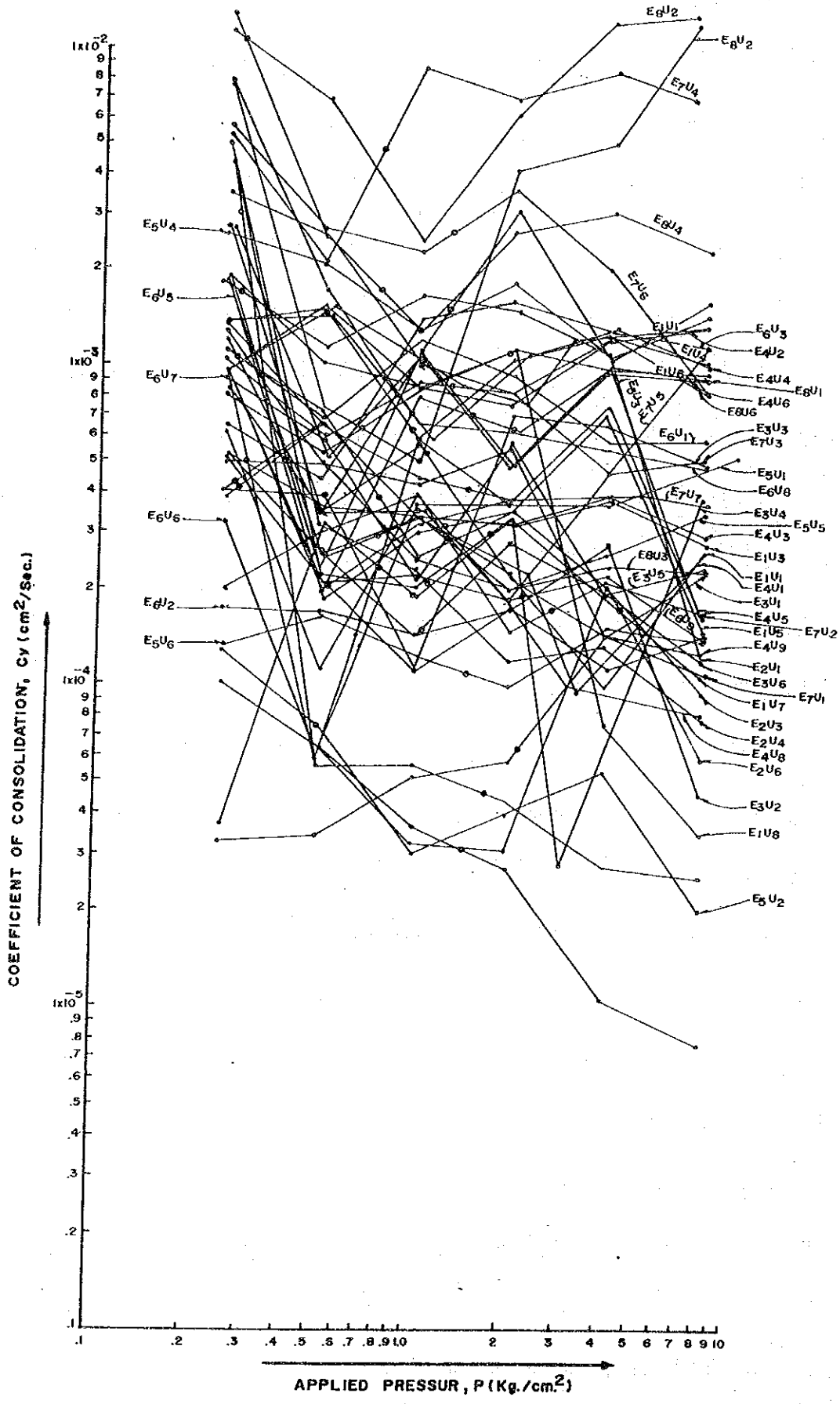
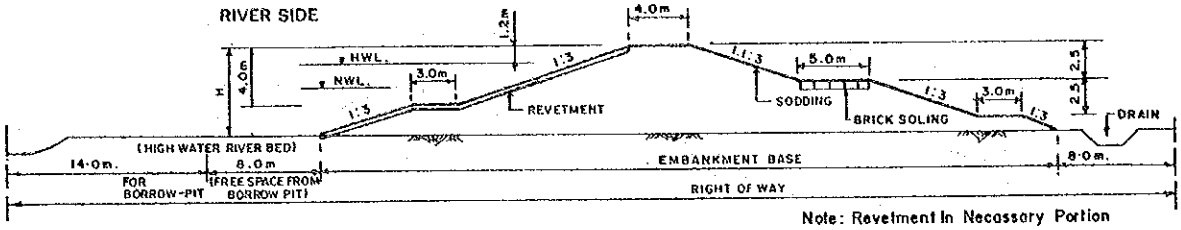


FIG. F.1.9 APPLIED PRESSURE (P) AND COEFFICIENT OF CONSOLIDATION (CV)

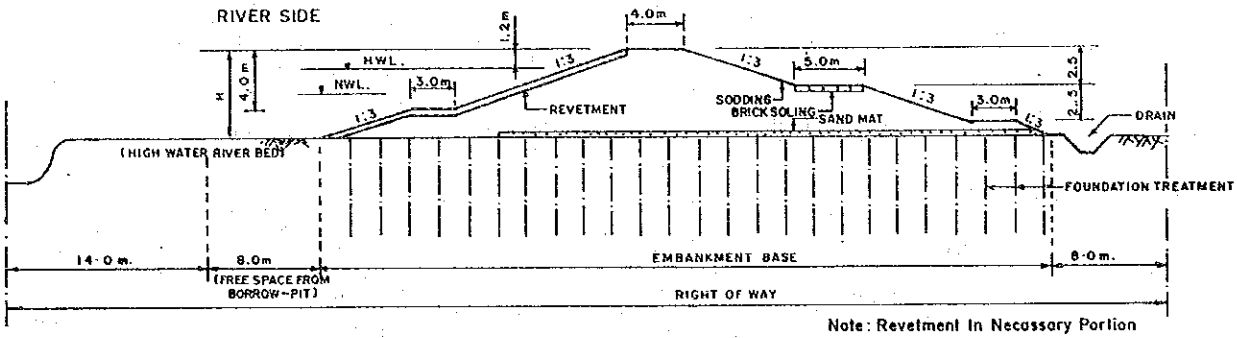
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROLOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

TYPICAL SECTION OF EMBANKMENT



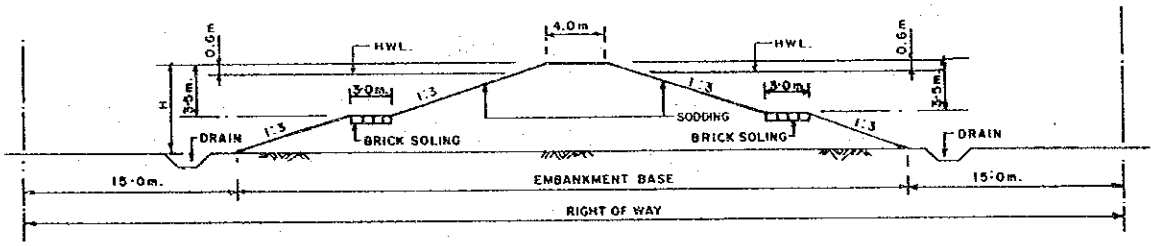
Note: Revetment In Necessary Portion
Otherwise Sodding

TYPICAL SECTION OF EMBANKMENT WITH FOUNDATION TREATMENT



Note: Revetment In Necessary Portion
Otherwise Sodding.

TYPICAL SECTION OF SUB-EMBANKMENT



TYPICAL SECTION OF SUB-EMBANKMENT WITH FOUNDATION TREATMENT

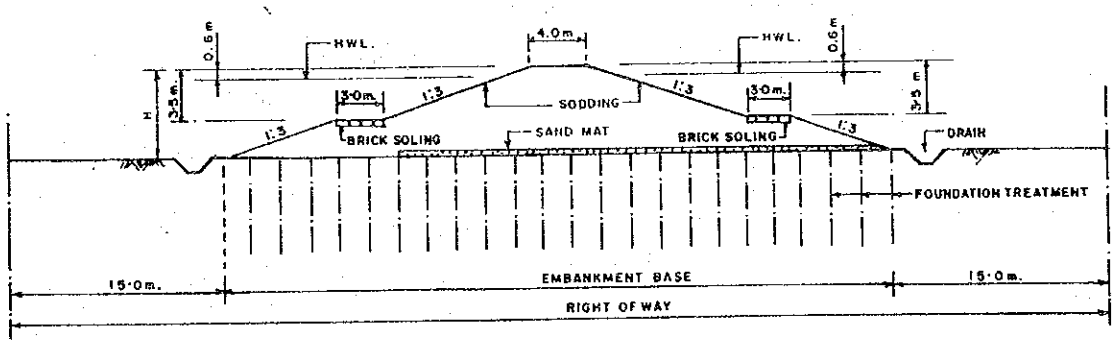


FIG. F.1.10(1) STANDARD CROSS SECTION OF EMBANKMENT : GREATER DHAKA EAST

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

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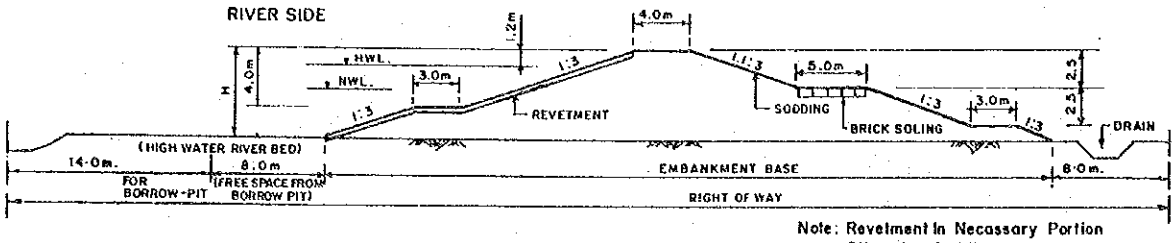
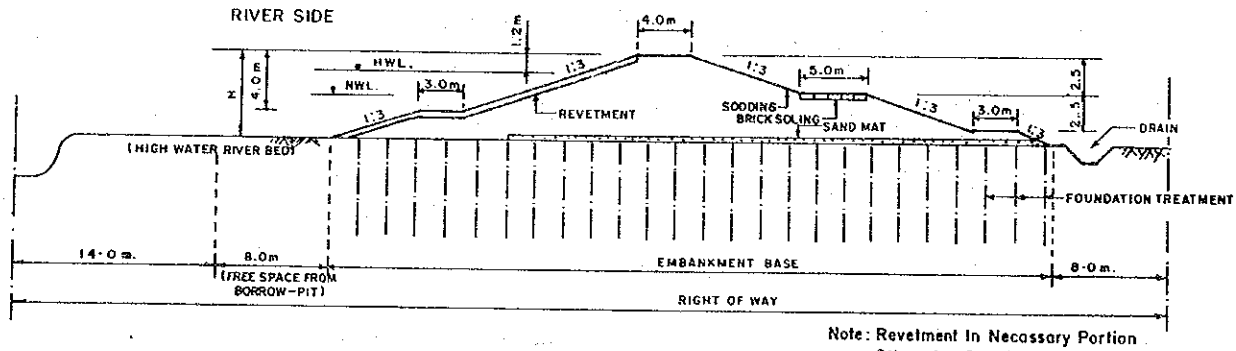
TYPICAL SECTION OF EMBANKMENT



Note: Revetment In Necessary Portion
Otherwise Sodding

TYPICAL SECTION OF EMBANKMENT WITH FOUNDATION TREATMENT



Note: Revetment In Necessary Portion
Otherwise Sodding.

TYPICAL SECTION OF ROAD-CUM EMBANKMENT

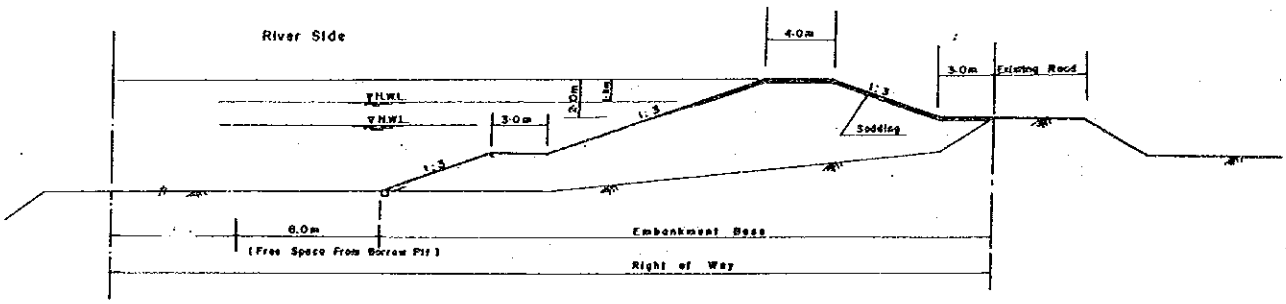
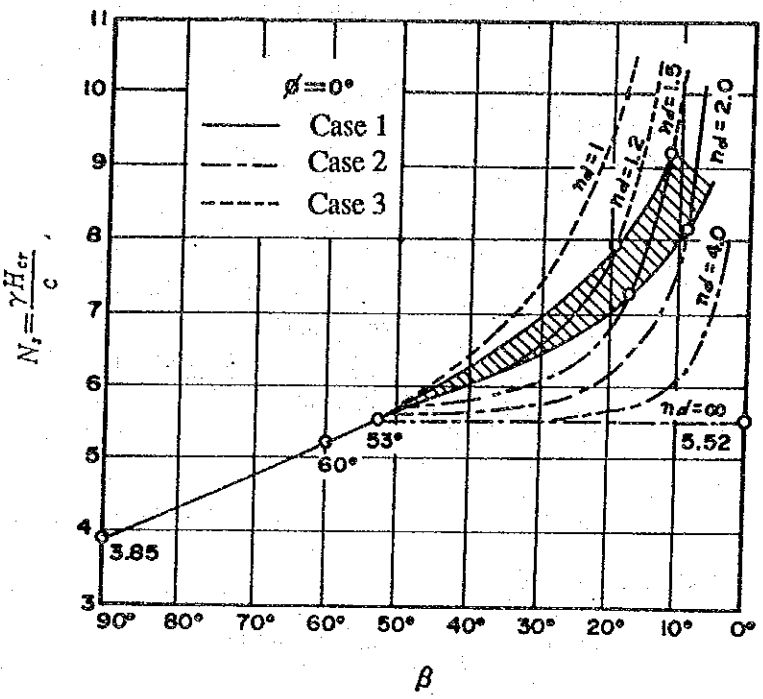


FIG. F.1.10(2)	STANDARD CROSS SECTION OF EMBANKMENT : NARAYANGANJ WEST

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

JICA

Taylor's Chart For Stability Analysis



Case 1 : Case 2 : Case 3 :

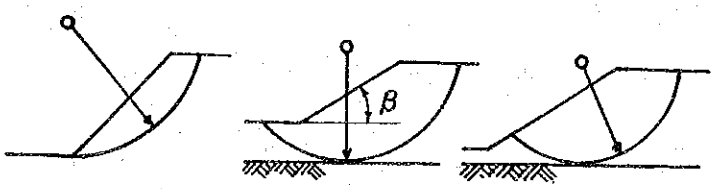
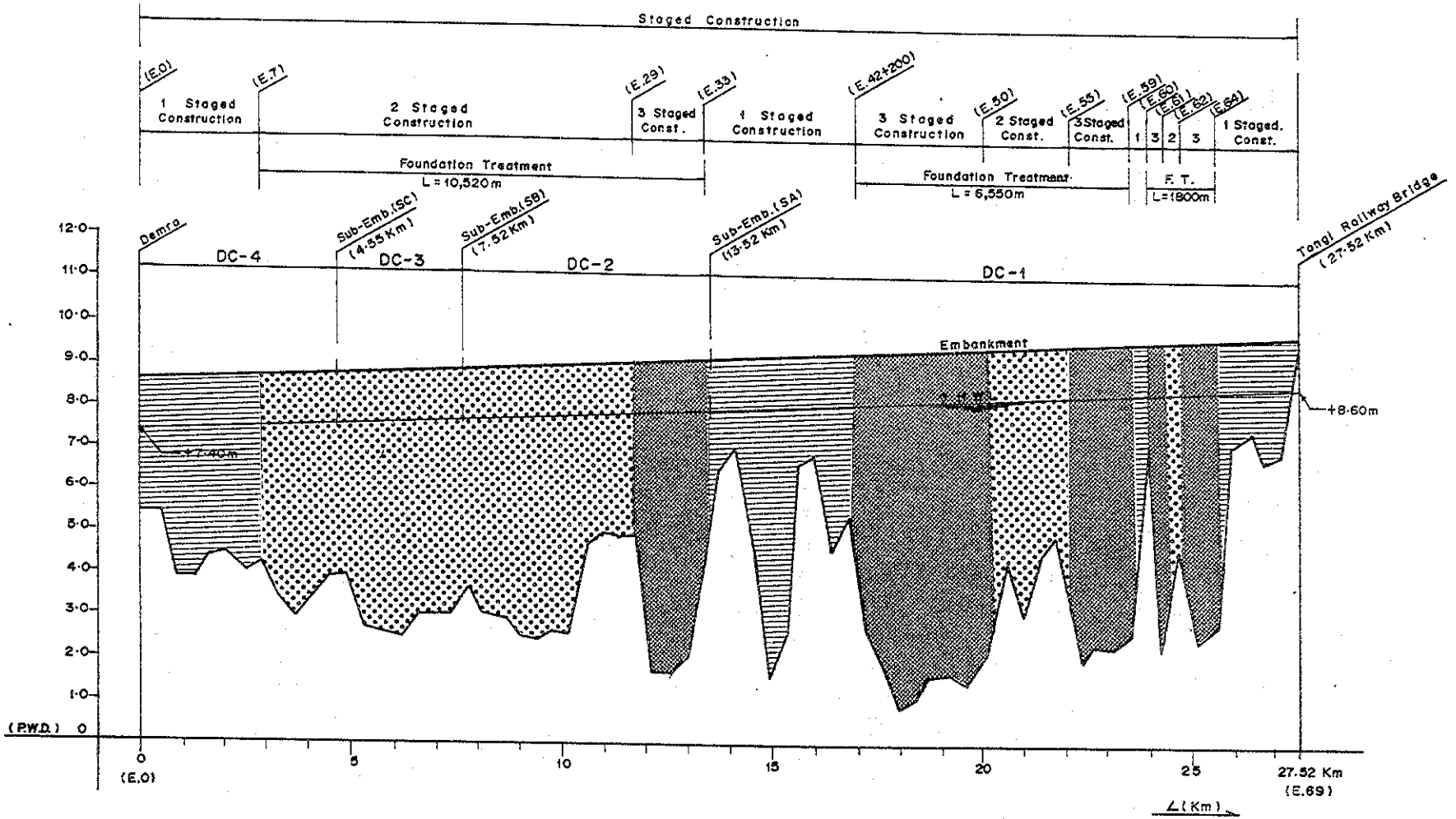


