United Nations Development Programme
World Bank
Bangladesh Water Development Board
Ministry of Irrigation, Water Development and Flood Control
Government of the People's Republic of Bangladesh

South East Region
Water Resources Development Programme
BGD/86/037

(FAP 5)

Regional Plan Report
Volume 5

	Fisheries
Annex VII	Financial and Economic Analyses
Annex VIII	Estimate of Costs of Minor Irrigation
Annex IX	Engineering Costs
Annex X	Comments, Replies and Actions on
Annex XI	Draft Regional Plan Report
Annex XII	Terms of Reference and Amendments
Annex XIII	Dakatia/Little Feni Transfer Draft TOR

August, 1993

Sir M MacDonald and Partners Limited, UK
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CHAPTER VII.1

INTRODUCTION

VII.1.1 Introduction

The area of the South East Region Water Resources Development Programme consists mainly of the greater Comilla and Noakhali Districts. The South East Region (SER) borders India to the east; the Chittagong area to the south-east; the North West Region (FAP 6) to the north and north-east; the North Central Region (FAP 3) to the west and the South West Region (FAP 4) to the south-west. To the south, the South East Region meets with the Bay of Bengal (Figure VII.1.1).

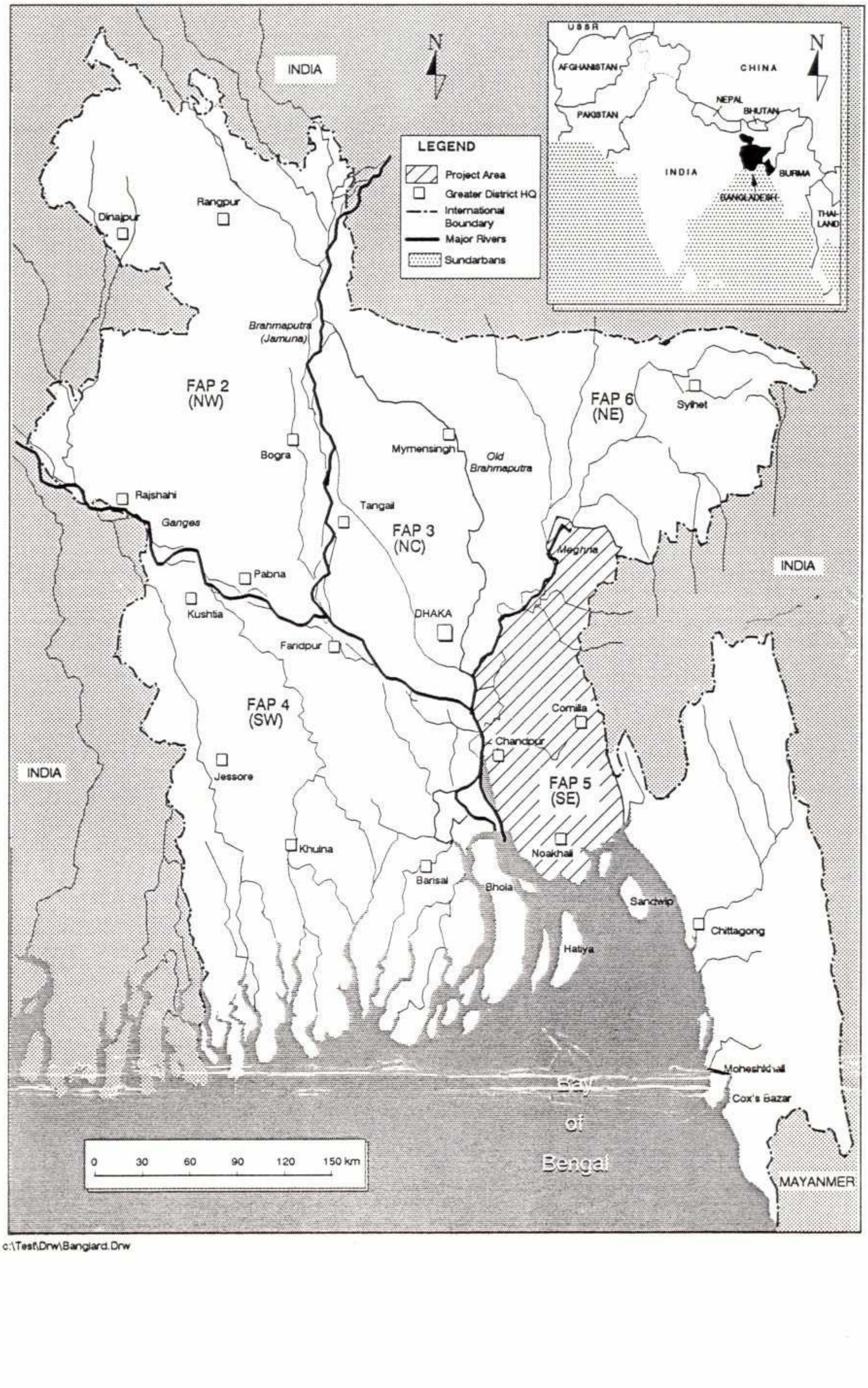
As a whole, the importance of freshwater fish lies in the fact that they are an important source of income and cheap protein for a large proportion of the human population in Bangladesh. Thus, the objective of the present study is to prepare a regional water resources development plan with the integration of all aspects of water development, of which, fisheries is one of the most important ones as shown by the recent feasibility studies carried out in the Gumti Phase II and Noakhali North areas within the South East Region, which will be used as examples throughout this text.

There are two main types of fisheries in the country, capture and culture fisheries. Capture fisheries takes place through the exploitation of fish in open waters such as rivers, Khals, Beels and in other depressions that hold water for any length of time. Culture fisheries occur in closed water bodies such as ponds, dighis, borrow pits and lakes, where stocking of fish, feeding and fertilization is carried out.

There is an extensive network of seasonal and perennial rivers with Khals cris-crossing the South East Region making it potentially very important for capture fisheries. A large proportion of the Region lies within the annual flooding area of the country and as such, it is believed to play an important role as fish habitat, especially in those areas isolated during the dry season which often merge into one vast expanse of water during the floods. This extensive flooding enhances the fisheries every year by carrying those species which migrate from the main rivers into the floodplain aquatic habitats for breeding, feeding or dispersal purposes. In addition, the man-made Khals and other type of artificial depressions (estuaries, road-side borrow pits and canals) also found in the area, act as fisheries production sites and are good settings for the cultivation of commercially important species. However, ecological and biological data regarding fish and their utilization is lacking, especially for the smaller species and it is thus not possible at present to assess the fisheries situation of the Region in detail.

Therefore, it is vital that an evaluation of the existing fish diversity and fisheries in the region and the potential ecological impacts that any flood control project might have on their life cycles and on the natural environment be carried out, taking into account the lessons learnt from existing FCD/FCDI schemes in the region, as well as the experience gathered from the more recent feasibility studies in the Gumti Phase II and Noakhali North areas.

Figure VII. 1. 1
South-East Region, Bangladesh



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However, as has been pointed out in these two studies (Gumti Phase II and Noakhali North Studies, 1993), to carry out such an evaluation properly, a detailed ecological assessment of the interactions between the ecosystem and the use of these resources by the local human population is indispensable. Any further development plans in the Region will thus have to incorporate appropriate programmes to look at the fisheries, both capture and culture, and the ecology of the Region.

As a whole, fisheries studies in Bangladesh are currently undergoing substantial changes and it has become indisputable that capture fisheries are considerably more important than previously realised. Relevant studies in this respect include the work by FAP 17, who are looking at the fisheries from the national perspective; FAP 6 the North East Regional study, the fisheries component of this study identified important fishery areas which were termed 'mother fisheries'; and the Gumti Phase II and Noakhali North feasibility studies within the South East Region, which used hydraulic models to estimate the areas of floodland which together with current field data allowed more accurate estimates for the potential fisheries outputs for each area to be made.

The Gumti Phase II area, in the northern part of the SER, has been identified as one of the most important fisheries areas in the country benefiting directly from the Upper Meghna and Titas Rivers. Within Gumti Phase II, the northern, central and western areas are especially important because of the early flooding from the fish-rich Meghna waters which enter via the northern part, extending rapidly throughout the basin. In the Noakhali North area, the most important fishery areas appear to be the Dakatia River and its floodplain. It is expected that other such areas may be identified within the Region after further work is carried out in this respect.

CHAPTER VII.2

EXISTING CAPTURE FISHERIES

VII.2.1 Open water situation in the Region

There is an extensive network of seasonal and perennial water bodies in the South East Region which often merge into one vast expanse of water during the floods. Figure VII.2.1 shows the river and Khal network in the Region as a whole while Figure VII.2.2 shows the areas that typically go under water in the SER in general. The area of these water bodies can be obtained with the aid of the MIKE II Hydraulic Model for the whole of the SER.

Table VII 2.1 provides details of the waterbodies in Gumti Phase II and Noakhali North.

TABLE VII.2.1

Area of Fishery Systems in Gumti Phase II and Noakhali North

Fishery System	Gumti Phase II (ha)	Noakhali North	Total
Meghna River	8,469	11,968	20,437
Dakatia River	-	594	594
Int River/Khal	2,955	1,216	4,171
Beels*	2,330	-	2,330
Floodplains#	109,217	72,768	181,985
Subtotal	**122,971**	**86,546**	**209,517**
Ponds@	4,202	8,014	12,216
Grand Total	**127,173**	**94,560**	**221,733**

Source: 1993 Gumti Phase II and Noakhali North Feasibility Studies

* Thana Fisheries Office Surveys carried out during the feasibility studies

\# Area calculated from results of the MIKE II hydraulic model

@ Refers to 'Cultured' ponds only

In the Gumti Phase II area, the area of natural water bodies which influence its fish production amounts to nearly 123,000 ha including 8,469 ha that correspond directly to the area of the Meghna River adjacent to Gumti Phase II. In Noakhali North, the area of natural water bodies contributing to fish production amounts to over 86,000 ha if the area of the adjacent Lower Meghna (11,968 ha) is included.

Figure VII.2.1 12

Rivers and Canal Network in the Study Area

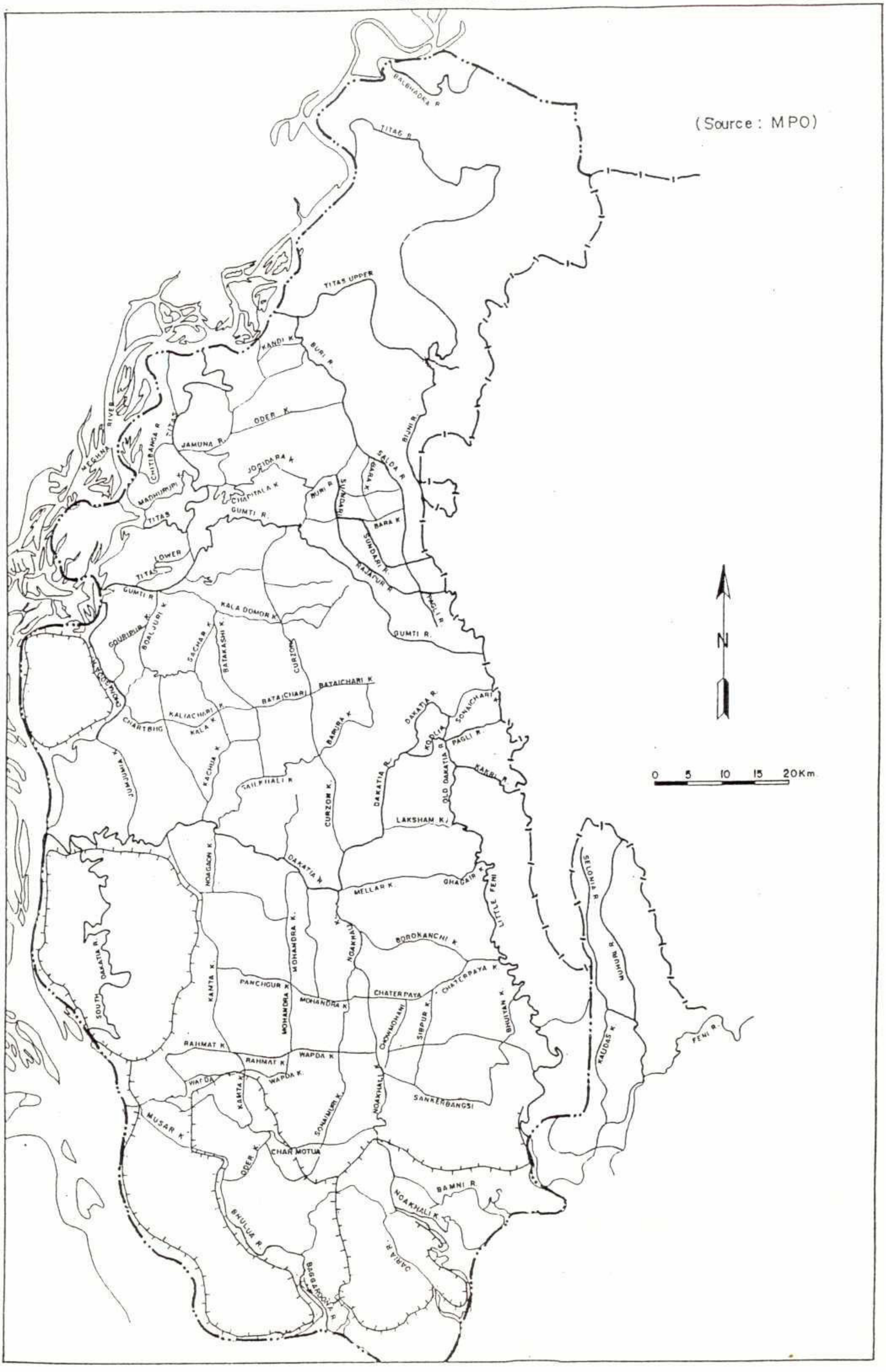

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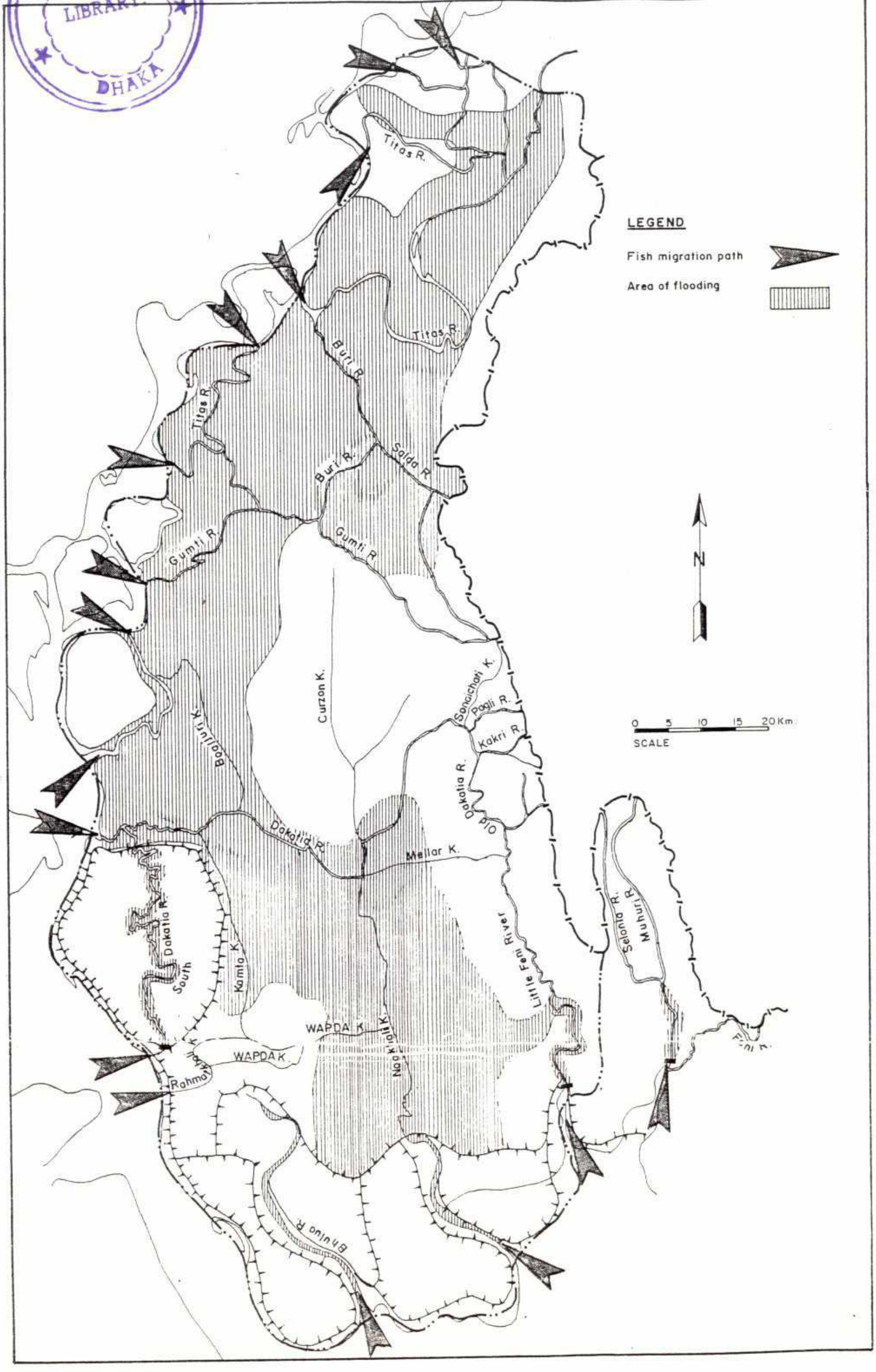
Figure VII.2.2

Presumed Fish Migration Path from the Meghna to the Floodplains/Rivers in the Area



It should be pointed out that for both the 1993 Gumti Phase II and the Noakhali North feasibility studies, the areas of floodplain were calculated from the results of the MIKE II hydraulic model which aggregated all the water levels greater than the MPO Flood Phase F0 (30 cm). This water level was considered the minimum level for fish production. Direct comparison between these results with earlier ones for the same areas of floodplain or for different ones is thus not possible as other studies in general have only included the MPO Flood Phases F3+F4. Further analyses of the floodplain area including all MPO Flood Phases greater than F0 should be carried out for the Region as a whole in order to obtain a more realistic value for the extent and duration of the flooding within the SER.

Table VII.2.2 shows the areas of water bodies for each planning unit in the SER. However, it should be noted that further hydraulic model runs should be made including the MPO Flood Phases greater than F0 (30 cm) for any fisheries analysis in the future. The difference can be clearly seen in the values for Gumti Phase II and Noakhali North when compared to the other planning units.

TABLE VII.2.2

Areas of standing water and rivers

Planning Unit	Total area including Floodplain (ha)	Standing water (ha)	River (ha)	Total
Ashuganj	21 740	16	63	79
Titas	52 180	175	350	525
Gumti II	118 704	6 532	2 995	9 527
Gumti I	14 910	22	33	55
Meghna-Dhonagoda	620	-	508	508
Dhonagoda	65 230	122	314	436
Sonaichari	4 350	13	-	13
CIP	7 770	68	-	68
Polder 59/2	25 510	970	355	1 325
Noakhali North	82 592	8 014	1 810	9 824
South Sudharam	87 280	11 863	500	12 363
Little Feni	77 340	900	300	1 200

Note: Excludes Meghna River.

Source: Surface Water Simulation Model

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VII.2.2 Jalmahals in the South East Region

Jalmahals are sections of permanent water bodies where fishing rights have been leased by the Government, usually on a three year basis. In the greater Comilla area there were 433 Jalmahals in the form of rivers, Khals, Beels, road-side ditches and large ponds with an estimated area of around 8,000 ha. These Jalmahals, according to information received from the Department of Fisheries (DOF), are scattered throughout the Region with areas ranging from 0.5 ha to over 500 ha. The numbers have been shown separately for the three old subdivisions, Brahmanbaria, Comilla and Chandpur. Jalmahals under the Chandpur subdivision have been further divided for three circles, i.e.: Matlab, Sharasti and Faridganj. The largest number of Jalmahal was reported for Brahmambaria (199 with an area of 5,139 ha), followed by Comilla (100, with an area of 1,500 ha) and lastly, Chandpur (34, with an area of 1,378 ha). In the greater Noakhali area, 258 Jalmahals were reported with an estimated area of approximately 400 ha (Table VII.2.3).

However, a New Fisheries Management Policy (NMFP) has already been introduced by the Government and Jalmahals will eventually have to be leased under this policy. Table VII.2.4 shows the Jalmahals under the NMFP for the Gumti Phase II area, as well as the number of fishermen involved per Jalmahal and Thana.

VII.2.3 Flood Phasing Situation in the SER

According to the MPO, normal FCD projects transform 65% of the F3-F4 land into F1 or F2 land. It is important to establish that the deeply flooded areas within the SER are potentially important fishing grounds as well as crucial feeding, breeding and nursery areas for fish. Table VII 2.5 shows the areas of F3 and F4 land in the SER. Further work related to fisheries in the SER should include an estimate of all land greater than F0 (i.e. 30 cm) available in the SER.

VII.2.4 Fish Migrations and Movements

There is a lack of detailed information regarding the migration patterns of the numerous fish species reported for Bangladesh. By and large, existing information has concentrated on a few of the commercially important species such as the major carps (i.e. Rui, Catla, etc.) and Hilsa.

There are vast floodplain areas within the SER such as the Gumti Phase II study area, where fish migration is rather an important issue for the whole energetics of the system, especially since the number of fish species recorded there is so large. Please refer to the 1993 Gumti Phase II Fisheries and Ecology Annexes for full details (Annexes F and D respectively). In addition, it is important to note that although some fish are in general referred to as 'migratory' fish, by and large **all** fish species migrate or move from one area to another in the floodplain. In the Fisheries Annex F, these species have been referred to as 'long-distance' migrants and 'floodplain resident' species.

TABLE VII.2.3

Number and areas of Jalmahal in the greater Comilla and Noakhali areas

District	Nr	Area (ha)
Brahmanbaria	199	5 139
Comilla	100	1 500
Chandpur		
Matlab circle	14	819
Shahrasti circle	6	30
Faridganj circle	14	Not known
Sub-total:	333	7 488
Noakhali:		
Sonagazi	9	2
Chhagalnaiya	22	10
Sudharam	24	12
Ramganj	13	11
Feni Sadar	17	6
Lakshmipur	77	82
Ramgati	8	13
Senbag	17	219
Begumganj	63	28
Companyganj	8	1
Sub-total:	258	384
Grant-total:	591	7 872

Source: **Department of Fisheries**

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TABLE VII.2.4

Jalmahals under the New Fisheries Management Policy in Gumti Phase II

Sl. No.	Name of Jalmahals	Location	Area (ha)	Number of Fishermen Involved
1.	Daudkandi thana Fisheries	Daudkandi	70	1 272
2.	Kairapur Fisheries	Daudkandi	30	1 216
3.	Nalia Fisheries	Muradnagar	33	133
4.	Dead Titas	Muradnagar	13	233
5.	Noabad Fisheries	Homna	500	1 085
6.	Titas Nadi Block "A"	Nabinagar	400	1 200
	Total:		1 046	5 139

Source: DFO, Comilla and Brahmanbaria. Thana Survey carried out during this study.

Number of Fishermen Per Thana

Sl. No.	Name of Thana	Full Time Fishermen	Part Time Fishermen	Occasional Fishermen	Total Fishermen
1.	Nabinagar	14 285	20 590	180 000	214 875
2.	Muradnagar	4 150	11 675	25 600	41 425
3.	Kasba	2 100	3 250	10 105	15 455
4.	Bancharampur	8 000	10 000	19 500	37 500
5.	Brahmanpara	480	780	4 310	5 570
6.	Homna	5 130	15 650	69 685	90 465
7.	Burichang	150	300	2 797	3 247
8.	Daudkandi	2 488	5 402	21 089	28 979
9.	Debidwar	2 100	2 800	16 802	21 702
10.	Kotwali (Comilla)	400	1 200	3 300	4 900
11.	Akhaura	270	460	2 600	3 330
	Total:	39 553	72 107	355 788	467 448

Source: Thana Fisheries Offices. Thana Survey carried out during this study.

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TABLE VII.2.5

$F_3 + F_4$ Lands in the Planning Units

Planning Unit	Irrigated	Rainfed	Total	Per cent of the gross total area
1. Ramgati	0	0	-	-
2. South Sudharam	0	0	-	-
3. Noakhali North	243	788	1 031	1
4. Little Feni river	0	0	-	-
5. Dakatia	1 745	6 005	7 750	9
6. CIP	0	0	-	-
7. MDIP	925	2 305	3 230	-
8. Dhonagoda	8 083	23 913	31 996	28
9. Sonaichari	0	0	-	-
10. Gumti I	5 717	8 796	14 513	46
11. Gumti II	24 389	21 575	45 964	32
12. Ashuganj	3 451	661	4 157	12
13. Titas	20 369	11 572	31 941	31

According to Welcomme (1979), most fish have two distinct centres of concentration, their wet and dry season habitats, and thus they have to travel sometimes over long distances in order to reach them. The two main components of such migratory movements recognised for tropical species are longitudinal and lateral migrations. Longitudinal movements taking place within the main river channel (i.e. 'long-distance' migrants), and lateral migrations being those where fish leave the main channel and distribute themselves over the floodplain, or the 'floodplain residents'. It is now known that both of these migrations are active since often fish migrate against the current to gain access to the main floodplain. Most healthy adult fish tend to direct their movements rather that drift in the current although fish eggs and larvae do drift.

There appear to be six main phases in the distribution of fish if both lateral and longitudinal migrations are combined. These are:

- longitudinal migration within the main channels for breeding: these are usually upstream
- lateral feeding migration in the floodplain
- local movements throughout the floodplain and distribution in seasonally flooded habitats
- lateral migration from the floodplain towards the main channels
- longitudinal migrations within the main channels for feeding, usually downstream
- local movements within the dry season habitats; these may be rivers, adjacent lakes, or the sea

In general, fish initiate their riverine migrations with the onset of the floods and lateral migrations when the banks spill onto the floodplain. In addition, fish appear to move actively against the current rather than to enter passively on incoming flows. Migration also appears to be an ordered sequence of species with some species moving first. Adult fish tend to leave the floodplain before the young-of-the-year, which appear to stay in the floodplain until the later stages of its emptying.

VII.2.5 Environmental Stimuli Influencing Fish Breeding and Migration

Breeding

Breeding begins during the pre-monsoon flood and depending on the rain and water volume in the river and floodplain, most of the catfish, live fish and other species such as Magur, Singi, Koi, Tengra, Pabda, Air, Boal, Gazar and Sol, start breeding towards the end of March and early April. It would appear that piscivorous fish such as some of the catfishes Boal, Gazar and Sol breed earlier than the non-piscivorous species. Optimal environmental conditions for breeding are tempestuous and include flash floods, heavy continuous rain and thunder, which together stimulate fish breeding, especially for Ghonia, Boal, Pabda, Koi, Batasi, Puti and Laso.

Fish Migration

In general, a series of environmental factors appear to trigger fish migrations, although these may not always be effective as fish are on occasions left stranded. Some of the main factors influencing fish movements include depth of water, (there seems to be a general tendency for bigger fish to leave the floodplain earlier than the smaller fish), dissolved oxygen concentrations, temperature, light (many fish prefer to move at night) and lunar phase.

In the present review it was not possible to examine fish migration and/or movements in the floodplain or the channels throughout the SER as the period of time and the resources available to carry out the present study were insufficient. However, since fish access to the river channels and floodplain areas is crucial to the ecology and to the fisheries as a whole, especially in areas such as the floodplain areas in Gumti Phase II and Noakhali North, it is strongly recommended that such a study be carried out before any intervention takes place in areas already identified as important for fish access, such as the northern part of Zone C in Gumti Phase II, which carries the early floods into the system and presumably the fish (Figure VII.2.3) and the Dakatia River floodplain in Noakhali North (Figure VII.2.4). Such a study should also consider other possible areas important for access for fish and other species.

In addition, full polderization of part or the whole of such important floodplain areas could have devastating effects on the fisheries and the ecology of the area due to their proximity to the Meghna River. The potential effects on the fisheries and the ecology of the Gumti Phase II and Noakhali North areas have been described more fully elsewhere (1993 Gumti Phase II and Noakhali North Draft Final Reports for Fisheries and Ecology).

It should also be emphasised that floodplain areas in general are vast wetlands which are believed to be a heaven for numerous species of flora and fauna. This has been confirmed from the preliminary evaluation of the biodiversity of the study area as described in Annexes D for both feasibility studies. It is therefore believed that any proposed polder schemes will also have devastating consequences on the wildlife, both flora and fauna, of the area.

Figure VII.2.3

Rising 1 in 2 Year Flood Pattern

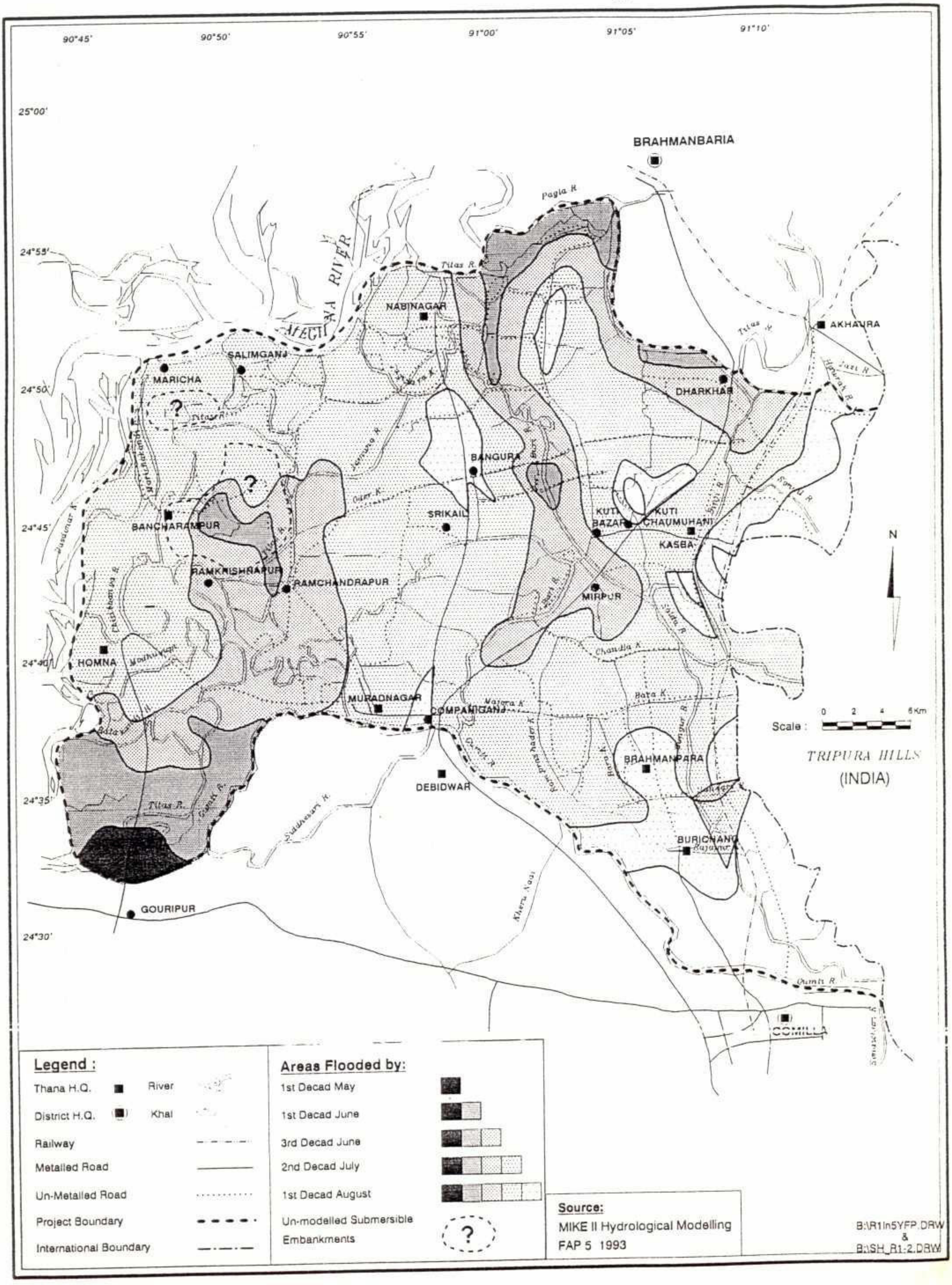
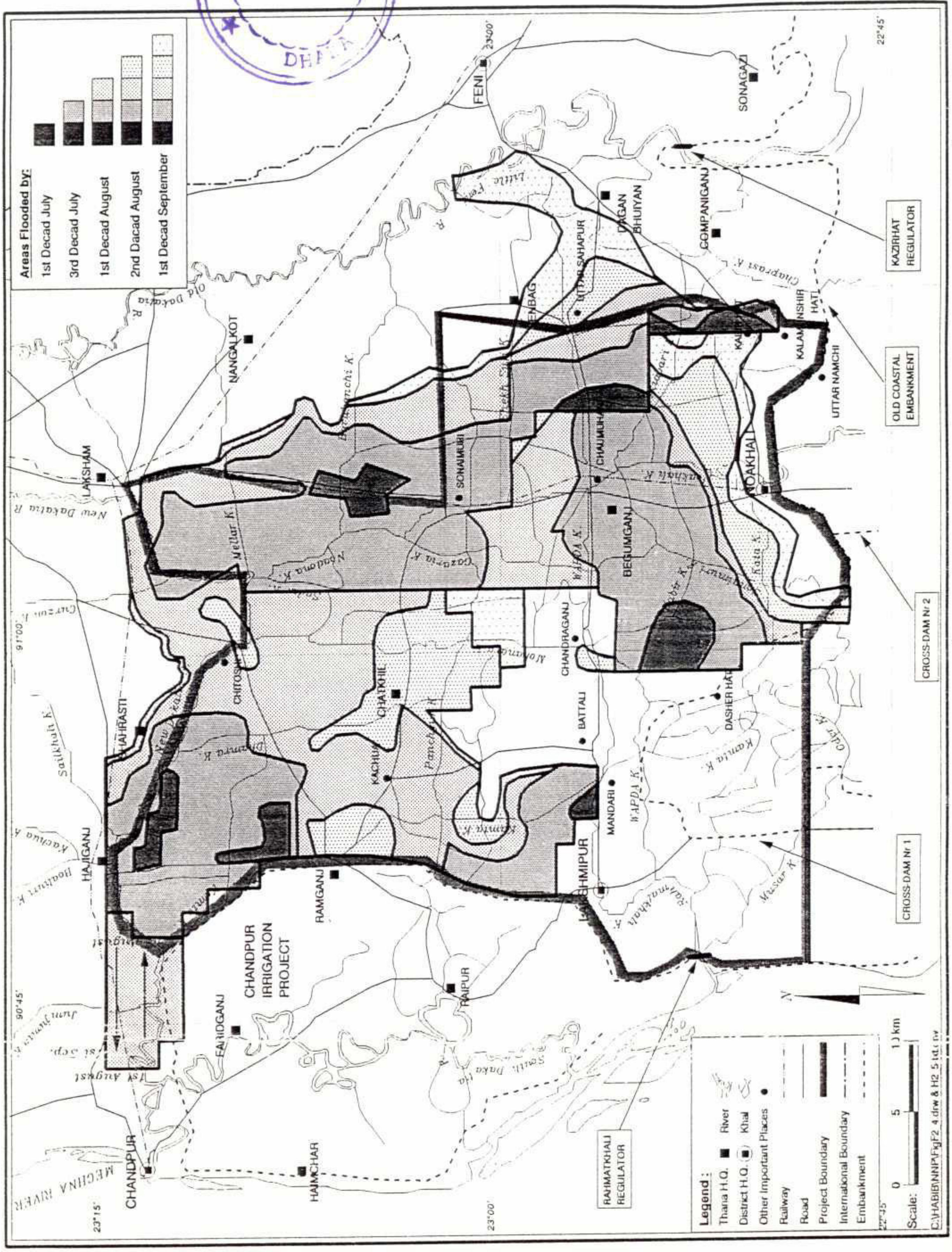


Figure VII.2.4

Extent of Rising Flood, 1 in 2 Year



VII.2.6 Notes on the Life History of the Major Carps and Hilsa

Major Carps These are important commercial species of which Rui is probably the favoured food fish in Bangladesh. It is thought that different geographical carp populations may exist. There are four carp species usually referred to this group: Rui, Catla, Mrigal and Kalbasu and all four are thought to have similar reproductive strategies. These four species are important in the fish catches in the whole of the SER.

Broodstock overwinter the dry season in large rivers and beels with the spawning migration occurring in the early monsoon. In general, brood stock from the move from the beels into the Khals and rivers, from where they move upstream to shallower areas suitable for spawning. According to Tsai *et al.* (1981), it appears that ox-bow bends in particular are favoured, probably because they possess unusual hydrological features (deep pools in the outer bend, turbulence, upwelling and backwater current in the inner bend). Eggs are non-adhesive and drift with the current, embryos hatch in 5 to 24 hours depending on the species. Major carp spawning grounds can be found from the sightings of drifting eggs and hatchlings.

No spawning sites for these species were located within the SER area. However, there was not enough time available in the study to carry out a thorough field survey in this regard. According to fishermen in the North East Region, major carps also spawn in Beels (FAP 6, 1993). Increasing Beel water levels during the early monsoon may be enough stimulus to induce them to spawn in their overwintering Beels. Broodstock which have overwintered in rivers may have the option of carrying a spawning migration upstream at the onset of the monsoon, or to remain in the vicinity of the overwintering grounds, wait until the river banks are overtopped and then move laterally onto the floodplain to spawn. The possibility of major carp spawning in the Beels located to the west and north of the Gumti Phase II study area, since these Beel areas are located close to the Lower Meghna River needs to be investigated further.

Hilsa (Hilsa ilisha) This is an anadromous species which ascends to the Gangetic river systems and which is extremely important from the fisheries point of view. Studies by the Fisheries Resource Institute (DOF) have shown that the distribution areas and spawning grounds of this species centre on the confluence of the Padma and Meghna Rivers, although it enters several of the other rivers in the region.

VII.2.7 Production Trends at National and District Levels

Fish Catch Statistics published by DOF from 1983-84 to 1989-90 have been used to assess National and District production. The annual fish production for each relevant system at these two levels is shown in Table VII.2.6 and Figures VII.2.5a, b and c (Table F.5.1 and Figures F.5.1a and F.5.1.b. form Gumti Fisheries Report plus new figure for Noakhali data). It can be seen that the contribution of each production system to the total catch is different at these levels. At the National level, rivers and floodplains contribute substantially and in a similar proportion to the annual total catch in the country, with pond production following closely, especially during the last three years up until 1989-90. Beel production remains low and shows a declining trend (Table VII.2.6). Overall the levels of production remain fairly constant.

The production of these systems for the Comilla District is variable throughout this period, with floodplain and ponds contributing mostly to the total catch, followed by rivers. Beel production appears to be virtually negligible.

Figure VII.2.5a

Percentage Catch Composition per Fishery System

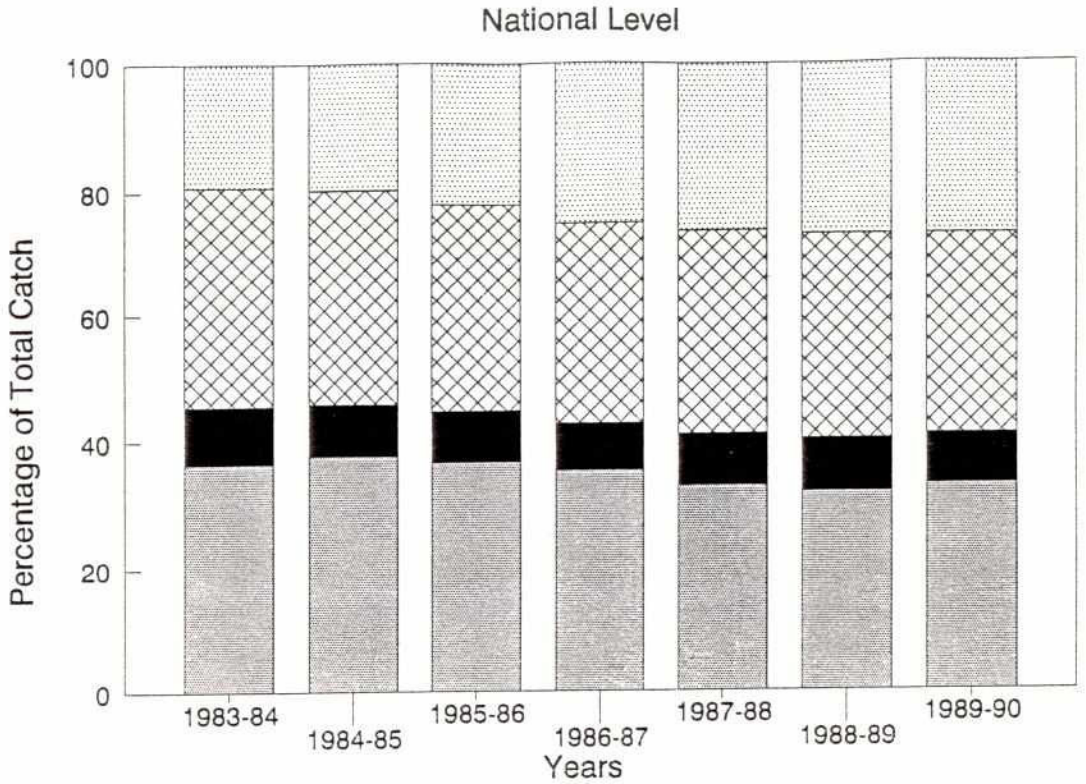


Figure VII.2.5b

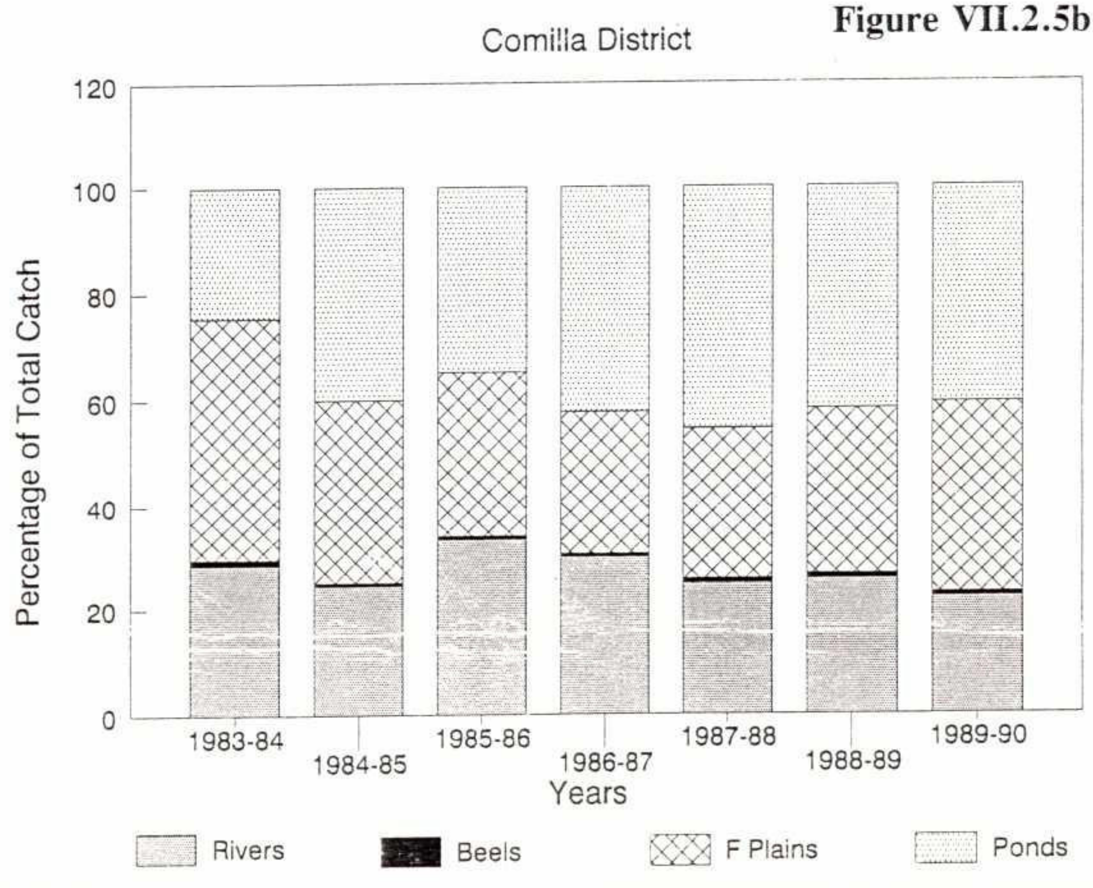


TABLE VII.2.6

Total Catch per Fishery System at National and District Levels

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90
National Level							
Rivers	207,766	213,057	206,712	201,152	183,817	181,140	198,941
Beels	51,373	45,893	45,258	42,077	45,610	47,019	46,594
F Plains	200,616	194,130	187,396	183,796	182,037	186,126	193,762
Ponds	109,333	111,567	123,804	142,876	149,423	155,012	163,730
Total	569,088	564,647	563,170	569,901	560,887	569,297	603,027
Old Comilla District Level							
Rivers	13,678	10,860	17,297	17,082	13,692	15,345	14,659
Beels	497	267	337	316	480	458	474
F Plains	22,002	15,526	16,145	15,563	15,983	19,069	23,972
Ponds	11,845	17,726	17,960	24,077	24,983	24,935	26,753
Total	48,022	44,379	51,739	57,038	55,138	59,807	65,858
Noakhali District Level							
Rivers	24,845	7,807	11,960	15,244	16,568	18,966	NA
Beels	1	1	1	1	1	1	NA
F Plains	11,883	8,019	7,919	9,821	9,722	11,164	NA
Ponds	9,799	14,687	15,186	10,460	11,344	11,595	NA
Shrimp Farm	0	0	0	5	5	11	NA
Total	46,528	30,514	35,066	35,531	37,640	41,737	NA

Percentage of Total Catch per Fishery System at National and District Levels

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90
National Level							
Rivers	36.5	37.7	36.7	35.3	32.8	31.8	33.0
Beels	9.0	8.1	8.0	7.4	8.1	8.3	7.7
F Plains	35.3	34.4	33.3	32.3	32.5	32.7	32.1
Ponds	19.2	19.8	22.0	25.1	26.6	27.2	27.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Old Comilla District Level							
Rivers	28.5	24.5	33.4	29.9	24.8	25.7	22.3
Beels	1.0	0.6	0.7	0.6	0.9	0.8	0.7
F Plains	45.8	35.0	31.2	27.3	29.0	31.9	36.4
Ponds	24.7	39.9	34.7	42.2	45.3	41.7	40.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Noakhali District Level							
Rivers	53.4	25.6	34.1	42.9	44.0	45.4	NA
Beels	0.0	0.0	0.0	0.0	0.0	0.0	NA
F Plains	25.5	26.3	22.6	27.6	25.8	26.7	NA
Ponds	21.1	48.1	43.3	29.4	30.1	27.8	NA
Shrimp Farm	0.0	0.0	0.0	0.0	0.0	0.0	NA
Total	100.0	100.0	100.0	100.0	100.0	100.0	NA

Source: FRSS, DOF. Data for riverine catch for 1989-90 represents the average for 6 years.

The production in the Noakhali District was also variable with rivers contributing substantially to the total catch. It should be pointed out that most of the riverine catch consisted of Hilsa (*Hilsa ilisha*) with about 17,000 MT out of the total of 19,000 MT. Pond production reached nearly 50% of the total production in the Year 1984-85 and although fairly variable appears to have stabilized in subsequent years. Floodplain production remained relatively constant throughout the period, while production from Beels and Shrimp Farms was negligible (Table VII.2.6).

VII.2.8 Average Annual Trends

Average annual trends in total fish production at the National level and for the Comilla District level were calculated and are presented here as an example of the high level of variation found between the data at the National and District levels. These production trends were 0.97% and 5.41%% respectively (Table VII.2.7). National fish production increased from 569,088 to 603,730 MT (an increment of 34,642 MT), while production in the Old Comilla District rose from 48,022 to an estimated 65,858 MT (an increment of 17,836 MT) (Table VII.2.6). Table VII.2.7 and Figure VII.2.6a show details of the average annual change in the total catch of the various production systems in the Old Comilla District, and it emphasizes the differences between these and the National trends.

VII.2.9 Percentage Annual Change

The percentage annual change per production system at National and Comilla District levels is presented in Figure VII.2.6b. Although differences in trends between the two are clearly marked and could be a reflection of the differing fishing systems, it was however considered unjustified to use these District trends for the Gumti study since they are based on a very small sample (FAP 17 personal communication). Details of the percentage annual change in production at the District level are given in Table VII.2.8.

TABLE VII.2.7

Average Annual Change in Total Catch per Fishery System at National and District Levels from 1983-84 to 1989-90

Fishery Systems	National Level	District Level
Rivers	- 0.73	1.16
Beels	- 1.64	-0.79
F Plains	- 0.58	1.44
Ponds	6.96	14.54
Total	0.97	5.41

Derived from FRSS, DOF Data.

Figure VII.2.6a

Comparison Between National Level and Comilla District

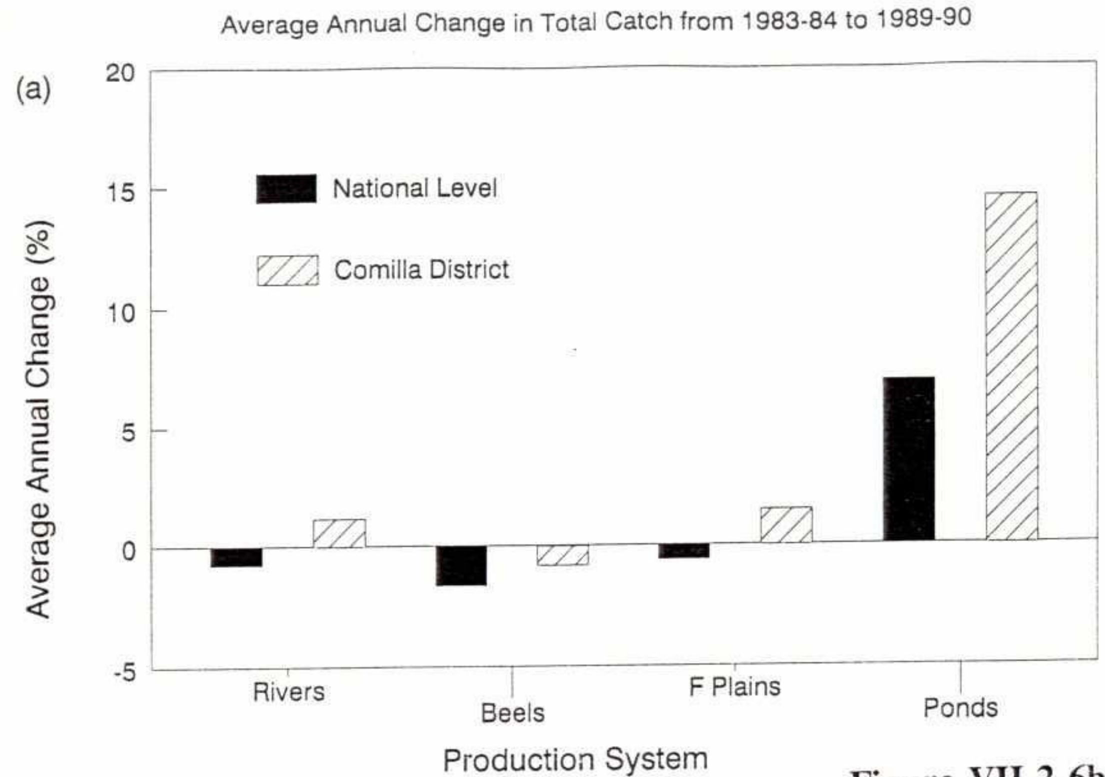


Figure VII.2.6b

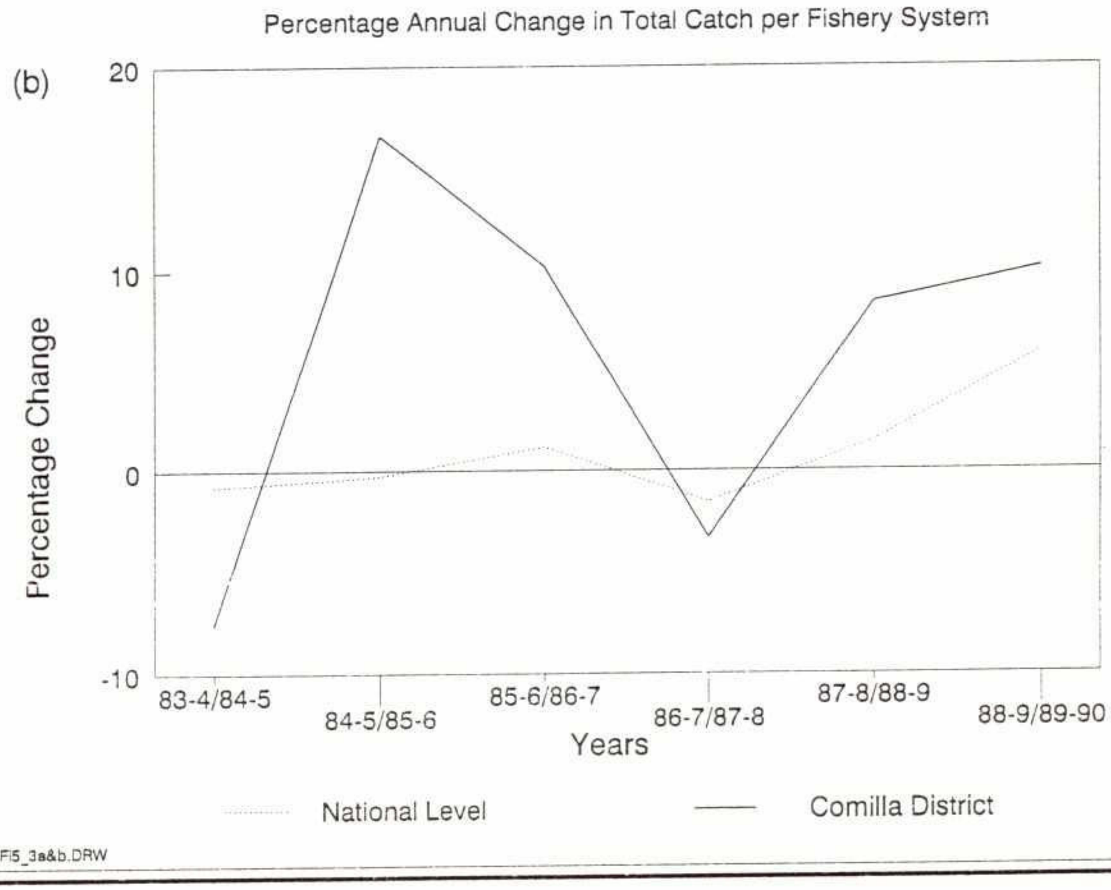


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TABLE VII.2.8

Percentage Annual Change in Fish Production in Different Fishery Systems

Old Comilla District

Fishery Systems	83-4 & 84-5	84-5 & 85-6	85-6 & 86-7	86-7 & 87-8	87-8 & 88-9	88-9 89-90
U-L Meghna	-32.9	71.7	-1.3	-26.9	25.1	-6.5
O Rivers	37.3	30.8	-1.1	1.4	-16.2	2.2
Beels	-46.3	26.1	-6.2	52.0	- 4.5	3.49
F Plains	-29.4	4.0	-3.6	2.7	19.3	25.71
Ponds	49.6	1.3	34.1	3.8	0.2	7.29
Total	- 7.6	16.6	10.2	-3.3	8.5	10.10

Riverine Data for 1989-90 calculated from the average catch of 6 years.

Despite the decision not to use the District data for the feasibility studies (Gumti Phase II and Noakhali North), further analyses into trends per production system at for the Comilla District were carried out and the findings are presented in Figure VII.2.7 indicating a very volatile situation. The analysis done for the Comilla District set of data are presented below.

VII.2.10 Production Levels in the Old Comilla District

VII.2.10.1 Capture Fisheries

Meghna and Other Rivers Riverine fish production represented over 22% of the total catch of the Comilla District in 1989-90. Trends in river production over 7 years can be seen in Figure VII.2.5b. The percentage change in annual fish production in the Meghna River (Upper and Lower Meghna) contributing to the District's total catch shows wide fluctuations from year to year (Figure VII.2.7). However, the two increments in the fish catch in the Meghna River appear to correspond to high water levels in the area and the decrease in production found from 1986-87 to 1987-88 appears to correspond to low water levels recorded during 1986. The production trend of the Other Rivers in the District show a dramatic and steady decline from 1983-84/1984-85 to 1987-88/1988-89, after which it shows a slight improvement (Figure VII.2.7). Overall riverine production increased by 1.16% in the District in the 7 years from 1983 to 1990. The overall estimated total riverine catch for the Comilla District for 1988-89 is shown in Table VII.2.9.

Beels Beel production represented only 0.7% of the total catch in 1989-90 (Table VII.2.6, Figure VII.2.5b). However, annual changes varied considerably throughout the period from 1983 to 1990, despite such low levels (Figure VII.2.7). The two peaks in the trends in 1984-85/1985-86 and in 1986-87/1987-88 also appear to be a response to increased water levels during those years. Overall Beel production declined by -0.79% from 1983 to 1990.

TABLE VII.2.9

Estimated Total Catch of Riverine Fisheries on the Basis of Catch Assessment Survey
District Total by Rivers in MT

Code	Type of Fish	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
01	Major Corp	0	3	3	86	95	109	30	31	30	25	16	12	144
02	Other Corp	0	0	0	13	20	10	6	4	4	4	3	1	22
03	Catfish	2	4	3	24	44	87	33	33	19	23	17	14	139
04	Snake head	0	0	0	1	1	3	3	4	1	1	0	0	9
05	Live fish	0	0	0	0	0	0	1	1	1	0	0	0	3
06	Other inland fish	177	206	206	814	588	487	450	246	215	278	168	230	1,587
07	Hilsa, ilish	537	979	2,533	240	210	191	3,231	283	230	206	175	611	4,736
08	Bombay duk	0	0	0	0	0	0	0	0	0	0	0	0	0
09	Indian salmon	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Pomfret	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Sharks & Rays	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Other Marine fish	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Big prawns & shrimps	1	2	3	49	18	17	10	7	1	0	7	3	28
14	Small shrimps	40	43	44	53	47	49	49	38	35	46	54	50	272
15	Crabs	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	75	1,237	2,793	1,280	1,023	953	3,813	647	536	583	440	921	6,940

Source: Department of Fisheries
District: Comilla, 1988 & 1989

Floodplain There is a general positive trend in floodplain production although not a dramatic one, and it represents over 36% of the total catch in 1989-90 (Figure VII.2.5b). Overall, floodplains contributed slightly more than rivers to the total catch in the 7 year period, showing an increase of 1.44% (Figure VII.2.7).

VII.2.10.2 Culture Fisheries

The contribution from pond production to the total Comilla District catch in 1989-90 was 40.6% (Figure VII.2.5b, Table VII.2.6). Overall, the increase in pond production in the District during the period was 14.5%, substantially higher than any of the trends of the other systems. However, there was a sharp decline in production during 1984-85/1985-86.

VII.2.11 Open Water vs Pond Production

In general, pond production in the Comilla District shows an inverse relationship to capture fisheries production in all open water systems (i.e. rivers, Beels and floodplains) (Figure VII.2.7). With the exception of the fish production in the Meghna River, there was an improvement in the production of all other systems during 1988-89/1989-90. This might be due to an increased availability of fish in open water fisheries after the high floods of 1987 and 1988 as shown by the higher catches in these systems during the same period.

According to SPARRSO (1984), there is a high pond concentration in both the Comilla and Noakhali Districts (120,608 and 99,781 respectively). Traditionally, ponds have been grouped into three categories: cultured (58%), culturable (30%) and delelict (12%). However, the proportion of Culturable and Derelict ponds do not appear to reflect reality as they are similar for both Districts. It is understood that the proportion of Culturable and Derelict ponds is estimated from the number of Cultured ponds.

There are important aquaculture developments in both Districts. In Comilla, the Rotary Club has been carrying out training programmes and has been developing pilot integrated farming projects with impressive results. Please refer to the 1993 Gumti Phase II Draft Final Report for more details.

VII.2.12 Existing Culture Fisheries in the SER

VII.2.12.1 Hatcheries and Nurseries

The existence of hatcheries and nurseries might serve as good indicators of the development of aquaculture in an area. The south-east region appeares to lead in fish culture in general. The 1988 data (Table VII.2.10) shows that there were 14 fish seed farms with hatchery and nursery facilities under the public sector in the area. The actual production capacity of the farms has not been available, however the target production was 464 kg of spawn and 7 million fry/fingerlings; the actual production achieved in one recent year was 269 kg of spawn and 4 million fry/fingerlings. Figure VII.2.8 shows the locations of the major and minor hatcheries in the region. In the private sector on the other hand, the figure for the same period shows that there were 85 hatcheries and 730 nurseries in the area. The total capacity of production was about 9 000 kg of spawn and about 400 million fry/fingerlings, the actual production being obtained was about 3 000 kg of spawn and about 280 millions fry/fingerlings.

In Noakhali, the production of fish seed and fingerlings is notable and the Raipur Hatchery and Training Centre has been instrumental in developing this activity in the area.

VII.2.12.2 Private Fish Farming

Together with the development of hatcheries and nurseries in the area, private fish farming on a commercial scale has also been under way. The 1988 data (Table VII.2.11) on the number of private fish farms in the greater Comilla and Noakhali areas show that there were a total of 97 fish farms, the total capacity of production of the farms was 356 tonnes with the actual production being 215 tonnes. The area of the individual fish farms is not known, thus the production per area of water cannot be calculated.

