6.4 River Facilities Design

6.4.1 River Training and River Bank Protection Works

6.4.1.1 River Bank Erosion

Investigation results (see Appendix) of Phase-I, revealed that during the course of time the river bank erosion caused the Rupsa river to shift to the east and the south. However, at the proposed site and along bridge route 1-3, no major change is observed between 1973 - 1990. This fact was confirmed through local interview hearing survey.

However, the side of the east bank must be protected because the deepest point is close to this side. Moreover, there is a tendency of erosion spreading to the east bank side, according to the analysis using the topographic map and the satellite image from the 1960s to the present. The causes of the river bank erosion are the wind, the waves generated by winds shipping vessels, apart from river velocity.

Especially, the sides of the east bank needs the protection works but there is no necessity for protection works on the side of the west bank except in the range, which is expected to be influenced by the construction of the pier.

6.4.1.2 Selection of the Type of River Training Works for River Bank Erosion

In the Rupsa river, the guide bank, a kind of river training works, whose basic objective is to constrict waterway, is unnecessary for the following reasons;

1) River width and waterway are almost stable, and both sides of the river are nearly parallel and almost straight.

2) Length of proposed bridge from abutment to abutment is more than the bank to bank distance of river, and the flow towards the bridge is not oblique.

However, because there is a possibility for small-scale slope erosion, it is planned to construct revetment as a slope protection measure.

In designing the revetment, importance is paid to keep existing topography of bank as much as possible, in order to prevent discontinuity of river bank and become easy to connect with upstream and downstream non-constructed bank.

The entire plan is described below.

(1) Construction area of revetment

From hydraulic consideration, length of protection work for the bridge comes about 140m on either bank.

Revetment is planned as 50m length each of upstream and downstream from proposed bridge construction point along the bank, and 50m width from the bank because transverse slope of river bed turns flat at about 50m from the bank.

Actual revetment length in the deep water portion is planned as 75m upstream and 75m downstream, so that chances of erosion in the deep water portion which is 40m away from the river bank can be encountered.

(2) Revetment alignment

Straight line is recommended as alignment in order to prevent erosion and sedimentation due to a curve of structural line.

Construction area and alignment of revetment are shown in Fig. 6.4.1.

(3) Structure of revetment

Considering the ease of construction, economy and durability, cement concrete block (hereinafter referred to as "C.C.block") is proposed as revetment material. The sucking-up of fine materials of the river bank will be protected by laying properly selected geotextile filter cloth under C.C.blocks.

From point of view of existing topography and construction method, construction area is divided into the following 3 sections and structure of revetment is planned in each section.

1) Road embankment slope

From crest of embankment to intersection of steep slope and gentle slope.

2) River bank up to L.W.L.

From intersection of steep slope and gentle slope to intersection of gentle slope and steep slope, which is an around point of contact of L.W.L.

3) Underwater section

From intersection of gentle slope and steep slope to channel bottom (50m from crest of embankment).

The division of cross section is shown in Fig. 6.4.2.

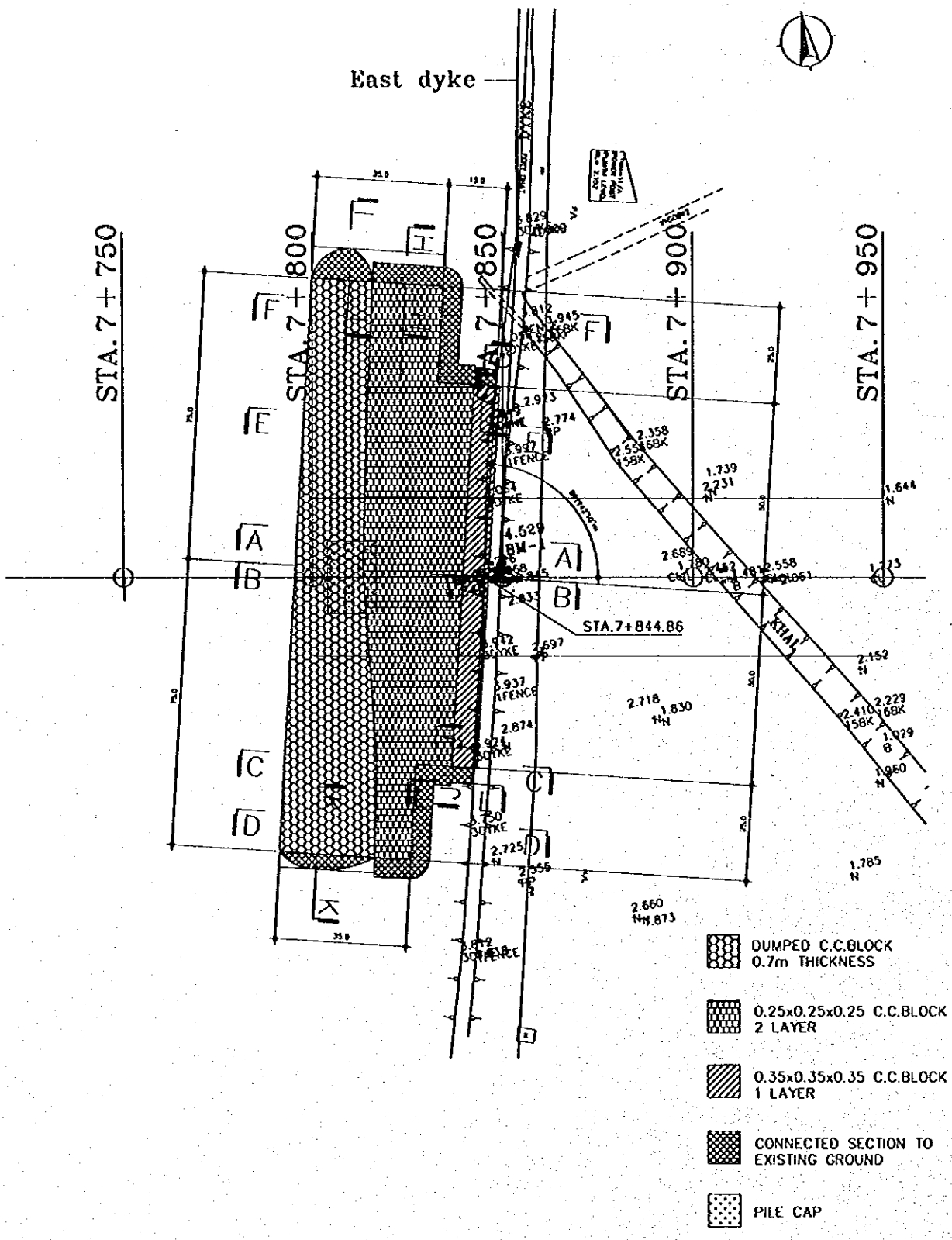


Fig. 6.4.1 Construction Area and Alignment of Revetment

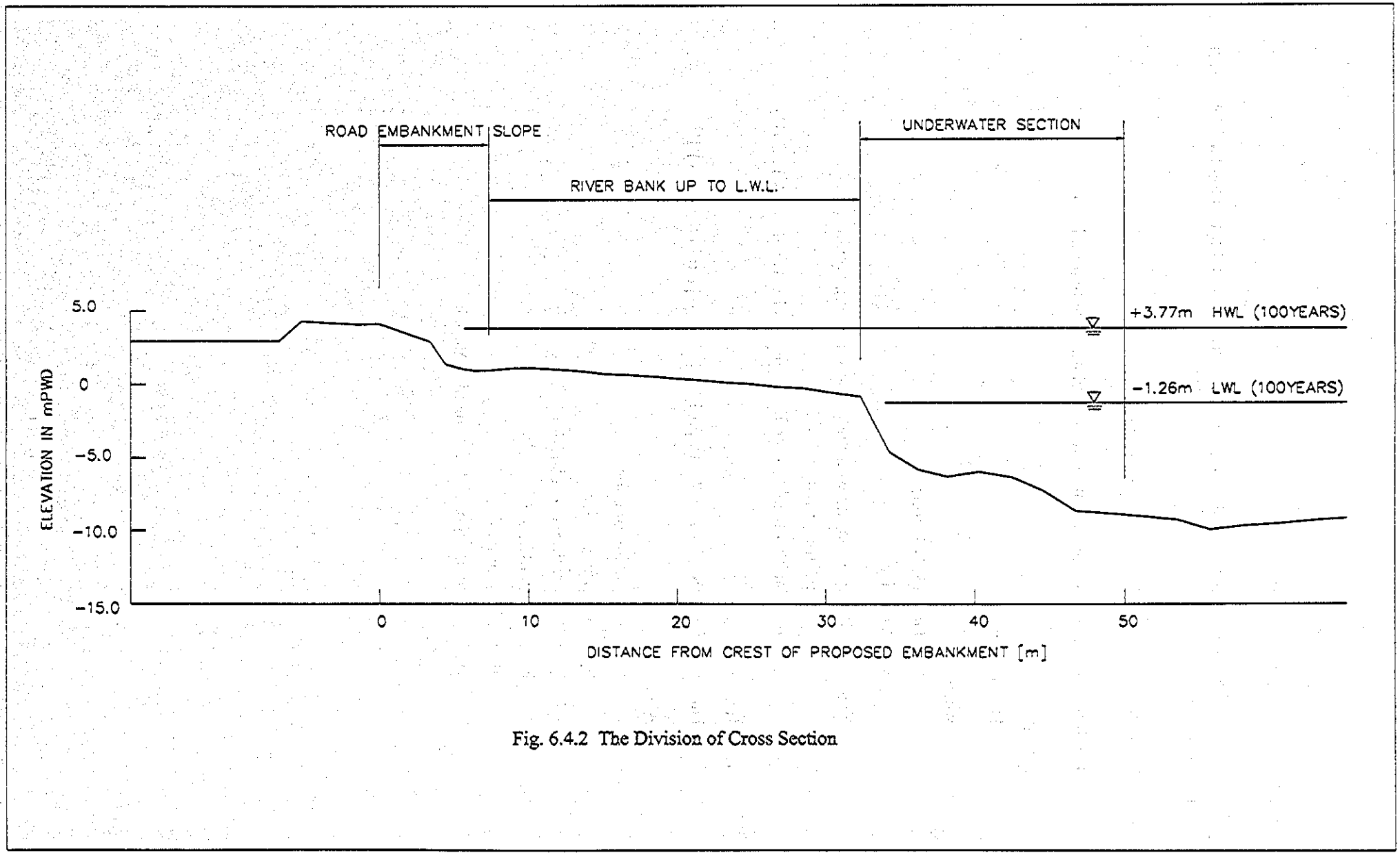


Fig. 6.4.2 The Division of Cross Section

6.4.1.3 Rip-Rap Material Size

The material size of rip-rap has been selected considering its stability against both stream velocity and waves.

(1) Revetment material size against stream velocity

The following two equations are used for calculating the material size.

i) Neil

$$D = 0.034V^2$$

where,

D : Diameter of stone

V : Velocity

Note: Neil's equation fits well under the following conditions;

Specific gravity = 2.65,

Bank slopes between horizontal and vertical = 1(V) : 2 (H)

ii) JMBA

$$Dn = 0.7V^2 / (2(Sg-1)g) \times 2 / [\log(6h/D)]^2 \times 1 / [1-(\sin \theta / \sin \phi)^2]^{0.5}$$

where,

Dn : Dimension of cube

Sg : Specific gravity

g : Gravitational acceleration

h : Depth of water

θ : Slope of bank

ϕ : Angle of repose of revetment materials

The result is shown below;

	Velocity [m/s]	Slope of bank	Diameter of material [m]
Neil	2.30	1:2	0.180
	1.68	1:2	0.095
JMBA	2.30	1:2	0.206
	2.30	1:2.5	0.181
	2.30	1:3	0.170
	1.68	1:2	0.109
	1.68	1:2.5	0.096
	1.68	1:3	0.090

Note: 2.30 m/s is the maximum velocity of proposed bridge cross section, 1.68 m/s is mean velocity of the cross section, which is calculated by Manning equation.

(2) Revetment material size against waves

The following equation is used for calculating the material size.