FIG. F.1.11	TAYLOR'S CHART FOR STABILITY ANALYSIS

STAGED CONSTRUCTON OF EMBANKMENT



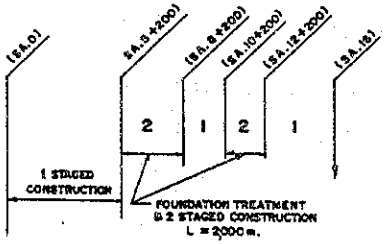
LEGEND

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

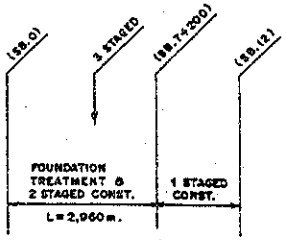
FIG. F.1.12(1) STAGED CONSTRUCTION OF EMBANKMENT : GREATER DHAKA EAST

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

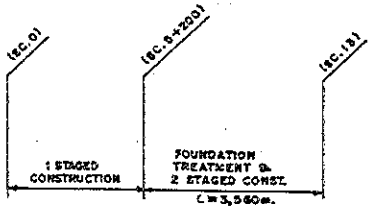
Sub-Embankment : SA

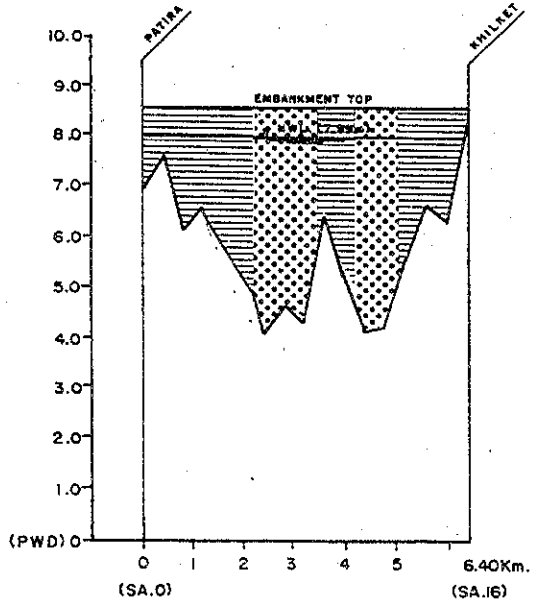


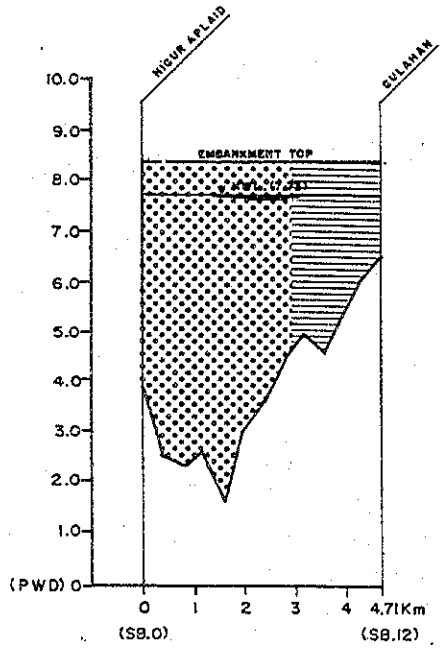
Sub-Embankment : SB

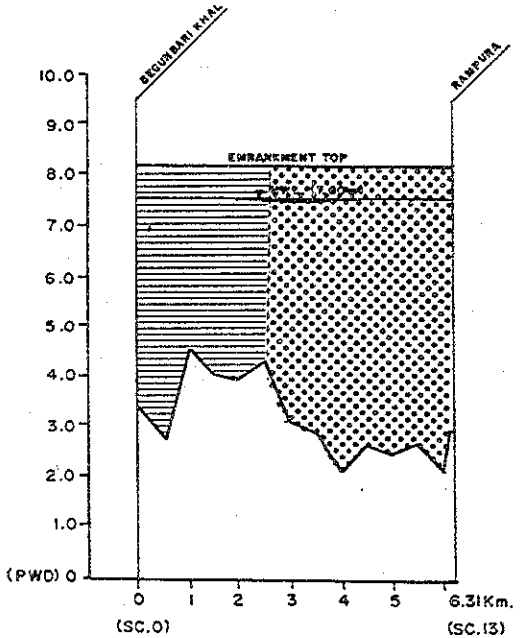


Sub-Embankment : SC









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 METROLOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA

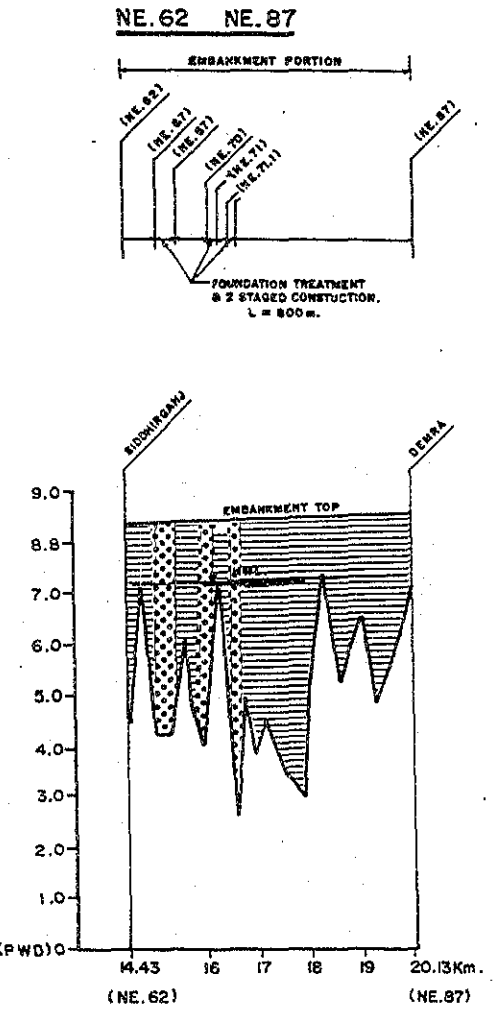
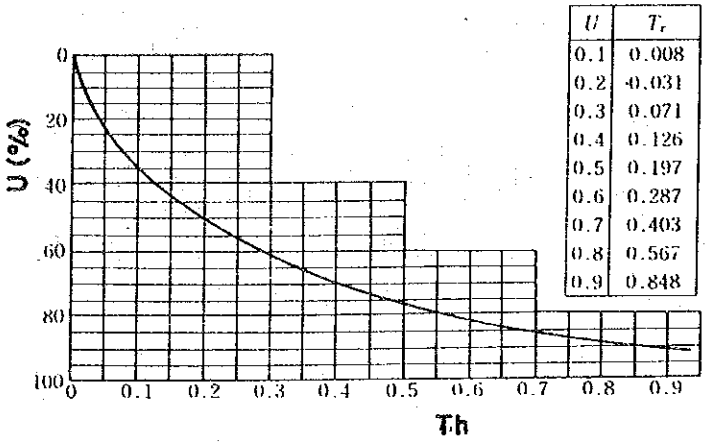


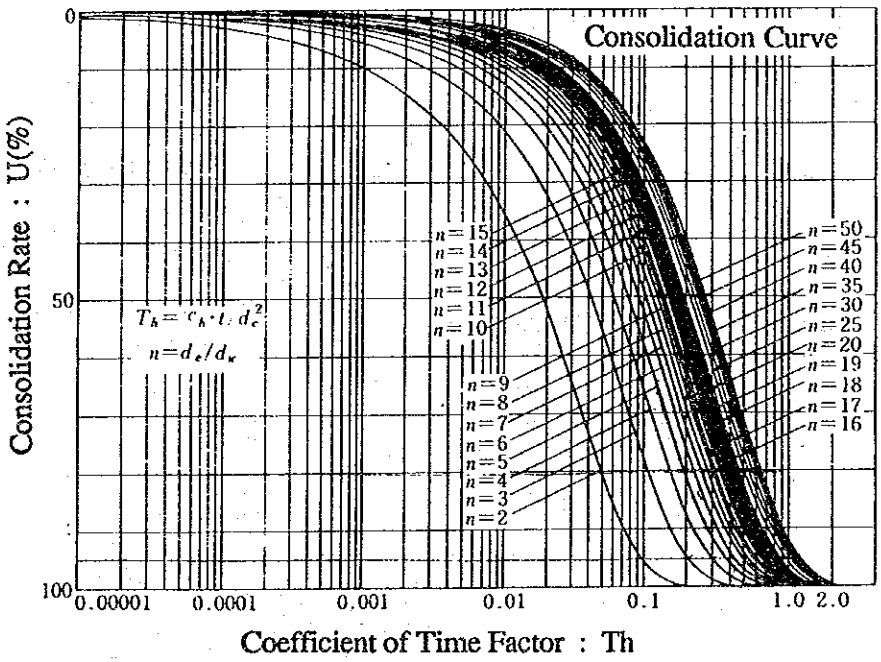
FIG. F.1.12(3) STAGED CONSTRUCTION OF EMBANKMENT : NARAYANGANJ WEST

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

JICA

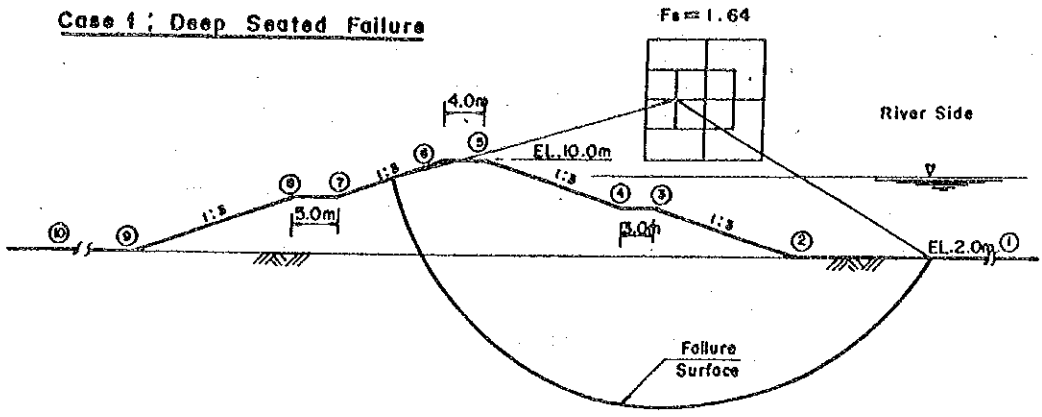


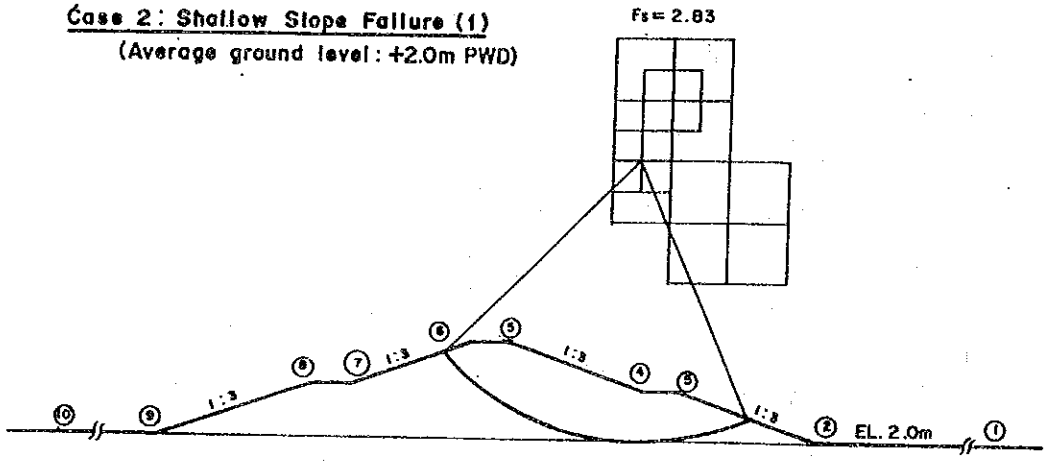
U	T_v
0.1	0.008
0.2	0.031
0.3	0.071
0.4	0.126
0.5	0.197
0.6	0.287
0.7	0.403
0.8	0.567
0.9	0.848



U - Th Relation

FIG. F.1.13 CONSOLIDATION CURVE AND TABLE





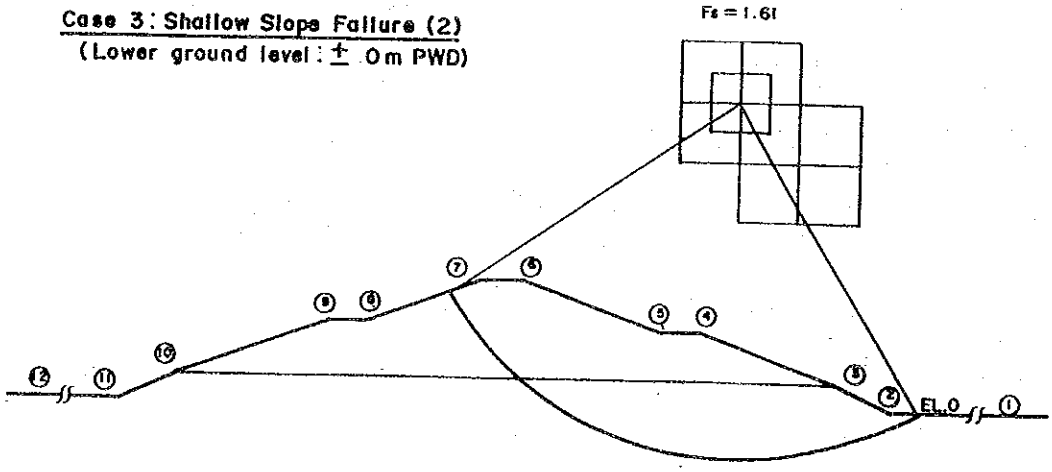
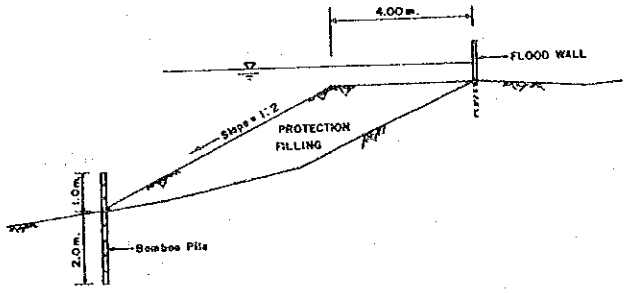
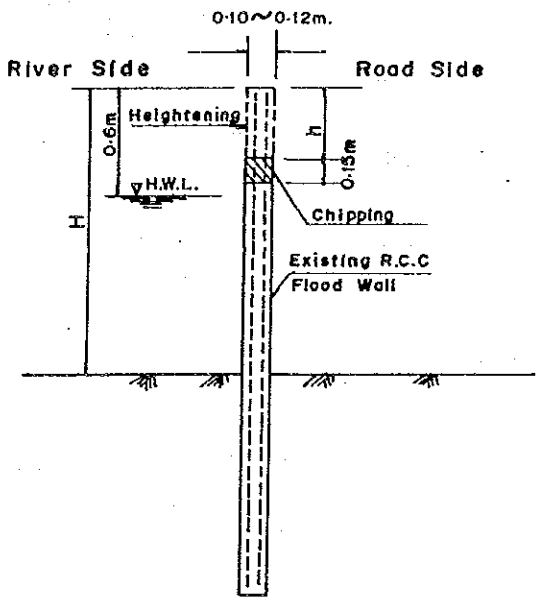


FIG. F.1.14 RESULT OF STABILITY ANALYSIS OF EMBANKMENT

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





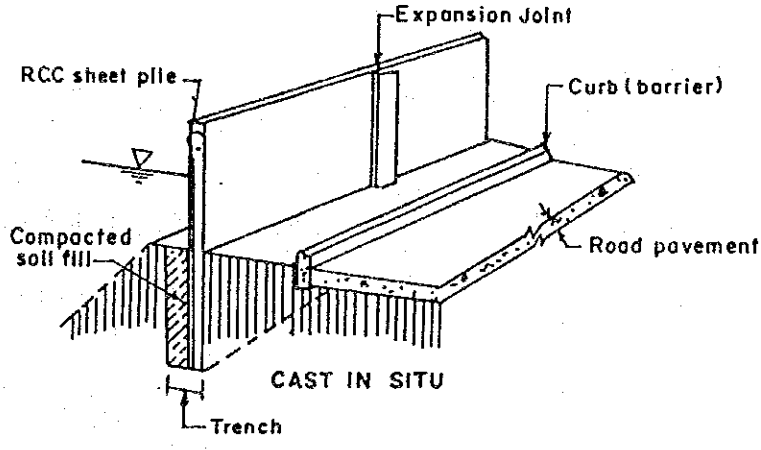
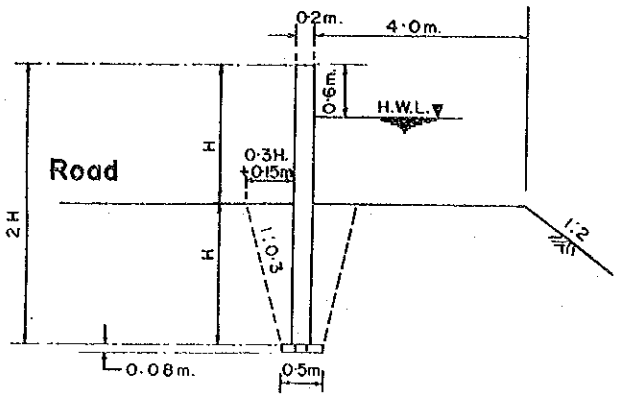
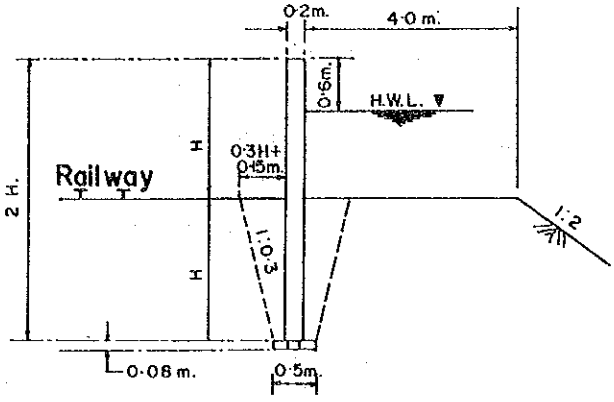


FIG. F.2.1 STANDARD CROSS SECTION OF EXISTING FLOOD WALL AND REHABILITATION WORKS

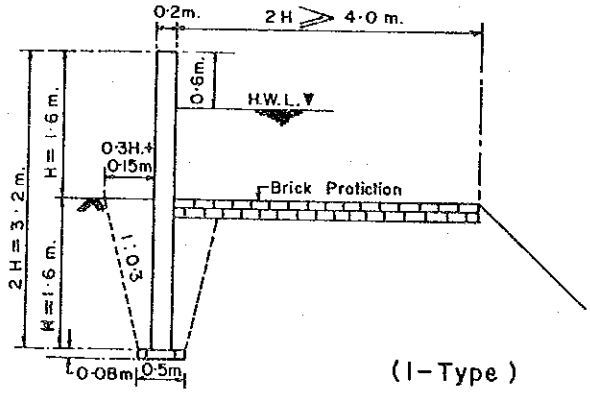
TYPICAL SECTION OF FLOOD WALL



TYPICAL SECTION OF FLOOD WALL

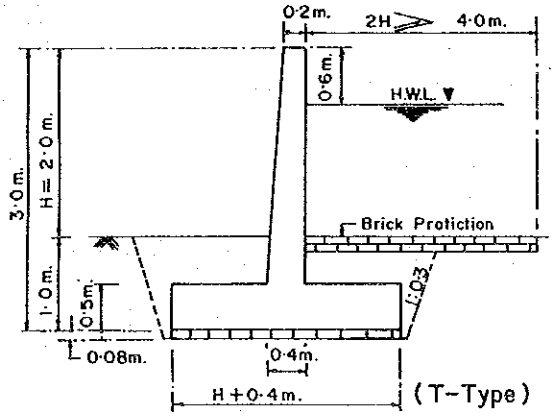


TYPICAL SECTION OF FLOOD WALL



(I-Type)

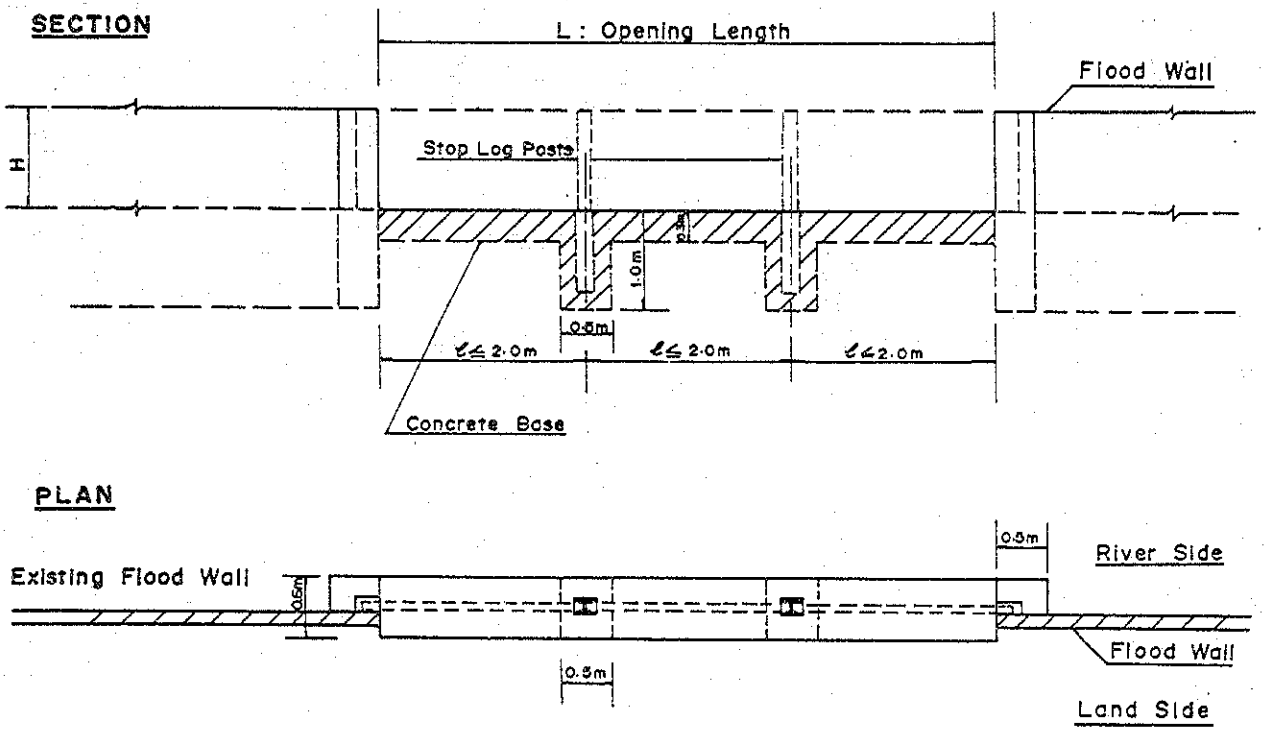
TYPICAL SECTION OF FLOOD WALL



(T-Type)