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TABLE VII.2.10

Hatcheries and nurseries - Production (1988)

Public Sector

Name of place	Spawn		Fry/fingerling	
	Target of production (kg)	Actual production (kg)	Target of production (Nr)	Actual production (Nr)
Feni Sadar	25	15	200 000	144 000
Chaumohoni	20	19	100 000	185 000
Raipur	210	132	3 800 000	1 720 500
Kachwa	15	7	250 000	12 400
FRI'S riverine Station, Chandpur	-	50	-	-
Jangalia	50	53	405 000	460 000
Burichang	15	4	100 000	16 000
Chouddagram	16	6	305 000	368 000
Debidwar	20	9	350 000	452 000
Laksham	10	10	360 000	395 000
Chandina	10	3	200 000	97 000
Brahmanbaria (Sadar)	8	3	200 000	51 000
Private Sector				
Lakshmipur	2 950	617	64 500 000	45 900 000
Noakhali	305	104	29 180 000	11 029 000
Brahmanbaria	360	197	37 000 000	27 300 000
Feni	565	136	41 000 000	33 100 000
Chandpur	280	109	33 300 000	23 100 000
Comilla	4 255	1 867	263 700 000	137 300 000

Source: Department of Fisheries

TABLE VII.2.11

Private farms - Production (1988)

Name of area	Nr of farms	Capacity of production (tonnes)	Actual production (tonnes)
Lakshmipur	8	59	38
Noakhali	25	134	52
Brahmanbaria	29	44	30
Feni	31	74	67
Chandpur	4	45	28
	97	356	215

Source: Department of Fisheries

TABLE VII.2.13

Species Composition (percentage by weight) of Pond Catch

Species	Comilla	Noakhali
Rohu (Labeo rohita)	34.62	34.88
Catla (Catla catla)	28.38	31.14
Mrigal (Cirrhina mrigala)	19.93	19.43
Minor carp	7.95	3.34
Silver Carp (Hypophthalmichthys molitrix)	5.42	0.00
Tilapia O. niloticus O. mossambicus	0.00	1.14
Shrimp	0.23	0.00
Boal (Wallago attu)	0.54	0.00
Shol/Gajar/Taki (Channa Spp.)	0.11	0.00
Shing/Magur (H. fossilis/C. batrachus	0.4	0.00
Puti (Puntius Spp.)	0.54	0.00
Others	1.79	9.78

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TABLE VII.2.12

Fish Ponds by Thana

DISTRICT & Thana	Total Number of Ponds				Total Area of Ponds (ha)			
	Total	Cultured	Culturable	Derelict	Total	Cultured	Culturable	Derelict
BRAHMANBARIA	36 097	21 700	10 212	4 105	3 852	2 594	885	373
Akhaura	1 826	1 049	536	241	202	136	47	19
Ashuganj								
Bancharampur	3 361	1 959	1 002	400	378	254	87	37
Brahmanbaria	9 041	5 271	2 694	1 076	1 016	684	234	98
Kasba	3 787	2 208	1 128	451	426	287	98	41
Nabinagar	6 579	3 836	1 961	782	740	498	170	72
Nasirnagar	5 538	3 229	1 650	659	623	419	143	60
Sarail	5 965	4 228	1 241	496	468	315	108	45
CHANDPUR	30 247	17 634	9 014	3 599	3 400	2 289	781	329
Chandpur	5 917	3 450	1 763	704	665	448	153	64
Faridgang	4 213	2 456	1 256	501	474	319	109	46
Haimchar	2 367	1 380	705	282	266	179	61	26
Hajigang	3 455	2 014	1 030	411	388	262	89	38
Kachua	4 307	2 511	1 284	512	484	326	111	47
Matlab	7 195	4 195	2 144	856	809	545	186	79
Shahrasti	2 793	1 628	832	333	314	211	72	30
COMILLA	56 091	32 701	16 715	6 675	6 437	4 245	1 543	650
Barura	4 402	2 566	1 312	524	495	333	114	48
Brahmanpara	2 461	1 435	733	293	277	186	64	27
Burichang	2 887	1 683	860	344	325	219	74	32
Chandina	3 692	2 153	1 100	439	415	279	96	40
Chouddagram	4 923	2 870	1 468	585	553	372	127	54
Daudkandi	6 674	3 891	1 989	794	749	505	172	71
Debidwar	4 213	2 456	1 255	502	474	319	109	46
Homna	3 077	1 794	917	366	467	233	160	74
Comilla Kotwali	5 254	3 063	1 566	625	591	398	136	57
Laksham	8 473	4 940	2 525	1 008	952	641	219	92
Muradnagar	6 201	3 615	1 848	738	709	469	172	68
Nangolkot	3 834	2 235	1 142	457	431	290	99	42
FENI	12 023	7 009	3 583	1 431	1 351	910	311	131
Daganbhuiyan	3 597	2 097	1 072	428	404	272	93	39
Feni	3 976	2 318	1 185	473	447	301	103	43
Sonagazi	4 450	2 594	1 326	530	500	337	115	48
LAKSHMIPUR	25 987	36 675	18 747	7 486	2 921	1 967	671	283
Lakshmipur	7 952	4 636	2 370	946	894	602	205	87
Raipur	3 408	1 987	1 015	406	383	258	88	37
Ramganj	3 077	1 794	917	366	346	233	79	34
Ramgati	11 550	6 734	3 442	1 374	1 298	874	298	126
NOAKHALI	36 921	21 524	11 003	4 394	4 150	2 795	954	402
Begumganj	7 479	4 360	2 229	890	841	566	194	81
Chatkhil	2 461	1 435	733	293	277	186	64	27
Companiganj	4 923	2 870	1 467	586	553	372	127	54
Senbag	2 935	1 711	875	349	330	222	76	32
Sudharam	19 123	11 148	5 699	2 276	2 149	1 447	494	208
Total	**197 366**	**126 561**	**63 773**	**25 493**	**22 112**	**14 800**	**5 145**	**2 168**

VII.2.12.3 Culture Fisheries Production

According to DOF (1988-1989) data, the total production obtained from ponds from the greater Comilla and Noakhali areas was estimated to be 24 935 tonnes and 11 595 tonnes respectively. Table VII.2.12 shows the total area and of ponds in the study area by thana. Yield data is of poor quality but the thana statistics are based on yields of about 1 200 kg/ha, 640 kg/ha and 690 kg/ha for cultured cultivable and derelict ponds respectively. Yields may reasonably be expected to double with proper management in controlled flooding conditions.

The composition of species in the pond production/pond catch is shown in Table VII.2.13. In total, at least 12 different species and five species groups are known to be obtained from pond production.

VII.2.12.4 Population Engaged in Fisheries Activities

There is a dearth of data on the actual number of full-time and subsistence fisherman in South-East Region as a whole. It would be assumed that the number and proportion of the people engaged in fishery either as full-time fishermen or as subsistence fishing would vary from area to area, and it would be safer to assume that the number and proportion would be higher in those areas which have more potential for capture fisheries (Table VII.2.14). The rapid rural appraisal conducted at a few of the thanas of the region revealed that about 2% of the population are engaged as full-time fishermen and about 5% of the population catch fish on a subsistence basis.

However, it should be pointed out that the number of fishermen, or fishing households, in the Region vary according to their surrounding environment and the type of fishing systems in the area.

In the Gumti Phase II and Noakhali North study areas, for example, the number of fishing households was estimated from information received from the Thana Fisheries Office survey. This indicated the number of fishermen per Thana and the number of households in the area as per the 1981 census (BBS, 1981) for the Gumti study and the 1991 census (BBS, 1991) for Noakhali North. It was assumed that there was one fisherman per fishing household and that these households were uniformly distributed through the project area. It would be valuable to verify these data from the 1991 BBS census for both studies when this census becomes available.

TABLE VII.2.14

Number of Rural Population Involved in Fishing

Name of Thanas	Nr of Fishermen Full-time	Nr of Fishermen Subsistence	Total population
1. Sarail	3 250	3 750	198 005
2. Nasirnagar	10 000	15 000	250 000
3. Madhabpur	200	30 000	194 710
4. Nabinagar	3 300	61 519	335 179
5. Bancharampur	8 000	19 500	222 705
6. Homna	5 100	69 685	250 000
7. Hajiganj	2 000	4 000	221 176
8. Matlab	2 000	25 000	434 680
9. Chandpur	8 600	3 000	336 539
10. Lakshmipur	7 385	6 000	473 611
11. Daganbhuiyan	2 015	4 500	160 722
12. Sudharam	1 169	53 730	542 000
13. Chauddagram	160	4 000	366 002
Total:	53 179	299 684	4 005 529

Gumti Phase II

Table VII.2.15 shows details of these results per zone for the 1993 Gumti Phase II study. In total, there were 167,162 fishing households in the Gumti Phase II area equal to 57% of the total households in the area. Of these, 16,458 (5.6%) were full time, 34,895 (11.9%) were part time and 115,809 (39.5%) were occasional. The data was analyzed according to the four zones in which the Gumti study area had been divided. Zone A, consisted of slightly higher ground, followed by Zone B; Zones C and D were located in the deeply flooded region of the project area. For a detailed explanation of the Zones and their differences please refer to the Fisheries Annex F of the 1993 Gumti Phase II Draft Final Report.

In Zone A, the total number of households was 14,129, 23% of the total number of households in the study area, and represented 23% of the total number of households in that zone. The proportion of fishing households was very similar in Zones B and C with 47.7% (25,354) in Zone B and 48.6% (40,012) in Zone C. Not surprisingly, the largest number of fishing households was found in Zone D, which had 87,667 (90%).

This interesting progression in the number of fishing households per zone from Zone A to Zone D follows a similar pattern to the one shown by the production figures for open waters in the Gumti Phase II project area (see Table F.7.4 in the 1993 Gumti Phase II Draft Final Report).

TABLE VII.2.15

Number of Fishing Households in the Gumti Phase II Study Area

	Number of Fishing Households								
	Number of Households	Full - Time	%	Part - Time	%	Occasional	%	Total	%
Zone A	61.140	1.207	2	1.888	3	11.034	18	14.129	23
Zone B	53.193	2.173	4	3.374	6	19.807	37	25,354	47.7
Zone C	82.281	7,650	9	11.270	13	21.092	26	40,012	48.6
Zone D	96.653	5.428	6	18.363	18	63.876	66	87,667	90
Total	293.267	16.458	5.6	34.895	11.9	115.809	39.5	167.162	57

Source: BBS 1981 Census for Number of Households.
1993 Gumti Phase II Thana Fisheries Office Survey for Number of Fishermen

Noakhali North

Table VII.2.16 shows details of the results per zone. In total, there were 60,698 fishing households in the Noakhali North project area equal to 15% of the total households in the area. Of these, 16,352 (4.1%) were full time, 3,889 (1%) were part time and 40,457 (10%) were occasional. The proportion of fishing households varied from zone to zone and not surprisingly, the largest number of fishing households was found in Zone A (adjacent to the fish-rich Meghna River), where the total number of fishing households was 9,957, representing 19.6% of the total number of households in that zone. It is assumed that the vast majority of these fishermen actually fish the waters of the Meghna River as shown by the proportion of full time fishermen in this zone as well as in Zone D. The overall number of fishing households in Zone C was higher than expected although in this zone, the proportion of occasional fishing households was the highest. It would appear that full time and part time fishermen concentrate their effort on the riverine areas such as Zones A and D (adjacent to the Meghna and the Dakatia Rivers), whereas occasional fishermen converge on the areas of floodplain.

Interestingly, the proportion of fishing households as a whole was very different in the two areas, with only the proportion of full-time fishermen being similar.

This type of situation clearly emphasises the need for detailed analyses prior to any development within the SER, especially at the pre-feasibility and design level, as there are likely to be a wide range of differences in the various planning units with the Region.

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TABLE VII.2.16

Number of Fishing Households in the Noakhali North Study Area

	Number of Fishing Households								
	Number of Households	Full - Time	%	Part - Time	%	Occasional	%	Total	%
Zone A	50,755	3,294	6.5	633	[illegible]	6,030	11.9	9,957	19.6
Zone B	114,383	927	0.8	393	0.34	12,081	10.6	13,401	11.7
Zone C	87,462	2,070	2.4	471	0.54	12,335	14.1	14,876	17
Zone D	145,841	10,061	6.9	2,392	1.6	10,011	6.8	22,464	15.4
Total	398,441	16,352	4.1	3,889	0.98	40,457	10.2	60,698	15.2

Source: 1991 estimates of population and BBS 1991 Census for Number of Households.
1993 Noakhali North Thana Fisheries Office Survey for Number of Fishermen

VII.2.12.5 Market Price for Fish

An RRA conducted on market prices for fish in 11 different thanas of the study area revealed that prices for the different fish groups are similar in all the thanas, however, prices for some fish do vary according to fish the location of the thana with regard to natural fish resources and/or availability due to production. The field visits were made during March-April, 1991 and as the season was towards end of the dry season when fish are mostly caught from open waters, the prices are more likely to represent the usual price for the fish group. The prices were noted on the following major groups of fish (Table VII.2.17).

TABLE VII.2.17

Fish Price Tk/kg (March-April, 1991)

	Major Carp	Minor Carp	Catfish	Shol/ Shal	Small fish	Shrimp	Hilsa
Sarail	40	35	40	20	12	200	30
Nasirnagar	35	-	45	-	15	150	x
Madhabpur	55	23	90	25	18	175	x
Nabinagar	50	28	60	25	13	240	50
Banchharampur	50	40	55	33	25	250*	45
Homna	50	40	55	-	15	100	35
Dhaganbhuiya	55	35	75	-	23	175	35
Chauddagram	60	35	80	20	20	-	45
Chandpur	50	30	60	-	20	150	40
Matlab	40	-	35	20	20	180	40
Sudharam	35	20	45	25	15	200	25

Note:
- \- indicates no price available
- x indicates species is not available
- * the rate of Tk 250 per kg applies when the average weight is about 100 gm; if the average weight drops to 35 gm the price falls to Tk 115/kg.

VII.2.6.7 Shrimp Farming Activities

(a) Introduction

During the last two decades or so, shrimp farming has become one of the most attractive investments in many coastal areas of Bangladesh. Shrimp has become the fourth most important foreign exchange earner. The shrimp export statistics do not show the amount of freshwater and brackish water shrimps; however, it is apparent that the bulk of the exported shrimps are of brackish water origin.

The brackish water shrimp forms the bulk of production because of its higher profitability due to several factors. The available higher international market is one of the main reason of the growth of farming of the species. Moreover, brackish water shrimp have faster growth rates, higher natural availability of seed and higher production per unit area than the freshwater species. One other main reason for the rapid expansion of the brackish water shrimp farming in Bangladesh is the comparative easy access of suitable coastal lands from the public sector against negligible fees, compared with the costs of water bodies suitable for freshwater shrimp culture.

During the last few years there has been an increasing trend of export earnings from freshwater shrimp in Bangladesh. Many countries of the world, especially Asian countries have taken up elaborate plans to culture the freshwater shrimp and have reported profitable financial returns.

The life cycle pattern of the freshwater shrimp is different from that of the brackish water shrimp. They do have overlapping ecological parameters in their life cycle, in that, although both of the two groups spawn in the estuarine area, the freshwater ones migrate at their juvenile stage to the inland freshwater areas while the brackish water ones spend their whole life in the saline waters. In Bangladesh, the brackish water shrimp Penaeus monodon is mainly cultured in three coastal districts of Satkhira, Khulna and Cox's Bazar. There are a few freshwater shrimps of which, Macrobrachium rosenbergii (giant freshwater shrimp) is the most suitable one for culture. This species can be introduced very easily in the pond aquaculture systems of Bangladesh.

(b) Shrimp culture in the coastal bheries of Noakhali District:

Not many coastal bheries have so far been developed for brackish water shrimp farming in the Noakhali area. DANIDA 1989 listed six bheries of total 80 ha of water area in the Sudharam thana. The situation is atypical there and development has not yet occurred as in the coastal districts of Satkhira, Khulna and Cox's Bazar. Although the bheries have been constructed for aquaculture, as these are mostly rainfed, there is no scope for using those exclusively for brackish water shrimp farming, instead, the bheries have been planned to be used for one monoculture of freshwater shrimp (July-January) and one monoculture of brackish water shrimp (February-June). The bheries do not have access to tidal flooding to ensure supply of saline water and as such there have to be arrangements for pumping saline water from nearby rivers, but the river is silting up very rapidly, thus making that provision more difficult.

(c) **Freshwater Shrimp Farming**

The Noakhali area in general, appears to have gone ahead in culturing freshwater shrimp in polyculture with carp in ponds, road-side ditches and in confined rivers and irrigation canals.

1. **Culture in Ponds**

Though M. rosenbergii is a potentially important species to be introduced in the pond culture systems of Bangladesh, very little effort has so far been made on the experimentation of the aquacultural aspects of the species. Several sporadic experimental attempts were made, some by NGO and others by the government, however, the results with respect to growth, production and survival are very variable. At its Mymensingh station the FRI is conducting a research project on the polyculturing of freshwater shrimp with carp. The results of the research project are not yet available.

In Noakhali area, fish culture in ponds has a good base, especially due to the development projects activities of Raipur Fish Hatchery and Training Centre and the DANIDA assisted carp culture development project under the Noakhali Rural Development Project. These development activities have led to stocking of freshwater shrimp together with carp in ponds. The common practice is to stock a few shrimps along with different species of carp. The practice is limited and at the same time widespread with little regard to stocking density, feed and fertilisation of the ponds. There is no information on the survival rate of the prawn stocked. There is not an available statistics either on shrimp culture in the old Noakhali district and the DANIDA report on the socio-economics of shrimp farming indicated that the statistics are fragmentary and based on estimates. However, the report suggests that the number of ponds under shrimp-carp polyculture is increasing in recent years though on a very limited scale. The report quoted the District Fishery Officer, Lakshmipur as saying that in 1989 a total of 73 ponds were under fish-shrimp polyculture which is 0.4 % of all ponds of the district and 1.3 % of the total existing cultured water area.

The reasons of the existing limited practice of the polyculture systems are lack of shrimp seed, either collected from nature or produced in a hatchery, and lack of proven culture technology that could be demonstrated to the farmers. Such technology could be based on better growth and production and gradual turnover to monoculture with the provision of higher stocking density and intensive feeding.

2. **Shrimp culture in confined rivers, irrigation canals, and roadside ditches**

As mentioned above, the initiation of the practice of polyculturing freshwater shrimp with carp is linked with the development of pond culture in general, in the greater Noakhali area the technical and management inputs have been provided by the development projects. However, aquaculture in the waters like large enclosed rivers, irrigation canals or in the road-side ditches, has not been started commercially. As one would know, the area has extensive areas of water under the above categories and thus provides an excellent opportunity to extend the pond aquacultural technologies. At present a few entrepreneurs have started. DANIDA 1989 reported aquacultural activities in a cut-off in the Dakatia river near the Hajimara regulator where a 2 km section of the 5 km long and 45-50 m wide river slope has been converted into a shrimp-fish farm by providing an earthen dam. Another such area suitable for shrimp-fish farming is a closed section of the Darianadi river that extends a few kilometres upstream from the BWDB's Darianadi sluice gate where it is closed by a privately constructed sluice gate.

Shrimp culture with fish is being done on a very limited scale in the irrigation canal of CIP in Lakshmipur district and in the MIP canal in Feni district. As has been said, the level is widespread with regard to stocking, feeding and fertilisation etc. In the CIP canals, at several locations, many private persons are at present engaged in shrimp-polyculturing with fish and their activities appear not to be officially approved of by the authority. The canals is under the control of the BWDB and utilisation of the water, it is feared, would damage the embankment.

There is a serious need to resolve the rights to use of the waters; the DOF can be given the right to use water, so that it can test and demonstrate the practice of fish-shrimp polyculturing in the waters without altering the existing physical condition of the embankment. Of late, the DOF has obtained approval to use the waters of CIP and MIP for stocking with fish as a culture-based capture fishery development.

The situation of shrimp farming in the road-side borrow pit is the same. Although detailed statistics are lacking, in the DANIDA report on the socio-economics of shrimp farming in the Noakhali area, it is suggested that quite a large stretches of the borrow pits in the area are now stocked, though at a very low rate and mainly with fish. Very occasionally the people put shrimp in the pits, but not in any planned way. The borrow pits result from road construction. They are mainly seasonal and dry up in the winter. The pits also function as drainage channels during the monsoon and thus the present aquacultural practices in the pits hamper to an extent, the drainage functions, as many earthen dams are constructed to hold water. There are huge borrow pits along the road leading from Begumganj via Sonaimuri, to Chatkhil and Ramganj. At present some aquacultural activities are going on in these waters but on a very limited scale; there is however big potential for development of shrimp-fish polyculture in these waters if some technical improvements are undertaken, for example drainage provisions with sluices to prevent flooding.

Freshwater shrimp polyculture with fish is not known in the greater Comilla area, however shrimp as a capture fishery in the Meghna, Dakatia, Gumti, and Titas rivers is important. As the study area is bounded by the Meghna from north to south, a considerable fishery for shrimp does exist in the area. A study of seven thanas of the area revealed that a total of 6 000 fishermen are engaged in full time fishing on shrimp in different waters of the area with an annual total production of 61.5 tonnes of shrimp.

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CHAPTER VII.3

SUPPORT SERVICES

VII.3.1 Involvement of Department of Fisheries

Other than the regular administrative and management arrangement under the revenue head the DOF works in the study area under four main development projects. A brief account of the areas and the project activities is given below:

(a) Integrated Fisheries Development Project

This is a three year project which started in 1987/88, and the first phase ended in 1990. The second phase for another three year is under approval. The project has seven different sub-project activities, these are:

1. Improved management of natural spawn fishery in Halda River,

2. Pond fish culture development in the rural areas; under this sub-project 15 mini hatcheries will be constructed in 15 different thanas throughout Bangladesh, of which three thanas fall within the region, the thanas are: (i) Nasirnagar, (ii) Nabinagar and (iii) Bancharampur, all in Brahmanbaria District. There will be arrangements for spawn production and fry raising, however at present, only the hatchery at Nasirnagar is under construction.

3. Aquaculture development in public waters in and around Dhaka,

4. Establishment of fish sanctuaries for conservation in and management of open water fisheries, this sub-project does not have work within the region.

5. Development of fisheries in the irrigation and flood control project areas e.g. South Dakatia River, Muhuri River, Gohala River, and Chunar River; the Chandpur Irrigation Project falls within the region; it has been gathered from DOF that the activities for the sub-project have started in CIP; the programmes there include bringing the entire water area in CIP under artificial stocking; the total water area within CIP is estimated at 2 800 ha of which, the project proposes to bring 2 000 ha under stocking. A 25 ha nursery pond area will be developed and 5" (125 mm) size fingerlings will be stocked in the open waters of borrow pits, the South Dakatia river and in the canals, the project has established an office at Chandpur and until now has stocked 4 km of the borrow pits on both side of the Char Bagadi Pump Station, the 1991 further programme under the project was cleaning of the water hyacinth from South Dakatia with wheat obtained from Food For Works (FFW) programme in association with the CIP.

   In Muhuri Irrigation Project there is a similar programme to stock the Muhuri Reservoir; the project has established on office at Feni; no stocking has so far been made in the reservoir, the DOF has obtained 15 ha of land from the Bangladesh Water Development Board (BWDB) to construct a hatchery near the regulator area; the production capacity of nursery will be 600 000 of fingerlings per year.

6. Culture based flood plain fisheries development, this sub-project does not concern the region.

7. Survey of public water bodies, how far progress has been made under this sub-project is not known.

(b) Second Aquaculture Development Project

This Asian Development Bank (ADB) funded project run for a five year development period which terminated in June 1992. The project had four different components. These were:

- Shrimp culture development,
- Carp culture development,
- Culture based floodplain fisheries development and,
- General implementation and institutional support.

Out of these four components, only the second component concerns the Region. Under this component there were programmes of establishing demonstration ponds in about 6-7 ponds of 181 thanas in 21 districts. There were credit components of the programme to be given to the pond owners. All the thanas of greater Comilla and Noakhali fall within the programme, stocking of ponds for demonstration has started in 27 different thanas.

(c) Institutional Strengthening Project

This is a Food and Agriculture Organization/United Nation Development Program (FAO/UNDP) funded project. It is mainly connected with the institutional building of the DOF. However, it has a programme on fisheries training and extension system development. Under the extension part, the project will work among other areas of the country, in Daudkandi, Muradnagar and in Chauddagram, where carp polyculture technology will be demonstrated.

(d) New Fisheries Management Policy

The inland open water capture fishery in the forms of river, canal, floodplain, haor, boar and beel constitute more than 50 % to the total fish production of the country. The production from the sector is declining at an alarming rate due to many reasons, proper management and conservation of the fishery has become imperative. At present the fishery is managed and looked after by several Departments through which waters are leased out to fishermen's co-operatives but, due to the poor socio-economic conditions of the fishermen, and weak organisational set up of the co-operatives, they cannot act as the lease holder, instead the local elite tend to control the situation. Through this system the conservation and sustainability of the fishery resources decline year after year.

As such in 1986 the government decided to formulate and adopt a new fisheries management policy. Under this policy, a licensing system was introduced in place of the leasing system of the water bodies. The genuine fishermen's groups or co-operatives are being identified and will be given a license to fish in the waters under government supervision and control. Through this system, it is hoped that the fisheries will be more controlled by the creation of some sort of identify with the fishery in the mind of the fishermen.

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Under this policy, initially ten jalmahal were selected from throughout Bangladesh. Subsequently jalmahal from twelve sites covering three environmental situations such as flowing river, dead river (baor) and beel/haor were taken and put in experimental management under different organisational set up and management issues. After the experimental trials were over, 300 jalmahal from all over the country have now been put under the new management policy and the following jalmahal have been included in the list.

Comilla:

- Noabad fishery
- Nalia fishery
- Curzon khal fishery
- Mara Titas fishery
- Dakatia fishery
- Daudkandi Thana fishery
- Nalchar fishery
- Khairapur fishery

Brahmanbaria:

- Meghna river, Sarail area
- Meghna river, Brahmanbaria Sadar
- Meghna river, Bancharampur
- Titas river, Nabinagar
- Dhaleswari beel, Nasirnagar
- Titas river

Block A	Brahmanbaria Sadar
Block B	Sarail

Chandpur:

- Dhonagoda-Gumti
- Dakatia river
- Dakatia river (Hajiganj)
- Khidirpur-Gangamandal
- Meghna balaria
- Eklashpur Kol

Feni:

- Baro Feni river Machhmohal
- Selonia river
- Little Feni river Machhmohal (Sonagazi)
- Little Feni river downstream.

Lakshmipur:

- Daimandi-Mahendra khal

Noakhali:

- Meghna river

VII.3.2 Fisheries Research Institute's involvement in the SER

The Fisheries Research Institute (FRI) was established by a Presidential Ordinance in 1984. Before that, both fisheries research and management were looked after by the DOF. The FRI has four different research stations located at different places of the country to carry out environment specific adaptive research. The stations are:

1. Fresh water station (pond aquacultural) at Mymensingh.
2. Riverine station (river and other open waters) at Chandpur.
3. Brackish water station at Khulna and
4. Marine and Technological station at Cox's Bazar

The head-quarters of FRI are located at the freshwater station campus in Mymensingh.

The riverine station at Chandpur comes within the SER and conducts problem oriented riverine and open water research connected with management and conservation of fisheries.

At present there are ten different on-going research projects which are at various stages of completion and three projects have been completed. The projects are:

- Hilsa fishery development and management,
- Artificial reproduction and pond culture of pangas Pangasius/pangasius,
- Paddy-cum-shrimp culture,
- Toxicity of rice pesticides to fish and shrimp,
- Limnological studies on Kaptai lake,
- Population dynamics and stock assessment studies on Kaptai lake,

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- Culture of fish in pens and cages.

- Hatchery production and pond management.

Completed projects are:

- Investigation into the nutritional requirements of major carp.

- Survey of reproduction areas of riverine fish and,

- Investigation on local fish toxicant.

The role of the Chandpur station of FRI in riverine and open water capture fisheries research and technology derivation and conservation of the fishery is significant. The completed projects on local fish toxicants and survey of major carp reproduction areas have came up with important findings and suggestions. With regard to Hilsa stock/strains assessment and spawning biology, the team, discerned the spawning area of hilsa in the Padma-Meghna river systems for the first time. Pen and cage culture of fish offer promise for developing culture systems in the various seasonal and perennial waters. The station has started a pilot project on pen culture in the borrow pit of CIP and similarly cage culture trials have been conducted in the Kaptai lake. Other project works are Macrobrachiun integrated farming with paddy, and rice pesticides toxicity on fish/shrimp, these are remarkably important and relevant for capture fisheries in general.

VII.3.3 DANIDA Activities

There is a DANIDA assisted programme called Noakhali Integrated Rural Development Programme (NIRDP). It's Phase I was completed in 1982, the second Phase, called Noakhali Rural Development Project was recently completed with regard to the assistance to the agricultural extension services through training and demonstrations, availability of credits, formation of co-operatives and making provision of minor irrigation and drainage in the greater Noakhali area, the programme on fisheries is one of the above activities :

The main objectives of the fisheries component are:

- To increase fish production, so that more fish are available for local consumption.

- To create financial means through surplus of production, so that poor fishermen can organize themselves.

These broad objectives are met by the following activities:

- imparting skill training to the resourceless farmers,

- production of fish fry and fish fingerlings in the fish seed farms and in the private ponds.

- Repair of pond embankments.
- Development of induced breeding technique.
- Development of nursery operation techniques, both in government and private nurseries
- Promotion of marketing facilities of the co-operatives.

During Phase I of the programme, significant achievements were obtained in pond aquaculture development. This was accomplished through formation of landless co-operative members and simultaneous research on short-term critical aquacultural problems. During the period in question, 25 ponds were leased out to 22 landless co-operatives and three Krishak Samabaya Samities (KSS), consisting of a total of 1 067 members; the total pond area involved with the co-operatives and the KSS was 33 ha. The total share deposits and savings of the co-operatives accounted to Tk 65 800 and Tk 8 104 respectively. The amount of net profit for the co-operatives stood at Tk 110 800 which was further expected to rise at Tk 400 000 when the final harvest of the fish would be made. The co-operative movement appears to have been highly successful in the greater Noakhali area. Many villagers have shown their interest. The private pond owners are now becoming interested in fish culture. The lease values of various ponds are increasing, many members of the co-operatives who have homestead ponds, are interested in nursery operation or culturing indigenous small fish in their ponds.

The individual farmers and the co-operative members receive support form the programme through free distributions of fry/fingerlings (after the completion of training), technical assistance in spawning and hatchery operation and procurement and free distribution of hormones (HCG) and chemicals.

A large number of training courses were conducted to provide training for the private pond owners and co-operative members on various topics. These training was conducted at the Raipur Fish Hatchery and Training Centre. An account of the training conducted up to December 1987 is as follows:

is it that
no training was conducted Raipur since 1987 ?.

Topic	Trainees	Numbers
Fry raising and fish culture	Farmers, Co-operative members	1 184
Refresher course (1 day)	Contact farmers	2 832
Follow up course (5 days)	Co-operative members	695
Establishment of training pond	Villagers	200
Compost preparation	Contact farmers	870

In addition to the above training, field demonstrations, including farmers' rallies were held on the subject of compost preparation, fish culture in paddy fields and fertiliser trials.

The research component of the programme is looked after by staff from the Dhaka University Zoology department. Appreciable results are reported to have been obtained with respect to polyculture of fish, growth, life history, food and feeding habits, stocking rate, predation control, feeding and fertilisation of the ponds (NIRDP-I evaluation report).

Building up of infrastructure for extension programmes has been accomplished through the construction of three training centres at Feni, Lakshmipur and at Begumganj and also a spawning unit and shallow tubewell have been installed at Lakshmipur government hatchery.

A baseline survey on the pond aquacultural resources of the greater Noakhali area was conducted in 1986. This survey has further formed a basis for comprehensive look of the aquacultural situation of the region (Ameen et al, 1986).

Fish culture in greater Noakhali area is proceeding well with the initiation of the extension activity of NRDP in the recent years. Department of Fisheries statistics put 58 % of the total ponds of the three districts of greater Noakhali district as cultured, however, the pond survey done of the NRDP group put this percentage at 55; the national average of pond utilisation being 32 %. Productivity of ponds has increased in the Noakhali area. A well managed medium sized fish pond on an average is estimated to produce 2 500 kg/ha and the net income could stand at Tk 9 000 per year. The total amount of fish produced from greater Noakhali, according to DOF data of 1988-89, is 41 739 tonnes and the contribution of pond production is 27 %.

Operation of hatcheries and nurseries is an attractive business for private investors. According to DOF statistics, 27 hatcheries and 255 nurseries were operated in the great Noakhali area in 1988. The number of private fish farms was 68 in that year. The potential earning from a hatchery of 20 kg spawn production capacity could stand at Tk 150 000 per season.

Based upon the experience gathered, the project has planned to expand its activity to organising small poor groups around small village ponds to make credit available to them, this effort would increase the possibilities of involving women in fish culture.

The support from the programme has been limited to technical assistance; supply of inputs like fish seed, chemicals, hormones, pump and oxygen etc. has been made against payment.

VII.3.4 Mennonite Central Committee Activities

The Mennonite Central Committee (MCC) has been working in Noakhali and Comilla areas for many years has a strong and wide base in the study area. The agricultural programme adopts a comprehensive farming system approach taking into consideration year-round cultivation of horticultural crops, agriculture in general, livestock, and fisheries activities, mainly with resource poor farmers, with rural women at the homestead level, (in order to improve general health and nutrition conditions), and with groups of rural men and women, (to increase their savings for them to find other opportunities), and literacy and social awareness. The whole agricultural work falls into three broad types of activities, extension, marketing and research.

The involvement with fisheries activities is not as old as the other activities, beginning in 1988. At first a survey was conducted in the working area of southern Comilla and greater Noakhali area to obtain information on present fishery technology, costs and returns, fish species available at the farm level and the feasibility of introducing integrated fish culture systems (duck-fish, paddy-fish, etc.).

The activities are widespread in the greater Noakhali area with regards to introducing culture system of small indigenous species which could be cultured in seasonal shallow ponds/ditches with minimum of inputs, and integrated aquaculture with other components viz. paddy, livestock, poultry, etc. The aquacultural programmes are very relevant and technical linkages have been established with the FRI aquacultural research programmes; training and demonstration on adaptive aquacultural technologies on Thai sharpunti and carp breeding, nursery, pond preparation etc. has been done in conjunction with FRI.

TABLE VII.3.1

Performance of Fish Pond Co-operatives

Thana	Fish Released	Fish No.	Harvested Maund	Loan Advanced Tk	Loan Repaid Tk	Gross Profit Tk	Net Profit Tk	
Lakshmipur	17 700	101 870	490	148 700	148 700	255 180	70 200	+ 2 boats and one house
Raipur	27 200	7 620	70	20 000	14 000	16 050	14 600	
Chhagalnaiya	274 500	42 600	450	271 500	251 000	277 000	26 000	
	479 800	152 290	1 010	440 270	413 700	548 230	110 800	+ 2 boats and one house

The data is from three ponds.

Note: It was estimated that the income will stand at a minimum of another Tk 400 000 at final harvest.

Source: NIRDP - I Evaluation Report.

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CHAPTER VII.4

IMPACTS OF WATER CONTROL PROJECTS

VII.4.1 General Impact

Flood control drainage and irrigation projects have effects on both culture and capture fisheries. Any water control project has negative effects on the capture fishery. The open water fisheries grounds are mainly the flooded lands, beels khals and the rivers from where flood water comes; flood protection, drainage improvement and/or irrigation reduce the flooded area. Construction of embankments or regulators prevents migration and recruitment of fish inside the project. As the flooded lands serve as the nursery grounds of the freshwater migratory species are well as for the resident species, flood protection and embankments also cause reduced stocking of the outside waters.

Reduced or full flood protection can create new possibilities for culture fishery inside the project area, as there will then be no risk of fish loss from the culture ponds. This however, will entail availability of the culture inputs and support services. Nonetheless, the ponds which used to be naturally restocked due to the flood will have no production and would add negatively to the flood protection option.

In general the beneficiaries of culture fisheries are the more wealthy elements of society, i.e. pond or tank owners.

The beneficiaries of the open water capture fisheries are the subsistence households in general and the poor and lower class fishermen in particular, thus loss to that category cannot be overcome by the gain in culture fishery unless alternative cultural methods in the closed waters are developed and the affected people/fishermen inside are grouped into co-operatives. Culture programmes increase production, but the species diversity cannot be protected, thus the low priced fish that are consumed by the poor people through their subsistence catching are lost from the area, causing socio-economic problems.

The water use conflicts between dry season agriculture and fisheries can reasonably be reduced through having irrigation options in the project together with drainage. If, for example, the channel inside the project is topped up with water throughout the dry season, the resident small species can find places for breeding in the shallow areas of khals and creeks during the monsoon season; care should be taken to prevent the khals from drying up.

VII.4.2 Fisheries Situation at the Chandpur Flood Control and Irrigation Project (CIP)

(a) Introduction

The Chandpur Irrigation Project was completed in 1979-80, the project has been designed to provide irrigation and flood control in a 56 000 ha area located south-east of Chandpur. The project area is encircled by a dyke approximately 108 ha long to control the water level inside. The construction of the embankment has created a borrow pit canal 40 m 97 km wide and up to 2 m along the inner side of the dyke. The South Dakatia river that passes through the project area has been closed at Charbagadi and down at Hajimara with water regulators.

there are pumps at Charbagadi. There are navigation locks at both points. Closure of the river has changed the riverine ecology into a standing water one. The area reportedly used to be a good floodplain and riverine fishery area and construction of a flood control project evoked concern among the fishermen during the implemention period. However, there had been investigations by fishery groups with respect to the possible harmful effects of the project. The consequence of such investigation let to the development of a hatchery and fish culture training centre in the project area at Raipur. Many years have passed, and there have been important lessons from the existing fishery situation of the area for every future flood control project.

(b) Background

The potential effects of the Chandpur project on the existing fishery were given no recognition in the feasibility study made by the BWDB's consulting engineering firm, Leedshill De Leuw (1969) or in the report subsequently prepared by Reese et al (1970). Nonetheless the BWDB approved the project on the basis of the above report. In 1970, the DOF expressed the concern about the possible damaging effects of the project on the natural fishery of the area. The International Bank of Re-construction and Development then sent Richard L Ridenhour in 1972 to investigate the situation. He concluded that a substantial fishery existed in the area and identified several specific problems that might occur in the area due to water level control. He specifically emphasised the need for field evaluation and development of carp and prawn culture in the area. In 1974 again an investigation was done by Mr. B.W. Kelly under the consulting firm of Jones and Stokes Associates Inc. Mr. Kelly agreed in principle with the idea of Mr. Ridenhour for a detailed field investigation.

Subsequently the Sell Environmental Group (SEG) of U.S.A. conducted an investigation study in three irrigation projects viz. Chandpur, Muhuri and Karnafuli during the period of 1978-1982. The study encompassed the whole of the culture and capture fishery status of the project areas and let to the development of a Fish Hatchery and Training Centre. The centre was established at Raipur which is within the CIP. The SEG's report contains a detailed information about the then fishery situation of CIP and predicted the trend which the situation would follow unless appropriate management methodologies were adopted. They reported that there were 204 species of fish and prawn available in the waters with 27 species identified as new in Bangladesh.

On the basis of relative abundance in collection they put ten species of fish as major fish from both flowing water and standing water habitats (Walla go attu being common in both the habitats) and three commercial species of prawn. Out of the ten species of fish, seven were predators and the report opined that the fishery was not in a good position to have such a percentage of predators. The major carp were not prevalent in the collection and as their availability would mainly be from ponds, this indicates that the culture situation at that time was limited.

The prawn and fish population of the South Dakatia river is a mixture of the shallow coastal freshwater species and the tidal estuarine species. Thus the fish and prawn stock of the Dakatia system is maintained by reproduction of the fresh water resident stock and by migration of the estuarine stock. Due to the closure of the river the migration of the estuarine fish and prawn species has stopped and severely altered the species composition in the river; the number of the resident fresh water species has increased.

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The Indian major carp were not reported to have spawned in the Dakatia system in the past. Their stock was maintained by migration of fry and fingerlings from outside the project area. During 1978, 65 individuals of major carp belonging to five different species were caught from jag fishery inside the project area. The water control structures obstruct the migration of several species of tidal estuarine prawn.

Hilsa ilisha which is an anadromous species, suffered great reduction in numbers and they are reflected in the catch within the project area in very small numbers.

Quantitative stock assessment made by the SEG showed that the standing crop in all habitats was declining during the two years of the investigation period which was immediately after closure of the river.

It was clear that the CIP has a detrimental effects on the natural fishery of the area. However, in other ways, the controlled water situation has opened up new opportunities for culture based fisheries in ponds and other closed or semi-closed waters; provided aquacultural technologies with respect to seed, feed, and fertiliser are made available to the farmers.

The SEG report especially pointed out the following major effects of Chandpur FCDI project on fisheries :

1. Reduction of migratory open water species such as major carp and hilsa,
2. Reduction of nursery area for growing natural fish and prawn stock,
3. Reduction of overall fish crop available for harvest,
4. Reduction of catch of fish within the area,
5. Reduction of fish consumption in the area,
6. Reduction of average size of fish in the waters of the area,
7. Over-fishing,
8. Increase of aquatic vegetation,
9. Change of type of habitat,
10. Reduction of the economic status of fishermen,
11. Increased need for an extensive fishery management programme,
12. Improved fishery management potential, and
13. Reduction in contribution of CIP area as nursery area to overall fishery in Bangladesh (recruitment from inside the area to the outside).

(c) Raipur Fish Hatchery and Training Centre

As has been mentioned in the foregoing, the fish hatchery and training centre at Raipur, Lakshmipur, was part of the development activities of the SEG's investigative programme in the CIP. The hatchery was established as a possible means of creating mitigating effects of the damages of the natural fishery due to the irrigation and flood control project.

The centre has been established on a land area of 22 ha. It has a pond complex of 75 ponds of area 13 ha. Fifty four ponds of these 75 ponds are of 9 ha water area and used for rearing purposes. The remaining 21 ponds are of 4 ha water area and used for holding brood fish of 7 000 kg annually. The hatchery building consists of eight circular spawning cum hatching tanks each of one million egg holding capacity, five jar units having a total egg holding capacity of 5.2 to 6.5 million eggs for hatching and 20 fish/fry/fingerling holding rectangular tanks. There are two deep tubewell of each 5-7 l/s capacity, used for filling the ponds and running the hatchery. The training facilities includes class room and dormitories.

Since its establishment in 1979, the Raipur Hatchery and Training Centre has had played a significant role in fish seed production and extension of breeding, nursery and fish cultivation in the area. A further augmentation of the process was led by the fish cultural activities of the NRDP fish programme. As the result there has been a break through in the increase of number of hatcheries and nurseries to meet the growing demand of the culturist. The net production of cultured carp has increased.

(d) Present Situation

Not many detailed studies have been conducted to review the impact of CIP on the fishery since the investigation work of SEG. Many of the recommendations of the SEG have not been implemented apart from the operation and maintenance of the hatchery and continuation of the training programme. The borrow pit, the khals and the entire South Dakatia river were left unstocked and has choked up with water hyacinth since the commissioning of the project and thus, although the aquacultural situations have reportedly improved in the area (Thompson, 1989), the open water capture fisheries potential has diminished, forcing poor and marginal fishermen who do not have ponds themselves or cannot hire ponds for culture, to capture less and less fish or become labourers for the bigger fishermen.

Thompson (1989) conducted a study on the impact of flood control on agricultural development in Bangladesh. In a detailed household survey from three locations of CIP and a control for the without project situation from outside CIP, he reviewed the impact of CIP on professional fishermen as well. The survey indicates that in CIP, 34 % of households caught fish before the project while after the project, 49 % household catch fish, the figures in the control area are 55 % and 64 % before and after project. Thirty nine per cent of household within the CIP had access to a large pond and although the control areas had the same situation of pond accessibility the growth of fish culture was more within CIP: in CIP, 30 % of the households cultivate fish. There had been no change in the open water fishing in CIP or in the control areas and this was especially true for the areas close to the Meghna River and the control area. Twelve per cent of the households who own a large pond or share in such a pond, cultivated fish before the project, but the percentage had increased to 72 by 1987, the figure for the control area by is 56 %. With respect to the change in fishing, Thompson's study revealed that 68 % of the 97 household reported increased importance of fishery and that is mainly due to better aquacultural/pond cultural practices, while the remainder complained about the lower availability of fish in the open waters. Of the households from the control areas; 50 % reported increased importance due to development of cultivation and higher fish prices and 50 % for decreased importance mainly due to decline in fish availability. From the above household survey, it is evident that within CIP, the fisheries situation is better than in the comparable control areas around CIP. However, with respect to the accessibility of cultivation the incidence has been uneven in the different socio-economic groups of farmers. Generally the better-off households have gained more i.e those who own a large pond or share such a pond for culture. The same is the case for the control areas, but cultivation as an additional source of income, benefitted more people in the CIP. The report on the main household survey concluded that the water control within CIP evidently induced wide-spread fish cultivation in the private ponds thus benefiting more people from fishing, given that the aquacultural techniques and inputs were available to the people of the area. Even so the wealthier farmers have gained more because they normally own ponds, the others, who depend on open water fisheries, have suffered because they are now catching less fish or are employees of the larger fishermen.

The result of the survey on fishermen's households indicate that the fishermen from the CIP have lower returns from their catch than the fishermen of the control area. In general commercial fishermen get a greater return which is likely because their capital outlay is more, allowing them to go to the river to catch larger fish. Boat ownership was lower in CIP than the control areas, this is likely because of the spread of aquaculture in ponds in CIP, fishermen from there go less to the outside river than the fishermen from the control areas. Net ownership pattern did not differ between the CIP and the control areas. The fishermen reported 59 different species of fish. The results of the survey indicated a decrease in the catch of large river fish in the CIP and in the control area and this was obvious as the effect of the flood control prevents these large river fish entering the river. This is also the case outside where there was a general decline of larger fish in the riverine catches. The incidence of catch of the other sized river fish was not clear, however, the medium sized river fish were more important in the CIP before the project.

Thompson's summary also indicated the following pattern inside CIP compared to the control situation.

- The composition of the catch is reduced, in particular the shrimp catch has suffered
- Commercial fishermen catch from rivers but are interested in cultivation in ponds by hiring ponds or sharing the catch
- New fishermen and farmers are fishing but they mainly fish in the khals because this requires less capital than fishing in the rivers, they also fish in ponds.

While Thompson's survey gives an idea of the present fisheries situation in the CIP area, it is not to be denied that there is a lot to be done with regard to the exploitation of the huge controlled water resources of the area with the application of the modern aquacultural technologies and through applying culture blended capture methodologies. The entire borrow pit, khals and the main stream Dakatia are yet unstocked, with water hyacinth choking everywhere. This situation has posed a serious challenge to the fisheries development and management authorities of the country. Karim (1990) has put forwarded some suggestions as to how the vast potential water inside CIP could be turned into productive resources. The first and main task is the removal of large masses of the water hyacinth. After the weeds are cleared from the system, he suggested dividing the river into 10-12 production and management units. The unit can be partitioned with simple screening materials so that water will flow but the fingerling of carp and other stocked fish will remain. The partition will have to made in such a way that boat traffic will not be hampered. The management unit will be given to the fishermen's groups to fish under a licensing system. The fishermen's group will be formed with the local fishermen living by the side of the unit specified. The borrow pits similarly can be partitioned into 200 m production and management units and given to two families adjacent to the canal. The units will be stocked with fish; integration can be brought about with broiler poultry being raised on a platform made on the water surface; also low tilling crops like banana, papaya, beans and pumpkin can be planted in the inner berm. The families given the allotment of the units, will need credits. Thus simultaneous arrangements for credit systems have to be developed.

These are all suggestions and there is still a comprehensive plan required for meaningful utilisation of the resources. Of late, the DOF has undertaken a programme for bringing a total water area of 2 800 ha into production with a yearly target 3 484 tonnes. As a pilot trial, in 1990, four km of borrow pit on both sides of Charbagadi pump station has been stocked with carp for polyculture. About half of the Dakatia river from Charbagadi up to Faridganj have been cleared of water hyacinth under Food For Works Programme jointly with the project management.

The FRI Chandpur station, which is mandated with the task of river and open water fisheries research, is currently conducting a pilot project on the feasibility of pen culturing in the borrow pit of CIP. Five pens 100 x 110 m each have been constructed in the borrow pit at west Ramdashi to Bahoria bazar. The fish stocked are Indian major carp and two species of Chinese carp. The results of this project and the DOF's polyculture trial are not yet available.

VII.4.3 Fisheries in the Meghna-Dhonagoda Irrigation Project

(a) Background

The Meghna-Dhonagoda Irrigation Project (MDIP) was commissioned in 1987-88 in the Matlab Thana of Chandpur district. The project area was an island circumscribed by the Meghna River in the west and north, and the Dhonagoda river on the east and south. It is a deep flooded area with very little area above 4.0 m and the lowest was 1.5 m above mean sea level. During the monsoon the entire area used to go under water.

The project has 64 km of embankment, 98 km irrigation canal, 120 km tertiary canal, 125 km drainage channel, 69 regulators and 62 drainage structures. There are two main and two secondary pumping stations. The main pumping stations are at Udamdi at the south and at Kalipur at the north; both of them are stationed at the ends of the Gajipur khal, which is the main khal in the project area.

The objective of the project is to increase agricultural production, attaining self-sufficiency in food, within to shortest possible time, and to increase employment opportunities of the people thereby improving the living standards of the farmers through flood control, drainage and irrigation.

(b) Present situation

The fisheries situation in the MDIP differs from that in the CIP. In MDIP there is no borrow pit inside the embankment, instead, there is an irrigation canal to supply water through other secondary and tertiary canals.

The total area of water inside the project is about 912 ha of which the pond area is 500 ha, marshy land is 180 ha and the irrigation canals that can be suitable for fish culture, 232 ha.

The potential water area in the project is about 700 ha including the ponds, khals and marshes. As the area was deep flooded, the flood water used to bring different species of fish and prawn. After the closure of the area the khals which had connection with the rivers have been blocked and the natural fishery of the khals and ponds has been badly damaged. There are 22 different khals inside the project area and those khals used to harbour a lot of fish before the project; after the completion of the project, the fishermen are getting less fish and they have been forced to catch fish in the Meghna River proper or in the Dhonagoda River.

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There are about 7 000 ponds in the Matlab thana; about 4 000 of these ponds are cultivable. About half of these ponds are within MDIP. Although flood protection has created new possibilities for aquaculture in the ponds, controllable khals and marshes, and although the feasibility report recommended a fisheries development programme in the form of pilot projects in the khals, no significant fishery development has taken place there until very recently.

It was suggested in the feasibility report that the main irrigation canal would be divided into 58 management units and pilot scale government projects will be undertaken in three such units; the other units will be leased out to the farmers living nearby or to the dislodged fishermen. Suitable weir mesh materials will be used to partition the canal to allow irrigation water to pass. The pond fishery development programmes were to take place through utilisation and application of feeding and fertilisation of the ponds. Similarly the khals would be artificially stocked with major carp and the shallow seasonal marshes would be utilised for culture with small indigenous species. The facility for fish seed provision in the project was deleted because the seeds were to be provided by the government fish seed farms nearby but this has not occurred. For easy availability of fish seed of the desired species and for rapid development of fish culture and stocking in the waters inside the project, establishment of a hatchery and nursery appears essential.

Recently the government has decided to establish a hatchery and nursery inside the project. In 1989 the government released 0.8 million fingerlings in the Gazipur khal. There is a nursery in a village called Amirabad within MDIP and fingerlings produced from that nursery have been released into 21 different khals through co-operatives formed with people residing along the khals.

VII.4.4 Impact of Polder Projects on Fisheries

The Coastal Embankment Project was to control intrusion in the areas potentially important for cultivation. Empoldering of the coastal areas has had both positive and negative effects on fisheries.

(a) Positive Impacts.

The positive impact was mainly with the development of the brackish water shrimp aquaculture industry in the country especially in the south-west regions and the areas of Cox's Bazar. The area empoldered is known as bheri where tidal water is retained and the larvae of shrimp and fin fish that come with the tide are managed and harvested. This sort of practice was also in vogue in the south-west region before the polder projects but now after the embankments the number of farms (gher) has increased dramatically. This is linked with the international market demand of the brackish water shrimp. Bangladesh now has 108 280 ha of tidal areas suitable for producing shrimp.

(b) Negative Impacts.

The negative impact is the conflict between various land uses in the coastal areas. Although the wild fishery in the coastal rivers and creek is lost because of empoldering, new fisheries situations arise with culture either in the created freshwater river sections, in the creeks or, allowing tidal water in the constructed ghers. The main conflicts that have arisen are the gradual conversion of the crop lands or the salt pans into shrimp farms. As shrimp farming is capital intensive and does not require as much labour as agriculture, the poor farmers or the fishermen in the coastal areas cannot be engaged in the industry.

(c) **Present Situation in the Area.**

The situation in the coastal areas of Southern Noakhali is atypical of the situation in general in other areas of Bangladesh. This area is the active accretion zone of the delta and unlike the areas of south-west and the south-east areas of Cox's Bazar the land is not suitable for coastal shrimp farm establishment. For gher construction, there is a requirement for a tidal water supply, and the areas have to have such a location and depth that the drainage would be slow, of course such suitable depth can be created by earthmoving but that would add extra cost to the operation. Bangladesh has 25 000 km^2 areas of coastal regions of which Noakhali has about 3 000 km^2.

In Noakhali area, because there is active siltation in the mouth of the few rivers or creeks such as the Darianadi, Baggar Dona and Noakhali khals, the prospects of gher construction have always been poor and as such no significant development of coastal aquafarms has taken place. DANIDA 1989 reported the existence of six such farms of a total area of 20 ha in Sudharam thana of Noakhali DOF fish production statistics of 1988-89 put 61 ha coastal shrimp farms in greater Noakhali district with total production of 11 tonnes. This indicates that the promise of brackish water shrimp farming in the area is not great.

The newly accreted areas of Noakhali face a different socio-economic situation from that of the other areas of Bangladesh. The resource base of the people living in the area is poor and thus the main task of the moment is to look for avenues for employment and earnings. Several government and non-government organizations have been involvement in this through undertaking development programs in agriculture, livestock, fishery and forestry in the area.

With respect to fisheries development, especially in pond culture development, DANIDA, the Land Reclamation Project (LRP) and MCC have worked in Southern Noakhali. All of these organizations' efforts have been to motivate the people to culture fish in their pond with low cost species and inputs. The DANIDA assisted fisheries programme in greater Noakhali has had a major impact on fish culture. There are programmes to introduce low cost culture sustained with indigenous small species. There has been growing interest on the polyculture of freshwater shrimp with carp in ponds. A feasibility survey of shrimp culture in the greater Noakhali district was funded. LRP has established a small freshwater shrimp hatchery in the char area with the technical assistance of DANIDA. In the coastal areas, because of empoldering some freshwater has been created e.g. Darianadi lake. There is now a 70 ha water area, created behind the dam on the Darianadi and new freshwater fisheries potential has emerged.

LRP expanded its activity in taking up fisheries development in the newly redeemed areas of Char Baggar Dona. It formed 30 co-operatives of the landless farmers and conducted trials on carp cum prawn culture in the ponds, carp culture in the collector drains and fry raising of carp and tilapia for use in the co-operative ponds in the pilot polder. In addition, the LRP fisheries programme tested the feasibility of wild fish entering and growing in the poldered area by opening the sluice gates during high tide, so that the co-operative members may fish in the waters.

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MCC's activities also centered around the poor and marginal farmers through introduction of low-cost fish culture technologies. There is a field research station in Char Matua. There has been a base line survey of aquacultural resources of their study area of medium high land, medium low land and charland of greater Noakhali and Comilla which has provided a good picture of the fisheries resources of the area in general.

It appears that the coastal empoldering in the Southern Noakhali areas has affected the new situation of pond aquaculture, bearing in mind that if open water wild coastal fishery is hampered by polder development, there will always be less promise for coastal aquafarm development in the area because of active siltation. The few coastal bheries that have been in existence in the area, are all intended to go for one mono culture of freshwater shrimp (July-January) one mono culture of brackish water shrimp (February-June), because of the rainfed nature of the bheries. Moreover because the saline water source from the nearby river is receding every year because of siltation, the provision saline water is becoming increasingly difficult.

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CHAPTER VII.5

POSSIBLE MITIGATION MEASURES

VII.5.1 Flood Plain Fishery

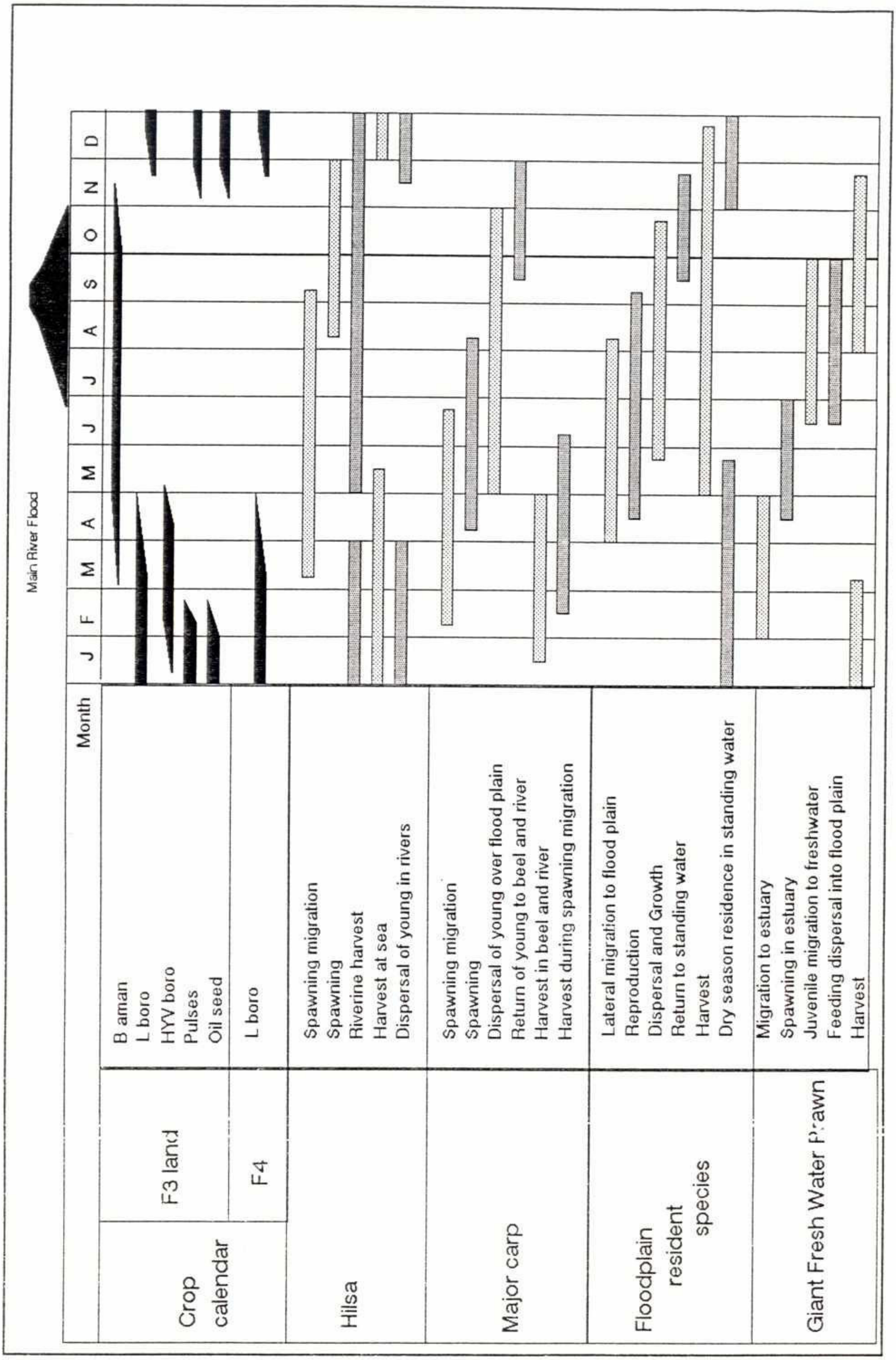
Ideally, there should be a compromise between the cultivation of HYV boro and aman and sustainability of floodplain fishery in a deeply flooded area. However, it has become increasingly clear that such a compromise may be extremely difficult, if not impossible to find. Losses to the floodplain fisheries are not easy to mitigate and vast expense usually has to occur before any benefits, if any, can be accrued from replacement culture fisheries. In a deeply flooded area, for cultivation of T aman and HYV boro to be possible, flood protection must be guaranteed and in this protection situation, keeping only the main khals, rivers and beels full of water would drastically reduce the open water fishery, even if there were provisions for fish passes in the embankment/regulators. Under such conditions proposals can be made for controlled flooding at the expense of the fishery. This would mean allowing a sub-normal flood situation, in such a way that, in a sub-normal flood situation, there would be controlled flooding instead of full flood control. If the purpose is to let the F_3 and F_4 land to be flooded, then the regulators have to be kept open until at least the middle of May, or until such time the F_3 and F_4 areas inside the project are flooded. The gates shall have to be kept open again from September onward. This would permit, up to a reasonable level, the migration, spawning and feeding and dispersal of the major carp and the flood plain resident species. The migration of juveniles of the fresh water prawn would be affected under the situation as their migration starts from the middle of June and end in September and the gates would be kept shut during this time. Hilsa migration is restricted to the Meghna River proper and their activities may not be affected by the flood protection embankments in the area. However, detailed hydraulic models for specific areas are needed to establish these general fish migration patterns in such areas. Figure VII.5.1 shows the fisheries activities side by side with crop calendar in typical F_3 and F_4 lands. It should be noted that pattern of fish activities will change according to the environmental factors at play in a given area.

// For a compromise between the sustainability of open water fishery and crop production under a flood control situation, a proposition on controlled flooding has been made above. What is important for open water fishery is flooded area, and all land greater than F_0 (30 cm) are suitable. In general it is seen that 35 % of the potential F_3 lands could be available as flooded area where fish can breed and feed; those areas would be generally adjacent to the rivers, khals and beels inside the project and thus the resident species of the closed waters can take advantage of the adjacent flooded lands. but if the natural life cycle is broken it is impossible to be reestablished by artificial manipulation.

Table VII.2.5 shows the amount of F_3 + F_4 lands in the individual project areas and the proportion of the project area. It is seen that quite large areas within Dakatia, Dhonagoda, MDIP, Gumti I, Gumti II, Ashuganj and in Titas planning units will be available for open water fisheries. However, recent work on the Gumti Phase II and Noakhali North feasibility projects showed that the areas of floodplain increase considerably when land greater than 30 cm (F^0) are taken into account. Since this situation reflects more realistically what happens in nature, it is strongly recommended that such approach be taken in the future in all fisheries work in the SER. General mitigation measures, proposed in the Gumti Phase II and Noakhali North studies are outlined below:

Figure VII.5.1

Fisheries Calendar



In general, the main issues concerning possible mitigation measures centre around water and fisheries management. These two aspects have been described briefly below:

VII.5.1.1 Water Management

Water resources management is, and will continue to be, possibly the most crucial factor in the development of any activities in the country, the region and the sub-region. It will thus be vital to establish priorities as to how and where the water will be directed to, and for whom. It includes the following components and possibilities for fisheries.

VII.5.1.2 Re-excavation of Khals

Possible re-excavation of Khals, and their interconnections to Beels, with an aim of ensuring free and timely flow of water and fish (both breeding adults and fry). This could be most important during the dry season when Khals become refuge areas for some species.

VII.5.1.3 Gate Design and Operation

Gate design, operation and location of structures is extremely important. These would ensure the timely flow of water and fish, and would be crucial for maintaining water levels in the system throughout the year, and particularly at times critical for fish.

VII.5.1.4 Gate Structures

In general, gates will restrict the passage of fish unless they are designed, operated and managed to minimise fish losses. Some of the possible measures to alleviate this problem include:

- Installation of overshot gates, to allow the passage of floating eggs, larvae, hatchlings, surface and midwater species.

- Timely opening of gates to coincide with critical migration periods for fish and other aquatic species, such as shrimps which are commercially important.

- Careful timing of closure to coincide with the end of the monsoon when the floodplain starts to dry out.

VII.5.1.5 Improved Fisheries Management

The continued improvement of fisheries management in the area should receive the highest priority, especially for those activities and/or policies that should take place despite interventions. Some of these activities include:

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VII.5.1.6 Restocking with Fry and/or Fingerlings

Restocking of suitable areas such as specific Beels and Khal sections with fry or fingerlings. However, this will need to take into account the ecology of the existing resident species in the area so as to prevent a major environmental unbalance due to any introduction of species. Restocking programmes should therefore only be carried out using indigenous species which occur naturally in the selected areas.

VII.5.1.7 Improvement of Culture Fisheries

Pond culture improvement, especially of those ponds at present under utilised. Leasing of existing ponds to fishermen groups, especially displaced ones. Use of borrow pits by displaced people who are the groups most likely to suffer the nutritional losses resulting from any reduction in their ability to fish. Training and extension programmes to ensure that suitable technology becomes available and to provide alternative sources of income for fishermen. Promotion of integrated farming schemes such as those underway in Comilla, as well as those such as the small/seasonal pond project in Mymensingh carried out by the Fisheries Research Institute (FRI) and ICLARM. The incorporation of local NGOs into the setting up and management of fishing groups could be instrumental in these type of fisheries projects.

VII.5.1.8 Enforcement of Existing Fisheries Regulations

The enforcement of existing regulations should particularly be carried out in relation to important areas such as Satdona and Chandal Beels, along with other known breeding, nursery and feeding areas for fish and other commercially important groups such as shrimps.

The following section deals with possible mitigation measures specific to each intervention.

VII.5.2 Fish Passes

Various types of structure have been known to be used to permit fish to move up and down stream, past dams and other structures. These are specially important for maintaining and managing spawning migration and preserving natural populations in rivers and flood plains. Despite of being a deltaic country with vast flood plains connected with many important rivers and though several dams and water structures have been built in Bangladesh in the past, nowhere have any provisions been made for fish passes. Thus there is no information available with regard to the design and construction of a typical fish pass in a flood control project.
Isaev and Kappova (198....) and Paulou (1989) have provided information on five major types of fish passes in USSR. These are:

- Simple fish passes; a continuous water flood enables fish to pass upstream,
- Hydraulic and mechanical fish lifts; migrating fish enter into a chamber and are periodically lifted to the reservoir upstream of the dam,
- Fish passes that work on the principle of lock,

- Floating equipment: fish are gathered in to containers, which are then transported to upstream reservoirs, and

- Fishing complexes: fish are caught, then gathered into containers for transportation by truck to upstream reservoirs. This system is used where there is no navigation lock.