・Pilarczyk

$$D = Hs / (Sg-1) \times 1 / \beta \times E^{1/2} / \cos\theta$$

where,

D : Cubic dimension
Hs : Significant wave height
Sg : Specific gravity
β : Strength coefficient, 3 for cubes and 2 for randomly dumped cubes
θ : Bank slope angle
E : Wave breaking parameter
$=1.25T/Hs^{0.5} \tan\theta$
T : Wave period (sec)

The result is shown below;

Slope of bank	Diameter of material [m]
1:2	0.197
1:2.5	0.170
1:3	0.152

Comparing the size of block/stone required against velocity and waves, 250x250x250mm/250mm in diameter is recommended.

6.4.1.4 Structure of Each Section

(1) Road embankment slope

Considering possible overtopping due to wave runup and wind setup, 350x350x350mm C.C.blocks are laid on one layer, on a geotextile underlayer.

(2) River bank up to L.W.L.

This section has a role of launching apron, when underwater section is eroded possibly. In addition, this section is under water during high tide almost all the year round. Therefore, laying two layers of 250x250x250mm C.C.blocks is recommended. Geotextile is hand placed under C.C.blocks.

(3) Under water section

Mixed sized C.C.Blocks are dumped as revetment material. Geotextile is installed using bamboo framework.

The mixed portion is described below.

300x300x300mm = 20%
250x250x250mm = 50%
200x200x200mm = 30%

Rip-rap thickness of this section should be 2 times the thickness of road embankment slope section since the C.C.blocks shall have to be laid under water and cannot be hand placed.

The structural drawing is shown in Fig. 6.4.3.

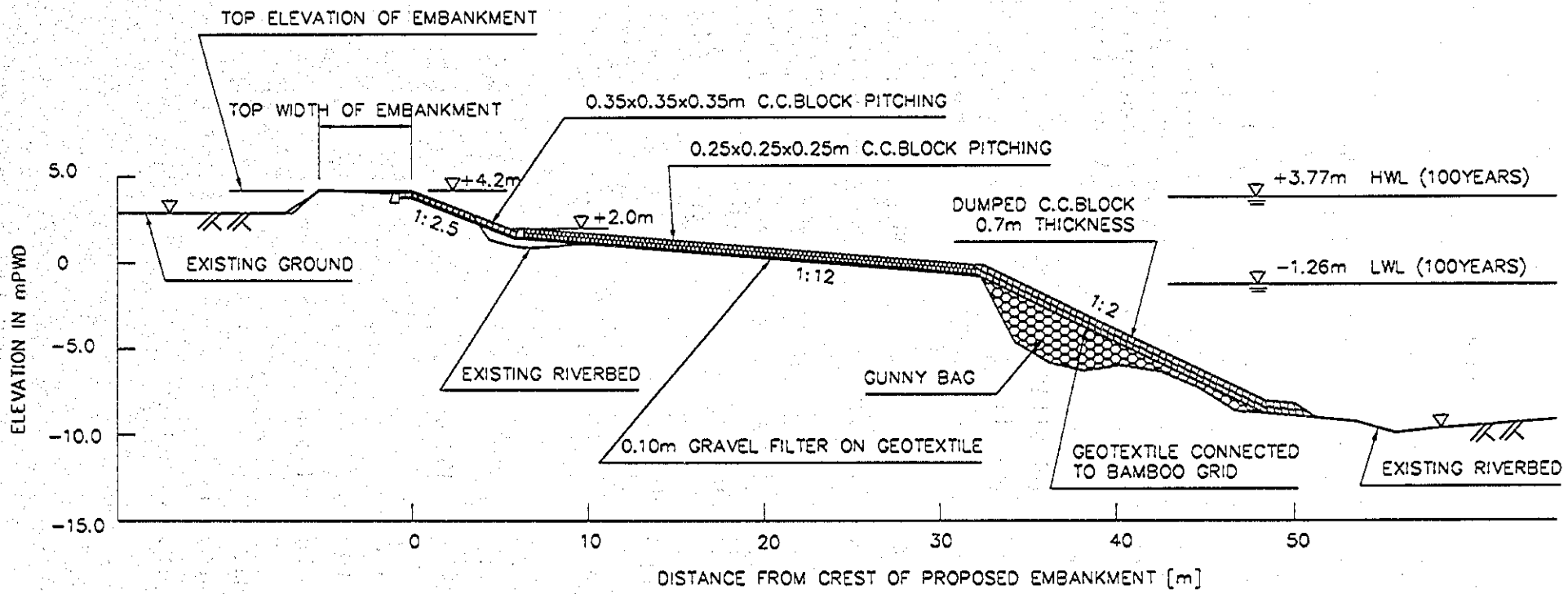


Fig. 6.4.3 Typical Cross Section of Revetment

6.4.2 Protection of Pier against Scouring

6.4.2.1 Bridge Pier Scour Depth

Pier scour depth can be determined using the following equations.

① Ishihara's method

$ds = (1.0 \sim 1.5)\, b$

$= 10.0 \sim 15.0$ m

ds :The scour depth which was measured as the scour from the river bed
b :Pier width (10 m)
H :Max water depth (13 m)
V :Average velocity (2.0 m/sec)

② Laursen's method

From figure $H/b = 13/10 = 1.3$

$ds/b = 1.6$ $ds = 16.0$m

③ Ogawa's method

$Fr = V / \sqrt{gH}$

$= 2.0 / \sqrt{9.8 \times 13} = 0.18$

From figure $ds/H = 0.55$

$ds = 0.55 \times 13$

$= 7.2$ m

④ Shen's method

$$ds/H = K\left[Fr^2\left(\frac{b}{H}\right)^3\right]^{1/3}$$

$$= 1.1\left[0.18^2\left(\frac{10}{13}\right)^3\right]^{1/3}$$

$= 0.47$

$ds/H = 0.47$

$ds = 13 \times 0.47 = 6.1$ m

⑤ Tarapore's method

$ds = 1.35b$

$= 1.35 \times 10 = 13.5$ m

⑥ Murakami's method

$ds = 1.45b$

$= 1.45 \times 10 = 14.5$ m

⑦ Andru's method

$ds/b = 0.8 \times H/b$

$ds = 0.8 \times 13 = 10.4$ m

⑧ Larras's method

$$ds = 1.05\ K \cdot b^{0.75}$$
$$= 1.05 \times 1 \times 10^{0.75} = 5.9\ m$$

⑨ Breusers's method

$$ds = 1.4 \times b = 1.4 \times 10 = 14.0\ m$$

⑩ Nail's method

$$ds/b = K(H/b)^{0.3}$$
$$= 1.0(13/10)^{0.3} = 1.08$$
$$ds = 10 \times 1.08 = 10.8\ m$$

⑪ Japan National Railway's method

$$ds/b = 1.6$$
$$ds = 1.6 \times 10 = 16.0\ m$$

From the above, maximum scour depth becomes about 16.0 m of Japan National Railway's method when the pier width is 10.0 m. Actually, three RC Bored Pile of 2.5 m diameter is constructed so that maximum scour depth becomes 8.0 m (1.6 × (2.5 × 2)=8.0 m). Therefore, 15.0 m from existing river bed should be considered as the maximum degradation of river bed, which is the value that includes 8.0 m of local scour depth by pier and 5.0 m of the natural degradation of river bed (Refer to Section 4.3.1.4).

6.4.2.2 Protection Works

Protection Works shall be conducted for all piers in the river except the pier of the eastern end in the river, which is situated in the revetment area and shall be protected by revetment.

(1) Protection Works for MP2 Pier

MP2 pier is western-most of the piers constructed in the river. The area around MP2 pier is up to L.W.L., so that C.C.Blocks and Geotextile are able to be hand placed.

This area is under water during high tide almost all the year round. Laying two layers of 250x250x250mm blocks is recommended.

(2) Protection Works for MP3-6 Piers

Mixed sized C.C.Blocks are dumped as pier protection material.

The mixed portion is described below.

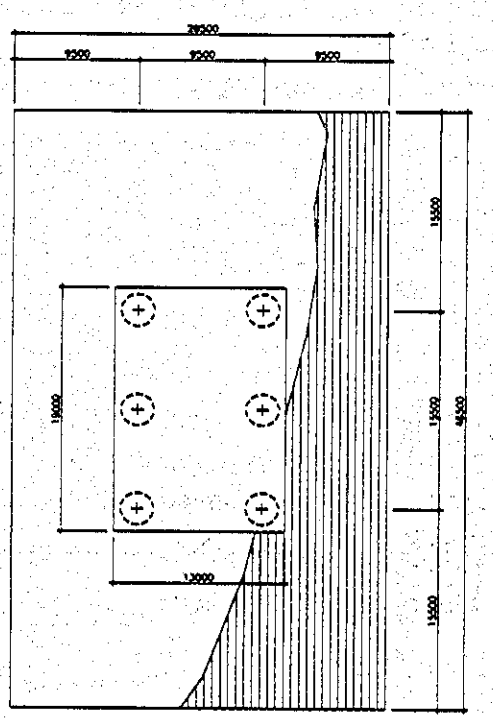
300x300x300mm = 20%

250x250x250mm = 50%

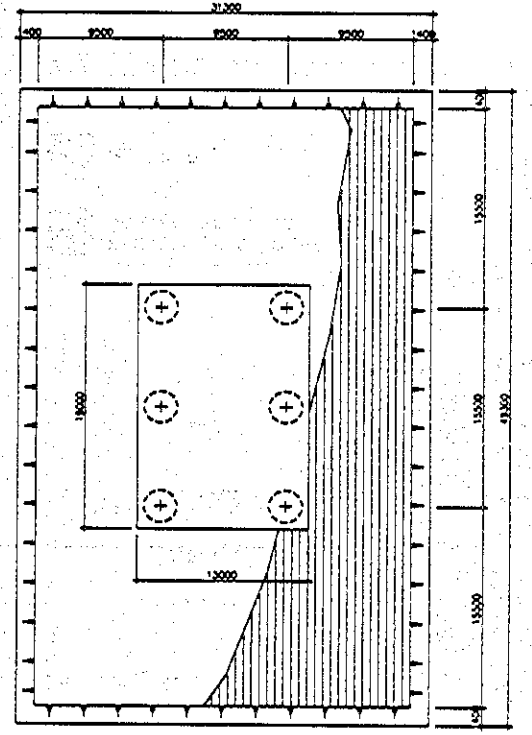
200x200x200mm = 30%

Thickness of C.C.blocks is recommended as the same thickness, 0.7m, of underwater section of revetment since the C.C.blocks shall have to be dumped.

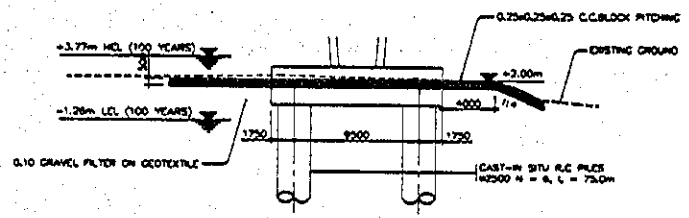
The structural drawing is shown in Fig. 6.4.4-5.



