</u>	<u>Designation</u>	<u>Organisation</u>
1. M.N.Huda	Chairman, Local Specialist Panel	FPCO
2. A.M.M.Nurul Huq	Chief Engineer	FPCO
3. A.K.M.Halimur Rahman	Superintending Engineer	FPCO
4. Md.Abdu'r Rahman	Superintending Engineer	BWDB
5. Md.forhad Hussain	Executive Engineer	Roads & Highways Deptt.
6. Md.Emdadul Islam	Executive Engineer	RAJUK
7. Joynul Abedin Khan	Executive Engineer	Housing & Settlement Directorate.
8. M.Anwarul Islam	Deputy Director	Deptt.of Environment
9. Alauddin Ahmed	Deputy Director	URBAN DEV.DTE.
10. J.Dempster	Chairman, Panel of Experts(expatriate)	FPCO
11. Van Ellen	Panel of Experts(E)	FPCO
12. Dr.Ainun Nishat	Panel of Experts(L)	FPCO
13. Dr.M.S.Zaman	Institutional Specialist	FPCO/UNDP
14. Mr.Emdad Ali	Local Consultant	FPCO
15. Nurul Absar	Local Consultant	FPCO
16. Md.Badiuzzaman	Morphological Engineer Local Consultant	FPCO
17. Dr.Asad Ali Shah	Sr.Urban Dev.Specialist	Asian Dev.Bank
18. R.D.Berlin	Team Leader, FAP-8B	Louis berger Inter-national Inc.
19. Max Williams	Hydraulic Engineer, FAP-8B	"
20. Shaheedul Islam	Flood Control, Planning Engineer FAP-8B.	"

## JICA TEAM

1. HIDETOMI OI	Advisory Team	JICA
2. HIROSHI ENOMOTO	Coordinator	JICA
3. TAKESHI NARUSE	Deputy Representative	JICA Dhaka office
4. N.MURATA	Team Leader	JICA STUDY Team, FAP-8A
5. T.Tokumasu	deputy Team Leader	do
6. I.MISONO	Flood Prevention Engr.	do
7. N.Ishibashi	Socio-Economist	do
8. Dr.S.Jayamohon	Environmental Engineer	do



Minutes of the Meeting  
for  
Greater Dhaka Protection Project  
(Study in Dhaka Metropolitan Area)  
Of Bangladesh Flood Action Plan No. 8A  
Between JICA and FPCO on 28th July, 1991.

The Advisory Committee of Japan International Cooperation Agency, headed by Dr. Hiroyoshi Shiigai and the members of the study team on Greater Dhaka Protection Project, FAP 8A, discussed with the officials of Flood Plan Co-ordination Organization (FPCO), POE(L), BWDB, RAJUK, DCC, DOE, HSD, RHD, LGEB, WORLD BANK AND Consultants of FAP-8B, Dhaka Integrated Flood Protection Project, the copy of Draft Master Plan (summary, main report and supporting report) of the study on 28th July 1991 in FPCO office, Dhaka, Bangladesh. A list of the personnel attended the discussion are shown in Annex I.

A draft copy of the draft Master Plan Report was submitted by the JICA study team to the meeting. Mr. Hajime Tanaka, the team leader of the JICA study team, explained the outline of the Master Plan and priority areas for the Feasibility Study. During the discussion some observation were made by the participants. The JICA study team will submit the Draft Master Plan by the 1st week of August, 1991 after incorporating the comments made during the discussion.

FPCO will collect the additional comments of various ministries and agencies of GOB and send them to JICA by the end of August, 1991.

During the discussion GOB expressed its satisfaction to Draft Master Plan in principle and the following points were raised:

1. The JICA study team have proposed the priority areas as follows:

1st Priority Area:

- Greater Dhaka West
- Greater Dhaka East
- Narayanganj DND
- Narayanganj West.

2nd Priority Area:

- Tongi
- Keranigonj

3rd Priority Area:

- Narayanganj East
- Savar

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The JICA study team recommended Greater Dhaka East and DND for the F/S areas, as the priority area of Dhaka West has been taken by ADB financed consultants, FAP 8B.