Among these five types, the simple passes that consists of fish ladders, troughs and by-pass channels are widely used in many countries of the world. The ladders or troughs would simply not work in Bangladesh, as the major carp are not known as leapers, by-pass channels are not compatible with FC/FCD/FCDI projects. The other types, floating equipment or fishing complexes, are not relevant, the only type that might offer a chance to function is the lock type fish pass. This type of fish pass has been build in the Don reservoir of USSR. They normally have two separately acting chambers; the inlet channel leading to the lock is usually 6-8 m wide and 40-50 m long, so that the entrance is away from fast flowing water beneath the dam. The water would pass through the lock chamber into the inlet channel at a rate of 0.8-1.2 m/sec which is suitable for attracting fish. This stage would last for about 30 minutes. The inlet channel is then closed and the lock chamber fills with water from below. The fish tend to congregate in the chamber and when the required height of water in the chamber reached, the chamber opens and fish readily swim upstream. When the fish have left the chamber the upper gate is closed, water is discharged and the cycle is repeated, the whole process lasts for 1.5-2.0 hours. While one chamber is filling with water, the other one is discharging.

The design of the lock chamber in respect to its length and width and duration and timings of operation would depend upon the extend of the area within the project and on the onset of the monsoon season in a particular year. It will also depend on the dynamics of the water current and the extent, depth and duration of the flooding in a given area. The use of the hydraulic model would be crucial for determining where any such structure might be placed.

VII.5.3 Culture-based Capture Fishery.

In the situation where flood water is allowed into the beels, rivers and khals inside the project area, the methodology for fisheries management could have a blend of culture and capture fisheries. In such a case, the large water bodies in their varied forms can be stocked with the fingerlings of culturable species viz., the major carps. The Baor fisheries development and management project in the south-west region of Bangladesh is an example of such type of activity. The government has also taken up similar programmes in MIP and in CIP. For this type of programme to be established in a project area, infra-structure facilities with regard to fish seed production, nursery operation, extension and credits will have to be developed. The management of the water bodies has to be given to the NGO or to the fish co-operatives through the GOB under the New Fisheries Management Policy.

VII.5.4 Aquaculture in Completely Closed Water

Ponds, homestead small pond, road-side ditches, pits and khals which are mainly seasonal in nature, will be available for the development of culture systems with different type of species; these different water bodies will hold water for longer period than the without project situation if an irrigation option is included in the project in addition to flood control. Different types of aquaculture technologies suitable for different types of water are

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available now in the country (FRI has developed a few low cost culture technologies suitable for seasonal water). The hatchery and the nursery facilities established within the project for meeting the demand for stocking the open waters will also serve the need of the closed water cultures.

Depending upon the extend of the area under the project i.e. the area of such closed waters, the design and capacity of the seed production facilities have to be determined.

VII.5.5 Open Water Fisheries within Submersible Embankment Project

Submersible embankments are built to protect HYV boro and aus in very low lying areas from early flooding, a mechanism whereby the flood water is checked until the boro crops have been harvested and after that the area is flooded as usual. This is an option for a reasonable gain in crop production, in a situation, where the construction of full height embankment for complete flood protection is not viable.

Though at first sight, such as arrangement looks as if it is good for open water fishery, in practice it does little good to the migratory and the resident species of the flood plain. This is due to the spawning migration pattern of the majority of the inland fish. Almost all the freshwater fish spawn at the onset of the monsoon season and water level rise in the systems. Thus the protection of the rivers, khals or beels from early flooding by the submersible embankment, prevents the migratory carp from entering the rivers, as the water bodies remain separated, in the same way, the rivers, khals and beels are not flooded during the early monsoon, and resident species cannot perform their lateral migration to the inundated plains. However, the conflicts between the time of fish migration and cropping time of HYV boro would be significantly reduced if the time of HYV boro transplantation could be made earlier. This would necessitate purpose-geared extension work with regard to availability of credit and input supply. This proposition also applies in the case of controlled flooding.

CHAPTER VII.6

DEVELOPMENT PROPOSALS

VII.6.1 Introduction

For the Regional Plan the study area has been divided into Planning Units as shown in Figure VII.6.1.

The data presented in this section is derived from various sources, the data on ponds (cultured, culturable and derelict) is based on WPRO DATA which was initially compiled by SPARRSO. The data on fishermen hatcheries catches etc. was collected from thana fisheries offices by the consultants and is more limited since the consultants did not have sufficient time to visit every thana and in any case the post of thana fishery office is sometimes vacant. Data on areas of rivers is often obtain from the Surface Water Modelling Centre of the WRPO. In most cases the data has been collected by an thana basis and it has been necessary to allocate the figures to planning unit areas in protection to the area of the thana in the planning unit.

Table VII.6.1 shows the estimated number and areas of ponds in the planning units and Table VII.1.2 gave the areas of standing water and rivers. Comments on individual planning units are given in the next sections. Table VII.6.2 gives the open water fisheries data available based on the RRA by the study team.

VII.6.2 Planning Unit 2, Polder 59/2

Culture fisheries in this area are small and capture fisheries within the unit are also believed to be small but the unit is close to the Lower Meghna and these are ample opportunities for capture fisheries in the river. The unit has virtually no F_3 class land and capture fisheries are unlikely to suffer when the polder is completed, however there would be large benefits should irrigation be introduced and water can be kept in the system all the time.

VII.6.3 South Sudharam

The Planning Units main drainage channels are the Noakhali khal and Bhulua river and the Unit covers areas of the Phase II of the coastal embankment project's polders 59/3A, 3B and 3C.

There are about 18 000 ponds covering an area of about 2 000 ha and the total production obtained is 2 000 t. The major portion of the unit (62%) is under Sudharam thana, and the total ponds under the thana portion number about 12 000. The statistics on other fisheries aspects such as areas under standing waters and rivers, have been shown in Table where information on number of fishermen, fisherman's cooperatives, hatcheries and nurseries, production of shrimp and production from open waters of the area have been shown for Sudharam thanas.

The drainage channels, i.e. Noakhali khal and Bhulua river, together with the numerous khals in the area as a whole indicate the potential for capture fishery if properly managed. Together with the development of pen culture technology, the khals and rivers can be fenced with suitable screening materials and may stocked with suitable species of fish for culture.

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Figure VII.6.1

Planning Units

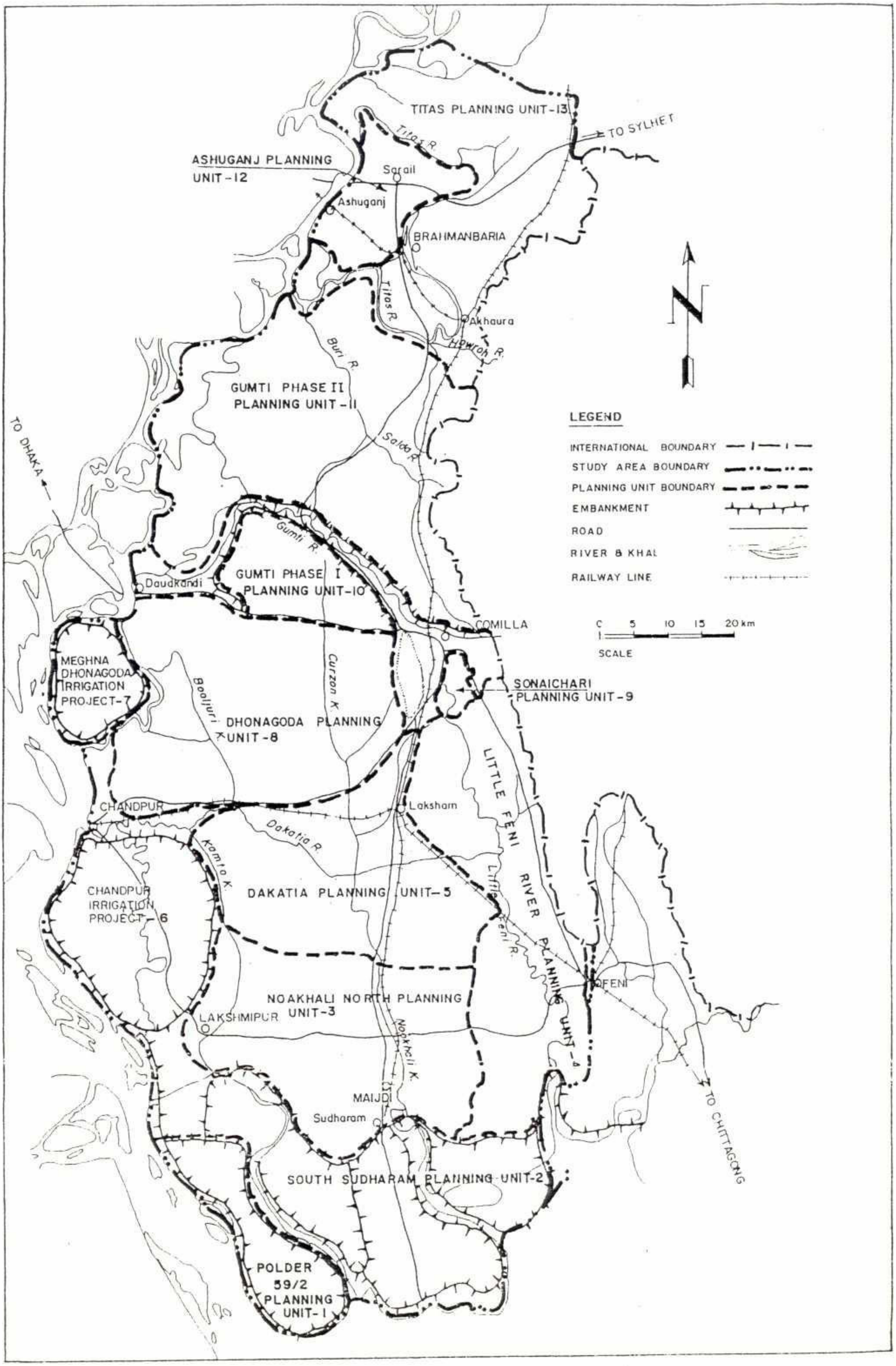

Figure VII.2.7

Percentage Annual Change in Different Systems In Old Comilla District

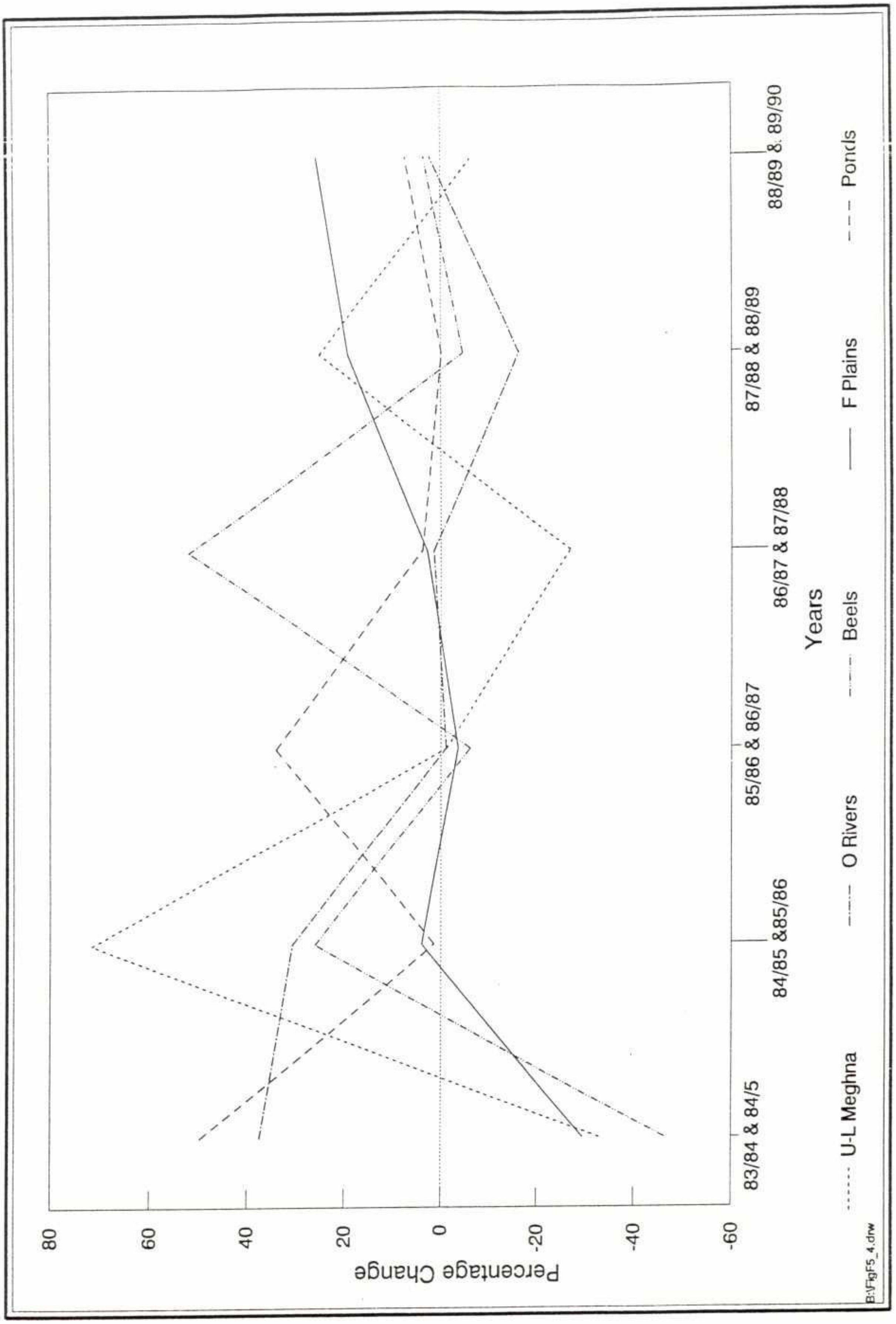

Figure VII.2.8

Location of Major and Minor Hatcheries in the Region

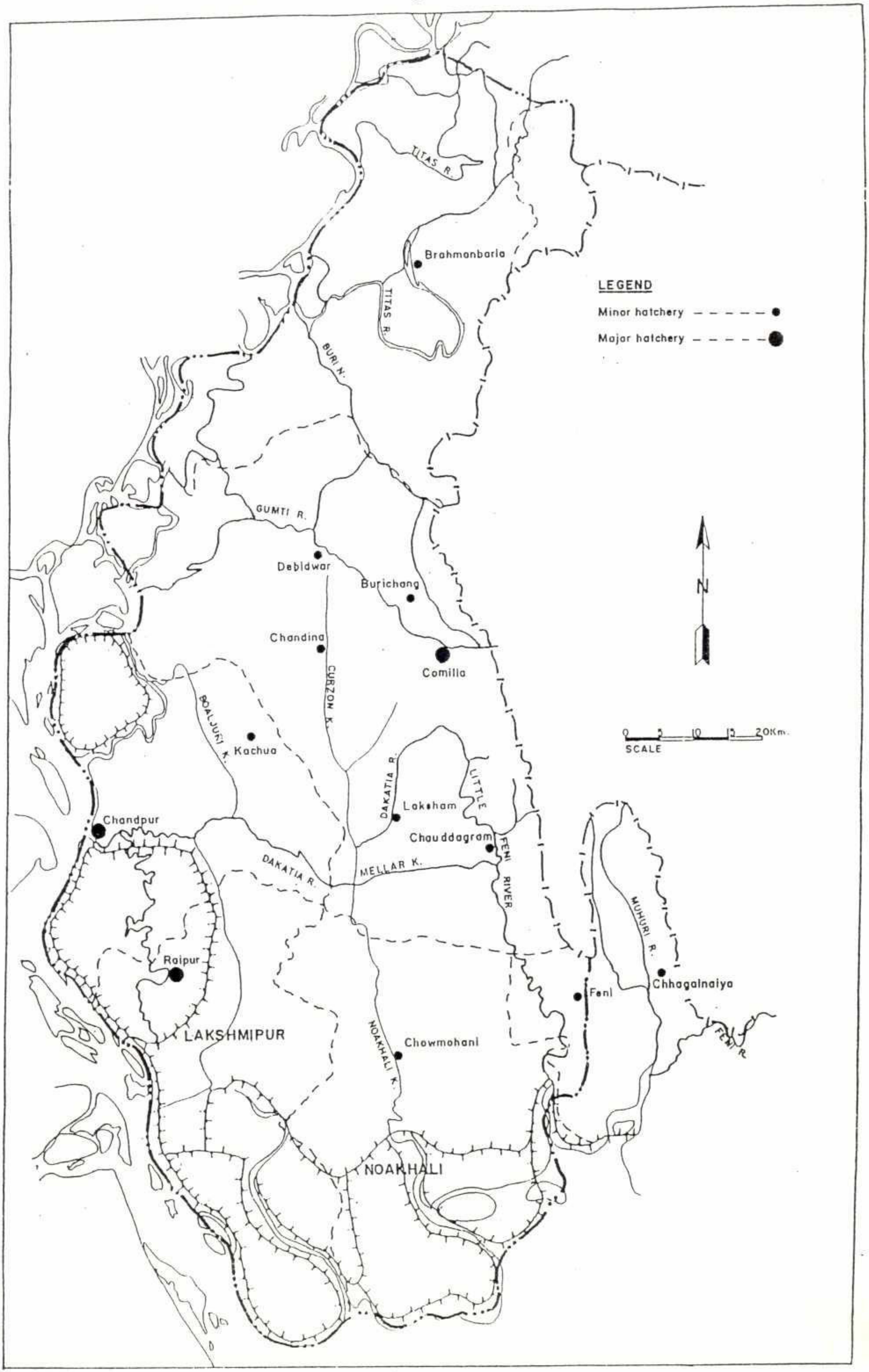

TABLE VI.6.1

Fish Ponds by Planning Unit

Ref. No	Planning Unit	Gross Area (ha)	Total No. of Ponds: Total	Cultured	Culturable	Derelict	Total Area of Ponds: Total (ha)	Cultured (ha)	Culturable (ha)	Derelict (ha)
1	Polder 59/2	30 848	5 986	3 490	1 784	712	673	453	155	65
2	South Sudharam	110 046	18 265	10 648	5 443	2 174	2 053	1 383	472	199
3	Noakhali North	99 535	17 305	10 089	5 157	2 059	13 817	8 014	4 145	1 658
4	Little Feni	97 362	18 591	10 838	5 541	2 212	2 090	1 407	480	203
5	Dakatia	86 108	15 539	9 059	4 630	1 850	1 746	1 176	402	169
6	Chandpur	52 398	9 104	5 308	2 713	1 083	1 023	689	235	99
7	Meghna Dhonagoda	16 189	2 846	1 659	848	339	320	215	74	31
8	Dhonagoda	112 405	20 745	12 094	6 183	2 468	2 331	1 570	536	225
9	Sonaichari	5 603	1 093	637	326	130	123	83	28	12
10	Gumti Phase I	31 486	5 615	3 273	1 673	669	634	425	149	61
11	Gumti Phase II	140 854	25 486	14 855	7 592	3 039	7 244	4 202	2 173	869
12	Ashuganj	28 913	5 151	3 465	1 204	481	454	306	104	44
13	Titas	101 510	16 694	9 969	4 796	1 929	1 809	1 218	416	175
Study area total		913 257	162 420	95 384	47 891	19 144	34 317	21 141	9 369	3 810

TABLE VI.6.2

Open Water Fisheries Data

	Planning Unit Thana	Fishermen: Full-time	Subsistance	Shrimps	Cooperatives	Hatcheries	Nurseries	Shrimp Production (kg)
2	South Sudharam							
	Sudharam	725	33 313	620	1	1	21	3 100
3	Little Feni River							
	Senbag	2 015	4 500		7	3	76	
	Sudharam	23	1 074	20			1	100
	Chauddagram	160	4 000		1	7	44	
12	Ashuganj							
	Sarail	2 015	2 325	1 240	1	1	16	620
	Brahmanbaria	1 332	4 106	n.a.	7	1	4	3 000
	Nabinagar	2 000	1 000	500	18	1	13	250
13	Titas							
	Brahmanbaria	8 811	27 165		45	3	26	13 000
	Nasirnagar	9 100	13 650	455	15	1		900
	Madhabpur	144	21 600		10			
	Sarail	1 040	1 200	640			8	320
	Nabinagar	680	2 550	170	7		3	85

Note: Data for each Planning Unit incomplete

Source: Study survey

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The Planning Unit is new in formation and as would be expected there are freshwater ponds that are under traditional fish culture. There are homestead ponds but these are mainly used for retaining rainwater for household use. A general review of the positive and negative impact of polder projects on fisheries has been made in the main fisheries annex and the present fisheries situation in the southern Noakhali area as a whole has been discussed there. However, as has been indicated in the foregoing, technical inputs with regard to culture systems employed, species of fish used and input utilisation have to be provided by public/private sector participation.

VII.6.4 Planning Unit 3, Little Feni River

There are about 19 000 ponds with an area of 2 000 ha and the total production is about 3 000 tonnes. The area of standing water and rivers in the area is 900 and 300 hectares respectively. Of the ten thanas falling under the Planning Unit, four thanas were visited for data collection such as number of fishermen, fishermen's cooperatives, hatcheries, nurseries.

The main constraint for development of the Planning Unit is the siltation of the Little Feni river and drainage congestion at the Kazirhat regulator. The fisheries potential in the Little Feni river itself is limited. The regulator was constructed a long time ago and the impounded water is now under management where artificial stocking takes place and fishing rights are now with the fishermen cooperatives of the nearby areas. There are no F_3 lands in this Planning Unit, thus there is little potential for capture fisheries. The water in the Little Feni river itself is exhausted during the dry season, thus there is no potential for fish except in the downstream areas where reasonable water volumes permit formation of a reservoir for capture fisheries.

The Kazirhat regulator at the mouth of the river was built to prevent saline water intrusion, since then the sea has retreated by about 30 km. The gates of the regulator are shut during the winter, but are opened during the monsoon season to release flood water. Because there is no salinity problem downstream of the regulator these days, arrangements are made for periodical opening of the gates for the estuarine fish species to enter the reservoir.

Because there is little capture fishery potential the proposals under the study will not cause any reduction upstream of the Kazirhat regulator but the area which would be protected by a new regulator downstream would lose direct areas to the Bay of Bengal and therefore suffer, but this area is comparatively small compared to the Planning Unit as a whole.

VII.6.5 Planning Unit 4, Noakhali North Planning Unit

The total number of ponds in the PU is about 17 000, the area covered is about 8 014 ha and the total production obtained is 15 339 tonne. These estimates only include cultured ponds. The culture fisheries situation in the Chandpur, Lakshmipur and Noakhali areas is in good shape as reflected by the growth of hatcheries and nurseries of in the private sector. In this respect, Raipur Fish Hatchery and Training Centre and the DANIDA'S NIRDP have made an important contribution. There are a total of 29 hatcheries and 312 nurseries in the public and private sectors in the Noakhali North Planning Unit.

The open water area in the form of standing waters and rivers is 140 ha and 12 562 ha respectively; the latter figure includes the area of the Meghna River adjacent to the Planning Unit, and the area of the Dakatia River. Please refer to the Noakhali North feasibility study Draft Final Report for full details. There are numerous khals and their total length is about 223 km with a total area of 1 216 ha; the main khals are Noakhali khal and the WAPDA khal. These are perennial and have potential for capture fisheries, together with the inundated plains which include the Begumganj depression. The area of floodplain, land which floods to depths greater than 30 cm, is 72 768 ha.

The main objective of the proposal for this unit is the removal of the water accumulated in the Begumganj depression which is in the centre of the PU and for that two options have been suggested. The options propose improvement of drainage and increased potential of irrigation in the area either by water taken through the new and improved Rahmatkhali regulator taken from the Dakatia through Kamta khal. In either situation it is assumed that the openwater fisheries situation will reasonably increase. As it is proposed that WAPDA khal will be re-excavated and other secondary khals may be deepened to increase availability of irrigation water, potential for breeding of the resident shallow water fishes will increase; fish will be able to maintain their population in the khal systems. However, the loss of floodplain stand to be severe (62%) and the increase in water depths in the khal system is not enough to counteract the loss in the floodplain fishery. The freshwater shrimp fishery is reported to be good in Rahmatkhali regulator area and provisions of keeping the regulator open for taking water for irrigation or for letting water out during monsoon will help in allowing shrimp larvae to enter the khal. Other than openwater fisheries gains, the khals can be brought under culture-based capture fishery through artificial stocking or culture can be performed in pens, constructed in the khals. The khals can be divided into suitable production units and fenced with suitable netting materials that, will allow water to pass, while the stocked fish will be retained.

VII.6.6 Planning Unit 5, Dakatia Planning Unit

Both culture and capture fisheries are important in the area. There are in total 16 000 ponds with a total area of about 1 420 ha and the total production obtained is 2 900 t. The culture fisheries situation in this part of the region has been developed as is reflected by the number of hatcheries and nurseries in the area.

The openwater fishery is important in the planning unit in general, as the Dakatia River floodplain is substantial and provides for good capture fisheries. The amount of F_3 and F_4 lands in an area provide an indication as of potential of the area for openwater fishery. In this respect the PU is important, as there are a total of about 8 thousand hectares of F_3 and F_4 lands.

The Dakatia River has a total length of 65 km in the PU and the different khals viz., Kamta khal, Dharma khal, Curzon khal, Khila khal, Mellar khal, Noakhali khal and Barakanchi khal together constitute a total length of about 95 km. The river and khals proper, and the adjoining deeper areas offer the opportunity for openwater subsistence and full time fishing.

The Dakatia Planning Unit has a substantial portion of deeper areas having good potential for capture fisheries. Due to the availability of water in the river and khal during the dry season the resident shallow water fish would benefit, they would be able to breed in the semi-inundated plains and in the creeks during the monsoon season. Shrimp would also enter through the open regulators.

The main concern would be for the migratory species that need to go out to the Meghna river for up river migration during the rainy season. Certain areas of the project have to be allowed to be flooded at least during the early monsoon season and the gates of regulators should be kept open then. Conflicts that would arise with boro harvesting time in the semi-deeper lands have to be minimized by early transplantation of boro.

During the early monsoon season the water level of Dakatia may rise for one of three reasons; it may rise due to rainwater run off; due to flash flood from upper areas or due to the rise of the Meghna. However, what ever may be the cause, the gates of the regulators have to be kept open during this time.

It is common for about 35% of the F_3 and F_4 lands to remain as such even after flood control in an area. Dakatia area has about 27 000 ha of F_3 and F_4 lands. These areas can provide a good fish habitat.

With a regulator or with a pump station the provision of a fish pass must be considered

The khals and the canals throughout the planning unit, can be suitably divided into several production units with suitable screening materials and stocked with culturable species. The ownership of the production units can be given to the farmers who own the adjacent agricultural plots or to fishermen's cooperatives formed for the purpose.

VII.6.7 Dhonagoda Planning Unit

The PU is the second largest with respect to the gross area. The culture fisheries situation is similar to the other planning units in the area in general. There are about 20 000 ponds with an area of 2 400 ha and the total production obtained is 4 000 tonnes. Dhonagoda PU is within the very core areas of Chandpur and Comilla region where fish hatcheries and nurseries have sprung up and would be expected to play a useful role in the pond culture fisheries.

The openwater in the form of standing waters and rivers amount to 122 ha and 314 ha respectively. The PU has a total of about 32 000 ha of F_3 and F_4 lands. This, however, suggests that the area has potential for flood plain fishery in the vicinity of the Dhonagoda river and the many khals that criss-cross in the PU. The total length traversed by all these khals and the Dhonagoda river is 262 km.

Two thanas - Matlab and Hajiganj - were studied. 5 000 tonnes of fish is caught annually from the rivers and khals of Matlab thana. The total number of full time and subsistence fishermen in the thana are 2 000 and 25 000 respectively. There are 14 fish cooperatives in the thana. The shrimp fishery in the Dhonagoda river is very important; 23 tonnes of shrimp is reported to be caught annually in the river and 1 000 fishermen are engaged in shrimp fishery. From Hajiganj thana data could not be obtained, however, it is known that there are 25 jalmahals. There are 2 000 and 4 000 full time and subsistence fishermen respectively in the thana and 80 fish nurseries.

This unit has been studied intensively and closure of the Dhonagoda river was contemplated, this would have had a serious effect on deepwater fisheries and therefore the proposed line of the embankment was moved away from the river to the new Matlab-Gouripur road, this was partially because of fishing interests. Any proposal to develop irrigation further in the area would be beneficial.

The presumed increased opportunities for the development of culture-based capture fishery in the semi-closed waters of khals, creeks or in the F_3 and F_4 lands/depressions within the PU, will require large quantities of fish seed of the desired species. Although it is said the fish seed technology has been disseminated well in the region, it is difficult at this stage to calculate the demand and supply of fish seed required. However, depending upon the exact situation, which can better be told at the feasibility study stage, proposals can be made on the establishment of fisheries intra-structure facilities to be built up by the public/private sector in the area.

VII.6.8 Planning Unit 10, Gumti Phase I

The gross area covered in the PU is about 31 000. There are about 6 000 ponds with an area of about 650 ha and the total production obtained is 1 000 tonnes. Culture fisheries are expected to improve gradually as this area is within the reach of Comilla area. In Muradnagar itself, the fishermen were seen producing fish seed using traditional methods but with quite good results.

There is 500 ha of river in the PU. The area is genuinely deeper as is reflected by the existence of about 15 000 ha of F_3 and F_4 lands. This area will suffer due to the implementation of the FCD project and requires attention from the DOF to improve the capture fisheries but in particular to develop culture fisheries in lands where flooding is reduced, the number of ponds in this area is relatively low.

The proposed development of irrigation would increase culture fisheries in ponds and culture-based capture fisheries in the khals and creeks.

VII.6.9 Planning Unit 11 - Gumti Phase II

This unit is the largest planning unit and has a very high proportion of deeply flooded land, more than 75%. Capture fisheries are very important and any attempts at flood control must take this into account. There are two submersible polders recently constructed in the deeply flooded lands to the west and care must be taken to ensure that these are operated in such a way that migratory species may be allowed to pass. The eastern part of the unit is slightly higher, but the rest of this planning unit is deeply flooded. Therefore, careful consideration needs to be taken of problems in this area. The total area of ponds in this unit is comparatively low (4 202 ha) reflecting the risk of ponds being overtopped and cultured fish being allowed to escape.

The 1993 Gumti Phase II feasibility study Fisheries Annex F, provides the most complete analyses so far carried out on this complex system. It also highlights that this particular area is without doubt one of the most important fishing areas in the Region and the country. Further details on these complex fisheries can be found in the Draft Final Report (Annes F).

VII.6.10 Ashuganj Planning Unit

Two broad types of fisheries, culture and capture have been discussed with presumed changes in with project and without project situation. Table VI.6.1 and Table VI.6.2 give statistics on fisheries, pond data was available from DOF, however capture fisheries data could not be obtained from secondary sources.

The Planning Unit, is important from a fisheries point of view. It has a total of about 5 000 ponds with an area of 450 ha and production of about 800 tons. Standing water and rivers are also substantial in the area; the number of full time and subsistence fishermen shows the importance of open water fishery of the area. Hatchery and nursery technologies are not as developed as elsewhere. There are three hatcheries in Brahmanbaria area and one each in Sarail and Nabinagar. The openwater capture fisheries production was not available from any secondary sources; however, if national average for the openwater production is considered the amount stands at about 14 000 tonnes (DOF, 1988-89 data).

The importance of the capture fishery of the unit is emphasised by the existence of a high proportion of F_3 and F_4 land in the unit. Such lands are adjacent to rivers, or other depressions and form part of the jalmahal which serve as the breeding and feeding grounds of the inland shallow water fish that reside in the jalmahal during the dry periods of the year. The culture fisheries situation will be expected to change gradually with the diffusion of aquacultural technology packages related to hatchery, nursery and pond rearing methodologies, a large part of the pond areas within the genuine deeper areas would take a long time to come under culture, simply because of flood risks.

The floodplain fishery or the capture fishery in the inland water of rivers and F_3 lands has a major conflict with the cultivation of boro, as the latter must have to be harvested before the early monsoon season when most of the low lying areas are submerged and the majority of the species residing in the enclosed waters must disperse in the rivers or in the adjacent flooded areas. Under such a situation, provision of even a submersible embankment would do little good to the cause of flood plain fishery. The proposition of having no submersible embankment in the deeper areas of the planning unit, would add to the sustenance of the existing capture fishery.

Ashugonj Sabuz Prakalpa falls in the sub-unit 3 of the Planning Unit and the proposal to use power plant cooling water for irrigation would also provide increased opportunities for culture fisheries in the area. The very slight rise in temperature of the cooling water in the winter (five degrees C) might be of considerable benefit to fish. As irrigation water will be available throughout the dry season, the culture will be easier. The main irrigation canal can be stocked with small fish species like Tilapia and Rajpunti by partitioning the canal into small production units.

VII.6.11 Titas Planning Unit

The fishery is rich in this unit being represented by a total of about 17 000 ponds of about 1 600 ha. The production from pond culture is about 3 000 tonnes. The area has vast standing waters and river resources with areas covering 175 and 350 hectares respectively. Production figures from such openwaters were not available. The number of full time and subsistence fishermen are 20 000 and 66 000 respectively. There are 77 fishermen's cooperatives, 4 hatcheries and 37 nurseries.

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CHAPTER VII.7

CULTURE FISHERIES MITIGATION PROGRAMME

Improved control over flooding is expected to improve productivity in the culture fisheries and to encourage a more rapid development of the industry. Data presented in the MPO Technical Report 17 indicate that for the Chandpur Irrigation and Flood Protection Project, the proportion of ponds cultivated increased from 16% to 51% in the first two years after project completion (1978 and 1979) and had reached the very high level of 95% by 1984. However, the same report highlights the severe losses incurred by the open water fisheries.

To what extent these increases in fish cultivation can be attributed to flood control on its own is not clear. Fish cultivation in adjacent areas outside the Chandpur scheme also increased markedly during the 1980's. Some 56% of households which owned a large pond in control areas outside the Chandpur scheme were engaging in fish cultivation by 1987, compared to around 12% of households in 1977 according to recent surveys (Paul M. Thompson, 'The Impact of Flood Control on Agricultural Development in Bangladesh', 1989). Within the Chandpur Project area, Thompson's surveys showed that the proportion of households owning a large pond who cultivated fish had increased more than in the control areas, reaching 72% in 1987. Chandpur has traditionally been an area of intensive fish cultivation, with a much higher concentration of fish ponds than in other parts of the South-East Region; the applicability of the percentage increases in fish culture realised in Chandpur to other parts of the region is therefore questionable. A part of the growth in fish cultivation between 1977 and 1987 could also be attributed to the construction of the Raipur Fish Hatchery, which should have encouraged fish culture both within the Chandpur scheme area and in adjacent areas; a further part of the growth would have been due to a general increase in farmers' appreciation of the profitability of fish culture and better knowledge of the techniques.

NB

Data on the development of culture fisheries produced by the BBS/Department of Fisheries provide little help in determining trends in fish cultivation. The BBS data show no increase over the past few years in the numbers/area of ponds which are cultivated as opposed to 'culturable' or 'derelict': this is hardly probable in view of the growth in fish cultivation recorded both inside and outside FCD schemes in studies such as Thompson's. The BBS data show some changes in average yields from the different types of pond, but the figures are erratic, as shown in Table 7.1

There is no obvious reason why 'culturable' and derelict ponds should have shown the marked increases in yields suggested by these data: by definition, these categories of pond receive no inputs other than those occurring naturally. The estimated average yields in culturable and derelict ponds, at about one ton per ha in 1987/88, appear to be very high. It could be expected that yields in 'culturable' ponds would approximate to those for beels (around 400 kg/ha) and that yields in 'derelict' ponds would be much lower. However, the yields from the floodplain in Gumti Phase II and Noakhali North were found to be 130 kg/ha in average. The apparent large decline in yields in cultured ponds in Noakhali cannot be explained easily either. Further analyses and data gathering need to be undertaken to assess this situation further.

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TABLE VII.7.1

Average Yields (tons/hectare)

Year	Comilla Region			Noakhali Region		
	Cultured	Culturable	Derelict	Cultured	Culturable	Derelict
1985/86	1.7	0.5	0.4	1.9	0.2	0.2
1986/87	2.1	1.1	0.9	1.1	0.5	0.4
1987/88	2.1	1.2	1.1	1.1	0.8	0.6

(Source: Consultants' estimates based on BBS Statistical Yearbook, 1990)

It may be assumed that with FCD, a proportion of the ponds which would remain uncultivated in the 'without' project case will be cultivated once the flood control measures have been implemented. This would be subject to the availability of adequate credit facilities and fisheries extension services. For the purposes of making an initial estimate of the potential increases in net incremental income from pond fisheries development in a 'with' FCD project case, the following general assumptions have been made:

- yields in uncultivated (culturable and derelict) ponds in the 'without' project case will average between 250 kg/ha per year (based on comparable yields in beels and the floodplain - see above) and 1 000 kg/ha per year (the approximate 1987/88 average recorded in the BBS statistics for the south-east region as a whole), with an average value of Tk 40 per kg in market prices, reflecting present (mid-1991) price levels in the project area for a typical mix of fish species

- in cultivated ponds, more intensive management practices will be adopted in future, both within and outside FCD projects, as the financial profitability of fish farming becomes more widely recognised and as the techniques of fish farming become better known; an average yield of 2 500 kg/ha per year for cultivated ponds has been assumed, at an average value of Tk 50 per kg (the prevailing price in the project area for major carp species).

An indicative annual cost and revenue model for a semi-intensive fish farm producing high value carp is shown in Table VII.7.2. The net annual income (in economic prices) is estimated at Tk 36 989 per ha of ponds. Net annual returns with uncultivated ponds (ie, in the 'without' FCD project case) have been estimated (see Table VII.7.3) at between Tk 6 150 and Tk 24 600 per ha, with yields of 250 kg and 1 000 kg respectively. Net incremental annual income per ha of ponds in the 'with' project case (when a presently uncultivated pond becomes cultivated) has therefore been estimated at between Tk 12 389 and Tk 30 839 per ha in economic prices, (or Tk 19 907-42 407 in financial prices), as shown in Table VII.7.3.

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TABLE VII.7.2

Annual Cash Flow for Carp Pond Production per Hecrate

Item	Unit	Unit Cost (Tk)		Quantity	Total Cost (Tk/year)	
		Financial	Economic		Financial	Economic
Gross Revenue	kg	50.0	41.0	2,500	125,000	102,500
Production Costs:						
Pond Dewatering	lump sum			4,200	3,444	
Bank Repair/ re-excavation	man-days	40.00	28.4	80	3,200	2,272
Feed Preparation/ feeding	man-days	40.00	28.4	80	3200	2272
Fingerlings	piece	1.0	0.8	5,000	5,000	4,100
Lime	kg	6.0	4.9	250	1,500	1,230
Rice Bran	kg	1.5	1.2	3,300	4,950	4,059
Mustard Oil Cake	kg	4.0	3.3	3,300	13,200	10,824
Cowdung	kg	0.3	0.3	12 355	4,201	3,459
Urea	kg	5.0	5.9	300	1,488	1,770
T S P	kg	4.8	10.8	600	2,904	6,456
Sub-Total					43,843	39,886
Harvesting Cost	kg	50.0	41.0	625	31,250	25,625
Net Revenue					49,907	36,989

Source: Estimated quantities: based on DANIDA 'identification of Socioeconomic Feasibility of Freshwater Shrimp Culture in Old Noakhali District, Dec.'89, records for 16 ponds.
Prices: Consultants' estimates, mid-1991 prices.

Note: Conversion factor of 0.82 used to derive economic prices for fish and pond dewatering. Conversion factor of 0.71 used for labour. Economic prices of other items based on consultants' estimates.

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TABLE VII.7.3

Fish Cultivation: Estimate of Net Incremental Income
(Per Hectare/year)

Item	Unit	Unit Cost (Tk)		Quantity	Total Cost (Tk/year)	
		Financial	Economic		Financial	Economic
'Without' Project:						
a) 1,000 kg yield						
Gross Revenue	kg	40.0	32.8	1,000	40,000	32,800
Harvest Cost	kg	40.0	32.8	250	10,000	8,200
Net Income					30,000	24,600
b) 250 kg Yield						
Gross Revenue	kg	40.0	32.8	250	10,000	8,200
Harvest Cost	kg	40.0	32.8	62.5	2,500	2,050
Net Income					7,500	6,150
'With' Project:						
Gross Revenue	kg	50.0	41.0	2,500	125,000	102,500
Harvest Cost	kg				75,093	65,511
Net Income					49,907	36,989
Net Incremental Income 'with' minus 'without'						
a)					19,907	12,389
b)					42,407	30,839

Source: Consultants' estimates - see text.

Note: 'Without' case assumes ponds uncultivated

'With' case assumes cultivation: revenues and costs as estimated in previous table.

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A comparison of the prospective economic gains from increased cultivation of presently uncultivated ponds (on the basis of these estimates) with the expected losses from capture fisheries suggests that there is no practicable possibility of the incremental income from cultured fisheries offsetting the losses from the open water fisheries. Indeed, the incremental gains to fish cultivation would appear to be negligible in comparison to losses to the open water floodplains fisheries. For the proposed Dakatia (Planning Unit 5) project, for example, the area of floodplains (F1-F3 land) affected would be 47 612 hectares, yielding some 2 380 tons of fish per year (at 50 kg/ha), valued in economic prices at about Tk 78.1 million (@Tk 32.80 per kg). It would require between 2 532 and 6 302 ha of uncultivated ponds to be brought into cultivation to offset this loss in value terms (ie, Tk 78 083 680 divided by Tk 12 389 or Tk 30 839 net incremental income per ha of pond): this is equivalent to between one-third and three-quarters of the total area of uncultivated ponds in the whole of the south-east region (of about 8 100 ha according to BBS data). The total area of uncultivated ponds within the Dakatia project area is estimated at about 1 400 hectares or between 22% and 55% of the area required to offset the losses (in economic terms) from the capture fisheries.

The available data on the proportions of ponds which are uncultivated as opposed to cultivated are highly suspect (see above). The validity of any assumptions which might be made about differential rates of development of pond cultivation with or without flood control measures would therefore be highly questionable. It might be argued that with FCD, new ponds may be constructed in greater numbers than without FCD, given that FCD increases the relative share of higher land best suited to pond development. However, here again there is no firm evidence available from experience in existing FCD schemes on which to base any such estimates.

No incremental gains to fish cultivation have been calculated for the pre-feasibility studies in this Report. This decision has been taken on the grounds that the almost complete lack of reliable data on which to base any estimates of future pond cultivation would make any estimates highly arbitrary and unreliable. In addition, the gap between prospective capture fisheries losses from additional FCD works and the practicable incremental gains from fish cultivation would appear to be so large as to preclude the possibility of enhanced returns from fish cultivation offsetting more than a very small part of the losses from the capture fisheries.

The analysis here does emphasise the necessity of including mitigatory measures for fisheries in the event of any new FCD schemes being implemented. These could include artificial stocking and the introduction of appropriate management regimes for open water bodies, as well as enhanced levels of extension work for culture fisheries in general.

In designing mitigation programmes it should be borne in mind that the direct beneficiaries of pond cultivation will in general be the better-off members of the rural community, with access to sufficient land to allow them to own a pond of adequate size. The direct losers from the loss of the migratory fish open water capture fisheries, on the other hand, will include both the fishermen (generally among the poorest members of the community) and the landless and other poorer groups who depend on open water fisheries for a significant part of their dietary requirements. While fish cultivation and the artificial stocking of open water bodies can help to offset the losses from capture fisheries in terms of quantities of fish, the costs of cultivated fish are inevitably greater than for fish caught in the wild, because of the costs of artificial breeding and rearing. Mitigation programmes must therefore include special provision to meet the needs of fishermen and other poorer groups (especially the landless) if the income distribution disbenefits of the loss of the open water fisheries are to be offset. These programmes could include, for example, organisation of cooperatives of fishermen and/or landless labourers who would be assigned the leases on particular areas of open water (in khals, etc); this approach has already been tried in the South-East Region by the Mennonite Central Committee.

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ANNEX VIII

FINANCIAL AND ECONOMIC ANALYSES

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VIII.1

Average Financial Returns by Land Category

TABLE VIII.1.1

Estimated Net Returns per Hectare

Land Category F0I0

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Production costs: Hired labour	Production costs: Irriga-tion	Production costs: Other	Total costs: incl. family labour	Total costs: excl. family labour	Net income: incl. family labour	Net income: excl. family labour
B Aus, local	20%	2683	699	411	0	852	1962	1263	721	1420
T Aus, HYV	7%	1454	322	173	0	323	818	496	636	958
B Aman local dw	0%	0	0	0	0	0	0	0	0	0
T Aman, local	4%	773	176	108	0	162	446	270	327	502
T Aman, HYV	82%	21608	3594	2298	0	4196	10087	6493	11521	15115
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	1%	178	35	22	0	76	133	98	45	80
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	1%	633	56	42	0	248	347	291	286	342
Jute	3%	543	145	97	0	118	360	215	183	328
Pulses: ave.	11%	1258	173	55	0	263	492	318	766	939
Mustard	21%	2241	408	78	0	911	1396	989	845	1252
Sugarcane	1%	345	83	60	0	128	271	188	73	157
Spices (chilli)	4%	1290	156	109	0	211	476	320	814	970
Veg. (brinjal)	10%	2938	427	192	0	470	1089	662	1850	2276
Total	166%	35944	6274	3644	0	7959	17877	11603	18067	24341

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TABLE VIII1.1.2

Estimated Net Returns per Hectare

Land Category F0Ir

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Production costs: Hired labour	Production costs: Irriga-tion	Production costs: Other	Total costs: incl. family labour	Total costs: excl. family labour	Net income: incl. family labour	Net income: excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	10%	1988	440	237	34	442	1153	713	835	1275
B Aman local dw	0%	0	0	0	0	0	0	0	0	0
T Aman, local	19%	3520	801	491	0	740	2032	1231	1488	2289
T Aman, HYV	83%	22067	3670	2346	0	4285	10301	6631	11766	15436
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	90%	29244	4393	3181	3928	5795	17297	12904	11948	16340
Wheat irrig.	11%	1690	331	212	241	650	1434	1103	256	587
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	1%	655	47	36	33	193	309	261	347	394
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	1%	119	16	5	0	25	47	30	73	89
Mustard	1%	113	21	4	0	46	71	50	43	63
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	3%	979	119	83	0	160	361	243	618	737
Veg. (brinjal)	0%	0	0	0	0	0	0	0	0	0
Total	219%	60378	9838	6594	4237	12336	33004	23166	27373	37211

TABLE VIII.1.3

Estimated Net Returns per Hectare

Land Category F1I0

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs Family labour	Hired labour	Irriga-tion	Other	Total costs incl. family labour	excl. family labour	Net income incl. family labour	excl. family labour
B Aus, local	36%	4899	1277	750	0	1556	3583	2306	1316	2593
T Aus, HYV	9%	1803	399	215	0	400	1014	615	788	1187
B Aman local dw	2%	285	61	34	0	79	174	113	111	172
T Aman, local	47%	8579	1952	1197	0	1803	4952	3000	3627	5579
T Aman, HYV	34%	8947	1488	951	0	1737	4176	2689	4770	6258
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	2%	276	54	35	0	117	206	152	70	124
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	3%	1471	130	98	0	577	806	675	665	795
Jute	5%	1052	281	187	0	229	697	416	355	635
Pulses: ave.	9%	974	134	42	0	204	381	247	593	728
Mustard	13%	1389	253	48	0	564	865	613	524	776
Sugarcane	1%	267	64	47	0	99	210	146	57	121
Spices (chilli)	2%	666	81	56	0	109	246	165	420	501
Veg. (brinjal)	6%	1939	282	126	0	310	718	437	1220	1502
Total	170%	32545	6456	3787	0	7786	18028	11573	14516	20972

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TABLE VIII.1.4

Estimated Net Returns per Hectare

Land Category F1Ir

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Hired labour	Irriga-tion	Other	Total costs: incl. family labour	excl. family labour	Net income: incl. family labour	excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	11%	2274	503	271	39	505	1319	815	956	1459
B Aman local dw	0%	0	0	0	0	0	0	0	0	0
T Aman, local	54%	9886	2250	1379	0	2078	5707	3457	4179	6429
T Aman, HYV	39%	10328	1718	1098	0	2006	4821	3104	5507	7225
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	77%	25094	3769	2729	3371	4972	14842	11072	10252	14021
Wheat irrig.	14%	2214	434	277	316	852	1879	1445	335	769
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	2%	1227	88	67	62	361	578	489	649	738
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	0%	0	0	0	0	0	0	0	0	0
Mustard	0%	0	0	0	0	0	0	0	0	0
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	2%	611	74	51	0	100	226	151	386	460
Veg. (brinjal)	4%	1194	173	78	0	191	442	269	751	925
Total	203%	52829	9010	5951	3788	11065	29813	20804	23016	32025

TABLE VIII.1.5

Estimated Net Returns per Hectare

Land Category F2I0

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs Family labour	Hired labour	Irriga-tion	Other	Total costs incl. family labour	excl. family labour	Net income incl. family labour	excl. family labour
B Aus, local	31%	4223	1101	646	0	1341	3088	1988	1135	2235
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	36%	4700	1007	566	0	1298	2871	1864	1829	2836
T Aman, local	8%	1465	333	204	0	308	845	512	619	952
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	11%	1392	273	174	0	592	1040	767	352	625
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	2%	900	80	60	0	353	493	413	407	487
Jute	6%	1158	309	206	0	253	767	458	391	700
Pulses: ave.	9%	1006	139	44	0	211	393	255	612	751
Mustard	15%	1593	290	55	0	648	993	703	600	890
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	1%	306	37	26	0	50	113	76	193	230
Veg. (brinjal)	3%	895	130	58	0	143	332	202	564	694
Total	122%	17637	3698	2041	0	5196	10935	7237	6702	10400

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TABLE VIII.1.6

Estimated Net Returns per Hectare

Land Category F2Ir

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs Family labour	Hired labour	Irrig- -ation	Other	Total costs incl. family labour	excl. family labour	Net income incl. family labour	excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	25%	3264	699	393	0	901	1994	1295	1270	1969
T Aman, local	14%	2563	583	358	0	539	1480	896	1084	1667
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	88%	28678	4308	3119	3852	5683	16962	12654	11716	16024
Wheat irrig.	9%	1424	279	178	203	548	1208	929	216	494
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	2%	1227	88	67	62	361	578	489	649	738
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	0%	0	0	0	0	0	0	0	0	0
Mustard	9%	956	174	33	0	389	596	422	360	534
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	0%	0	0	0	0	0	0	0	0	0
Veg. (brinjal)	1%	298	43	19	0	48	111	67	188	231
Total	148%	38410	6175	4168	4117	8467	22927	16752	15483	21658

TABLE VIII.1.7

Estimated Net Returns per Hectare

Land Category F3I0

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Hired labour	Irriga-tion	Other	Total costs: incl. family labour	excl. family labour	Net income: incl. family labour	excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	61%	7964	1706	960	0	2199	4865	3159	3099	4805
T Aman, local	0%	0	0	0	0	0	0	0	0	0
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	5%	965	146	90	0	140	376	230	588	735
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	4%	506	99	63	0	215	378	279	128	227
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	7%	782	108	34	0	164	306	198	476	584
Mustard	10%	1062	193	37	0	432	662	468	400	594
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	0%	0	0	0	0	0	0	0	0	0
Veg. (brinjal)	0%	0	0	0	0	0	0	0	0	0
Total	87%	11278	2253	1184	0	3150	6587	4334	4692	6944

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TABLE VIII.1.8

Estimated Net Returns per Hectare

Land Category F3lr

1991 Financial Prices Tk

Crop	Share of cropped area %	Gross income	Production costs				Total costs		Net income	
			Family labour	Hired labour	Irriga-tion	Other	incl. family labour	excl. family labour	incl. family labour	excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	24%	3133	671	378	0	865	1914	1243	1219	1890
T Aman, local	0%	0	0	0	0	0	0	0	0	0
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	11%	2122	322	197	241	308	1068	746	1054	1376
Boro, HYV irrig	89%	29004	4357	3155	3896	5747	17155	12798	11849	16206
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	0%	0	0	0	0	0	0	0	0	0
Mustard	0%	0	0	0	0	0	0	0	0	0
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	0%	0	0	0	0	0	0	0	0	0
Veg. (brinjal)	0%	0	0	0	0	0	0	0	0	0
Total	124%	34260	5350	3730	4137	6921	20137	14787	14122	19472

TABLE VIII.9

Estimated Net Returns per Hectare

Land Category F0I0

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs Family labour	Hired labour	Irriga-tion	Other	Total costs incl. family labour	excl. family labour	Net income incl. family labour	excl. family labour
B Aus, local	20%	2357	524	308	0	810	1643	1118	714	1239
T Aus, HYV	7%	1279	241	130	0	318	689	448	589	831
B Aman local dw	0%	0	0	0	0	0	0	0	0	0
T Aman, local	4%	679	132	81	0	157	370	238	309	441
T Aman, HYV	82 %	19001	2695	1723	0	4509	8928	6232	10073	12768
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	1%	249	26	17	0	91	133	107	116	142
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	1%	551	42	32	0	255	329	287	222	264
Jute	3%	553	109	72	0	119	300	192	253	361
Pulses: ave.	11%	1094	130	41	0	226	398	268	696	826
Mustard	21%	1972	306	58	0	1099	1463	1157	509	815
Sugarcane	1%	327	62	45	0	120	228	166	99	162
Spices (chilli)	4%	1122	117	81	0	255	453	336	669	786
Veg. (brinjal)	10%	2556	550	247	0	472	1269	719	1287	1837
Total	166%	31741	4936	2836	0	8431	16203	11268	15537	20473

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TABLE VIII.10

Estimated Net Returns per Hectare

Land Category F0Ir

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Production costs: Hired labour	Production costs: Irriga-tion	Production costs: Other	Total costs: incl. family labour	Total costs: excl. family labour	Net income: incl. family labour	Net income: excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	10%	1748	330	178	18	435	961	631	787	1117
B Aman local dw	0%	0	0	0	0	0	0	0	0	0
T Aman, local	19%	3094	601	368	0	716	1685	1084	1409	2010
T Aman, HYV	83%	19405	2752	1760	0	4605	9117	6365	10287	13040
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	90%	25712	3295	2386	2102	6050	13832	10537	11881	15175
Wheat irrig.	11%	2365	248	159	129	769	1305	1057	1060	1308
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	1%	570	35	27	18	194	274	239	296	332
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	1%	104	12	4	0	21	38	25	66	78
Mustard	1%	100	15	3	0	56	74	59	26	41
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	3%	852	89	62	0	193	344	255	508	597
Veg. (brinjal)	0%	0	0	0	0	0	0	0	0	0
Total	219%	53949	7378	4946	2267	13039	27629	20251	26320	33698

TABLE VIII.1.11

Estimated Net Returns per Hectare

Land Category F1I0

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Hired labour	Irrigation	Other	Total costs: incl. family labour	excl. family labour	Net income: incl. family labour	excl. family labour
B Aus, local	36%	4304	958	562	0	1480	3000	2042	1304	2262
T Aus, HYV	9%	1585	299	161	0	394	855	555	730	1030
B Aman local dw	2%	250	46	26	0	69	141	95	110	155
T Aman, local	47%	7539	1464	897	0	1744	4106	2641	3433	4897
T Aman, HYV	34%	7867	1116	713	0	1867	3696	2580	4171	5287
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	2%	386	41	26	0	140	207	166	179	220
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	3%	1280	98	74	0	593	764	666	515	613
Jute	5%	1071	210	140	0	231	582	371	490	700
Pulses: ave.	9%	847	101	32	0	175	308	207	539	640
Mustard	13%	1222	189	36	0	681	906	717	316	505
Sugarcane	1%	254	48	35	0	93	177	128	77	125
Spices (chilli)	2%	579	61	42	0	131	234	174	345	406
Veg. (brinjal)	6%	1687	363	163	0	311	838	474	849	1212
Total	170%	28871	4994	2908	0	7910	15812	10819	13059	18052

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TABLE VIII.1.12

Estimated Net Returns per Hectare

Land Category F1lr

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Hired labour	Irriga-tion	Other	Total costs: incl. family labour	excl. family labour	Net income: incl. family labour	excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	11%	2000	378	203	21	497	1099	722	901	1278
B Aman local dw	0%	0	0	0	0	0	0	0	0	0
T Aman, local	54%	8688	1687	1034	0	2010	4731	3044	3956	5644
T Aman, HYV	39%	9082	1288	824	0	2155	4267	2979	4815	6103
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	77%	22063	2827	2047	1803	5191	11868	9041	10194	13021
Wheat irrig.	14%	3099	325	208	169	1008	1710	1385	1389	1714
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	2%	1067	66	50	33	364	513	447	554	621
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	0%	0	0	0	0	0	0	0	0	0
Mustard	0%	0	0	0	0	0	0	0	0	0
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	2%	532	56	39	0	121	215	159	317	373
Veg. (brinjal)	4%	1038	224	100	0	192	516	292	523	746
Total	203%	47569	6851	4505	2026	11537	24920	18069	22649	29500

TABLE VIII.1.13

Estimated Net Returns per Hectare

Land Category F2I0

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Production costs: Hired labour	Production costs: Irriga-tion	Production costs: Other	Total costs incl. family labour	Total costs excl. family labour	Net income incl. family labour	Net income excl. family labour
B Aus, local	31%	3710	826	485	0	1276	2586	1760	1124	1950
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	36%	4133	755	425	0	1142	2322	1567	1811	2566
T Aman, local	8%	1287	250	153	0	298	701	451	586	836
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	11%	1948	205	131	0	708	1043	839	905	1109
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	2%	783	60	45	0	363	468	408	315	375
Jute	6%	1180	232	154	0	254	641	409	539	771
Pulses: ave.	9%	875	104	33	0	181	318	214	557	661
Mustard	15%	1402	217	41	0	781	1040	822	362	579
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	1%	266	28	19	0	60	107	80	158	186
Veg. (brinjal)	3%	779	168	75	0	144	387	219	392	560
Total	122%	16362	2844	1562	0	5206	9612	6768	6750	9593

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TABLE VIII.1.14

Estimated Net Returns per Hectare

Land Category F2lr

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Production costs: Hired labour	Production costs: Irriga-tion	Production costs: Other	Total costs: incl. family labour	Total costs: excl. family labour	Net income: incl. family labour	Net income: excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	25%	2870	524	295	0	793	1613	1088	1257	1782
T Aman, local	14%	2252	437	268	0	521	1227	789	1026	1463
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	0%	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	88%	25214	3231	2340	2061	5933	13564	10333	11651	14881
Wheat irrig.	9%	1992	209	134	109	648	1099	890	893	1102
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	2%	1067	66	50	33	364	513	447	554	621
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	0%	0	0	0	0	0	0	0	0	0
Mustard	9%	841	130	25	0	469	624	493	217	348
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	0%	0	0	0	0	0	0	0	0	0
Veg. (brinjal)	1%	260	56	25	0	48	129	73	131	187
Total	148%	34497	4655	3136	2203	8775	18768	14114	15729	20383

TABLE VIII.1.15

Estimated Net Returns per Hectare

Land Category F3I0

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs Family labour	Hired labour	Irriga-tion	Other	Total costs incl. family labour	excl. family labour	Net income incl. family labour	excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	61%	7003	1280	720	0	1935	3935	2655	3068	4348
T Aman, local	0%	0	0	0	0	0	0	0	0	0
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	5%	847	110	67	0	122	299	189	549	659
Boro, HYV irrig	0%	0	0	0	0	0	0	0	0	0
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	4%	708	74	48	0	257	379	305	329	403
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	7%	680	81	26	0	141	247	166	433	514
Mustard	10%	934	145	28	0	521	693	548	241	386
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	0%	0	0	0	0	0	0	0	0	0
Veg. (brinjal)	0%	0	0	0	0	0	0	0	0	0
Total	87%	10173	1689	888	0	2976	5553	3863	4620	6310

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TABLE VIII.16

Estimated Net Returns per Hectare

Land Category F3Ir

Economic prices Tk

Crop	Share of cropped area %	Gross income	Production costs: Family labour	Hired labour	Irriga-tion	Other	Total costs: incl. family labour	excl. family labour	Net income: incl. family labour	excl. family labour
B Aus, local	0%	0	0	0	0	0	0	0	0	0
T Aus, HYV	0%	0	0	0	0	0	0	0	0	0
B Aman local dw	24%	2755	503	283	0	761	1548	1045	1207	1711
T Aman, local	0%	0	0	0	0	0	0	0	0	0
T Aman, HYV	0%	0	0	0	0	0	0	0	0	0
Boro, local	11%	1864	241	148	0	268	657	416	1207	1449
Boro, HYV irrig	89%	25501	3268	2366	2084	6000	13718	10450	11783	15051
Wheat irrig.	0%	0	0	0	0	0	0	0	0	0
Wheat unirrig.	0%	0	0	0	0	0	0	0	0	0
Potato irrig.	0%	0	0	0	0	0	0	0	0	0
Potato unirrig.	0%	0	0	0	0	0	0	0	0	0
Jute	0%	0	0	0	0	0	0	0	0	0
Pulses: ave.	0%	0	0	0	0	0	0	0	0	0
Mustard	0%	0	0	0	0	0	0	0	0	0
Sugarcane	0%	0	0	0	0	0	0	0	0	0
Spices (chilli)	0%	0	0	0	0	0	0	0	0	0
Veg. (brinjal)	0%	0	0	0	0	0	0	0	0	0
Total	124%	30121	4012	2797	2084	7029	15923	11911	14198	18210

TABLE VIII.1.17

Summary of Net Returns per Hectare by Land Category

Land category	Gross income	Total cost incl. family labour	Total cost excl. family labour	Net income incl. family labour	Net income excl. family labour	Improvement in Net inc. (incl. family labour) from drainage	Improvement in Net inc. (incl. family labour) from Irrigation
1991 Financial Prices Tk							
F0I0	35944	17877	11603	18067	24341	3551	
F0Ir	60378	33004	23166	27373	37211	4358	9306
F1I0	32545	18028	11573	14516	20972	7814	
F1Ir	52829	29813	20804	23016	32025	7533	8499
F2I0	17637	10935	7237	6702	10400	2010	
F2Ir	38410	22927	16752	15483	21658	1360	8781
F3I0	11278	6587	4334	4692	6944		
F3Ir	34260	20137	14787	14122	19472		9431
Economic Prices Tk							
F0I0	31741	16203	11268	15537	20473	2478	
F0IR	53949	27629	20251	26320	33698	3671	10782
F1I0	28871	15812	10819	13059	18052	6309	
F1Ir	47569	24920	18069	22649	29500	6920	9590
F2I0	16362	9612	6768	6750	9593	2130	
F2Ir	34497	18768	14114	15729	20383	1531	8979
F3I0	10173	5553	3863	4620	6310		
F3Ir	30121	15923	11911	14198	18210		9577

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TABLE VIII.1.18

Land Acquisition: Economic Cost Estimates

Land category	Share of total SER NCA (%)	Net income per ha including family labour cost (Tk)	Weighted average of net income per ha (Tk)
F0l0	18	15537	2797
F0lr	9	26320	2369
F1l0	27	13059	3526
F1lr	11	22649	2491
F2l0	18	6750	1215
F2lr	6	15729	944
F3l0	9	4620	416
F3lr	2	14198	284
Total	100		14041
PV @ 12%, 30 years (Tk/ha)			113104

VIII.2

Non-Agricultural Flood Damage

ANNEX VIII.2

NON-AGRICULTURAL FLOOD DAMAGE, 1988 FLOODS

VIII.2.1 Introduction

Flood damage data are not collected systematically in Bangladesh. Therefore, analysis of flood damages over a significantly long period is not possible. However, during the colossal floods of 1987 and 1988, efforts were made to collect data on flood damages. The 1988 floods being the highest in recorded history, it will be worthwhile to have a comprehensive estimate of its damages to the south-east region.