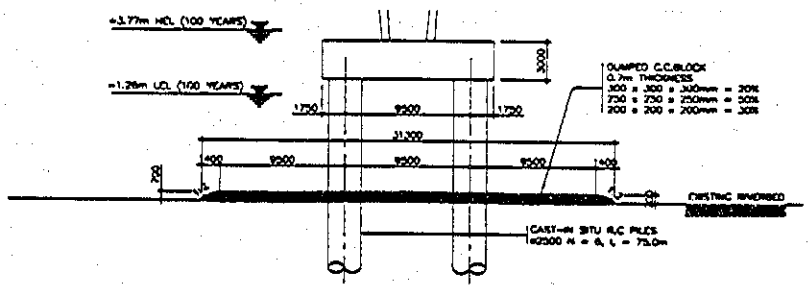
PLAN
(MP2)



PLAN
(MP3–MP6)



ELEVATION
(MP2)



ELEVATION
(MP3–MP6)

Fig. 6.4.4 Protection of Pier against Scouring

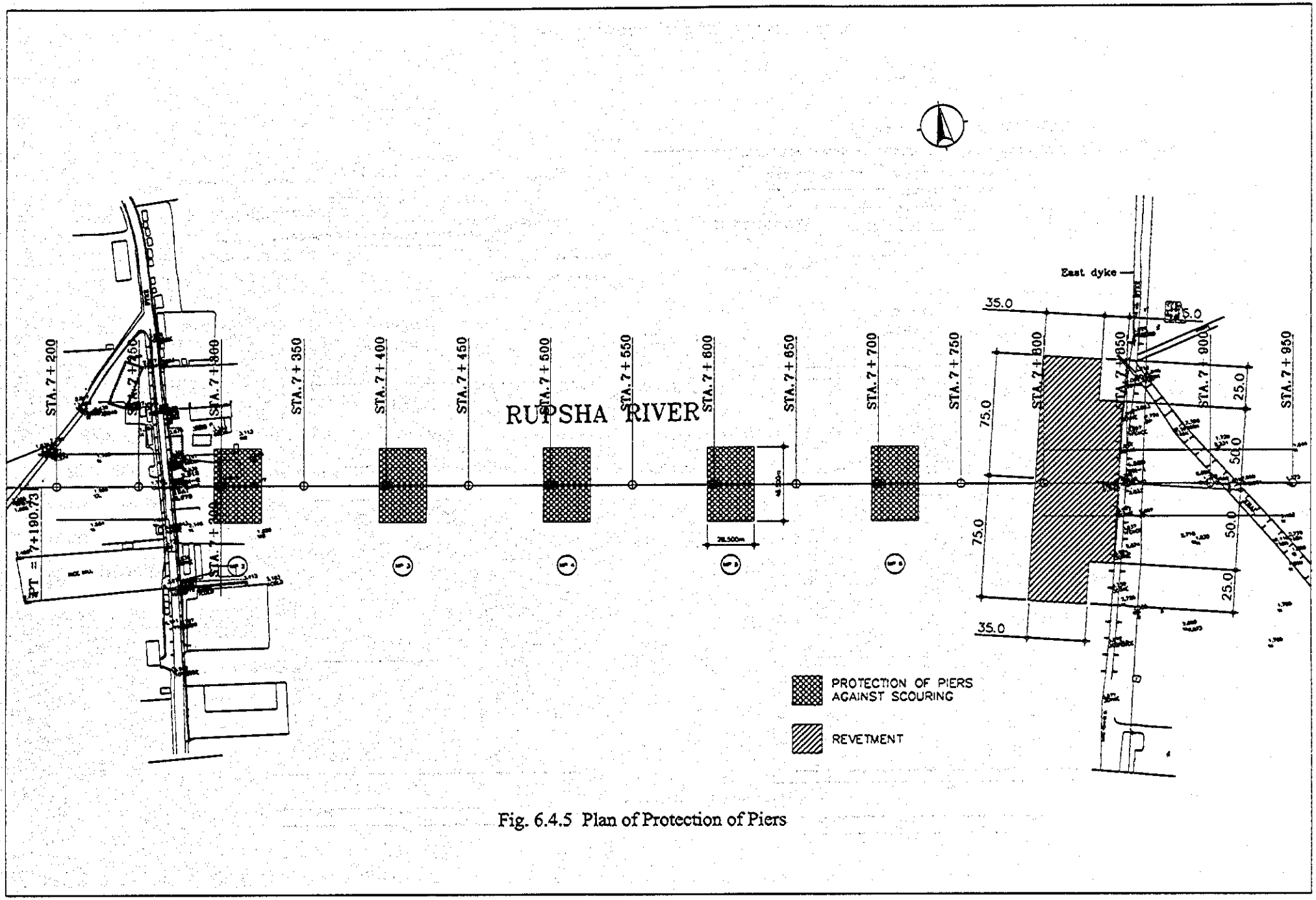


Fig. 6.4.5 Plan of Protection of Piers

6.4.3 The Inland River

All other rivers and the channels lie crosswise in the eastern side and the western side of the Rupsa river is termed as inland river, that have been kept by a small polder dike. An approach road of the Rupsa bridge is constructed to this section.

Almost all the inland rivers are connected with small channels. These water levels are artificially controlled by the water level control gates which are installed in polder dike. Accordingly, in spite of the river size H.W.L. is considered as the same level in the each side.

No water level record is available for these rivers and channels. But according to the hearing survey, the water level has not been over the existing polder dike during flood.

From the above, H.W.L. of each side may be taken as existing dike top elevation of the biggest inland river of each side. In the western side H.W.L. is 1.9m, which is dike top elevation of the Hatia river. In the eastern side HWL is 1.6m of the Molonghata canal.

The inland rivers are used as boat ways.

6.4.4 Recommendation

The Rupsa river is more stable than the other rivers in Bangladesh because the flood discharge is small in comparison with the river width.

However, even though it is comparatively stable near the location of bridge, there is a deep scouring in parts of the river bed in the upper stream and on the lower reaches, which needs attention.

It is difficult to predict long term breakouts and hence careful maintenance plan and design needs to be formulated.

Therefore, the following are recommended in this project:

1. Regular measurement (every 2 or 3 year) and analysis on the changes in river bed and the river bank.
2. Proper maintenance of the structures of revetment, pier and so on.
3. It is not possible to assert that there is no possibility for the river bank to shift to the east side in future. Therefore, the 1st pier on the side of the land should secure the maximum penetration depth as to that of pier in the Rupsa river.

6.5 Project Cost Estimates

6.5.1 General

Each project cost as a financial cost is estimated based on the results of design at a preliminary level, quantity take-off of each work item, and the studies on construction planning and method.

The basic premises of project cost estimates are as follows:

1) All the construction work will be executed by constructor(s) to be selected by international competitive bidding provided that it shall exempt foreign personnel from tax, duties and other charges on equipment, machinery and other materials brought into and out of Bangladesh for the construction work.
2) The unit cost of each cost component is determined based on the economic conditions prevailing in August 1999 (USD $1 .0 = 48.6 Taka).
3) Engineering and supervisory service costs is assumed to be 5.5% of construction cost.

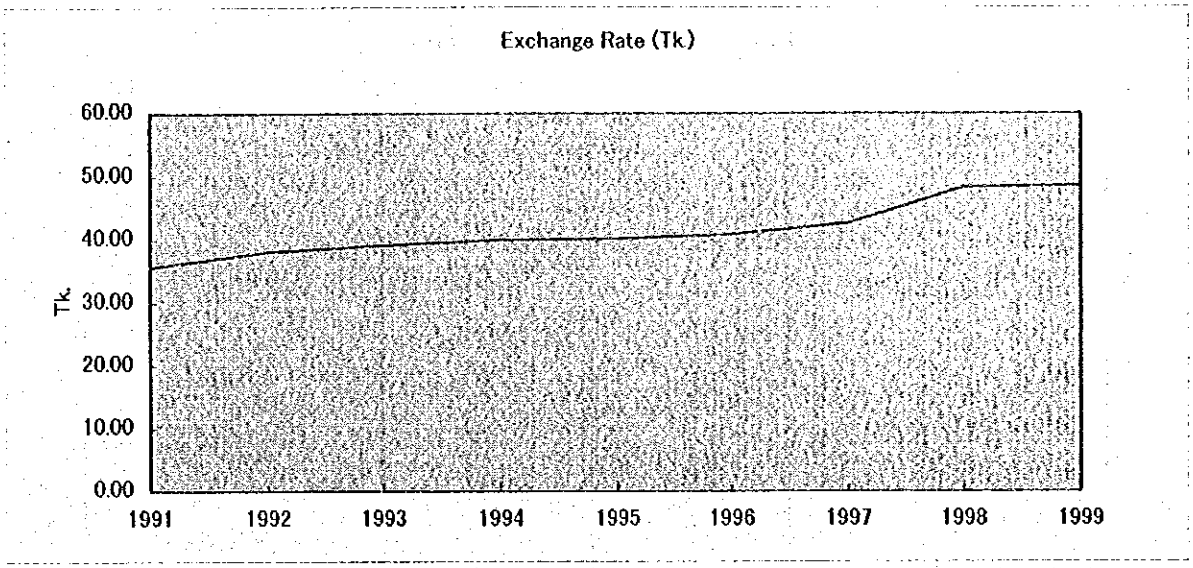
6.5.2 Construction Cost

(1) Basis of Unit Cost of Construction Works

- The unit cost of each construction work is estimated in principle based on labor costs, material costs, equipment costs prevailing in Khulna.
- The unit costs are analyzed and compared with similar work items of approved agency's estimate, and they are adjusted as required to obtain more realistic ones.
- Table 6.5.1 shows trend of exchange rates against US dollar for eight (8) years, and averaged devaluation of 3.9% per annum is found for the Study.
- Table 6.5.2 shows key macroeconomic indicators of Bangladesh. Annual average of inflation based on Consumer Price Index (CPI) is found to be 5.1% and it is applied to the Study.

Table 6.5.1 Trends of Foreign Exchange Rate Against US$

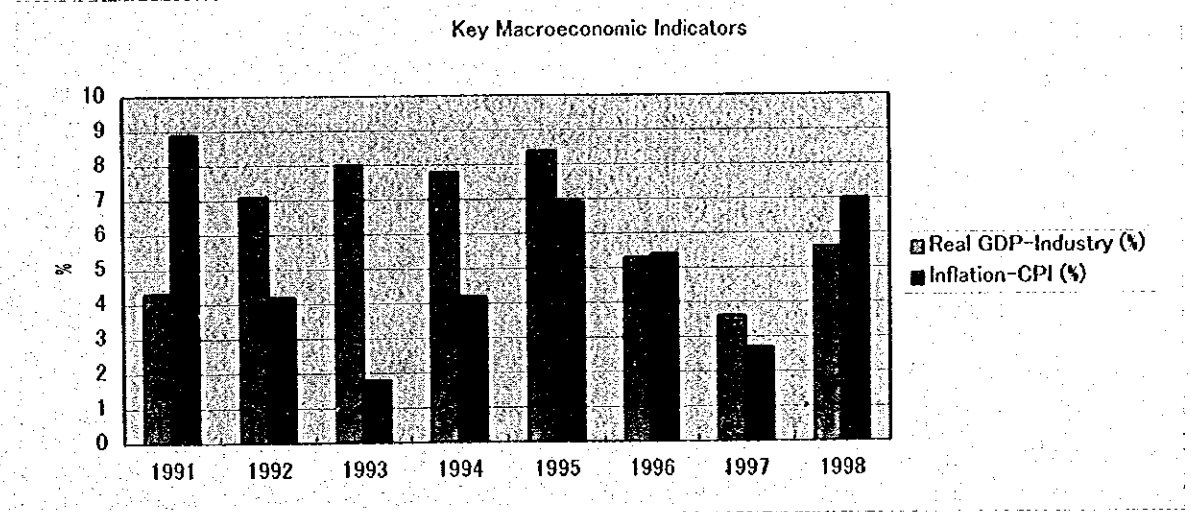
Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	Ave. Devaluation
Exchange Rate (Tk.)	35.68	38.15	39.14	40.01	40.20	40.84	42.63	48.30	48.60	3.9%



Note : The Rate in 1999 shows the selling rate prevailed in August 1999.

Table 6.5.2 Key Macroeconomic Indicators

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	Annual Average
Real GDP-Industry (%)	4.3	7.1	8	7.8	8.4	5.3	3.6	5.6		6.3
Inflation-CPI (%)	8.9	4.2	1.8	4.2	6.9	5.4	2.7	7.0		5.1



(2) Unit Cost of Labors

Table 6.5.3 shows the unit cost of labors applied to cost estimates, which include such allowances as social benefits, insurance, etc. and are based on eight-hour work day.

Table 6.5.3 Unit Cost of Labors

Tk./Day

Classification	Unit Cost		
	Foreign	Local	Total
Senior Field Engineer	0	499	499
Junior Field Engineer	0	464	464
Foreman	0	406	406
Driver	0	290	290
Equipment Operator	0	290	290
Mason/Carpenter	0	186	186
Skilled Labor	0	151	151
Semi-skilled Labor	0	116	116
Unskilled Labor	0	70	70

(3) Unit Cost of Materials

Table 6.5.4 shows the unit cost of major construction materials. The cost of imported materials is based on the Mongla Port prices including port handling and clearance charges and import duties. The cost of domestic materials is based on the market prices in Khulna area.