FIG. F.2.2 STANDARD CROSS SECTION OF PROPOSED FLOOD WALL

STOP LOG STRUCTURE



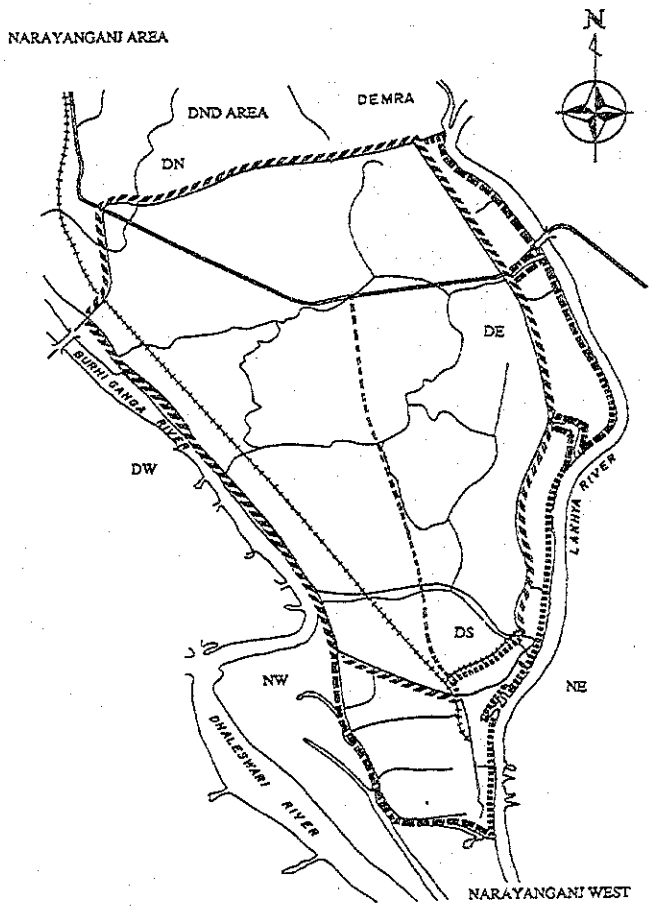
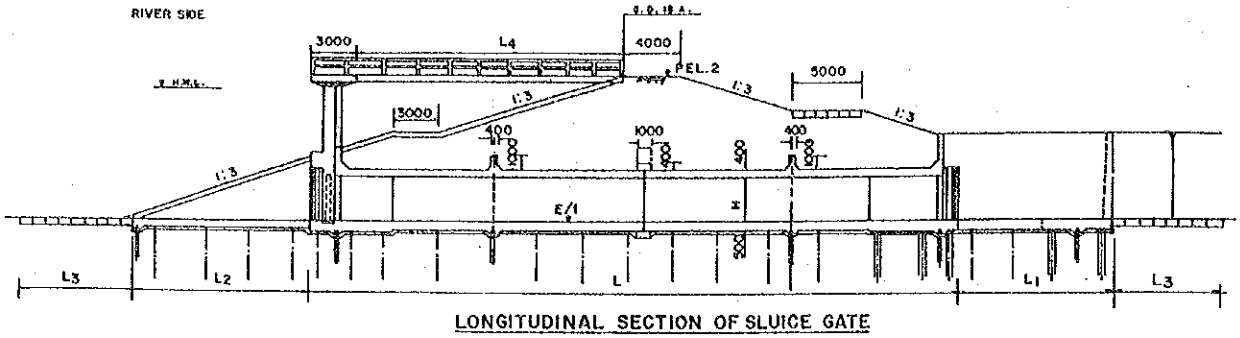


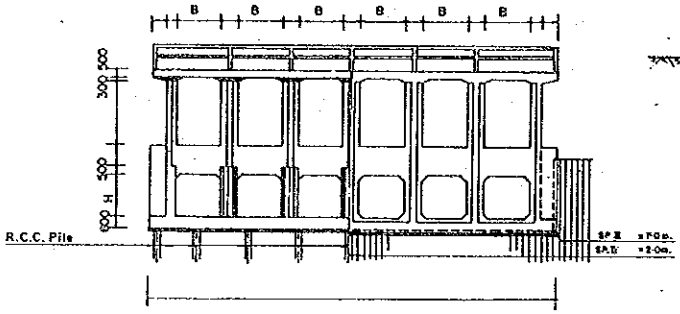
FIG. F.2.3 TYPICAL SECTION OF STOP LOG STRUCTURE

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

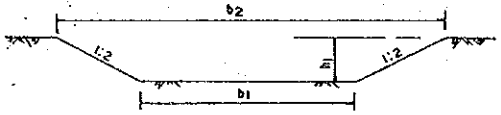
JICA



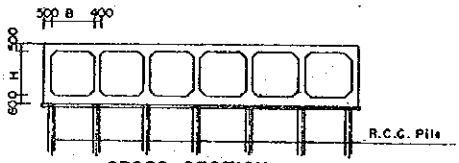
LONGITUDINAL SECTION OF SLUICE GATE



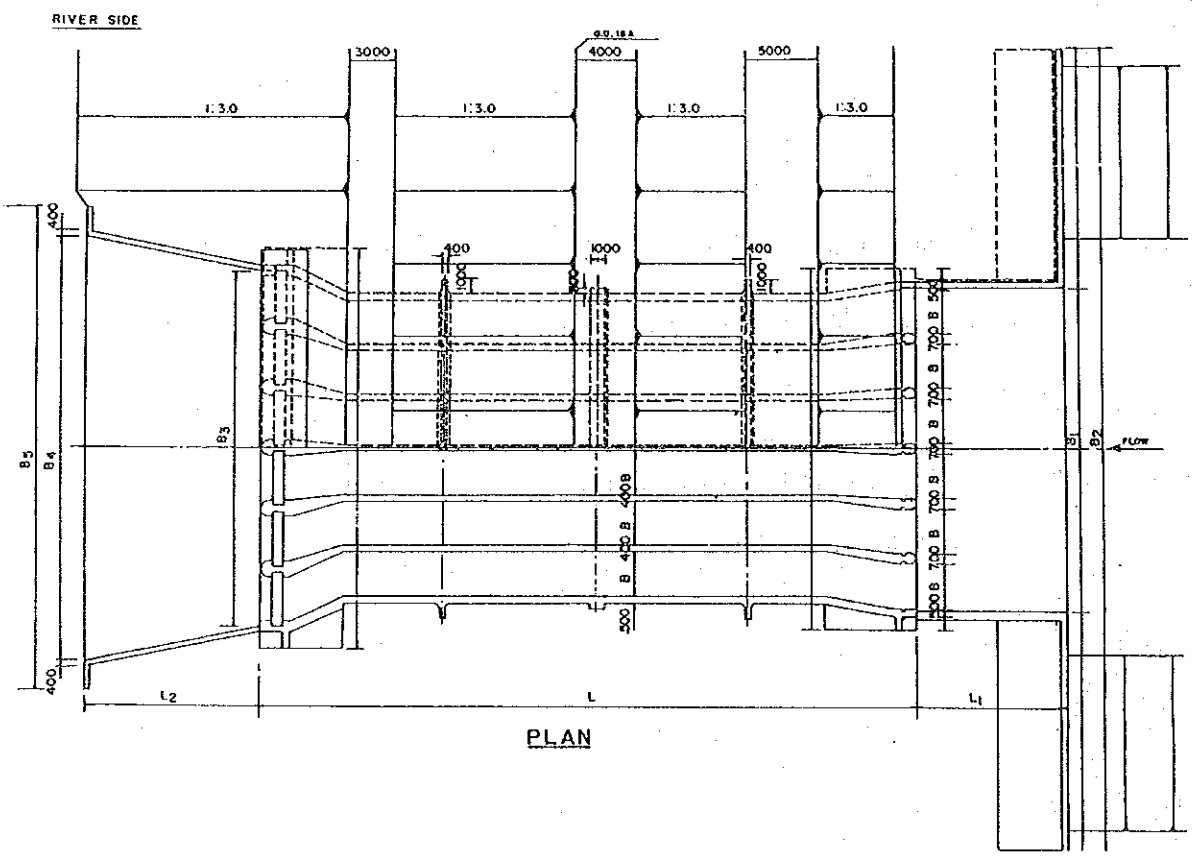
FRONT VIEW (RIVER SIDE)



DIMENSION OF KHAL

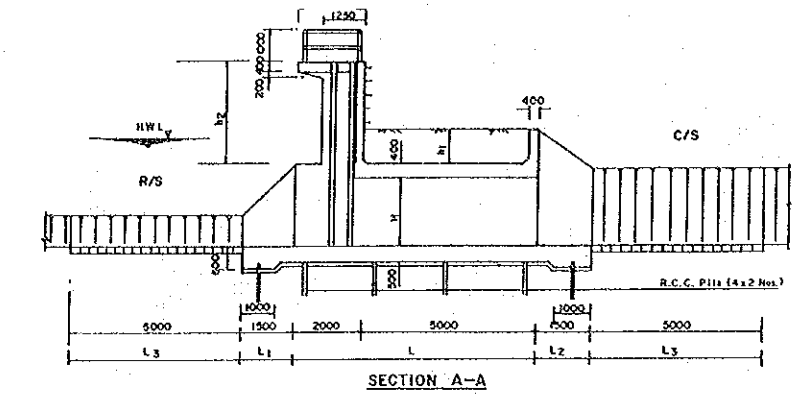


CROSS SECTION

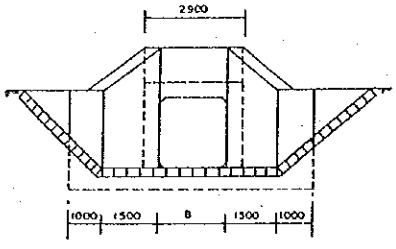


PLAN

FIG. F.3.1 STANDARD SECTION OF SLUICE GATE APPLIED ON EMBANKMENT SECTION

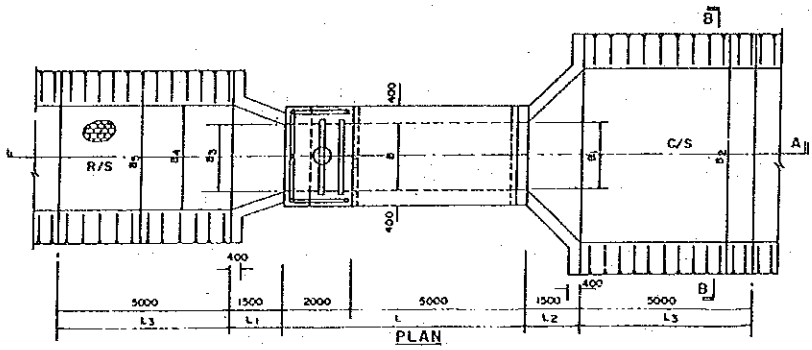


SECTION A–A



SECTION B–B

SCALE : 1:100



PLAN

MAIN FEATURE OF SLUICE GATES :DHAKA EAST

No.	Sta. No.	Mark (Khal No.) Q(m3/s)	Dimensions of Culvert B (m)	H (m)	L (m)	N	Inlet B1 (m)	L1 (m)	B2 (m)	Outlet B3 (m)	B4 (m)	B5 (m)	L2 (m)	L3 (m)	O.Bridge LA (m)	Remarks
1	E68 + 150	14	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	E55	15	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	
3	E43 + 320	16	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	With Pump:P5
4	E28 + 150	17	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	With Pump:P6
5	E11 + 340	18A	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	With Pump:P7A
6	E8 + 90	18B	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	With Pump:P7B
7	SA.11+100	Sub-1	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	Sub Emb.SA

MAIN FEATURE OF PROPOSED SLUICE GATE: DND & N.WEST

I.DND

No.	Sta. No.	Mark (Khal No.) Q(m3/s)	Dimensions of Culvert B (m)	H (m)	L (m)	N	Inlet B1 (m)	L1 (m)	B2 (m)	Outlet B3 (m)	B4 (m)	B5 (m)	L2 (m)	L3 (m)	O.Bridge LA (m)	Remarks
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	Pump:P11/Wall
2	DE.17+350	19	2.40	2.70	-	2	-	-	-	-	-	-	-	-	-	Pump:P 10(Existing)
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	Emb
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	Pump:P12/Emb
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	Pump:P13/Emb
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	Emb
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	F. Wall
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	F. Wall
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	F. Wall
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	F. Wall
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	F. Wall
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	F. Wall
11	NE5 + 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	F. Wall
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	F. Wall
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	Pump:P14A/Emb
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	Pump:P14B/Emb

Note:
1).Emb: Embankment
2).F.Wall:Flood Wall

FIG. F.3.2 STANDARD SECTION OF SLUICE GATE APPLIED ON FLOOD WALL SECTION

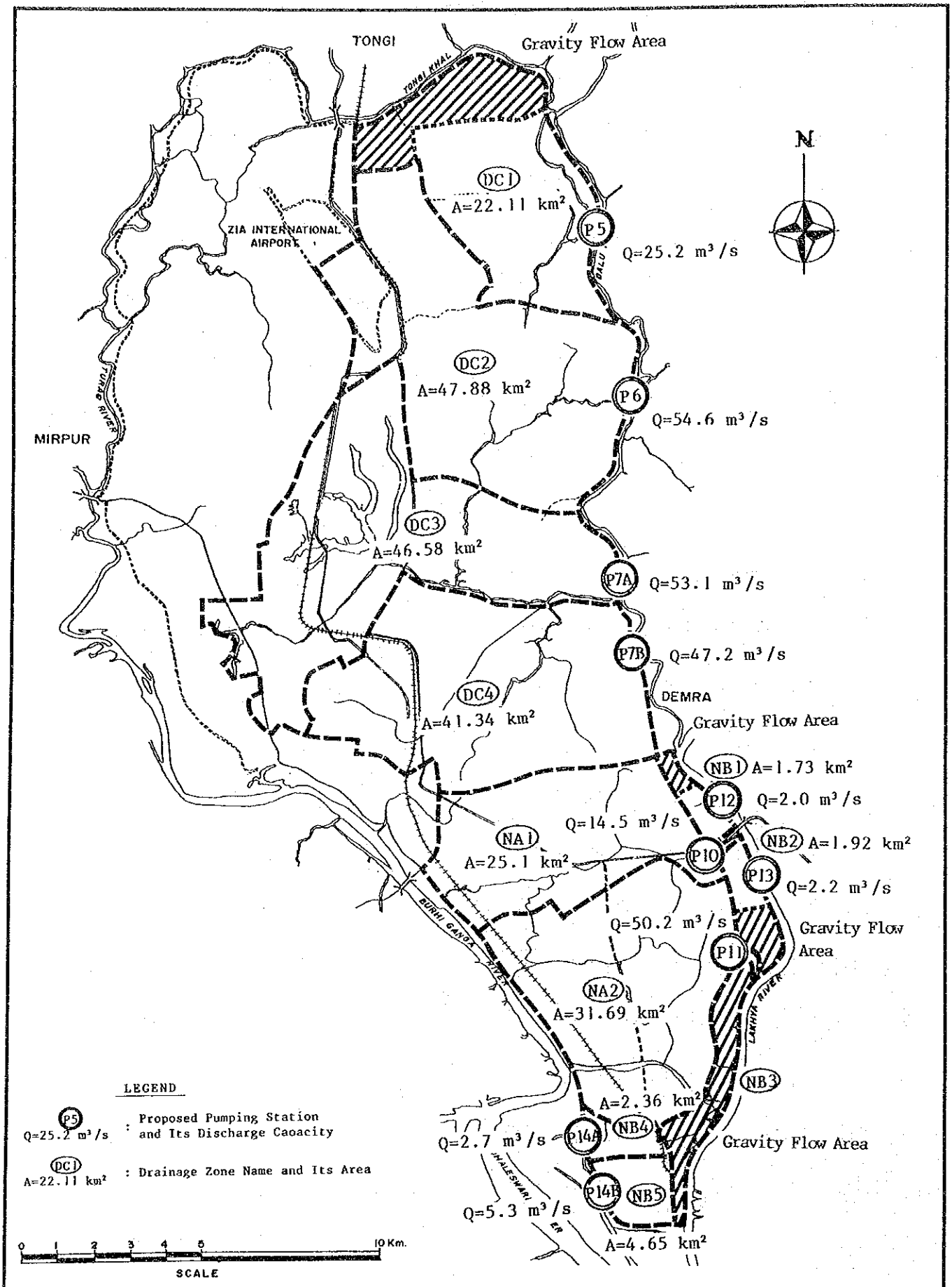
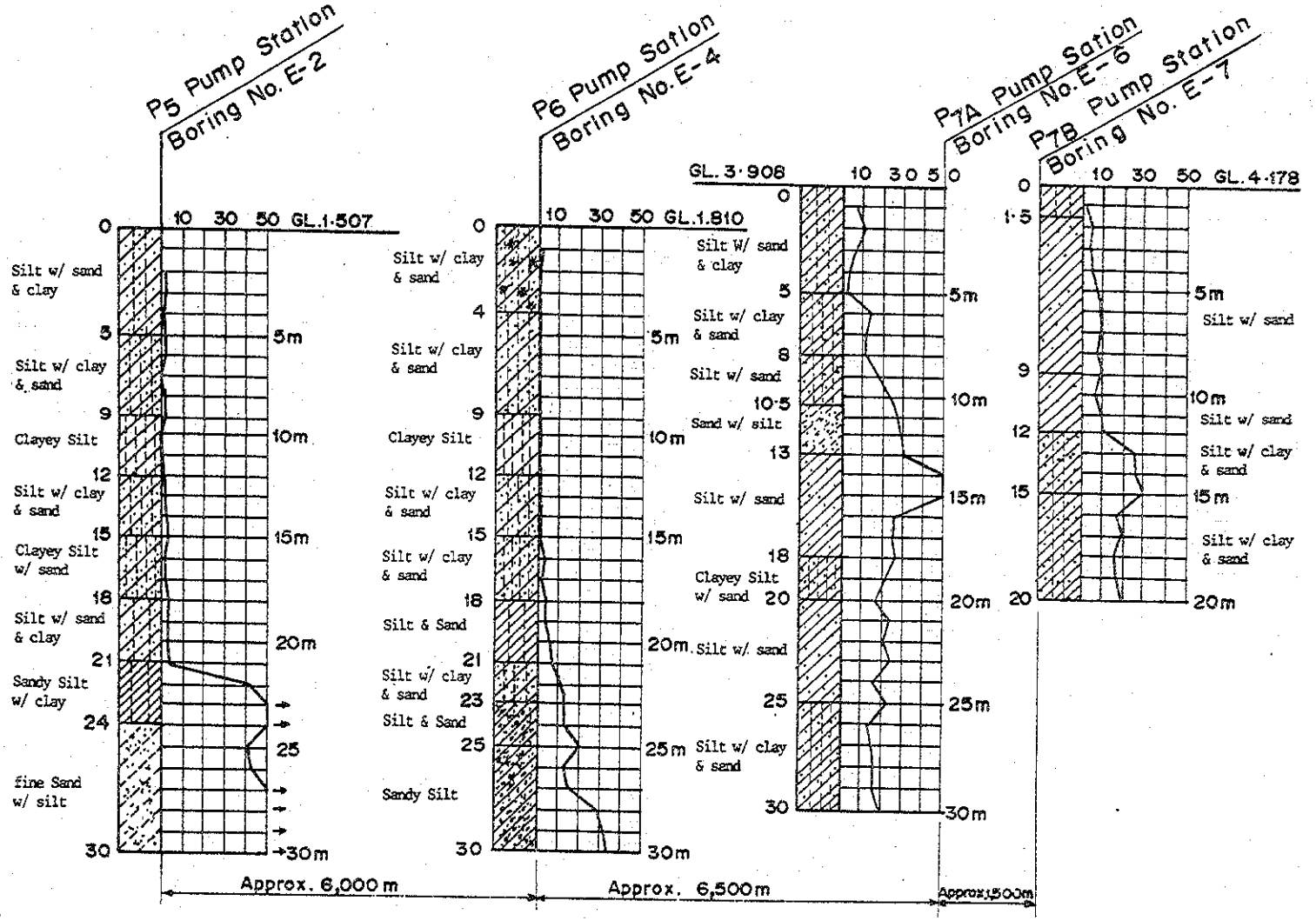