VIII.2.2 Existing Studies of Damages of 1988 Floods

(a) GOB-UN Task Force estimated flood damages for 1988 to be US $ 2 237.1 m (Tk 69 000 m) including $ 1 100 m (Tk 3 400 m) attributed to private sector housing. A regional breakdown of these estimates is not available. (Throughout this paper a rate of exchange of US$ 1.00 = Tk 31.2 has been used, figures have been rounded).

(b) Following the above estimates, the government prepared the Rehabilitation Programme in connection with the 1988 flood. The estimated cost of the government Rehabilitation Programme was US $ 1 562.77 m (Tk 48 000 m) which does not include private sector housing programme of about US $ 1 000 m (Tk 31 000 m). No regional breakdown of this estimate is readily available.

(c) The "Pre-feasibility Study for Flood Control in Bangladesh" prepared by the French Engineering Consortium (1989) accepted 1988 flood damages to be US $ 1.3 billion (Tk 40 000 m) which included a sum of US $ 132 m (Tk 41 000 m) for private housing following a 1988 post-flood study on rural housing conducted by the Bangladesh Institute of Development Studies (BIDS). This study also gave a district-wise breakdown of damages, based on information gathered from the Bangladesh Ministry of Relief and Rehabilitation. The sum of the regional damages is Tk 14 026 m (or US $ 445 m approximately). The reason for this wide divergence between US $ 1.3 billion (Tk 40 000 m) accepted as the total damage and US $ 445 million shown as sum of regional damages is that the latter does not cover estimates on such vital sectors as industries, post and telecommunications, railways, family planning and public health, educational facilities etc.

VIII.2.3 Sectoral Breakdown of 1988 Flood Damages

There are two sets of sectoral allocations on flood damages namely one from the GOB-UN Task Force and the other from the GOB Rehabilitation Programme for 1988 Flood. These are shown below.

Summary Statement on Flood Damage Estimates and Rehabilitation Programme 1988

Economic Rehabilitation Sectors		(US $ million) GOB-UN Task Force Estimates of Damages	G O B Programme 1988
1.	Agriculture	168.0	164.14
2.	Flood Control & Irrigation	226.6	221.32
3.	Transport	309.9	331.60
4.	Communication	101.4	216.08
5.	Energy	55.2	38.63
6.	Industry	225.2	221.76
7.	Health and Family Planning	37.7	50.62
8.	Education	58.0	80.16
9.	Physical Planning & Housing	1 055.1	98.06
10.	Social	N.A.	140.20
11.	Public Administration	N.A.	0.20
	Total	2 237.1*	1 562.7*

*. [These do not include private sector housing programme of about $ 1 000 m (Tk 31 000 m)].

N.A.: Not available

Summary Statement on Flood Damage Estimates and Rehabilitation Programme 1988

Economic Rehabilitation Sectors		(US Tk million) GOB-UN Task Force Estimates of Damages	G O B Programme 1988
1.	Agriculture	5 210	5 090
2.	Flood Control & Irrigation	7 020	6 860
3.	Transport	9 610	10 280
4.	Communication	3 140	6 700
5.	Energy	1 710	1 200
6.	Industry	6 980	6 870
7.	Health and Family Planning	1 170	
8.	Education	1 800	2 480
9.	Physical Planning & Housing	3 2170	3 040
10.	Social	N.A.	4 350
11.	Public Administration	N.A.	10
	Total	69 350*	4 8450*

* [These do not include private sector housing programme of about Tk 31 000 m]
N.A.: Not available

Thus, we have to apportion close to US $ 1.5 billion (Tk 46 000 m) among the several flood affected districts.

VIII.2.4 Breakdown of Damage by Region

Project digests are available in the document entitled, Bangladesh Flood 1988: Rehabilitation Programme, indicating the total sum earmarked for each project and the nature of flood damage rehabilitation. However, these projects were drawn up in great haste towards the close of 1988 or early 1989. Both conceptual and statistical issues were to be faced while considering the project digests, which did not show regional/district-wise allocations.

Therefore, the approach used by the consultants was to obtain data from the ministries and agencies sponsoring these projects ; background materials were sometimes available with the Project Proformas (PPS). In some cases the cost of individual sectoral projects did not add up to the sectoral totals, due mainly to constant changes in the project profiles occasioned by availability or otherwise of donors and funds. Sometimes, the nature of the project cost and objectives of the project indicated that flood control could not have saved these particular damages in the SE Region. Therefore, judgement had to be exercised to accept a certain project or its particular component before regional allocation could be made. The following pages detail the process of regionalisation of the 1988 flood damages by sectors. Only non-agricultural damages are being considered. Crop damages are estimated separately.

The following Table VIII.2.1 presents the non-agriculture damages by Districts in the south east region where available. The total is estimated at Tk 3,539.9 million. The basis for the estimates is described below.

Table VIII.2.1

1988 Flood Non-crop Damages by sectors and by Districts/SE Region

District	Transport		Railway	Communication		Energy	Industries	Health and Family Planning	Education	Dwelling	Total
	Roads	Bridges		T&T	P.Office						
Comilla	35.5	0.0	@	12.0	*	441.6	176.5	5.8	101.2	108.8	881.4
Brahmanbaria	80.8	9.6	0.0	3.8	-	931.7	169.5	5.5	60.5	69.7	1 331.1
Chandpur	0.0	0.0	0.0	10.2	-	471.2	15.6	19.0	50.9	21.9	588.8
Noakhali	30.2	0.6	0.0	2.5	-	0.0	29.3	20.5	9.2	6.4	98.7
Lakshmipur	30.3	78.1	0.0	3.0	-	0.0	11.9	1.8	23.3	19.1	167.5
Feni	0.0	0.0	0.0	1.5	-	0.0	15.2	0.0	16.8	3.4	36.9
Greater Comilla	0.0	0.0	0.0	0.0	-	-	269.0 #	8.2 $	0.0	0.0	277.2
Greater Noakhali	0.0	0.0	0.0	0.0	-	-	156.7 #	1.6 $	-	-	158.3
South-East Region	176.8	88.3	71.9@	33.0	14.4*	1 844.5	843.7	62.4	261.9	229.3	3 539.9

@ Most damages are reported by sections of railway tracks only, area specific damage to station buildings being very minor. Hence, no district-wise distribution.

* Total damage could be approximated to the region only.

Certain BSCIC allocations are available by old districts only.

$ Certain Family Planning allocations are by old districts only.

VIII.2.5 Breakdown by Sector within South East Region

VIII.2.5.1 Transport (TK 337.0 million)

Roads and Bridges

The regional allocation in the French Engineering Consortium pre-feasibility study was compared with departmental records. The regional allocation of the pre-feasibility study was based on information derived from the Ministry of Relief and Rehabilitation and was accepted here. The national total on roads and bridges damages reported in the above study is close to the GOB estimates.

Railway

The latest project proforma (PP) of the Railway Department was used to apportion the rehabilitation costs. The PP shows Tk 1 244 million as total cost for the country, of which Tk 498 m are for the Eastern Zone. Area specific costs are found for about 70 per cent of the costs. The rest of the costs on track repairs, sleepers, signals, etc. are divided on the basis of the share of the affected track. South East region's share is rather small, compared to East Zone's rehabilitation expenditures, as a large section of the severely affected tracks lie outside the region in greater Dhaka and Mymensingh and the huge cost of Meghna Railway Bridge is not attributed to this region.

Aviation and Navigation

Costs of rehabilitation of inland water transport or civil aviation are not regionalised as their contribution to the region is marginal.

VIII.2.5.2 Communication (Tk 47.4 million)

Telephone and Telegraph

T & T Board's estimates showed a damage of Tk. 3 186 m following the GOB-UN Task Force compared to about Tk. 6 555 m later shown as the sum of rehabilitation projects. This is the sector where the divergence between GOB-UN Task Force and GOB estimates is the greatest. We followed the former GOB-UN estimates, and the costs were available by districts.

Postal Department

Costs were available in a highly aggregated form. Tk 250 m were shown as total damage to the country and Tk 14.4 m or six per cent could be earmarked to the region.

VIII.2.5.3 Energy (Tk 1 844.5 million)

The PP for 1988 Flood damage rehabilitation was available with the Energy Section of the Planning Commission.

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(a) Power Development Board (PDB)

The PP showed a total cost or rehabilitation of Tk 1 153 million which is in consonance with the GOB estimates shown above, but falls short of the GOB-UN Task Force estimates. Area specific costs are available for 25 per cent of the estimates. About 50 per cent of the costs are for damaged meters or associated accessories. The judgement of the experts in the field was to apportion this cost among the districts on the basis of area specific damage costs. None of the districts of greater Noakhali appears to have sustained any loss on this count.

(b) Rural Electrification Board (REB)

Tk 128 m were shown as cost of rehabilitation for 1 793 000 households shown by each of the affected districts. The entire sum was allocated by the number of affected households in each district.

(c) Gas

Total original cost shown in the GOB estimates is Tk 11.7 m for greater Dhaka Comilla and Sylhet. However, the relevant corporation now considers that only Tk 1.8 m were spent in Comilla and no further rehabilitation work is necessary, as gas transmission is designed to withstand annual floods.

VIII.2.5.4 Industries (Tk 843.7 million)

Source

i) Project Digests of Bangladesh Food 1988: Rehabilitation Programme,

ii) Bangladesh Small and Cottage Industries Corporation (BSCIC), and

iii) Bangladesh Handloom Board.

Total allocation by GOB was for US $ 221.76 m or about Tk 6,985 m. Out of this, Bangladesh Sugar Mills Corporation's Tk 137 m or Jute Mills Corporation's Tk 2 million were not relevant for South East region. Again, the Ministry of Industries, Weaver Assistance Programme costing Tk 1 060 m was not considered to be flood rehabilitation oriented. Thus, allocations are made for projects of BSCIC (Tk 4 730 m) and Handloom Board (Tk 1 020 m).

(a) BSCIC

The office of the Director of Planning offered detailed information by Districts for BSCIC industrial estates and BSCIC assisted industries. However, rehabilitation of small and cottage industries which were not assisted by BSCIC also required rehabilitation assistance. These programmes were also drawn up by BSCIC but shown by old (greater) districts.

(b) **Handloom Board**

The office of the Chief Planning Officer furnished the details of the project, entitled "Post-flood Weaver Rehabilitation (Tk 1 020 m) by districts.

VIII.2.5.5 Health and Family Planning (Tk 62.4 million)

Source

Health Section and Family Planning Section of the Planning Commission.

The GOB-UN Task Force estimated total damage of US $ 37.7 m while the GOB Rehabilitation Programme offered project digests for US $ 50.6 m (Tk 1 170 m). Regional allocation were however, available for Tk 1 186 m from the GOB-UN Task Force Studies. The latest PPs for US$ 50.6 m were not available.

(a) **Family Planning**

Damage to Family Welfare Centres in the country was estimated at Tk. 139 m. In all 898 Family Planning Welfare Centres were affected; 17 in greater Noakhali and 86 in greater Comilla, each costing Tk 94,989 to repair. Nineteen Training Centres were rehabilitated in the country costing Tk 42.3 m. One was located in Comilla and the other in Chandpur in the South East region. Each was allocated Tk 2.3 m.

(b) **Health Sector**

Three projects under the sector were allocated Tk 1 023 m. Location specific allocations were available from the PP.

Education (Tk 262 million)

Source

Deputy Chief, Ministry of Education.

Total cost of rehabilitation under the Education Sector was US$ 58 m (Tk 1 800 m) as per the GOB-UN Task Force and US$ 80.16 m (Tk 2 480 m) as per GOB Project Digest. Allocations were made by districts for various types of educational institutions such as primary, secondary, college, madrasha and vocational training institutions. The sub-allocations added upto the total of Tk 252 million.

Dwelling (Tk 230 million)

Private dwelling repair and rehabilitation costs are somewhat debatable. The GOB-UN Task Force estimates of about US$ 1000 m (Tk 31 000 m) are considered to be too high. Following the post-flood survey of rural housing damages by the Bangladesh Institute of Development Studies (BIDS), the prefeasibility study mentioned

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above accepted a national damage of rural housing to be US$ 162 m (Tk 5 000 m) which was apportioned by districts. GOB project digest did not offer any comprehensive plan for rural housing. As such, the damages allocated by the prefeasibility study has been used here.

The pre-feasibility study had a separate category under government building. This is not reported in this study, as government buildings are subsumed in the sectoral allocations.

Concluding Remarks

A note of warning may be given here. Many national and international experts have opined that the flood damage estimates are significantly on the high side, due mainly to:

(1) the official habit of calculated or conscious overestimation for budgetary provisions, particularly if external assistance is expected,

(2) the fond hope to undertake most accumulated or foreseeable maintenance work in the name of flood damage, and

(3) the marginal push of 1988 flood triggering off the potential damages lying under the veneer of inadequate repair and maintenance work of many buildings, equipments, roads and other infrastructures. Besides, while crop damages are persistently followed over the years, non-agricultural damages are only estimated occasionally during catastrophic floods and cyclones. Thus both expertise and experience are lacking in this case.

It may be mentioned that some direct damages such as urban housing losses or losses to rural hats and bazars or municipal water supplies etc. are not included in the above estimates due to the lack of data. Besides, secondary effects of floods in terms of reduced economic activity, consumer demand, reduced employment, etc. are not also estimated.

It may also be noted that the 1988 Flood did not significantly affect the Noakhali and Feni districts of the South East region and as such, the region's share of the national damage is considerably less than that of other areas.

VIII.3

Project Evaluations - Additional Economic Analysis Tables

TABLE VIII.3.1

Distribution of Land by Flood Phase/Irrigation (ha)

Planning Unit 1, Polder 59/2

Gross area 33086
Net Cultivated Area (NCA) 26469 (excluding orchards)

Land Category	F0I0	F0Ir	F1I0	F1Ir	F2I0	F2Ir	F3I0	F3Ir	All	All	All
Present											
Area (ha)	0	0	24879	2	1554	34	0	0	26433	36	26469
% NCA	0	0	94	0	6	0	0	0	100	0	100
Project year 1											
Area (ha)	0	0	24879	2	1554	34	0	0	26433	36	26469
%NCA	0	0	94	0	6	0	0	0	100	0	100
Future Without (1)											
Area (ha)	0	0	24879	2	1554	34	0	0	26433	36	26469
% NCA	0	0	94	0	6	0	0	0	100	0	100
Future Without (2)											
Area (ha)	0	0	24879	2	1554	34	0	0	26433	36	26469
% NCA	0	0	94	0	6	0	0	0	100	0	100
Future With (1)											
Area (ha)	0	0	16889	7992	1044	544	0	0	17933	8536	26469
% NCA	0	0	64	30	4	2	0	0	68	32	100
Future With (2)											
Area (ha)	0	0	16889	7992	1044	544	0	0	17933	8536	26469
% NCA	0	0	64	30	4	2	0	0	68	32	100

Note: F0I0 land excludes orchards

TABLE VIII.3.2

Labour requirements and paddy production

Planning Unit 1, Polder 59/2

		LABOUR REQUIREMENTS					PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW(1) Labour md ('000s)	FW(2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW(2) tonnes
B Aus, local	141	1339	1339	1339	908	908	17148	17148	17148	11637	11637
T Aus, HYV	176	438	438	438	297	297	7327	7327	7327	4974	4974
B Aman local dw	109	74	74	74	64	64	1126	1126	1126	979	979
T Aman, local	168	2702	2702	2702	2648	2648	35140	35140	35140	34442	34442
T Aman, HYV	181	808	808	808	1126	1126	15105	15105	15105	21034	21034
Boro, local	118	4	4	4	2	2	83	83	83	56	56
Boro, HYV irrig	211	8	8	8	1801	1801	175	174	174	41357	41357
Wheat irrig.	127	0	0	0	0	0					
Wheat unirrig.	102	79	79	79	54	54					
Potato irrig.	194	0	0	0	0	0					
Potato unirrig.	175	218	218	218	148	148					
Jute	215	53	53	53	36	36					
Pulses: ave.	51	13	13	13	9	9					
Mustard	58	221	221	221	150	150					
Sugarcane	255	1150	1150	1150	781	781					
Spices (chilli)	157	39	39	39	27	27					
Veg. (brinjal)	270	202	202	202	137	137					
Total		7346	7346	7346	8187	8187	76105	76103	76103	114478	114478

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TABLE VIII.3.3

Annual Total (Net) Income, and Cropped Area by Crop

Planning Unit 1, Polder 59/2

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO (1) Area (ha)	Future WO (1) Total Income (Tk'000)	Future WO (2) Area (ha)	Future WO (2) Total Income (Tk'000)	Future With (1) Area (ha)	Future With (1) Total Income (Tk'000)	Future With (2) Area (ha)	Future With (2) Total Income (Tk'000)
B Aus, local	3237	9500	29218	9500	29218	9500	29218	6447	19828	6447	20872
T Aus, HYV	6433	2488	15205	2488	15204	2488	15204	1689	10321	1689	10865
B Aman local dw	3894	677	2504	677	2504	677	2504	589	2177	589	2292
T Aman, local	4840	16083	73947	16082	73947	16082	73947	15763	72477	15763	76292
T Aman, HYV	9988	4479	42499	4479	42499	4479	42499	6237	59178	6237	62293
Boro, local	7965	31	235	31	235	31	235	21	158	21	166
Boro, HYV irrig	12368	36	425	36	423	36	423	8536	100293	8536	105571
Wheat irrig.	9367	0	0	0	0	0	0	0	0	0	0
Wheat unirrig.	6834	777	5048	777	5048	777	5048	528	3425	528	3605
Potato irrig.	27301	0	0	0	0	0	0	0	0	0	0
Potato unirrig.	14391	1244	17007	1244	17006	1244	17006	844	11545	844	12152
Jute	4783	249	1130	249	1130	249	1130	169	767	169	808
Pulses: ave.	4922	249	1163	249	1163	249	1163	169	790	169	831
Mustard	1976	3841	7210	3841	7210	3841	7210	2606	4893	2606	5151
Sugarcane	6309	4509	27029	4509	27029	4509	27029	3061	18347	3061	19312
Spices (chilli)	14786	249	3495	249	3495	249	3495	169	2372	169	2497
Veg. (brinjal)	12094	746	8575	746	8575	746	8575	507	5821	507	6127
Total		45158	234691	45158	234688	45158	234688	47334	312394	47334	328836

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	:	Assumed 1994/95
Future Without (1)	:	Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	:	Future Without Project Conditions, Year 30
Future With (1)	:	Future With Project Conditions, 5 years after project completion
Future With (2)	:	Future With Project Conditions, Year 30
% Increment (1)	:	% difference FW (1) over FWO (1)
% Increment (2)	:	% difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

TABLE VIII.3.4

Cash Flows (1991 Economic Prices)

Planning Unit 1, Polder 59/2

(Million Taka)

Year	Net Crop Income FWO	Net Crop Income FW	Benefits Incre-mental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	235	235	0	0.0	0.0	0.0	0.0	49.1	0.0	49.1	-49.1
2	235	235	0	0.0	0.0	0.0	0.0	49.1	0.0	49.1	-49.1
3	235	235	0	0.0	0.0	0.0	0.0	49.1	0.0	49.1	-49.1
4	235	235	0	0.0	0.0	0.0	0.0	49.1	0.0	49.1	-49.1
5	235	235	0	0.0	0.0	0.0	0.0	49.1	0.0	49.1	-49.1
6	235	248	13	0.0	10.4	23.3	4.9		12.4	17.2	6.1
7	235	260	26	0.0	10.4	36.3	4.9		12.4	17.2	19.0
8	235	273	39	0.0	10.4	49.2	4.9		12.4	17.2	31.9
9	235	286	52	0.0	10.4	62.1	4.9		12.4	17.2	44.9
10	235	299	65	0.0	10.4	75.0	4.9		12.4	17.2	57.8
11	235	302	68	0.0	10.4	78.3	4.9		12.4	17.2	61.1
12	235	306	71	0.0	10.4	81.6	4.9		12.4	17.2	64.4
13	235	309	74	0.0	10.4	84.9	4.9		12.4	17.2	67.6
14	235	312	78	0.0	10.4	88.2	4.9		12.4	17.2	70.9
15	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
16	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
17	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
18	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
19	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
20	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
21	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
22	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
23	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
24	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
25	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
26	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
27	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
28	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
29	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
30	235	316	81	0.0	10.4	91.4	4.9		12.4	17.2	74.2
Present Value @12%	2150	260	0.0	46.4	306.0	21.6	176.9	55.0	253.5	52.5	

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TABLE VIII.3.5

Distribution of Land by Flood Phase/Irrigation (ha)

Planning Unit 2, South Sudharam, Polder-59/3A & Polder-59/3B (Options 1 and 2)

Gross area 84800

Net Cultivated Area (NCA) 69800 (excluding orchards)

Land Category	F0I0	F0Ir	F1I0	F1Ir	F2I0	F2Ir	F3I0	F3Ir	All	All	All
Present											
Area (ha)	0	0	63635	1483	4570	112	0	0	68205	1595	69800
% NCA	0	0	91	2	7	0	0	0	98	2	100
Project year 1											
Area (ha)	0	0	63635	1483	4570	112	0	0	68205	1595	69800
%NCA	0	0	91	2	7	0	0	0	98	2	100
Future Without (1)											
Area (ha)	0	0	63635	1483	4570	112	0	0	68205	1595	69800
% NCA	0	0	91	2	7	0	0	0	98	2	100
Future Without (2)											
Area (ha)	0	0	63635	1483	4570	112	0	0	68205	1595	69800
% NCA	0	0	91	2	7	0	0	0	98	2	100
Future With (1)											
Area (ha)	0	0	63635	1483	4570	112	0	0	68205	1595	69800
% NCA	0	0	91	2	7	0	0	0	98	2	100
Future With (2)											
Area (ha)	0	0	63635	1483	4570	112	0	0	68205	1595	69800
% NCA	0	0	91	2	7	0	0	0	98	2	100

Note: F0I0 land excludes orchards

TABLE VIII.3.6

Labour requirements and paddy production

Planning Unit 2, South Sudharam, Polder-59/3A & Polder-59/3B (Options 1 and 2)

		LABOUR REQUIREMENTS					PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW (1) Labour md ('000s)	FW (2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW (2) tonnes
B Aus, local	141	3440	3440	3440	3440	3440	44066	44066	44066	44066	44066
T Aus, HYV	176	1120	1120	1120	1120	1120	18740	18740	18740	18740	18740
B Aman local dw	109	197	197	197	197	197	2998	2998	2998	2998	2998
T Aman, local	168	7070	7070	7070	7070	7070	91954	91954	91954	91954	91954
T Aman, HYV	181	2175	2175	2175	2175	2175	40630	40630	40630	40630	40630
Boro, local	118	11	11	11	11	11	243	243	243	243	243
Boro, HYV irrig	211	337	337	337	337	337	7728	7728	7728	7728	7728
Wheat irrig.	127	0	0	0	0	0					
Wheat unirrig.	102	203	203	203	203	203					
Potato irrig.	194	0	0	0	0	0					
Potato unirrig.	175	557	557	557	557	557					
Jute	215	136	136	136	136	136					
Pulses: ave.	51	32	32	32	32	32					
Mustard	58	567	567	567	567	567					
Sugarcane	255	2944	2944	2944	2944	2944					
Spices (chilli)	157	100	100	100	100	100					
Veg. (brinjal)	270	515	515	515	515	515					
Total:		19404	19404	19404	19404	19404	206360	206360	206360	206360	206360

TABLE VIII.3.7

Annual Total (Net) Income, and Cropped Area by Crop
Planning Unit 2, South Sudharam, Polder-59/3A & Polder-59/3B (Options 1 and 2)

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3237	24413	75082	24413	75082	24413	75082	24413	75082	24413	79033
T Aus, HYV	6433	6363	38890	6363	38890	6363	38890	6363	38890	6363	40936
B Aman local dw	3894	1803	6670	1803	6670	1803	6670	1803	6670	1803	7021
T Aman, local	4840	42084	193503	42084	193503	42084	193503	42084	193503	42084	203688
T Aman, HYV	9988	12048	114314	12048	114314	12048	114314	12048	114314	12048	120331
Boro, local	7965	91	692	91	692	91	692	91	692	91	728
Boro, HYV irrig	12368	1595	18740	1595	18740	1595	18740	1595	18740	1595	19727
Wheat irrig.	9367	0	0	0	0	0	0	0	0	0	0
Wheat unirrig.	6834	2000	12988	2000	12988	2000	12988	2000	12988	2000	13672
Potato irrig.	27301	0	0	0	0	0	0	0	0	0	0
Potato unirrig.	14391	3182	43499	3182	43499	3182	43499	3182	43499	3182	45788
Jute	4783	636	2891	636	2891	636	2891	636	2891	636	3044
Pulses: ave.	4922	636	2976	636	2976	636	2976	636	2976	636	3132
Mustard	1976	9865	18521	9865	18521	9865	18521	9865	18521	9865	19495
Sugarcane	6309	11546	69204	11546	69204	11546	69204	11546	69204	11546	72847
Spices (chilli)	14786	636	8938	636	8938	636	8938	636	8938	636	9409
Veg. (brinjal)	12094	1909	21933	1909	21933	1909	21933	1909	21933	1909	23087
Total		118809	628841	118809	628841	118809	628841	118809	628841	118809	661938

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	: Assumed 1994/95
Future Without (1)	: Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	: Future Without Project Conditions, Year 30
Future With (1)	: Future With Project Conditions, 5 years after project completion
Future With (2)	: Future With Project Conditions, Year 30
% Increment (1)	: % difference FW (1) over FWO (1)
% Increment (2)	: % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

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TABLE VIII.3.8

Cash Flows (1991 Economic Prices)

Planning Unit 2, South Sudharam, Polder-59/3A & Polder-59/3B (Option 1)

(Million Taka)

Year	Net Crop Income FWO	Net Crop Income FW	Benefits Incre-mental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	626	626	0	0.0	0.0	0.0	0.0	38.1	0.0	38.1	-38.1
2	626	626	0	0.0	0.0	0.0	0.0	38.1	0.0	38.1	-38.1
3	626	626	0	0.0	0.0	0.0	0.0	38.1	0.0	38.1	-38.1
4	626	626	0	0.0	0.0	0.0	0.0	38.1	0.0	38.1	-38.1
5	626	626	0	0.0	0.0	0.0	0.0	38.1	0.0	38.1	-38.1
6	626	626	0	0.0	56.3	56.3	13.2		8.1	21.3	35.0
7	626	626	0	0.0	56.3	56.3	13.2		8.1	21.3	35.0
8	626	626	0	0.0	56.3	56.3	13.2		8.1	21.3	35.0
9	626	626	0	0.0	56.3	56.3	13.2		8.1	21.3	35.0
10	626	626	0	0.0	56.3	56.3	13.2		8.1	21.3	35.0
11	626	633	7	0.0	56.3	62.9	13.2		8.1	21.3	41.6
12	626	639	13	0.0	56.3	69.5	13.2		8.1	21.3	48.2
13	626	646	20	0.0	56.3	76.1	13.2		8.1	21.3	54.8
14	626	653	26	0.0	56.3	82.8	13.2		8.1	21.3	61.4
15	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
16	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
17	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
18	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
19	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
20	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
21	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
22	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
23	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
24	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
25	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
26	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
27	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
28	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
29	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
30	626	659	33	0.0	56.3	89.4	13.2		8.1	21.3	68.1
Present Value @12%		5107	62	0.0	250.4	312.9	58.7	137.5	36.2	232.3	80.6
										EIRR (%)	16.86

FPP-5
Polder-59/3B

TABLE VIII.3.9

Cash Flows (1991 Economic Prices)

Planning Unit 2, South Sudharam, Polder-59/3A & Polder-59/3B (Option 2)

(Million Taka)

Year	Net Crop Income FWO	Net Crop Income FW	Benefits Incre-mental Crop Income	Flood damag e non-agr.	Flood damag e crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	626	626	0	0.0	0.0	0.0	0.0	63.0	0.0	63.0	-63.0
2	626	626	0	0.0	0.0	0.0	0.0	63.0	0.0	63.0	-63.0
3	626	626	0	0.0	0.0	0.0	0.0	63.0	0.0	63.0	-63.0
4	626	626	0	0.0	0.0	0.0	0.0	63.0	0.0	63.0	-63.0
5	626	626	0	0.0	0.0	0.0	0.0	63.0	0.0	63.0	-63.0
6	626	626	0	0.0	56.3	56.3	13.2		14.4	27.6	28.7
7	626	626	0	0.0	56.3	56.3	13.2		14.4	27.6	28.7
8	626	626	0	0.0	56.3	56.3	13.2		14.4	27.6	28.7
9	626	626	0	0.0	56.3	56.3	13.2		14.4	27.6	28.7
10	626	626	0	0.0	56.3	56.3	13.2		14.4	27.6	28.7
11	626	633	7	0.0	56.3	62.9	13.2		14.4	27.6	35.3
12	626	639	13	0.0	56.3	69.5	13.2		14.4	27.6	41.9
13	626	646	20	0.0	56.3	76.1	13.2		14.4	27.6	48.5
14	626	653	26	0.0	56.3	82.8	13.2		14.4	27.6	55.2
15	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
16	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
17	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
18	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
19	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
20	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
21	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
22	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
23	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
24	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
25	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
26	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
27	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
28	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
29	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
30	626	659	33	0.0	56.3	89.4	13.2		14.4	27.6	61.8
Present Value @12%		5107	62	0.0	250.4	312.9	58.7	227.1	64.2	350.0	-37.0
										EIRR (%)	10.37

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TABLE VIII.3.10

Labour requirements and paddy production

Dakatia/Little Feni Transfer Scheme (Option 1 - includes 12871 ha served from the Dakatia)

	LABOUR REQUIREMENTS						PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW (1) Labour md ('000s)	FW (2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW(2) tonnes
B Aus, local	141	888	808	677	370	239	11969	10894	9133	4988	3227
T Aus, HYV	176	490	528	590	533	595	8627	9299	10398	9386	10485
B Aman local dw	109	1124	1126	1128	869	872	18008	18032	18073	13926	13967
T Aman, local	168	1927	1896	1847	1826	1776	26379	25963	25281	25003	24321
T Aman, HYV	181	2350	2380	2431	2376	2427	46209	46814	47803	46738	47727
Boro, local	118	99	100	102	157	159	2360	2381	2415	3737	3771
Boro, HYV irrig	211	5630	5936	6438	8288	8790	136074	143479	155603	200335	212459
Wheat irrig.	127	328	356	401	459	504					
Wheat unirrig.	102	62	62	62	0	0					
Potato irrig.	194	101	107	118	146	157					
Potato unirrig.	175	106	91	66	70	45					
Jute	215	100	99	96	31	29					
Pulses: ave.	51	6	6	6	6	6					
Mustard	58	86	84	80	34	30					
Sugarcane	255	612	601	583	151	134					
Spices (chilli)	157	36	38	42	16	20					
Veg. (brinjal)	270	311	316	325	330	339					
Total		14255	14535	14993	15665	16123	249626	256861	268705	304113	315958

TABLE VIII.3.11

Annual Total (Net) Income, and Cropped Area by Crop

Dakatia/Little Feni Transfer Scheme (Option 1 - includes 12871 ha served from the Dakatia)

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	6299	22850	5734	20797	4807	17436	2625	9522	1698	6161
T Aus, HYV	7030	2783	19563	3000	21086	3354	23578	3028	21283	3382	23776
B Aman local dw	4268	10290	43920	10304	43981	10327	44080	7958	33966	7981	34066
T Aman, local	5325	11469	61077	11288	60113	10992	58534	10871	57890	10574	56312
T Aman, HYV	10802	13017	140601	13187	142439	13466	145449	13166	142210	13444	145220
Boro, local	8541	843	7198	850	7263	862	7366	1335	11399	1347	11503
Boro, HYV irrig	13363	26681	320879	28133	338341	30510	366931	39281	524907	41659	556673
Wheat irrig.	10150	2584	26224	2803	28446	3161	32084	3612	36665	3971	40304
Wheat unirrig.	7444	606	4510	606	4510	606	4510	0	0	0	0
Potato irrig.	29370	521	15292	554	16271	609	17875	754	22153	809	23757
Potato unirrig.	15764	607	9569	521	8212	380	5989	399	6296	258	4073
Jute	5316	465	2473	459	2442	450	2391	145	772	136	721
Pulses: ave.	5274	126	663	125	657	123	647	123	651	121	641
Mustard	2263	1500	3395	1457	3298	1387	3138	596	1348	525	1189
Sugarcane	7068	2400	16960	2357	16660	2288	16169	593	4192	524	3701
Spices (chilli)	15847	229	3625	244	3865	269	4258	101	1604	126	1997
Veg. (brinjal)	13069	1151	15040	1170	15294	1202	15709	1223	15987	1255	16402
Total		81570	713840	82792	733673	84792	766145	85811	890846	87811	926495

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1: assumed 1994/95

Future Without (1): Future Without Project Conditions, 5 years after project would have been completed

Future Without (2): Future Without Project Conditions, Year 30

Future With (1): Future With Project Conditions, 5 years after project completion

Future With (2): Future With Project Conditions, Year 30

% Increment (1): % difference FW (1) over FWO (1)

% Increment (2): % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

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TABLE VIII.3.12

Cash Flows (1991 Economic Prices)

Dakatia/Little Feni Transfer Scheme (Option 1 - includes 12871 ha served from the Dakatia)

(Million Taka)

Year	Benefits						Costs				
	Net Crop Income FWO	Net Crop Income FW	Incre-mental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	687	687	0	0.0	0.0	0.0	0.0	114.0	0.0	114.0	-114.0
2	688	688	0	0.0	0.0	0.0	0.0	114.0	0.0	114.0	-114.0
3	689	689	0	0.0	0.0	0.0	0.0	114.0	0.0	114.0	-114.0
4	691	691	0	0.0	0.0	0.0	0.0	114.0	0.0	114.0	-114.0
5	692	692	0	0.0	0.0	0.0	0.0	114.0	0.0	114.0	-114.0
6	693	721	27	0.0	0.0	27.5	0.0		25.4	25.4	2.0
7	695	750	55	0.0	0.0	54.9	0.0		25.4	25.4	29.5
8	696	779	82	0.0	0.0	82.4	0.0		25.4	25.4	57.0
9	698	808	110	0.0	0.0	109.8	0.0		25.4	25.4	84.4
10	700	837	137	0.0	0.0	137.3	0.0		25.4	25.4	111.9
11	726	864	138	0.0	0.0	137.9	0.0		25.4	25.4	112.5
12	725	864	139	0.0	0.0	138.6	0.0		25.4	25.4	113.1
13	725	864	139	0.0	0.0	139.2	0.0		25.4	25.4	113.8
14	725	864	140	0.0	0.0	139.8	0.0		25.4	25.4	114.4
15	724	865	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
16	724	864	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
17	723	863	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
18	722	863	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
19	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
20	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
21	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
22	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
23	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
24	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
25	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
26	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
27	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
28	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
29	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
30	722	862	140	0.0	0.0	140.5	0.0		25.4	25.4	115.1
Present Value @12%		6141	492	0.0	0.0	492.0	0.0	410.8	113.1	524.0	-31.9
										EIRR (%)	11.25

TABLE VIII.3.13

Distribution of Land by Flood Phase/Irrigation (ha)

Dakatia/Little Feni Transfer Scheme (Option 2 - includes 12871 ha served from the Dakatia and 2333 ha in Noakhali/Muhuri)

Gross area 30982 | Within Little Feni Planning Unit
Net Cultivated Area (NCA) 20758 (excluding orchards)

Land Category	F0I0	F0Ir	F1I0	F1Ir	F2I0	F2Ir	F3I0	F3Ir	All I0	All Ir	All I0+Ir
Present											
Area (ha)	5875	5927	2660	2683	1736	1751	63	63	10334	10424	20758
% NCA	28	29	13	13	8	8	0	0	50	50	100
Project year 1											
Area (ha)	5875	5927	2660	2683	1736	1751	63	63	10334	10424	20758
%NCA	28	29	13	13	8	8	0	0	50	50	100
Future Without (1)											
Area (ha)	4833	6969	2188	3155	1428	2059	52	74	8501	12257	20758
% NCA	23	34	11	15	7	10	0	0	41	59	100
Future Without (2)											
Area (ha)	3128	8674	1416	3927	924	2563	33	93	5501	15257	20758
% NCA	15	42	7	19	4	12	0	0	27	73	100
Future With (1)											
Area (ha)	698	11104	316	5027	206	3281	7	119	1228	19530	20758
% NCA	3	53	2	24	1	16	0	1	6	94	100
Future With (2)											
Area (ha)	0	11802	0	5343	0	3487	0	126	0	20758	20758
% NCA	0	57	0	26	0	17	0	1	0	100	100

Note: F0I0 land excludes orchards

TABLE VIII.3.14

Labour requirements and paddy production

Dakatia/Little Feni Transfer Scheme (Option 2 - includes 12871 ha served from the Dakatia and 2333 ha in Noakhali/Muhuri)

	LABOUR REQUIREMENTS						PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW(1) Labour md ('000s)	FW(2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW (2) tonnes
B Aus, local	141	1018	938	807	53	0	13722	12647	10887	720	0
T Aus, HYV	176	531	569	632	714	739	9353	10025	11123	12574	13024
B Aman local dw	109	1160	1161	1164	895	896	18574	18599	18640	14343	14359
T Aman, local	168	2012	1982	1932	1815	1794	27551	27135	26454	24844	24565
T Aman, HYV	181	2539	2570	2620	2647	2668	49939	50543	51532	52064	52469
Boro, local	118	99	100	102	163	163	2360	2381	2415	3857	3871
Boro, HYV irrig	211	5630	5936	6438	9913	10118	136074	143479	155599	239603	244564
Wheat irrig.	127	328	356	401	596	615					
Wheat unirrig.	102	72	72	72	0	0					
Potato irrig.	194	101	107	118	183	188					
Potato unirrig.	175	109	94	69	10	0					
Jute	215	112	110	108	26	25					
Pulses: ave.	51	7	7	7	6	6					
Mustard	58	90	87	83	24	23					
Sugarcane	255	660	649	631	108	101					
Spices (chilli)	157	45	47	51	25	27					
Veg. (brinjal)	270	337	342	350	382	385					
Total		14848	15127	15585	17562	17749	257574	264809	276649	348005	352852

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TABLE VIII.3.15

Annual Total (Net) Income, and Cropped Area by Crop

Dakatia/Little Feni Transfer Scheme (Option 2 - includes 12871 ha served from the Dakatia and 2333 ha in Noakhali/Muhuri)

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	7222	26197	6656	24144	5730	20784	379	1375	0	0
T Aus, HYV	7030	3017	21209	3234	22732	3588	25223	4056	28514	4201	29534
B Aman local dw	4268	10614	45303	10628	45363	10651	45462	8196	34982	8205	35022
T Aman, local	5325	11979	63791	11798	62827	11502	61249	10802	57522	10680	56876
T Aman, HYV	10802	14067	151950	14238	153788	14516	156797	14666	158414	14780	159646
Boro, local	8541	843	7198	850	7263	862	7366	1377	11764	1382	11807
Boro, HYV irrig	13363	26681	311965	28133	328943	30510	356729	46981	627794	47954	640792
Wheat irrig.	10150	2584	26224	2803	28446	3161	32083	4693	47637	4840	49126
Wheat unirrig.	7444	705	5248	705	5248	705	5248	0	0	0	0
Potato irrig.	29370	521	15292	554	16271	609	17875	945	27742	967	28398
Potato unirrig.	15764	621	9788	535	8431	394	6209	58	909	0	0
Jute	5316	520	2764	514	2733	505	2682	122	648	118	627
Pulses: ave.	5274	138	726	137	720	135	710	119	627	118	622
Mustard	2263	1559	3527	1516	3429	1445	3270	425	962	396	897
Sugarcane	7068	2587	18283	2544	17983	2475	17492	425	3002	396	2801
Spices (chilli)	15847	285	4524	301	4764	325	5156	161	2556	171	2717
Veg. (brinjal)	13069	1246	16291	1266	16544	1298	16959	1414	18485	1427	18655
Total		85189	730280	86411	749629	88410	781296	94819	1022933	95638	1037520

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	: Assumed 1994/95
Future Without (1)	: Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	: Future Without Project Conditions, Year 30
Future With (1)	: Future With Project Conditions, 5 years after project completion
Future With (2)	: Future With Project Conditions, Year 30
% Increment (1)	: % difference FW (1) over FWO (1)
% Increment (2)	: % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

TABLE VIII.3.16

Cash Flows (1991 Economic Prices)

Dakatia/Little Feni Transfer Scheme (Option 2 - includes 12871 ha served from the Dakatia and 2333 ha in Noakhali/Muhuri)

(Million Taka)

Year	Net Crop Income FWO	Net Crop Income FW	Benefits Incre-mental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	704	704	0	0.0	0.0	0.0	0.0	176.7	0.0	176.7	-176.7
2	705	705	0	0.0	0.0	0.0	0.0	176.7	0.0	176.7	-176.7
3	706	706	0	0.0	0.0	0.0	0.0	176.7	0.0	176.7	-176.7
4	707	707	0	0.0	0.0	0.0	0.0	176.7	0.0	176.7	-176.7
5	708	708	0	0.0	0.0	0.0	0.0	176.7	0.0	176.7	-176.7
6	710	757	47	0.0	0.0	47.5	0.0		51.5	51.5	-4.0
7	711	806	95	0.0	0.0	95.0	0.0		51.5	51.5	43.5
8	713	855	142	0.0	0.0	142.4	0.0		51.5	51.5	91.0
9	714	904	190	0.0	0.0	189.9	0.0		51.5	51.5	138.5
10	716	953	237	0.0	0.0	237.4	0.0		51.5	51.5	185.9
11	741	976	235	0.0	0.0	234.9	0.0		51.5	51.5	183.4
12	741	973	232	0.0	0.0	232.5	0.0		51.5	51.5	181.0
13	740	970	230	0.0	0.0	230.1	0.0		51.5	51.5	178.6
14	740	968	228	0.0	0.0	227.7	0.0		51.5	51.5	176.3
15	739	965	225	0.0	0.0	225.5	0.0		51.5	51.5	174.0
16	739	965	227	0.0	0.0	226.6	0.0		51.5	51.5	175.2
17	738	966	228	0.0	0.0	227.9	0.0		51.5	51.5	176.4
18	738	967	229	0.0	0.0	229.2	0.0		51.5	51.5	177.8
19	737	968	231	0.0	0.0	230.6	0.0		51.5	51.5	179.1
20	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
21	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
22	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
23	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
24	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
25	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
26	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
27	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
28	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
29	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
30	737	968	231	0.0	0.0	231.4	0.0		51.5	51.5	179.9
Present Value @12%		6601	823	0.0	0.0	823.4	0.0	636.9	229.0	865.9	-42.5
										EIRR (%)	11.36

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TABLE VIII.3.17

Distribution of Land by Flood Phase/Irrigation (ha)

Planning Unit 4 - Little Feni River (Option 3 - Musapur Regulator)

Gross area 64851
Net Cultivated Area (NCA) 45396 (excluding orchards)

Land Category	F0I0	F0Ir	F1I0	F1Ir	F2I0	F2Ir	F3I0	F3Ir	All I0	All Ir	All I0+Ir
Present											
Area (ha)	20013	8125	7976	3238	4160	1689	138	56	32288	13108	45396
% NCA	44	18	18	7	9	4	0	0	71	29	100
Project year 1											
Area (ha)	20013	8125	7976	3238	4160	1689	138	56	32288	13108	45396
%NCA	44	18	18	7	9	4	0	0	71	29	100
Future Without (1)											
Area (ha)	18455	9683	7355	3859	3836	2013	128	67	29774	15622	45396
% NCA	41	21	16	9	8	4	0	0	66	34	100
Future Without (2)											
Area (ha)	16816	11322	6702	4512	3495	2353	116	78	27130	18266	45396
% NCA	37	25	15	10	8	5	0	0	60	40	100
Future With (1)											
Area (ha)	21381	12061	6182	3487	1399	789	62	35	29024	16372	45396
% NCA	47	27	14	8	3	2	0	0	64	36	100
Future With (2)											
Area (ha)	19433	14008	5619	4050	1271	916	57	41	26380	19016	45396
% NCA	43	31	12	9	3	2	0	0	58	42	100

Note: F0I0 land excludes orchards

TABLE VIII.3.18

Labour requirements and paddy production

Planning Unit 4 - Little Feni River (Option 3 - Musapur Regulator)

		LABOUR REQUIREMENTS					PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW(1) Labour md ('000s)	FW(2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW(2) tonnes
B Aus, local	141	1461	1347	1228	1419	1290	19702	18168	16555	19136	17393
T Aus, HYV	176	719	774	832	856	919	12671	13638	14655	15071	16188
B Aman local dw	109	142	144	145	54	55	2273	2299	2326	872	882
T Aman, local	168	2318	2275	2229	2212	2161	31740	31143	30515	30286	29589
T Aman, HYV	181	4435	4481	4529	5078	5135	87230	88133	89083	99869	100998
Boro, local	118	5	5	6	3	3	109	130	151	60	70
Boro, HYV irrig	211	2168	2584	3021	2647	3074	52402	62452	73022	63976	74308
Wheat irrig.	127	213	253	296	303	352					
Wheat unirrig.	102	0	0	0	0	0					
Potato irrig.	194	47	56	66	62	72					
Potato unirrig.	175	280	258	235	279	253					
Jute	215	82	81	79	90	88					
Pulses: ave.	51	15	15	15	18	18					
Mustard	58	88	85	82	73	72					
Sugarcane	255	387	374	362	323	316					
Spices (chilli)	157	18	21	25	24	28					
Veg. (brinjal)	270	258	266	275	257	268					
Total		12636	13021	13425	13698	14105	206126	215963	226309	229272	239429

TABLE VIII.3.19

Annual Total (Net) Income, and Cropped Area by Crop

Planning Unit 4 - Little Feni River (Option 3 - Musapur Regulator)

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	10370	37613	9562	34684	8713	31604	10072	36533	9154	33205
T Aus, HYV	7030	4087	28732	4399	30926	4728	33232	4862	34176	5222	36708
B Aman local dw	4268	1299	5543	1314	5607	1329	5674	498	2127	504	2152
T Aman, local	5325	13800	73490	13541	72107	13268	70653	13168	70122	12865	68508
T Aman, HYV	10802	24572	265413	24826	268162	25094	271054	28132	303871	28450	307307
Boro, local	8541	39	331	46	395	54	462	22	184	25	214
Boro, HYV irrig	13363	10275	137301	12246	163634	14318	191329	12544	167627	14570	194698
Wheat irrig.	10150	1674	16987	1995	20245	2332	23672	2388	24238	2774	28152
Wheat unirrig.	7444	0	0	0	0	0	0	0	0	0	0
Potato irrig.	29370	244	7171	291	8546	340	9992	319	9364	370	10877
Potato unirrig.	15764	1600	25216	1475	23252	1344	21188	1592	25095	1447	22809
Jute	5316	383	2038	375	1996	367	1951	420	2233	412	2191
Pulses: ave.	5274	304	1601	302	1592	300	1583	358	1889	356	1878
Mustard	2263	1525	3450	1476	3340	1425	3224	1272	2879	1244	2814
Sugarcane	7068	1516	10717	1468	10377	1418	10020	1266	8948	1238	8750
Spices (chilli)	15847	114	1801	135	2146	158	2509	155	2464	181	2862
Veg. (brinjal)	13069	954	12473	985	12877	1018	13302	950	12422	992	12971
Total		72754	629876	74437	659887	76206	691449	78019	704172	79805	736096

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	: Assumed 1994/95
Future Without (1)	: Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	: Future Without Project Conditions, Year 30
Future With (1)	: Future With Project Conditions, 5 years after project completion
Future With (2)	: Future With Project Conditions, Year 30
% Increment (1)	: % difference FW (1) over FWO (1)
% Increment (2)	: % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

TABLE VIII.3.20

Cash Flows (1991 Economic Prices)

Planning Unit 4 - Little Feni River (Option 3 - Musapur Regulator)

(Million Taka)

Year	Benefits Net Crop Income	Net Crop Income FWO	Incremental Crop FW	Flood damage non-agr. Income	Flood damage crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	595	595	0	0.0	0.0	0.0	0.0	79.0	0.0	79.0	-79.0
2	597	597	0	0.0	0.0	0.0	0.0	79.0	0.0	79.0	-79.0
3	599	599	0	0.0	0.0	0.0	0.0	79.0	0.0	79.0	-79.0
4	601	610	9	12.6	21.2	42.7	15.0	0.0	4.2	19.1	23.6
5	603	621	18	13.0	21.2	51.9	15.0	0.0	4.2	19.1	32.8
6	605	632	26	13.4	21.2	61.0	15.0		4.2	19.1	41.8
7	608	643	35	13.4	21.3	69.6	15.0		4.2	19.1	50.5
8	610	654	44	13.8	21.3	78.7	15.0		4.2	19.1	59.5
9	613	656	43	14.2	21.3	78.9	15.0		4.2	19.1	59.7
10	616	659	43	14.6	21.3	79.1	15.0		4.2	19.1	59.9
11	642	685	43	15.1	24.9	83.2	15.0		4.2	19.1	64.0
12	641	684	43	15.5	24.9	83.7	15.0		4.2	19.1	64.6
13	640	684	43	16.0	24.9	84.2	15.0		4.2	19.1	65.1
14	640	683	43	16.5	24.9	84.8	15.0		4.2	19.1	65.7
15	639	682	43	17.0	24.9	85.4	15.0		4.2	19.1	66.2
16	638	681	43	17.5	24.9	85.9	15.0		4.2	19.1	66.7
17	637	681	43	18.0	24.9	86.4	15.0		4.2	19.1	67.3
18	637	681	43	18.5	24.9	86.9	15.0		4.2	19.1	67.8
19	637	681	43	19.1	24.9	87.5	15.0		4.2	19.1	68.4
20	637	681	43	19.7	24.9	88.1	15.0		4.2	19.1	68.9
21	637	681	43	20.2	24.9	88.7	15.0		4.2	19.1	69.5
22	637	681	43	20.8	24.9	89.3	15.0		4.2	19.1	70.1
23	637	681	43	21.5	24.9	89.9	15.0		4.2	19.1	70.8
24	637	681	43	22.1	24.9	90.5	15.0		4.2	19.1	71.4
25	637	681	43	22.8	24.9	91.2	15.0		4.2	19.1	72.1
26	637	681	43	23.5	24.9	91.9	15.0		4.2	19.1	72.8
27	637	681	43	24.2	24.9	92.6	15.0		4.2	19.1	73.5
28	637	681	43	24.9	24.9	93.3	15.0		4.2	19.1	74.2
29	637	681	43	25.6	24.9	94.1	15.0		4.2	19.1	74.9
30	637	681	43	26.4	24.9	94.8	15.0		4.2	19.1	75.7
Present Value @12%		5136	196	87.4	129.	412.8	84.5	189.9	23.6	298.0	114.8
										EIRR (%)	17.60

TABLE VIII.3.21

Labour requirements and paddy production

Planning Unit 8, Dhonagoda Project: Option 1

		LABOUR REQUIREMENTS					PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW(1) Labour md ('000s)	FW(2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW(2) tonnes
B Aus, local	141	2341	1827	1827	1939	1939	31572	24631	24631	26152	26152
T Aus, HYV	176	936	888	888	971	971	16486	15649	15649	17097	17097
B Aman local dw	109	1933	1755	1755	1529	1529	30961	28105	28105	24486	24486
T Aman, local	168	2554	2604	2604	2888	2888	34965	35652	35652	39538	39538
T Aman, HYV	181	4425	4267	4267	4646	4646	87022	83923	83923	91372	91372
Boro, local	118	239	325	325	206	206	5665	7717	7717	4884	4884
Boro, HYV irrig	211	5276	7186	7186	7307	7307	127512	173699	173699	176624	176624
Wheat irrig.	127	302	412	412	435	435					
Wheat unirrig.	102	221	172	172	173	173					
Potato irrig.	194	122	166	166	177	177					
Potato unirrig.	175	53	42	42	43	43					
Jute	215	196	153	153	174	174					
Pulses: ave.	51	11	8	8	9	9					
Mustard	58	118	92	92	84	84					
Sugarcane	255	1251	976	976	946	946					
Spices (chilli)	157	159	124	124	131	131					
Veg. (brinjal)	270	695	707	707	793	793					
Total:		20831	21704	21704	22451	22451	334184	369377	369377	380152	380152

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TABLE VIII.3.22

Annual Total (Net) Income, and Cropped Area by Crop

Planning Unit 8, Dhonagoda Project: Option 1

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	16617	60273	12964	47023	12964	47023	13764	49926	13764	49926
T Aus, HYV	7030	5318	37384	5048	35487	5048	35487	5515	38768	5515	38768
B Aman local dw	4268	17692	75513	16060	68548	16060	68548	13992	59720	13992	59720
T Aman, local	5325	15202	80956	15501	82547	15501	82547	17190	91544	17190	91544
T Aman, HYV	10802	24513	264780	23640	255351	23640	255351	25739	278016	25739	278016
Boro, local	8541	2023	17281	2756	23541	2756	23541	1744	14899	1744	14899
Boro, HYV irrig	13363	25002	334100	34059	455116	34059	455116	34632	462779	34632	462779
Wheat irrig.	10150	2381	24167	3244	32921	3244	32921	3423	34747	3423	34747
Wheat unirrig.	7444	2171	16159	1694	12607	1694	12607	1707	12709	1707	12709
Potato irrig.	29370	628	18437	855	25114	855	25114	913	26807	913	26807
Potato unirrig.	15764	305	4812	238	3754	238	3754	248	3902	248	3902
Jute	5316	913	4853	712	3786	712	3786	811	4313	811	4313
Pulses: ave.	5274	211	1114	165	869	165	869	169	890	169	890
Mustard	2263	2053	4646	1602	3625	1602	3625	1455	3291	1455	3291
Sugarcane	7068	4905	34667	3826	27046	3826	27046	3711	26227	3711	26227
Spices (chilli)	15847	1015	16077	791	12543	791	12543	833	13195	833	13195
Veg. (brinjal)	13069	2574	33645	2617	34206	2617	34206	2939	38409	2939	38409
Total		123524	1028866	125773	1124082	125773	1124082	128784	1160143	128784	1160143

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	: Assumed 1994/95
Future Without (1)	: Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	: Future Without Project Conditions, Year 30
Future With (1)	: Future With Project Conditions, 5 years after project completion
Future With (2)	: Future With Project Conditions, Year 30
% Increment (1)	: % difference FW (1) over FWO (1)
% Increment (2)	: % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

TABLE VIII.3.23

Cash Flows (1991 Economic Prices)

Planning Unit 8, Dhonagoda Project: Option 1

(Million Taka)

Year	Net Crop Income FWO	Net Crop Income FW	Benefits Incre-mental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	948	948	0	0.0	0.0	0.0	0.0	51.8	0.0	51.8	-51.8
2	955	955	0	0.0	0.0	0.0	0.0	51.8	0.0	51.8	-51.8
3	963	963	0	0.0	0.0	0.0	0.0	51.8	0.0	51.8	-51.8
4	972	972	0	0.0	0.0	0.0	0.0	51.8	0.0	51.8	-51.8
5	982	982	0	0.0	0.0	0.0	0.0	51.8	0.0	51.8	-51.8
6	992	1000	7	0.0	32.1	39.3	44.5		5.6	50.1	-10.9
7	1000	1014	14	23.2	32.0	69.7	44.5		5.6	50.1	19.5
8	1004	1025	22	23.9	32.0	77.6	44.5		5.6	50.1	27.4
9	1004	1032	29	24.6	32.0	85.5	44.5		5.6	50.1	35.3
10	1004	1040	36	25.3	32.0	93.4	44.5		5.6	50.1	43.3
11	1004	1040	36	26.1	32.0	94.2	44.5		5.6	50.1	44.1
12	1004	1040	36	26.9	32.0	95.0	44.5		5.6	50.1	44.8
13	1004	1040	36	27.7	32.0	95.8	44.5		5.6	50.1	45.6
14	1004	1040	36	28.5	32.0	96.6	44.5		5.6	50.1	46.5
15	1004	1040	36	29.4	32.0	97.5	44.5		5.6	50.1	47.3
16	1004	1040	36	30.3	32.0	98.4	44.5		5.6	50.1	48.2
17	1004	1040	36	31.2	32.0	99.3	44.5		5.6	50.1	49.1
18	1004	1040	36	32.1	32.0	100.2	44.5		5.6	50.1	50.1
19	1004	1040	36	33.1	32.0	101.2	44.5		5.6	50.1	51.0
20	1004	1040	36	34.1	32.0	102.2	44.5		5.6	50.1	52.0
21	1004	1040	36	35.1	32.0	103.2	44.5		5.6	50.1	53.0
22	1004	1040	36	36.1	32.0	104.2	44.5		5.6	50.1	54.1
23	1004	1040	36	37.2	32.0	105.3	44.5		5.6	50.1	55.2
24	1004	1040	36	38.3	32.0	106.4	44.5		5.6	50.1	56.3
25	1004	1040	36	39.5	32.0	107.6	44.5		5.6	50.1	57.4
26	1004	1040	36	40.7	32.0	108.8	44.5		5.6	50.1	58.6
27	1004	1040	36	41.9	32.0	110.0	44.5		5.6	50.1	59.8
28	1004	1040	36	43.1	32.0	111.2	44.5		5.6	50.1	61.1
29	1004	1040	36	44.4	32.0	112.5	44.5		5.6	50.1	62.4
30	1004	1040	36	45.8	32.0	113.9	44.5		5.6	50.1	63.7
Present Value @12%		8055	128	113.1	142.6	383.3	198.1	186.7	25.1	409.8	-26.5
										EIRR (%)	10.67

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TABLE VIII.3.24

Labour requirements and paddy production

Planning Unit 8, Dhonagoda Project: Option 2

	LABOUR REQUIREMENTS						PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW(1) Labour md ('000s)	FW(2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW(2) tonnes
B Aus, local	141	2018	1584	1584	1677	1677	27210	21361	21361	22608	22608
T Aus, HYV	176	808	767	767	836	836	14229	13515	13515	14734	14734
B Aman local dw	109	1585	1444	1444	1258	1258	25381	23136	23136	20148	20148
T Aman, local	168	2175	2219	2219	2451	2451	29781	30377	30377	33558	33558
T Aman, HYV	181	3817	3682	3682	4002	4002	75063	72424	72424	78705	78705
Boro, local	118	175	238	238	151	151	4144	5645	5645	3571	3571
Boro, HYV irrig	211	4410	6007	6007	6089	6089	106582	145188	145188	147163	147163
Wheat irrig.	127	255	347	347	365	365					
Wheat unirrig.	102	188	148	148	148	148					
Potato irrig.	194	103	140	140	149	149					
Potato unirrig.	175	45	36	36	37	37					
Jute	215	167	131	131	149	149					
Pulses: ave.	51	9	7	7	7	7					
Mustard	58	99	78	78	70	70					
Sugarcane	255	1054	828	828	801	801					
Spices (chilli)	157	138	108	108	113	113					
Veg. (brinjal)	270	595	605	605	677	677					
Total:		17640	18368	18368	18979	18979	282391	311646	311646	320487	320487

TABLE VIII.3.25

Annual Total (Net) Income, and Cropped Area by Crop

Planning Unit 8, Dhonagoda Project: Option 2

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	14321	51947	11243	40780	11243	40780	11899	43161	11899	43161
T Aus, HYV	7030	4590	32265	4360	30647	4360	30647	4753	33410	4753	33410
B Aman local dw	4268	14504	61905	13221	56429	13221	56429	11513	49142	11513	49142
T Aman, local	5325	12948	68953	13207	70333	13207	70333	14590	77698	14590	77698
T Aman, HYV	10802	21145	228394	20401	220365	20401	220365	22170	239474	22170	239474
Boro, local	8541	1480	12640	2016	17218	2016	17218	1276	10894	1276	10894
Boro, HYV irrig	13363	20898	279261	28468	380412	28468	380412	28855	385587	28855	385587
Wheat irrig.	10150	2004	20343	2730	27712	2730	27712	2872	29149	2872	29149
Wheat unirrig.	7444	1851	13777	1453	10816	1453	10816	1461	10875	1461	10875
Potato irrig.	29370	529	15531	720	21157	720	21157	766	22509	766	22509
Potato unirrig.	15764	260	4096	204	3216	204	3216	211	3322	211	3322
Jute	5316	780	4145	612	3254	612	3254	694	3690	694	3690
Pulses: ave.	5274	184	970	144	762	144	762	148	779	148	779
Mustard	2263	1721	3893	1351	3056	1351	3056	1221	2763	1221	2763
Sugarcane	7068	4134	29222	3246	22941	3246	22941	3140	22196	3140	22196
Spices (chilli)	15847	877	13893	688	10907	688	10907	722	11445	722	11445
Veg. (brinjal)	13069	2204	28805	2240	29276	2240	29276	2507	32768	2507	32768
Total		104429	870042	106305	949279	106305	949279	108800	978863	108800	978863

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	: Assumed 1994/95
Future Without (1)	: Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	: Future Without Project Conditions, Year 30
Future With (1)	: Future With Project Conditions, 5 years after project completion
Future With (2)	: Future With Project Conditions, Year 30
% Increment (1)	: % difference FW (1) over FWO (1)
% Increment (2)	: % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

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TABLE VIII.3.26

Cash Flows (1991 Economic Prices)

Planning Unit 8, Dhonagoda Project: Option 2

(Million Taka)

Year	Net Crop Income FWO	Net Crop Income FW	Benefits Incre-mental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	797	797	0	0.0	0.0	0.0	0.0	32.6	0.0	32.6	-32.6
2	803	803	0	0.0	0.0	0.0	0.0	32.6	0.0	32.6	-32.6
3	809	809	0	0.0	0.0	0.0	0.0	32.6	0.0	32.6	-32.6
4	816	816	0	0.0	0.0	0.0	0.0	32.6	0.0	32.6	-32.6
5	823	823	0	0.0	0.0	0.0	0.0	32.6	0.0	32.6	-32.6
6	832	838	6	0.0	27.4	33.4	29.9		4.8	34.8	-1.4
7	837	849	12	21.0	27.4	60.2	29.9		4.8	34.8	25.5
8	840	858	18	21.6	27.4	66.8	29.9		4.8	34.8	32.0
9	840	864	24	22.3	27.4	73.3	29.9		4.8	34.8	38.6
10	840	870	30	22.9	27.4	79.9	29.9		4.8	34.8	45.2
11	840	870	30	23.6	27.4	80.6	29.9		4.8	34.8	45.8
12	840	870	30	24.3	27.4	81.3	29.9		4.8	34.8	46.6
13	840	870	30	25.1	27.4	82.0	29.9		4.8	34.8	47.3
14	840	870	30	25.8	27.4	82.8	29.9		4.8	34.8	48.0
15	840	870	30	26.6	27.4	83.6	29.9		4.8	34.8	48.8
16	840	870	30	27.4	27.4	84.4	29.9		4.8	34.8	49.6
17	840	870	30	28.2	27.4	85.2	29.9		4.8	34.8	50.4
18	840	870	30	29.0	27.4	86.0	29.9		4.8	34.8	51.3
19	840	870	30	29.9	27.4	86.9	29.9		4.8	34.8	52.1
20	840	870	30	30.8	27.4	87.8	29.9		4.8	34.8	53.0
21	840	870	30	31.7	27.4	88.7	29.9		4.8	34.8	54.0
22	840	870	30	32.7	27.4	89.7	29.9		4.8	34.8	54.9
23	840	870	30	33.7	27.4	90.7	29.9		4.8	34.8	55.9
24	840	870	30	34.7	27.4	91.7	29.9		4.8	34.8	56.9
25	840	870	30	35.7	27.4	92.7	29.9		4.8	34.8	58.0
26	840	870	30	36.8	27.4	93.8	29.9		4.8	34.8	59.0
27	840	870	30	37.9	27.4	94.9	29.9		4.8	34.8	60.1
28	840	870	30	39.0	27.4	96.0	29.9		4.8	34.8	61.3
29	840	870	30	40.2	27.4	97.2	29.9		4.8	34.8	62.4
30	840	870	30	41.4	27.4	98.4	29.9		4.8	34.8	63.6
Present Value @12%		6751	105	102.3	122.0	329.0	133.2	117.6	21.5	272.3	56.7
										EIRR (%)	15.90

TABLE VIII.3.27

Distribution of Land by Flood Phase/Irrigation (ha)

Planning Unit 8, Dhonagoda Project: Option 3 (Khal Excavation for Irrigation)

Gross area 13955
Net Cultivated Area (NCA) 9081 (excluding orchards)