Table 6.5.4 Unit Costs of Major Materials

Unit: Taka

Material	Unit	Unit Cost		
		Foreign Portion	Local Portion	Total
Gasoline	liter		22	22
Diesel Fuel	liter		14	14
Lubricant Oil	liter		50	50
Cutback Asphalt MC-70/RC-250***	kg	47	2	49
Asphalt Cement ***	ton	8,910	2,000	10,910
Mineral Filler ***	ton	2,615	1,000	3,615
Portland Cement ***	kg	4	2	6
Timber Plank	m^3		28,000	28,000
Plywood (12.5mm)	m^2		480	480
Reinforcing Steel (SD 30)	ton		23,000	23,000
Rolled Structural Steel (SM 50 YB)***	ton	15,680	14,000	29,680
PC Strand (12T12.7) ***	kg	282	20	302
Boulder	m^3		1,910	1,910
Shingles	m^3		1,720	1,720
Pea-gravel	m^3		1,053	1,053
Sand (for concrete)	m^3		860	860
Brick	1000No		2,900	2,900

Notes:

1. Unit Costs of imported goods (marked ***) are based on CIF Mongla price, i.e. including port handling and clearance costs, plus Bangladeshi tax and duty.
2. Bangladeshi value added tax (VAT) is not included.

(4) Unit Cost of Equipment

To assist in determining appropriate unit costs for work items an assessment of hourly costs was made for major plant and equipment which are likely to be used in the construction of the project roads. The hourly costs comprised depreciation cost, operation and maintenance cost (fuel, lubricants, spare parts, etc.) and management cost. The design life of the equipment and usable hours per year were adjusted to reflect local conditions. Table 6.5.5 shows the unit cost of equipment that will be used for major works of road and bridge construction.

Table 6.5.5 Unit Cost of Equipment

Unit: Taka

Item	Spec./Capacity	Unit	Unit Cost		Total Cost
			Foreign Portion	Local Portion	
Bulldozer	15 ton	hr.	2,952	263	3,215
Swamp bulldozer	16 ton	hr.	2,842	322	3,164
Excavator	backhoe 0.6m^3	hr.	2939	331	2,210
Excavator	clamshell 0.6m^3	hr.	2072	266	2,338
Tractor shovel	3.1 m^3	hr.	3753	407	4,160
Tractor shovel	1.4 m^3	hr.	1663	204	1,867
Crawler crane	100 ton	hr.	11616	336	11,952
Crawler crane	40 ton	hr.	3643	203	3,846
Truck crane	120 ton	hr.	18040	249	18,289
Truck crane	40 ton	hr.	5368	228	5,596
Truck crane	20~22 ton	hr.	2583	174	2,757
Truck crane	15~16 ton	hr.	2261	172	2,434
Dump truck	10 ton	hr.	1210	237	1,447
Truck	11 ton	hr.	2,231	248	1,867
Motor grader	w=3.1m	hr.	2,090	182	2,272
Road roller	macadam 10~12 t	hr.	1,474	148	1,622
Tire roller	8~12 ton	hr.	1,461	84	1,545
Concrete plant	60m3/hr	hr.	7,392	70	7,462
Concrete plant	30m3/hr.	hr.	3,995	70	4,065
Truck mixer	6.0~6.2m^3	hr.	1,747	310	2,057
Truck mixer	3.0~3.2 m^3	hr.	752	196	948
Concrete pump	90~110m^3/hr	hr.	3,907	276	4,183
Concrete pump	55~ 60m^3/hr.	hr.	2,803	191	2,994
Asphalt plant	100t/hr.	hr.	27,852	5,600	33,452
Asphalt finisher	2.4~5.0 m	hr.	6,380	124	6,504
Reverse circulation	Drill;D=3,000mm	hr.	4,808		4,008
Generator	200 kVA	day	5,808	3,871	9,679
Generator	125 kVA	day	3,797	1,610	5,407
Air compressor	10.5~11.0m^3/min	day	5,236	1,382	6,618
Form Traveler	for Main Bridge	day	23,276		23,276
Erection girder	for Canal Bridge	day	14,256		14,256
Jaw crusher	75 kW	hr.	2,231		2,231
Cone crusher	75 kW	hr.	2,565		2,565
Gantry crane	40 ton	day	16,324		16,324
Gantry crane	3 ton	day	730		730

(5) Direct Construction Cost

The base cost is obtained to multiply quantity by unit cost.

The direct construction cost is estimated based on the base cost and additional general cost of 10% of the base cost which consists of mobilization and demobilization cost, tax and duty and overhead & profit.

(6) Unit Cost for Major Construction Work Items

The unit cost for major construction work items are shown in the Appendix based on the cost estimate conditions mentioned above.

(7) Physical Contingency

The physical contingency of 10% of Direct Construction Cost is estimated in addition to Direct Construction Cost to obtain Construction Cost.

6.5.3 Land Acquisition and Property Compensation Costs

Land acquisition and property compensation costs are estimated based on the field investigations in affected area where each alternative route would require to acquire land and to compensate affected properties such as homesteads, trees, rights of fishing/farming/common, costs for resettlement and so forth.

The summary of estimated land acquisition and resettlement cost by each alternative plan is shown in Chapter 7.

6.5.4 Estimated Project Cost

The summary of project cost in 1999 prices is shown in Table 6.5.6. The project cost is expressed in term of financial cost by each alternative route.

Table 6.5 6 Summary of Cost Estimate (1/3)

ALTERNATIVE:
ROUTE : ALT-1 Urban Structure Scheme L=10.043 km
BRIDGE : OPT-1 PC Box Girder Bridge 7-Span Option

At 1999 Prices

Description	Financial Cost	
	Expressed in Million Taka	Expressed in Million US Dollar
1. Direct Construction Cost	3,243.9	66.7
1) General	294.9	6.1
2) Earthwork	167.6	3.4
3) Drainage	275.6	5.7
4) Bank & Pier Protection	89.5	1.8
5) Pavement	484.0	10.0
6) Bridge	1,842.7	37.9
7) Incidental Work	79.6	1.6
8) Toll Facilities	10.0	0.2
2. Physical Contingency (10% of 1.)	324.4	6.7
3. Construction Cost (total of 1. &2.)	3,568.3	73.4
4. Land Acquisition and Compensation	203.6	4.2
5. ES & SS Services	196.3	4.0
Total	3,968.1	81.6

	Description	Financial Cost (Million Taka)
1.	Direct Construction Cost	3,243.9
	1) Highway	1,205.9
	2) Bridge	2,027.0
	3) Toll Facilities	11.0
2.	Physical Contingency (10% of 1.)	324.4
3.	Construction Cost	3,568.3
4.	Land Acquisition and Compensation	203.6
5.	ES & SS Services	196.3
	Total	3,968.1

	Description	Economic Cost (Million Taka)
1.	Direct Construction Cost	2,881.3
	1) Highway	1,022.6
	2) Bridge	1,858.7
	3) Toll Facilities	0.0
2.	Physical Contingency (10% of 1.)	288.1
3.	Construction Cost	3,169.5
4.	Land Acquisition and Compensation	203.6
5.	ES & SS Services	176.2
	Total	3,549.3

Million Taka

Year	Financial Cost	Economic Cost
2000	141.1	137.0
2001	497.9	454.0
2002	1,109.7	986.1
2003	1,288.1	1,144.6
2004	931.3	827.6
Total	3,968.1	3,549.3

Note : USD $1.0 = 48.6 Taka

Table 6.5.6 Summary of Cost Estimate (2/3)

ALTERNATIVE:
ROUTE : ALT-2 Mobility Scheme L=9.234 km
BRIDGE : OPT-1 PC Box Girder Bridge 7-Span Option

At 1999 Prices

Description	Financial Cost	
	Expressed in Million Taka	Expressed in Million US Dollar
1. Direct Construction Cost	3,163.0	65.1
1) General	287.5	5.9
2) Earthwork	155.1	3.2
3) Drainage	268.2	5.5
4) Bank & Pier Protection	89.5	1.8
5) Pavement	439.1	9.0
6) Bridge	1,842.7	37.9
7) Incidental Work	70.8	1.5
8) Toll Facilities	10.0	0.2
2. Physical Contingency (10% of 1.)	316.3	6.5
3. Construction Cost (total of 1. &2.)	3,479.3	71.6
4. Land Acquisition and Compensation	255.4	5.3
5. ES & SS Services	191.4	3.9
Total	3,926.1	80.8

	Description	Financial Cost (Million Taka)
1.	Direct Construction Cost	3,163.0
	1) Highway	1,125.0
	2) Bridge	2,027.0
	3) Toll Facilities	11.0
2.	Physical Contingency (10% of 1.)	316.3
3.	Construction Cost	3,479.3
4.	Land Acquisition and Compensation	255.4
5.	ES & SS Services	191.4
	Total	3,926.1

	Description	Economic Cost (Million Taka)
1.	Direct Construction Cost	2,812.8
	1) Highway	954.0
	2) Bridge	1,858.7
	3) Toll Facilities	0.0
2.	Physical Contingency (10% of 1.)	281.3
3.	Construction Cost	3,094.0
4.	Land Acquisition and Compensation	255.4
5.	ES & SS Services	171.8
	Total	3,521.3

Million Taka

Year	Financial Cost	Economic Cost
2000	166.0	162.1
2001	513.9	471.5
2002	1,082.1	962.6
2003	1,256.0	1,117.3
2004	908.1	807.9
Total	3,926.1	3,521.3

Note : USD $1.0 = 48.6 Taka

Table 6.5.6 Summary of Cost Estimate (3/3)

ALTERNATIVE:
ROUTE : ALT-3 Accessibility Scheme L=7.758 km
BRIDGE : OPT-1 PC Box Girder Bridge 7-Span Option

At 1999 Prices

Description	Financial Cost	
	Expressed in Million Taka	Expressed in Million US Dollar
1. Direct Construction Cost	3,066.7	63.1
1) General	278.8	5.7
2) Earthwork	135.8	2.8
3) Drainage	263.9	5.4
4) Bank & Pier Protection	89.5	1.8
5) Pavement	378.4	7.8
6) Bridge	1,842.7	37.9
7) Incidental Work	67.6	1.4
8) Toll Facilities	10.0	0.2
2. Physical Contingency (10% of 1.)	306.7	6.3
3. Construction Cost (total of 1. &2.)	3,373.4	69.4
4. Land Acquisition and Compensation	325.1	6.7
5. ES & SS Services	185.5	3.8
Total	3,884.0	79.9

	Description	Financial Cost (Million Taka)
1.	Direct Construction Cost	3,066.7
	1) Highway	1,028.7
	2) Bridge	2,027.0
	3) Toll Facilities	11.0
2.	Physical Contingency (10% of 1.)	306.7
3.	Construction Cost	3,373.4
4.	Land Acquisition and Compensation	325.1
5.	ES & SS Services	185.5
	Total	3,884.0

	Description	Economic Cost (Million Taka)
1.	Direct Construction Cost	2,731.1
	1) Highway	872.3
	2) Bridge	1,858.7
	3) Toll Facilities	0.0
2.	Physical Contingency (10% of 1.)	273.1
3.	Construction Cost	3,004.2
4.	Land Acquisition and Compensation	325.1
5.	ES & SS Services	166.6
	Total	3,495.9

Million Taka

Year	Financial Cost	Economic Cost
2000	199.7	195.9
2001	537.0	496.3
2002	1,049.1	934.6
2003	1,217.8	1,084.8
2004	880.5	784.4
Total	3,884.0	3,495.9

Note : USD $1.0 = 48.6 Taka

6.5.5 Project Cost Estimates for Project Implementation

(1) Criteria for Cost Estimates

The project cost consists of the following cost items:

- Direct Construction Cost
- Physical Contingency (10%)
- Land acquisition and Compensation
- Value Added Tax (VAT) and Income Tax
- Engineering & Supervisory Services

The basic premises in estimating the project cost are as follows:

1) It is assumed that all construction works will be executed by general contractors to be employed by RHD with contractors being selected by international competitive bidding (ICB).
2) The unit price of each cost component is determined based on the economic conditions prevailing in August 1999.
3) For the construction works, Bangladeshi taxes and duties on imported equipment and materials (tax percentage depending on type/kind of equipment and materials) is included in the estimates. However, it shall exempt from tax, duties and other charges on equipment, machinery and other materials which will be brought into Bangladesh for the construction work and taken out of Bangladesh after the work.
4) Bangladesh value added tax (VAT) of 5.25% and income tax of 5% are not included in the unit cost of each work item, but are calculated separately and added in the summary of construction cost.
5) The unit price of each work item includes the labor cost, equipment cost, material cost and the contractor's overhead and profit (11%), consisting of 5% for overhead and 6% for profit.
6) The engineering & supervisory services cost is estimated separately from the construction cost. The cost of the services is estimated in accordance with the scope of work for the consulting services.
7) A physical contingency of 10% of the construction cost has been added.
8) The cost is split into foreign currency and local currency portions, both indicated in Taka. Foreign currency and local currency portions of the unit cost of each work item are estimated based on the following classifications:

   a) The foreign currency portion includes but is not limited to the following costs:
      - Salaries and costs of foreign personnel;
      - Overhead and profit of foreign firms;
      - Foreign component of depreciation and operating/maintenance costs of construction equipment;
      - Bituminous materials;
      - Steel sheet pile, steel H-beam and steel forms;
      - Prestressing strand, wire and bars;

- Sheaths and anchorages for prestressing;
- Rubber water stops and joint fillers;
- Metal bearing shoes;
- Rubber bearing pads;
- Portland Cement;
- Sixty percent (60%) of boulder;
- Materials for road supporting facilities; and
- Foreign component of domestic materials.

b) The local currency portion includes but is not limited to the following costs:
- Salaries and cost of local personnel;
- Overhead and profit of local firms;
- Local component of depreciation and operating/maintenance costs of construction equipment;
- Forty percent (40%) of boulder
- Import duty on imported materials; and
- Local component of domestic materials.