FIG. F.4.1 LOCATION OF PROPOSED PUMPING STATIONS

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

JICA



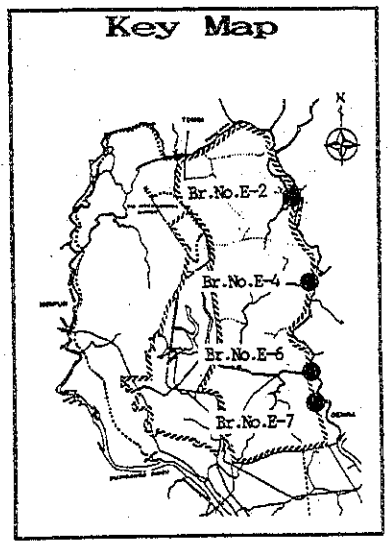
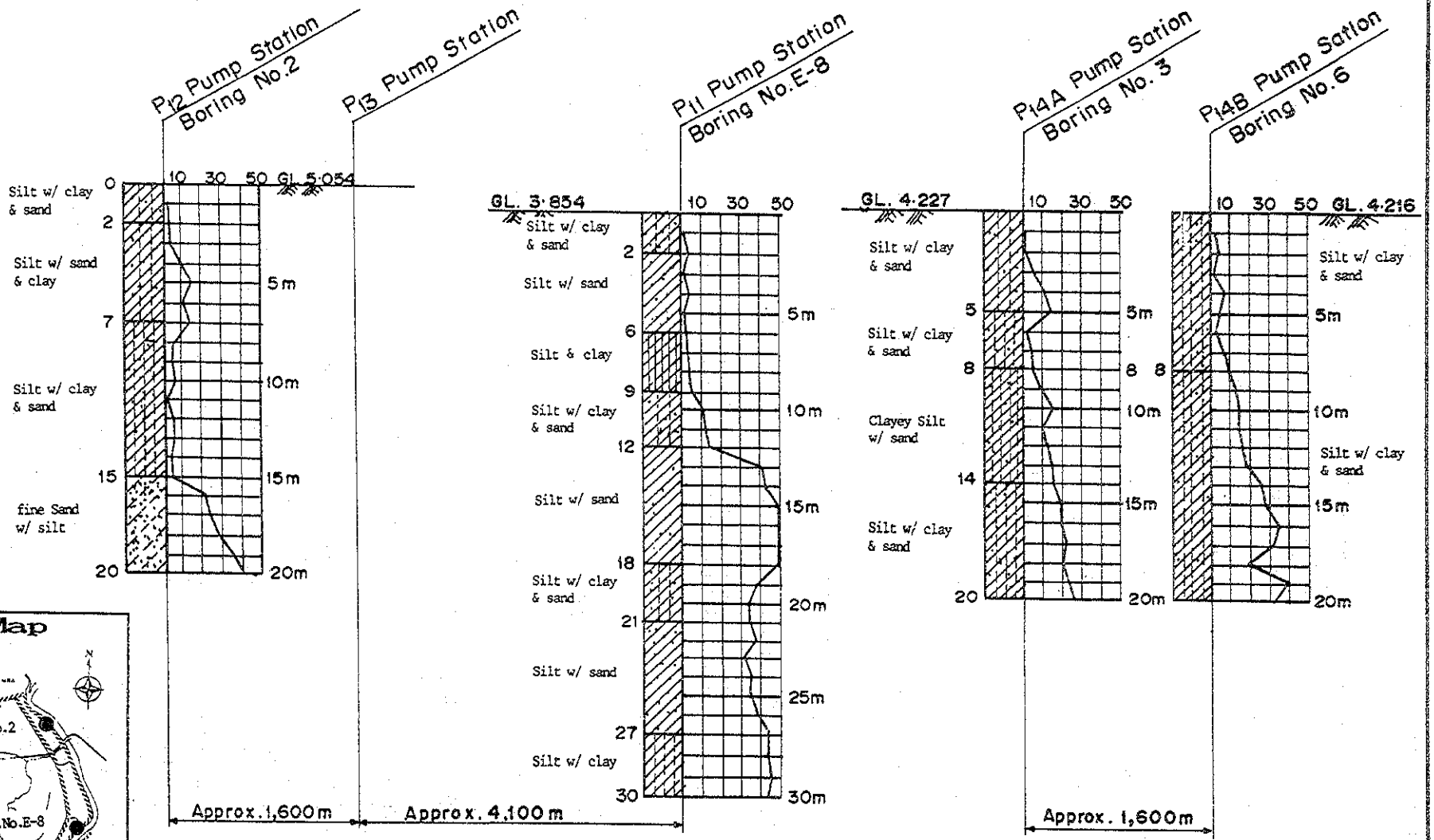


FIG. F.4.2(1) SOIL CONDITION AT PROPOSED PUMPING STATIONS : GREATER DHAKA EAST

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

JICA



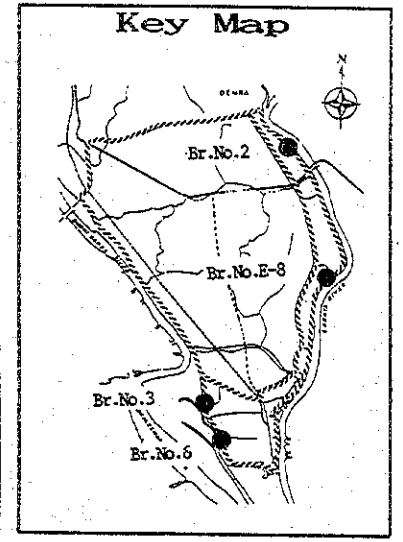
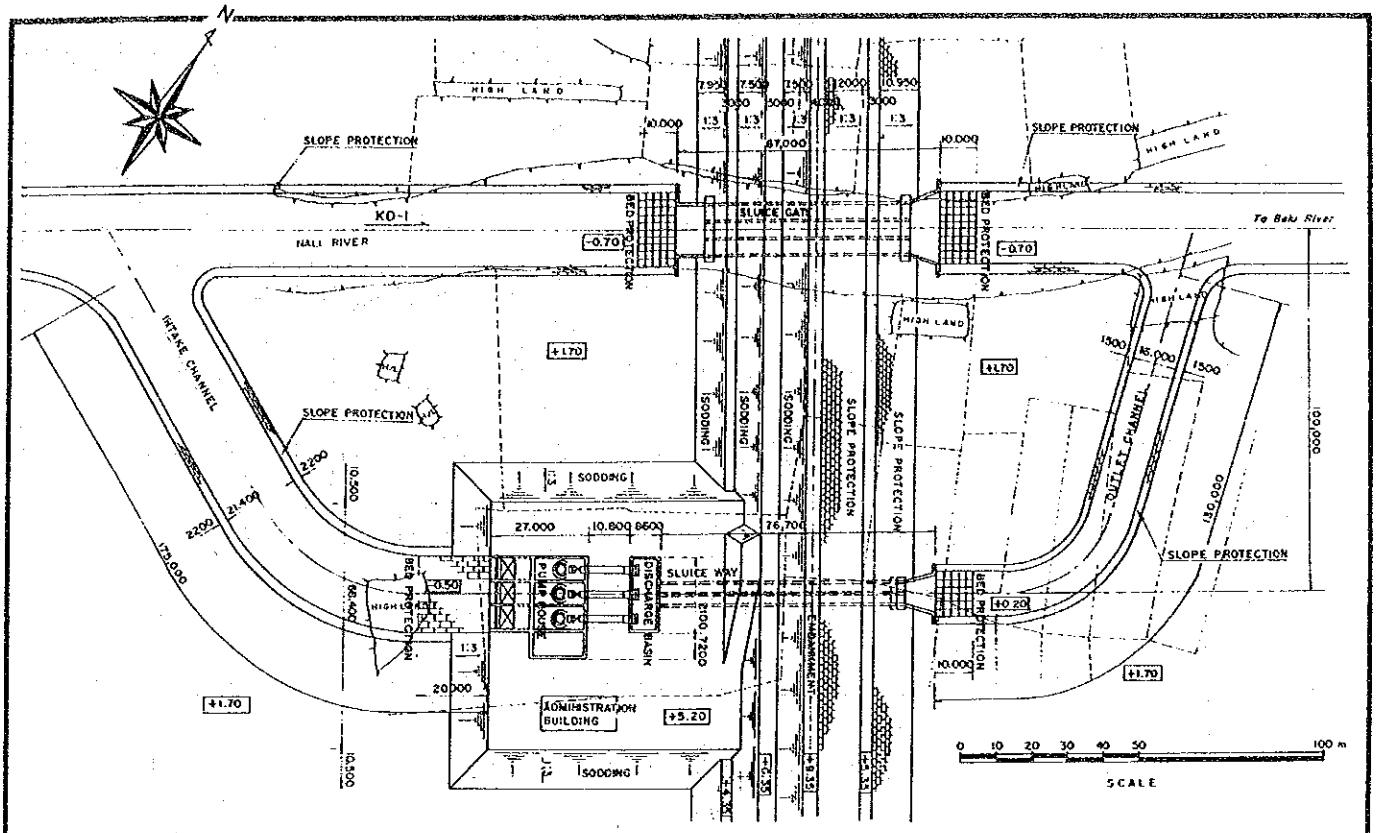
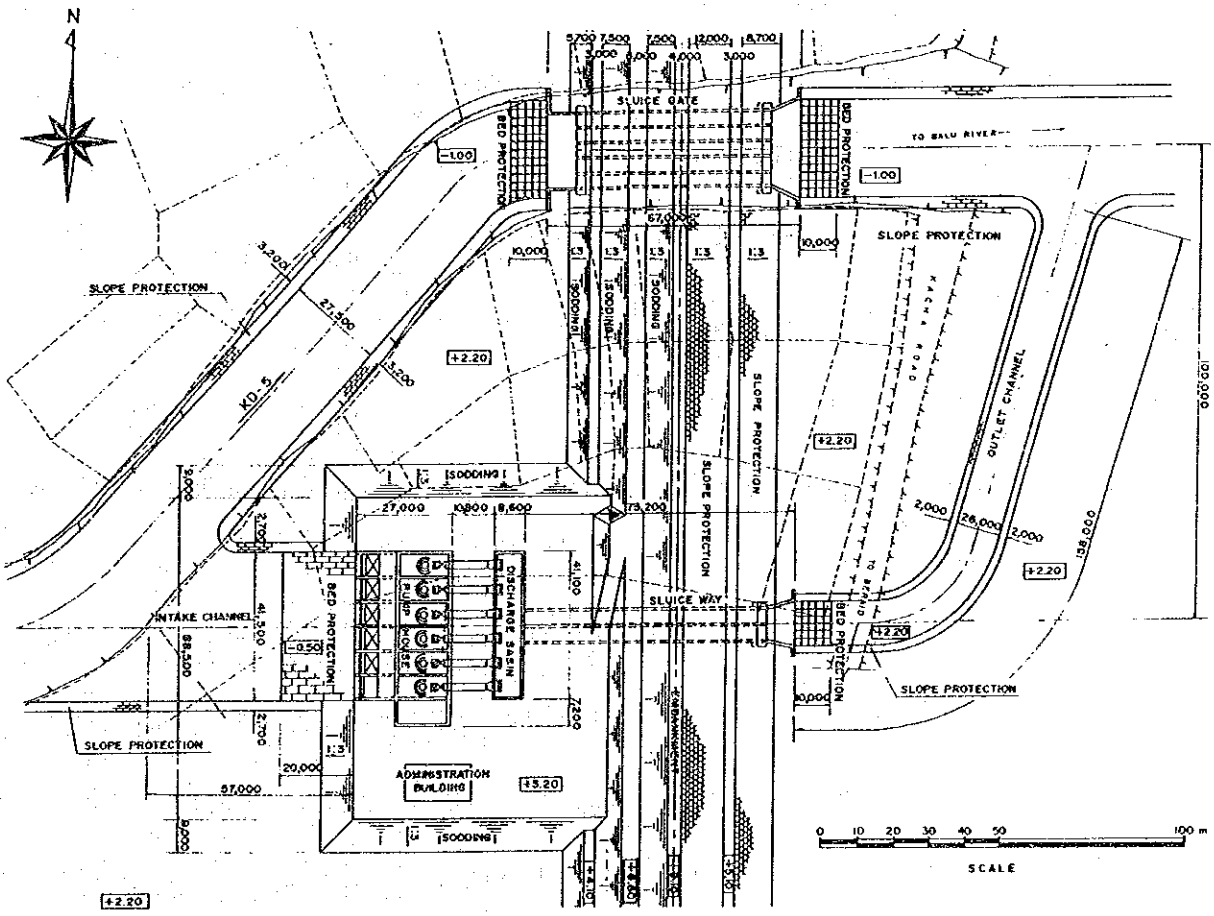


FIG. F.4.2(2) SOIL CONDITION AT PROPOSED PUMPING STATIONS : DND AND NARAYANGANJ WEST

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



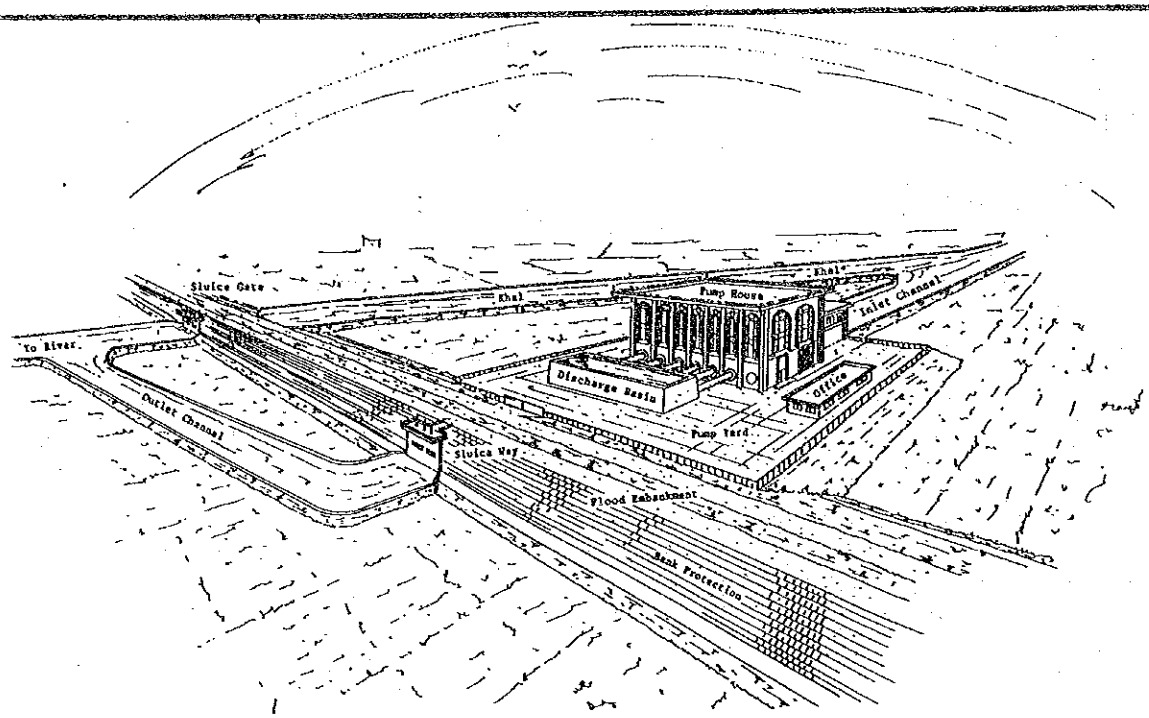
P.5 Pumping Station (Q=25.6 m3/s)



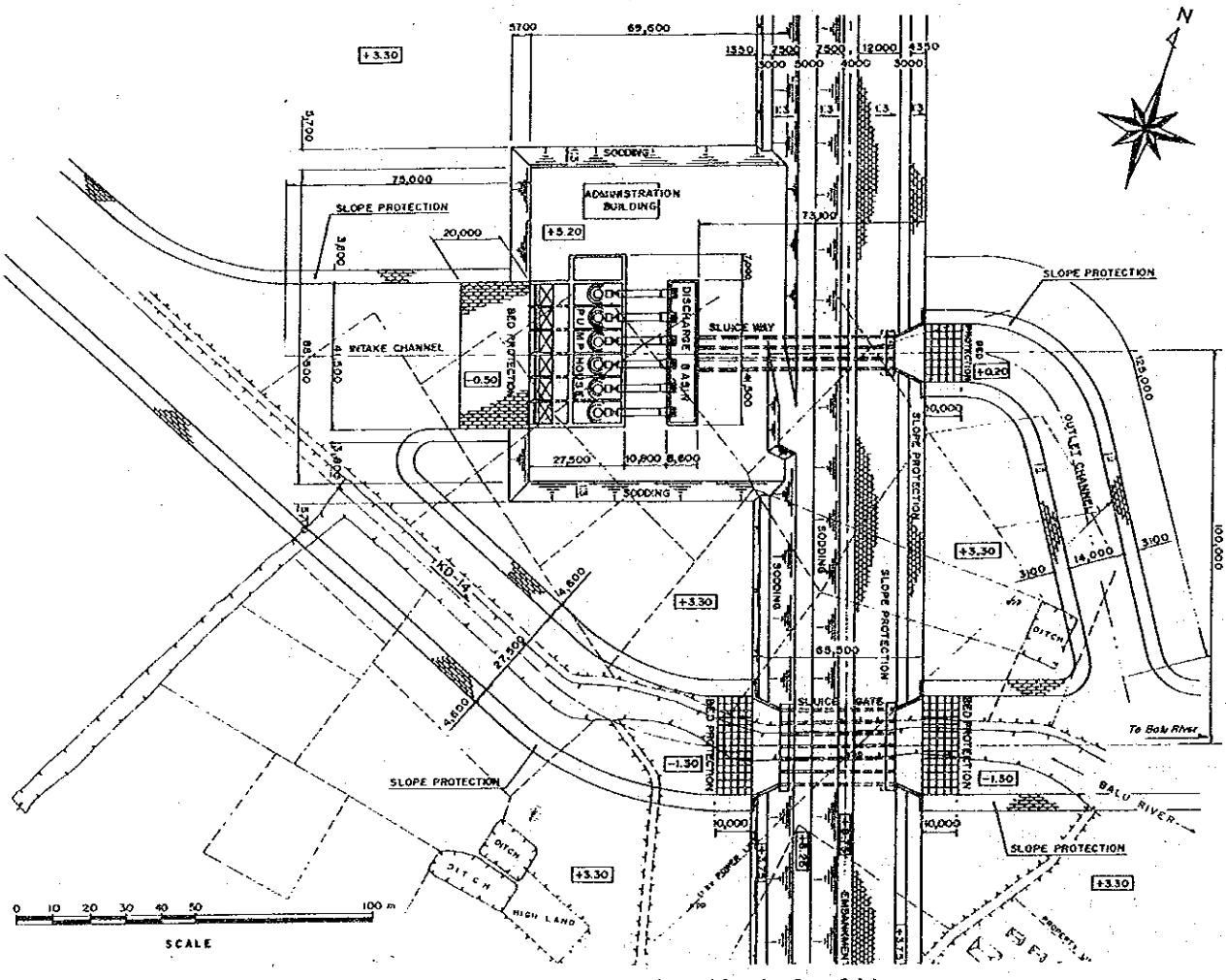
P.6 Pumping Station (Q=54.6 m3/s)