Land Category	F0I0	F0Ir	F1I0	F1Ir	F2I0	F2Ir	F3I0	F3Ir	All I0	All Ir	All I0+Ir
Present											
Area (ha)	999	956	1142	1094	1739	1665	759	727	4639	4442	9081
% NCA	11	11	13	12	19	18	8	8	51	49	100
Project year 1											
Area (ha)	999	956	1142	1094	1739	1665	759	727	4639	4442	9081
%NCA	11	11	13	12	19	18	8	8	51	49	100
Future Without (1)											
Area (ha)	653	1303	746	1490	1136	2268	496	990	3032	6050	9081
% NCA	7	14	8	16	13	25	5	11	33	67	100
Future Without (2)											
Area (ha)	653	1303	746	1490	1136	2268	496	990	3032	6050	9081
% NCA	7	14	8	16	13	25	5	11	33	67	100
Future With (1)											
Area (ha)	0	1955	0	2236	0	3404	0	1486	0	9081	9081
% NCA	0	22	0	25	0	37	0	16	0	100	100
Future With (2)											
Area (ha)	0	1955	0	2236	0	3404	0	1486	0	9081	9081
% NCA	0	22	0	25	0	37	0	16	0	100	100

Note: F0I0 land excludes orchards

TABLE VIII.3.28

Labour requirements and paddy production

Planning Unit 8, Dhonagoda Project: Option 3 (Khal Excavation for Irrigation)

	LABOUR REQUIREMENTS						PADDY PRODUCTION				
	Labour md/ha	Present Labour md ('000s)	FWO(1) Labour md ('000s)	FWO(2) Labour md ('000s)	FW(1) Labour md ('000s)	FW (2) Labour md ('000s)	Present tonnes	FWO(1) tonnes	FWO(2) tonnes	FW(1) tonnes	FW (2) tonnes
B Aus, local	141	196	128	128	0	0	2643	1727	1727	0	0
T Aus, HYV	176	88	84	84	77	77	1552	1485	1485	1360	1360
B Aman local dw	109	215	181	181	117	117	3437	2897	2897	1879	1879
T Aman, local	168	307	315	315	330	330	4206	4316	4316	4524	4524
T Aman, HYV	181	417	402	402	373	373	8206	7906	7906	7340	7340
Boro, local	118	66	90	90	135	135	1567	2134	2134	3204	3204
Boro, HYV irrig	211	702	956	956	1435	1435	16967	23108	23108	34688	34688
Wheat irrig.	127	40	54	54	82	82					
Wheat unirrig.	102	19	12	12	0	0					
Potato irrig.	194	16	22	22	34	34					
Potato unirrig.	175	5	3	3	0	0					
Jute	215	22	14	14	0	0					
Pulses: ave.	51	1	0	0	0	0					
Mustard	58	10	7	7	0	0					
Sugarcane	255	116	76	76	0	0					
Spices (chilli)	157	12	8	8	0	0					
Veg. (brinjal)	270	81	84	84	90	90					
Total		2314	2439	2439	2673	2673	38577	43574	43574	52995	52995

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TABLE VIII.3.29

Annual Total (Net) Income, and Cropped Area by Crop

Planning Unit 8, Dhonagoda Project: Option 3 (Khal Excavation for Irrigation)

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	1391	5046	909	3297	909	3297	0	0	0	0
T Aus, HYV	7030	501	3519	479	3368	479	3368	439	3084	439	3084
B Aman local dw	4268	1964	8382	1655	7066	1655	7066	1074	4584	1074	4584
T Aman, local	5325	1828	9737	1876	9993	1876	9993	1967	10474	1967	10474
T Aman, HYV	10802	2312	24969	2227	24056	2227	24056	2068	22334	2068	22334
Boro, local	8541	560	4780	762	6510	762	6510	1144	9773	1144	9773
Boro, HYV irrig	13363	3327	44455	4531	60547	4531	60547	6801	90886	6801	90886
Wheat irrig.	10150	314	3192	428	4347	428	4347	643	6526	643	6526
Wheat unirrig.	7444	187	1390	122	908	122	908	0	0	0	0
Potato irrig.	29370	85	2487	115	3387	115	3387	173	5084	173	5084
Potato unirrig.	15764	29	454	19	297	19	297	0	0	0	0
Jute	5316	103	549	68	359	68	359	0	0	0	0
Pulses: ave.	5274	13	68	8	45	8	45	0	0	0	0
Mustard	2263	177	401	116	262	116	262	0	0	0	0
Sugarcane	7068	454	3210	297	2097	297	2097	0	0	0	0
Spices (chilli)	15847	79	1254	52	820	52	820	0	0	0	0
Veg. (brinjal)	13069	301	3930	312	4077	312	4077	333	4353	333	4353
Total		13624	117824	13977	131436	13977	131436	14642	157097	14642	157097

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	: assumed 1994/95
Future Without (1)	: Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	: Future Without Project Conditions, Year 30
Future With (1)	: Future With Project Conditions, 5 years after project completion
Future With (2)	: Future With Project Conditions, Year 30
% Increment (1)	: % difference FW (1) over FWO (1)
% Increment (2)	: % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

TABLE VIII.3.30

Cash Flows (1991 Economic Prices)

Planning Unit 8, Dhonagoda Project: Option 3

(Million Taka)

Year	Benefits Net Crop Income FWO	Net Crop Income FW	Incremental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs Capture Fisherie Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	108	108	0	0.0	0.0	0.0	0.0	3.9	0.0	3.9	-3.9
2	108	108	0	0.0	0.0	0.0	0.0	3.9	0.0	3.9	-3.9
3	109	114	5	0.0	0.0	5.1	0.0	0.0	0.4	0.4	4.7
4	110	120	10	0.0	0.0	10.3	0.0	0.0	0.4	0.4	9.9
5	111	126	15	0.0	0.0	15.4	0.0	0.0	0.4	0.4	15.0
6	112	132	20	0.0	0.0	20.1	0.0		0.4	0.4	19.7
7	113	138	25	0.0	0.0	24.9	0.0		0.4	0.4	24.5
8	114	139	25	0.0	0.0	24.6	0.0		0.4	0.4	24.2
9	116	140	24	0.0	0.0	24.4	0.0		0.4	0.4	24.0
10	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
11	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
12	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
13	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
14	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
15	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
16	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
17	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
18	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
19	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
20	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
21	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
22	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
23	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
24	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
25	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
26	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
27	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
28	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
29	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
30	116	139	23	0.0	0.0	23.3	0.0		0.4	0.4	22.9
Present Value @12%		1027	123	0.0	0.0	122.7	0.0	6.5	2.6	9.1	113.6
										EIRR (%)	88.97

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TABLE VIII.3.31

Distribution of Land by Flood Phase/Irrigation (ha)

Planning Unit 12, Ashuganj Project

Gross area 14000
Net Cultivated Area (NCA) 12500 (excluding orchards)

Land Category	F0I0	F0Ir	F1I0	F1Ir	F2I0	F2Ir	F3I0	F3Ir	All I0	All Ir	All I0+Ir
Present											
Area (ha)	0	0	549	339	4478	700	4172	2262	9199	3301	12500
% NCA	0	0	4	3	36	6	33	18	74	26	100
Project year 1											
Area (ha)	0	0	537	351	4453	725	4091	2343	9081	3419	12500
%NCA	0	0	4	3	36	6	33	19	73	27	100
Future Without (1)											
Area (ha)	0	0	523	365	4424	754	3997	2437	8943	3557	12500
% NCA	0	0	4	3	35	6	32	19	72	28	100
Future Without (2)											
Area (ha)	0	0	464	424	4303	875	3607	2827	8374	4126	12500
% NCA	0	0	4	3	34	7	29	23	67	33	100
Future With (1)											
Area (ha)	0	0	178	710	1036	4142	1287	5147	2500	10000	12500
% NCA	0	0	1	6	8	33	10	41	20	80	100
Future With (2)											
Area (ha)	0	0	178	710	1036	4142	1287	5147	2500	10000	12500
% NCA	0	0	1	6	8	33	10	41	20	80	100

Note: F0I0 land excludes orchards

TABLE VIII.3.32

Labour requirements and paddy production

Planning Unit 12, Ashuganj Project

	LABOUR REQUIREMENTS						PADDY PRODUCTION				
	Labour	Present Labour	FWO (1) Labour	FWO (2) Labour	FW (1) Labour	FW (2) Labour	Present	FWO (1)	FWO(2)	FW (1)	FW (2)
	md/ha	md ('000s)	md ('000s)	md ('000s)	md ('000s)	md ('000s)	tonnes	tonnes	tonnes	tonnes	tonnes
B Aus, local	141	143	142	135	36	36	1931	1910	1824	489	489
T Aus, HYV	176	6	6	7	13	13	109	113	131	220	220
B Aman local dw	109	330	327	316	272	272	5288	5243	5057	4354	4354
T Aman, local	168	206	206	208	175	175	2816	2821	2842	2390	2390
T Aman, HYV	181	45	45	45	48	48	882	884	895	946	946
Boro, local	118	108	110	117	164	164	2556	2601	2787	3891	3891
Boro, HYV irrig	211	553	576	668	1700	1700	13372	13911	16137	41081	41081
Wheat irrig.	127	8	9	10	34	34					
Wheat unirrig.	102	39	39	37	10	10					
Potato irrig.	194	3	3	3	11	11					
Potato unirrig.	175	24	24	23	6	6					
Jute	215	230	228	220	55	55					
Pulses: ave.	51	1	1	1	0	0					
Mustard	58	30	30	28	9	9					
Sugarcane	255	395	389	365	108	108					
Spices (chilli)	157	10	10	10	3	3					
Veg. (brinjal)	270	68	67	65	41	41					
Total		2200	2211	2259	2683	2683	26954	27485	29674	53372	53372

TABLE VIII.3.33

Annual Total (Net) Income, and Cropped Area by Crop

Planning Unit 12, Ashuganj Project

Economic Prices

Crop	Net Income (Tk/ha)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	1016	3686	1005	3647	960	3483	257	934	257	934
T Aus, HYV	7030	35	247	37	257	42	298	71	499	71	499
B Aman local dw	4268	3022	12898	2996	12788	2890	12335	2488	10620	2488	10620
T Aman, local	5325	1224	6520	1227	6532	1236	6580	1039	5533	1039	5533
T Aman, HYV	10802	248	2683	249	2691	252	2723	266	2878	266	2878
Boro, local	8541	913	7798	929	7935	995	8501	1390	11870	1390	11870
Boro, HYV irrig	13363	2622	35035	2728	36450	3164	42280	8055	107639	8055	107639
Wheat irrig.	10150	64	653	67	679	78	788	264	2679	264	2679
Wheat unirrig.	7444	385	2865	381	2836	365	2718	96	715	96	715
Potato irrig.	29370	14	419	15	436	17	506	56	1634	56	1634
Potato unirrig.	15764	139	2190	138	2174	134	2108	33	518	33	518
Jute	5316	1071	5693	1062	5646	1026	5452	258	1372	258	1372
Pulses: ave.	5274	16	85	16	83	14	73	5	28	5	28
Mustard	2263	529	1197	521	1178	486	1101	161	364	161	364
Sugarcane	7068	1549	10951	1526	10789	1432	10119	424	2996	424	2996
Spices (chilli)	15847	66	1046	65	1032	62	976	17	277	17	277
Veg. (brinjal)	13069	251	3285	249	3260	242	3160	151	1969	151	1969
Total		13166	97252	13211	98413	13394	103201	15032	152522	15032	152522

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	:	Assumed 1994/95
Future Without (1)	:	Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	:	Future Without Project Conditions, Year 30
Future With (1)	:	Future With Project Conditions, 5 years after project completion
Future With (2)	:	Future With Project Conditions, Year 30
% Increment (1)	:	% difference FW (1) over FWO (1)
% Increment (2)	:	% difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

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TABLE VIII.3.34

Cash Flows (1991 Economic Prices)

Planning Unit 12, Ashuganj Project

(Million Taka)

Year	Benefits: Net Crop Income FWO	Net Crop Income FW	Incremental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs: Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	90	90	0	0.0	0.0	0.0	0.0	18.1	0.0	18.1	-18.1
2	90	90	0	0.0	0.0	0.0	0.0	18.1	0.0	18.1	-18.1
3	90	90	0	0.0	0.0	0.0	0.0	18.1	0.0	18.1	-18.1
4	90	90	0	0.0	0.0	0.0	0.0	18.1	0.0	18.1	-18.1
5	90	90	0	0.0	0.0	0.0	0.0	18.1	0.0	18.1	-18.1
6	90	99	9	0.0	0.0	8.9	0.0		3.0	3.0	5.9
7	90	108	18	0.0	0.0	17.9	0.0		3.0	3.0	14.9
8	90	117	27	0.0	0.0	26.9	0.0		3.0	3.0	23.8
9	91	126	36	0.0	0.0	35.8	0.0		3.0	3.0	32.8
10	91	135	45	0.0	0.0	44.8	0.0		3.0	3.0	41.8
11	95	139	44	0.0	0.0	43.9	0.0		3.0	3.0	40.9
12	95	138	43	0.0	0.0	43.0	0.0		3.0	3.0	40.0
13	95	137	42	0.0	0.0	42.1	0.0		3.0	3.0	39.1
14	95	136	41	0.0	0.0	41.2	0.0		3.0	3.0	38.2
15	95	135	40	0.0	0.0	40.3	0.0		3.0	3.0	37.3
16	94	135	40	0.0	0.0	40.3	0.0		3.0	3.0	37.3
17	94	135	40	0.0	0.0	40.4	0.0		3.0	3.0	37.4
18	94	135	40	0.0	0.0	40.5	0.0		3.0	3.0	37.5
19	94	135	41	0.0	0.0	40.6	0.0		3.0	3.0	37.6
20	94	135	41	0.0	0.0	40.7	0.0		3.0	3.0	37.7
21	94	135	41	0.0	0.0	40.8	0.0		3.0	3.0	37.8
22	94	135	41	0.0	0.0	40.9	0.0		3.0	3.0	37.9
23	94	135	41	0.0	0.0	41.0	0.0		3.0	3.0	38.0
24	94	135	41	0.0	0.0	41.2	0.0		3.0	3.0	38.1
25	94	135	41	0.0	0.0	41.3	0.0		3.0	3.0	38.3
26	94	135	41	0.0	0.0	41.5	0.0		3.0	3.0	38.5
27	94	135	42	0.0	0.0	41.7	0.0		3.0	3.0	38.7
28	93	135	42	0.0	0.0	41.9	0.0		3.0	3.0	38.9
29	93	135	42	0.0	0.0	42.1	0.0		3.0	3.0	39.1
30	93	135	42	0.0	0.0	42.4	0.0		3.0	3.0	39.3
Present Value @12%		887	151	0.0	0.0	150.8	0.0	65.2	13.4	78.6	72.1
										EIRR (%)	20.27

TABLE VIII.3.35

Labour requirements and paddy production

Planning Unit 13, Titas Project: Sub-unit 1

	Labour md/ha	LABOUR REQUIREMENTS Present Labour md ('000s)	FWO (1) Labour md ('000s)	FWO (2) Labour md ('000s)	FW (1) Labour md ('000s)	FW (2) Labour md ('000s)	PADDY PRODUCTION Present tonnes	FWO (1) tonnes	FWO(2) tonnes	FW (1) tonnes	FW (2) tonnes
B Aus, local	141	515	227	227	227	227	6946	3065	3065	3065	3065
T Aus, HYV	176	80	158	158	158	158	1416	2786	2786	2786	2786
B Aman local dw	109	737	719	719	768	768	11807	11517	11517	12304	12304
T Aman, local	168	496	641	641	641	641	6788	8778	8778	8778	8778
T Aman, HYV	181	514	592	592	592	592	10116	11648	11648	11648	11648
Boro, local	118	122	122	122	141	141	2899	2899	2899	3340	3340
Boro, HYV irrig	211	2098	2962	2962	3531	3531	50713	71586	71586	85339	85339
Wheat irrig.	127	128	228	228	228	228					
Wheat unirrig.	102	128	74	74	59	59					
Potato irrig.	194	37	61	61	61	61					
Potato unirrig.	175	22	10	10	10	10					
Jute	215	362	178	178	178	178					
Pulses: ave.	51	6	2	2	2	2					
Mustard	58	74	48	48	37	37					
Sugarcane	255	800	610	610	501	501					
Spices (chilli)	157	43	31	31	31	31					
Veg. (brinjal)	270	260	196	196	196	196					
	Total	6422	6860	6860	7363	7363	90685	112279	112279	127260	127260

TABLE VIII.3.36

Annual Total (Net) Income, and Cropped Area by Crop

Planning Unit 13, Titas Project: Sub-unit 1

Economic Prices

Crop	Net Income (Tk/h)	Year 1 Area (ha)	Year 1 Total Income (Tk'000)	Future WO(1) Area (ha)	Future WO(1) Total Income (Tk'000)	Future WO(2) Area (ha)	Future WO(2) Total Income (Tk'000)	Future With(1) Area (ha)	Future With(1) Total Income (Tk'000)	Future With(2) Area (ha)	Future With(2) Total Income (Tk'000)
B Aus, local	3627	3656	13259	1613	5852	1613	5852	1613	5852	1613	5852
T Aus, HYV	7030	457	3212	899	6318	899	6318	899	6318	899	6318
B Aman local dw	4268	6747	28798	6581	28091	6581	28091	7031	30010	7031	30010
T Aman, local	5325	2951	15716	3816	20323	3816	20323	3816	20323	3816	20323
T Aman, HYV	10802	2850	30779	3281	35440	3281	35440	3281	35440	3281	35440
Boro, local	8541	1035	8842	1035	8842	1035	8842	1193	10189	1193	10189
Boro, HYV irrig	13363	9944	132876	14036	187565	14036	187565	16733	223600	16733	223600
Wheat irrig.	10150	1011	10265	1793	18199	1793	18199	1793	18199	1793	18199
Wheat unirrig.	7444	1261	9389	724	5389	724	5389	582	4332	582	4332
Potato irrig.	29370	189	5558	315	9261	315	9261	315	9261	315	9261
Potato unirrig.	15764	127	2000	58	922	58	922	58	922	58	922
Jute	5316	1686	8963	831	4416	831	4416	831	4416	831	4416
Pulses: ave.	5274	111	587	45	237	45	237	45	237	45	237
Mustard	2263	1282	2900	840	1900	840	1900	651	1472	651	1472
Sugarcane	7068	3136	22166	2391	16897	2391	16897	1965	13888	1965	13888
Spices (chilli)	15847	271	4298	195	3097	195	3097	195	3097	195	3097
Veg. (brinjal)	13069	964	12595	727	9500	727	9500	727	9500	727	9500
Total		37678	312203	39182	362249	39182	362249	41729	397056	41729	397056

Notes:

Total income is net of all on-farm costs except for irrigation which is analysed separately

Project Year 1	: Assumed 1994/95
Future Without (1)	: Future Without Project Conditions, 5 years after project would have been completed
Future Without (2)	: Future Without Project Conditions, Year 30
Future With (1)	: Future With Project Conditions, 5 years after project completion
Future With (2)	: Future With Project Conditions, Year 30
% Increment (1)	: % difference FW (1) over FWO (1)
% Increment (2)	: % difference FW (2) over FWO (2)

Vegetables includes both irrigated and unirrigated

TABLE VIII.3.37

Cash Flows (1991 Economic Prices)

Planning Unit 13, Titas Project: Sub-unit 1

(Million Taka)

Year	Net Crop Income FWO	Net Crop Income FW	Benefits Incre-mental Crop Income	Flood damage non-agr.	Flood damage crop	Total Benefits	Costs Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Increment Benefits
1	281	281	0	0.0	0.0	0.0	0.0	83.4	0.0	83.4	-83.4
2	282	282	0	0.0	0.0	0.0	0.0	83.4	0.0	83.4	-83.4
3	283	283	0	0.0	0.0	0.0	0.0	83.4	0.0	83.4	-83.4
4	284	284	0	0.0	0.0	0.0	0.0	83.4	0.0	83.4	-83.4
5	285	285	0	0.0	0.0	0.0	0.0	83.4	0.0	83.4	-83.4
6	286	293	7	0.0	49.3	56.2	57.5		20.8	78.3	-22.0
7	292	306	14	0.0	49.6	63.5	57.5		20.8	78.3	-14.7
8	297	318	21	0.0	50.0	70.9	57.5		20.8	78.3	-7.4
9	303	331	28	0.0	50.4	78.2	57.5		20.8	78.3	-0.1
10	310	345	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
11	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
12	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
13	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
14	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
15	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
16	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
17	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
18	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
19	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
20	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
21	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
22	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
23	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
24	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
25	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
26	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
27	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
28	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
29	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
30	306	340	35	0.0	50.8	85.6	57.5		20.8	78.3	7.3
Present Value @12%		2483	123	0.0	224.3	347.5	255.9	300.5	92.4	648.8	-301.3
										EIRR (%)	-6.01

ANNEX IX

ESTIMATES OF COSTS OF MINOR IRRIGATION

ANNEX IX

ESTIMATES OF COSTS OF MINOR IRRIGATION

Costs used in project economic appriasal

1. Specification:

The attached tables show the cost of different modes of minor irrigation. Capital and operating costs have been calculated for a range of different technologies. These include:

a. LLP 1 - 0.7/1.0 cu.sec pump irrigating 10 ha, using the same 8hp engine as a STW.

b. LLP 2 - 2 cusec pump irrigating 20 ha.

c. STW - a conventional STW using a Japanese engine. Although many STWs have cheaper Chinese engines, these are slightly less fuel efficient and have a shorter life (crankshfts usually break after 2 or 3 years, so their overall cost has been calculated to be slightly higher than the Japanese engine.

d. DSSTW - as for the STW but in an unlined pit 1.5 m deep.

f. SFMTW 1 - force mode shallow well for areas where there is gas. Although it uses the same engine, it has higher output that the STW as it would not run into suction problems at the end of the season.

g. SFMTW 2 - for areas where there is also a salinity problem as well as gas - this well skims of fresh water from a shallow fresh upper aquifer.

h. SFMTW 3 - a larger version of SFMTW 1

i. DFMTW 1 - a 1 cu sec version of a DTW for deeper aquifers.

j. DFMTW 2 - a 2 cusec DTW similar to existing wells but with materials and costs adjusted to make it more appropriate for private sector investment.

k. DFMTW 3 - a special well for the conditions of the saline area of Noakhali.

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2. Capital costs

a. The screen cost of SFMTW 2 is high as its a large diameter screen into which the pump in placed.

b. Capital costs annualized over the life of the well/pump at an interest rate of 12% per year.

c. The pump survey showed that less than 10% of engines are used for other purposes in the off-season so no allowance has been made for this extra income.

d. The cost of water channel construction (unlined earth) has been calculated for different well options. The length of channel per ha irrigated and the average cross section rises as the command area increases, as more and bigger channels would be needed. The cost is purely that of labour for earth moving.

3. Operating Costs

a. Hours of pump operation are all well within normal limits. The relative short hours of LLP 2 and DTW 2 indicate that command areas for 2 cusec pumps are more likely to be limited by management/distribution issues than by pump capacity.

b. Pump and engine efficiency is based on the DTW II Project Technology Report. The efficiency of centrifugal pumps in STW is lower than the same pump in LLP or FM pumps as they reach suction limits when water levels fall.

c. The static water table varies between modes to reflect the varying conditions that they would be used under.

d. Draw down is based on well output and well yield - the 2 cusec DTW 3 is 12 lt/sec/m, the 1 cusec DTW is 10.29 (as screen diameter is smaller) -this is also used for the FMSTWs - and STW/DSSTWs, with crude and cheap screen only get 6 l/s/m.

e. Total pumping head is SWL + draw-down +2% friction loss + 1 metre above the surface.

f. Fuel consumption is calculated as cu.m. water ÷ 275 ÷ pump efficiency × 0.25. It gives similar fuel consumption rates to the DTW II report for DTW, but rather less for STW.

g. Fuel cost is Tk14/lt plus 10% for oil. Costs have not been calculated for electric pumps as, although the financial cost is lower, the economic cost is similar to that of diesel as the high cost of rural power disrtribution needs to be taken into account.

h. Spares cost as a percentage of engine and pump cost per 1000 hours of operation. 10% is added for mechanics charges.

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i. The cost of the pump operator is the hourly wage rate times the annual hours of operation. However as operators do other work such as water distribution, only a third of a man is need for the LLP, STW and SFMTW, and half a man for the DTW.

j. Water guard and channel maintenance as based on the cost of one man per day of the season per 30 ha irrigated.

k. Miscellaneous costs include annual re-excavation of DSSTW pits.

3. Total cost per ha indicates that:

- LLP is significantly cheaper, at a cost of under Tk2,500 per ha per year.
- DTW and DSSTW are more expensive, at over Tk5,500 per year. The special DTW 3 for the special saline conditions of Noahkali is particularly expensive, suggesting that development of alternative surface water supplies is a more feasible option.
- There is little difference between STW and SFMTW. For small command areas STW remain the cheapest option, and will continue to be prefered due to their lower capital costs. Howver SFMTWs do provide a low cost option,even at slightly greater depths to water than STW and DSSTW: - but this is a new and largely untried concept in Bangladesh.

4. Costs have also been calculated at economic prices using conversion factors determined by FPCO. Irrigation costs are substantially lower than at financial prices, but the relative ranking of the different modes and technologies remain broadly similar.

5. The cost of traditional irrigation has been calculated as the cost of two men operating a swing basket for a 90 day period during the boro season. This amounts to Tk7,200 per ha in financial prices or Tk5,400 at economic prices. This is substantially more than alternative sources such as LLP and STW. In fact what the farmer is paying for with his own labour is a saving on hiring a mechanical pump. Therefore the labour cost has been reduced by 50% which puts it between an LLP and STW. In practice actual labour use may be less than 180 days per ha as farmers apply less than optimal amount of water. There is evidence from Gumti (but not Naohkali) that traditionally irrigated boro does yields less (and also gets lower levels of fertiliser).

6. Crop budgets at financial prices include irrigation costs based on fees charged in pumps surveyed in the Gumti II irrigation pump survey. An overall fee for irrigating boro has been calculated using the average for different modes wieghted by the proportion of modes found in the region. The cost for other crops has been calculated according to the proportion that their fees are to the boro fee. It is assumed that local boro only needs half the irrigation of hyv boro as it is grown in naturally wet places. In both Noahkali and Gumti a flat rate irrigation fee is the normal method of charging for water, rather than a share of the crop.

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Appraisal of Shallow Force Mode Tubewells

In some parts of the region farmers complain that groundwater supplies are limited and STW run dry towards the end of the season. Although recharge may be sufficient to support a larger area of irrigation, the aquifer may lack suffient storage in its uppermost layer which is easily accessible to STWs. As the water table falls the STWs' suction pump reaches its limit and the operator has to reduce the rate of pumping by slowing the engine. This in turn makes the pump less efficient in terms of energy needed to raise water and the reduced supply also limits the command area.

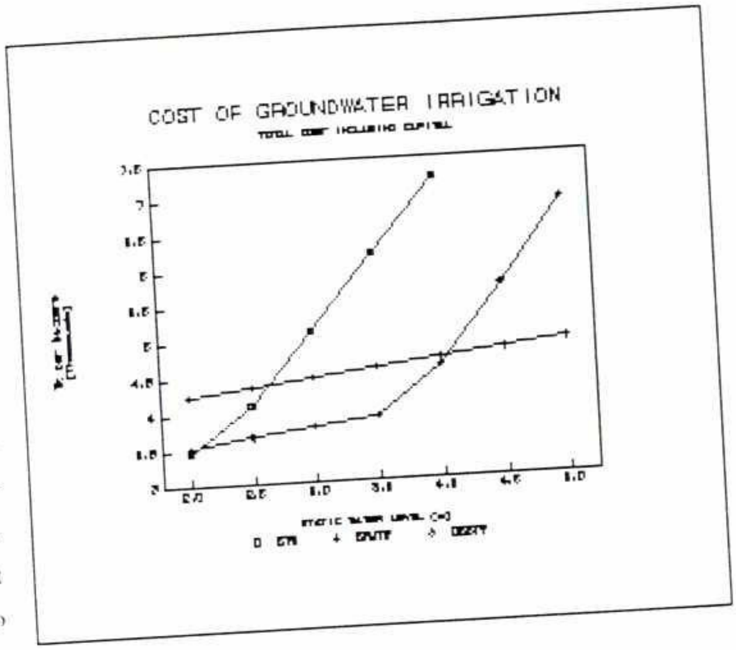

Table 2 and Figure 1 compare the cost of three technologies, STW, DSSTW and SFMTW, with the depth to water table varying from 2 to 5 metres. The STW, with its low capital cost, produces water most cheaply when the water is within 2 m of the surface, but as soon as the water table starts to fall, it is worth deep setting the STW to maintain pump efficiency. It is prehaps surprising that more STW are not deep set - which only tends to happen as the water table falls out of reach of the suction limit. The SFMTW has a higher capital cost, but its efficiency is not effected by the depth to the water table. At over 2.5 metres the SFMTW becomes a cheaper water source than the STW, but the DSSTW maintains its efficiency up to 4.5 m - and if the pit were deeper than 1.5m its advantage would be continued further.

This analysis indicates that both DSSTW and SFMTW can provide an enonomic alternative to STW in situations where the water table has fallen sufficiently to reduce the efficiency of STW operation.

COST OF MINOR IRRIGATION

WATER CHANNELS

Type of well	LLP 1	LLP 2	STW	DSSTW	SFMTW 1	SFMTW 2	SFMTW 3	DFMTW 1	DFMTW 2	DFMTW 3
Command area	10.0	20.0	4.5	4.5	7.5	7.5	11.0	15.0	22.0	15.0
Channel length/ha	80	80	60	60	60	60	80	90	90	90
Ave. cross section	0.9	0.9	0.6	0.6	0.6	0.6	0.9	0.9	0.9	0.9
Cu.m. soil per ha	72	72	36	36	36	36	72	81	81	81
Cu.m. dug per day	3	3	3	3	3	3	3	3	3	3
cost/person – day	40	40	40	40	40	40	40	40	40	40
Cost per ha	960	960	480	480	480	480	960	1080	1080	1080
Cost per well	9600	19200	2160	2160	3600	3600	10560	16200	23760	16200

IRRIGATION EQUIPMENT

		LLP 1	LLP 2	STW	DSSTW	SFMTW 1	SFMTW 2	SFMTW 3	DFMTW 1	DFMTW 2	DFMTW 3
SPECIFICATION											
Discharge l/sec		20	56	8	8	15	15	23	30	60	30
Command area		10.0	20.0	4.5	4.5	7.5	7.5	11.0	15.0	22.0	15.0
Pump chamber – m		0	0	0	0	18	12	18	21	24	27
screen length – m		0	0	12	12	12	12	18	18	24	18
Blank casing – m		3	3	18	18	0	0	0	21	22	105
Well depth – m		0	0	30	30	30	24	36	60	70	150
CAPITAL COST	(financial prices)										
Prices:											
pump chamber	per metre	0	0	0	0	330	330	340	1250	1608	1250
well screen	per metre	0	0	180	180	240	1280	656	656	656	656
blank casing	per metre	150	150	150	150	330	330	340	623	623	623
installation	per metre	0	0	60	60	300	300	400	500	780	900
Costs:											
pump chamber		0	0	0	0	5940	3960	6120	26250	38592	33750
well screen		0	0	2160	2160	2880	15360	11808	11808	15744	11808
blank casing		450	450	2700	2700	0	0	0	13083	13706	65415
other costs		500	500	1700	1700	10000	10000	12000	15000	25000	15000
total well components		950	950	6560	6560	18820	29320	29928	66141	93042	125973
engine and pump		26500	66250	26500	26500	51500	51500	63000	74500	200000	74500
installation & pit		0	0	2160	3160	10800	9000	16800	33000	59280	140400
water channels		9600	19200	2160	2160	3600	3600	10560	16200	23760	16200
total capital		37050	86400	37380	38380	84720	93420	120288	189841	376082	357073
assumed life	years	5	5	5	5	10	10	10	10	10	10
Capital cost (incl.channel)		37050	86400	37380	38380	84720	93420	120288	189841	376082	357073
Cost per year – int. =	16%	11315	26387	11416	11722	17529	19329	24888	39278	77812	73879
Total/ha/yr.		1132	1319	2537	2605	2337	2577	2263	2619	3537	4925

		LLP 1	LLP 2	STW	DSSTW	SFMTW 1	SFMTW 2	SFMTW 3	DFMTW 1	DFMTW 2	DFMTW 3
OPERATING COSTS (financial prices)											
Requirements											
water: mm/season		740	740	740	740	740	740	740	740	740	740
peak: mm/day		9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
length of season		140	140	140	140	140	140	140	140	140	140
hours of operation											
per day: peak		13.54	9.67	15.23	15.23	13.54	13.54	12.95	13.54	9.93	13.54
average		7.34	5.24	8.25	8.25	7.34	7.34	7.02	7.34	5.38	7.34
total per year		1027	[illegible]	1155	1155	1027	1027	982	1027	753	1027
Pump/engine efficiency		50%	50%	38%	38%	50%	50%	50%	50%	55%	50%
Static water level	metres	3.0	3.0	3.0	4.5	5.5	5.5	5.5	9.0	9.0	9.0
Drawdown – m	metres	0.0	0.0	1.3	1.3	2.5	1.3	2.2	2.9	5.0	2.9
Total pump head	metres	4.1	4.1	5.4	7.0	9.2	7.9	8.9	13.2	15.3	13.2
Fuel consumption	litre/hr.	0.53	1.49	0.37	0.48	0.90	0.77	1.34	2.58	5.46	2.58
	litre/yr.	546	1092	431	553	924	795	1315	2653	4109	2653
	litre/ha.	55	55	39	50	50	43	48	72	76	72
Operating costs											
fuel and oil		8407	16813	6645	8521	14225	12245	20250	40858	63278	40858
Spares cost as % of pump/engine											
cost per 1000 hours per yr.		4%	4%	4%	4%	4%	4%	4%	4%	3%	4%
Taka per year		1089	1944	1225	1225	2116	2116	2476	3061	4519	3061
Mechanics charges		109	194	122	122	212	212	248	306	452	306
Labour cost operator		1712	1223	1926	1926	1712	2568	2456	2568	1883	2568
water guard/channel maint.		1400	2800	630	630	1050	1050	1540	2100	3080	2100
Micscelleneous costs & pit		300	450	300	1300	600	600	700	750	1000	750
Total cost	per year	13016	23425	10848	13724	19914	18790	27670	49643	74212	49643
(operating)	per ha	1302	1171	2411	3050	2655	2505	2515	3310	3373	3310
TOTAL ALL COSTS PER HA		2433	2491	4948	5655	4992	5083	4778	5928	6910	6235
Total cost per ha/mm		3.29	3.37	6.69	7.65	6.75	6.87	6.46	8.02	9.34	11.14
ECONOMIC PRICES											
Capital costs:	C.F.										
pump chamber	0.61	0	0	0	0	3623	2416	3733	16013	23541	20588
well screen	0.61	0	0	1318	1318	1757	9370	7203	7203	9604	7203
blank casing	0.61	275	275	1647	1647	0	0	0	7981	8361	39903
other costs	0.87	435	435	1479	1479	8700	8700	10440	13050	21750	13050
total well components		710	710	4444	4444	14080	20485	21376	44246	63256	80744
engine and pump	0.62	16430	41075	16430	16430	31930	31930	39060	46190	124000	46190
installation & pit	0.87	0	0	1879	2749	9396	7830	14616	28710	51574	122148
water channels	0.75	7200	14400	1620	1620	2700	2700	7920	12150	17820	12150
Total capital cost		24340	56185	24373	25243	58106	62945	82972	131296	256649	261232
Cost per year – int. =	12%	6752	15586	6761	7003	10284	11140	14685	23237	45423	46234
total/ha/yr.		675	779	1503	1556	1371	1485	1335	1549	2065	3082
Operating Costs	c.f.										
fuel and oil	0.63	5296	10592	4186	5368	8962	7714	12758	25741	39865	25741
spares	0.62	675	1205	759	759	1312	1312	1535	1898	2802	1898
mechanic	0.87	95	169	107	107	184	184	215	266	393	266
operator	0.75	1284	917	1444	1444	1284	1926	1842	1926	1412	1926
water guard	0.75	1050	2100	473	473	788	788	1155	1575	2310	1575
miscelleneous	0.87	261	392	261	1131	522	522	609	653	870	653
total		8661	15375	7230	9282	13051	12446	18114	32058	47652	32058
total per ha		866	769	1607	2063	1740	1659	1647	2137	2166	2137
TOTAL ALL COST PER HA		1541	1548	3109	3619	3111	3145	2982	3686	4231	5219

COMPARISON OF COST OF SUCTION AND FORCE MODE PUMPS AT DIFFERENT DEPTHS TO WATER TABLE

SPECIFICATION	STW	STW	STW	STW	STW	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW
Depth to water table(m)	2.0	2.5	3.0	3.5	4.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Discharge l/sec	12	10	8	6	5	12	12	12	12	12	12	12	12	12	12	12	10	8	6
Command area	7.5	6.0	4.5	3.8	3.2	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	6.0	4.5	3.8
													0	0	0	0	0	0	0
Pump chamber – m	0	0	0	0	0	18	18	18	18	18	18	18	12	12	12	12	12	12	12
screen length – m	12	12	12	12	12	12	12	12	12	12	12	12	18	18	18	18	18	18	18
Blank casing – m	18	18	18	18	18	0	0	0	0	0	0	0	30	30	30	30	30	30	30
Well depth – m	30	30	30	30	30	30	30	30	30	30	30	30							
CAPITAL COSTS (financial prices)																			
Prices:																			
pump chamber/m	0	0	0	0	0	330	330	330	330	330	330	330	0	0	0	0	0	0	0
well screen/m	240	240	240	240	240	240	240	240	240	240	240	240	180	180	180	180	180	180	180
blank casing/m	230	230	230	230	230	330	330	330	330	330	330	330	150	150	150	150	150	150	150
installation/m	100	100	100	100	100	300	300	300	300	300	300	300	60	60	60	60	60	60	60
Costs:																			
pump chamber	0	0	0	0	0	5940	5940	5940	5940	5940	5940	5940	0	0	0	0	0	0	0
well screen	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2160	2160	2160	2160	2160	2160	2160
blank casing	4140	4140	4140	4140	4140	0	0	0	0	0	0	0	2700	2700	2700	2700	2700	2700	2700
other costs	1700	1700	1700	1700	1700	10000	10000	10000	10000	10000	10000	10000	1700	1700	1700	1700	1700	1700	1700
total well components	8720	8720	8720	8720	8720	18820	18820	18820	18820	18820	18820	18820	6560	6560	6560	6560	6560	6560	6560
engine and pump	26500	26500	26500	26500	26500	51500	51500	51500	51500	51500	51500	51500	26500	26500	26500	26500	26500	26500	26500
installation & pit	3600	3600	3600	3600	3600	10800	10800	10800	10800	10800	10800	10800	3160	3160	3160	3160	3160	3160	3160
water channels	2160	2160	2160	2160	2160	3600	3600	3600	3600	3600	3600	3600	2160	2160	2160	2160	2160	2160	2160
total capital	40980	40980	40980	40980	40980	84720	84720	84720	84720	84720	84720	84720	38380	38380	38380	38380	38380	38380	38380
assumed life	5	5	5	5	5	10	10	10	10	10	10	10	5	5	5	5	5	5	5
Capital cost	40980	40980	40980	40980	40980	84720	84720	84720	84720	84720	84720	84720	38380	38380	38380	38380	38380	38380	38380
Cost per year	12516	12516	12516	12516	12516	17529	17529	17529	17529	17529	17529	17529	11722	11722	11722	11722	11722	11722	11722
	1669	2086	2781	3294	3911	2337	2337	2337	2337	2337	2337	2337	1563	1563	1563	1563	1954	2605	3085

compcost.wk1

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	STW	STW	STW	STW	STW	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW
OPERATING COSTS (financial prices)																			
Requirements																			
water: mm/season	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740
peak: mm/day	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
length of season	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
hours of operation																			
per day: peak	16.93	16.25	15.23	17.15	17.33	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.25	15.23	17.15
	9.17	8.80	8.25	9.29	9.39	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	8.80	8.25	9.29
total per year	1284	1233	1155	1301	1315	1284	1284	1284	1284	1284	1284	1284	1284	1284	1284	1284	1233	1155	1301
Pump/engine efficiency	45%	42%	38%	32%	30%	50%	50%	50%	50%	50%	50%	50%	45%	45%	45%	45%	42%	38%	32%
Static water level	2.0	2.5	3.0	3.5	4.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Drawdown – m	2.0	1.7	1.3	1.0	0.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.7	1.3	1.0
Total pump head	5.1	5.3	5.4	5.6	5.9	5.1	5.6	6.1	6.6	7.1	7.6	8.1	5.1	5.6	6.1	6.6	6.8	7.0	7.1
Fuel consumption: lt/hr	0.44	0.41	0.37	0.34	0.32	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.44	0.49	0.53	0.58	0.53	0.48	0.44
lt/year	569	504	431	446	425	512	564	615	667	718	769	821	569	626	683	741	651	553	568
lt/ha	31	34	39	48	54	28	30	33	36	39	42	44	31	34	37	40	44	50	61
Operating costs																			
fuel and oil	8766	7765	6645	6872	6549	7889	8681	9473	10265	11057	11849	12641	8766	9646	0526	11406	10028	8521	8753
Spares cost as % of pump/engine																			
cost per 1000 hours	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Taka per year	1361	1306	1225	1379	1394	2645	2645	2645	2645	2645	2645	2645	1361	1361	1361	1361	1306	1225	1379
Mechanics charges	136	131	122	138	139	264	264	264	264	264	264	264	136	136	136	136	131	122	138
Labour cost	2140	2054	1926	2168	2191	2140	2140	2140	2140	2140	2140	2140	2140	2140	2140	2140	2054	1926	2168
water guard/channel maint.	1400	1120	840	709	597	1400	1400	1400	1400	1400	1400	1400	1050	1050	1050	1050	840	630	532
Micscelleneous costs & pit	300	300	300	300	300	600	600	600	600	600	600	600	1300	1300	1300	1300	1300	1300	1300
Total cost per yr.	14102	12676	11058	11567	11170	14938	15730	16522	17314	18106	18898	19690	14752	15632	16512	17392	15659	13724	14271
(operating) per ha	1880	2113	2457	3044	3491	1992	2097	2203	2309	2414	2520	2625	1967	2084	2202	2319	2610	3050	3755
TOTAL ALL COSTS PER HA	3549	4199	5239	6338	7402	4329	4434	4540	4646	4751	4857	4962	3530	3647	3765	3882	4563	5655	6840
Total cost per ha/mm	4.80	5.68	7.08	8.57	10.01	5.85	6.00	6.14	6.28	6.42	6.57	6.71	4.77	4.93	5.09	5.25	6.17	7.65	9.25

ANNEX X

ENGINEERING COSTS

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ANNEX X - ENGINEERING COSTS

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ANNEX X

ENGINEERING COSTS

1 Introduction

The objective of engineering costing at the pre-feasibility stage is to derive costs for the various options being considered, in sufficient detail and accuracy to establish whether they merit further study, to set priorities for implementation and to schedule budgetary requirements. Full detailed costings are not appropriate and an estimating procedure has been developed generally in accordance with the FPCO Guidelines for Project Assessment. The major source of costs has been Technical Report Nr 13 - Procedure for preparing Cost Estimates, prepared by MPO in March 1987. Other sources have been used for various elements as described below, and all rates have been checked against those prepared for the Feasibility Studies for the Noakhali North Drainage and Irrigation Project and the Gumti Phase II Sub-Project.

2 Inflation

Costs have been drawn from various sources originating at various times. To convert them to mid 1991 rates the General Index of the Index of Building Materials, Transport and Wage Rates published by the Bangladesh Bureau of Statistics has been used, as given in Table X.1.

TABLE X.1

Index of Building Materials, Transport and Wage Rates

Year	General Index	Growth Per cent	Factor
1980/81	724		
1981/82	847	16.99	1.77
1982/83	831	-1.89	1.81
1983/84	833	0.24	1.80
1984/85	924	10.92	1.62
1985/86	1050	13.64	1.43
1986/87	1089	3.71	1.38
1987/88	1162	6.70	1.29
1988/89	1259	8.35	1.19
1989/90	1339	6.35	1.12
1990/91 e	1450	8.29	1.03
Jun 91 e	1500	3.45	1.00

e = estimated

Several of the sources of cost information relate to mid 1988 and mid 1983, and the respective factors were interpolated as 1.25 and 1.80. respectively.

3 Embankments

Embankments are normally constructed by taking soil from adjacent borrow pits. Land is acquired for the embankments and borrow pits at the current market price. It has been assumed that soil is excavated, carried and placed manually, and compaction carried out mechanically. Embankments have typically been costed on the basis of the BWDB standard sections for different heights, as shown in Table X.2 and Figure X.1.

Where no-standard embankments are required (for instance, coastal embankments with 1 in 7 seaward facing slopes and 1 in 3 country side slopes), they have been costed individually. Similarly embankments requiring imported fill have also been costed individually at the appropriate rates.

4 Channel Excavation

Channel excavation constitutes a major component of the proposals, and special attention has therefore been given to deriving as realistic rates as possible for this part of the works. Various combinations of manual and mechanical methods were investigated under the feasibility studies referred to above, in order to arrive at the most effective approach for any given circumstances.

It was concluded that manual excavation is best employed in all locations except where the depth of water makes it difficult or impossible. Under these conditions mini-dredgers have been adopted. Enquiries from manufacturers led to calculations that a machine of 65 m^3/s output would cost about Tk 19 million in Bangladesh, with running costs of about Tk 1 280 per hour. Assuming cost recovery over a three year contract gave a basic rate excluding labour costs of Tk 43.75 per hour. Full-sized dredgers as presently used in Bangladesh were also investigated, but found to be more expensive and less appropriate for the works envisaged.

The spoil would be pumped as a slurry and retained within small bunds to the required depth. The basic delivery pipe length is assumed to be 450 m of which 150 m is floating pipe, giving an effective transport distance of about 300 m.

Considerable attention was also paid to the matter of spoil disposal. The system eventually most favoured has been to spread the material on adjacent land, and pay the farmers compensation for the loss of a season's production. Compensation for the loss of one season's cropping was set at Tk 15 000 per hectare, plus an additional Tk 1 000 per hectare for fertiliser for the next season. Assuming a spreading thickness of 0.3 m gives a rate of Tk 5 per m^3 to be added to the basic excavation rate. This approach appears preferable to acquiring land for spoil disposal, as it minimises both the loss of land for agriculture and the displacement of people.

Excavation of major channels for drainage improvement or khal deepening for irrigation has been estimated as a volume and costed at the appropriate unit rate, including the allowance for compensation for spreading where necessary.

TABLE X.2

Calculation of Costs per Unit Length of Standard Embankment

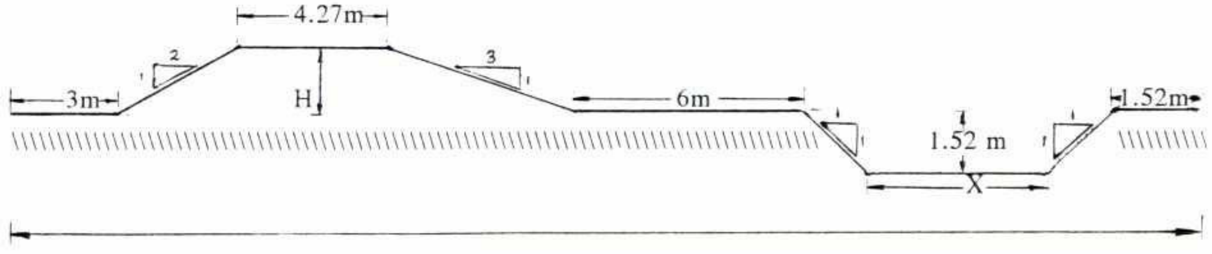
Height H (m)	Fill Volume (m³/m)	Bed Width of Borrow Pit X(m)	Turfing Area (m²/m)	Land Acquisition Width (m)	Cost of Earthworks (Tk/m)	Cost of Turfing (Tk/m)	Total Cost (Tk/m)
1.00	6.77	2.93	9.67	25.76	406.20	29.00	435.20
1.25	9.24	4.56	11.02	28.64	554.63	33.05	587.68
1.50	12.03	6.39	12.37	31.72	721.80	37.10	758.90
1.75	15.13	8.43	13.72	35.01	907.73	41.15	948.88
2.00	18.54	10.68	15.07	38.51	1112.40	45.20	1157.60
2.25	22.26	13.13	16.42	42.21	1335.83	49.25	1385.07
2.50	26.30	15.78	17.77	46.11	1578.00	53.30	1631.30
2.75	30.65	18.64	19.12	50.22	1838.93	57.35	1896.27
3.00	35.31	21.71	20.46	54.54	2118.60	61.39	2179.99
3.25	40.28	24.98	21.81	59.06	2417.03	65.44	2482.47
3.50	45.57	28.46	23.16	63.79	2734.20	69.49	2803.69
3.75	51.17	32.14	24.51	68.72	3070.13	73.54	3143.67
4.00	57.08	36.03	25.86	73.86	3424.80	77.59	3502.39
4.25	63.30	40.13	27.21	79.21	3798.23	81.64	3879.86
4.50	69.84	44.43	28.56	84.76	4190.40	85.69	4276.09
4.75	76.69	48.93	29.91	90.51	4601.33	89.74	4691.06
5.00	83.85	53.64	31.26	96.47	5031.00	93.78	5124.78
5.25	91.32	58.56	32.61	102.64	5479.43	97.83	5577.26
5.50	99.11	63.68	33.96	109.01	5946.60	101.88	6048.48
5.75	107.21	69.01	35.31	115.59	6432.53	105.93	6538.46
6.00	115.62	74.55	36.66	122.38	6937.20	109.98	7047.18

Unit Rates Used:

Excavation & Shaping (Manual)	-	Tk 35/m³
Mechanical Compaction	-	Tk 25/m³
Turfing (Manual)	-	Tk 3/m²

FIGURE X.1

BWDB Standard Embankment Section



Land Acquisition Width

In some of the options the provision of minor drainage channels has been specified, and costed on an area basis. Drainage of individual paddy fields is the responsibility of the farmers, and the minor drainage system to be installed by the project is assumed to provide drainage outlets for each 100 acre (40 ha) block. The cost of such local drainage has been estimated on the basis of the stylized layout prepared by MPO and reproduced in Figure X.2. The MPO calculations are based on a complete drainage system for an area of 12,150 ha as shown in Table X.3. The channel sizing and excavation quantities have been estimated on the basis of discharges at different reaches for a drainage co-efficient of 38 mm/day. The drainage co-efficient is based on the data available from various studied or executed projects within the region, as shown in Table X.4.

TABLE X.3

Minor Drainage Channel Earthworks for Stylized Layout Covering 12,150 ha

Name of Reach	Nos. of Reach	Length of Reach (ft)	Total Length (m)	Depth d (m)	Bed Width b (m)	Area per metre (m^2)	Volume (m^3)	Spoil top width (m)	Bank height (m)	Berm (m)	LA (m^2)/m	Total LA m^2
C-C1	4	2 090	2 549	0.51	1.53	1.17	2 983	0.6	0.52	0.9	7.25	18 480
A-B	9	2 950	8 095	0.6	1.8	1.62	13 113	0.6	0.65	0.9	8.29	67 108
A-G	2	2 950	1 799	0.6	1.8	1.62	2 914	0.6	0.65	0.9	8.29	14 914
C1-C1	2	2 090	2 549	0.7	2.1	2.21	5 620	0.6	0.79	0.9	9.47	24 139
C2-D	2	2 950	1 799	0.89	2.67	3.56	6 412	0.6	1.07	0.9	11.71	21 066
C2-F	2	2 950	1 799	0.89	2.67	3.56	6 412	0.6	1.07	0.9	11.71	21 066
B-B1	3	2 950	2 698	1.19	3.57	6.37	17 194	0.6	1.51	0.9	15.28	41 225
B1-B2	1	2 950	899	1.32	3.96	7.84	7 052	0.6	1.70	1.5	17.43	15 670
B1-D	2	2 950	1 799	1.32	3.96	7.84	14 104	0.6	1.70	1.5	17.43	31 357
B2-E	1	2 950	899	1.53	4.6	10.55	9 488	1.22	1.77	1.5	20.20	18 160
D-E	2	2 950	1 799	1.64	4.93	12.12	21 801	1.6	1.79	1.5	21.70	39 038
E-F	1	2 950	899	2.23	11.13	32.28	29 032	7.25	1.79	1.5	40.96	36 823
F-F1	1	2 950	899	2.3	11.52	34.43	30 967	7.75	1.80	1.5	42.63	38 324
F1-G	1	2 950	899	2.27	11.33	33.45	30 083	7.75	1.76	1.5	42.18	37 920
G-G1	1	2 950	899	2.58	12.88	43.22	38 867	10.25	1.79	1.5	49.80	44 770
G1-O	1	2 950	899	2.61	13.03	44.23	39 777	10.5	1.80	1.5	50.55	45 444
Sub total (4050 hec.)			31 179				275 818					515 504
Sub total (12,150 hec.)			93 537				827 453					1 546 512
O-P	1	2 950	899	3.25	16.25	68.66	61 749	17	1.82	1.8	69.09	62 112
TOTAL VOLUME OF EARTH FOR 12,150 ha							889 202					1 608 624

Source: Technical Report Nr 13, MPO.

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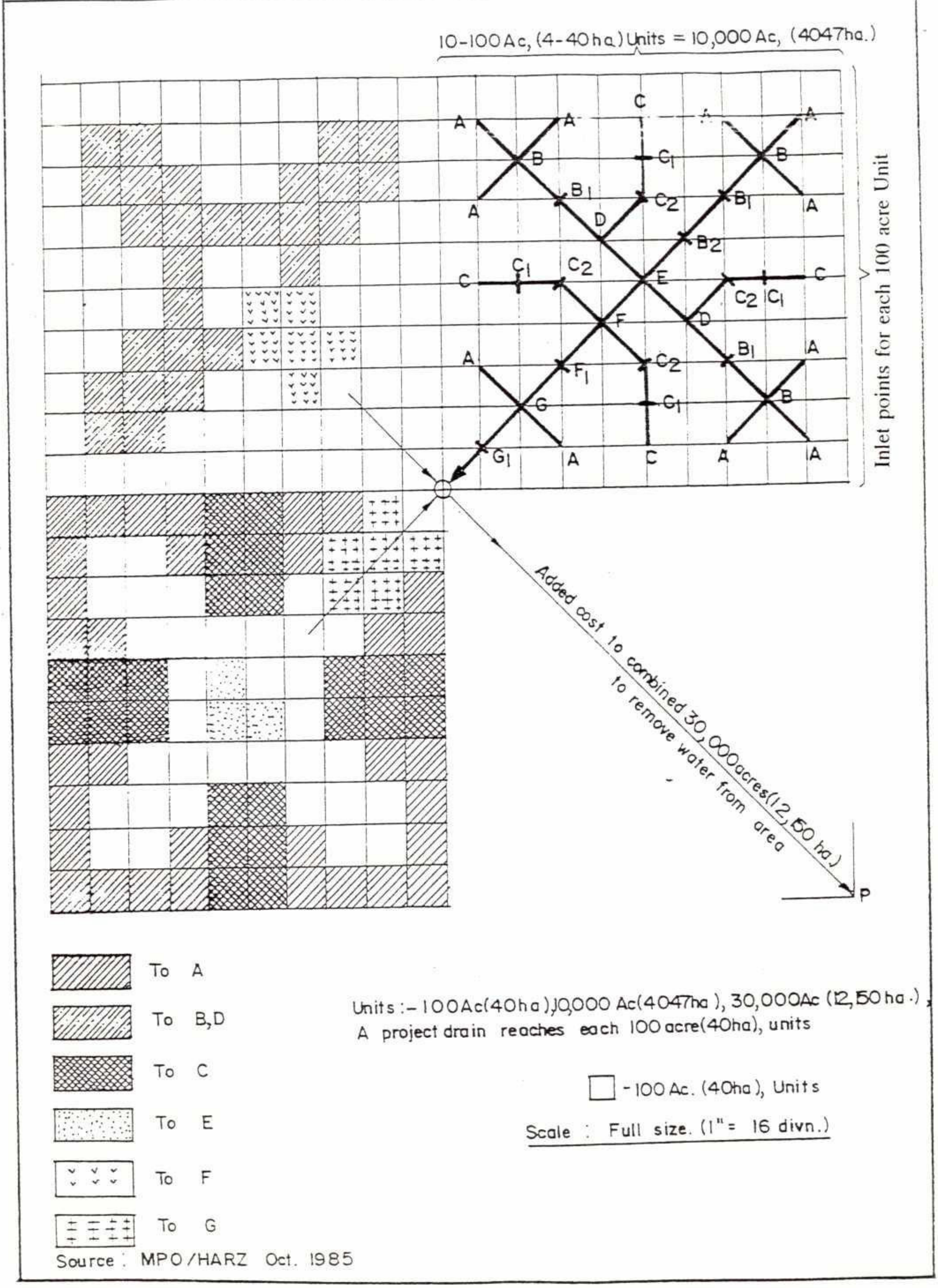
Figure X.2

Stylized Drainage Layout for 30,000 Acre (12,150 ha) Block



Source : MPO/HARZ Oct. 1985

In the study area there is a substantial density of existing drainage channels, and it has been assumed that the actual excavation volume required is half that calculated for the stylized layout. Using a unit excavation rate of Tk 35 per cubic metre, including compensation for spoil spreading, the total cost of 444 600 m^3 of excavation over a 12 150 ha area is Tk 15.56 million, equivalent to Tk 1 300 per ha. It is assumed that this cost will also cover any minor drainage structures necessary within the system. Since existing channels are generally being excavated, land acquisition is assumed to be negligible.

TABLE X.4

Drainage Coefficients from Various Projects

Project	Drainage co-efficient mm/day
Gumti - I	35
Gumti Phase II	35
Little Feni	44-47
MDIP	35
Delta Dev. Project (Part 1 Phase IV-VIII)	36
Recommended for SERWRDP	38

5 Summary of Earthworks Rates

A summary of the earthworks rates used in the engineering capital cost estimates is given in Table X.5.

TABLE X.5

Unit Rates for Engineering Capital Cost Estimates

Item Nr	Description	Remarks	Unit	Rate Tk/Unit
1	Channel Excavation & Dumping	Manual	cu.m	30
2	Channel Excavation & Dumping	Dredging	cu.m	50
3	Channel Excavation and Spreading including Compensation	Manual	cu.m	35
4	Channel Excavation and Spreading including Compensation	Dredging	cu.m	55
5	Embankment Construction (Excavate, Shape & Compact)	Manual Compaction	cu.m	45
6	Embankment Construction (Excavate, Shape & Compact)	Mechanical Compaction	cu.m	60
7	Embankment Construction with Imported Fill	Manual Compaction	cu.m	80
8	Embankment Construction with Imported Fill	Mechanical Compaction	cu.m	95
9	Excavation of Minor Khals & provision of Structures		ha	1 300
10	Turfing	Manual	sq.m	3
11	Land Acquisition		ha	400 000

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6 Drainage Regulators

6.1 Size and Number of Vents

The required capacity of drainage regulators has generally been estimated from SERM results or, where these are unavailable, from catchment runoff calculations. The required size and number of vents has then been estimated in the manner described below.

Discharge through a sluice or drainage regulator is similar to that through a culvert or pipe. Under Bangladesh conditions the following extreme flow characteristics may be considered:

- **Flow Type 1**

  $Q = CA\sqrt{(2gh)}$

  where
  Q = Discharge through the barrel
  A = Flow area through the barrel
  g = Acceleration due to gravity
  h = Water level difference between u/s and d/s
  C = Discharge Coefficient, taken as 0.8

  The pipe may run full.

- **Flow Type 5**

  Broad crested weir. Water level in the down stream is below the critical level in the barrel.

  $Q = CLH^{3/2}$

  where
  C = Discharge Coefficient, taken as 1.35
  L = width of opening
  H = head over crest

Two standard vent sizes have been considered:

1.52 m X 1.82 m (BWDB Standard Size)
3.05 m X 3.05 m (BWDB Larger Size)

BWDB also has a special size, 1.2 m X 1.52 m, but this has been avoided as it is difficult to clean, especially when the barrel length is quite long, as in the case of drainage sluices (up to 25 m).

Discharges per vent for different vent sizes under the two flow conditions considered are given in Table X.6.

TABLE X.6

Discharge Through Drainage Regulators (m^3/s)

	Barrel Size 1.52 m X 1.82 m	3.05 m X 3.05 m
A. FLOW TYPE 1, $Q = CA\sqrt{(2gh)}$		
h = 0.2 m	4.5	15
h = 0.3 m	5.0	18
B. FLOW TYPE 5, $Q = CLH^{3/2}$		
H = 2.9 m	-	20
H = 1.7 m	4.5	-
C. RECOMMENDED	5.0	18

Note:

h = head difference between u/s and d/s of the drainage sluice.
H = Head over crest i.e. depth of water in the barrel.

6.2 Costs

To develop parametric costs, data have been collected from different projects or studies, and are presented in Table X.7. However, various inconsistencies are apparent. This may be due to the following causes;

- not all were estimated on the basis of standard (BWDB) designs,
- tendered rates are influenced by local socio-political conditions,
- special foundation treatment may have been included, and
- local hydrological conditions may have called for special designs.

In order to resolve these inconsistencies, discussions were held with engineers associated with several of the projects concerned, especially the DFC-III project, and MPO estimates were also collected. Based on all the sources of information, a consistent set of estimated costs was adopted, as presented in Table X.8.

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TABLE X.7

Cost of Various Drainage Regulators Studied or Implemented (1990 prices unless noted)

Sl Nr	Name of structure		Size of Structure	Total cost (000 Tk)	Cost per vent (000 Tk)
1	Nabinagar	Drainage Regulator	4 - 9.14 m X 4.50 m	95 400	23 850
2	Homna	Drainage Regulator	7 - 9.19 m X 4.50 m	208 000	29 714
3	Bijni	Drainage Regulator	7 - 3.05 m X 3.05 m	54 000	7 714
4	Nabinagar East	Drainage Regulator	6 - 3.04 m X 3.04 m	48 400	8 067
5	Nabinagar West	Drainage Regulator	6 - 3.04 m X 3.04 m	48 400	8 067
6	Rahmatkhali	Drainage Regulator	14 - 3.05 m X 3.05 m	86 912	6 208 (a)
7	Naogaon Zia Khal	Drainage Regulator	20 - 2.44 m X 3.05 m	229 700	11 485 (b)
8	Buri Nadi	Drainage Regulator	1 - 1.52 m X 1.82 m	3 900	3 900
9		Drainage Regulator	1 - 1.52 m X 1.82 m	4 600	4 600
10	Little Feni River	Drainage Regulator	1 - 1.52 m x 1.82 m	2 580	2 580
11	Matia	Drainage Regulator	2 - 1.52 m X 1.82 m	5 600	2 800
12	Batakandi	Drainage Regulator	2 - 1.52 m X 1.82 m	5 600	2 800
13	Madhupur	Drainage Regulator	2 - 1.52 m x 1.82 m	3 000	1 500
14	Saddona beel sub-project		2 - 1.52 m X 4.00 m	3 870	1 935
15	Chandal beel project		3 - 1.52 m X 1.82 m	4 950	1 650
16	Kahua river sub-project		3 - 1.52 m X 1.82 m	4 260	1 420
17	Chandina	Drainage Regulator	3 - 1.52 m X 1.82 m	7 000	2 333
18	Banshkela	Drainage Regulator	3 - 1.52 m X 1.82 m	7 600	2 533
19	Muktarampur	Drainage regulator	4 - 1.52 m X 1.82 m	6 900	1 725
20	Lalpur	Drainage Regulator	4 - 1.52 m X 1.82 m	6 900	1 725
21	Siddeswari	Drainage Regulator	12 - 1.52 m X 1.82 m	15 000	1 250
22	Elliotgang	Drainage Regulator	14 - 1.52 m X 1.82 m	13 000	929

Note:

(a) On the basis of quick estimate at 1991 prices
(b) Based on International Tender Rate (1991). The cost is high mainly due to excessive earth work in site filling and major protective works.