9) Foreign and local currency portions are quoted in Taka. Foreign costs may be converted into foreign currency using exchange rates applicable in August 1999: US$1.00 = ¥110=Tk. 48.6.

(2) Engineering & Supervisory Services

The engineering & supervisory services cost is estimated separately from the construction cost. The cost of the services is estimated in accordance with the scope of work for the consulting services.

(3) Estimated Project Cost for Project Implementation

The total project costs including physical contingency, price contingency and value added tax (VAT)/income tax are shown in Table 6.5.7 for the selected route for the Southern Section of Khulna Bypass including Rupsa Bridge. The assumed price escalation is 4% p.a. for foreign currency component and 6% p.a. for local currency component.

Table 6.5.7 Summary of Estimated Project Cost

Description		Foreign Currency Component (Million Yen)	Local Currency Component (Million Taka)	Total (Million Taka)
1. Land Acquisition and Compensation Costs including Price Contingency		0.0	215.8	215.8
2. Construction Cost				
	Construction Cost including Price	7,684.2	400.8	3,795.8
	Physical Contingency	768.4	40.1	379.6
	Sub-total	8,452.6	440.9	4,175.4
3. Value Added Tax (5.25%) for 2.		0.0	219.2	219.2
4. Engineering & Supervisory Services				
	Services Cost including Price Contingency	689.8	56.4	361.2
	Physical Contingency	69.0	5.6	36.1
	Sub-total	758.8	62.0	397.3
5. Value Added Tax (5.25%) for 4.		0.0	20.9	20.9
6. Income Tax (5%) for Professional Services		0.0	17.1	17.1
7. Total Estimated Project Cost		9,211.4	975.8	5,045.6

Note:

1. Foreign costs may be converted into foreign currency using exchange rates applicable in August 1999:

US$	1.00
Yen	110
Taka	48.6

2. The assumed price escalation is 4% p.a. for foreign currency component and 6% p.a. for local currency component.

F.C	4%
L.C	6%

3. Etimated costs for construction and land acquisition are shown in Table 6.5.8.
4. Estimated cost for engineering & supervisory services is shown in Table 6.5.9.

Table 6.5.8 Estimated Construction Cost and Disbursement Schedule

1. Expected Disbursement Schedule of Yen Component

Items	(construction)	FY-2000 0%	FY-2001 20%	FY-2002 35%	FY-2003 35%	FY-2004 10%	Total
Construction Cost (M.Tk.	F-Real	0.0	441.7	773.0	773.0	220.9	2,208.6
	F-Escalation	0.0	36.0	96.5	131.3	47.8	311.7
	Sub-total	0.0	477.8	869.5	904.3	268.7	2,520.3
	L-Real	0.0	199.5	349.1	349.1	99.8	997.5
	L-Escalation	0.0	24.7	66.7	91.6	33.7	216.7
	Sub-total	0.0	224.2	415.8	440.8	133.5	1,214.2
Total		0.0	701.9	1,285.3	1,345.1	402.2	3,734.5
Construction Cost (M.Yen.)		0.0	1,588.7	2,909.2	3,044.4	910.3	8,452.6

2. Expected Disbursement Schedule of Taka Component

Items	(construction) (land acquisiti	FY-2000 0% 100%	FY-2001 20%	FY-2002 35%	FY-2003 35%	FY-2004 10%	Total
Land Acquisition and Compensatation Cost	L-Real	203.6	0.0	0.0	0.0	0.0	203.6
	L-Escalation	12.2	0.0	0.0	0.0	0.0	12.2
	Sub-total	215.8	0.0	0.0	0.0	0.0	215.8
Construction Cost (M.Tk.	L-Real	0.0	72.4	126.8	126.8	36.2	362.2
	L-Escalation	0.0	9.0	24.2	33.3	12.2	78.7
	Sub-total	0.0	81.4	151.0	160.0	48.5	440.9
Total of Taka Component (M. Tk.)		215.8	81.4	151.0	160.0	48.5	656.7

Notes:

1) The escalation allowances of 4% per annum for foreign currency and 6% per annum for local currency have been assumed to formulate the disbursement schedule.
2) The figures denoted "Real" show the cost at August 1999 prices.
3) Yen component will be appropriated by JBIC ODA Loan proceed to cover 85% of the total project cost.
4) Taka component will be appropriated by the GOB own fund.
5) The cost breakdown of the total project cost is shown in Table 6.5.10.

Table 6.5.9 Estimated Enjineering & Supervisory Services Cost and Disbursement Schedule

1. Expected Disbursement Schedule of Yen Component

Items	(services)	FY-2000 25%	FY-2001 20%	FY-2002 20%	FY-2003 20%	FY-2004 15%	Total
Services Cost (M.Tk.)	F-Real	63.8	51.1	51.1	51.1	38.3	255.3
	F-Escalation	2.6	4.2	6.4	8.7	8.3	30.1
	Sub-total	66.4	55.2	57.4	59.7	46.6	285.3
	L-Real	10.6	8.5	8.5	8.5	6.3	42.3
	L-Escalation	0.6	1.0	1.6	2.2	2.1	7.7
	Sub-total	11.2	9.5	10.1	10.7	8.5	49.9
Total		77.6	64.7	67.5	70.4	55.1	335.3
Services Cost (M.Yen.)		175.6	146.5	152.8	159.3	124.6	758.8

2. Expected Disbursement Schedule of Taka Component

Items	(services)	FY-2000 25%	FY-2001 20%	FY-2002 20%	FY-2003 20%	FY-2004 15%	Total
Services Cost (M.Tk.)	L-Real	13.1	10.5	10.5	10.5	7.9	52.5
	L-Escalation	0.8	1.3	2.0	2.8	2.7	9.5
	Sub-total	13.9	11.8	12.5	13.3	10.5	62.0
Total of Taka Component (M. Tk.)		13.9	11.8	12.5	13.3	10.5	62.0

Notes:

1) The escalation allowances of 4% per annum for foreign currency and 6% per annum for local currency have been assumed to formulate the disbursement schedule.
2) The figures denoted "Real" show the cost at August 1999 prices.
3) Yen component will be appropriated by JBIC ODA Loan proceed to cover 85% of the total project cost.
4) Taka component will be appropriated by the GOB-ADP fund.
5) The cost breakdown of the total project cost is shown in Table 6.5.10.

Table6.5.10 Summary of Cost Estimate and the Cost Breakdown

ALTERNATIVE:
ROUTE : ALT-1 Urban Structure Scheme L=10.039 km
BRIDGE : OPT-1 PC Box Girder Bridge 7-Span Option

AT AUGUST 1999 PRICES

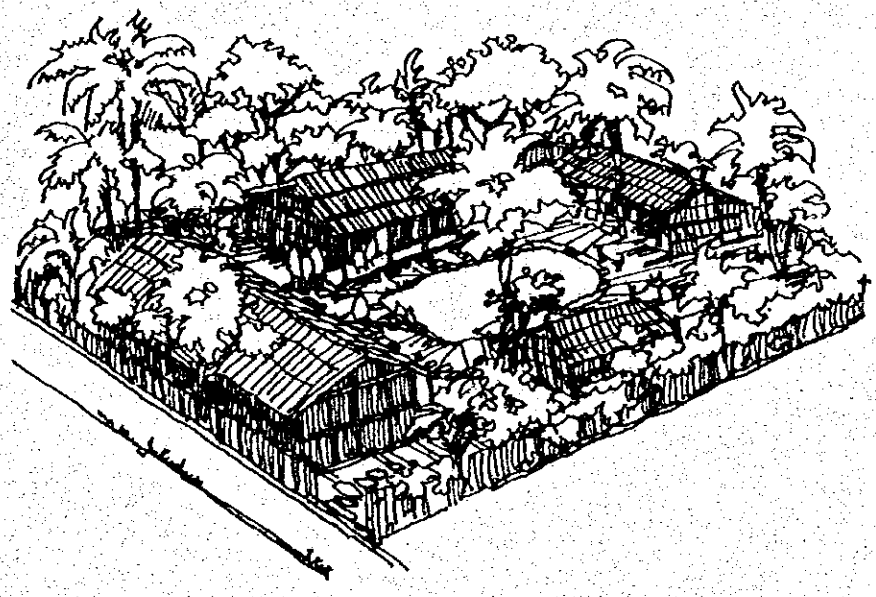
	Description	Financial Cost (Million Taka)		
		Foreign Component	Local Component	Total
1.	Direct Construction Cost	2,007.8	1,236.1	3,243.9
	1) General	182.5	112.4	294.9
	2) Earthwork	16.8	145.6	162.4
	3) Drainage	66.6	56.2	122.8
	4) Bank & Pier Protection	45.7	43.7	89.5
	5) Pavement	268.3	215.7	484.0
	6) Bridge	1,367.8	632.8	2,000.6
	7) Incidental Work	56.4	23.2	79.6
	8) Toll Facilities	3.5	6.5	10.0
2.	Physical Contingency (10% of 1.)	200.8	123.6	324.4
3.	Construction Cost (total of 1. &2.)	2,208.6	1,359.7	3,568.3
4.	Land Acquisition and Compensatio	0.0	203.6	203.6
5.	ES & SS Services *1	255.3	94.8	350.0
	Total of(3.+4.+5.)	2,463.8	1,658.1	4,121.9

	Description	Financial Cost (Million Taka)			
		Foreign Component	Local Eligible to JBIC	Local Component	Total
1.	Direct Construction Cost	2,007.8	1,236.1		3,243.9
2.	Physical Contingency (10% of 1.)	200.8	123.6		324.4
3.	Construction Cost	2,208.6	997.5	362.2	3,568.3
4.	Land Acquisition and Compensatio	0.0	0.0	203.6	203.6
	Su-total	2,208.6	997.5	565.8	3,771.9
5.	ES & SS Services *1	255.3	42.3	52.5	350.0
	Total of(3.+4.+5.)	2,463.8	1,039.8	618.3	4,121.9

Note:
*1: The cost of ES & SS Services includes Contingency (10%).

CHAPTER 7

ENVIRONMENTAL IMPACT ASSESSMENT



CHAPTER 7 ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Introduction

7.1.1 Environmental Outlook

In JICA Phase 1 Study Initial Environmental Examination (IEE) and Initial Social Impact Examination (ISIE) have been carried out simultaneously on two alternative road alignments. Aignment A is located on the western side of the Rupsa River and Alignment B is located on the eastern side of the River.

After taking into consideration many points, the Phase 1 Study concluded that the western route is superior to the eastern route at almost all aspects, also in environmental and social indices.