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

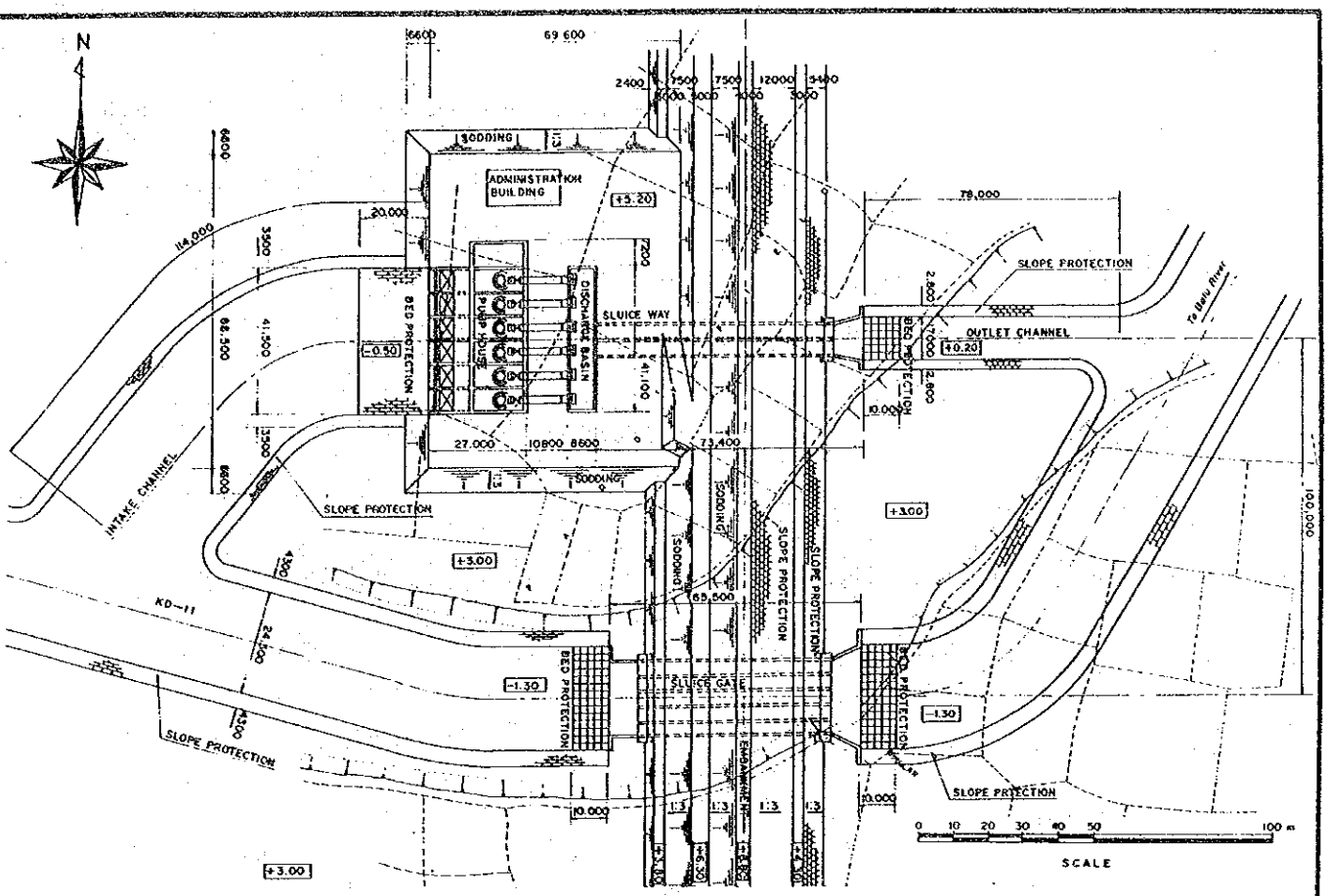


Perspective of Pumping Station

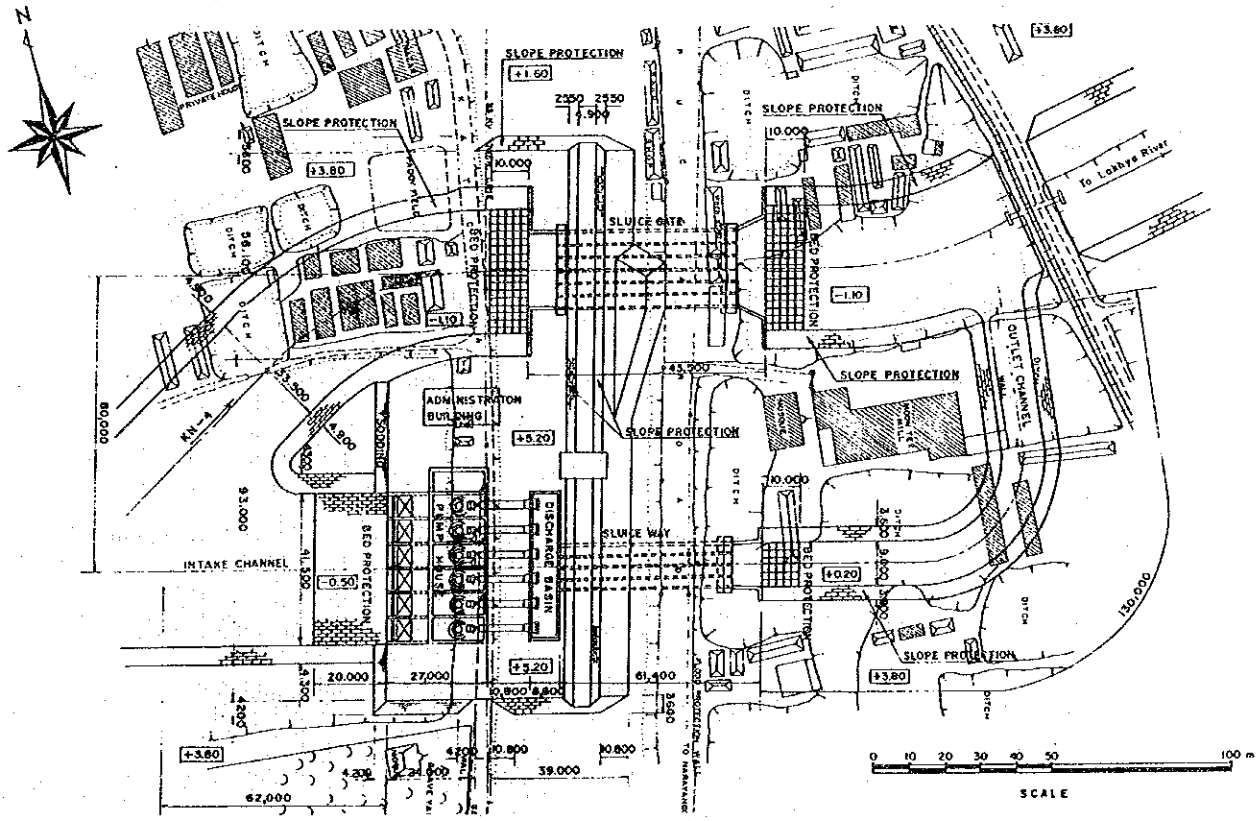


P.7B Pumping Station (Q=47.2 m3/s)

FIG. F.4.3(2)	LAYOUT OF PROPOSED P7B PUMPING STATION



P.7A Pumping Station (Q=53.1 m3/s)



P.11 Pumping Station (Q=50.2 m3/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

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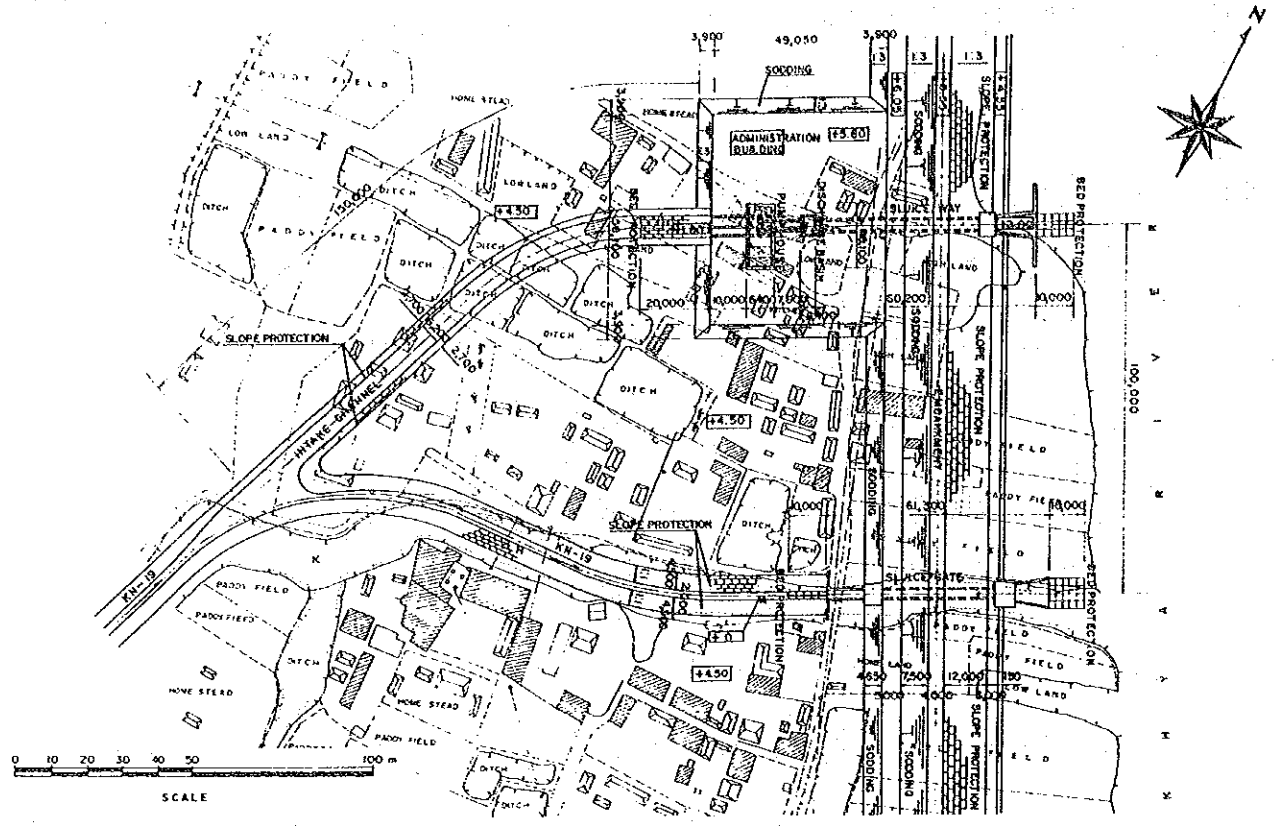
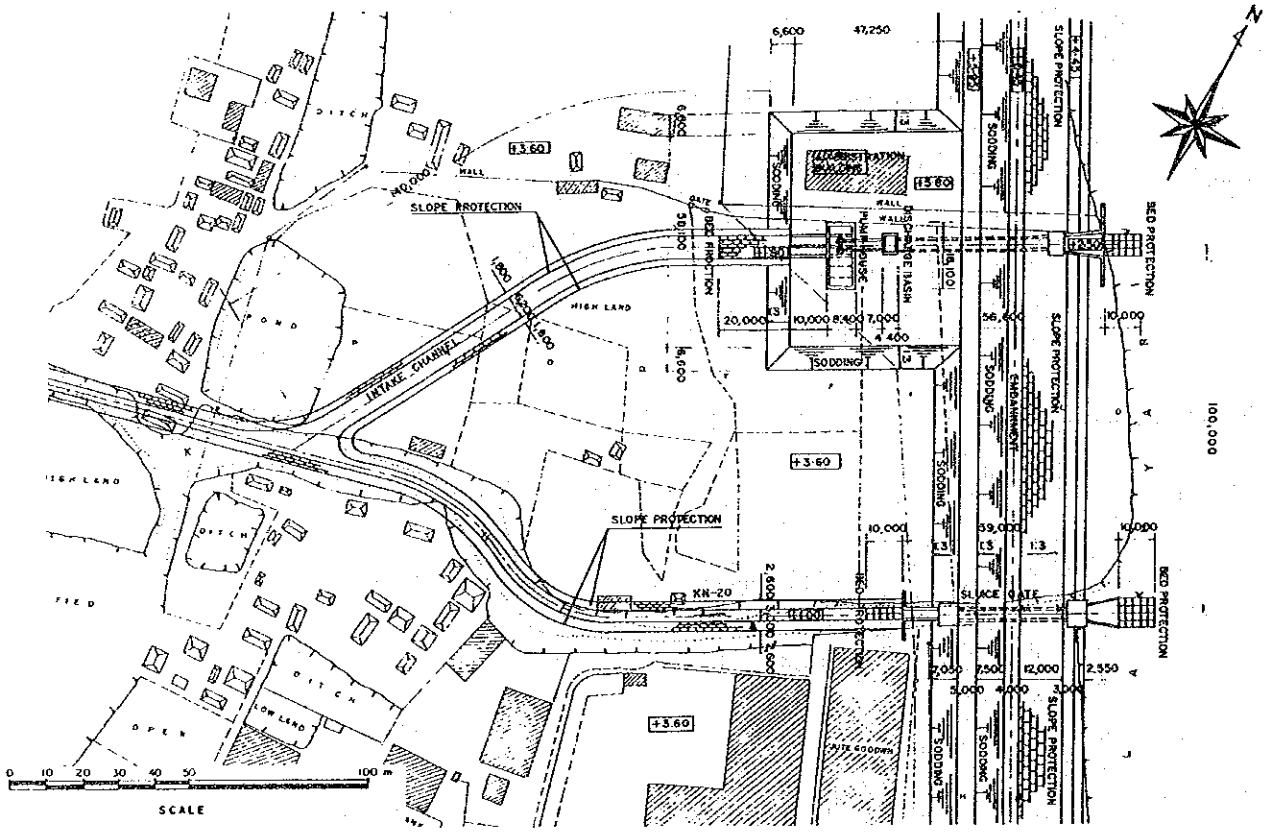


P.12 Pumping Station (Q=2.0 m3/s)

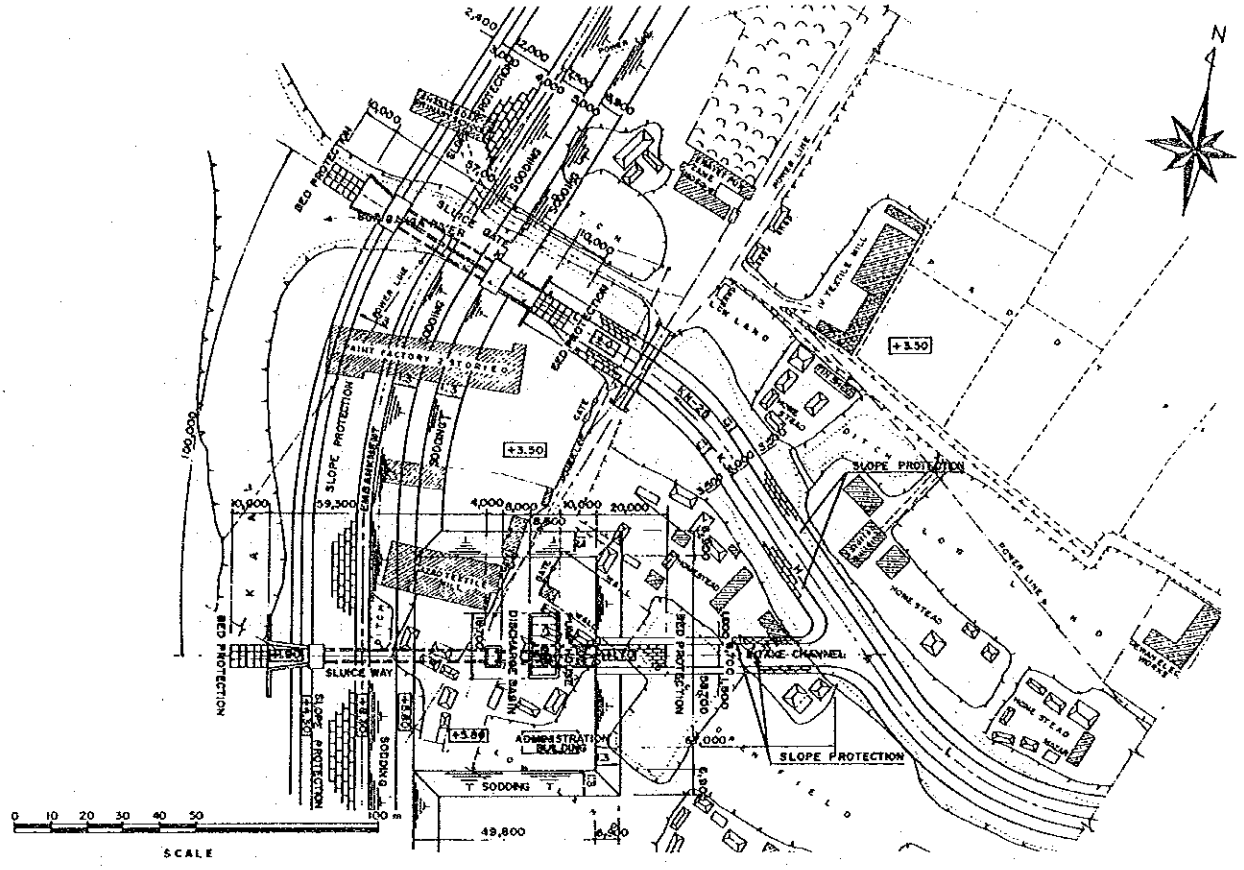


P.13 Pumping Station (Q=2.2 m3/s)

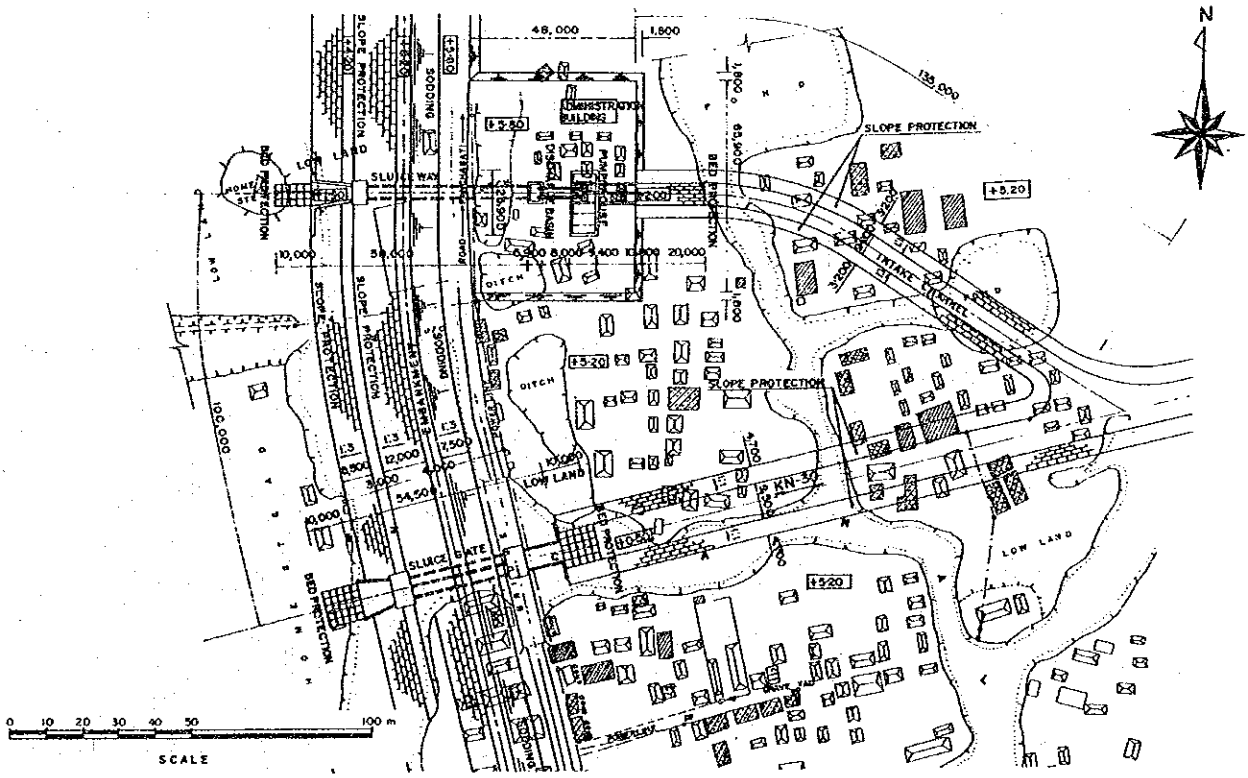
FIG. F.4.3(4) LAYOUT OF PROPOSED P12 AND P13 PUMPING STATIONS

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

JICA



P.14A Pumping Station (Q=2.7 m3/s)

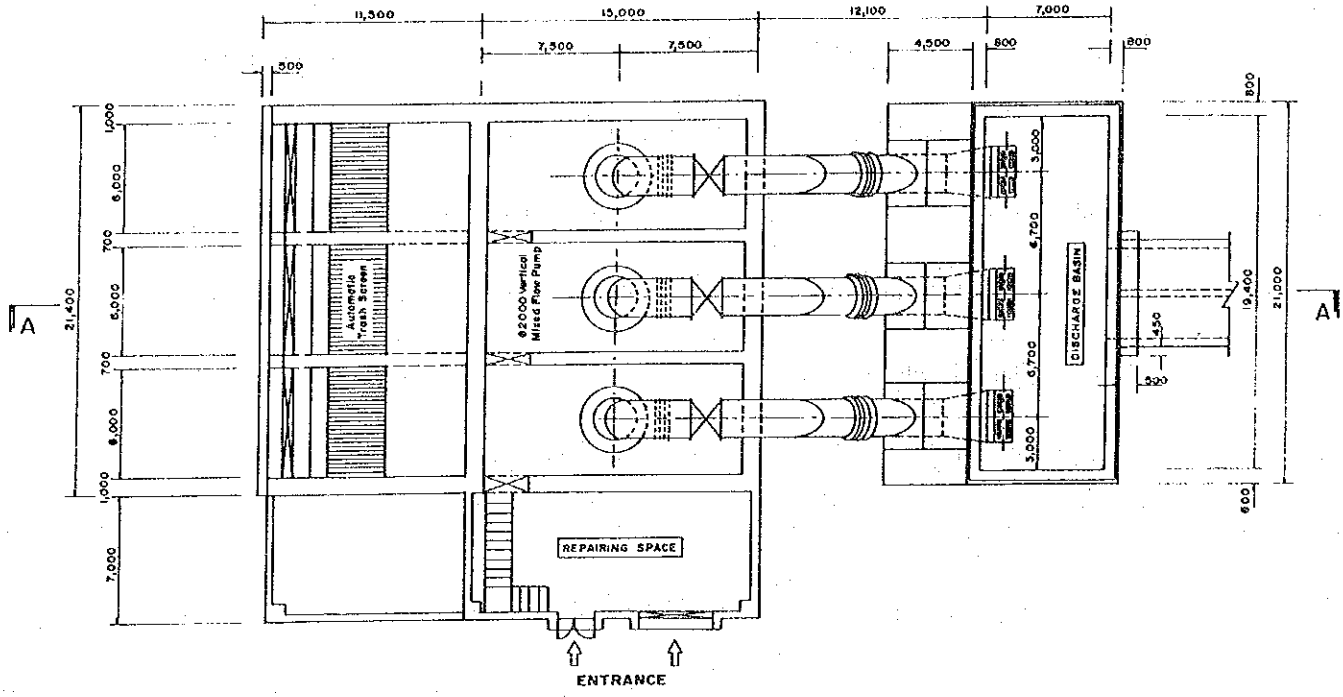


P.14B Pumping Station (Q=5.3 m3/s)