7 Pump Stations

Parametric cost for pump stations have been developed from MPO estimates. The formulae recommended by MPO have been adopted after applying a multiplying factor 1.81 to take into account price rises between 1983 and 1991. These formulae are shown below:

Civil structure cost = Tk 2 700 000 x $(QU)^{0.66}$

Mechanical and electrical cost = Tk 3 026 000 x $(QH)^{0.81}$

where Q = total discharge of station in m^3/s
H = static head (m).
U = Nr. of Units

TABLE X.8

Costs of Drainage Regulators Adopted for the Present Study
(1991 price in Tk million)

Nr of vents	From Table X.6	MPO	Other Sources (a)	Adopted Cost/Vent
A. BWDB STANDARD SIZE (1.52 m X 1.82 m)				
1	2.5 - 4.6	2.30	2.50 - 3.00	2.50
2	1.5 - 2.8	2.28	1.75 - 2.00	2.25
3	1.4 - 2.5	2.10	1.50 - 1.67	2.00
4	1.7	1.98	1.25 - 1.38	2.00
5	-	1.91	1.10 - 1.20	1.75
6	-	1.87	1.00 - 1.08	1.75
7	-	1.82	0.93 - 1.00	1.60
8	0.3	1.82	0.88 - 0.94	1.60
9	-	1.80	0.83 - 0.89	1.60
10	-	1.80	0.80 - 0.85	1.60
11	-	-	-	1.60
12	1.2	-	-	1.60
B. LARGER SIZE (3.05 m X 3.05 m)				
6	8.10	-	-	8.00
7	7.71	-	-	7.50
8	-	-	-	7.00
9	-	-	-	6.00
14	6.21	-	-	6.00
22	-	-	-	6.00

Note: (a) From discussions with the construction engineers, DFC-3 and others.

8 Power Supply

Electric power is required for all primary pump stations (it has been assumed that LLPs are driven by diesel engines). Allowance has been made for the provision of 33 kV distribution line, based upon the shortest practical distance to an existing high voltage supply point. On the basis of discussions with the Power Development Board, it has been assumed that there is ample capacity within the existing system. Transmission line costs have been calculated at a rate of Tk 450 000 per km, in accordance with information gathered from the Power Development Board (PDB) and the Rural Electrification Board. The cost of a 33/11 kV transformer has been taken as Tk 9 000 000. The cost of power consumed has been taken as Tk 2.5 per kWH, which is the rate charged by the PDB for bulk supplies for agricultural use. Annual power consumption has been based upon a typical operating period of 1 400 hours and an overall pumping efficiency of 60%.

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9 Buildings

It is anticipated that most of the schemes considered would be managed from existing BWDB facilities, and therefore new buildings have only been proposed where they are needed at the site of major regulators etc. In such cases, a sum of Tk 500 000 has been allowed.

10 Operation and Maintenance (O&M) Costs

Expenditure on O&M varies widely from scheme to scheme, and it is not practical to make a detailed assessment at the pre-feasibility stage. In many existing schemes, actual expenditure on O&M is much less than desirable, with important maintenance items being deferred apparently through lack of funding. The FPCO Guidelines for Project Assessment give recommended O&M costs for various works, expressed as a percentage of capital cost, and these have been adopted for the present study, as shown in Table X.9.

TABLE X.9

Annual Operation and Maintenance Costs

	Description	Percentage of Capital cost
1	Full Flood Embankment	6
2	Submersible Embankment (a)	10
3	Drainage Channels	6
4	Structures	3
5	Buildings	6
6	Pump Station	
(i)	Civil	2
(ii)	E&M	2
7	Transmission line and Sub-station (a)	2

Source: FPCO Guidelines except (a), Consultants' estimate

11 Breakdown of Costs

The estimated breakdown of major items of construction cost in terms of the main categories of labour, materials and equipment etc are presented in Table X.10. Similar breakdowns in respect of O&M costs are presented in Table X.11. The resulting calculations of weighted conversion factors for the conversion of capital and O&M costs from financial to economic prices are presented in Tables X.12 and X.13 respectively.

TABLE X.10

Breakdown of Capital Costs in Financial Prices by Main Category
Share of Costs (per cent)

Item		Skilled labour local cost	Unskilled labour local cost	Transport local cost	Transport F. E. cost	Cement and Bitumen (a) local cost	Cement and Bitumen (a) F. E. cost	Steel local cost	Steel F. E. cost	Machinery and equipment local cost	Machinery and equipment F. E. cost	Gravel/ Bricks(b) local cost	Total local cost	Total F. E. cost	Total
Embankments	(c)	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Canals	(c)	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Major drains	(c)	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Drainage	(c)	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Regulators	(d)	11.0	42.0	1.0	1.0	6.0	2.0	6.5	6.5	10.0	10.0	4.0	80.5	19.5	100.0
Culverts	(d)	12.0	49.0	1.5	1.5	4.5	1.5	6.5	6.5	6.5	6.5	4.0	84.0	16.0	100.0
Pump stations Civil	(d)	12.0	48.0	1.0	1.0	6.0	2.0	6.5	6.5	6.5	6.5	4.0	84.0	16.0	100.0
Pump stations E & M	(e)	5.0	1.0	1.5	1.5	0.0	0.0	0.0	0.0	45.5	45.5	0.0	53.0	47.0	100.0
Roads E/W	(c)	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Roads Pavement	(f)	13.0	13.0	2.0	2.0	10.0	3.0	0.0	0.0	10.5	10.5	36.0	84.5	15.5	100.0
Bridges	(d)	12.0	47.0	1.5	1.5	7.0	2.0	6.5	6.5	6.0	6.0	4.0	84.0	16.0	100.0
Footbridges	(d)	13.0	48.0	2.0	2.0	7.0	2.0	6.5	6.5	4.5	4.5	4.0	85.0	15.0	100.0
Power supply	(g)	5.0	1.0	2.0	2.0	0.0	0.0	0.0	0.0	45.0	45.0	0.0	53.0	47.0	100.0
Buildings	(h)	15.0	14.0	0.0	0.0	17.0	6.0	6.5	6.5	3.0	3.0	29.0	84.5	15.5	100.0

Notes:

(a) Bitumen is applied for road pavement only.

(b) Bricks are mostly used for buildings.

(c) Based on MPO analysis and schedule of rates BWDB Comilla, 1988.

(d) Source: Naogaon polder with some adjustment.

(e) Meghna-Dhonagoda Irrigation project and North Rajshahi Irrigation project with some adjustment.

(f) Schedule of Rates BWDB Comilla, 1988 after some adjustment.

(g) Data collected from FDB & REB.

(h) Updated from cost analysis of buildings under Feni Regulator, 1983.

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TABLE X.11

Breakdown of O&M Costs in Financial Prices by Main Category

Share of Costs (per cent)

Item	Skilled labour	Unskilled labour	Transport		Cement and Bitumen		Machinery equipment		Electricity		Total		Total
	local cost	local cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	
Embankments	22.5	57.5	1.5	1.5	0.0	0.0	8.5	8.5	0.0	0.0	90	10	100
Canals	22.5	57.5	1.5	1.5	0.0	0.0	8.5	8.5	0.0	0.0	90	10	100
Major drains	22.5	63.0	1.5	1.5	0.0	0.0	5.8	5.8	0.0	0.0	93	7	100
Drainage	11.5	87.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	100	1	100
Regulators	28.0	56.5	1.3	1.3	3.0	3.0	3.5	3.5	0.0	0.0	92	8	100
Culverts	28.5	63.0	1.3	1.3	3.0	3.0	0.0	0.0	0.0	0.0	96	4	100
Pump stat. Civil	28.5	57.5	1.3	1.3	0.0	0.0	5.8	5.8	0.0	0.0	93	7	100
Pump stat. E & M	29.0	29.0	1.0	1.0	0.0	0.0	20.0	20.0	0.0	0.0	79	21	100
Pump stat. Power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	25.0	75	25	100
Roads	22.0	59.5	1.3	1.3	3.0	3.0	5.0	5.0	0.0	0.0	91	9	100
Bridges	28.5	56.0	1.3	1.3	3.0	3.0	3.5	3.5	0.0	0.0	92	8	100
Footbridges	28.5	63.0	1.3	1.3	3.0	3.0	0.0	0.0	0.0	0.0	96	4	100
Buildings	28.5	63.0	1.3	1.3	3.0	3.0	0.0	0.0	0.0	0.0	96	4	100

TABLE X.12

Estimates of Conversion Factors for Capital Cost Items

Item	Skilled labour	Unskilled labour	Transport	Cement/ Bitumen	Steel	Machinery & equpt	Gravel/ Bricks	Weighted average Conversion Factor
Conversion Factor	0.87	0.65	0.79	0.79	0.75	0.62	0.87	
Embankments	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Canals	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Major drains	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Drainage	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Regulators	9.6	27.3	1.6	6.3	9.8	12.4	3.5	0.70
Culverts	10.4	31.9	2.4	4.7	9.8	8.1	3.5	0.71
Pump stations Civil	10.4	31.2	1.6	6.3	9.8	8.1	3.5	0.71
Pump stations E & M	4.4	0.7	2.4	0.0	0.0	56.4	0.0	0.64
Roads E/W	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Roads Pavement	11.3	8.5	3.2	10.3	0.0	13.0	31.3	0.78
Bridges	10.4	30.6	2.4	7.1	9.8	7.4	3.5	0.71
Footbridges	11.3	31.2	3.2	7.1	9.8	5.6	3.5	0.72
Power supply	4.4	0.7	3.2	0.0	0.0	55.8	0.0	0.64
Buildings	13.1	9.1	0.0	18.2	9.8	3.7	25.2	0.79
Other conversion factors from FPCO Guidelines			vehicles					0.68
			standard conversion factor					0.87

TABLE X.13

Estimates of Conversion Factors for O&M Cost Items

Item	Skilled labour	Unskilled labour	Transport	Cement/ Bitumen	Machinery & equipment	Pump station power	Weighted average Conversion Factor
Conversion Factor	0.87	0.65	0.79	0.79	0.62	1.54	
Embankments	19.58	37.38	2.37	0.00	10.54	0.00	0.70
Canals	19.58	37.38	2.37	0.00	10.54	0.00	0.70
Major drains	19.58	40.95	2.37	0.00	7.13	0.00	0.70
Drainage	10.01	56.88	0.79	0.00	0.00	0.00	0.68
Regulators	24.36	36.73	1.98	4.74	4.34	0.00	0.72
Culverts	24.80	40.95	1.98	4.74	0.00	0.00	0.72
Pump stat. Civil	24.80	37.38	1.98	0.00	7.13	0.00	0.71
Pump stat. E & M	25.23	18.85	1.58	0.00	24.80	0.00	0.70
Pump stat. Power	0.00	0.00	0.00	0.00	0.00	154.00	1.54
Roads	19.14	38.68	1.98	4.74	6.20	0.00	0.71
Bridges	24.80	36.40	1.98	4.74	4.34	0.00	0.72
Footbridges	24.80	40.95	1.98	4.74	0.00	0.00	0.72
Buildings	24.80	40.95	1.98	4.74	0.00	0.00	0.72
				standard conversion factor			0.87

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ANNEX XI

COMMENTS, REPLIES AND ACTIONS
ON
DRAFT REGIONAL PLAN REPORT

ANNEX XI

COMMENTS, REPLIES AND ACTIONS ON DRAFT REGIONAL PLAN REPORT

CONTENTS

Category 1

Comments, Replies by Consultants and Action Taken in final Report on Draft Final Report of regional Plan of South East Regional Water Resources Development Programme BGD/86/037 (FAP-5), April, 1992

BWDB COMMENTS

Comment	Replies by the Consultants	Action Taken in Final Report
Chief Engineer, Design II, BWDB, Dhaka: **C. 5.2 Planning Unit 2 - South Sudharam.** In the proposed 'Project Options' for flood control and drainage it has been stated that "Noakhali Khal would be blocked by an embankment near Gangchil and a regulator. This option will effectively drain polder 59/3A and 59/3B. For Polder 59/3C no solution is suggested for the plan period since the area is too low to drain by gravity "(P5-12). It is quite important to take appropriate measures such as coastal afforestation to enhance rate of accretion and raising of land in polder 59/3C. The final report should throw some light on this matter so that during the plan period the polder can see some of improvement.	The polder 59.3C will require a substantial period to mature and stabilize before investments in water resources development are likely to prove cost effective. There is already an afforestation programme in the area and this will continue but is not considered as a part of the plan.	Since polder 59/3C is now understood to be scheduled for full closure from the sea under the Coastal embankment Rehabilitation Project (included afforestation) drainage benefits have now been included in the final report analysis (Chapter 5 of Part 2).

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Comment	Replies by the Consultants	Action Taken in Final Report
5.3 Planning Unit 3 - Noakhali North The report states". It is assumed that the water admitted by Rahmatkhali Regulator will not be too saline for irrigation purpose at some time in the future, because the national allocation of surface water ______ Meghna River, and it is assumed that the allocation will be enforced (Subject to any appropriate redistribution of resources)". (Para 2. P 5-12). It is a very vital assumption upon which evaluation of this Planning Unit has been made. The consultants have not examined this matter to indicate whether the present salinity level is tolerable to be used as irrigation water. And if it is not on the safe side what appropriate step should be initiated to achieve it has also not been referred. In this regard the report is deficient and efforts may be made to overcome it in the final version.	Salinity in the Lower Meghna at Rahmatkhali Regulator Three independent sets of data have been used to check the suitability of water for irrigation at Rahmatkhali Regulator. The limiting value of salinity acceptable for water to be used for irrigation has been taken as 2000 μ S/cm: (a) Data collected by the Land Reclamation Project downstream of the Regulator in 1987. Readings were taken of high and low tide on a weekly basis. Salinity rose from 200 to 300 μ S/cm in April to a peak of 1000 μ S/cm in June. (b) Data collected by the Surface Water Modelling Centre (SWMC) in Rahmatkhali Khal both upstream and downstream of the regulator in 1991 and 1992. Readings were taken at hourly intervals between 0700 and 2100 hours for one day a week from March to May. In 1991, salinities remained in the range 500 to 1000 μ S/cm from March to mid-May, and peaking at 1800 μ S/cm in the second half of May (well past the normal time for boro irrigation). In 1992, despite the low main river flows, the maximum salinity recorded by the middle of April (limit of data so far received) was 283 μ S/cm (apart from one day of anomalously high readings in early May, which were regarded as spurious following discussion with SWMC staff). (c) Data recorded at the BWDB salinity station at Ilshaghat at the northern tip of Bhola Island, about 5 km south of Rahmatkhali Regulator, but on the opposite side of the main Lower Meghna channel) for the years 1966 to 1989 (with some gaps). This data was used in the National Water Plan Phase I and Phase II salinity studies. The data is based upon instantaneous monthly peak recordings. Annual peaks are generally observed in March and April (rather than May and June at Rahmatkhali Regulator). The magnitude of the 1987 peak value (1430 μ S/cm) is a little higher than that observed at Rahmatkhali Regulator in the same year (1000 μ/S/cm (a), but still not critical for irrigation use. The data series does however exhibit a long term decline in salinities at Ilshaghat, from a peak of 5000 μ/S/cm in April 1979 to 1200 μ S/cm in 1989. The last time the 2000 μ S/cm threshold was exceed was in March 1985 (2100 μ S/cm).	The data referred to in the previous column has been discussed in some detail in the Draft Feasibility Study of the Noakhali North Drainage and Irrigation Project, and is summarised in Chapter 6 of Part 2 of the Final Regional Plan Report.

Comment	Replies by the Consultants	Action Taken in Final Report
5.7 Planning Unit 7 - Meghna - Dhonagoda Irrigation Project. In this planning unit, three options were considered out of which either option 'a' i.e. retirement of about 1.5 km. embankment behind Eklaspur or option 'b' i.e. retirement of about 3 km of embankment behind Eklaspur should be combined with option 'c' wherein construction of about 1.5 km. of retired embankment behind Amirabad. (P 5-82). It has been mentioned in the report that the inhabitants reported about "reduction in soil fertility ard contamination of the water so that bathers often suffer from skin irritations (P 5-86). "In fact reduction in soil fertility has reportedly been a problem in some of the empoldered irrigation projects for some quite long period. The consultants have reported it here in a casual manner & have not investigated any reason behind it. Besides, this is probably the first irrigation scheme where the inhabitants reported about skin irritations. There is a diarrhoeal research centre at Matlab quite close to the scheme. Local peoples were known to have been suspicious about a link of out-break of diarrhoeal diseases in this area in recent years with this research centre. The consultant could have investigated this matter as this is one of most serious issue associated with the future development and success of the scheme. In this regard the report is deficient.	The report accurately describes the situation as reported by FAP 12 and suggests both a temporary partial solution (flushing) and indicates that a research programme is required. This is not a task for the regional plan study.	No action.

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Comment	Replies by the Consultants	Action Taken in Final Report
5.8 Planning Unit 8 - Dhonagoda.		
For this planning Unit in the interim Report four options were evaluated and none seemed economically viable and even some were unrealistic (e.g. proposal of closure of Dhonagoda river). This time option 5 (to raise irrigation water from the Meghna River at Daudkandi Pump Station) has been proposed which indicated an EIRR of 2.85% (P 5-95).	The method used for calculating cropping intensity which uses averages for the entire planning unit tends to mask the changes which occur on the areas which are developed within the unit, for example an increase in C.I. of 30% on a quarter of the unit will only increase the C.I. of the whole unit by 7.5%. The figures as quoted are correct.	The FCD proposals have been re-analysed in the Final Report using revised assumptions, and a new irrigation intervention based upon khal excavation investigated (Chapter 7 of Part 2). The Regional Plan now includes proposals for this planning unit.
From the report it is evident that the cropping intensity has been projected to 161% with project (30 years) and 154% without project (30 years) respectively in the future (Table 5.8.4). It has been stated in the report that "In establishing the standard cropping patterns the "average" has been taken of the MPO cropping pattern for MPO Planning Areas 32 and 33, since the Dhonagoda planning unit straddles the boundary (P-5, 95). This led the consultants to conclude this Planning Unit "Unsuitable for inclusion in the Regional Plan" It is evident that the consultants did not make any effort to collect field data and solely depended on the MPO data. How can it be guaranteed that the MPO data were fully genuine and cent percent correct? From table 5.8.1 (P5-94), it is seen that total irrigated area with project are 52323 (ha) and without project are 27707 (ha) respectively in the future. This two statements do not appear to be consistent. This leaves a room for further investigation in detail before this Planning Unit is dropped out of the Regional Plan once for all. The final report should take care of this issue in detail.	The consultants agree that MPO data cannot be guaranteed but is the best data available for use at this level of planning. Collection of field data was only anticipated at feasibility level. The resources available to the study precluded collection of primary data. The unit is not "dropped" from the regional plan but FCD proposals appear unattractive economically.	
5.9 Planning Unit 9 - Sonaichari (P 5-100)		
The consultants do not appear to have studied this project in detail. However, they mentioned the scheme is "very well run" by the KTCCA. It pointed out that " there is a problem of flash flooding and drainage congestion, the obvious solution to this is excavation of the Dakatia river which is the main drainage route" (P 5-100). The report has not indicated the extent of drainage congestion nor highlighted any adverse impact on the overall performance of the Project and the environment. It made no effort to make any economic analysis of the probable engineering solution to overcome the existing problems. From this view point the report is deficient and incomplete.	The consultants agree that coverage of this unit in the report is thin. This will be revised in the final version. However the problems of drainage congestion can only be solved as part of an overall programme for the Dakatia/Little Feni units otherwise the problem will merely be diverted from one area to another. This will be clarified in the final report.	Chapter 7 of Part 2 of the Final Report now includes detailed analysis of the drainage problem. Recommendations for future studies are included.

Comment	Replies by the Consultants	Action Taken in Final Report
5.10 Planning Unit 10 - Gumti Phase-I This Planning Unit is mentioned to be nearing completion for flood control and drainage. Accumulation of "internal drainage water" has been pointed out to be a flood hazard" Embankment of the Gumti River without the provision of surface water for irrigation may have had a net negative impact in some areas" it continued. (P 5-101). It is known that this particular Planning Unit is at the final stage of completion. The consultants should have investigated these adverse effects in detail and indicated remedial measures, if any, in this report so as to allow yielding of benefits immediately after completion of the project. The final report should take care of this particular issue.	The report clearly indicates that the Gumti Phase I scheme has reduced the flood hazard and that the only remaining flood hazard is due to accumulated rainfall but this is a much reduced hazard than that existing before the project. The previous studies of Gumti I and Gumti II have studied various methods of supplying pumped irrigation supplies to the Gumti I project area and the consultants for SERS have examined yet another method. However none of these attempts have yielded an economically viable scheme.	The section on this planning unit has been revised (Chapter 9 of Part 2) to include a discussion of irrigation using Meghna backflow into the Gumti via Siddeswari Regulator and by LLPs drawing direct from the Gumti River over the embankment. The full potential cannot be identified until the ongoing changes in the Gumti Phase II profile discussed in the recent Gumti Phase II revised feasibility study have stabilised.
Director of Planning (General) BWDB, Dhaka: **09. Vol.II, Page 5-12, Section 5.2.4 Planning Unit-2 South Sudharam** No solution has been suggested to drain polder 59/3C during the plan period since the area is too low to drain by gravity. the final report should throw some light on drainage of polder 59/3C by other than conventional method (like raising of land by afforestation).	See reply to comment Nr. 5.2 above	See reply to comment on Page 1-1.
10. Vol.II, Page 5-24, Section 5.3.4 Planning Unit-3 Noakhali North The assumption of non salinity or salinity on tolerable limit in the water admitted by Rahmatkhali Regulator is a very vital assumption upon which evaluation of the planning unit has been made. Before this assumption, the present salinity level should have been examined. Necessary data may be collected and incorporated in the final report.	See reply to comment Nr.5.3 above	This is reported in detail in the Noakhali North feasibility study and summarised in Chapter 6 of Part 2.

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Comment	Replies by the Consultants	Action Taken in Final Report
Office of the Environment, House Nr 2, Road Nr 16 (new), Dhanmondi R/A, Dhaka.		
1. The Draft Regional Plan report being commented upon comprises a total of five volumes and an Album of Drawing. But unfortunately the entire report contains hardly anything that could be considered good for Environmentally Sound and Sustainable Development (ESSD).	The consultants cannot agree with this comment. Almost all interventions proposed have been conceived in a way which minimises negative environmental effec s.	Environmental issues have now been given greater prominence in the Main Report (Parts 1 and 2)
2. The environmental impacts of and FCD(I) projects start from changes brought about by the project in the Hydrodynamics and Morphology of the streams and water bodies. And these can be simulated and modelled. The report does not make any attempt to predict and quantify the changes in surface end ground water levels, erosion patterns, siltation etc. And without quantified prediction of such changes the question of Impact Assessment remains completely unanswered.	Again this is incorrect. There are extensive references to modelling in an attempt to predict changes in surface and groundwater levels and two maps in the Album show detailed predictions of changes for the Noakhali North project. There are also references to erosion patterns and river morphology. The comment is not accurate	
3. It is obvious that there was no field data collection for the study and the report is entirely based on whatever secondary data was available. Thus there is no data on the species of flora, fauna, fish or birds existing as now in the study-area. All that is mentioned area number of species in the country and it appears that the entire country has uniform distribution of all species. Without giving prevalence of particular species at specific location in the study area realistic assessment of impacts on ecology could not be made. The name of species currently existing but apprehended to the endangered and their specific habitats have not also been listed.		
4. No figures are given for the areas of different types of habitats and the predicted changes in these if any. Nor are there any quantified prediction of changes in land-use, crop patterns, yields of crops, yield of fisheries, occupational patterns etc. 5. The issue of Environment has not been dealt with properly in the report. This may please be done.	3, 4 & 5 Again these comments are incorrect. Although it is true that primary data collection was not undertaken (as proposed) there is much data in Annex IV. It is suggested that the commentator reads Annex IV and its appendixes A to H where references to habitats, species of flora, fauna, fish and birds are given.	For regional studies IEE is required, not EIA, and this is what has been provided in the report.

<table>
<tr><th>Comment</th><th>Replies by the Consultants</th><th>Action Taken in Final Report</th></tr>
<tr><td>Team Leader, H.D. Wiebe, North East Regional Study.

In general the following statement from Volume II Part II pp 6-1 of the regional plan should be of some concern:

"The ranking system adopted is dominated principally by the economic criteria and is then checked against the qualitative criteria."

The general philosophy and planning approach of the document follows this line of logic. This approach to planning was common during the past several decades - both nationally and internationally. In fact it was used in preparing the IECO Master Plan. The International Community has moved from this approach because of its various short comings - not the least of which is that it provided misleading conclusions in directing investments in sustainable fashion.

For reference to FPCO's own position, the following is excerpted from the FPCO Guidelines for Project Assessment, pp 61:

"The assessment of water resources management strategies and potential FAP projects can not be based solely on financial and economic analysis of benefits and costs. A number of other impacts that can only be quantified in physical terms or described quantitatively should also be taken account in the decision making process".

Donors and GOB would seem to be in agreement that much of the investment resulting from the previous analytical approach has been sub-optimal. Hence the need for better and more focused studies. The Flood Action Plan Components were designed in Such a way that more than lip service would be paid to social and environment parameters. If the South-east Regional Plan continues on its present course dominated by economics but fundamentally ignoring social and environmental parameters, it could well be expected that the international community will be cautious about buying into this plan. In this regard, the plan does not serve GOB well.</td><td>The commentator has misunderstood both the purpose of the quoted statement and its relation to the overall philosophy of the planning approach.

The statement is meant to indicate that unless a project meets some minimum economic criteria it will not attract donor interest in which case there is no point in further examining environmental criteria.

In addition it has been mentioned in many parts of the report that social and environmental needs and conditions have been carefully examined at the project formulation stage and suggestion made as to how negative effects can be minimised and / or mitigated.

It may be noted that project interventions proposed have a minimum of new embankments, control structures etc which is a direct result of the team's concern to reduce negative effects whilst providing worthwhile benefits. On the other hand many of the projects which fail to meet the economic criteria do so because of the measurable negative economic effects of identified impacts (eg fisheries) taken into account.

Thus the allegation that the SER fundamentally ignores social and environmental issues is unfounded.

The consultants have pointed out in the report (volume II part 2 section 2.2.3 page 2-5/2-6 and also in Chapter 7) that the TOR for the SER and the resources available in terms of manpower, money and time are not commensurate with the evolving requirement and guidelines now being demanded by FPCO and donors. The incompatibility between expectations and resources differs from one regional study to another but the SER is probably the least well resourced in this respect and was largely completed before the guidelines were issued. Even now, as the consultants have indicated the revised resources which might be made available for the forthcoming feasibility studies are still insufficient to fulfil all the requirements of the guidelines.</td><td>The final report has many revisions which identify the multi criteria assessment for the various planned developments.</td></tr>
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Comment	Replies by the Consultants	Action Taken in Final Report
Superintending Engineer, Muhuri O&M Circle, BWDB, Mohipal, Feni.		
Comments related to the major aspects associated with the study area under this Circle are given below: **1. Study Area:** The consideration behind the exclusion of major part of Parashuram, Sonagazi, Feni and Chhagalnaiya Upazilla, presently not under Muhuri Irrigation Project, is not clear. These areas are closely associated with the operation of the Muhuri and the Little Feni River System. Flash flood is common phenomenon in these excluded areas and should not be under estimated in planning of projects in the adjoining areas. The study area in the east should extend upto Indian Border with specified limited provision for MIP area. Presently the local people of Parashuram area are demanding for construction of a Regulator across the Muhuri River just in the upstream of MIP along with the construction of flood embankment along the Muhuri and the Kahua banks. If kept outside the study area, these problems or any project formulated out of these problems may interfere with the formulation of Projects in the present study area.	Please see page 1-9 of the Inception report where the scope of the study is clarified and revised. However the Muhuri augmentation study does include the additional area which could be taken up above the project boundaries.	No action required.
2. Augmentation of MIP In the original TOR, augmentation of Muhuri Irrigation Project (Meghna-Muhuri Water Transfer Concept) Was rightly included; but subsequently, it is understood the scope in this regard has either been eliminated or reduced. MIP is a completed project and, fortunately, it has been highly acclaimed by the local people. It is undisputed locally that the full cost of implementation of the project has already been realised in the form of additional crops due to the project within the first 3 to 4 years of operation. The project and the project officials are being highly esteemed by the local people.	See reply to comment 1 above. The Irrigation Project Augmentation Study remained within the revised TOR and has been carried out in full (see Annex XII Chapter 5.4). The results of this study showing the augmentation requirements were then assessed as part of the Muhuri Transfer Scheme (Part II, Chapter 5 section 5.14). The limitations of water transfer referred to in sections 5.4 and 5.5 also apply since they are a function of the conditions at the mouth of the Dakatia river.	Muhuri augmentation possibilities are now discussed in Chapter 7 of Part 2.

Comment	Replies by the Consultants	Action Taken in Final Report
This project has got some problems, inherited from the planning stage. Apart from flash floods, the adequacy of water supply for irrigation within the MIP and its adjoining areas has not yet been established. Due to absence of any control in drawing water beyond MIP from the inter connected canals, the project area appreciably extended. This tendency is increasing day by day and may pose to be a serious problem affecting the present image of the project. In the Regional Plan Report, the Augmentation of MIP and Meghna-Muhuri Water Transfer Concept have been insignificantly discussed. Any Water Resources Development Plan conceived independently without considering the aspects of Water Transfer Project may ultimately interfere with the Meghna-Muhuri Water Transfer Concept and make it partially redundant and complicated. So, the potentiality of Meghna-Muhuri Water Transfer Project should be clearly evaluated and co-ordinated before formulating any project in the adjoining basin.		
3. Package Study The areas under Planning Unit, 2, 3, 4 and 5 are inter connected. In planning isolately, these aspects should be given due care to. As for example, is absence of Development of Planning Unit 4, if Planning Unit 3 is developed, the affect of flash flood and drainage congestion in the Little Feni River basin may get an way towards developed area of Planning Unit 3. Local people also may interfere to accelerate the situation in the shape local initiative schemes.	This aspect has been studied. The model results show that effects in the extreme east and north of the planning units are limited. Also the sediment data indicate that local action in the upper catchments will not adversely affect sediment condition downstream. Only extensive embankments could have such an effect and this has not been recommended partly because of such possible effects. The problem of upstream sediment deposition has been recommended for study when and if a Dakatia/Little Feni scheme is taken forward to feasibility study stage.	The discussion of the proposed Dakatia/Little Feni transfer scheme has now been brought into a single chapter (Chapter 7 of Part 2). The planning units 4, 5 and 9 are now considered as part of the same system.
The aspects of (i) Cross Dam across Noakhali Khal and (ii) Regulator at Chitakhali should be studied in detail. Construction of a Cross Dam across Noakhali Khal at the out-fall may eliminate necessity of internal dyke and structure around the internal polders and also may create a situation for transfer & reserve of irrigation water in the Noakhali Khal System.	The figure 5.2.1 is incorrect and shows the cross dam in the wrong location. The proposed drainage plan is not shown. This will be revised in the final report	Corrected.

Comment	Replies by the Consultants	Action Taken in Final Report
WRPO COMMENTS:		
1. Water Resource Planning Organisation (WRPO), Ministry of Irrigation WD and FC: **Comments on Fisheries** South-east Regional Water Resources Development Programme (FAP 5) BGD/86/037, Draft Regional Plan Report, April 1992, Annexes Volume IV-Annex Fisheries is a good representation of its kind. The report contains description on Fisheries in its existing form with suggestion for improvement. But details Plan and Programme for future development are wanting. The report should have specified how and to what extent the plan and programme could help increase fish production and ensure fish population and fish habitat in the project areas. Strategy on fish culture should have been incorporated into the report showing the loss of fish production and the compensatory measures thereon. The report should also have packages of development for integration of Fish farming with Agriculture and Poultry and for biological management of fisheries to make the approach more realistic and worthy.	The consultants agree that the report lacks detail on the development of new fisheries initiatives. However given the resources available to the study team and the status of the other related FAP studies it is considered that they have done as much could have been expected. The incorporation of specific development packages based on the recommendations in part 2 section 5.18 should be elaborated at the feasibility study stage.	The Main Report (Chapter 10 of Part 2) now includes a fisheries mitigation programme. However, we consider that this matter needs to be elaborated on a project by project basis at the feasibility and detailed design stages, not in a regional plan.
2. Volume I, Page 1-2, Para 1, Item C & D Methodology for involving beneficiaries is hardly possible to ascertain. The study area is densely populated and have enough landless men as such employment opportunities should be identified for them instead of conservative women.	See Chapter 16 of part 1 Opportunities have been identified for both men and women.	This matter is now discussed in Chapter 10 of Part 1 and Chapter 10 of Part 2, and detailed proposals were developed for the feasibility studies for Noakhali North and Gumti Phase II.

Comment	Replies by the Consultants	Action Taken in Final Report
Flood Plan Coordination Organisation (FPCO): **1. Preliminary Comments by Prof. Van Ellen Panel of Expert of FPCO.**		
<u>General</u> The report appears to be well prepared. It presents a balanced approach to the development potentials and constraints of the region. As such it offers a sound basis for project identification. The following comments are designed to improve the report in some respects and to enhance its affectiveness as an instrument in sound planning and implementation.		
Category I **Volume I Part 1 - Existing Situation** 1.1. While chapter 6 may give a good description about present agriculture, it does not identify constraints related to water resources development towards which efforts to enhance output should be directed primarily. Not all the information given is equally relevant; the importance of production per capita (section 6.6) is not clear; furthermore, there is no relation between consumption per capita and potential for production increase.	This chapter describes the existing situation. The Annex II relates flood phasing to cropping patterns as do chapter 3 of part 2. We agree that not all data is of equal importance. There is a relation between local production per capita and the need for production increase.	The chapter on existing agriculture (Chapter 6 of Part 1) and the associated annex (Annex II) have been substantially revised.
1.2 In various places in the report, reference is made to the flooding situation and related aspects, for instance figure 8.2 shows the estimated flow directions. However these directions, and various other aspects, will vary through the flood season. In some of the planning units it is necessary to make a distinction between pre-mid, and post monsoon conditions. In Annex XII it is argued that this would require too much effort at this stage, but for a balanced approach it cannot be avoided for all units. The consultants may have another look, especially for those units where early floods and late drainage are important constraints.	The consultants have identified in chapters 5 to 9 of part 2 where each stage of flooding is important. We reiterate that the resources available to the regional plan are not sufficient to allow this level of detail. This has been proposed for feasibility study analysis.	No action except in feasibility study areas and lower Little Feni.
1.3. In the description of the fluvial system, the consultants should add a section about salinity in the rivers, especially on the seasonal variation of the intrusion in the Lower Meghna.	Agreed. This was done for the Noakhali North feasibility study.	Chapter 2 as revised meets this comment. Also see Noakhali North feasibility study.

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Comment	Replies by the Consultants	Action Taken in Final Report
1.4. Chapter 10. The information about flood conditions in the region is very meagre, certainly considering that flood control is the main dimension of FAP! It would be appreciated if a more comprehensive description could be given about the flooding phenomena, distinguishing for the various causes of floods, the seasonality and the different areas in the region. It will certainly be possible to present more relevant figures than 10.6 and 10.7. Section 10.3 is also too general to be of any value; it should be made more area-specific.	Flood conditions are also described in Chapters 2 and 5 of Part 2 and in Annex XII. In these sections it is also more area specific.	Annex VI (Hydrology) is comprehensive.
In a study like this a balanced description of advantages and disadvantages of embankments should be given; one would expect rather more emphasis of the positive sides than on the negative! The description clearly gives the impression that the author favours submersible embankments over full embankment.	Other readers have not gained this impression and it does not read that way to us. The proposed developments do not "favour" submersible embankments.	No submersible embankments have been recommended.
1.5. Chapter 11 Also this chapter is too meagre; see remarks for chapter 10. Section 11.2, para 1: It should be explained what the adopted drainage modulus of 4 l/s/ha is based on and why it has been adopted.	Again the subject is further discussed in Chapter 2 and 5 of Part 2. It is not an "adopted" drainage modulus merely an indication that the SER would require a modulus at or above the high end of the currently adopted design criteria in Bangladesh, which are based on drainable surplus over 5 or 10 day periods.	No action.
Section 11.4 last sentence. It is unlikely that especially big tides (what are these?) and tidal bore events have led to siltation problems.	This sentence should be attached to the previous paragraph. This deposition which occurs at high tides is a part of the general accretion in this area.	The paragraph has been amended.

Comment	Replies by the Consultants	Action Taken in Final Report
Volume II Part 2 - The Regional Plan **1.6. P. 5-93, section 5.8.4, para 2** The explanation why some of the options have not been pursued further is not entirely satisfactory. Full data should have been presented in any case. Also the statement that Options 1 and 2 have unacceptable adverse impacts on navigation, deeply flooded wetlands and possibly river morphology is not acceptable. The (non-) acceptability of such impacts is not to be decided by the consultants. Moreover, the stated negative impacts could possibly be overcome, by navigation locks (which the consultants propose in other instances without any justification) and low embankment surrounding valuable wetlands. There are some very good reasons some options for Unit 8 could be very attractive: - It satisfies one of the main objectives of FAP: providing protection against floods from the main river by means of embankments; - closing the Dhonagoda shortens the embankment of MDIP and thus enhances the safety of the polder, reducing at the same time the costs of maintenance; - closing the Dhonagoda creates a reservoir that is most valuable for MDIP and Unit 8; while an additional pumping station may have to operate for some period of intensive rainfall in the wet season a regulator could operate during low tide and could thus make a substantial contribution to the total discharge capacity; in the dry season again the pumping station may have to operate continuously in time of peak water requirements and the regulator could let in water during high tide, reducing the costs of secondary pumping. It is strongly recommended that the consultants study such options more thoroughly than apparently done at present.	It is accepted that Options 1, 2, 3 and 4 should have been presented in full, and this omission will be amended in the final version of the Regional Plan. It is reiterated however that these options all showed negative rates of return on the basis of the standard methodology, and were excluded primarily for this reason rather than any perceived unacceptability on the grounds of impacts upon navigation, wetlands or river morphology. Options 3 and 4 in fact did minimise these impacts by avoiding closure of the Dhonagoda River and excluding part of the important wetland areas from flood control. The specific observations on the possible attractiveness of options for Unit 8 are discussed in order as follows: - the provision of embankments to exclude main river floods was tested under Options 1, 2, 3, and 4 using the SERM, and the changes in flood phases within the planning unit were found to be very small hence the low rates of return. It appears that internal runoff would cause flooding to a depth comparable with that caused by the Meghna, and that main river embankments in themselves do not provide a satisfactory solution in this location. - it is agreed that there are several additional benefits to closing the Dhonagoda River, including enhancing the security and reducing the maintenance costs of MDIP. These were discussed in the Interim Report, and will now appear in the final Report. The benefits were not evaluated quantitatively, but they would almost certainly be insufficient to justify an otherwise unattractive intervention. - it was not anticipated that the Dhonagoda River closures would encompass the MDIP pump stations, since this could then result in a need for the double pumping of both irrigation and drainage water. The reservoir referred to would not thus benefit MDIP, but it is agreed that it could provide a useful "sump" for the Dhonagoda Planning Unit. The tidal range at Matlab (at the southern end of the Dhonagoda River) corresponding to the flood peak is generally between 0.2 and 0.3m, whilst at Daudkandi (at the northern end) the range is about 0.1m. The mean March tidal ranges are about 0.9m and 0.5m respectively. The tidal benefit to drainage is therefore insignificant, but it is agreed that there may be some theoretical saving available in irrigation pumping cost.	The options for planning unit 8 have been re-evaluated in Chapter 7 of Part 2 of the final report. A specific allowance has been made for the saving on maintenance of the MDIP embankment in the case of Option 1 (closure of the Dhonagoda River) but this option remains less attractive than using the new Gouripur-Matlab road embankment.

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Comment	Replies by the Consultants	Action Taken in Final Report
1.7. Page 5-180, section 5-16		
It must be emphasized, that while in some deeply flooded areas, flood proofing may be the only option under present conditions, in other areas, however, it may be an additional measure, since the risk of flooding through direct rainfall may always exist. The consultants should indicate where such additional measures may be necessary.	This is accepted. Flood proofing should be an integral part of all proposals at feasibility level and the consultants have indicated this in their recent proposals for Gumti II area. People outside embankments need protection as well as those inside.	No action other than as described in the feasibility studies.
1.8. Page 5-185, Polder 59/2		
FPCO should look into this matter and remove any unclarity or contradiction.	No reply necessary	No action required.
1.9. Chapter 6		
The conclusions and recommendations of this chapter are fully supported with 2 observations:		
- a more in-depth study of some options for Unit 8 should be done, as experienced before. - before a full feasibility study for Unit 3 is done, the consultants should make a special study of present and expected salinity conditions along the Lower Meghna, avoiding studies for a project that may not be possible after all.	See reply to comment Nr 1.6 above. Existing data suggest acceptable salinity conditions in the critical months (see reply to BWDB comment 5.3 on page B-3). FAP 5B (Estuary study) will be covering this. FAP 5 cannot forecast the results of unknown conditions and does not have the resources available to FAP 5B. The existing data will be properly referenced to the final report.	See 1.6 and 5.3 (BWDB) above.
1.10. Page 6-7, section 6.5.2:		
It will be necessary to decide which agency will be made responsible for which activities. It could prove to be efficient to let BWDB be responsible for all major works, particularly for external embankments and associated structures, and LGEB for all minor internal works. The observation of the consultants regarding the required implementation capacity is appreciated. However, the outcome of the Institutional Study FAP 26 should be awaited before any action is taken. For all projects under FAP the solution may have to be to make maximum use of private consultants, maintaining only a minimum staff of government (BWDB, LGEB) staff to supervise and coordinate.	Agreed	None required.

Comment	Replies by the Consultants	Action Taken in Final Report
2. Comments from Mr. Dempster Panel of Expert of FPCO (Volume II)	-	
A. Preliminary General Observations - prior to completing reading the report.	-	
B. WvE's general comments on the standard of the report are endorsed. The following principles of FAP planning could be added.	-	
C. Public Participation. The importance of proper consultations and effective public participation should have a greater emphasis than given in the repot.	The consultants consider that their proposals for participation at the feasibility study stage are reasonable in view of the resources available.	More prominence has now been given in Chapter 10 of Part 1 and Chapter 10 of Part 2.
D. Fisheries. The importance of fisheries in any water development/management plan is recognized. However it now time that fisheries are considered along with agriculture as a main output component and not just as an impact effect. The sooner FAP 17 can come up with some ideas on integrating fishery development with FCD, the better.	The consultants agree.	See WRPO comment Nr 1 on Fisheries.
E. Phased Development. The Consultant has mentioned staged implementation and incremental benefits but without considering the multi-sectoral aspects of protected (drained) area development. Planning the development of a relatively large area with diverse conditions (extreme in the case of FAP 3.1) is pointing towards a multipurpose approach, which would include flood proofing fisheries, navigation, increasing urban activities etc and address public participation and institutional issues. The breakdown of a major project into sub-projects which preferably would be viable in their own right could result in more assured benefits and certainly more public confidence (FAP 12 finding that smaller projects are more effective).	It is not reasonable to expect that all projects for the FAP can be broken down into small isolated components with each phase viable but the consultants have indicated in their proposal for the feasibility study (Chapter 7, Part 2) that this is a preferred objective. The feasibility proposals for both Gumti and Noakhali North anticipate a multi sectoral approach within the limited resources allowed.	Several smaller independent interventions have now been included in the Regional Plan eg khal deepening in the Dhonagoda planning unit and the Gumti Phase II revised feasibility study proposals.
Category I **1.1 Page 2-1/3, section 2.1, General** No mention is made of fisheries until the end of the section, where it is treated as an impact. FAP planning studies should include fisheries as a real water development component along with agriculture.	This is a reflection of the TOR, proposal and contract and also please see comment D on the previous page.	See WRPO comment Nr 1 on Fisheries.
Also an introduction to a chapter on development issues should certainly include the social and environmental factors.	It does so (see penultimate paragraph of the section).	Revised in final report.

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Comment	Replies by the Consultants	Action Taken in Final Report
1.2 Page 3-37, last para, Also P 5-186/7, Section 5.18		
It is a pity that the delay in starting FAP 17 data collection, study and pilot project programmes should have such a significant effect on some results of the regional plan. Provision should be made for the reformulation of projects and reappraisal of priorities when potential benefits of improved capture and "common-good" fisheries have been understood, worked-up and evaluated.	This is agreed but who should do it, when and with what resources?	None required. The evaluation of fisheries impacts has however been improved (Chapter 3 of Part 2).
1.3 Page 5-30/31, section 5.3.5, 1st and last bullets		
It is not logical to knowingly under or overestimate benefits (in this case (W) & (WO) respectively). In all cases best estimates should be made, whether costs, benefits, (W) or (WO). Possible variations are covered by sensitivity analyses. Clearly this will be rectified in the feasibility study. However care should be taken to avoid any inconsistencies in the ranking exercise.	The consultants have attempted to improve the analysis to account for the last bullet by changing the methodology but at this stage of analysis it is only possible to identify the benefits of reduced flood duration but not to quantify it. See also reply WvE comment no 2.24 on page F-7.	The evaluation methodology has been significantly revised, particularly in the case of the Noakhali North Feasibility Study, which now addresses the two points raised.
1.4 Page 5-31, 2nd bullet		
The whole fisheries aspect of water development should be examined during the feasibility study. Possibilities for fisheries indicated in section 2.3.6 should be discussed with FAP 17 and examined in the feasibility study.	Discussions with FAP 17 have already started and it is already clear that previous perceptions may need to be changed which reinforces our belief that it is better to want for recommendations based on the results of FAP 17 studies.	See Feasibility Study Report and Chapter 6 of Part 2.
1.5 Page 5-31, additional bullet?		
The Consultant has mentioned staged implementation (section 5.3.6) and expected incremental benefits. This should be examined very carefully during the prefeasibility study taking account on the relevance of phased sub-projects which would cover irrigation, flood proofing (where applicable), fisheries, navigation, water management (special form of compartmentalisation?) as well as the conventional FCD/I components listed in section 5.3.6. An added advantage of step by step implementation which should be included is the build up of public confidence through proper consultation/participation.	This is agreed and sections 5.3.5 and 5.3.6 taken together with the proposals in Chapter 7 indicate the intentions for the feasibility study.	See Feasibility Study Report and Chapter 6 of Part 2.

Comment	Replies by the Consultants	Action Taken in Final Report
1.6 Page 5-180, last para - supplementary to WvE		
Provision should be made for emergency measures (usually non structural) in the protected areas when design conditions are exceeded. Thus failure of embankments may occur, the drainage system may not cope with excessive rainfall etc.	Disagreed. The economics of providing flood proofing against such rare occurrences are non-viable. Non-structural measures should be covered by a national programme (Min of Relief etc.), and are of limited relevance within this Region).	This section has been revised (see Chapter 10 of Part 2).
There could be a fallacy in giving priority to flood proofing F3 and F4 land. People in these areas are accustomed to flooding and are probably more advanced than those in relatively safer areas in proofing themselves against flooding.	This is possibly so but areas where flooding is minor generally already line with the situation and are prepared for it.	

Comment	Replies by the Consultants	Action Taken in Final Report
3. Comments from Dr. S. Brammer Panel of Expert of FPCO		
I have read parts 1 and 2 para Annexes 1 and in general. I like the analysis and presentation. and have very few major comments. My comments below refer to the Agriculture sections.		
The agricultural analysis used in plan assessment appears sound. It was sensible of the consultants to use the MPO cropping (part 2. pages 3.32-33).		
In view of the sensitivity of economic returns to cropping patterns and yields. it will be essential for follow-up studies. including feasibility studies. to obtain more reliable and up-to-date crop data than were used in the pre-feasibility studies. I recommend that consultants make (or commission) their own field studies of actual cropping patterns and yields in developed FCD/I developments on the Middle Meghna Similar sample studies could be made across FO-F3 land types in established DTW/STW/LLP schemes to verify farmers' crop choices. input use and yields. as well as flood damage experience in different parts of the region.	It is hoped that the sample areas proposed for study will provide this data together will the result of the agro-socio-economic surveys.	See Noakhali North Feasibility Study and Chapter 6 of Part 2.
In part 1 of the report. the sections dealing with crop diversification and mechanisation are unrealistic and rather academic. and the section on agricultural marketing seems disproportionately long; (fortunately. these sections seem not to have influenced the project analyses in part 2). The potential for crop diversification needs to be related to actual physical and socio-economic conditions in the region; a large-scale change to betel nuts and coconuts seems unrealistic. and the SE region climate is better suited to paddy cultivation than for most dryland crops (including the maize and yams proposed). Also. for crop diversification to succeed. farmers will need to obtain higher returns than they can for rice. and that will depend on their being a market demand for the alternative crops. The UNDP Agriculture Sector Review 1989 has relevant findings in this respect.	Mechanised tillers area a major component of the proposed NMIDP so these seem to fit quite well. We agree that large scale changes are unlikely and that paddy rice will continue to dominate wet season cropping. However dry season irrigated drops may have more potential for diversification and our analysis suggests that there may be potential for such diversification.	The chapter on existing agriculture (Chapter 6 of Part 1) and the associated annex (Annex II) have been substantially revised.

Comment	Replies by the Consultants	Action Taken in Final Report
Comments from Mr. Edward Clay of Overseas Development Institute, London (Revised Eco. Analyses):		
With reference to your express letter of 29 June which was received on 1 July 1992 requesting me to review the revised estimates of WITH PROJECT benefits prepared by FAP 5 Consultants. These new estimates have been compared with the original estimates in the Regional Plan Report Volume II, Regional Plan, and Volume V Annex VII Project Evaluation - Additional Economic Analysis Tables.		Further revisions have been made to the evaluation methodology, which is explained in Chapter 3 of Part 2.
<u>General Comments:</u>		
1. The basis for the revised calculations is not always clear, and this is something which the PoE may wish to discuss with the consultants. In particular, they should explain the agricultural production assumptions and estimates that lie behind the "improved irrigation benefits" that are referred to in the explanatory statement that accompanies the revised calculations for each Planning Unit.		
2. The consultants are concerned that the widely used estimates of yields underestimate rice yields by around 0.5 tonnes per ha. At this level of appraisal that concern is misplaced when there are many other simplifying assumptions recommended by the Guidelines for use in pre-feasibility studies that probably lead to an optimistic estimate of the EIRR. For example, as discussed below, the period for full development of benefits of only five years after project completion is in some cases too brief, construction cost estimates are probably conservative etc.		
3. Full-development of irrigation benefits: the projected ratio of irrigated area to Net Cultivated Area (NCA) is very high for some PUs: PU1 - 69% PU2 - 71%, PU8 - 64% PU11 South East Polder 70% PU12 - 80% PU13 - 77%; Addendum Gumti Phase II MPO Cropping Pattern 88.4%.		With project irrigated areas have now been reduced in some of the cases indicated. However, in the case of units 11 to 13, the figures should be seen in the context of the very substantial existing irrigated areas (57% of NCA in the case of unit 12 - Ashuganj).

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Comment	Replies by the Consultants	Action Taken in Final Report
The consultants follow the Guidelines which suggest five years for the phasing in of benefits. But where these involve, for example, as in PU1 and PU2 a shift from negligible (2%) to a high 70 percent of irrigation of NCA in areas of saline intrusion, this rate of development is implausible. There will be micro variations in topography that in practice further reduce the area can be irrigated economically. Also, the economic analysis makes no allowance for the substantial institutional difficulties and private costs to farmers of developing a network of channels to carry irrigation water and other farm-level land improvements that may be necessary to efficiently utilise irrigation water. Experience in Bangladesh is that these will be serious constraints on the rate of development irrigation by DTW and LLP assumed as necessary to achieve the very high proportion of NCA projected to be irrigated in several PUs. Overall, the combination of these high levels of irrigation linked to HYV Boro and assumed relatively rapid phasing-in of benefits probably results in EIRR which are on the high side. For example, the sensitivity analysis, which is usefully reported in detail by the consultants, indicate that the EIRR for PU1 falls from 17.8% to 12% for a four year delay in benefits.		The rapid increments in irrigated area have now been reduced.

Comment	Replies by the Consultants	Action Taken in Final Report
<u>Detailed Comments:</u> PU1 Polder 59/2: HYV Boro and GCA 5% higher than in draft RPR. Irrigated area and HYV Boro rising to 69% of NCA within 5 years of end of construction phase seems very optimistic for area of saline intrusion and currently only 2% of NCA irrigated. PU2 59/3: Drainage and Irrigation Option - the projections of HYV Aman 25% with Irrigated HYV Boro rising from 2% to 72% of NCA only five years after project completion seems optimistic. PU3 Noakhali North Option 1 & 3 - Why does Future WO increase irrigated area by 39% and net crop income by only 7%, but Future with project increase irrigated area by 90% and net crop income by 26%? PU4 Little Feni River Options 1, 2 and 3: Consultants to explain why re-estimated irrigation benefits are higher. Also is an assumed 12% of NCA under irrigated wheat a likely development in this agro-ecological zone in which wheat is at its climatic margin? There appears to be a numerical error in the summary of crop benefits table for Project Year 1 irrigated area - 57.6 thousand ha which is higher than Future with and without irrigated area. There is similar error in several other Summary of benefit tables [PU4 Option 2 combined with Dakatia etc, Dakatia Option 4; Muhuri Option 1; Option 2].		All these comments are answered by the revisions in the final report.
Dakatia Option 4: Explain "improved returns to irrigation". PU8 Dhonagoda Option 2 and 5: Assumes increase in irrigated proportion of NCA from 24% to 64%. Planning Unit 11 Gumti Phase 2: South East Polder: Unable to follow explanation of the "logic of the assumed benefits". Assumes increase in irrigated area to 70% of NCA. PU12 Ashuganj: Needed to explain basis of improved irrigation benefit assumption. Future with project irrigated area rising to 80% of NCA seems highly optimistic, especially if this also involves switch to LLP from TW irrigation.		See reply to general comment 3 on page 1.19.

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Comment	Replies by the Consultants	Action Taken in Final Report
Comments on Methodology for Project Appraisal: South East Region (FAP 5) By Dr. Quazi Shahabuddin		
a. It would appear that the consultant has followed the same approach (same as in the Interim Report) in the estimate of economic prices for evaluation of alternative development options, despite considerable reservation expressed in this respect earlier. It was commented earlier that if the consultant directly compute the economic prices of some agricultural products and production inputs, while for others use the conversion factors from the guideline (1991), then this may introduce inconsistency and bias in the evaluation exercise. This is particularly because the conversion factors both specific as well as standard factors presented in the guideline (1991) are those based in planning commission estimates derived in the early 80's. The charges in world market conditions, estimates of internal trade and transport margins, taxation structure etc. has made these estimates largely obsolete. That is why a new set of conversion factors has recently been estimated and incorporated in the final version of the guideline (May, 1992.), for use in Regional and other FAP studies. This would ensure consistency and comparability of economic evaluation of alternative development options in different studies.	The draft Regional Plan report was issued before the guidelines were available.	The revised methodology uses the conversion factors from the FPCO guidelines (May 1992).

	Replies by the Consultants	Action Taken in Final Report
This has unduly led to inflated values of net economic benefit in the evaluation exercise. There is therefore, a compelling need to recompute the economic return of alternative development options identified using updated set of conversion factors (both specific factors for e.g. products, inputs and project inputs as well as standard		
b. The Report seem to lacking in the application of Multicriteria Analysis in order to capture the impact of those events which cannot be valued by physically quantified and those which can neither be valued nor physically quantified but only qualitatively described such as impacts on resource sustainability, specific social groups etc. For these events, ordinal ranking would suffice. As mentioned in the guidelines, such an approach would have helped in summarising and bringing together, as and to decision-making the potential positive and negative impacts of a range of alternative project and **Comment** strategies. Therefore, MCA should be carried out if not already done and the results incorporated in the Final Report.	The commentator has not seen the whole report. Multi-criteria analysis is included.	No action.
c. In the Interim Report (Option 3), some anomalies were detected in the application of standard and specific conversion factors for steel while evaluating cost items. It is hoped that this has been converted in the draft Final Report as it affects the estimation of weighted average conversion factors for quite a number of items such as regulator, culverts, pump station, bridges and buildings.	This has been done.	No action.
Subject: FAP-5 REVISED ECONOMIC ANALYSIS.		
From: K. Mustahidur Rahman		
COMMENTS		
1. Economic analysis should be revised using conversion factors provided in guidelines for Project Assessment (May, 1992). The consultants need not use their own estimate, as it happened since this would defeat the requirement of consistency among the FAP studies. Further, specific conversion factor for rice is now 10% lower and since rice constitutes the major benefit of any FAP project, this will significantly alter the estimated EIRR, etc.		This has been done.

Comment	Replies by the Consultants	Action Taken in Final Report
2. There appears to be some inadequacies in estimating farmers net income in future. Consultants have used a single set of various input requirement and yield rates for different crops for both present and future. The input mix for any crop is most likely to change in future because of better agronomic practices as it happen in the past. Thomson's (1989) finding of constant yield rates before and after the project in CIP is truly an outlier since in most places there are very strong evidences of increasing yield rates during the last 20 years (MPO (1991); M Hossain (1991)). Use of separate set of input requirements and yield rates for future, which is appropriate, will change both farmers costs and benefits and have net incomes. The consultants are advised to use MPO's input mix for different crops and of estimated yield rates for future so as to keep the consistency with the present input mix and yield rates used in their analysis. Also, there will be changes in flood phases with project in futures and hence changes in the cropping patterns.	This comment is not in accordance with the revised agricultural guidelines (March 1993).	The final report follows the March 1993 guidelines in respect to yields. Input and yields are now based on primary data as well as secondary.
3. There appears to be some inadequacies in incorporating the costs of ground water development in future with/without project conditions in the economic analysis. One may envisage the following two situations:		
a: There is groundwater development potential in a project area, and some autonomous development of minor irrigation takes place regardless of whether the project is implemented or not;	Methodology as applied is considered correct for each case. Where groundwater development occurs with and without project there is no effect on economics.	No action
B: The groundwater development is contingent upon the implementation of the project (only changes in flood phases in the project induce farmers to invest minor irrigation). In (a) above, the incremental benefit due to project (the differences, in net benefits between "Future with project" and "Future without project" will be smaller and investment cost in minor irrigation could either be incorporated as farmer's cost (annualized) or in the project cost in the economic analysis. I suspect that the minor irrigation costs has not been incorporated	The answer appears to be ambiguous and needs further clarifications particularly pertaining to (B).	

Comment	Replies by the Consultants	Action Taken in Final Report
In (b) above, the cost of development of minor irrigation should be incorporated in the project cost. It is easy to find the numbers of STW/DSSTW and DTW under a mixed strategy and associated O&M costs in order to estimate the investment required and incorporated in project cost. In both situation above, they will significantly change EIRR. Constraints regarding the expansion of minor irrigation through DTW will limit the rate of development.		
4. Irrigation development appears to be very rapid, compared to what in practice has been achieved during the past (MPO: Historical Water Resources Development, 1990). Also, area under irrigation under full development appears to be very high (PU-1-69%, PU-2-71%, PU-8-64%, PU-11-71%, PU-12-80%,PU-13-73%) and achieved quite rapidly. It is unlikely to have such rapid growth considering past experiences.		See action on page 1.19 comment 3.

Comment	Replies by the Consultants	Action Taken in Final Report
A. General Comments <u>Relationship to the Phase II National Water Plan (NWP)</u> 1. The excellent work done under NWP by MPO in deriving national water resources estimates, modes and a project planning data base has been used to good effect by the RPR. The limitations of applying this solely agriculturally originated data base to a program having broad flood control objectives is clearly evident in the RPR which was not able to capture the non-agricultural aspects of the benefit equation (although, admittedly, the study area is not as prone to flood damage as other region). There is therefore a pressing need for FPCO to refine its Project Evaluation Guidelines to cope with non-agricultural flood and river bank protection benefits in a more satisfactory manner. The RPR approach of disregarding NWP's future abstraction limits in the Lower Meghna (e.g. to prevent salinity intrusion) may be justified by the unrealistic nature of NWP's proposals; these issues must, however, receive attention when regional FAP proposals are integrated into a national FAP programme. It is also interesting to note that the RPR's twenty year programme of major project investments of about Tk 8 665 million (see Table 6.5, Volume II), is only about sixty percent of the NWP's proposed programme of major FCDI projects for the study area. The absence of adequate project identification, consideration of environmental externalities, ranking and screening in the apparently contrived NWP's investment programme, is thus made evident by the in-depth regional planning under the FAP initiative.	1. The RPR approach of ignoring the NWP abstraction limit was justified solely on the basis that when all the Regional Plans are available it will be possible to reconsider national policy and priorities in terms of regional allocations. It was not the intention to suggest that NWP estimates are unrealistic.	Chapter 10 of Part 2 revises the assessment.

Comment	Replies by the Consultants	Action Taken in Final Report
<u>General Shortcomings</u> 2. The RPR is a well presented report, but in its present from may not be as useful as it could be for the purposes of drawing up an initial draft of FAP, or an IDA decision as to whether it should processed with formal initiation of a FY 94 South East Irrigation Project based on the Noakhali North Project. The RPR is lacking with respect to the following:		
(a) <u>Public Consultation</u>. There is little evidence that the "participatory approach" of public consultation (specified in Attachment A of the TOR), was applied within project areas in formulating the preferred Noakhali North Projet (NNP) - or other proposed project. This is regarded as essential in the FAP framework for identifying the potential social conflicts, affected socio-economic groups and their interest in general project proposals.	2) a), b) and c) It is accepted that these aspects are covered in a limited way at the regional plan stage. It should be pointed out that the consultant's proposal and contract did not include the internationally recommend social scientist called for in Attachment A to the TOR, nor did it include an internationally recruited fisheries specialist. The consultant's proposal also drew attention to the fact that their proposed methodology was to rely almost entirely on secondary data for the regional plan since the programme and resources did not permit otherwise. However the consultants have covered much of the ground originally foreseen as being the requirements for regional plan given the limitations of the existing database.	Appropriate sections of the report have been revised. (see chapters 6, 8 and 10 of part 1).
(b) <u>Review of Agricultural Constraints</u>. With the exception of environmental issues, the identification and discussion of agricultural development constraints and their impact on the achievement of future potential (clause 10(h) or TOR), is relatively weak and not focused in terms of their role in project identification. On the other hand, given the inordinate importance of impacts on capture fisheries in project formulation, the RPR seems to base all its findings in this crucial area on secondary data. Annex VI (Fisheries) does not mention any fisheries market (catch) surveys of its own. One of the possible important agricultural constraints of the region may be limited ownership of draft animals and fodder availability. Consideration of this aspect may add greater credibility to assumptions of greater cropping intensity in project areas: in fact, the full increased cropping intensity potential may not be possible because of shortage of draft animals and the need to lease them. Similarly, the requirement of TOR clause 10(h) to discuss future infrastructure needs for increased agricultural production (e.g. rural electrification for LLP's and flood-proof feeder roads) is poorly addressed.	The amount of participation which took place may not have been fully described in the report. In the final version a better description will be included. The sections on the draft aninal/mechanisation agricultural constraint/solution will be strengthened in the final report. Land tenure data has only been presented in terms of land holding sizes.	As indicated in reply.