Construction of the Rupsa Bridge and linked Bypass is anticipated to cause impacts in various degrees on social and natural environment and also to induce pollution. Particularly, it will require a wide stretch of land and such a land based development project displaces people involuntarily from their land and of residence or means that of livelihood and thereby gives rise to physical, economic and social problems. The displacement also affects de-links income source and productive assets, reduces access to employment opportunities in a new environment. Re-location of the households weakens the community structure and social network of kinship, mutual assistance, cultural identity etc. These may cause long term hardship and social environmental damage unless the resettlement and rehabilitation of affected persons is carefully planned and implemented with appropriate mitigates measures.

7.1.2 Components and Objectives of Environmental Impact Assessment

The Environmental Impact Assessment (EIA) study consists of the following components:

i) Social Impact Assessment.
ii) Natural Environmental Impact Assessment.
iii) Resettlement Action Planning.
iv) Environmental Monitoring Program.

Based on the IEE and ISIE findings, the following steps have been taken to fulfill the objectives:

- Assessment of the existing environment (natural and social) in the project area.
- Delineation of the impact areas in terms of positive and negative impacts on potential parameters.
- Recommendation of mitigation measures for negative impacts and enhancement for the positive impacts during and after construction phases of the project.
- Formulation of the Resettlement Action Plan (RAP) and Environmental Monitoring Program (EMP) to minimize or control the negative impacts and enhance the positive impacts.

7.1.3 Study Method

The survey was carried out along the following three routes.

1) Route-1: under this route, the bridge point is located in Labanchara, about 2.6 km south of the Rupsa Ferry Ghat.
2) Route-2: located adjacent to and north of the Khulna Steel Mill and 2 km south of the Rupsa Ferry Ghat
3) Route-3: located about 1 km south of the Rupsa Ferry Ghat and 200 m north of Khulna shipyard.

The EIA has been carried out in line with the Environmental Guidelines for Infrastructure Project-III Road prepared by JICA together with consideration of environmental laws and rules in Bangladesh.

The work is based on site investigation and hearing interview to the project locations, meeting and discussion with representatives of related sectors, review of documents, regulation and data concerning the project. Resettlement plan shall be considered on the basis of affected homesteads and households with their family populations. The field surveys have been carried for investigating the households affected by these three route alternatives.

The central line of each alignment was marked through putting stakes at 100 m distance by the JICA survey team on the settlement area in particular from starting to ending points over entire length of the three alignments. Then the EIA survey team under the guidance of the Survey

Coordinator and Sociologist demarcated the 36 meter Right of Way (ROW) measuring through gauge tape taking 18 meter width from both sides of the central line. Afterwards, the socio-economic survey team has identified all the households residing on the ROW alignment on which survey was conducted.

7.1.4 Application and Acquisition of Environmental Clearance

7.1.4.1 Environmental Policy and Laws of Bangladesh

(1) Environmental Policy, 1992

The Government of Bangladesh enacted its Environment Policy in 1992.
In view of the various adverse impacts on environment, the Government of Bangladesh have attached special importance to its protection and improvement. A number of environmental problems, which inter-alia include natural disasters like recurrent floods, droughts, cyclones, tidal bores etc., primary signs of desertification in the northern districts, intrusion of salinity in the rivers, land erosion, fast depletion of forest resources, instability of the weather and climatic conditions etc. are prevalent in the country. Against this backdrop, the Government has established the Ministry of Environment and Forest (MOEF) and upgraded the Department of Environment (DOE) in order to coordinate and supervise the activities concerning protection and improvement of the environment. Simultaneously, major problems related to environmental pollution and degradation have also been clearly identified.

Since various socio-economic malaise like poverty, population pressure, illiteracy, inadequate health care, lack of public awareness etc. have emerged as serious impediments to the protection of environment, it is necessary that these problems are adequately addressed simultaneously along with issues concerning to improvement of environment in an integrated manner. Implementation of government's commitment to environment and mitigation of other environment related problems are possible only through a well defined national policy.

(2) Environment Conservation Act, 1995

In these decades, nearly all the countries of the world have been working towards the creation of adequate legal framework to prevent the gradual decline of the environment and conserve the

natural resources. In order to meet the present changed circumstances, the revision and upgrading of the Environment Pollution Control Ordinance 1977 has become necessary. Thus the Government introduced the Environment Conservation Bill in the parliament in 1994 to prevent escalation of pollution problems in the country. The bill was discussed through 1994 and finally the Environment Conservation Act 1995 (ECA 1995) was enacted by the parliament and gazetted in February 1995 and came into force in June 1995.

The ECA 1995 is defined as "Law Enacted for Conservation, Improvement of Quality Standard, and Control and Mitigation of Pollution of the Environment". The ECA 1995 contains mainly the following regulations and stipulations:

- Department of Environment, and power and function of the Director General
- Declaration of ecologically critical area
- Regulation in respect of driving vehicles emitting smoke harmful to the environment
- Information to the Director General regarding environmental pollution or degradation
- Formulation of environmental guideline
- Offenses committed by companies

(3) Environment Conservation Rule, 1997

While the enacting of ECA1995 was most certainly an achievement, in order to enforce, the Act in practice, Environmental Conservation Rule came into force on 28 August1997. In the Rule, all proposed projects are classified into 4 categories depending on the extent of impact on the environment and accompanying complexity of obtaining Environmental Clearance; namely Green, Orange A, Orange B and Red. List No. 68 of Red Category is of Bridge construction for the length 100m or more and List No.67 is of Road construction for regional and national roads. In application and acquisition of Environmental Clearance for the Red Category projects, IEE and EIA too must be completed and submitted for obtaining Environmental Clearance.

7.1.4.2 Procedure of Application and Acquisition of Environmental Clearance

The Department of Environment (DOE) manages these activities. DOE has 4 divisional offices in Dhaka, Chittagong, Khulna and Rajshahi in addition to its headquarters in Dhaka. For this Project, Environmental Clearance application should be submitted by the Project Director of Khulna

Division of RHD to the Director of Khulna Division Office of DOE. This application must be accompanied with Feasibility Study report, IEE report and EIA report following to Form 3 and the structure of EIA report prescribed in ECR. According to the ECR, Environmental Clearance shall be granted to the Applicant within 60 working days for Red category project, or the application will be turned down giving reasons.

7.2 Description of the Present Environment along the Proposed Project Routes

7.2.1 Social Environment

Site investigation survey was carried out all along the three (3) routes to obtain the information on social conditions and land use of the area for Bypass Routes from the view points of social and environmental issues related to land acquisition and compensation of project sites.

1) General Socio-Economic Conditions of the Khulna Region

① Population

Khulna is the third largest metropolitan city in Bangladesh with a population of nearly one million (1998). The old town, with half of the population of Khulna City, is characterized by narrow lanes and tightly packed housing ranging from multistoried buildings to poorly serviced squatter slums.

② Major Occupation

The total economically active population of Khulna Statistical Metropolitan Area (SMA) aged 10 years and over has been presented in Table 7.2.1. Occupation was classified into two broad occupational categories, i.e. (I) persons who are engaged purely in agriculture and (II) persons who are engaged in non-agriculture. It has been observed that 91.9 percent of the total economically active population of the SMA are engaged in non-agriculture occupation and 8.1 percent are engaged in agriculture activities. The percentage of persons engaged in agriculture is found very insignificant in Khulna City Corporation where 97.2 percent are engaged in non-agriculture sector. It could also be seen that a significant percent of economically active population of other urban area is engaged in agriculture sector. The particular situation may be the effect of the inclusion of some areas where agricultural activities still predominantly exist.

Table 7.2.1 Economically Active Persons Aged 10 years and Over by Agricultural and Non Agricultural Occupation – 1991

Locality	Population engaged in Agriculture	Percent	Population engaged in Non-Agriculture	Percent
Khulna SMA	23,305	8.1	264,648	91.9
Khulna City Corporation	5,999	2.8	208,483	97.2
Other Urban Area	17,306	23.6	56,165	76.4

③ Aesthetics and Cultural Heritage

With regard to the aesthetics of Khulna, the world heritage and the largest mangrove forest of the world, the Sundarbans is located south of the city and the major attraction of tourist from all over the world. The Sundarbans protect the region from storms, cyclones and tidal surge of the Bay of Bengal.

Khulna is also the regional center for higher education and the Khulna University, Khulna Engineering Collage and Khulna B.L. University are important

④ Economic Development

Historically Khulna served as a major port and the center for the jute and paper industries and as the main shipping center and transit point for the western half of Bangladesh. However, population growth has been much higher than anticipated while urbanization has tended more to densification within the existing built-up areas rather than the development at much lower density and in the peripheral area. So, the city has been seriously encroached upon and infrastructure lags seriously behind the actual development.

⑤ Agriculture and Fishery

Although population engaged in agriculture is low, agriculture is the dominant land use in floodplain area around Khulna City area. Irrigated and rainfed rice based cropping pattern is the usual practice in floodplain area. Wheat, oilseeds, pulses, etc. are the major crops and vegetables and horticultural crops are grown locally as alternatives. Fisheries play an important economic role in the area. In the floodplain, some people locally known as fishermen live mainly by fishing in open water bodies, beels and puddles. Many others supplement protein in their day to day meals from capture fisheries while the marginal farmland holders and land less households though are not traditional fishermen also supplement their income from capture fisheries. Numerous ponds, ditches and borrow pits owned privately are used for captive fisheries or aquaculture for family consumption and marketing.

The people in urban areas are involved in working in the public, private and informal sectors for

earning their livelihood.

Several types of divergent landuses characterize the suburban area around the Khulna City. The shallowly flooded (< 30-cm) part on the northwest is used for seasamun during the winter season and broadcast aus paddy during the Kharif –1 season. The moderately deeply flooded (30-cm 1.0m) basin sites in the north and west part are used for growing broadcast aman paddy during Kharif –2 season. The deeper basin sites (> 1.0m) are used for boro (winter paddy) cultivation. Large part of the basin area in the northwest of Khulna City has become water logged. Part of this landscape is being used for agriculture while the other part remains under capture fisheries.

The flat basins that occur on the northwest and south-west parts of the Khulna City are shallowly flooded (< 30-cm). These basins are used for cultivation of transplanted aman paddy during Kharif – 2 season. The narrow ridges occurring along the tidal channels though remain saturated during the monsoons are not subjected to tidal inundation. These lands are not suitable for paddy cultivation. Part of this landscape is used for cultivation of rabi crops during the winter season and sesbania during the monsoon. The farmers, in order to make this land suitable for paddy cultivation sell the topsoil to the earth filling contractors. This mechanism though makes the land suitable for paddy cultivation may not be considered as environment friendly. Because, this kind of change of inundation level shrinks the crop diversity in the area further.

Orchards in the tidal floodplain area occupy the homestead platforms and the non-flooded parts.

Homestead forests are highly productive and efficiently managed, compared to the low productivity and under-utilization of reserved forests and government controlled lands.

Homestead forests provide about 85% of all the wood consumed, which included nearly 90% of all fuelwood and 80% of all timber. In addition, homesteads provide about 90% of bamboo, extremely important commodity for rural life.

⑥ Pattern of Rural Settlement

The physical environmental factors, particularly the presence of rivers and ponds and the nature of the topography largely determine the pattern of rural settlement, which may be classified into the following three major patterns: Nucleated (Clustered settlement), Linear Settlement and Dispersed Settlement. In Khulna region, rural settlement is different from area to area considering the topography of the area.

Most typical homesteads have independent enclosed courtyards, generally rectangular in shape with dwelling units on 3 or even all four sides.

The courtyard forms an essential and integral part of the rural homestead and performs several

functions. It is used as outdoor living or sitting space for adults, mainly women, as children's play space, and as space for drying field crops, clothes, utensils etc.

Ponds also form an essential element of rural settlements in some areas of Bangladesh and serve multi-purpose activities mainly bathing, washing and fishing.

Tree species growing on homestead platforms include fruits, fuel wood timber and horticultural species. They have width of 140 m² to 600 m² and are consisted of 4 to 6 families with a total member of 8 to 20.

What is the most important in this living form is that it has very strong bondage among the members of immediate kin who live together on the same homestead or in close proximity.

Fig.7.2.1 illustrates a typical homestead described above.