GOB, however, requested the inclusion of Narayanganj West and Kamrangir Char for the F/S areas instead of DND.

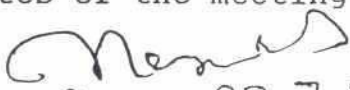
The JICA study team expressed their opinion that Kamrangir Char belongs to the side of Greater Dhaka West area, and that appropriate data on both Narayanganj West and Kamrangir Char are not fully available for feasibility study. The JICA study team still recommends DND instead of Narayanganj West and Kamrangir Char for the F/S area. However this will be finalised after August, 1991.

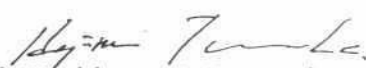
2. Although DOE requested a full scale EIA in the F/S, the JICA study team expressed its difficulties to prepare a full scale EIA for the F/S, because it is beyond the scope of works agreed upon between GOB and JICA, and also not planned in the Inception Report (FAP 8A).

The JICA study team, however, expressed that the F/S will cover assessment of environmental impacts based on the secondary data.

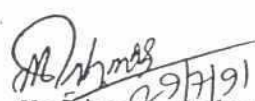
3. The necessity of more detailed information supplied from FAP 8B to FAP 8A was confirmed. The Plan proposed by FAP 8B in its Interim Report No.-I is confirmed in the draft Master Plan.
4. Importance of continuous presence of the JICA study team in Dhaka was stressed by GOB side.
5. Possibility of more intensive use of local consultants was also stressed by GOB side.

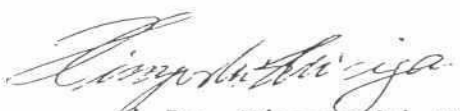
The minutes of the meeting was signed on 29th July, 1991.

  
( A. M. M. Nurul Haq )  
Chief Engineer,  
Flood Plan Coordination  
Organization.

  
( Hajime TANAKA )  
Team Leader,  
JICA Study Team  
Greater Dhaka Protection Project

Witness

  
( A. K. M. Hafimur Rahman )  
Superintending Engineer  
Flood Plan Coordination  
Organization

  
( Dr. Hiroyoshi SHIIGAI )  
Chairman  
Advisory Committee  
Japan International  
Cooperation Agency.

ANNEX - 1

MEMBERS ATTENDED IN THE MEETING

Sl. No.	Name	Designation	Organisation
1.	M. N. Huda	Chairman, Local Specialist Panel	FPCO
2.	A. M. M. Nurul Huq	Chief Engineer	FPCO
3.	A. K. M. Halimur Rahman	Superintending Engineer	FPCO
4.	Md. Masud Ahmed	Sub-Divisional Engineer	FPCO
5.	Md. Abdur Rahman	Superintending Engineer	BWDB
6.	Md. Yusuf Harun	Executive Engineer	BWDB
7.	Md. Mehdi Ali Khan	Superintending Engineer	D.C.C
8.	Emdadul Islam	Executive Engineer	RAJUK
9.	Md. Forhad Hussain	Executive Engineer	RHD
10.	M. Anwarul Islam	Deputy Director	DOE
11.	Joynul Abedin Khan	Executive Engineer	HSD
12.	Abdullah	Sub-Divisional Engineer	HSD
13.	Ross Wallace	Co-ordinator	World Bank
14.	Max Williams	Acting Project Manager FAP-8B	Louis Berger International Inc.

JICA TEAM

1.	Dr. Hiroyoshi Shiigai	Chairman, Advisory Committee	JICA, Tokeyo
2.	Motohauce Sekizawa	Advisory Committee	JICA, Tokyo
3.	Hiroshi Enomoto	Co-ordinator	JICA, Tokyo
4.	Hajime Tanaka	Team Leader	JICA StudyTeam
5.	Toshiaki Tokamasu	Deputy Team Leader	JICA StudyTeam
6.	N. Ishibashi	Socio-Economist	JICA StudyTeam
7.	I. Misono	Flood Prevention Engineer	JICA Study Team
8.	J.R. Jones	Urban Planner	JICA StudyTeam