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Comment		Replies by the Consultants	Action Taken in Final Report
(c)	Land Tenure The RPR contains no data on land tenure conditions and does not directly discuss the incentives to farmers and fisherman to adopt improved technology (as required by clause 10(h) of the TOR). These data and their interpretation are crucial in assessing the potential success of project proposals and social impacts. Direct consideration of land tenure as a surrogate for income data would make the assumptions about the areas that have to be irrigated by LLP's instead of low-cost traditional irrigation more plausible: it would also identify the size of the disadvantaged groups who benefit from the projects and therefore facilitate their multi-criteria and social impact evaluations. Rural electrification may also make the transition from traditional irrigation to LLP's more likely and should be considered in the RPR.		
(d)	Multi-Criteria Analysis The multi-criteria analysis ranking for some of the more quantifiable impacts may be somewhat subjective. The FPCO methodology of adding up diverse impact positive and negative impact ranking without weighting their relative importance makes this analysis ineffective for comparison of alternative projects. The immediately important impacts on regional income, employment and poverty alleviation are wholly submerged by the long term sea-level rise assessment. Thus, although some projects may have a relatively low EIRR, decision-makers have no way of knowing whether important quantifiable social objectives would make the "problem project" as attractive as those with a higher EIRR but lower social benefits. The analysis would be more plausible if such impacts as incremental employment, fisheries losses, population displacement, investment opportunities (e.g. income multipliers due to secondary benefits) and net cash income were allocated quantified ranges and computed according to a standard estimating methodology: the results could then be fitted into the ranking ranges concomitant with a range's delineation as minor, notable or major impact. At present, the mainly subjective multi-criteria analysis has almost no bearing on project ranking, albeit that other important national objectives are relevant in project selection. FPCO would be well advised to refine its guidelines for the methodology and application of multi-criteria analysis.	d) We doubt that consistent weighting of relevant importance can be developed at this stage for all projects in Bangladesh. (e.g. sea level rise is relatively important in some areas but not in others). Also there is an insufficient database of many environmental aspects to do more than is currently proposed by FPCO. Indeed the consultants consider that many of the FPCO guidelines cannot be met in full without extensive research programmes far beyond the resources of any of the regional plans (See Annex IV).	The multi-criteria analysis includes quantified estimates of incremental employment, fisheries losses and land acquisition (displacement). Weighting of these and non-quantified aspects would lend spurious credence to the level of accuracy possible.

Comment	Replies by the Consultants	Action Taken in Final Report
(e) Estimation of Benefits. The low EIRRs as implied by the consultant, may be partially due to the methodology used for benefit estimation: i.e. consideration of cropping pattern changes due to SERM simulation of the impact of reduction in peak flood phases. The analysis did not consider the impact of shorter overall flooding duration and the incentive this may have in inducing cropping pattern and scheduling changes. Since the consultant's analysis did identify an average year for estimation of benefits for each project (see Section 3.2.2, Volume II), it may be asked why the simulation for such a year did not consider the impact of shorter flooding periods (albeit that draught constraints may limit possibilities for increased cropping intensity). At the pre-feasibility level of the RPR, it may have been adequate to assess these additional potential benefits using monthly decade rainfall and outside river level averages. Given the poor economic justifications generated by the present methodology, the consultants could be asked to perform the above-mentioned assessment of additional benefits. Incorporation of new feeder roads facilitated by reduced flooding, may also enhance agricultural benefits.	e) The consultants have identified two separate areas where methodology of the draft RPR underestimates project benefits. The first of these concerns the treatment of yields where use of a single set of crop yields led to consistent underestimation of irrigation benefit. The consultants are in the process of reviewing the analysis and have developed a more coherent methodology which more accurately represents the benefits of introducing irrigation to new areas and to areas previously using traditional and/or partial irrigation techniques. The final RPR will include these results. Completed analyses to date include the Noakhali North Project for which the EIRR improves to about 13.0% with this adjustment. The second limitation of the methodology which has been identified at the pre-feasibility stage is that referred to in this comment, namely, the inability of the methodology to take account of reduced flood duration if land does not change its peak flood phase. It is not correct to attribute this inability to the status or accuracy of the model. In fact it is related to the decision to use MPO cropping patterns and MPO flood phases being the only coherent set of data available. If either of these data sets is abandoned then the other ceases to be valid. The consultants have been complimented for their consistent approach in this respect and their methodology recommended to others. However the consultants have identified the limitations of the methodology and have suggested how this may be overcome at the feasibility stage by collection of new primary data or cropping patterns directly related to known flood patterns for a series of years run on the SERM. This involves a great deal of topographic and agro-socio-economic data gathering and also extensive numbers of model runs with post processing at frequent intervals. This procedure is not possible at the pre-feasibility stage for a large number of projects. Since the North Noakhali option no longer presents a poor economic justification (see above) it seems appropriate to proceed direct to feasibility stage, knowing that there are additional benefits to be quantified. The introduction of new feeder roads have both costs and benefits which could not be even approximately assessed at the pre-feasibility stage.	The final report (Chapters 3 of Part 2) describes the finally adopted methodology which is considered to be an improvement. Decade analysis was carried out for feasibility level analysis.

Comment		Replies by the Consultants	Action Taken in Final Report
(f)	Incorporation of LLP's in Economic Analysis. The approach of incorporating annualised capital cost of LLP's, STWs etc. in crop budget as average annual costs per ha irrigated underestimates the cost to the economy in the EIRR computation and overestimates the NPVR(2) criterion. Whereas, the annual operating costs of minor irrigation equipment may be included in the net benefit assessment her ha, it would be more correct to show the cost of procurement of the requisite number of LLP's in the project cash flow table, and consequently the expenditures incurred in their replacement over the subsequent five and seven year periods. Needless to say, not only is this more transparent and realistic, but it would also possibly improve the low project EIRRs.	f) The consultants economists considered this but decided that it is in fact more realistic to leave it since it reflects how farmers pay for irrigation.	The revised methodology specifically refers to this point. (Chapter 3, Part 2).
(g)	Viability of LLP Irrigation Assumptions. A generally accepted BWDB design criterion for effective irrigation by 2 cusec LLPs is that there should be a natural khal density of 1.5 km per 200 ha irrigation. There is no indication that, for NNP (or other schemes), the consultants have attempted to estimate minor khal re-excavation needs or the numbers of LLP's in accordance with a similar criterion: accordingly, the latter costs may be underestimated. Of greater import, is the possibility that, given the actual khal length available, the areas assumption to be feasibly irrigable by LLP's are in fact over estimated unless tertiary distribution canals are provided to irrigate the khal's riparian areas. For well known reasons peculiar to Bangladesh, a farmer built ditch for 2 cusec LLP irrigation extended more than 300-400 meters: consequently about three LLPs are needed on each khal bank section 1.5 km long and irrigate about 300-400 meters on either side - as opposed to 1.5 km assumed by the consultant. This begs the questions regarding the above comments on the technical feasibility of LLP irrigation, number of LLPs required and irrigation distribution cost estimated of the RPR.	g) It should be borne in mind that there is already a substantial area irrigated from the existing khal system by LLP and that this can be considerably increased from the deepened Rahmatkhali/WAPDA khals for which costs are already included. The consultants estimate of an additional 200 km of khal for deepening is considered realistic. Using the quoted BWDB design figure of 1.5 km of khal per 200 ha suggests that 200 km of minor khals could irrigate 26,667 ha and the 74 km of WAPDA and Rahmatkhali khals another 9,867 (total 36,534 ha). If the existing 3,000 ha of area in the west which are on minor khals which do not need deepening are added then the proposed 38,100 ha of LLP can easily be served. The 1.5 km nominal distance between khals is a function of the difference between gross area and potentially irrigable area (70% x 70% = 49%) and allows for some groundwater areas in the areas remote from khals. The figures seem not unreasonable and even a 20% increase in this element could only increase the capital cost by 2%. The area per 2 cusec LLP was taken as only 16 ha so there has been no underestimate of costs of LLPs.	The feasibility study has answered this comment.

Comment	Replies by the Consultants	Action Taken in Final Report
(h) Primary Hydrological Data. The RPR seems to be devoid of the consultant's monsoon or dry season field measurements of discharges and water levels in the study area's rivers and khals in general, and in the proposed project areas in particular. Similarly, no data - or the consultants own measurements - of cross-boundary river and sediment discharges are provided to illustrate the impact of water resources and agricultural development in neighbouring India on RPR project formulation. No data on tidal fluctuations and river stages at various critical locations along the Lower Meghna (or elsewhere), are given for use in evaluating pre-feasibility level designs of regulators etc. Annex VII (Hydrology and Water Modelling) is also particularly parsimonious in describing the region's hydrology and generally consists of a pre-occupation with the calibration of the SERM model. This Annex is much shorter than what would be conventionally expected from a regional study. In these respects the RPR is incomplete and the consultants would seem to have lost an opportunity to collect valuable data during the regional planning phase.	h) The absence of primary hydrological data was to be expected given the consultants proposed and accepted methodology of relying on the existing database and ongoing data collection programmes (eg SWMC). The consultants are satisfied that the existing database supplemented by the ongoing programme of data collection for the SERM by SWMC was adequate for regional planning. The collection of additional information over a relatively short period for the whole region would be of very doubtful benefit. This data will be presented in the final report. The data on tidal fluctuations and river stages in the Meghna river are now incorporated in the SERM. A great deal of data was published in the Appendices to Annex V of the interim report and this has not been repeated for the draft RPR. There is no doubt in our view, that it was correct to concentrate on the development and improvement of the SERM. This represents the most powerful tool available to the consultants to process the hydrological data (rainfall and river and khal flows) to produce realistic and reliable estimates of flooding over the entire region and provide a clear understanding of flood mechanisms. It provides the only way of realistically measuring benefits of interventions. The time to add further data to parts of the model to improve its resolution is at the feasibility stage. The SERM has been under continuous development throughout the planning period and the calibration of vital elements (such as Rahmatkhali regulator) are still in progress. The timing of the modelling inputs for the regional plan date back to August/September 1991. More recent development of the model will be dealt with at the feasibility stages. The consultants are cooperating fully with the SWMC to ensure the maximum benefit from the time available to check verify and extend the various model elements.	The final report includes all data collected. Annex VI is a substantial document considering the resources applied.

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Comment	Replies by the Consultants	Action Taken in Final Report
(i) Flood-Proofing and Preparedness. The treatment of "non-structural" flood control alternatives to embankments - particularly flood-proofing - is inadequate for a regional study within the FAP framework, particularly for the deeply flooded ecologically sensitive areas north of the Gumti River. It is also noted that submersible embankments are also mentioned (possibly for the Gumti II area): this technological option is , however, not evaluated and considered in the light of possible finding by the FAP 6 regional study. All these alternatives should be included in project proposals and may enhance their overall EIRR. Arguments that FAP supporting studies (FAP 10, 11 & 23) are not sufficiently advanced are difficult to accept since FAP 23 has published adequate material on flood - proofing and held a workshop in 1991; what is lacking at this time are agreed proposals on how flood-proofing programs should be financed. It can only be concluded that the consultants have devoted little time to the survey and costing of these valid alternatives and should do so before issuing a final RPR. This is of particular concern to IDA as it may not be prepared to consider funding of future FCD projects (or even general infrastructure), it flood-proofing has not been considered and fully evaluated.	(i) The consultants do not consider that detailed evaluation of flood proofing can be covered realistically at the regional plan stage. It is regarded as an integral part of the development proposals for all projects at the feasibility study stage. The consultants have made this plain in their recent proposal for the Gumti II area where it was stated that complementary measures for flood proofing would include areas both "inside" and "outside" embankments. The development and implementation of a national programme for flood preparedness and flood-proofing is in its infancy and proposals for such developments are not at a stage which can be taken further for regional planning. The evaluation of flood proofing requires extensive inventorising of facilities in terms of size, locations, status, level etc. and this cannot be done at pre-feasibility stage.	Flood proofing section has been revised but generally in the south east region the proposed works and existing status suggests this aspect is not critical. See feasibility studies.
The Gumti II Project. 3. We note that IDA's position regarding the available feasibility study of the Gumti II FCD project has been fully vindicated by the finding when its proposals are compared to other potential projects using the RPR evaluation RPR methodology. The high EIRR obtained by the RPR when using the original study's yields is solely due to neglect of the high cost of bank revetment works required at Maniknagar (see FAP 9B Final Report) to maintain the FCD/FCDI embankments along their proposed alignment. The apparent attractiveness of the RPR's limited Gumti II South East Polder proposal - and other development options (inclusive of flood-proofing) - will be fully evaluated by the consultant in accordance with FPCO Guidelines under Japanese Grant Facility funding executed by IDA.	3. The high EIRR obtained using the original study's yields is largely due to the difference in yields assumed between areas inside and outside the scheme (i.e. yield increments due to agricultural extension etc.).	Gumti II revised study answers this point.

Comment	Replies by the Consultants	Action Taken in Final Report
B. Noakhali North Project (NNP) Pre-Feasibility Study Project Selection and Desirability 4. Economic Justification. The pre-feasibility level EIRR is relatively low and does not auger well for the outcome of the feasibility study, despite the consultant's optimism and claims of a conservative and cautious analysis. In this respect, however, all competing proposals - such as Dakatia - would FCDI likely fare even worse under closer scrutiny and past experience with FCDI projects. In reviewing the RPR, we find that, at the level of analysis used and its assumptions, the recommended NNP Option 1 to be the most attractive and appropriate project (in a relative sense in terms of comparable EIRRs and multi-criteria assessments), for the southern portion of the study area. This scheme's economic viability would apparently be enhanced (or possibly reduced) - not only by incorporation of some of the methodological suggestions in para 2. above (particularly by paras 1(e) and 2(i) - but also by the additional benefits of NNP's combination with the low-cost Little Feni Option 3 proposal. While this combination has been also suggested by the consultant, it was not evaluated for the reader's convenience and for expediting the decision-making process. The RPR also claims that their irrigation assessment and data indicating that the Begumganj Depression is wholly irrigated, may be wrong and that the W/O case net benefits may be an over-estimate. Without the field inspection, we find it difficult to accept this apparent reason for low EIRRs. Para 2(b) has already referred to the apparent paucity of field inspection and lost opportunities which could have resolved this issue by a dry season field trip lasting a day or two; such a trip may have also indicated that it is quite plausible that, aside of irrigated boro rice, unirrigated grain and other crops could be grown with the moisture available from the high groundwater tables prevalent in this low-lying area. Accordingly, there may not be a very strong economic justification for irrigation of the Begumganj Depression.	4. Please see the reply to comment 2(e). The adjustment of the EIRR for the incorrect treatment of yields for irrigated crops and other minor adjustments for LLP capital costs results in a more attractive EIRR of over 13%. To this result may be added the identified but as yet unquantified benefits to be derived from shortened durations of flooding. This benefit is likely to be more pronounced for the NNP than for other proposed projects. The evaluation of the Begumganj depression has been revised in the adjustments already referred to. However the consultants would point out that field trips were made to the area precisely to try to resolve the issue in the manner suggested but it is apparent that a detailed periodic programme on sample areas such as is proposed for the feasibility study is necessary for full evaluation. The benefits of a non-irrigated but drained Begumganj depression could be evaluated but it is considered that this may have serious social conflict implications and the additional irrigation costs are mostly in the private sector.	Completed feasibility study supersedes this comment.
5. Social Impact Analysis. The possibility of conflict between the drainage and irrigation beneficiaries in the Begumganj Depression has been given short shrift in the RPR and should have been elaborated upon by the participatory consultation (para 1(a) and preliminary social impact analysis. The mitigatory measures in the form of Rahmatkhali Regulator operation alluded to in the RPR should have been subject to a preliminary analysis by SERM (or simpler means), showing how drainage levels of the low-lying area could be regulated to resolve this issue.	5. There are existing social conflicts related to this issue and it is accepted that any intervention will alter these (this is true of all FCD proposals). Operation rules for the Rahmatkhali regulator will be kept as simple as possible. The gate arrangements will be such that it will be possible to maintain minimum required levels. However one doubts that it would ever be possible to satisfy everyone (as stated there are existing conflicts). It is accepted that a programme of meetings would be required through feasibility design and implementation to optimise the resolution of such problems. It is not possible to try to resolve such matters at pre-feasibility stage.	See above.

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Comment	Replies by the Consultants	Action Taken in Final Report
Technical Uncertainties 6. Important technical uncertainties exist which may not be satisfactorily resolved by the feasibility study; thus far, they have been superficially treated by the consultant. These technical uncertainties are the following:		
(a) Rahmatkhali Regulator. (i) Hydraulic Computations - No seasonal data on Lower Meghna stages and their tidal fluctuations are given for the vicinity in the Rahmatkhali Regulator, and no computations were apparently carried out to check the seasonal viability of the modified or expanded structure's operation with respect to tidal "windows"; (no cross-section of the existing structure showing critical sill levels is given either). If the apparent datum error causing an increase of +0.35 cm above the assumed average levels is added, these "windows" may require a much larger structure and/or not provide the same drainage effect exhibited in Figures 5.3.2 and 5.3.3. We believe that preliminary pre-feasibility level hydraulic computations could have been performed to "optimize" a structure that comprises about 25 per cent of Option 1's base cost.	6. (a) i) This data is available, has been checked, and can be included in the final R.P.R. The consultants accept that the pre-feasibility design (and therefore costs) are conservative. This allows for the present uncertainty concerning the datum of Daulat Khan gauge.	See above.

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Comment	Replies by the Consultants	Action Taken in Final Report
(ii) Susceptibility to Bank Erosion - While the RPR mentions the problem of river bank erosion in the Regulator's vicinity, it provides no data or analyses to support the contention that erosion rates are decreasing; thus the key structure of the project may soon require expensive (and possibly ineffective) bank protection measures to ensure its continued survival.	(a) ii) Data is given both on the present distance of the main Meghna channel from the regulator and its previous and present estimated rate of erosion with a description of how this information was obtained. The conclusion was that erosion is diminishing and present estimates are that the regulator would not be threatened within the next 20 years even if the expected further diminution of erosion did not occur. More recent data will become available during the proposed feasibility study.	See reply on page 1-33.
(iii) Fish Passage: Modifications - Proposals for incorporation of appurtenant structures in the Regulator for the passage of fish and shrimp spawn may turn out to be wishful thinking: they are not supported by evidence of working prototypes elsewhere in the country; the structure's operational cycle analyzed in relation to the fisheries life cycle diagram given elsewhere in the RPR. In fact, concern with this issue leads us to begin to question whether the consultant's assessment that NNP is environmentally benign with respect to capture fisheries - and superior to other competing schemes in this respect: possibly the Regulator's original construction led to a decline in fisheries productivity and ways need to be sought to mitigate its effect. In any event, FPCO has a major responsibility to overcome the poor scheduling of the FAP 17 Fisheries Study and provide crucial inputs for the resolution of the major uncertainties surrounding water control structures and capture fisheries issues. Failure to progress in this area will cast a cloud over all FAP projects for which donor funding will be requested.	(a) iii) This is agreed. The suggestion was made to indicate that there were possible benefits to be gained not that these were guaranteed. The consultants cannot understand how capture fisheries could be harmed by examination of such a proposal. No change at Rahmatkhali regulator cannot produce a negative impact. A change would only be incorporated if it could be demonstrated as beneficial. Since there is little capture fishery in the project area the proposed interventions cannot have much negative effect. It is for this reason that the consultants suggest the project as comparatively benign in this respect.	

Comment	Replies by the Consultants	Action Taken in Final Report
(b) <u>Viability and Sustainability of Khal Excavation</u>. Aside of the LLP irrigability and khal density issues raised in paras 2(c) and 2(f), further work needs to be done to establish the viability and sustainability of deepening major and minor khals. (i) Salina Seepage and Water Quality - Figure 5.3.2 shows that the proposed bed level of WAPDA khal would be below -2.0 m. P.W.D. whereas most groundwater levels in the NNP area are at 0-4 m. P.W.D. (the average floodplain level is about 3.5 m). This implies that predominantly saline groundwater would seep into the deepened khals and fill them to a depth of 2 m. or more: this would not only make their deepening difficult and expensive, but also degrade the quality of the irrigation water supplied by Rahmatkahli Regulator. Not only should the consultant elaborate on the construction cost aspects of this problem, but also assess the impact of quality degradation. The latter could most likely be done using a conventional steady state seepage model to estimate the quantities involved during the irrigation season and the simple arithmetic computation could estimate the resultant salinity of the irrigation water that would be available.	(b) i) The excavation of deepened khals is primarily required to allow adequate drainage to proceed whilst keeping land acquisition to a minimum. During the intense rainfall of the monsoon period the khals will be full of fresh water to push the saline water away from the open channels. It is also the case that the top layer of groundwater is not saline. As the floods recede the water levels in the khals will be maintained at levels generally above the zero datum. They could never be dry at a level of -2.00. This minimum level of water would be maintained by the fresh water admitted through Rahmatkhali regulator. This situation already occurs at the lower (southwest) end of the khal system where existing bed levels are at -2.00 relative to the PWD datum and the water is used for irrigation during the dry season. The consultants are proposing extension of the existing system.	See reply on Page 1-33.
(ii) **Siltation and Maintenance** - the question of the gradual siltation and possibly underestimated O&M cost of periodic khal desiltation needs to be examined. The origin of depositing sediment needs to be determined: this could be from the Little Feni areas or India (see para 2(g), or from the physio-chemical flocculation phenomena of fine suspended sediment, when water abstracted from the Lower Meghna is mixed with the saline groundwater in the deepened khals. It seems reasonable to expect that this problem could possibly have been initially explored by some empirical field experiments (e.g. based on mixing in a deep pit). (iii) **Spoil Disposal** - The problem of disposal of the large amount of excavated spoil from the deepening operation should be mentioned: i.e. how the earth would be spread without creating a drainage problem for adjacent fields.	ii) Of course this could be considered at the feasibility stage but as already explained with proper design and operation salinity of the water and hence flocculation is not anticipated to be a problem. Information already obtained (LRP and SWMC) suggests very low sediment concentrations in the existing khal system. This is to be expected since almost all the sediments from the Indian catchments are deposited in the upstream reaches of the Old Dakatia and the Little Feni. Most of the water arising in the khals is from direct rainfall on the flat lands of the project area this would produce very little sediment. iii) The consultants were criticised at the interim report stage for using too high an excavation rate. This has now been slightly reduced but remains 25% above the normal rate to allow for the possible additional removal and disposal costs. This will be subject for discussion at feasibility participation meetings.	See reply on page 1-33

Comment		Replies by the Consultants	Action Taken in Final Report
	(iv) **Irrigation of Areas Adjacent to the Dakatia River** - The RPR mentions this possibility for NNP irrigating these areas by excavation of the khal network without primary pumping. Given that the consultants have been proposing NNP as the recommended project for the past six months, we fail to understand why a preliminary assessment of this possibility was not undertaken to ensure NNP's justification: i.e. feasible in principle, whether the marginal costs exceed the marginal benefits (by the current methodology) or not.	iv) This is a possible additional benefit which does not affect the viability of the NNP drainage project itself since it can be developed independently. It was included in this section to indicate that the consultants will examine various supplementary options at the feasibility stage.	See reply on page 1-33.
(c)	Flooding. The report alludes to the need for interception of flooding from the Dakatia river by an embankment and to the need for three regulators and other measures on NNP's boundary with the Little Feni project area. Albeit that there would be adverse fisheries impacts from the former (and possible increased flooding elsewhere), neither alternatives have been preliminarily assessed or evaluated for NNP or Little Feni in the report. Given the NNP's low EIRR, it is not clear whey the consultant has not attempted these assessments.	(c) Again these are yet more supplementary options which may improve the quality of the project. It is agreed that the fishery and adjacent area implications, acknowledged in the report, must be considered. The revised EIRR of the Noakhali North Project is already much improved. It is not possible for consultants to examine every possible variation of every option at this stage given that no proposed schemes are economically outstanding. Obviously unless these further refinements show real benefits they could not be incorporated but again were included in this section of the report to identify possible avenues and opportunities for improvement at the feasibility stage.	
(d)	Topographic "Truth" and Drainage Efficiency. The NNP is a gravity drainage project whose water evacuation efficiency and net benefits are wholly dependent on micro-topography variations of tens of cm: thus the datum level and outdated mapping problems endemic to the Bangladesh context are clearly evident in this case, and are compounded by uncertainties arising from on-going sedimentation, land accretion and consolidation. The topographic uncertainty issues raises questions regarding the reliability of all hydraulic, hydrological and resultant agricultural benefit estimates. While the mapping problem generally presents a major obstacle to progress beyond the feasibility phase in the FAP program, it raises serious questions for a project feasibility study which is to serve as part of the preparation process of a forthcoming FY 94 IDA project whose post-implementation performance must be realistically appraised a priori. The RPR notes that updated maps may only be available in 1994 and proposals are made for the conduct of the feasibility study using vintage available 1:15840 scale maps. While these approaches may serve for the feasibility study, final appraisal may require the use of the new maps.	(d) It is not evident that the NNP area is subject to ongoing sedimentation, land accretion and consolidation. The topographic limitations are unfortunate but the benefits are dependent on differences in flood depths between with and without project situations and not on absolute levels for any condition. The consultants have indicated how they propose to overcome the mapping difficulties at feasibility stage.,	See reply on page 1-33.

Comment	Replies by the Consultants	Action Taken in Final Report
C. IDA Proposals for NNP Feasibility Study Work Plan Revision		
7. Upgrading of the RPR. Two difficult decisions are to be made by both FPCO/BWDB and IDA as executing agencies for this UNDP supported study: the former in the FAP context and the latter in terms of its responsibility for FAP 5 with respect to both RPR and the ensuing feasibility phase. IDA also needs to decide whether it wishes to consider NNP as the basis of a proposed FY 94 South East Irrigation Project. With respect to FPCO/BWDB and the FAP review process to determine the adequacy of the RPR as a regional study, we offer the foregoing comments for their consideration. We await the outcome of the review based on the comments of all GOB agencies and their decision as to whether further improvements in the draft RPR are warranted. In the event that this is also their view, IDA, UNDP and FPCO/BWDB together with the consultant - will have to determine the scope of the possible additional work to improve the RPR pre-feasibility analysis, how this may be accommodated within the remaining budget. In undertaking this exercise, we take the view that shortcomings of the SERM and the inadequacies of the DOS system which it used, are not to be attributed to the consultant; similarly, the NNP uncertainties and SERM difficulties created by the change of datum level arising from FAP mapping activities are also not attributable to the consultant.	7. The consultants are currently making improvements to the RPR as already described. The consultants take the view that the standard of the report is in accordance with the resources applied to it. If additional work is now required it would be extremely difficult to accommodate within existing budgets and time schedules unless the feasibility study funds are to be diverted to this end.	The final report is substantially upgraded.

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Comment	Replies by the Consultants	Action Taken in Final Report
8. <u>Additional Funding for Feasibility Study Completion</u> The consultant's proposal that an additional US$ 437,000 are needed to correct the SERM and meet FPCO environmental guidelines in undertaking the NNP feasibility study, is noted and raises several questions. Aside of the SERM problem (which is apparently beyond the consultant's control), two thirds of the requested additional cost is attributable to apparent shortcomings in the contractual TOR with respect to environmental assessment (EA) requirements. Since IDA would most likely require a category 'A' EA for NNP if it were to be formally entered into its project cycle, we have no quarrel with the need for extensive EA as per FPCO's mandatory guidelines. However, in principle, and in view of the minimal detail given to EAI the proposed work program (one line in Figure 7.3) we question whether 8 mm for a Senior Ecologist are really necessary in the case of NNP. Since the consultant will be undertaking the revised Gumti II feasibility study in parallel, IDA is agreeable that informal sharing of environmental inputs between NNP and Gumti II may reduce the need for such extensive inputs under NNP and apply them in the more sensitive Gumti II project. Clearly, this would reduce the additional budget required to complete NNP's feasibility study. In any event, the source of additional funding will have to be determined: this may be forthcoming from UNDP or, if GOB is willing, from IDA's forthcoming Technical Assistance VI Project. Whatever the source, the delays in processing this funding have to be considered by FPCO in terms of the consultant's work program logic and staff scheduling.	8. The consultants have already prepared and submitted a revised and consolidated proposal for the parallel studies of Noakhali North and Gumti II. However both the RPR Part 2 sections 2.2.3 pages 2.5 and 2.6) and the Gumti proposal make the point that the status of data and the presently allotted times and proposed budgets will not allow the meeting of the FPCO guidelines in full. It is essential that all parties fully understand and recognise and accept these limitations before undertaking the next stage.	Feasibility Study completed.
9. <u>Three Phase Feasibility Study Work Program</u>. NNP's technical and economic justification uncertainties, incomplete pre-feasibility analysis and unattractive economic justification - arising from the general comments of para 2.'s sub-paragraphs (c) and (e) - (i), as well as those of paras 4 to 6, - lead IDA to propose that the NNP feasibility study be undertaken in three phases. The first phase would last from June 1, 1992 to December 31, 1992 and include, inter alia, the following: (i) Undertaking of all SERM improvement, hydraulic, hydrologic and drainage efficiency studies needed to determine the technical viability of the irrigation, drainage and flood control concepts proposed including the combination with the Little Feni Option 3 proposal. These should include the assessment of sedimentation problems, etc. Whether these are to be undertaken at a preliminary level or full-fledged feasibility level, should be determined by FPCO/BWDB in consultation with the consultant.	9. The replies to the previous comments suggest that the basic premises of this comment are no longer valid. The economic justification is not now unattractive, and the technical uncertainties are not as serious as suggested by these comments. The proposed work plan for a three phase feasibility study is, therefore, no longer required. The need for coordination and parallel execution of the NNP and Gumti II studies, in any case precludes the suggested programme and additional interim reports for review could not be processed within acceptable time scales. The consultants maintain their view that with the more attractive EIRR now established that the project should proceed on the basis presented in their recent proposals for parallel studies of Gumti II and NNP.	Feasibility Study completed.

Comment	Replies by the Consultants	Action Taken in Final Report
(ii) Initiation of topographic and engineering surveys in May-July 1992 as proposed, but with the objective of providing the requisite assessment of the utility of the available maps (see section 7.3.2, Volume II) by December 15, 1992. (iii) Completion of the proposed agro-socio-economic surveys and environmental assessments, as well as analysis of principal findings relevant to project formulation and economic analysis. (iv) Preparation of a preliminary economic evaluation and multi-criteria analysis incorporating all sources of increased (or reduced benefits). (v) Preparation of an Interim Report for mid-term review. The second phase consists of a mid-term review in January 1993 which would determine whether completion of a detailed engineering, economic, institutional and social/environmental analysis at feasibility level is justified. In the event of a positive outcome, the third phase would consist of the study's completion. It would seem that the three phase approach (together with coordination of inputs with the parallel Gumti study), would enable to work to proceed immediately with available funding until additional funding is secured, or until a decision is made that study completion will serve no useful purpose.		

Category 2

Comments, Replies by Consultants and Action Taken in Final Report on Draft Final Report of regional Plan of South East Regional Water Resources Development Programme BGD/86/037 (FAP-5), April, 1992

BWDB COMMENTS

Comment	Replies by the Consultants	Action Taken in Final Report
Chief Engineer, Design-II, BWDB, Dhaka		
The report under consideration consisting five volumes and one Album of drawings was made available except the 'Volume V for comment on it. It is a very big report supported by review of relevant previous studies on the respective 'Planning Units' and necessary data, maps, figures etc. for evaluation. As many as five Consultants worked for its preparation and thus ended with a price worthy elaborate report which deserves warm appreciation.		
Staff schedule shows that a handsome number of expatriate consultants together with highly qualified local consultants worked long time for the study touching almost every relevant issue associated with the 'Planning Units'. But the time available for making comments has been very inadequate; to speak the truth the available time was not sufficient to give just one time quick reading to all the four volumes of the report available. Within such limitations, Volume II, "The regional Water Plan", was Consulted and comments on some of the issues/problems/ recommendations which appeared to have scope for further review/up-dating by the consultants are furnished below for necessary action.		
A. Figure 1.2 at page 1-3 shows the Meghna water Surface Profile indicating mean August High/ low water levels and Mean May high/low water levels of 1980-81 drawn for co parison with 'approximate flood plain levels' from Akhaura to as down as Daulat khan (Hatia). This map was obtained from **SERWRDP**. The intention of this exercise is obvious: demonstrating a comparison of the approximate flood plain levels with the mean high/low water levels. But use of data of a decade earlier and probably a borrowed drawing fall quite short to meet the requirement of the report. Could the consultants please look into it again to up-date the drawing with recent (or appropriate) data with proper technical justification section of water levels data.	The commentator has misunderstood. The SERWRDP is this study; the Figure is not borrowed. The calendar year used is not significant. Any year could be used to identify seasonal water level as compared with flood plain levels.	The description relating to the figure has been amended.

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Comment	Replies by the Consultants	Action Taken in Final Report
B. The report states, "The increase in the area developed represents in annual rate of increase of just under 4% in the present total of ground water development. This is less than has been achieved recently but is based on the assumption that DTWs which form most of the potential in the region will prove more difficult to develop for social regions (reasons)".(P 2-2).		
The social reasons have not been explained in the report in a convincing way. Could the consultants explain the social reasons they apprehend to prove difficult for development of DTWs in detail in the final report.	The consultants will review and if necessary revise the explanations given in the report. (See sections 2.3.1, 2.3.4(b) which are considered to give the necessary detail).	References have been revised.
5.4 Planning Unit 4 - Little Feni River The report states. "There have been report that some DTW are failing, in Chauddagram and Feni Upazilas which may indicate some local difficulties in full exploitation of the potential" (P 5-41).		
The consultants do not appear to have investigated any of the failed DTW to give a clear picture of such failure nor have they supplied any statistics of the reportedly failed DTW to serve as an indication of the magnitude of the problem. It will be appreciable if the consultants can take care of this matter in detail in the final report.	The generally low yield of wells in the area indicates that this area would be better suited to 1 cusec wells rather than the currently used 2 cusec type. This is discussed in Annex V where the numbers of operating and non operating wells is identified for each Upazila. It may be noted that existing development in Choudagram exceeds the recommended levels for mode 1 or 2. Further development would require a change to mode 3 (1 cusec DTW).	No action required but see amended report (Chapter 7 of Part 2).
5.4.4(b) Enlargement of Dakatia River The Report underlines that "The Dakatia River is to be enlarged, where necessary, to the required cross-section between Dakatia and Disaganj Pump Stations. The existing channel top width is generally adequate, but allowance has been made for an average 10m strip of land acquisition on each bank for access, spoil and formation of low embankment where necessary" (P 5-46). It is seen from the report that the excavation Volume will be 1.353 million cubic metre in a length of 58 km. This shows that on average 23.33 cu.metre spoil earth will be obtained to spread of over 20 sq. metre of land giving a thickness of about 1.166m. From this consideration, proposal for acquisition of average 10m strip of land on both side seems high and should be reconsidered. Perhaps acquisition of a 15m strip of land on one side may be adequate giving an average 1.555m high inspection embankment.	The distribution and location of the excavation quantities and of the need for low level embankments to prevent local flooding in the dry season due to high levels in the river upstream of the pump station cannot be accurately quantified at this level of planning. The difference between the allowance made in the report and that suggested by the commentator is not significant in terms of cost.	Chapter 7 of Part 2 has revised this proposal and no land acquisition is now required here.

Comment	Replies by the Consultants	Action Taken in Final Report
5.5 Planning Unit 5 - Dakatia Option 4		
The report says, "The number of regulators on tributary khals has been left unchanged, but these are now primarily for control/retention of irrigation water within the Dakatia River rather than flood control, and therefore shift away from the Chandpur - Comilla road to the river bank itself. The exact number and sizing is subject to review". (P 5-63). The above statement leaves doubt whether this report has been submitted without finalising the exact number and sizes of the regulators on the tributaries. This matter should be finalised and included in the final report.	All the development proposals are calculated to a similar level of accuracy appropriate to this level of planning. Accurate sizing of regulators and the finalisation of their locations and numbers is to be done at the feasibility stage.	Chapter 7 of Part 2 shows all regulators required.
5.6 Planning Unit 6 - Chandpur Irrigation Project (P 5-72). In this planning Unit, "Bank erosion by the lower Meghna, structural problems at Charbagadi Pump Station, loss of capture fisheries and growth of water hyacinth" have been identified as the major constraints of the project. "Retirement of embankment at Hanarchar and excavation of canals and drainage channels" have been mentioned as the main project option (P 5-74). The Capital costs and O & M costs were projected to be Tk. 40.2 million and Tk. 31.1 million respectively. EIRR was shown roughly around 60%. "For net differential economic return to F C D, the calculation was made in 1978 prices" which was multiplied by a "factor of 1.77" to commensurate with 1991 prices, the report says. **Comments:**		
In fact the consultants took the cost prepared by S R P of the BWDB. It does not seem to be a good practice to calculate the project cost just using figures obtained from SRP with some manipulation when the upto-date prices were available.	**(a) Capital Costs** The costs of the remedial measures proposed for CIP were calculated in a similar manner to those for other project proposals using the same costing methods (See Annex X). The proposals were discussed with the staff of SRP and the strategy agreed. They are therefore recent costs.	No action required.

Comment	Replies by the Consultants	Action Taken in Final Report
Regarding water hyacinth, the report mentioned that " In parts it is reported to be so dense that it is very difficult to cut through". This was followed by a comment that" these (there) appears to be no reason why it could not be dealt within a thorough manner and to a large extend (extent) flushed out through Hajimara regulator. "From this casual comment it appears that the consultants have not made any investigation into this problem which since commissioning of the project (CIP) has caused almost total steppage of navigation through the project area though it was the main route of communication for the peoples prior to implementation of the project. It has been simply impossible for last about 15 years to flush any water hyacinth effectively starting from Charbagadi through the Hajimara regulator. This caused resentment among the beneficiaries of the project. Every year in the month of May-June the water hyacinth is cleared by the fishermen for catch fish but within very short time it grows again causing such problem. The alternative to this problem is the development of the road from Chandpur to Raipur via Faridganj which will serve as the main route of communication for the beneficiaries and also for the inspection of the project as well as developing marketing facilities for the agricultural products. This issue may be taken care of in the final report.	**(b) Water Hyacinth** The water hyacinth problem is largely O&M problem and CIP has its own O&M consultants. The study team has merely pointed out that a properly developed O&M programme could substantially overcome the problem using manual/mechanical methods. This is not a matter for the regional plan to investigate. Longer term a more cost-effective solution could be researched but again this is not a proper subject for this regional plan.	No action required.
Regarding structural cracks in the Charbagadi Pump Station it has been mentioned to be an old (?) problem and has been stated that "the cracks do not appear to be deteriorating, they should also be carefully mentioned" (P 5-74). Five consulting firms having engaged a lot of engineers and experts have prepared the report but it fails to give any indication about location and magnitude of the cracks and any systematic statistics about the cracks since those were noticed. The water development Board successfully repaired cracks in the foundation of Udamdi Pump house in recent years but in case of CIP the cracks have been prescribed to be carefully monitored. Once the proposed rehabilitation works are done keeping the cracks at their present condition it will be difficult to initiate any repair works later for want of resources and probably due to inadequate experts help if they deteriorate in the future. Hence, the consultants should examine the cracks in detail and should recommend appropriate remedial measure in the final report in the greater interest of the project as a whole for prolonged existence.	**(c) Charbagadi Pump Station** The pump station developed cracks several years ago and these were the subject of a detailed study in 1990. (Mott MacDonald). The consultants have studied this report and have visited and inspected the pump station and have seen the repaired cracks and those that remain. The consultants have agreed with the conclusions of the previous study and see no reason to depart from their recommendations.	No action required.

Comment	Replies by the Consultants	Action Taken in Final Report
Director Planning (General) BWDB, Dhaka: 02. Capital investment cost of most of the planning units have been calculated on the basis of 1991 price. But in the capital cost of planning unit 1,2,7 price year has not been mentioned. In planning unit-6 different economic return for FCD was calculated on 1978 price multiplied by a factor of 1.77 to commensurate with 1991 price. The consultant should look into the matter and update/modify the economic analysis with 1991 price in all planning units.	All capital costs have been calculated on the same basis (See Annex XIII), this includes planning units 1, 2 and 7. The economic returns for FCD in planning unit 6 are calculated on a similar basis to that used by Thompson 1990. This has not affected the calculation of capital costs.	Reference in final report is clarified.
01. Vol I, Part-1, Page 6.4, Section 6.3.3 (3rd para) Here Kharif I and II crop season have been folded under one set of meteorological condition. In fact, Kharif I and Kharif II crop seasons differ from each other in certain aspects such as crop adaptability, crop culture, climatologically (to some extent) etc. therefore, these two crops seasons may be separately discussed so far as agricultural aspects are concerned.	Careful reading of the report shows that the consultants have differentiated and between the kharif I and II crop seasons. However we would agree that it could be better described. Annex II (Page II.10 to II.11) also discusses these seasons separately and in more detail.	Final report chapter is revised and clarified.
03. Annexes Vol.III, Page I.8, Section 2.1, 2.2 Soil survey data area compiled in this report from the Reconnaissance. Soil Survey Report prepared by the Department of Soil Survey (Now SRDI) from the period 1965 to 1976). These are back-dated data. So, for updating the Soil data, semi-detailed soil survey is necessary to know the present detailed information of the soils to determine the future agricultural cropping pattern.	Semi-detailed soil survey is not required for the regional plan.	No action required.
08. Annexes Vol.III, Pages II-12 to II-6, Figures II-2 to II-3 a) From the text it is seen that both local and HYV T.Aman are grown in the project area, but in the representative cropping patterns these have not been shown separately. b) B.Aman/TDW Aman has been shown to the grown under irrigated condition (refer to Figures II-4 and II-5), but reasons for doing this has not been explained. This may be clarified. c) Growing season of Boro appears to be shorter than usually required. Necessary adjustment in this respect may be made.	(a) The comment is correct but it is not considered necessary to change the figures. (b) This is not a correct interpretation of the figures. The B Aman/TDW Aman may be included in an irrigated cropping pattern an F2 - F4 land where irrigation takes place in the dry season but it does not suggest that these crops are irrigated. (c) The growing season for HYV borrow is shown to vary between 105 to 120 days which is quite normal for such crops. Local boro is shown to have a growing season of 120 to 135 days.	This figures have been amended to show irrigated crops in the cropping pattern.

Comment	Replies by the Consultants	Action Taken in Final Report
11. Vol.II, Page 5-41, Section 5.4.3 Planning Unit-4 Little Feni River It is reported that some DTW are failing but there is no mention of reasons/magnitude of failure. Reasons and magnitude of the problem should be indicated in detail in the final report.		Reference is revised in final report which explains why it is not further investigated.
Directorate of Planning Schemes I, BWDB, Dhaka. 'S O I L' 1. As the proposed project is necessary to project the natural calamities caused often reported phenomena of seasonal rainfall and drought and with a view to reducing the peoples suffering from Agro-socio-economical losses and consequently achieving the targets of high yielding varieties or crops in large areas of the project, a comprehensive information of preset soils and agriculture condition should obviously be there in the report. For having such idea present information of soils incorporated in the report is nit enough for recommendation of crop practice from which people will incur benefit in their Agro-socio-economic life. Reconnaissance soil survey was carried out by SRDI before 14-17 years. Only soil associations of 8 Nrs of Agro-Ecological Zone (AEZ) were identified. Neither particular areas of individual soils services nor any information of single soil series described in the report. Each soil series has its own characteristics and contribution to agricultural practices. So, it is essential establish soil series by field survey depending upon the changes to topography and agricultural practices. To have such a comprehensive information of soils, some detailed sample blocked locations scattered in the project area and from which information of almost all soils can be collected for determination of potentiality. Then only it will help boost up agricultural output and the project purpose will be served.	The consultants would point out that the TOR and the consultants proposal indicated that no new soil surveys would be carried out for this study. Existing data was to be used. This is primarily a water plan.	No action required.
Section 6.6, Tales 6.2, Page 6-8 (Main Report): The table 6.2 does not show the present foodgrain production requirement and the gap (deficit) regional basis, although the attempt is quite appreciating looking from the point of planning unit basis. But the total number or population for five planning unit counting from above is 3 130 000 with deficit per capita consumption while for the rest with population 8 171 000 each having per capita consumption of varying unit up to 0.77 kg. (whereas average requirement 0.454 Kg.) should needs clarification.	Bearing in mind that account is taken of exports from the area to Dhaka (See page 6.7) or other centres the higher production figures in Gumti, MDIP and Dhonagoda do not necessarily have any further significance. Equally a regional surplus/deficit is not necessarily significant. However deficits in more remote planning units such as Noakhali North, Polder 59/2 and Dakatia are of more interest.	This has been removed from the final report.

Comment	Replies by the Consultants	Action Taken in Final Report
'AGRICULTURE' **(Annex Volume III)** **1. Page 1.5, Section 1.3:** While discussion agricultural development possibilities outside CIP, it has been observed in 2nd para of page 1.5 that any large scale irrigation/drainage projects in this region need to take into account the following and while stating the points to be taken care of the impact related of hydrological hazards due to such empoldered projects to the west of Meghna river/region including to the north has not been mentioned. Flooding water of the entire Meghna basin (where medium to very low land constitute about 31% of this region) due to back water flow during high stage of the river would then divert towards those areas worsening the area further. Therefore aforesaid impact needs to be mentioned.	The consultants do not consider that these aspects should be discussed in the agriculture annex. They are discussed elsewhere in the report as appropriate.	No action.
3. Section 1.2; 1.2.1 and 1.2.2., Page 11.3, 11.4 & 11.8 (Table 11.4): (a) In the above section, statements as to BBS, MPO, & Consultants observation regarding crop and yield data area very much confusing. It is stated in 1st para of page 11.4 that due to doubts of BBS data, MPO Process six years data from 1983/87 to 1988/89. Intension of processing of these two periods are not stated. Moreover, in contrast to BBS limitation of manpower, administrative weakness, MPO's manpower, methodology of processing collection of data needs to he further elaborated to prove its superiority over BBS. This is needed because the consultants have quoted MPO as the source of crop related data very frequently.	It is agreed that the presentation is confusing and this will be amended. However it should be pointed out that all the data is from BBS. There is no question of superiority. MPO only process and analyse the data and so have the consultants. The comments of the consultants in the report have drawn attention to apparent inconsistencies and anomalies in the data. All the data has now been processed using similar methods.	This has been revised and much improved.

<table>
<tr><th>Comment</th><th>Replies by the Consultants</th><th>Action Taken in Final Report</th></tr>
<tr><td>(b)(i) It is also stated in 3rd para of page 11.4 that due to two big floods in 1987/88 and 1988/89, the data of these two years do not represent normal situation of the study area and accordingly 1986/87 figures, the consultant thought to be representing the present situation. By quoting data from table 11.3 & 11.4 and examining those, can it be agreed upon with the above statement (only grain crops).

'FOODGRAIN'

Year — % of Acreage — Gross Production in 000
1983/84 — 89.24 — 1 800.9
1984/85 — 86.62 — 1 772.5
1985/86 — 87.45 — 1 686.9
1986/87 — 83.34 — 1 805.6
1987/88 — 85.98 — 1 979.3
1988/89 — 84.64 — 2 038.9</td><td>No Comment.</td><td>Data now used is for 1989 and later</td></tr>
<tr><td>(b)(ii) Even individual crops yield do not justify the damage it compare those years with that of 1986/87 ones.

(c) Again crop damage data due to flood of 1987 has been shown in table 11.5 (page 11.9) where almost all the major crops area have been shown. But from 2.b above total grain even rice production of that year does not justify the above damage percent presented in that table. It also need further clarification.</td><td>(b)(ii) and (c) Because crops totally lost in floods are not recorded in the BBS figures the statistics do not represent the full extent of the damage.</td><td>Chapter 3 of part 2 describes the methodology used.</td></tr>
<tr><td>Comments on the Economic analysis:

I. The consultants have estimates NPV at 12% discount rate. But Planning Commission of Bangladesh not yet revised the discount rate figure. (Presently shown in 15%), so the consultant should make another exercise by calculating NPV at the rate of 15%.</td><td>The consultants have followed the FPCO guidelines.</td><td>No action required.</td></tr>
</table>

Comment	Replies by the Consultants	Action Taken in Final Report
II. Capital investment cost of most of the planning units have been calculated on the basis of 1991 price. But in the capital cost planning unit, 1,2,7 price year has not been mentioned. In planning unit-6 different economic return for FCD was calculated on 1978 price multiplied by a factor of 1.77 to commensurate with 1991 price. The consultant should look into the matter and update/modify the economic analysis with 1991 price in all planning units.	All units calculated on the same basis.	No action required.

Comment	Replies by the Consultants	Action Taken in Final Report
Deputy Director, Office of the Chief Engineer, Hydrology, BWDB, Dhaka. **Comments on FAP-5** The study area covers approximately 9 000 sq.km comprising the whole of the district of Brahmanbaria, Comilla, Lakshmipur, Noakhali, a part of Feni district and a part of Madhabpur, Upazila in Habigang district. expert the area from the Habiganj district the area is within the MWDB south Eastern Zone (Fig. 1.1) For the Regional plan the study area has been divided into 13 planning units as shown in figure 1.2.	-	
Of the many objectives, Control of flood in the area due to over bank spill and erosion of river banks along with the possibility of improvement of water resources for irrigation were also included in the TOR of the study (FAP-5). From the report, it reveals that in addition to local rainfall run-off, the part of the region North of Chandpur is affected by flood water from the upper Meghna; while the Eastern and the South-Western parts of the area South of Chandpur are affected by the flash floods coming from the Tripura Hills across the boarder. But the Eastern Catchment generating flash flood, is rather small and has short and less damaging effect. So, while embankment along the bank of the river Meghna North of Chandpur seems essential it is not so for the area of South of Chandpur. So, except of the Northern region and in the coastal area where tidal effect is high, embankment along the bank of the river Meghna has little justification. Local flooding is caused, principally by the local rainfall run-off and by poor drainage facilities.	This, broadly is also the consultants analysis but the type of embankment to be developed in the northern part of the region need careful analysis at the feasibility study stage.	No action required.
The rivers Titas, Gumti, Salda/Buri, Dakatia and Little Feni river drain most of the study area and provide the basis for the drainage of rainfall run-off in the rainy season (Fig. 8.1). Discharge stations function on the Little Feni, Gumti, Buri and on a Tributary of the river Titas. But neither any data nor its analysis has been presented in the report. Drainage of the area is found to be affected by the back water effect from high flood in Meghna either for flood water coming from the riparian areas or under tidal influence.	This data was presented in the Appendices to the Hydrology annex in the interim report but was not reproduced for the draft RPR. This will be added to the final report.	All data presented in Annex VI of final report.

Comment	Replies by the Consultants	Action Taken in Final Report
So, except navigation there seems to have little scope to improve drainage facility in the area dredging the internal rivers. So also, putting embankment along both sides of the internal river may further aggravate the flood situations in the region.		
On the west of the region the mighty river Meghna is actively eroding its bank at the Meghna Ferry-ghat, Eklaspur and at Haimchar. Measures for the protection of those area from erosion with hard materials were actively considered in this report as well as in another report of Meghna river bank protection. But study on morphological behaviour of the rivers, the Meghna, the lower Meghna and the Padma at their confluence reveals that resuscitation of any other channel to shift flood load and thereby improve situation for better bank stability is found absent in the report.	This aspect was discussed in the report and retirement of embankments was preferred to construction of hard points. The dredging of the main river channels was not considered.	See morphological section of chapter 2, part 1.
COMMENTS ON HYDRO-CHEMISTRY		
It seems from chapter 3 on Hydro-Chemistry that there is little investigation done about the Ground water quality.	Further studies were recommended.	No action required.
Presently groundwater is utilised for irrigation and other purposes from the recent alluvium formation within 153m depth. Except the Northern part of the study area, groundwater situation in the South & South Eastern part is more or less different either due to salinity problem or non-availability of good aquifer in the shallower Zone.		
It seems from Table 3.6 Page V-70 that in some areas the EC value has been increased & in some areas decreased, but the reason has not been mentioned. Sample depth is a pre-requisite for Geo-Chemical study. But in the comparative study (Table 3.6) it has not been furnished.	The revised data was obtained from the recent surveys by the DTW II project.	
Not only chloride or salinity problem exists in the Laksam area but also there exists some iron problem not mentioned. High iron content puddle the land which retards the plant growth and production. In Chandpur, Matlab, Haimchars, Haziganj, Raipur and Faridganj iron Content is less in deeper aquifer below 150 m depth.		See revised reference in Annex V and main report.

Comment	Replies by the Consultants	Action Taken in Final Report
From Chapter 3.4 para 4 Page V-82 chloride Content is higher mostly in the southern part of the study area. Some areas of south Western part is influenced by brackish & saline water intrusion and resulted higher chloride contents in ground water. A large number of tubewells failed in the area around Barura Saharasti & Kachua Upazila. Whereas in the eastern side of Barura Upazila salinity is less. Recommendations furnished in Page V-114 and V-115 in respect of ground water quality study considering the ground water quality hazard and monitoring of water quality at different depth zones to asses the causes of variation and its extent may be admitted.		No action required.
Detailed study and investigation in the constraint areas regarding groundwater quality at deeper zones to ascertain the presence of aquifers, quality and quantity, source of recharge, salt and fresh water interface, possibility of groundwater contamination by intrusion of saline water in the long run should have places in the report.	Further detailed studies were recommended in the report but resources available to the study do not permit such studies for this stage.	Recommendations for further study in the southern part of the region are included in the report.
Superintending Engineer, Chandpur O&M Circle, Chandpur: **Vol 2, Page 5-19, Planning Unit 3, Noakhali North.** Some area (3 000 ha) adjacent to CIP may be included within the existing project facilities as some area of the project in the west has been fallen out side due to retirement of embankment. Recommended for detail study in this regard.		No action. See NNDIP feasibility study.
Vol. II, Page 5-59, Planning Unit 5, Dakatia Area comprising part of Upazillas Haziganj, Shaharasti, Kachua of Chandpur and Laksham, Barura, Nangalkot of Comilla and Begumganj & Senbag of Noakhali are included in this unit. But the calculated EIRR is found too low which may be further studied considering combined with two adjacent units i.e. unit 3 & 4.	This has been studied and the results analysed, see section 5.4 of the report.	Now part of chapter 7, part 2. Revised treatment shows improved EIRR.
5.6.3 Other constraints may be included i.e. less ventage of Hajimara Regulator for drainage; the manual operation of gates of Hajimara Regulator instead of operation by power; absence of dykes in the bank of drainage/irrigation canals.	These are O&M problems which should be referred to the consultants assisting with O&M.	No action required.

Comment	Replies by the Consultants	Action Taken in Final Report
Vol. II, Page 5-89, Planning Unit 8, Dhonagoda The Upazilas included in whole or in part are Matlab, Haziganj, Kachua, Shaharasti & Chandpur in Chandpur District and Daudkandi Chandina, Barura, Burichang & Kotwali in Comilla District. It comprises a very big area resulting very low EIRR. So, it may be recommended for further study by Sub-dividing the total planning units into sub-units.	Several options were considered and not all comprised the whole unit but protection of only a part can cause disbenefits to other parts.	Revised proposals show better returns. Chapter 7, Part 2.
Superintending Engineer, Comilla O&M Circle, BWDB, Dhaka. 1. There is no indication about the requirement of dredging of Dakatia River in the down stream of the location of Kamta and Dakatia Pump Station. There is no study about further downwards shifting of the pump station to minimise dredging cost.	The calculations could be presented if required. These calculations showed that the amount of flow which can be reversed up the Dakatia reduces the further upstream the pump station is located.	Chapter 7, Part 2 now shows these calculations.
2. No thing has been specified about the reduction of siltation of Kakri & Dakatia River. This is a chronic problem which is to be looked into. Only enlargement of Dakatia River will not help much.	This is a complex problem requiring study at the feasibility study stage (as recommended).	TOR for further studies is now included as Annex XIII.
3. Similar is the case with New Dakatia also.	See Above.	See above.
4. Concrete suggestions regarding improvement of drainage congestion in Planning Unit 9, 4, & 5 are to be provided.	For units 4 and 5 this has been done but for unit 9 the same problem applies in respect of detailed study.	See above.
5. The proposed irrigation in Noakhali - North Unit through secondary lifting from Dishaganj Pump Station seems to be costly.	This is only recommended for the Dakatia/Little Feni combined development.	Revised proposals are in Chapter 7, Part 2.
6. Noakhali North Unit has been highlighted much not entirely for irrigation through it is already developed in irrigation. Drainage problem is much acute in this unit. Which is to be looked into.	The proposed project is primarily a drainage improvement scheme.	Chapter 6 of part 2 and feasibility study describe proposals in detail.
Comments from Design Branch of the Office of the Chief Engineer, SEZ, Comilla: **B. Comments on South East Regional Plan Report Volume V** 1. Art 1.7 storm reduction factor; figure 1.19 showing a Theissen polygon network has not attached to this report. Mean area rainfall for a station has been determined at three different levels by considering the nearby stations but the significance of determining these three level of mean area rainfall has not explained in the report.	Figure 1.19 will be included in the final revision. The explanation is in the first paragraph of section 1.7.	This figure is now included in Annex VI, Chapter 1.

Comment	Replies by the Consultants	Action Taken in Final Report
3. Chapter 3 Modelling part. The south eastern regional model study does not include in area of greater Chittagong, but why? This has not been explained any where in the report.	It was not included in the TOR.	Refer to Annex XII TOR.
4. Chapter 5, Page 5-31 Table 5.9 shows the Muhuri Reservoir characteristic but the tabulated value does not match with the elevation storage curve given in figure 5.17. So the correct curve matching with the tabulated value should be given.	These two sets of data are for different purposes. Please note that figure 5.17 covers only a part of the reservoir area but allows comparison of preconstruction and current storage volumes to assess siltation. Table 5.9 shows the preconstruction data for the full reservoir.	No action required.
5. In page 5-35 It has been explained that severe bank erosion problem has been occurred down stream of regulator and this problem is crucial and continuous observation and monitoring is necessary. But any solution for this problem has not been mentioned in this report.	Please see last sentence on page 5.36.	Now in Annex VI.

Comment	Replies by the Consultants	Action Taken by Final Report
4. WARPO (MPO) model resource potential has been based on calibration of multicell model with fixed parameters. SERS estimate is based on single cell upazila model. Details of parameters and other information not known. SERS estimate mostly exceed the WARPO (MPO) estimate. Details of parameters used and other information needed for comparison and verification in such cases.	Details will be included in an Appendix to the Annex.	The SCTM is now included as an Appendix to Annex V.
5. Further investigation regarding the saline problem in GW is necessary to determine the origins and source of salinity in the deep tubewell aquifers so that decision can be taken if this resource can be further developed.	This is agreed and is recommended in the report. It could form part of the forthcoming NMIDP project.	Coastal aquifer study is recommended in the report.
6. Volume III, Annex I All soil informations are given according to AEZ and soil association but no information on soils is given while individual planning units are described in Volume II.	Agreed.	No action.
7. Volume III, Page II-12, Figure II-2 Patterns with B.Aus and Jute in FO lands under irrigated condition not only uneconomic but absurd too. T. Aus is appropriate.	These figures illustrate cropping patterns with irrigation but not all the crops are irrigated. It is the HYV boro, wheat and potatoes which are irrigated in these patterns.	Figures revised and clarified.

Comment	Replies by the Consultants	Action Taken by Final Report
Comments from Mr. Van Ellen, Panel of Expert of FPCO:		
Category II		
Volume I, Part 1 - Existing Situation		
2.1. The order and emphasis of the various chapters is not quite logical: this is water resources development programme and one would expect matters directly related to these resources to come first and to get most attention. This is not the case and is rather disturbing while reading through the report.	This comment is noted. The present order sets out the regions socio-economic, agronomic profile before discussing the water aspects. This seems logical to us but this could be considered a matter of opinion.	The report has been recast as the commentator proposed.
2.2. p. 5-14, para 1:		
The statement about cyclones and associated events needs substantiation. There are too many stories and too few actual data: there are very few actual measurements of maximum wind speeds, one reason being that there are too few stations to have a good chance to observe the maximum values.	This is agreed. These are exceptional events; the lack of data is a handicap.	No action.
2.3. p. 8-7, section 8.3, para 2:		
A figure showing the flood-depth duration characteristics should be added.	See Volume 2 part 2 page 3.6 and also Annex XII. (Now Annex VI)	No action.
2.4. p. 9-1, para 9.1:		
Figure 9.1 does not show a salinity area around Matlab Bazar.	As the text explains this area requires further definition hence the question marks on the figure.	This has been revised.
2.5. p 12-2, section 12.2		
Is it correct to state, as a characteristic for Single Lift with Gravity Distribution, that the drainage system is completely separate from the irrigation system? In theory yes, probably, but it does not prevail in any of the described system, also not in MDIP.	The only connection in MDIP is the pump station itself however we accept the point and will revise.	Revised.
2.6. p 12-8, section 12.6 and related figures:		
The date of the figures presented, should be mentioned.	The source and data of the figures are given on page 12-12 in and below table 12.3.	No action.

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Comment	Replies by the Consultants	Action Taken by Final Report
2.7. p 13-15, line 9: The recommendation to construct a silt trap is made too casually. It would require a through study, regarding location, dimensions, maintenance etc.	This is also referenced in Volume II part 2 Chapter 5.4 Little Feni. There are already licensed abstractions of deposits for building sand. This should be developed at feasibility study stage.	No action.
2.8. p. 14-5, Systems Rehabilitation Project: The description is too concise to be understood well.	These projects are described more fully in the relevant sections of Chapter 5 of Part 2.	Now in chapter 7, part 2.
2.9. p. 14-9, National Minor Irrigation Development Project: The relevance for the project area should be explained.	The consultants consider this section clearly demonstrates NMIPs relevance as an essential component in the effective development of all types of minor irrigation.	No action.
2.10. p 15-1, section 15.2: The causes for cost and time overrun are probably even more complicated than indicated here. What lessons have the consultants drawn from the analysis and how do they propose to avoid the same conditions?	The section on implementation in Chapter 6 of Part 2 will be expanded to describe the recommendations (eg project staging, contract types, land acquisition etc).	Now explained in chapter 10, part 1.
Volume II, Part 2 - The Regional Water Plan **2.11. p.1-6, section 1.5: last sentence:** Chapter 5, unfortunately, given rather little information, qualitatively and quantitatively, about flooding and drainage characteristic. Reference is also made to earlier observations regarding the seasonal variations.	This section should also have referred to Chapter 2 where the sub regional strategy characteristics are set out. The number of projects and alternatives studied precludes detailed studies at the pre-feasibility stage.	This is now cross referenced to Annex VI (Hydrology).
2.12. p. 1-12, section 1.7, para 1: FAP 3 and 6 could some have impact on the physical conditions in the project area. Although full embanking of all upstream main rivers will have little impact on flood levels at Chandpur, the discharges, and thus velocities and intensities of morphological processes, could increase significantly.	The consultants have been informed that such impacts should be studied and costed by FAP 3 and 6 since they are costs of their interventions. Also FAP 5 cannot know at this stage what proposals FAP 6 may produce in a year's time. However FAP 5 will coordinate with FAP 6 during preparation of the Gumti II feasibility study.	FAP 6 has still not reported but final report indenfities where this is important.
2.13. p. 2-3, section 3: The first sentence does not agree with p. 1-10 Agriculture and should be changed.	Agreed	Corrected

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Comment	Replies by the Consultants	Action Taken by Final Report
2.14. p. 2-3, section 2.2.1: There are also notable gaps in the data on topography and (geo-) hydrology.	This is mentioned later in the section.	No action.
2.15. p. 2-4, last section: Why is it necessary for this study to make and estimate of the likely scale of available finance and what use is made of the provided information?	The consultants consider finance as a possibly limiting constraint in the rate of development and this is taken into account in Chapter 6	Referenced in chapter 10, part 2 of final report.
2.16. p. 2-5, section 2.2.3, para 2 It is not at all understood why it would be entirely reasonable to adopt a biased approach, looking primarily for potentially negative impacts.	A rigorous inventory of potentially negative impacts is necessary at this stage if all relevant impacts are to be properly studied at the feasibility EIA stage.	This reference has been slightly revised.
2.17. Page 2-7, line 7 What is the assumed irrigation development of only 70% of the area based on. Is land or water the scarce factor?	Other than formal irrigation project such as MDIP, which are not suggested in the plan since all future minor irrigation is to be in the private sector, this seems to be the maximum achievable and excludes areas of high ground, orchards and other areas planted to crops which do not benefit from irrigation.	This has been revised to 75% in light of feasibility work but limiting resource is water.
2.18. Table 2.1 and 2.2 How do the different figures compare; what is the source of the information?	The irrigated areas shown in the two tables are identical. The source will be added to the tables but see section 3.2.3 page 3.9.	Final report is clear.
2.19. Page 2-9 sub-section (b) para 2 The given statement underlines the importance of seasonal variation, referred to above.	This entire section describes how the accurate assessment of flood protection and drainage benefits requires detailed analyses of flood depths. This is not possible to achieve at the prefeasibility stage given the large number of projects. Thus benefits of shortened flood durations may be identified but not quantified at this stage.	Feasibility studies have described this for NNDIP and Gumti II.