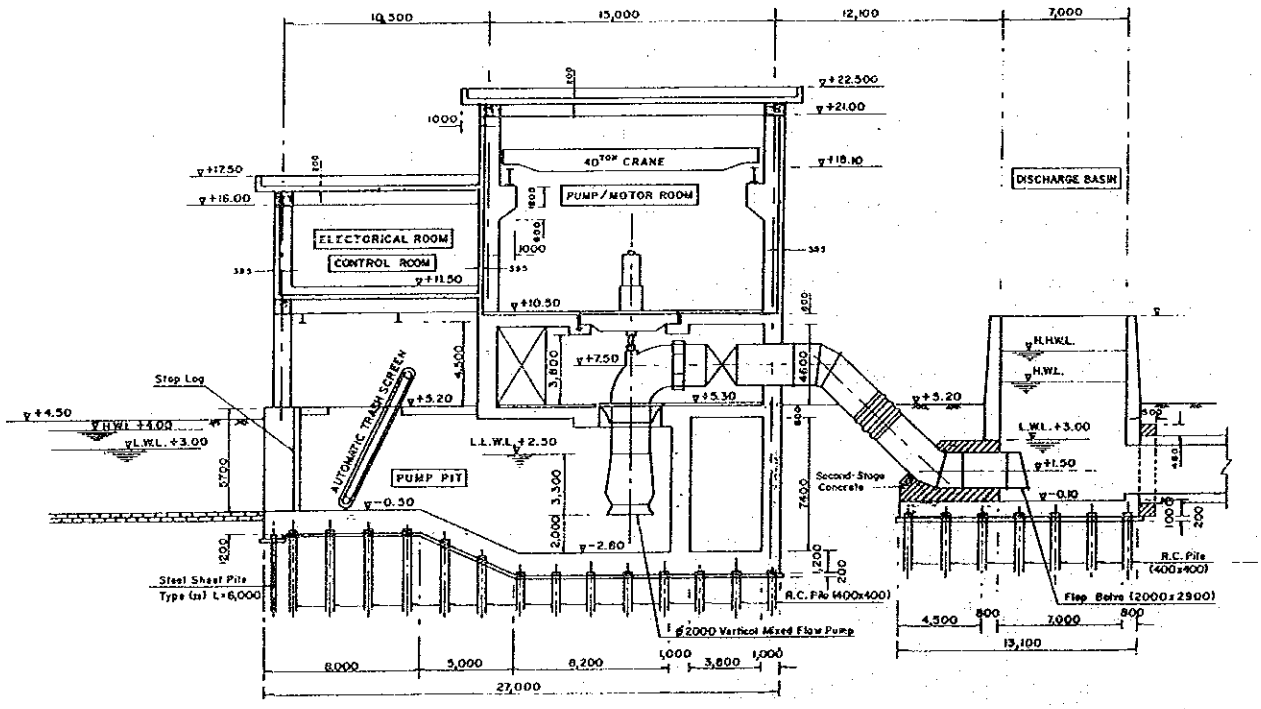
FIG. F.4.3(5) LAYOUT OF PROPOSED P14A AND P14B PUMPING STATIONS

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

JICA

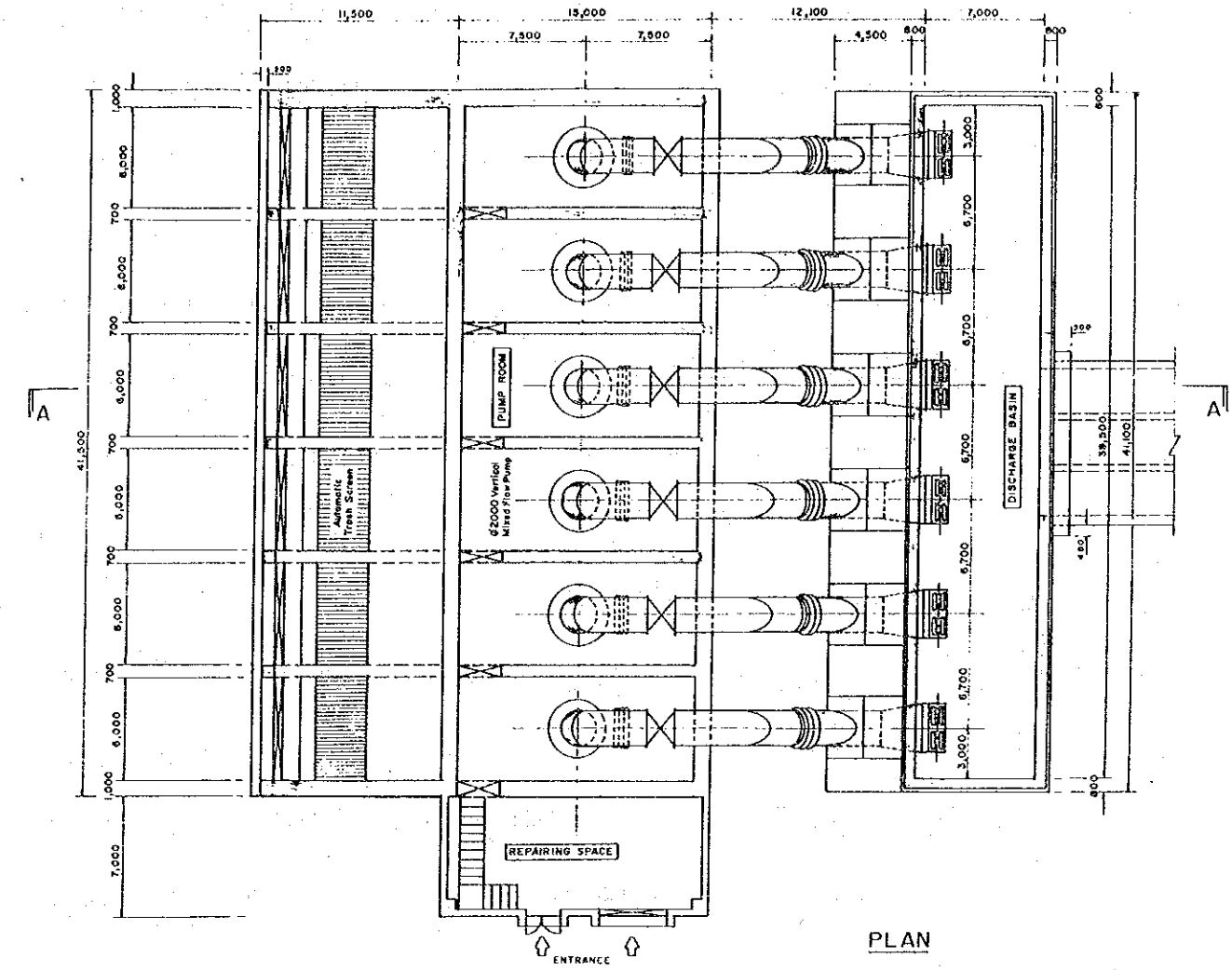


PLAN



SECTION : A-A

FIG. F.4.4(1) TYPICAL DESIGN OF PROPOSED 25 M^3/S CLASS PUMPING STATION (P5)



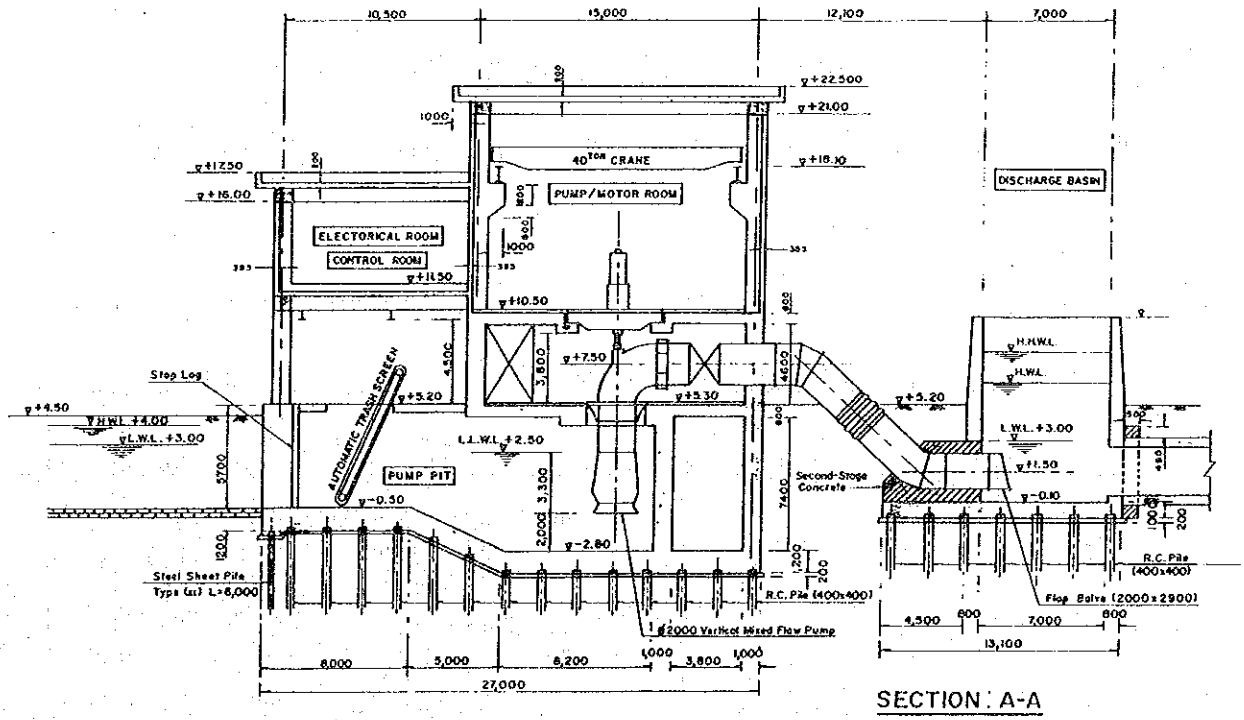
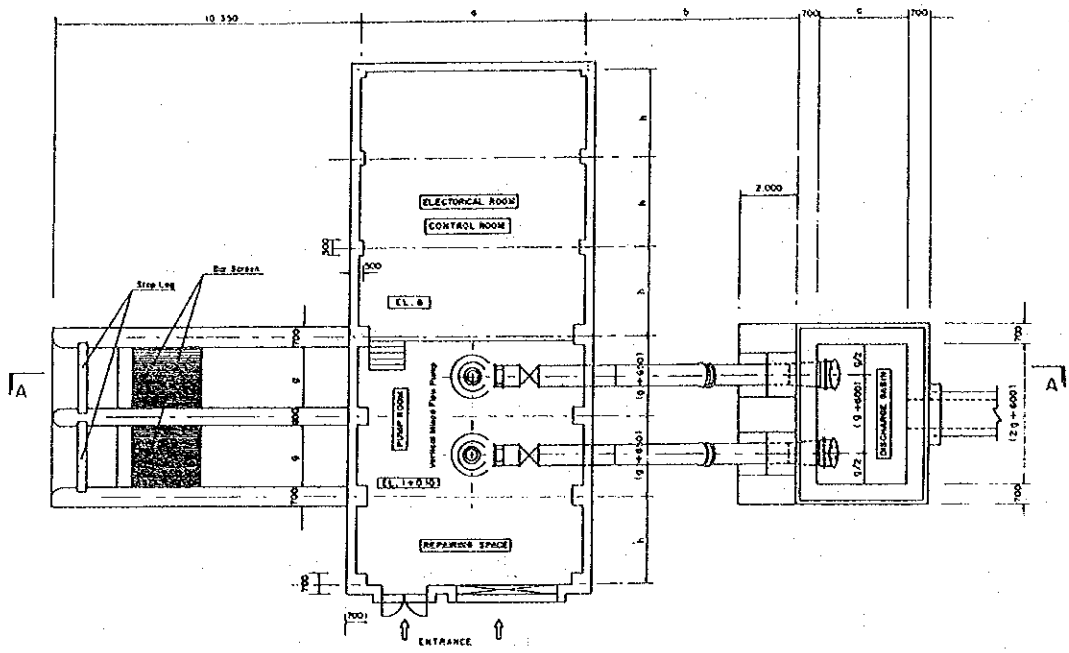
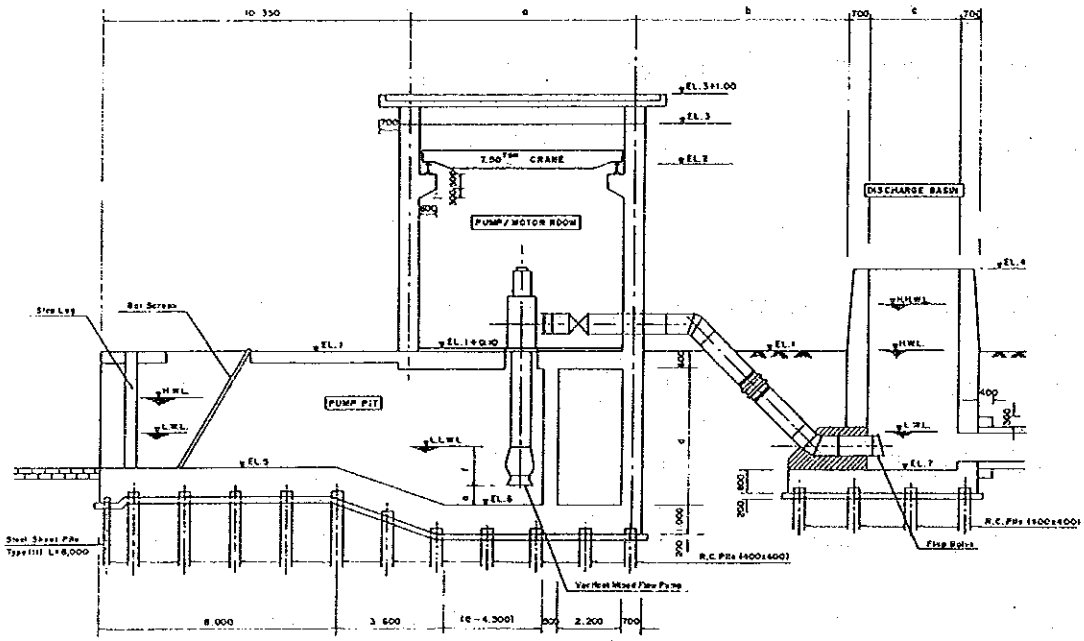


FIG. F.4.4(2) TYPICAL DESIGN OF PROPOSED 50 M^3/S CLASS PUMPING STATION (P6, P7A, P7B AND P11)



PLAN



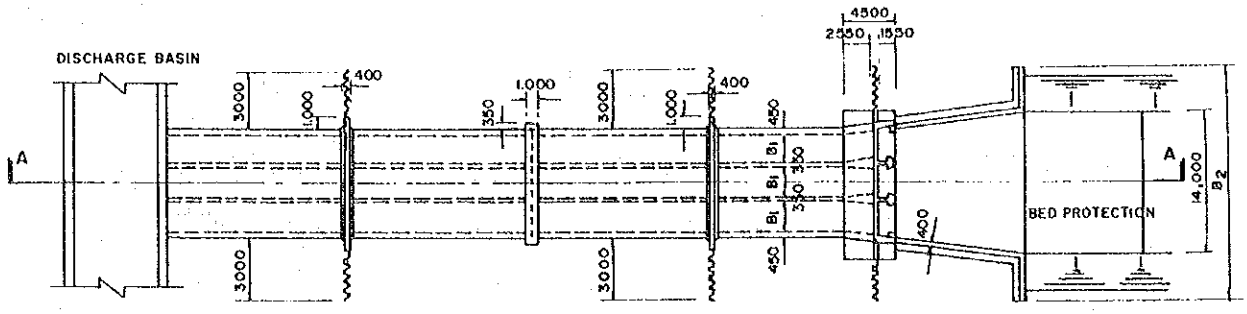
SECTION: A-A

Main Feature of Pump Station

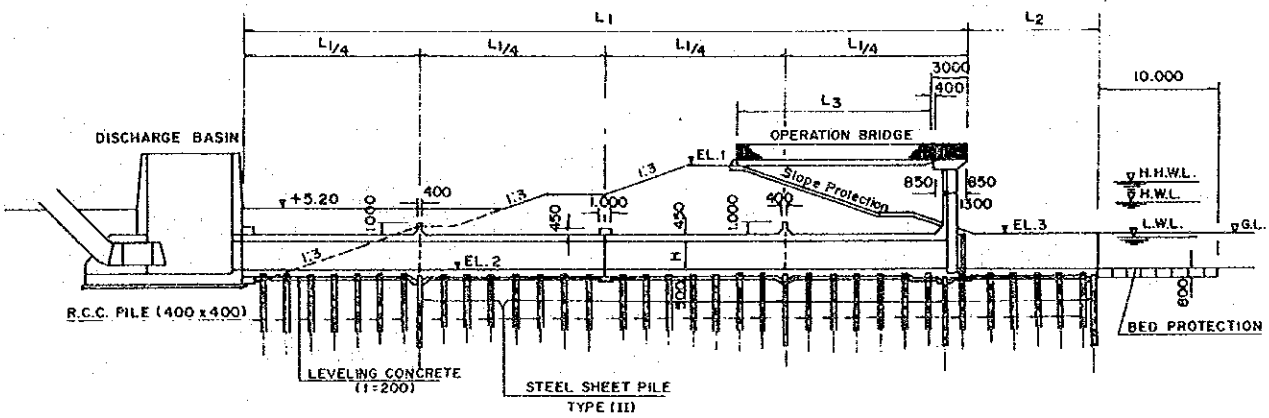
Pump No.	Demension (mm)								Elevation							
	a	b	c	d	e	f	g	h	EL.1	EL.2	EL.3	EL.4	EL.5	EL.6	EL.7	EL.8
P.12	7,700	7,000	3,000	4,700	700	1,300	2,100	3,000	+5.80	+11.70	+13.10	+8.55	+1.80	+0.50	+1.70	+7.00
P.13	7,700	7,000	3,000	4,200	700	1,300	2,100	3,000	+5.80	+11.70	+13.10	+8.45	+1.80	+1.00	+2.20	+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^3/S ~ 5 M^3/S CLASS PUMPING STATION (P12, P13, P14A AND P14B)

PLAN



SECTION A-A

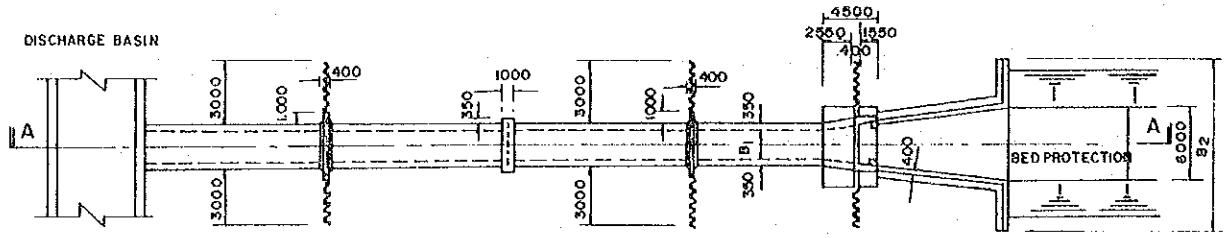


Main Feature of Sluice Way

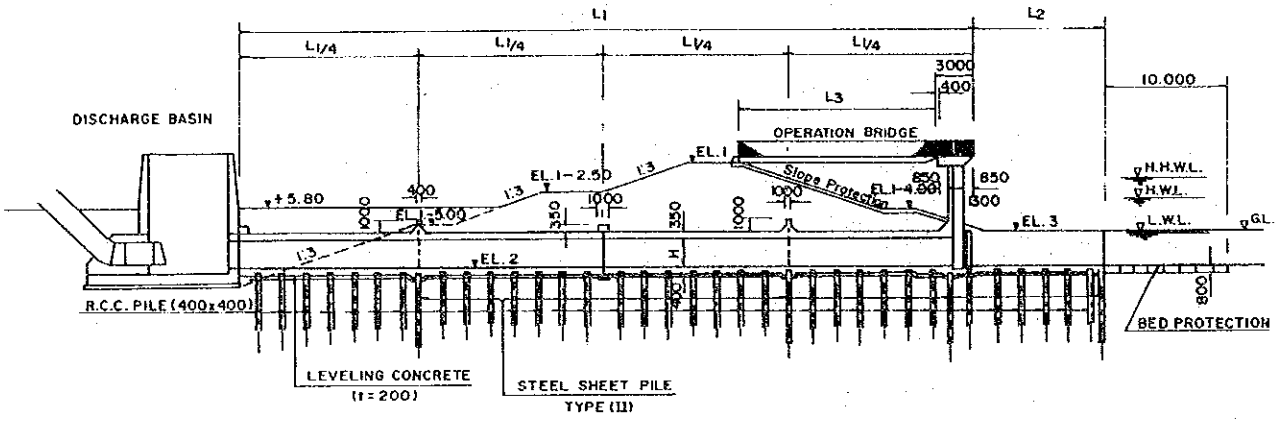
Pump No.	Culvert				Outlet		0.Bridge	Elevation		
	B1 (mm)	H1 (mm)	L1 (mm)	n (Nos.)	B2 (mm)	L2 (mm)	L3 (mm)	EL.1	EL.2	EL.3
P.5	2,300	2,300	62,000	2	19,000	14,700	14,850	+9.35	+0.20	+1.70
P.6	2,700	2,700	61,200	3	20,000	14,000	14,800	+9.10	+0.20	+2.20
P.7A	2,700	2,700	60,000	3	21,600	13,400	14,500	+8.80	+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^3/S ~ 50 M^3/S CLASS PUMPING STATION (P5, P6. P7A, P7B AND P11)