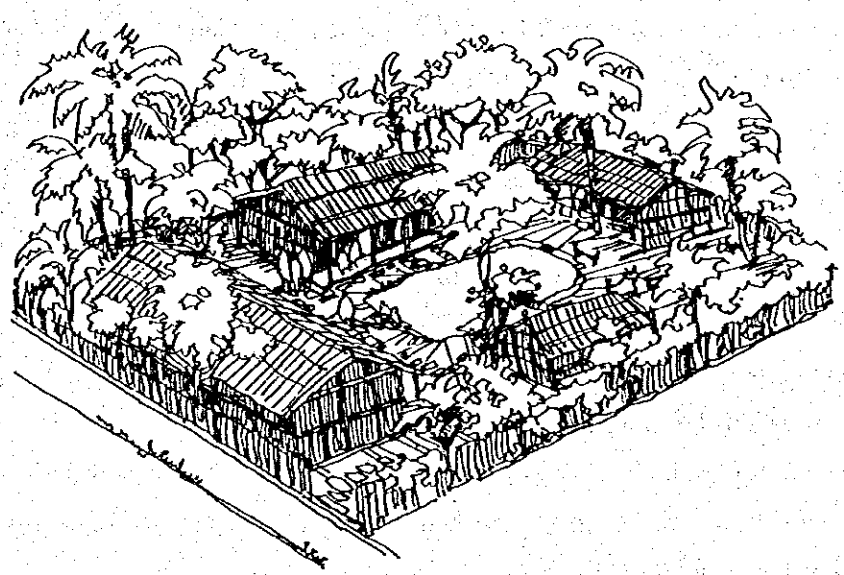


Fig.7.2.1 Illustrate of a Typical Homestead

2) Social Environment of the Project Affected Area

Through the three route alternatives of 36-meter width, numbers of homestead which sometimes consists of kin family group households within same property that has to be recognized as affected cluster formation. In most of the case, property of these homesteads will be affected partly but very few cases among the total. Through the survey the number of households maintained within same homestead land are also confirmed. These three route alternatives are shown in Fig. 7.2.2.

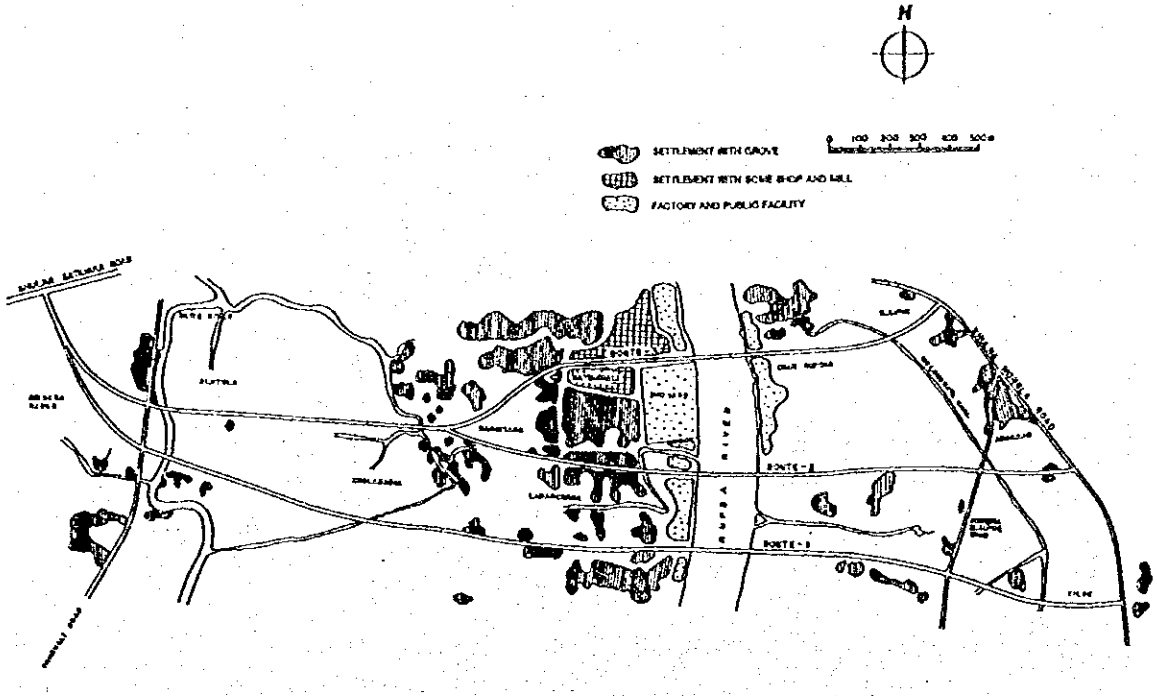


Fig. 7.2.2 Location of Route Alternatives

The results of the investigation are summarized in Tables 7.2.2 through 7.2.9, which illustrate various characteristics of the social environmental situations that is useful in formulating land acquisition and compensation as well as resettlement plans.

From Table 7.2.2, it can be seen that agricultural land shares large portion of Route 1 and 2, recognized as semi-urban area. On the other hand, Route 3, with high residential portion recognized as urban area. The number of house holds and their population along each Route is shown in Table 7.2.3.

Table: 7.2.2 Affected Landuse Pattern

Type of Land	Route – 1		Route – 2		Route – 3	
	Area in Sqm	% of Total	Area In Sqm	% of Total	Area in Sqm	% of Total
Agricultural:	3,54,931	88.97	2,40,433	71.05	1,21,120	41.03
Residential:	11,620	2.92	71,605	21.16	1,29,150	43.75
Commercial:	2,423	0.61	3,316	0.98	7,764	2.63
Industrial:	2,150	0.54	--	--	12,782	4.33
Pond:	6,232	1.56	7,005	2.07	13,668	4.63
Shrimp Gher:	15,040	3.77	7,318	2.18	5,461	1.85
Low Land	6,512	1.63	8,663	2.56	5,255	1.78
Total:	3,98,908	100	3,38,400	100	2,95,200	100

Source: Field surveys Sept. 1999.

Table 7.2.3 Number of Affected Households and Population

Route number	No. of Households	Population					
		Male		Female		Total	
		No.	%	No.	%	No.	%
1	53	125	51.65	117	48.4	242	100
2	114	267	51.1	256	48.9	523	100
3	325	811	52.1	746	47.9	1,557	100

The average household size affected by the project is 4.5 persons, 4.6 persons and 4.8 persons for Route 1, Route 2, Route 3 respectively ranging from 2 to more than 10 persons.

It can be seen that children and adults up to 45 years old form the majority of project affected persons in all the three routes.

Table 7.2.4 Age Structure and Sex Composition of the Affected Population

Age Group	Route-1						Route-2						Route-3					
	Male		Female		Total		Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1-5	20	16.0	17	14.5	37	15.3	38	14.2	46	18	84	16.1	98	12.1	94	12.6	192	12.3
6-10	14	11.2	15	12.8	29	12.0	43	16.1	38	14.8	81	15.5	99	12.2	100	13.4	199	12.8
11-15	12	9.6	18	15.4	30	12.4	37	13.9	28	10.9	65	12.4	89	11	90	12.1	179	11.5
16-25	29	23.2	24	20.5	53	21.9	43	16.1	56	21.8	99	18.9	173	21.3	208	27.8	381	24.6
26-35	21	16.8	23	18.8	43	17.8	49	18.5	50	19.5	99	18.9	170	21	125	16.8	295	18.8
36-45	17	13.6	13	11.1	30	12.4	33	12.3	20	7.8	53	10.2	73	9	70	9.4	143	9.2
46-60	6	4.8	4	3.4	10	4.1	19	7.1	13	5.2	32	6.1	75	9.2	49	6.6	124	8
61+	6	4.8	4	3.4	10	4.1	5	1.8	5	2	10	1.9	34	4.2	10	1.3	44	2.8
Total	125	100	117	100	242	100	267	100	256	100	523	100	811	100	746	100	1557	100

Marital status of the affected population in all the three routes are presented in Table 7.2.5. 43% to 45% of the population is married and the unmarried people are mostly children.

Table 7.2.5 Marital Status of the Affected Population

Marital Status	Route-1		Route-2		Route-3	
	No.	%	No.	%	No.	%
Married	103	42.6	236	45.1	699	44.9
Unmarried	123	50.8	273	52.2	798	51.3
Widow/widower	9	3.7	12	2.3	38	2.4
Divorced	2	0.8	-	-	3	0.2
Separated	5	2.1	2	0.4	19	1.2
Total	242	100	523	100	1557	100

Occupational pattern of the affected population is shown in Table 7.2.6. People engaged in service and business portions are 15% to 16% in all the three routes, and agricultural population is almost none, even though the major land use pattern is agriculture indicating the probability of certain degree of service and day labors in agricultural activities.

Table 7.2.6 Occupational Pattern of the Affected Population

Types of Occupation	Route-1		Route-2		Route-3	
	No.	%	No.	%	No.	%
Service	16	8.7	40	7.6	155	10
Business	23	7.9	38	7.3	91	6
Agriculture	1	-	-	-	3	0.2
Land Lord	-	-	-	-	5	0.3
Day Labour	21	5.4	74	14.1	169	10.9
Transport Driver	4	1.2	1	0.2	10	0.6
Others Profession	5	2.1	3	0.6	24	1.5
House wife/House hold work	42	18.7	108	20.7	317	20.4
Student	60	26.1	139	26.6	429	27.6
Unemployed	11	5.8	30	5.7	112	7.2
Children	31	13.7	80	15.3	197	12.7
Others (Retired, Old aged etc.)	28	10.4	10	1.9	42	2.7
Total	242	100	523	100	1557	100

Regarding on the distribution and average annual income of the affected families, as summarized in Table 7.2.7, majority of the people are in the income slab of the average income of families in the Route 2 area is less than other two routes.

Table 7.2.7 Distribution and Average Annual Income of the Affected Families

Income (in Taka)	Route-1		Route-2		Route-3	
	No.	%	No.	%	No.	%
Upto-10,000			3	2.6	4	1.2
10,001-20,000	8	15.1	9	7.9	33	10.2
20,001-30,000	10	18.9	50	43.9	87	26.8
30,001-50,000	15	288.3	31	27.2	107	32.9
50,001-100,000	17	32.4	16	14	63	19.4
100,0001+	3	5.7	5	4.4	31	9.5
Average annual income	51,876		38,681		51,146	

The average monthly expenditure of the affected households of route 1 , route 2 and route 3 are Tk 3,864, Tk 3,124 and Tk 3,936 respectively. According to the latest Household Expenditure Survey (HES) 1995-1996 by Bangladesh Bureau of Statistics (BBS), the national level average monthly expenditure per household was Tk 4,096.

Meantime, BBS also reports that poverty ratio of Khulna Region is 32 % of extremely poor level to 23 % of National ratio and below the national average.

Table 7.2.8 presents the religious status of the affected people. Majority of the population follows Islam. Minority Hinduism and Christianity people live in the urbanized area along Route 3.

Table 7.2.8 Religious Status of the Affected Population

Religious Status	Route-1		Route-2		Route-3	
	No. of Family	Population	No. of Family	Population	No. of Family	Population
Islam	53	242	114	523	307	1472
Hinduism	-	-	-	-	4	15
Christianity	-	-	-	-	14	70
Total	53	242	114	523	325	1557

3) Women in Development

It is an established fact that the female section of our country comprises nearly half of our country's total population. But in modern age, unfortunately, the women of our country are still playing a very traditional role and concentrated to household activities only. In case of Khulna, no differentiation is observed regarding the women issues compared to the rest of Bangladesh. There is no reliable data on 'women in development' activities in Khulna. However, through general observation and survey data of the project location, found that the women participation in income generating activities is not much pronounced in Khulna as because only an insignificant percentage of women is involved in the formal sector activities. But their participation in the informal activities is satisfactorily increasing. This increase is due to general poverty, increase in various development activities in different sectors, increase in NGO activities along with the increase in mass awareness about women development and decrease in various superstitions. The rate of women literacy is also increasing for various reasons especially for increased participation in school level due to introduction of female student scholarship program of the Govt. However, it is expected that expansion of education among the women will lead to increase in their participation in all socio-economic activities at local and national level. This is in contrast to the recent concept 'Women in Development' which is considered with greater importance all over the world and also by the Govt. of Bangladesh. Presently, the Govt., NGO and other development organizations are playing an active role in increasing the participation of women in uplifting socio-economic status of women community.