PLAN



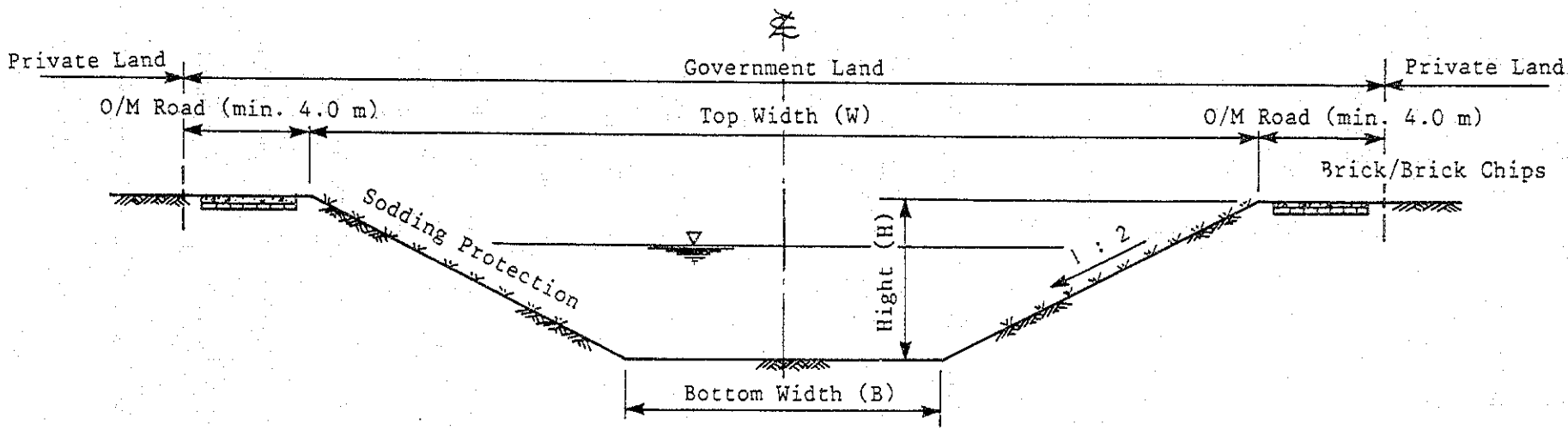
SECTION A–A



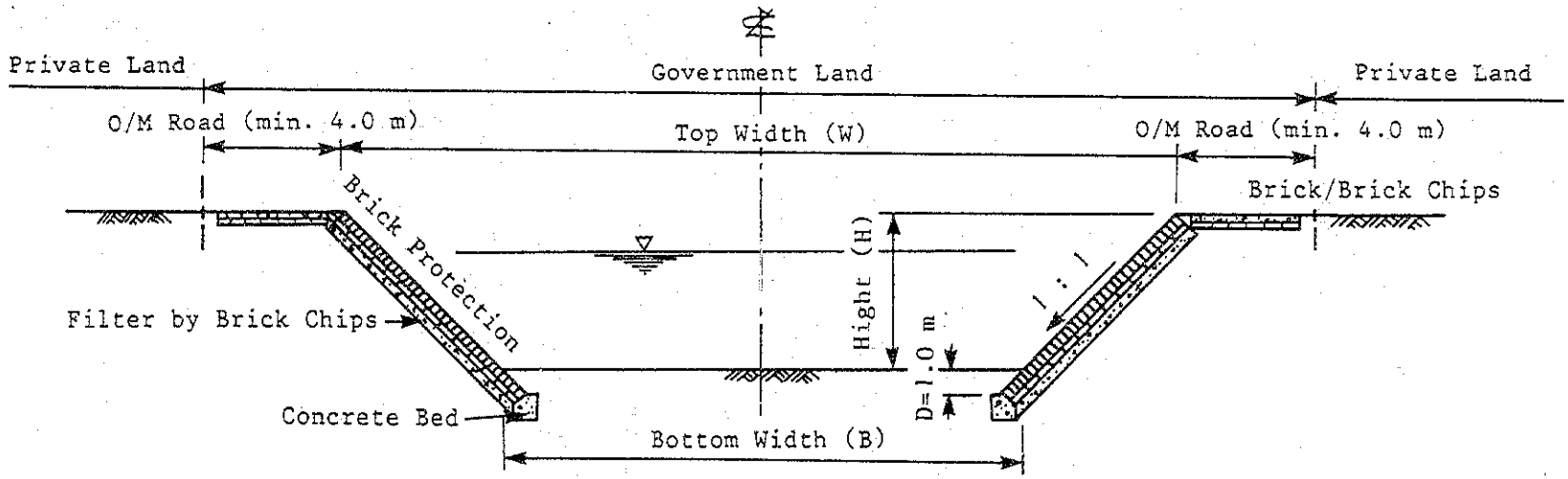
Main Feature of Sluice Way

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^3/S ~ 5 M^3/S CLASS PUMPING STATION (P12, P13, P14A AND P14B)



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	

JICA

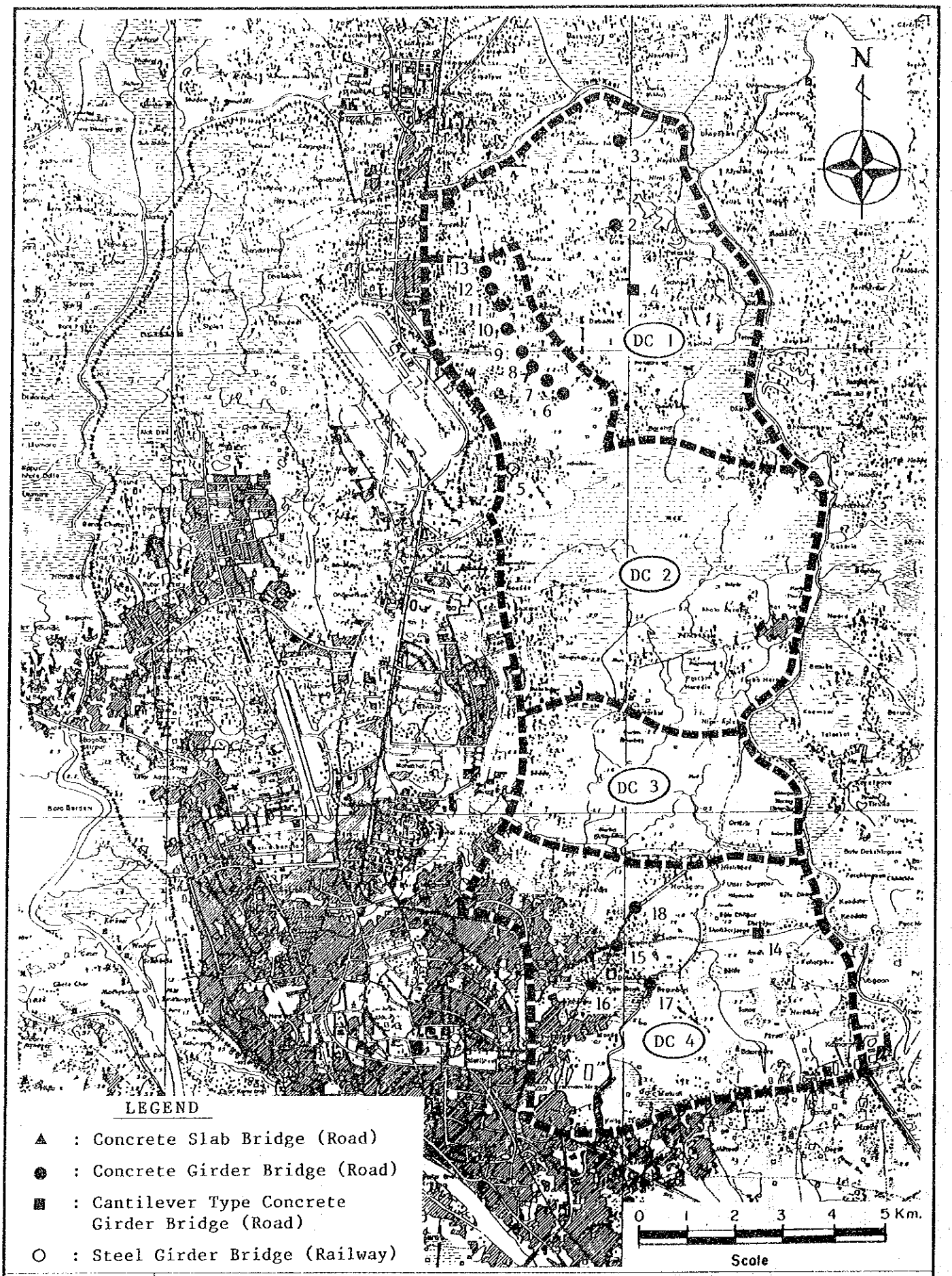


FIG. F.5.2(1) LOCATION OF PROPOSED BRIDGES : GREATER DHAKA EAST

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

JICA

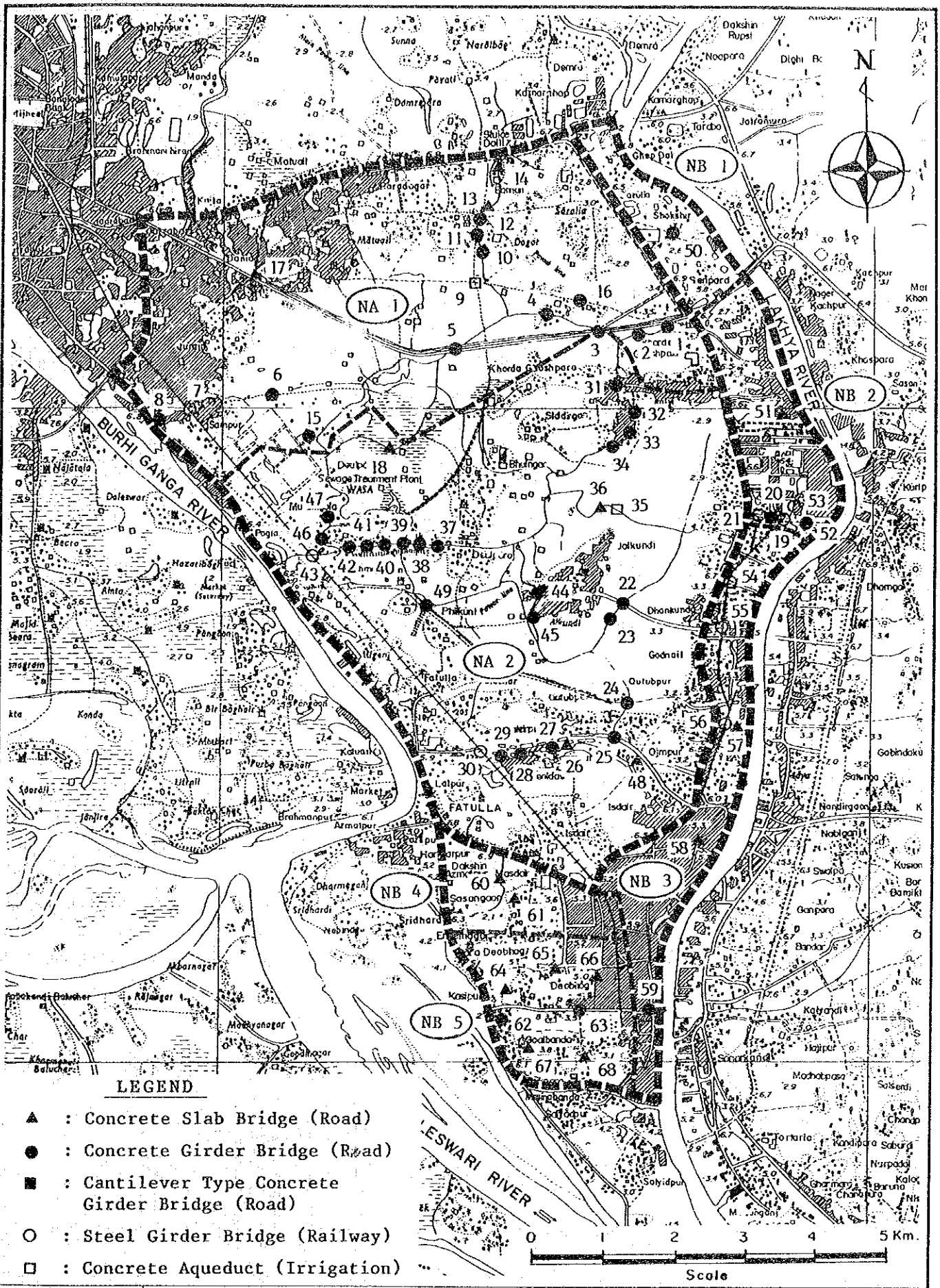
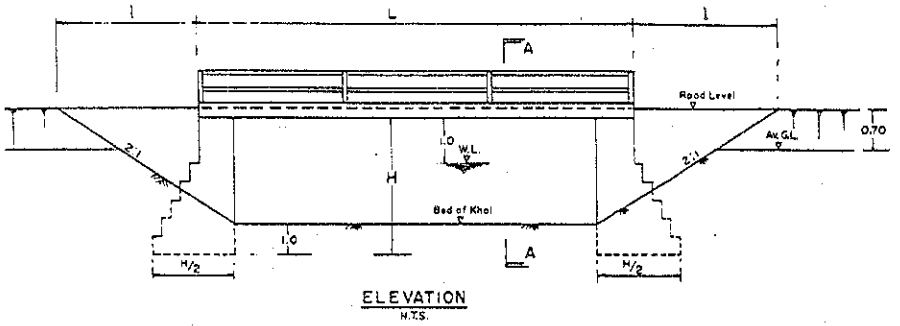


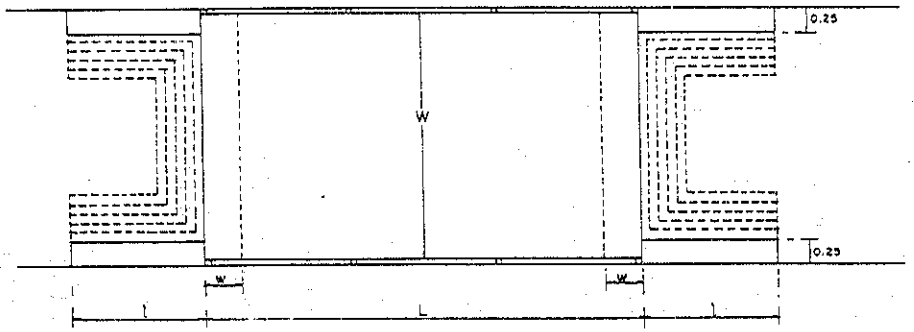
FIG. F.5.2(2) LOCATION OF PROPOSED BRIDGES AND AQUEDUCT : DND AND NARAYANGANJ WEST

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

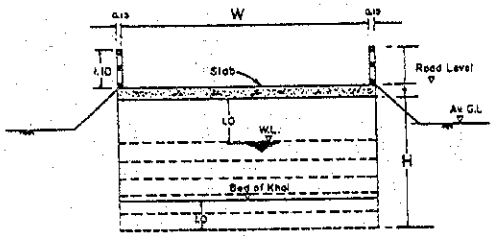
JICA



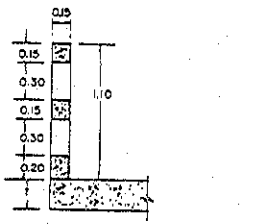
ELEVATION
N.T.S.



PLAN
N.T.S.

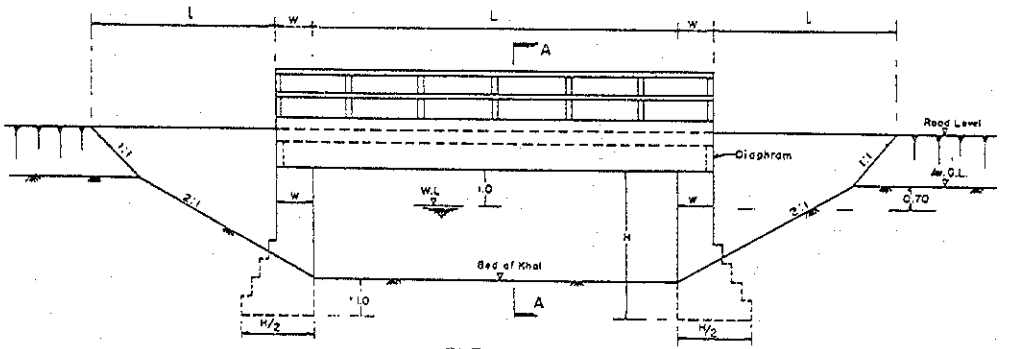


SECTION A-A
N.T.S.

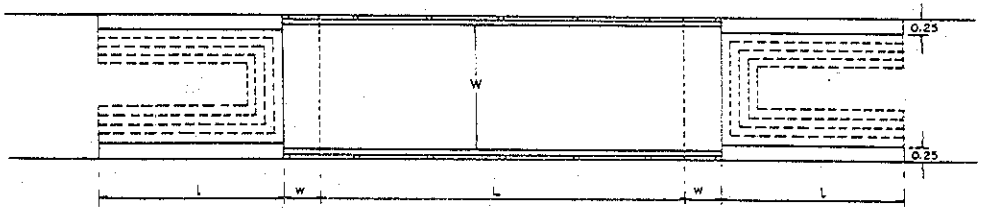


DETAILS OF RAILING BAR & POST
N.T.S.

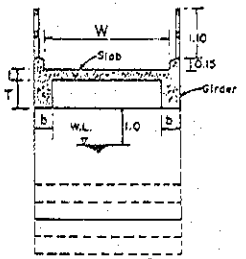
TYPE (1) : CONCRETE SLAB BRIDGE
(Span : Blow 5.0 m)



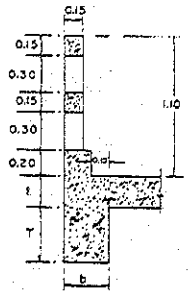
ELEVATION
N.T.S.



PLAN
N.T.S.



SECTION A-A
N.T.S.



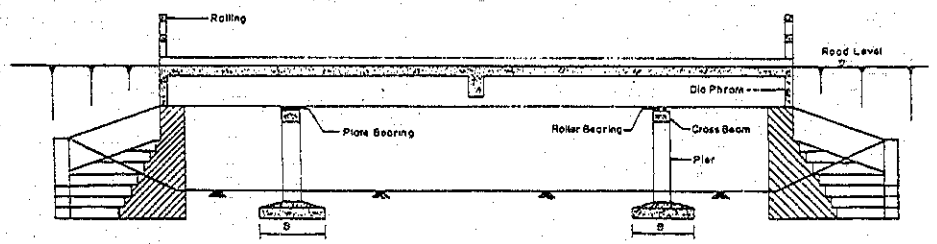
DETAILS OF RAILING BAR & POST
N.T.S.

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

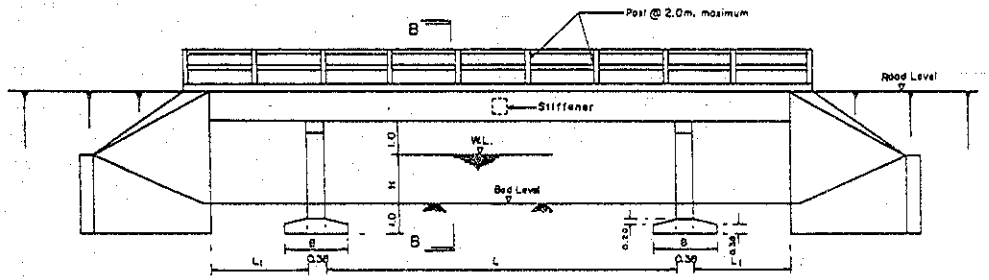
FIG. F.5.3(1) TYPICAL DESIGN OF PROPOSED BRIDGE (1)

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

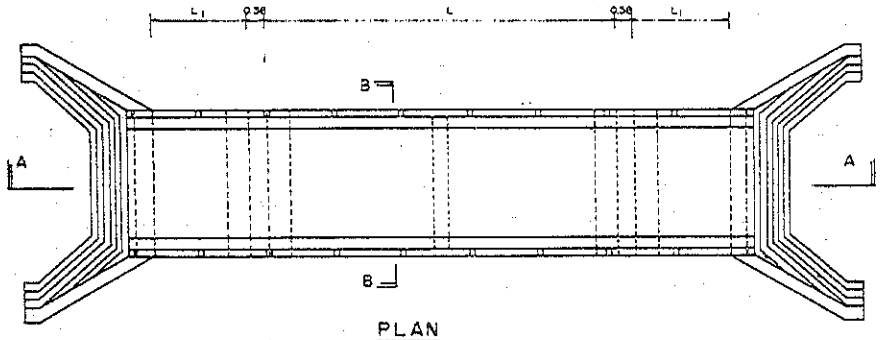
JICA



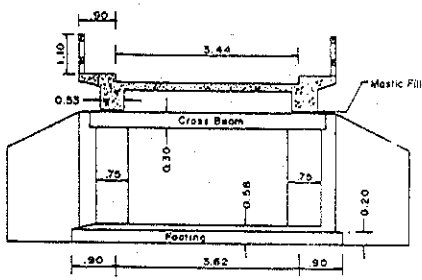
SECTION : A-A
N.T.S.