As evident from the survey findings in Table 7.2.9, women in the affected households are involved in different economic activities and share economic burden of the family. The important economic activities, include service in formal and informal sectors, labour and business in addition to the household work like kitchen gardening and vegetable production, animal tending, crop processing, etc.

Table 7.2.9 Occupational pattern of the Female Member of the Affected Household.

Occupation	Route-1		Route-2		Route-3	
	No.	%	No.	%	No.	%
Household Work	43	36.7	108	42.2	317	42.5
Service	2	1.7	6	2.3	17	2.3
Day Labour	3	2.6	7	2.7	23	3.1
Business	6	5.1	2	0.8	10	1.4
Student	29	24.8	66	25.8	208	27.9
Old ages	6	5.1	8	3.1	37	4.9
Others (casual work, match box preparation etc.)	5	4.3	9	3.5	27	3.6
Unemployed	7	6.0	7	2.7	12	1.6
Under ages	16	13.7	43	16.8	95	12.7
Total	117	100.0	256	100.0	746	100.0

4) Existing Conditions of Homestead in the Project Affected Areas

① Characteristics of the Alley in Settlement within the Project Affected Area

There are three alternative routes for the Rupsa bypass route being studied. Along these bypass routes, most of the homesteads are located in the west bank area, Khulna side, near by the Rupsa river fringe area. Each proposed crossing points of the routes from the existing ferry are 2.6 km for the Route 1, 2.0 km for the Route 2 and 1.0 km for the Route 3. Existing land use of the project-affected area is categorized as urbanized area to semi-urbanized area and all of this area will be identified as urbanized area in future by Khulna master plan.

Existing urban and semi-urban area have linear type parallel alleys which have been facilitated with 3 m width brick pavement for pedestrians to walk in ease. Also this type of alley is locally called as semi-Pucca road and the most alleys along the Route 2 and 3 area are of this type. Meanwhile in the suburban area such as the Route 1, along the alleys are brick paved for major length and remaining are with dirt surface, locally called as Kucha road.

In general, linear type alley formulation and homestead settlements facing these alleys are the common character in the project area, facilitating easy access toward the river, canal and their banks. Each homestead is always face to either Pucca road or Kucha road accordingly. Fig. 7.2.3 shows a typical alley and homestead settlement. along the Route 2 and the Route 3.

Fig. 7.2.3 Brick paved Alley and Linear Type Distribution of Homestead Settlement

② Homestead Type Characteristics of the Project Affected Area

The characteristics of the homestead in the urban, semi-urban and suburban areas such as the Route 3, 2 and Route 1, can be grouped into three types as below:

a) Permanent structured house made of rigid concrete frame with solid wall and roofing is a main living-house with modern furnishings of doors and glass windows in relatively large scale, and one household usually lives there. This permanent house is locally called Pucca house and some times it becomes 2 to 3 story buildings. Besides main house building, a simple structured bamboo hat is sometimes observed to function as storage or ware-space for the homestead. Most of these homesteads are enclosed by solid fences, built with mortal wall founded on brick masonry work, facing the alley. The homestead premises generally has a multi-purpose pond and kitchen garden planted with coconut palms, banana, phoenix, shadow providing trees and flower shrubs.

b) Semi-permanent structure house, made of brick masonry with either tin roofing or roofing with leaves of Nippa palm and generally one story simple building compared to the Pucca house. This type of house is locally called as semi-Pucca house and usually one household lives there. Besides semi-Pucca house within this type of homestead, some simple bamboo houses are also facilitated within the same homestead area for kins, in such a way that usually one homestead has several householders live in together.

The homestead area comprise a multi-use pond and courtyard in center, surrounded by bamboo houses or so called Kucha houses. Courtyard or kitchen garden is used as working space for daily fruit harvest, chicken and duck, and laundry space in semi-urban area. Fig. 7.2.4 shows a typical

layout of homestead in the urban area affected by Route 3. Fig. 7.2.5 is a sketch of common homestead landscape along the alley of Route 3.

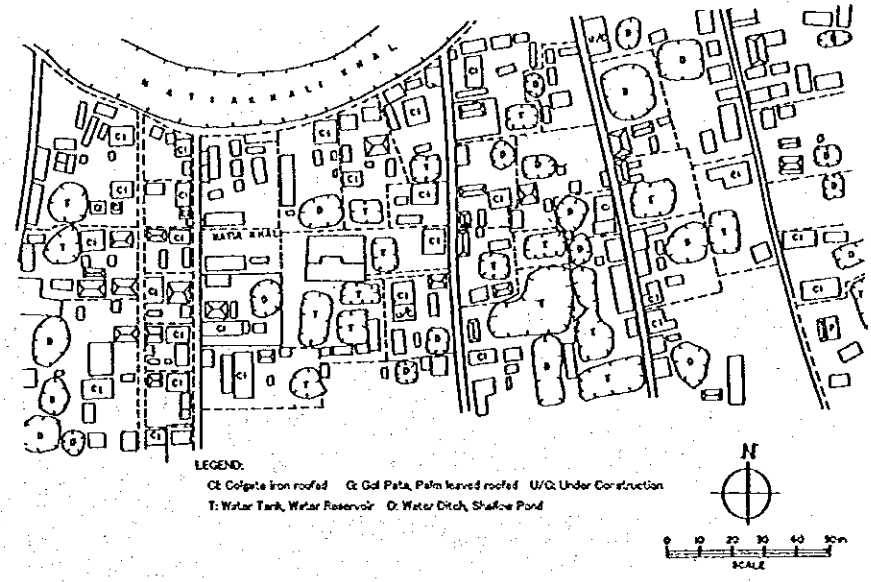


Fig. 7.2.4 Homestead Settlement Allocation Pattern in the Route 3 Area

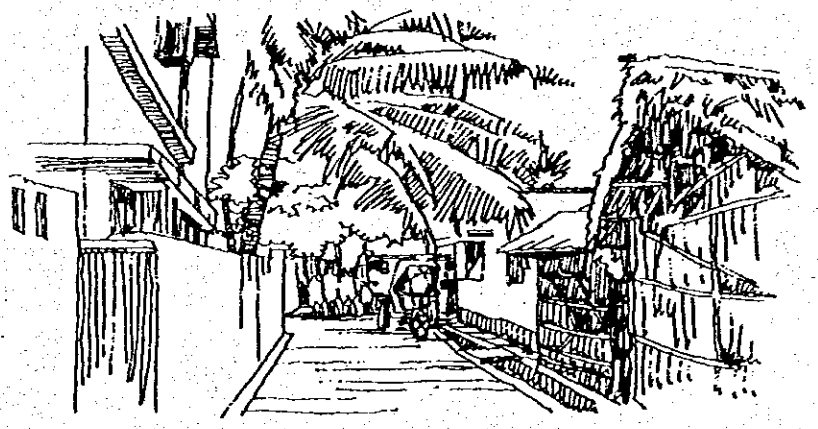


Fig. 7.2.5 Typical Pucha and Semi-pucha House in the Route 3 Area

Fig. 7.2.6 is the layout of a typical homestead area in the semi-urban area within the project-affected area of Route 2. Fig. 7.2.7 is the sketch of a common homestead landscape along the alley.

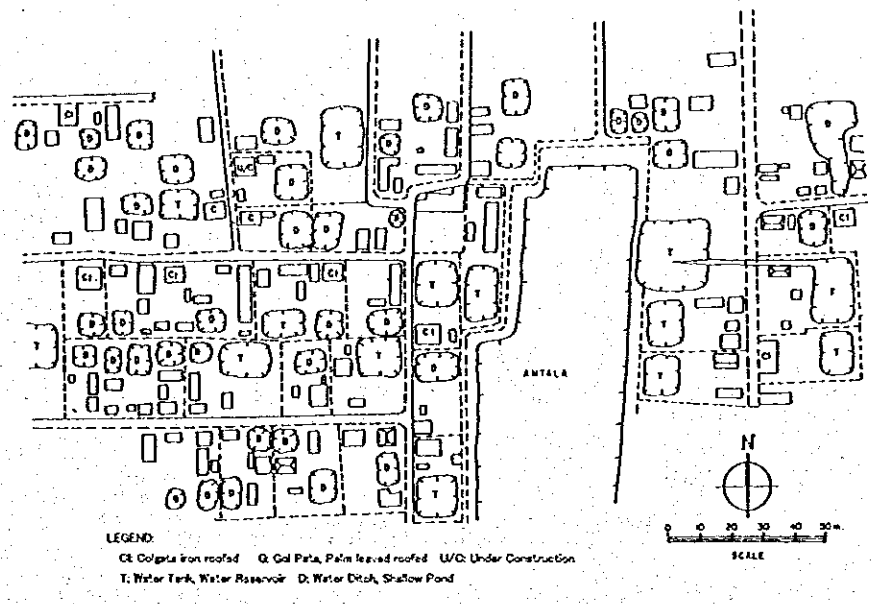


Fig. 7.2.6 Homestead Settlement Allocation Pattern in the Roue 2 Area

Fig 7.2.7 Kucha Houses And Some Semi-pucha House are Distributed in the Route 2 Area

③ Homesteads located away from the urbanized areas tend to form a cluster type which consists of simple bamboo huts, courtyard and pond. The bamboo hut has a structure with timber posts at each corner and front roof ends; wall of the hut made of bamboo woven sheets fixed with bamboo tie-beam and girders with diagonal supports for stability. Nippa palm leaves are used as roofing material.

This type of hut is locally called as Kucha house and generally is in square to rectangular in shape with extended lower roof which is used as a kitchen space as well as for semi-public activities. Sometimes a long rectangular shaped such Kucha house is observed; shared by several households, each unit being separated by bamboo woven walls, under a single hut structure. This type of homestead cluster also composes facilities same as that of semi-Pucca house homestead. Similar homestead in the suburban area is adjoined by paddy along with cowshed, chicken hut and duck hut within the homestead. The typical clustered homestead layout in suburban area is shown in Fig. 7.2.8 and a sketch of inside courtyard landscape is shown in Fig. 7.2.9

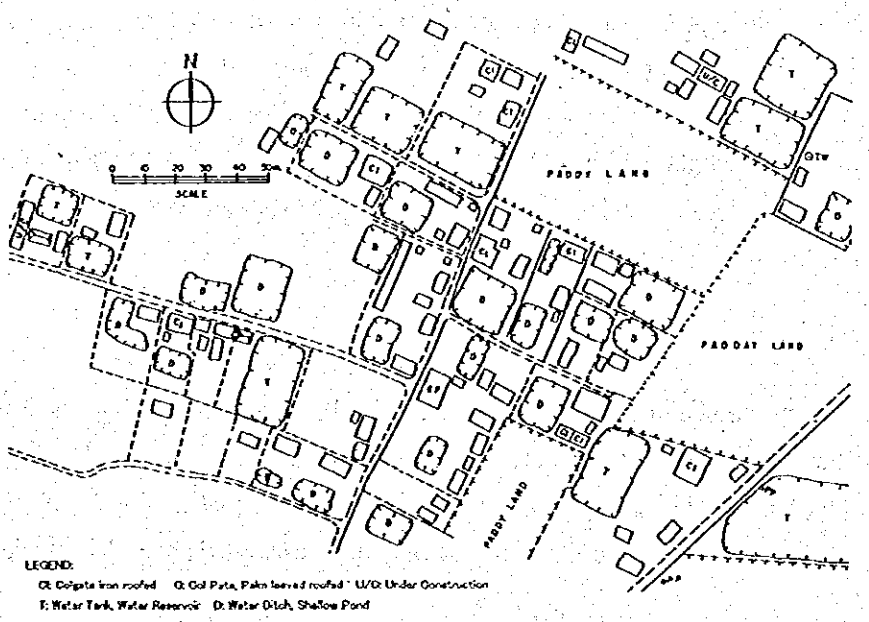


Fig. 7.2.8 Homestead Settlement Allocation Pattern in the Route 1 Area

Fig 7.2.9 Kucha Houses and Courtyard Adjacent Pond within the Route 1 Area