ELEVATION
N.T.S

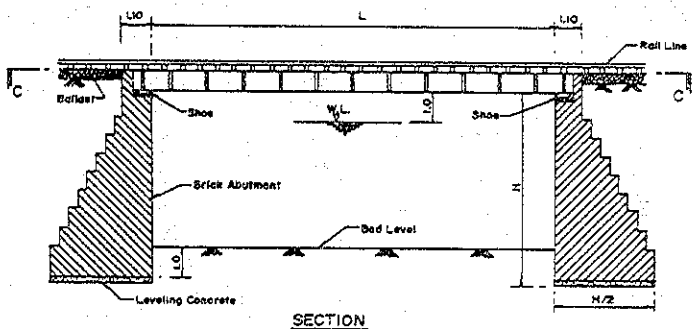


PLAN



SECTION : B-B
N.T.S.

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



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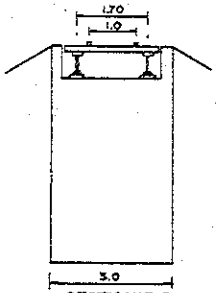

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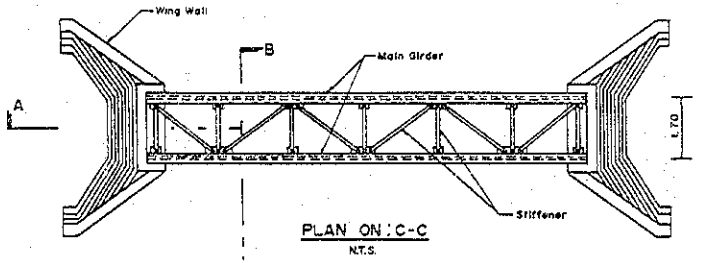
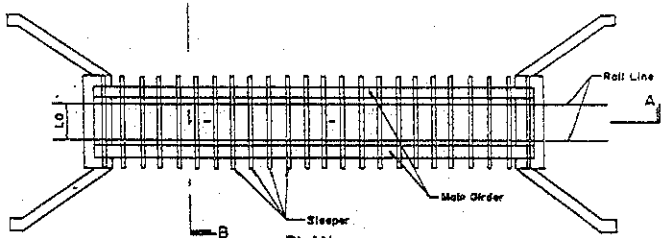


PLAN ON : C-C
N.T.S.



PLAN
N.T.S.

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.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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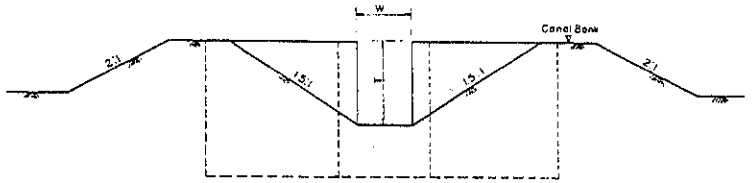
AQUEDUCT



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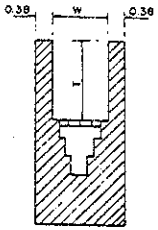

SECTION: B-B
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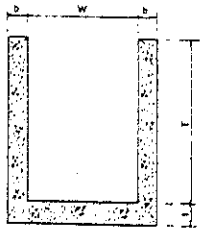
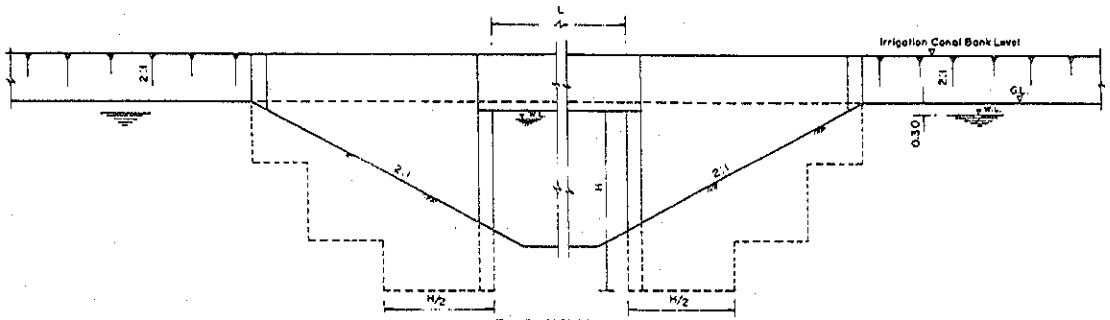


SECTION: A-A
N.T.S.



ELEVATION
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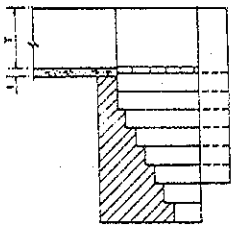
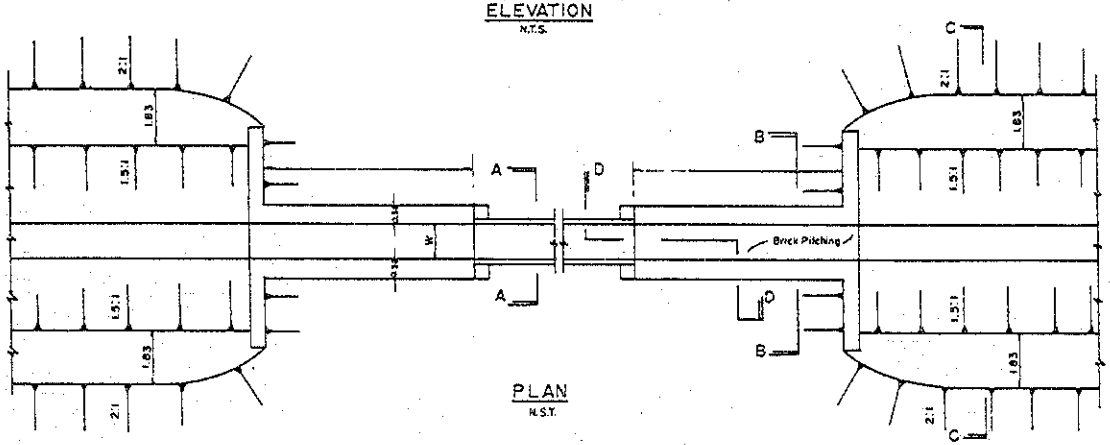


SECTION: D-D
N.T.S.



PLAN
N.S.T.

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

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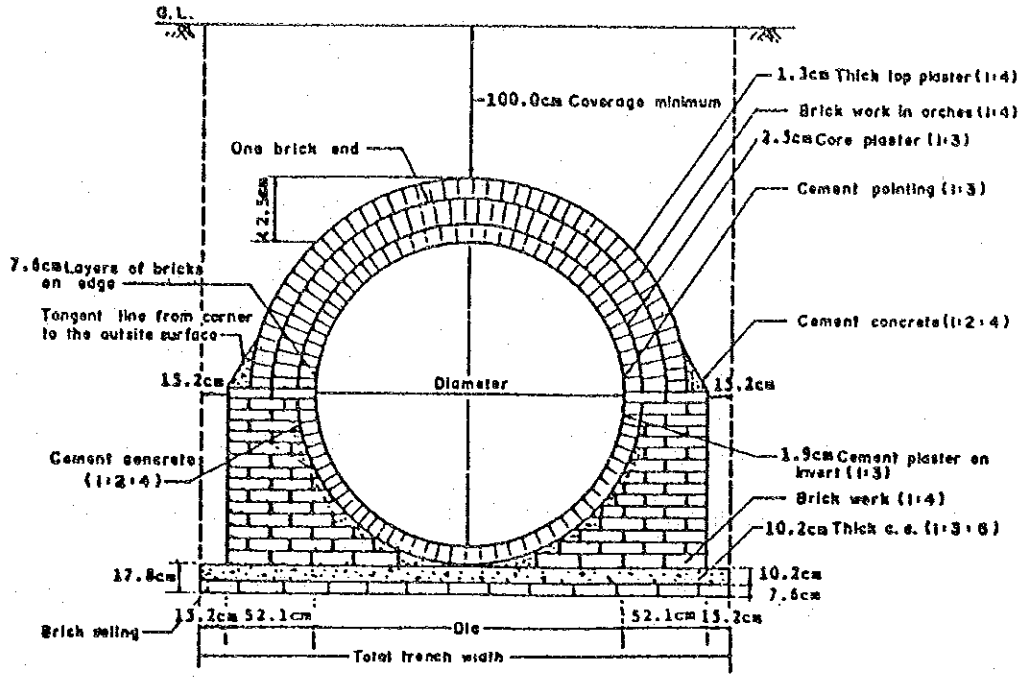
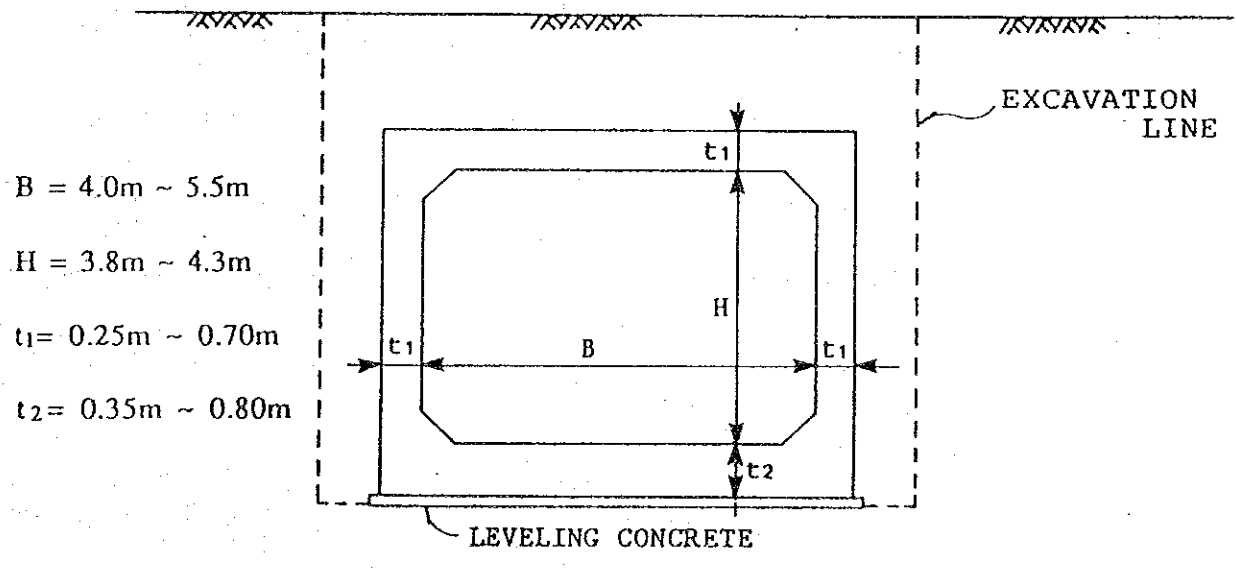


TYPE (1) : BRICK PIPE (Blow ϕ3,000 m/m)



B = 4.0m ~ 5.5m

H = 3.8m ~ 4.3m

t_1 = 0.25m ~ 0.70m

t_2 = 0.35m ~ 0.80m

TYPE (2) : SINGLE BOX CULVERT

FIG. F.5.5 | TYPICAL DESIGN OF PROPOSED TRUNK DRAIN

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.

(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.

(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.

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),

(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^3/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

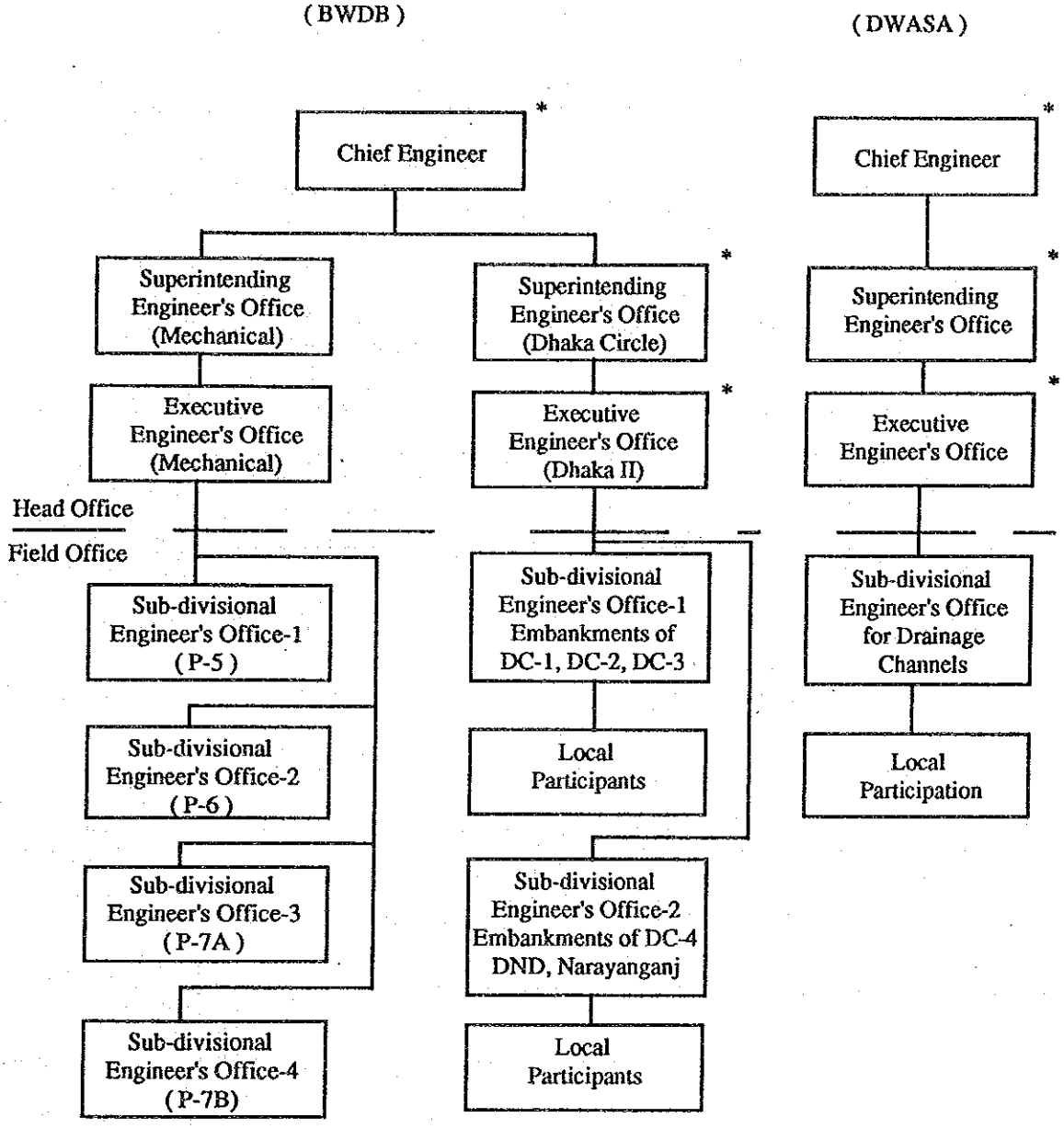
		Executive Engr's Office	Sub-divisional Engr's Office
1.	Executive Engineer	1	-
2.	Sub-divisional Engineer	1	1
3.	Sub-Assistant Engineer	1	2
4.	Accounts Assistant Cum Clerk	1	1
5.	LDA Cum Typist	1	1
6.	Line Cleaner	-	4
7.	Driver	-	1
8.	Sweeper	-	1
9.	MLSS cum Messanger	1	2
10.	Night Guard	-	1
	Total :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

Note: 1. Annual expenses

Executive engr's office : Tk. 516,800

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

Required O&M Organization for Greater Dhaka East



Note : * Existing Office

FIG. G.1	REQUIRED O&M ORGANIZATION FOR GREATER DHAKA EAST

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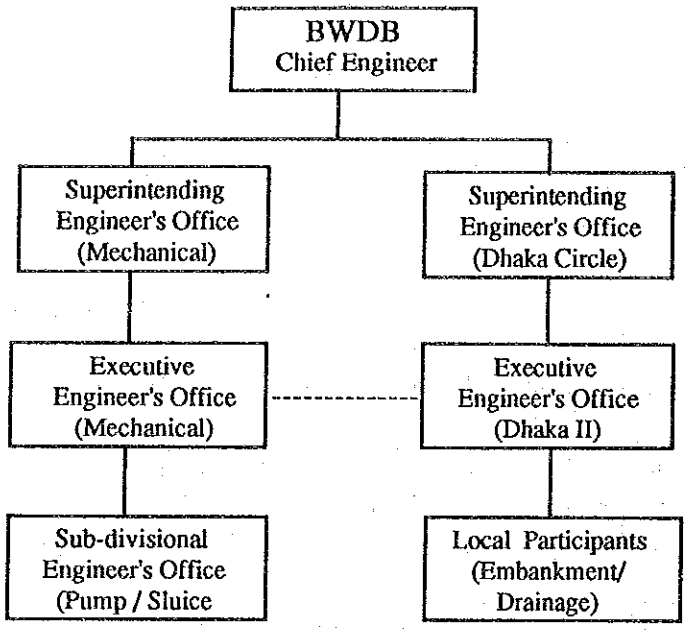
O&M Organization for DND



O&M Organization for Narayanganj West

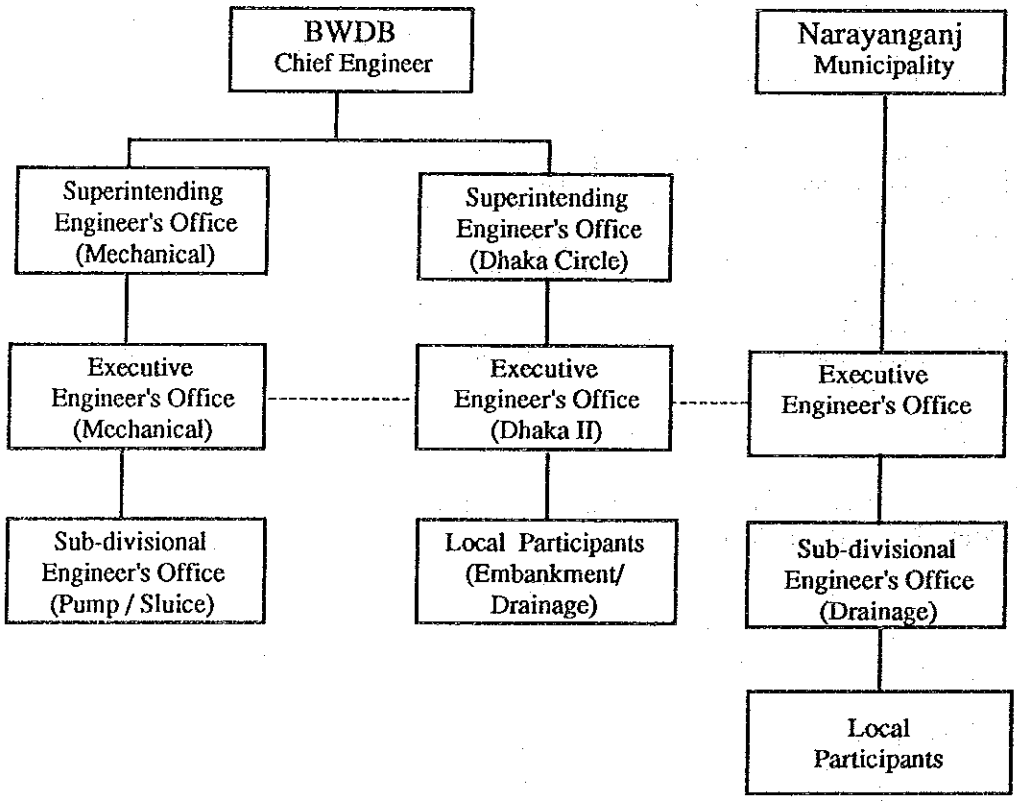


FIG. G.2 O&M ORGANIZATION FOR DND AND NARAYANGANJ WEST

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

JICA

SUPPORTING REPORT H
CONSTRUCTION PLAN, COST ESTIMATE AND IMPLEMENTAITON 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
   a. Embankment
   b. Flood Wall
   c. Sluice Gate
   d. Related Structures

2) Storm Water Drainage
   a. Pump Station
   b. Khal Improvement
   c. Bridge & others

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.

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, reparing 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 paling. 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.

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 refering 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 refered 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 m3/s)	1	1.4
Sub-divisional Engr's Office (BWDB) for Pump-(47 to 54 m3/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/m3/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.

(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.

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.