Comment	Replies by the Consultants	Action Taken by Final Report
2.20. Page 2-12 sub-section (a) para 4 The statement is not entirely satisfactory. Each regional study is expected to develop specific interpretations of the compartmentalisation concept. The principle will always be the integrated development of flood protection and of the protected area. In general the consultants in various instances too easily refer responsibilities to other FAP's.	FAP 5 has tentatively started to develop a philosophy in this respect in the Gumti II area but the consultants are unwilling to be more specific until the area is examined in more detail at feasibility stage. Also part 1 page 10-14. The consultants view is that much more study of this concept is needed before firm recommendations can be included in a regional plan. Only the supporting studies have the necessary resources. The supporting studies are supposed to support the regional studies but timing of these studies is unfortunate.	Even after feasibility work in Gumti II the consultants do not wish to make further commitments that those in the final report.
2.21. Page 2-13, sub-section (b), line 1 The first sentence does not do justice to the eventual outcome of the study, which gives first priority to these two schemes. The same observation applies to Page 2-15, para 3.	The first of these two references will be reworded, the second seems reasonable.	Revised as stated.
2.22. Page 2-16, para 3 It is not clear where the alleged demonstration is given. Is this a statement with general significance?	The results of the economic analyses for all the full FCDI intervention options (eg Gumti II) are the demonstration.	No action.
2.23. Page 2-17, section 2.3.5, para 2 The statement about the provision of locks is too general. In each case a study would have to demonstrate the feasibility.	This is exactly what the report has stated. The implications should be studied for each area at the feasibility study stage.	No action.
2.24. Page 3-4, section 3.2.2 In this region, where flash floods may occur, a differentiation between pre-, mid- and post monsoon conditions is meaningful, see also earlier related observations.	This is agreed but for the regional planning stage this is not a viable option. It involves abandoning the present flood phase analogy and therefore all the related MPO cropping patterns etc. This cannot be done unless additional primary data is collected and analysed and also requires extensive further modelling. This is beyond the resources of this regional plan study.	No action.
2.25. Page 5-23, Table 5.3.1 How do the presented figures compare with those from Tables 2.1 and 2.2? The same questions applies to similar tables for the other projects.	As explained in section 5.3 analysis of the SERM results led to a change in the boundary between planning units 3 and 4 (See also note 4 to table 2.2).	all the figures are now comparable for irrigaiton/water resources purposes.

Comment	Replies by the Consultants	Action Taken by Final Report
2.26. Page 5-24, para 2 The information regarding the salinity boundary should be handled with caution. The objective set by MPO probably refers to mean conditions. At high tide, when preferably water will be taken in and certainly during spring tide, the boundary will be more to the north. The consultants should investigate this point more in depth, because of its critical importance for the proposed project.	Feasibility study will define this.	Feasibility work has resolved this.
2.27. Page 5-24, sub-section (a) para 2 It is doubtful whether a 40-vent structure is efficient with respect to operation and maintenance. Probably a more compact type of structure would operate better.	This is properly studied at feasibility stage.	Feasibility study recommends a 24 vent structure.
2.28. Page 5-44, sub-section (ii) Option 2 Without further justification there is reason to assume that siltation will not continue.	This is agreed but the solution proposed should have a reasonable project life in the same way as the Little Feni regulator.	Revised proposal in chapter 7, part 2.
2.29. Page 5-80, last sentence Other studies have indicated the crucial importance of an improvement of the transportation systems in the polder and the consultants should give full attention to this point.	The consultants have recommended and costed the construction of two navigation locks to improve transportation and have also suggested that the design study considers the alternative of feeder roads.	No further action.
2.30. Page 5-82, section 2 A justification should be given why 2 locks have been included.	See item 2-23 above.	No action.
2.31. Page 5-130, section 5.11.9, section 1 It is not clear whether the cost of the previous feasibility have been scrutinized and if not, why not. There is clearly something wrong there, but this need not discredit the entire study, as is done now.	The consultants were asked to analyse the existing proposals using the same assumptions as used for other SER projects. This has been done with clear results. The entire study has not been discredited but the donor agency has requested a supplementary study.	New study has reported on this in detail and is summarised in chapter 8, part 2.
2.32. Page 5-133, sub-section (a) Could submersible embankments improve the situation. Consultants should study this option.	This long narrow sub-unit has a relatively small area but would require long embankments. Also this area is Titas flood plain and if proper set back distances were allowed an even smaller area would benefit. The cost/benefit status is very poor.	Submersible option is not attractive (see chapter 9, part 2).

Comment	Replies by the Consultants	Action Taken by Final Report
Annexes Volume V, Annex XII **2.33 Page XII. 2-6, section 2.4, last sentence** The conclusion is premature, also continuing embanking of the Ganges could increase high water levels.	The last sentence is not a conclusion but a hypothesis recommended for further study.	No action.
2.34 Page XII. 2-8, section 2 Although the analysis of hydrological data appears to be thorough, apparently no homogeneity test has been made of high water levels. It is well known fact that the increase of maximum levels slows down once the level of the banks (and of "permanent" chars) has been reached. Most of the figures 2.5-2.8 clearly demonstrate this effect. This would change if flood embankments would contain all flow within the river bed. Ignoring this fact and treating all data as one homogeneous population results in an over-estimation of high levels without embankments and an under estimation once embankments have been built. The consultants should review this matter.	The analysis carried out by FAP 25 so far do not suggest large changes in level even with embankments all along the main rivers. The errors involved therefore are so small as to be unimportant when compared to the design of embankment levels with suitable freeboard allowance and taking into account the limits of accuracy of the analytical techniques.	Revised Hydrology Annex VI explains this.

Comment	Replies by the Consultants	Action Taken in Final Report
Comments from Mr. Dempster, Panel of Expert of FPCO: Category II **2.1 2-18, section 2.3.6** Mention should be made of the relevance (or otherwise) of the FAP 13/POE ideas for submersible embankments (for fish, not boro rice) and multi-purpose water management.	This is under discussion with FAP 17 but conclusions will not be available to the regional plan.	Gumti II feasibility study suggest submersible embankments are not very fish friendly.
2.2. Page 2-19, section 2.3.8, bullets To raising publicly owned buildings, add protection of infrastructure (roads, markets etc).	Agreed.	-
2.3 Page 5-23, para 1/2 of Option 1 The area covered by LLP (Area 1 in Figure 5.3.1) does not appear to be determined by topography. To the east and southeast irrigation is possible beyond the 4 metre contour, whereas to the north irrigation on the average is only up to the 3.5m contour. Perhaps this is a result of the natural channel reticulation, perhaps it is because of the northern boundary is determined by Area 2 (which begs the question as to whether STW/DSSTW is more desirable than LLP if there is no constraint on the latter), or perhaps this is all explained elsewhere in the report - which may be picked up on careful perusal.	The irrigated area is not well defined at this stage and will in fact be much more limited than shown and may include areas north of the Lakshmipur/Begumganj road. However most of the STW/DSSTW area is to the north since the grounwater quality in the southern part is poorer. Also there will be substantial areas away from khals which cannot be irrigated by the proposed development.	Feasibility study of NNDIP has defined this (see chapter 6, part 2).

Comment	Replies by the Consultants	Action Taken in Final Report
Comments of Mr. S. Jones, Panel of Experts, FPCO General The report is well prepared. The consultants have closely followed the Guidelines on Project Assessment (GPA), and where problems have arisen this concerned aspects of the analysis where the draft GPA did not give detailed guidance on methods of analysis. The consultants have carefully and competently described their approach to project assessment, the technical assumptions made, and so the findings contained in Regional Plan Report, Volume 2 - the Regional Water Plan are transparent. The consultants have sensibly restricted themselves to what can be realistically quantified, and have considered other issues only in a qualitative way, as recommended in the GPA. The consultants stress a careful "conservative" approach to quantification of benefits and costs which strongly endorsed. Further elaboration of project assessment at the full feasibility stage to take account of additional requirements and modifications in the GPA, in particular requirements of the EIA and the new set of economic prices are likely to reduce rather than increase the economic rate of return (EIRR) for the options set out in the regional plan. Therefore, the suggested ranking in Chapter 6, which gives priority to options which have an EIRR of 12% or close to 12%, is a useful guide to selection of options for full feasibility studies.	Noted	The final report incorporates the new set of economic prices given in GPA, together with various other additional requirements and modifications, wherever possible.
Volume 2, Chapter 5: Qualitative analysis as required in the GPA for multi-criteria analysis. The consultants have followed the GPA in including a qualitative analysis of potential benefits and disbenefits of planning options where these cannot be quantified and included in the economic analysis. However, the qualitative analysis appears to include two conceptual errors. 1. Present/without project/with project conditions (p5-17): The MCA for Planning Units 1 and 2 indicates that these areas are likely to suffer from "any rise in sea level" and accords a negative qualitative impact. But, it is not clear how these negative physical impacts are associated with the project unless it is because further development leads to more people and more physical capital being located in areas vulnerable to inundation.	Noted.	The evaluation and discussion have been revised (Chapter 5 of part 2).

Comment	Replies by the Consultants	Action Taken in Final Report
2. The qualitative analyses are presented in tabular form (Tables 5.1.4, 5.2.7, 5.3.8, 5.4.14, 5.5.7, 5.6.4, 5.8.6, 5.10.5, 5.11.17, 5.12.7, 5.13.8, 5.14.13 and 5.15.5), in which the ranking or scores for individual criteria are summed by category (physical, ecological, socio-economic and quality of life), and in total. This is an incorrect procedure, because an average (mean) cannot be computed for ordinal rankings, either across planning units (e.g. income distribution ranking for all planning options) or across different variables (physical, ecological and socio-economic) within a single planning unit. If study teams are having difficulty in undertaking multi-criteria analysis then it may be necessary to provide further guidance in an annex to GPA. The consultant should have brought together qualitative findings from the different planning units and summarised these in Chapter 6. In addition, the qualitative analysis offers an opportunity to identify issues of special sensitivity in a particular planning unit and the qualitative analysis could have been used for this purpose.	Noted.	The summation of scores has been removed. The discussion has been revised and expanded where appropriate.
3. Presentation of results of economic analysis and sensitivity analysis: in each case, salient points of the analysis should be mentioned in the text rather than leaving interpretation to the reader, e.g. Volume 2 Section 5.2.6, page 5-15/16.	Noted.	The discussion of sensitivities etc. has been expanded, especially in the case of Noakhali North (Chapter 6 of Part 2)
Proposals for Full Feasibility Studies 4. Chapter 7.3 Surveys: 7.3.1 Agro-socio-economic surveys: The consultants recommend a survey design intended to minimize sampling errors and to provide estimates for populations of the whole planning unit. However, in seeking to minimize sampling errors there is a trade-off in terms of errors of observation and survey costs. The consultants should consider simplifying the proposed stratified survey: reduce the number of mauzas or clusters sampled at the first stage and increase the number of sampled households or farms at the second stage. This change would reduce the costs of organising and supervising surveys and importantly almost certainly substantially reduce errors of observation which are potentially more serious than sampling errors in rural Bangladesh. [The consultants might wish to consider a design including two mauzas or villages per zone and larger samples in each village. In addition, they may wish to verify that the sample adequately covers different land types by sampling transects of plots].	Noted.	The feasibility study methodology wa: modified along the lines suggested.

Comment	Replies by the Consultants	Action Taken in Final Report
5.7-9: Ecological Impact Assessment: The consultants indicate that the requirements of GPA Annex 5 (Ecological Impact Assessment) and Annex 8 (Environmental Impact Assessment) are considerable in terms of data and analysis. Having regard to these requirements it will be of vital importance at this stage to specify more clearly a limited set of agro-ecological and environmental impacts which will receive priority in the full feasibility study.	Agreed.	This has been reflected in the Noakhali North feasibility study.
6.5-17 Environmental Evaluation: Is the text here describing project impacts or problems of planning unit two in terms of risks associated with a coastal environment?	The evaluation and discussion will be revised	Revised in final report (Chapter 5 of Part 2)
7.7-11 Para 4: 'But it is known that fish provide 70% of the protein in each persons diet in Bangladesh' source? Studies of rural nutrition indicate that the greater part of protein in the average rural diet comes from consumption of cereals.	Noted.	This chapter has been supervised in the final report.
8.7-9 GPA Ecological Impact Assessment does not extend to include issues of human and animal health in particular nutrition (7-11). There appears to be a need to discriminate in planning full feasibility study for projects between activities which require intensive investigation at a planning unit level and issues where feasibility studies will have to draw upon information from scientific technical studies undertaken for Bangladesh as a whole e.g. FAP 17. Clarification on these issues needed urgently to ensure human resources are effectively used in feasibility study.	Agreed.	No action required in final Regional Plan Report.

Category 3

Comments, Replies by Consultants and Action Taken on Draft Final Report of regional Plan of South East Regional Water Resources Development Programme BGD/86/037 (FAP-5), April, 1992

BWDB COMMENTS

Comment	Replies by the Consultants	Action Taken in Final Report
Chief Engineer, Design II, BWDB, Dhaka:		
Lastly, the computer can check spelling but it can not check decide the intended word (e.g., their/there or region/reason). We came across a few spelling mistake (in volume II). Hence, prior to submission of the final report it will perhaps be worthy to edit it.	The consultants acknowledge that there are some editing errors in the draft report and every effort will be made to remove these from final version.	Further editing has taken place.
Directorate of Land & Water Use, BWDB, Dhaka		
1. Page Nr 1-19, 1-23 and 1-29 of Table Nr 19.		
The area of soil association of Nasirnagar, Burichang, Brahmanpara and Shahrasti Upazilas do not coincide with the area of land type of the same Upazilas of the project. The consultant is requested to check and correct the Data.	The figure will be checked and corrected as necessary	No errors were found.
2. Page Nr 1-38 & 1-41 Table Nr 1-10 & 1-11		
After correction of the above mentioned anomalies, the figures are to be inserted in the above mentioned two tables.	The figure will be checked and corrected as necessary	See above.
3. Page Nr II-2, Table Nr II-1		
The percentage of NCA in polder 59/2 has shown 0.0. The consultant is requested to recheck the figure.	Table headings are incorrectly identified. This will be corrected in the final report.	Corrected.
4. Page Nr II-6 & II-7 of Table Nr II-2 & II-3		
There are some mistakes in the production figures of different crops.	We are unable to identify any mistakes.	None - these tables are no longer included in the revised Annex II. See also the revised discussion of crop yields in Chapter 6 of Part 1.
The consultant is requested to check and correct the figures. The soil survey data compiled in this report have been taken from the Reconnaissance soil survey reports prepared by Department of soil survey (SRDI) between 1965 to 1976. Since the data collected long before and hence need to be updated for better optimum use.	In fact the original data has since been refined and updated using the FAO 1988 work and other sources. Also the consultants are aware that new survey data has been collected in some areas by SRDI but this data has not yet been published. Attempts will be made at the feasibility stage to obtain this data.	

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Comment	Replies by the Consultants	Action Taken in Final Report
Directorate of Planning (General), BWDB, Dhaka. Regional Plan Report, April-1992 (Draft) on South-East Regional prepared by a handsome number of expatriate consultants together with highly qualified local consultants of as many as five consulting firms touched every relevant issues both general and specific associated with the region. The report consisting of four volumes and one album of drawing is consulted and comments on some of the issues/problems/recommendations which appeared to have scope for further review/up-dating are furnished below for necessary action:		
A. General Comment: 01. Some of the data/figured used (e.g. Meghna Water Surface Profile (1980-81) Fig. 1.2, Page 1-3, Vol. II, Discharge of WAPDA Khal (1983) Figure 5.3.3, Page 5-26, Vol. II etc.) are of decade old. These borrowed old data fall quite short to meet the requirement of the study. The consultants should please look into it to update the figures with recent or appropriate data with technical justification.	See reply to comment A of CE Design II, BWDB.	None required.
02. VOL.I, Part-I, Page 6.4, Section 6.3.3. (4th para) It is stated that rainfall becomes heaviest during May and June, but Study of the rainfall data presented at page 5.5 shown that it is heaviest during June to August. This may be corrected.	This will be corrected	This chapter has been revised.
04. Annexes Vol.III, Page 1.17, i 44, Figure: 5.1, 5.2, Table: 1.8 & 1.12 Agro-ecological unit map and land capability association map of the study area along with the component of the soil mapping units (soil association number) are shown in the Annexes volume III. Report but the soil association map is not available with the Annexes Volume III. Report for quick reference.	It was not considered appropriate to reproduce all this material in the annex rather than the album because the maps could not be properly legible at the reduced scale and because of the additional cost.	None appropriate.
05. Annexes Vol.III, Annex I Soil-crop suitability ratings are not included in this report. it should be included.	This is not appropriate for regional planning.	None appropriate.

Comment	Replies by the Consultants	Action Taken in Final Report
06. Annexes Vol.III, Page II.2, Table II.1		
Discrepancy is observed as to figure of 'irrigated area' for Meghna-Dhonagoda Project which is given as 4 017 ha. Whereas in the table at page 6.2, Vol. I it is shown as 13 440 ha. this may be checked up and the anomaly may be removed.	This will be corrected.	Anomally has been resolved.
07. Annexes Vol.III, Page II.10, Section 1,2,3(b)		
Perhaps by mistakes Boro has been discussed in this sub-section (Kharif 1 season). First and Second para of this sub-section my be placed with sub-section(a). Boro is grown in the rabi season.	Boro is planted in the rabi season but harvested in the kharif 1 season. It can therefore be mentioned in both seasons provided it is understood what growth stage is being discussed.	Chapter has been revised.
08. Annexes Vol.III, Pages II-12 to II-6, Figures II-2 to II-3		
a) From the text it is seen that both local and HYV T.Aman are grown in the project area, but in the representative cropping patterns these have not been shown separately.	(a) The comment is correct but it is not considered necessary to change the figures.	None required.
c) Growing season of Boro appears to be shorter than usually repaired. Necessary adjustment in this respect may be made.	(c) The growing season for HYV is shown to vary between 105 to 120 days which is quite normal for such crops. Local boro is shown to have a growing season of 120 to 135 days.	
Directorate of Planning Scheme I BWDB, Dhaka: 2. 74 major soil series are available in the project area and its presence have been shown in association only. All soil series should be brought under a table which will be arranged chronologically.	This is considered adequately dealt with for regional planning purposes.	None required.
3. For land type categorisation 5 types of land categories as F_0, F_1, F_2, F_3 & F_4 have presented in the report. Here F_4 type of land is not suitable for recommendation for agricultural crops. Generally ponds and ditches possesses such depth of flooding. In addition F_4 type of land has beeb amalgamated with F_3 type of land. So F_4 land should be omitted.	Land type F4 has only been included to identify the source of data and to demonstrate its treatment in the report.	None required.
4. At least a table containing general characteristics of major soil series, should be incorporated for having an idea of soils for determination of crop suitability classification accurately.	Crop suitability is not generally a function of soils in the region - flooding is the main criterion.	None required.

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Comment	Replies by the Consultants	Action Taken in Final Report
'MAIN REPORT' **The Table 6.1, Page 6.2:** There seem some anomaly either in total cropped area or cropping intensity as the figures are derived from multiplying Net Cropped Area (NCA) by percentage to cropping intensity does not tally with the figures of total cropped area of each planning unit.	The consultants do not agree with this comment - all the figures tally.	No action required.
2. Section 1.1.1, Page 11.1: While discussion flood plan two sources of land grouping have been mentioned-former, the land Resource appraisal of bangladesh for agricultural Development sponsored by FAO/UNDP in 1988,.grouping land into six types, though under land type column 5 types are listed and the later sources, the MPO grouping 5 types of land elaborating flood depth range for each type mentioning flooding period. First flood phase column appearing in both the source confusing, the former having F_0 to F_2 and the later F_0 to F_4. Secondly, there should be indication here in this section as to which classification would be followed be the consultant with assigning reasons.	The consultants agree that the presentation is confusing. This will be amended.	This annex has been significantly revised. It is now clear.
3. Section 1.2, 1.2.1 & 1.2.2, page 11.3, 11.4 and 11.8 (Table 11.4) (d) Further assuming 1986/87 figures as representing a normal year, yield of present (5 years back ?) and attainable for individual crops shown in table 11.6 is also confusing. Again mentioning of data source as MPO. 1991 with remarks - Average of 1985/86 to 1987/88 (Table 11.6) is also confusing too.	The consultants have used the best data available at the time and 1986/87 was the most recent data for a "normal year" for production. See Volume II, Part 2, Table 3.7 which is a better presentation.	As above.
(e) Without presenting tables such as shown in 11.2 grouping crops irrigated & non-irrigated region basis or planning unit basis, how this table 11.6 has been developed ? It has not been explained in the text.	This table was developed from MPO processed data for the 3 year period 1985/86 to 1987/88 as stated in the text and in Volume II part 2 table 3.7.	As above.

Comment	Replies by the Consultants	Action Taken in Final Report
(f) The abbreviation of N.A in the foot note of table 11.6 page Nr 11.9, consultants means not applicable also raise some relevant questions such as,	The footnote is misleading since it means "not available".	Presentation revised and improved.
Grouping Boro local at present under column irrigated & HYV Boro & local boro at present under the column non-irrigated as the growing season of these crops fall in the dry season must require irrigation water; clarification is needed here also.	Local boro is generally grown on residual soil moisture and is therefore classed as non irrigated or "partially irrigated". Some HYV boro is also grown under these conditions (traditional irrigation for part of the season). Such conditions produce lower yields (See Table 3.7) of Part 2).	
Relevant question may also be raised as to sugarcane & other table do not tally with the representative yield for 1986 (page Nr 11.6) nor with other years.	The sugar cane yields do seem incorrect. This will be reexamined. Although it is not an important crop in this region.	
While damage shown for the year 1987 only when the same could shown for the year 1987/88, 1988/89 in the interim report. (Table 4.8 and 4.9). Moreover, flood of 1988/89 was more serious for this FAP studies have been initiated.	The presentation in the Annex is not as good as that shown in the main report (Volume II Part 2 Pages 3-16 to 3-22) . This shows how the situation has been assessed. However it should be pointed out that the most severe year is not a good indicator for assessment of average damage.	
Section 1.2.5, Page 11.19 to 11.23 The farming practice as described is of general nature. It lacks pin pointing peculiarity/dissimilarity condition needs inclusion of some priority measures that would increase yield/per unit area either in a normal year or in an abnormal year reducing yield due to flood, drought or pest attacks.	This part of the report is a description of the present situation. However we do not agree with the comment as pages II.23 to II.30 make a number of points and recommendations, with references to particular localities in the region.	As above.

Comment	Replies by the Consultants	Action Taken in Final Report
Superintending Engineer, Chandpur O&M Circle, BWDB, Chandpur: **Vol. I, Page 3-6, Figure 3.3** BWDB Organogram of SEZ No. of Sub-division under Chandpur O&M Division should be 4 instead of 3.	Noted.	Corrected.
Vol. I, Page 5-24, Figure 5.10 Chandpur Irrigation Project has been excluded from fisheries areas. But fish culture both under private sector and public sector is existing.	This figure identifies capture fisheries areas.	None required.
Vol. I, Page 10-17, Table 10-3 Year of completion of CIP would be 1978 instead 1980.	Noted.	Corrected.
Vol. II, Page 5-72, Planning Unit 6, Chandpur Irrigation Project **5.6.1** Correction is to be made that irrigation water is pumped from the main pump station in to peripheral canals as well as Dakatia River which passes through the project area.	Noted.	Corrected.
It is to be recorded that the bank erosion of Lower Meghna at Haimchar is severe now, for which, retirement of embankment is under process, resulting total reduction of area about 3 000 ha.	This is noted.	None required.
Vol. II The proposal submitted in the articles 5.7.6 at page 5-88 of Volume-II found more suitable than the proposal submitted in the Article 5.7.2 at page 5-82 of the same volume. The proposal submitted for Retired embankment from Eklashpur to Amirabad is not the permanent solution for the protection of Meghna Dhonagoda Irrigation Project.	The consultants have examined both proposals and the economic results have led to the recommendation given. However the final decision must be taken by the proper authorities.	None required.

Comment	Replies by the Consultants	Action Taken in Final Report
Vol. III The Irrigation water availability shown in the Table 11.12 of Volume-III, Page 11.34 planning units 7, gross irrigated area 4017 hectors and rainfed 12172 hectors about MDIP seem to be incorrect. As per our record the actual gross irrigated and rainfed areas in 1990-1991 are 11 085 hectors and 19 759 hectors respectively.	Noted, corrections will be applied.	Corrected.
Comments from Design Branch of the office of C.E. SEZ, Comilla.		
A. Comments on South East Regional Plan Report Volume-I (Existing Situations) **1. Art 8.1 Para 1** It has been described in the report that the river Gumti and river Titas have a high proportion of their Catchment area in India which produces high runoff yields. This is not true. Only the river Gumti has a high proportion of its Catchment area in India and this has also been reflected in table 8.1 where no value within bracket is found against river Titas.	Table 8.1 shows that 74% of the total catchment of the Titas and its tributaries are in India.	None required.
2. Art 8.1.2, Page 8.5 In the first para it has been said that two BWDB FCDI schemes abstract water from the river lower Meghna and those projects are Meghna Dhonagoda project and Chandpur Irrigation Project. But infect the latter one obstruct water from the river Dakatia.	Although the pump station is located on the Dakatia the water comes from the Meghna as there is little flow in the Dakatia in the dry season	None required.
3. Art 8.4, Page 8.8 para 2 It has been explained that the system was based on 30 modelled Catchments as delineated in figure 8.2. But in figure 8.2 only 24 Nos of Catchments are shown and the reaming Catchments are not found in that figure. So this figure should be corrected.	The other catchment areas are in India.	None required.
4. Chapter 10, Art 10.1 In the first para it has been said that about two thirds of the country is vulnerable to flooding and half of this e.g. one third of the country area is inundated almost every year. This limit is too much. In MPO final report July 1985 it was mentioned that 26 000 km^2 or 20% of the total area is being flooded normally in every year but this figures goes to 52 000 km^2 or 40% in worst flooding condition.	The MPO report precedes the floods of 1987 and 1988 and the figures quoted in the report are now generally accepted.	None required.

Comment	Replies by the Consultants	Action Taken in Final Report
5. In Figure 10.4 The water level hydrography where elevation was not given as a result the magnitude of peak flow in three rivers could not be determined. So elevation of the hydrography should be given?	The object of the figure is to demonstrate the near coincidence of the flood peaks not to show the actual flows.	None required.
B. Comments on South East Regional Plan Report Vol. V.: **2. Chapter 2, Art 2.2** The present flood problem. The general categories under which flooding in the region can be considered as follows. - Monsoon floods from the river Meghna and Lower Meghna spill. - Flash floods from these rivers rising in the east of region. - Localized flooding as a result of flat topography, flood plain heavy, uneven, intense rainfall, unplanned local development & lack of co-ordination among planning agencies. - Flood resulting from storm surge in the Bay of Bengal.	The consultants prefer the original statement as it appears in the report.	None appropriate.

WARPO COMMENTS

Comment	Replies by the Consultants	Action Taken in Final Report
1. The MPO agrees to the geological and hydrogeological findings as embodied in the report.	-	None required.
2. The WARPO (MPO) agrees to the findings of hydrochemistry and recommendations with regard to the saline water problems of the groundwater.	-	None required.
3. The groundwater assessment also conforms to the WARPO (MPO) assessment base.	-	None required.
Comments from WARPO, Ministry of Irrigation, W.D. & F.C. General 1. The SE region water resources development, plan report is an excellent one but too much voluminous and contains so much of informations many of which are unnecessary and make the readers tired and impatience (organogram of PM and all ministries). It is good that the region is divided into 13 planning units to facilitate data collection and work allocation.	-	None required.
3. Volume I, Page 2-22, Para 2.4.2, line-2 Panta rice is never the only one main meal rather dinner with rice if it is a one.	The sociologist stands by the statement in the report.	None requied.
4. Volume I, Page 6-2 How and why irrigated area have been interpreted from spot imagery when these are available with MPO.	Both sources of data were used but the SPOT imagery is more recent and results checked well with AST data on growth of groundwater development.	None required.
5. Volume I, Page 7-12 Why field crops have been included in Fisheries calendar.	This is to demonstrate the interrelationship between cropping and capture fisheries.	None required.

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Comment	Replies by the Consultants	Action Taken in Final Report
8. Volume III, Page II-15, Figure II-4 & II-II Growing of pulses, oilseeds and rabi crops in F2 and F3 lands under irrigation from October is neither possible and feasible.	Agreed. The crops are grown on land which has access to irrigation e.g. for the boro season.	The figures have been amended to identify crops which are actually irrigated.
9. Annex-IV, Environment Although too much but good EIA and data.	-	None required.

FPCO COMMENTS

Comment	Replies by the Consultants	Action Taken in Final Report
Comments from Mr. Van Ellen, Panel of Expert of FPCO: **Category III** **Volume I Part I - Existing Situation** **3.1. Figure 6.1** Not only is the relevance of Figure 6.1 not clear, there also seems to be something wrong with the legend.	The data in the figure corresponds with that in Table 6.2, and the legend appears correct.	None required.
3.2. Figure 13.4 The Sandwip Cross Dam does not exist and neither the related land accretion.	Agreed.	Figure corrected.
3.3. Page 13-15, line 2 .... average annual extraction .... instead of daily.	Agreed.	Text corrected.
Volume II Part II - The Regional Water Plan **3.4. Page 2-3, para 1** The emphasis that is given to irrigation in the preceding sections is not in accordance with the order given in this para.	There are no preceding sections. The consultants see no problem with the statement.	None required.
3.5. Figure 5.11.2 It does not show any pumping stations. Figures 1 and 2 may be mixed up to some extent.	This is the incorrect figure and the correct figure will be provided in the final version of the report.	This figure is now superseded by the findings of the Gumti Phase II revised feasibility study.

Comment	Replies by the Consultants	Action Taken in Final Report
Comments from Mr. Dempster, Panel of Expert of FPCO: **Category III** **2.4 Page 2-1, para 2, 2nd sentence** Except for groundwater	Agreed.	Text amended.
2.5 Page 2-13, penultimate para Meghna Estuary Study will be FAP 5B - and SERS will become FAP 5A.	Noted. Is this agreed by FPCO ?	Text amended.
2.6 Additional Notes 1. I like the treatment of flood phases (section 3.2.2 and tables); it should be read by other regional study teams.	-	None required.

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Comment	Replies by the Consultants	Action Taken in Final Report
Comments from Edward Clay, Overseas Development Institute, Panel of Expert of FPCO:		
Category 3 Comments		
Regional Planning Report Volume 2		
1.4 Agriculture: There is limited scope within the region for development other than agriculture but because of outmigration in the totals for population here are maximum rather than expected levels.	Noted	None required.
2.1 Introduction: Report should identify any future industrial and transport/navigation water needs.	Navigation is not a "consumer" of water, and is unlikely to increase in importance. Impacts of individual schemes are however considered.	Reference to water consuming industries added, but considered unlikely to become significant.
2.5 Environmental Factors: Because the IEE and Annex 4 have deliberately focused on negative impacts, the comments above on the attempt to summarise ranking results as averages are likely to be biased.	Noted.	The summation and average of the scores for qualitative impacts has been removed. Discussion has been expanded.
ditto: GPA require social impacts to be separately analysed and for EIA to take into account.		
2-18F Fisheries: As the project evaluations in Chapter 5 consider capture fisheries impact in each case, it is important in the text to draw attention to findings on sensitivity of overall EIRR to changes in level of fisheries impact.	Noted.	Sensitivity to fisheries and other impacts is now discussed in greater detail, especially for the Noakhali North Project (Chapter 6 of Part 2).
3-37 Mitigation measures: Important issue for full feasibility studies.	Agreed.	Specific provisions have been made, especially in the Gumti Phase II Project Proposals (Chapter 8 of Part 2).
4-9 Revised GPA no longer require NPV ratio 1 and NPV ratio 2 results in this study confirm these do not provide additional useful information for assessment.	Noted.	NPV ratios 1 and 2 now omitted.
4-5 Revised GPA will require -5 to +5 rankings. Some issues are not regional but will require the bringing together of findings from different planning studies at a national level e.g. (page 4-5 bio-diversity effects	Noted.	-5 to +5 ranking now used.
4-8 Project evaluations in Chapter 5 fail to quantify agricultural fisheries and employment changes specified on page 4-8, 4.61. Quantitative Criteria.	Changes in employment (labour requirement) and paddy production appear in the Summary of Benefits Tables e.g. Table 5.5.5, but it is agreed that fisheries production is absent.	All three parameters are now given in the Summary of Benefits Tables in the project evaluation in Part 2.

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Comment		Replies by the Consultants	Action Taken in Final Report
5-4	Section 5.1.6 Economic Evaluation: In this and subsequent economic evaluations for planning units there is a need to draw out in the text the results and sensitivity analyses (Table 5.1.3) etc.	Noted.	See item 2.18F above.
5-7	The initial environmental evaluations indicate that all projects will have negative impact on income distribution because landowners will benefit more than the landless. Is this a consequence of with-project conditions or of agricultural development with or without project.	It is a likely consequence of almost any large scale agricultural development, and is perhaps only heightened by the project.	None required.
5-15	Table 5.24 Project Area Cropping patterns (percentage): It would be useful in this and similar tables to indicate with an additional column the major changes e.g. HYV aman + 10%, HYV boro + 45%, B.aus - 19%. Recognising the time pressures on consultants, there is further scope for bringing out the main points of the analysis.	Noted.	Changes in cropping are discussed in more detail especially for the Noakhali North Project (Chapter 6 of Part 2).

ANNEX XII

TERMS OF REFERENCE AND AMENDMENTS

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APPENDIX A

TERMS OF REFERENCE

BANGLADESH

SOUTH EAST REGION WATER RESOURCES DEVELOPMENT PROGRAM

Terms of Reference

I. Background

Introduction

1. The Government of Bangladesh (GOB) aims to achieve foodgrain self sufficiency. With this objective in mind, GOB has selected in its priority program the development of the South East Region and has conducted surveys, investigations and modelling programs to be used as essential planning tools for the selection of projects for implementation. These activities have been undertaken under the UNDP assisted Surface Water Simulation Modelling Program for the South East Region, the hydro-morphological study of the Gumti-Titas basin, the aerial photogrammetry survey of the Gumti-Titas basin, the hydrographical surveys for the rivers and khals, and the hydrological data collection program for the basin. GOB requested the assistance of UNDP for financing the preparation of a development plan for the Region and a proposal for specific investments. The World Bank was requested and accepted to serve as executing agency. Assistance for the implementation of projects is expected from the International Development Association (IDA) and other donors.

2. GOB proposes to conduct the study through consultancy services provided by a consortium of foreign and local firms. These firms will prepare a regional plan at prefeasibility level for the development of water resources in the region to support agricultural production (crops, livestock, fisheries) and make recommendations for phasing of proposed development programs. The consultants will then carry out a feasibility study for a first phase development program. The prefeasibility study shall be completed within nine months, the feasibility study in the following 24 months. This timing is a mere estimate. The consultants will be expected to provide their own assessment of how the activities should proceed, keeping in mind that GOB attaches great importance to the preparation of an effective regional development plan for the South-East area.

Project Area

3. The project area has the following approximate boundaries: to the North, the line from Hasvinagar to Madhabpur; to the East, the border with India and the Eastern border of the Muhuri Project; to the West, the main stream of the Meghna River; and to the South, the Bay of Bengal.

4. The project area has an extensive system of waterways for irrigation and drainage, including major channels such as the Dakatia and Gumti rivers and the Noakhali Khal, and a dense network of natural khals. Many man-made

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khals were excavated several hundred years ago and still function without appreciable maintenance. Improvement of channels has been included in recently constructed works, such as the Chandpur and Meghna Dhonagoda projects, and works carried out under the Special Canal Excavation Program and the Food for Work Program (FFW). The project area covers approximately 9000 km2 with a population density approaching 1000/km2 in some parts. Present agricultural development is particularly constrained by flooding in the monsoon season and shortage of water during the dry season.

Justification for the Project

5. The project area suffers from problems of flood and drought. During the monsoon (May to October) high concentration of rainfall, high sediment discharges, storm surges and tides in coastal areas create difficult hydrological conditions and lead to silting up of outfall canals. The main rice crops, aus and aman, that are grown in the monsoon season, are frequently subjected to flooding to depths which severely reduce yields. These crops are also frequently affected by erratic rainfall and by a late onset or early cessation of the monsoon rains. Increase in cropping intensity, by expanding the area of boro rice and other rabi crops during the dry season, depends upon the provision of irrigation. The study will produce a plan for addressing these and other constraints to agricultural production (crops, livestock, fisheries).

Present Situation

6. Completed and on-going major water resources development activities in the South-East Region include:

(a) Chandpur Irrigation Project, which provides flood control and drainage to an area of 52,000 ha and irrigation to 27,000 ha, was completed in 1980;

(b) Muhuri Irrigation Project, which provides flood control, drainage and control of saline intrusion to an area of 27,000 ha and irrigation to 20,000 ha, was completed in June 1986;

(c) Meghna-Dhonagoda Project;

(d) Gumti Phase I Subproject being implemented under the Third Flood Control and Drainage Project provides flood control and drainage to a cultivable area of about 29,500 and irrigation to 10,000 ha. A second phase of the development of Gumti-Titas basin is under preparation. The proposed development comprises flood control and drainage to 100,000 ha and irrigation development to the extent permissible by the available dry season flow of the Lower Meghna River;

(e) other developments include:

(i) assistance in the Rural Development sector by DANIDA under the NRD II Project in the Noakhali District. This project supports minor surface water irrigation schemes, agricultural extension, credit and cooperative services;

(ii) land reclamation with Dutch assistance in the newly accreted lands in the south of the region; and

(iii) completed and ongoing Food for Work schemes, implemented by BWDB field divisions, involving mainly re-excavation of khals and resectioning of embankments.

Previous and Ongoing Studies

7. The results of earlier studies should be evaluated and the data base underlying them assessed. The Surface Water Simulation Model developed under UNDP project BGD/85/045 is expected to provide the analytical base for this preparation work. The Consultants will be expected to work closely with teams involved in the implementation of projects and studies in the Region, including Gumti Phase II, and the hydro-morphological study of the Gumti/Titas, and with teams working on the preparation of a National Water Plan and Flood Policy initiatives.

II. Terms of Reference

8. The first output of the project will be Regional Development Plan at pre-feasibility level, including: (i) a comprehensive data base for water resources, agriculture (crops, livestock and fisheries) and socio-cultural characteristics of the South-East Region; (ii) an assessment of the development potential in the Region and the associated requirements for water resources development; and (iii) identification of potential investment programs to help achieve the production potential. This plan shall include alternative scenarios for effective utilization of intra regional ground and surface water and transfer of surface water from boundary streams. Pertinent to the latter would be the transfer of the Meghna flows to meet requirements of existing /proposed schemes within the project area and the Muhuri Irrigation Project.

9. The regional plan should identify, how potential investment opportunities could be implemented in the contract of a well defined and phased development program. It should broadly describe the areas proposed and outline specific investment programs to be studied at feasibility level.

Scope of the Consultancy Services

10. For preparation of the regional plan using the participatory approach the consultants shall undertake the necessary work in relation to:

(a) Analysis of the Social Setting. The consultants will use the guidelines given in Attachment A to obtain information necessary to prepare Regional Plan and identify investment programs responsive to local needs and providing opportunities for various socio-economic groups in the area.

(b) Topographic Survey and Mapping. The consultants will use existing photographs, maps and surveys, recent topographical surveys on the region's khal and river systems conducted in connection with SWSM and the feasibility study of the Gumti-Titas basin. They will update this information to identify waterways, cultivable and irrigable land, and fisheries facilities.

(c) Hydrology. The Consultants will have access to surface water and geotechnical data available with GOB agencies. They will work closely with the MPO, BUET, BWDB and the consultant conducting the hydrological-morphological study of the Gumti-Titas rivers and the Gumti Phase II study. It should be specifically noted that the output from the SWSM will be a major input into this regional planning effort. All hydrological data needed for the study, including discharge, sediment, salinity and climatological data shall be collected from pertinent sources and presented in the prefeasibility studies, along with analyses to establish parameters for subsequent feasibility studies. An appraisal shall be made of the available water resources. Assessments shall be made of reliable flows, storm rainfall, flood frequencies, sediment loads and salinity. Crop water requirements shall be estimated for alternative cropping patterns, taking into account effective rainfall.

(d) Land Classification and Flood Depths. The Consultant shall make an assessment of flood depths and the capabilities of the soils in the area. Necessary soil surveys shall be conducted in selected locations as required.

(e) Crop, Livestock and Fisheries. The Consultant shall report on the present land use in the project area. The existing agricultural and fisheries practices in each area proposed for development shall be described, including varieties, fish species, current yields, inputs, labor requirements, cultivation methods, incidence of disease and pests and any other relevant aspects. The Consultant shall make estimates of future levels of production indicating suitable cropping patterns and technology for crop, livestock and fish production.

(f) Engineering:

(i) The Consultants shall assess all water resources schemes, partly or completely constructed in the project area. They shall review existing reports, surveys and designs to generally establish lessons learnt form and the impact made by existing schemes for the development of water resources in the project area. The Consultants shall identify all potential water resources in the project area, assess the availability of groundwater and define the role of groundwater in the development of the region. Account shall be taken of the requirements for domestic water supply and in-land water transport. Outline designs and alignments shall be prepared for major works and order-of-magnitude costs shall be calculated. Projects identified for feasibility level study shall be ranked according to their suitability for rapid development and potential for contribution to growth, employment creation and poverty alleviation.

(ii) Augmentation of Muhuri Reservoir. Irrigation withdrawals by riparians above the Muhuri Irrigation Project boundaries and the dry season discharge requirements for flushing of tidal silts accumulation in the outfall canal of the Feni regulator led to inadequate water in the reservoir during February/March to command the irrigable area of 20,000 ha. The Consultants shall, with the available stream flow data of Feni and Muhuri rivers collected since 1982 and the discharge records of the Feni regulator make an operational study of the reservoir for the existing cropping pattern and the post-project recommended cropping pattern to determine the augmentation requirements of the reservoir for the original command area of 20,000 ha, the additional area that could be taken up above the project boundaries and for flushing requirements to keep the outfall canal free of silt to facilitate operation of the regulator gates at the onset of the monsoons. The Consultant will them make recommendations on the potential engineering and economic feasibility of a Meghna-Muhuri link to transfer water.

(iii) Improvement of Drainage. Assess drainage problems of the area and suggest solutions.

(g) Environmental Considerations. The Consultant shall consider the impact on the environment of each alternative development option and recommend appropriate actions to mitigate adverse effects. The prefeasibility study shall clearly set forth the environmental consequences of recommended improvements and actions including the impact of displacing farmers and other residents resulting from proposed investment programs. Particularly consultants would broadly identify (a) the natural resources, ecosystems and human groups likely to be affected, and highlight actual vulnerable areas. Both direct and indirect impacts should be considered, (b) assess the reliability of data and information on environment, (c) make recommendations for further work and measures that may be needed, (d) identify institutions needed to manage environmental considerations related to the project and assess capacity in this regard of existing Bangladesh institutions particularly staff of BWDB and prepare a proposal for training of BWDB staff.

(h) Economics. The Consultant shall assemble relevant socio-economic information on the project area. Constraints to development shall be identified and their impact on the achievement of future production estimated. The consultant shall assess existing infrastructure and future requirements for increased agricultural production in the project area. All benefits and costs for proposed projects shall be estimated. The economic feasibility of each project shall be assessed. Particular attention shall be paid to land tenure and incentive systems for fishermen and farmers to adopt improved technology.

11. Feasibility Studies: The second project output will consist of two feasibility studies, one for a project covering a priority area of about 100,000 ha and the other one covering the augmentation of the Muhuri Project. The final decision on the location of the first project will be made during the first interim review (about six months following project start-up). Augmentation of the Muhuri Project will be the subject of a separate feasibility study unless otherwise agree by GOB, UNDP and the Bank to either modify its scope or combine it with the previous feasibility study. In that case, any additional resources required will be discussed and agreed with the consultants prior to initiation of the work. Specific tasks relating to the feasibility studies include:

(a) discussions/consultations with local officials and potential beneficiaries (Attachment A);

(b) discussions with Ministries of Agriculture, Forests, Environment, Shipping and IWT, Fisheries and Livestock, Irrigation, Water Development and Flood Control, Planning Commission, Roads and Highways Department, BADC, NGOS and other institutions involved in promoting local participation;

(c) assessment of the data base, review of topographical surveys, hydrological and morphological data, agro-economic and socio-economic data and assessment of ongoing surveys and data collection activities, with particular reference to their adequacy and the need for additional work, including a benchmark survey to be conducted as part of the Consultant work program (Attachment A);

(d) using the results of the simulation modelling program and other sources of data for the SE region, obtain information needed for determining design levels of embankments and discharge data for fixing capacities for drainage structures and for the design of drainage/supply khals or canals;

(e) assessment of the extent of benefitted area, the potential impact of the proposed project works on the adjacent areas and the region as a whole and on existing economic activities (fisheries, navigation, etc.); identification possible negative effects in the project area and preparation of proposals for possible remedial measures;

(f) establish design criteria and planning concepts, prepare project layouts, feasibility level engineering designs and drawings of relevant project components. In this respect, due consideration shall be given to:

- the possibility to improve irrigation facilities through pumping water from the Meghna and conveying it through an improved khal system, taking into consideration present and planned use of Meghna waters;

- the design height of embankments and the associated risk of failure;

- the special maintenance requirements of high embankments and the increased damage in case of failure (in particular in those areas where embankments have to be significantly raised as a result of river confinement and where the polder inundation levels will be considerably lowered through pumping);

- current groundwater abstractions in the project area and the potential for further development; and

- the need for access and service roads, necessary to construct, maintain and operate the embankments, structures and other project facilities;

(g) preparation of cost estimates of project works on the basis of recent actual contract rates, including annual expenditure schedules in both local and foreign exchange currencies;

(h) preparation of operation and maintenance schedules, including staff, equipment and budget requirements;

(i) preparation of realistic implementation schedules, showing project components in quantitative and monetary terms, equipment and staff requirements and procurement schedules, as well as specifications for engineering and other surveys required for detailed design and implementation; World Bank formats to be used for implementation schedules and procurement of equipment, vehicles and civil works;

(j) preparation of proposals for improved water management and an organizational structure for project implementation, and for improving the institutional infrastructure (e.g., extension, research, credit, marketing, and farmers' organization) in the area;

(k) assessment of benefits for relevant project alternatives and evaluation of project economics, including farm budgets, internal rates of return and sensitivity analysis; and

(l) for a sample of ongoing FCD&I projects, identify the implementation problems at the preconstruction and construction phases and

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recommend solutions to overcome such constraints under the proposed program.

III. Important Activities

Mapping

(a) produce a project works plan indicating the project area, embankments, khals and minor drainage channels, rivers, structures, roads, etc. The map should clearly indicate the existing and proposed works and the changes of the embankment and the major khals;

(b) preparation of a map indicating the preproject and post project flooding conditions, the proposed drainage compartments and a schedule indicating the proposed completion dates for the drainage compartments, and the items of work to be completed;

Flood Control and Drainage Improvement

(c) Flood data should be classified along the lines below:

Flood Depth (meters)	Area Ha	% of Total Area
0.3 to 0.6		
0.6 to 1.5		
1.5 to 3.0		
over 3		
Total		

The above data to be given separately for:

- average annual flood level and duration;
- maximum (historic) flood level and estimate of probability of occurrence;

(d) trends in water level at selected locations for different development scenarios. The return periods to be 20 and 30 years;

(e) determination of the required capacity of regulators. The following design criteria shall be adopted:

- the drainage system shall be capable of releasing runoff of 10 days rainfall with a return period of 5 years during the critical period, not exceeding a submergence duration of 3 days and/or;
- the drainage system shall be capable of releasing runoff of a 10 day rainfall with a return period of 10 years during the critical period not exceeding a submergence duration of 6 days;

(f) for the determination of the capacity of main drainage canals (usually an existing khal) the design criteria is the runoff of a storm with a return period of 10 years and drainage within a period of 3 days;

(g) the provision for new secondary canals on the basis of a minimum of 1.5 Km for 200 ha of drainage area with due consideration given to irrigation requirements if low lift pumps are utilized.

Irrigation Development

(a) assess water resources of the Lower Meghna River, taking into account the present withdrawals by the users and their future requirements and determine the availability of water for use in the project area, as well as that for a possible transfer to the Muhuri Irrigation Project;

(b) study the development options available, such as primary pumping with the secondary distribution system provided either by low lift pumps or gravity. Study the possibility of using lined canals or underground pipes and flexible pipes to reduce land acquisition and save water;

(c) study the existing irrigation systems in the project area (LLPs, STWs and DTWs) the organization and management of farm groups and water users associations as a means to improved water distribution and management; the condition of farm canals, designed and actual command areas; identify the constraints and suggest solutions;

(d) propose a strategy for development of irrigation;

Pump Drainage

12. Study the possibility of lowering flood levels in the protected area by designing the primary pumps to be able to function on a reversible basis. Determine the additional area that could be brought into cultivation using improved technology. Analyze the economics of the pump drainage system and make appropriate recommendations.

Navigation Facilities

13. Study the existing boat traffic during the wet and dry seasons in khals, major streams and rivers plying within the project area, serving the growth centers with special reference to markets, inter connecting the feeder roads and national road network.

Fisheries Development

14. Study the existing fisheries in floodplains, beels and ponds. Determine the reduction in area which may result from polder development. Study the possibility of incorporating design in the hydraulic structures to

reduce any such adverse effect on the floodplain fisheries and detail the operation of these structures; provide guidelines for intensifying existing fisheries and developing new ones to compensate for unavoidable losses and fully develop the fisheries potential in the area.

Land Acquisition

15. Assess the land acquisition requirements. Interview land owners and local leaders to identify potential problems and suggest feasible solutions.

Development Support Communications

16. Study the institutions and facilities available in the project area for development support communications, viz., BWDB field staff capability, KSS and other farmers organization, Union Council and Upazila staff, Deputy Commissioner staff and agricultural support services (extension, research, credit, marketing, input supply) and make proposals for the effective participation of local organizations in the proposed development program for the Region.

Water Control Structures

(a) list the structures required as in the example format below:

Identifying Number	Type of Structure	Describe Why the Structures are Needed
1	Regulator	To prevent river flood from entering protected area through drainage channel, and to drain excess water form the area when necessary.
2	Culvert	Drainage channel must be enlarged; the present culvert is too small and backs up water, etc.

(b) prepare a single line drawing for each structure in the list above. Show dimensions of opening or important features of structure. Indicate the top elevation, floor elevation, length, width, etc. Attach a standard drawing;

(c) prepare hydraulic calculations for structures;

(d) for a pumping plant, indicate the number, size and type of pumps. Show calculations to substantiate the size and number of pumps. Evaluate and compare diesel and electric power alternatives;

(e) show the cost of each structure and total cost of structures in the scheme, using the same identifying number as in the list above;

(f) show the typical cross-section of each existing embankment as designed and built, and for each new embankment to be constructed. Show the elevation of embankment and flood levels (annual and 20-year probability) and describe the present condition of the embankment; estimate quantity of earthwork for new construction required;

(g) show the typical cross-sections of each drainage channel as designed, built, to be re-excavated and/or for new excavation. Give bed levels. Show the hydraulic computation for the amount of water required to be removed and the capacity of the drainage channel and describe its present condition; estimate the quantity of earthwork;

(h) for existing earthworks, indicate the status of completion and calculate the quantity of earthwork required to improve them to an acceptable standard and to proper elevation (with drawings of new cross-sections);

(i) indicate the elevation of top of embankment at every two miles along the length. Indicate minimum freeboard above normal (annual) flood level.

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Cost Estimates

17. Estimate capital costs by construction year along the lines of components which would generally follow the undermentioned guidelines:

1. Preconstruction Activities

   a. Land acquisition;
   b. Engineering surveys and foundation investigations;
   c. Preparation of bidding documents for procurement of goods, services and for award of civil works contracts;

2. Civil Works

   Flood Control and Drainage

   a. Embankments

      (1) New
      (2) Resectioned
      (3) Protection works

   b. Drainage channels

      (1) Khal resectioning
      (2) New
      (3) Appurtenant structures:

         (a) Road bridges
         (b) Culverts
         (c) Footbridges

      (4) Hydraulic Structures

         (a) 1 vent regulator
         (b) 2 vents regulator
         (c) etc.
         (d) Flushing sluice
         (e) Contingency for additional regulators to be decided at detailed engineering phase
         (f) Navigation locks

   Irrigation Development

      (1) Primary pump stations;
      (2) Inlet and outlet canals;
      (3) Main canal;
      (4) Secondary canal;
      (5) Canal structures, siphons, flumes, bridges, turnouts, etc.;
      (6) Outlets in flood embankment for low lift pumps utilization.

Access Roads Needed for Construction and O&M

(1) New roads -paved, brick soling, bitumen;
(2) Improvement of existing roads - earthwork, paved, brick soling, bitumen;
(3) Embankment paving - brick soling, bitumen;
(4) Road bridges, culverts.

3. Fisheries Infrastructure

4. Procurement of equipment and vehicles

5. Support Services

6. Studies

7. Technical assistance and training

8. Engineering and administration

9. Operation and maintenance during the construction period and after project facilities become operational.

Cost Recovery

18. Prepare a program and procedures for recovery of O&M costs, making use of procedures developed under the BWDB System Rehabilitation Project.

Project Management

19. Prepare a proposal for project management during the construction period and after projects become operational.

Production

(a) Cropping Pattern, Yields and Production:

Without Project

Crops	Area (ha)	Yield (Kg/ha)	Total Production (Tons)
Aus	.....	....	....
Aman	.....	....	....
Boro	.....	....	....
T. Boro	.....	....	....
Wheat	.....	....	....
Sugarcane	.....	....	....
Other Crops			

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Yields shall be considered on a "normal year", flood year" and "average year" basis. Cropped areas shall be subdivided into irrigated and non-irrigated areas.

With Project (same format as Without Project).

(b) Cropping Intensities

Without Project................
With Project...................

(c) Fisheries Production (with and without Project)

(d) Livestock Production (with and without Project)

Describe potential for change in cropping pattern, yields and cropping intensities resulting from the project. The major agricultural production constraints would be identified, the extent of the impact of such constraints would be quantified and cost of production will be estimated. Constraints to intensification/ diversification shall be identified and suggestions made as to how they can be addressed.

Farm Budgets

20. Prepare farm models for representative farm types, including tenants and/or share-croppers and analyze the financial benefits of the project and their distribution between different classes of beneficiaries. Estimate the potential for cost recovery and calculate levels of cost recovery consistent with farmers capacity to pay.

Economic Analysis

21. Estimate project net economic benefits and rates of return on the investments.

Employment

22. Analyze the expected impact of the project on employment in the project area, considering male, female and landless employment.

IV. BWDB's Responsibility

23. The consultants shall work with the Planning Schemes Unit headed by a Superintending Engineer (SE) under the Chief Engineer (CE) Planning. The specialized departments of BWDB shall assist the Project Team as required, particularly with regard to the hydrological, morphological and foundation aspects of the study. BWDB's Central Designs Organization shall provide guidance in the design of major structures as required.

24. The SE shall ensure that the objectives of the study as detailed in the TOR would be achieved within the agreed time schedule and that the contents of the report are acceptable to GOB. He would, in the context of the TOR, direct the planning process and work programming, supervise the execution of the study and monitor progress according to the set objectives. He would have regular meetings with the BWDB professional staff and the consultants to discuss technical and project management issues. Any unresolved issue, technical or otherwise, should be taken up with BWDB's senior staff (Chief Engineer Planning, Chief Engineer Designs, Director General of River Research Institute, Chief Engineer Hydrology etc.) or other GOB agencies as required.

25. BWDB shall make arrangements for SE's staff and the consultants to meet concerned GOB agencies in Dhaka and the project area to enable these agencies to be aware of the objectives of projects and be involved from the inception in adapting it to their needs, particularly in relation to such matters as extension, research, pump irrigation, input supply, credit, farmers organization, land acquisition, fisheries infrastructure, domestic water supply, environmental impact etc.

26. BWDB shall provide the following data, services and facilities:

(a) all hydrological, morphological, meteorological data and records or river stages;

(b) contour maps, mouza maps, aerial photographs, previous reports on surface and groundwater development of the project area;

(c) results of mathematical modelling studies;

(d) standard design manuals and type plans for hydraulic land other civil engineering structures and buildings; and

(e) transport vehicles, office and drawing equipment, including computers all of which to be procured through the Executing Agency using project funds.

27. The Consultant's contract shall include, in addition to funding for consultacny services, provision for funding the following items to be financed through UNDP contribution

(a) additional topographical surveys, foundation investigations and hydrological data collection needed for the prefeasibility, feasibility and detailed designs for the first year's construction program. These works shall be undertaken through contract according to IBRD procurement guidelines;

(b) adequate office space to accommodate Consultant and BWDB staff;

(c) support staff including administrative and financial staff needed for the effective delivery of the consultancy services; and

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(d) operation and maintenance of the office, including operation of transport vehicles, office equipment, stationery, printing reproduction, and utilities.

V. TIME SCHEDULE

28. The study period is estimated at 9 months for preparation of the regional plan and 24 months for the feasibility study. This is a tentative schedule which consultants should feel free to change while preparing their proposals to ensure that they can produce an effective regional development plan and an adequate feasibility study.

Operation or Event	Responsibility	Date
Project start-up	Consultants	Sept. 90
Inception Report	Consultants/ BWDB	Oct. 90
Prefeasibility Study (Development Plan)	Consultant/ BWDB	July 91
Benchmark Surveys for proposed project(s)	Consultant/ BWDB	Oct. 91
Feasibility Study Report	Consultant/ BWDB	Sept. 92

VI. DURATION OF CONSULTANCY SERVICES AND COMPOSITION OF TEAM

29. Based on the above schedule the consultancy will commence about January 1990 and end about September 30, 1992, giving a duration of 33 months. It is estimated that 345 man-months of specialist input will be required, of which 95 man-months would be internationally recruited specialists and 250 man-months of local specialists. In addition, the consultant would provide junior planning and design engineers, surveyors, draftsman, field staff for the socio-economic survey, benchmark survey, fisheries and navigation studies. The following composition is provided as a guide and the invited firms are free to suggest variations:

Internationally Recruited Specialist	Man-Months
Senior Planning Engineer (Team Leader)	33
Senior Design Engineer -	9
Senior Hydraulics Engineer -	5
Senior River Training and Dredging Specialist -	3
Senior Mechanical Engineer -	3
Senior`Economist - 15	
Senior Irrigation Engineer -	9
Senior Coastal Engineering Specialist -	2
Senior Agronomist -	6
Environmental Specialist	4
Short Term Specialist	6
Total:	95

Local Professionals	Man-Months
Senior Water Resources Engineer	33
Planning Engineer	18
Senior Hydraulic Engineer	18
Senior Design Engineer	40
Senior Irrigation/Drainage Engineer & River Training Specialist	34
Senior Hydrologist	12
Senior Agronomist	20
Senior Agriculture Economist	12
Soils Specialist	4
Economist	18
Fisheries Specialist	6
Environmental Specialist	4
Mechanical Engineer	4
Socio-Economist	8
Hydro-Geologist	6
Unallocated	13
Total:	250

VII. REPORTING REQUIREMENTS

30. The prefeasibility and feasibility report shall generally follow the outlines given in the FAO/IBRD cooperative program publication "Guidelines for the Preparation of Feasibility Studies" published in December 1970. The report outline shall be agreed with the World Bank. The feasibility report shall be a comprehensive document and shall determine that the project is:

- in conformity with the country's development objectives and immediate priorities;

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- technically sound, and the best of the available alternatives under existing technical and other constraints;

- administratively workable; and

- economically, financially, socially and institutionally viable.

31. The Consulting firm shall work directly with BWDB professionals and keep the SE informed of the progress and problems. They will prepare discussion papers for weekly (or as needed) meetings to be conducted by the SE and monthly meetings by Chief Engineer Planning. In particular, they will submit to the World Bank for subsequent transmittal to GOB and UNDP:

(a) an inception report in 20 copies. This report, which should be submitted within 6 weeks after the contract award, will include the work plan, along with detailed task specific manpower allocation budget for the whole project team, the program for surveys, investigations and hydrological data collection needed for the prefeasibility study and actions taken and progress on these activities during the first 6 weeks. The inception report should also include the program for the feasibility study and the detailed engineering documents. Staffing requirements, transport, office accommodation and other relevant matters should also be discussed;

(b) quarterly progress report in 20 copies. These reports should be utilized by consultants to inform the World Bank, GOB and UNDP on progress, outstanding issues and to suggest solutions to any problems facing them in their work;

(c) the draft final reports in 20 copies for the prefeasibility and the feasibility study; and

(d) final reports in 30 copies within 2 weeks after the tripartite meeting is convened to discuss the draft reports.

VIII. PROFILE OF SPECIALISTS

Team Leader and Deputy Team Leader

32. They should possess as a minimum a degree in civil engineering with broad experience in water resources planning and as a team leader in the preparation of feasibility studies for flood control, drainage and irrigation projects in countries with similar conditions as Bangladesh. Experience in regional planning is required along with significant past involvement in assessment of land and water resources for the integrated development of crops, livestock and fish production. He should also be fully literate about streamflow simulation and computer assisted water resources planning. The Team Leader will be nominated with the concurrence of all the members of the consortium.

Senior Design Engineer

33. He shall have a degree in civil engineering with substantive experience in the design and construction of hydraulic structures, embankments, including pump stations, navigation locks, etc. He should have at least 5 years of such experience in developing countries, preferably Bangladesh.

Senior Hydraulic Engineer

34. He shall have a degree in civil engineering. He should be a specialist in modelling of river basins including surface water and sedimentation. In addition, he should be able to advise and assist in the design of physical models if required to be conducted in BWDB's River Research Laboratory. His experience should include planning of river basins, preferably under conditions similar to those existing in Bangladesh.

Senior River Training and Dredging Specialist

35. He should have broad experience in dredging and in the planning, design and construction of river training works. His experience should include physical and mathematical modelling for determination of protection measures to arrest erosion of river banks, using available local resources.

Senior Mechanical Engineer

36. He should have a degree in mechanical engineering with a varied experience of at least 12 years including at least 8 years experience in designing controlled gates for hydraulic structures, gates for navigation locks, etc.

Senior Coastal Engineering Specialist

37. He should possess a degree in engineering with proven experience in coastal engineering works. He should understand the application and development of mathematical and physical models to assist in the hydraulic design of coastal works.

Senior Economist

38. He shall possess at least a master degree in economics or agricultural economics. He should have broad experience in collection, computation, analysis and evaluation of socio-economic data. He should have had experience as a lead member in the preparation of feasibility reports.

Senior Agronomist

39. He shall possess a degree in agriculture, with broad experience in irrigated agriculture. He should have proven experience in planning effective water management program for the conditions prevailing in Bangladesh. He should have had experience as a lead member in the preparation of feasibility reports.

40. Environment Specialist. He should possess at least a Master's degree in environmental/natural science, with over 10 years experience in countries with similar conditions as Bangladesh where vulnerability to natural disasters, pollution due to agrochemicals, resettlement of displaced persons, landlessness, etc. are major factors.

Senior Water Resources Engineer

41. He should possess a degree in civil engineering and broad experience in planning, design and construction of flood control, drainage and irrigation facilities. he should have had experience in the preparation of feasibility reports and should have past experience in the management of multi-disciplinary teams.

Senior Construction Engineer

42. He shall possess a degree in civil engineering with wide experience in construction, operation and maintenance of flood control, drainage and irrigation facilities. His experience on similar types of projects should enable him to identify the constraints in project implementation both in procedural matters and at the construction sites. He should be able to detail the implementation problems and suggest solutions. He, together with the team leader, should be able to detail the O&M requirements and work out realistic budgets.

Senior Hydrologist

43. He shall possess a post-graduate degree in civil engineering and have experience in surface water hydrology with basic knowledge in groundwater. He should be proficient in computation and analysis of hydrological data to assist the planning and design engineer in formulation project planning and design works.

44. Environmental Specialist. He should possess at least a Master's degree in environmental or natural science/ecology/biology and a minimum of 5 years experience in environmental studies or an individual consultant or as a staff of a consulting firm/university specialized in conducting environmental studies.

Local Participation
(Detailed Guidelines for the Study Team)

1. The consultants are expected to identify methodologies and means for ensuring meaningful local participation in the preparation of the Regional Plan and design of associated investment programs.

2. The consultants will require the services of at least two social scientists and necessary support services:

(a) a national social scientist, familiar with the methods of analysis of the social structure of communities in Bangladesh, trained in rural development and in field implementation strategies, and fully familiar with the socio-economic complexities of the project area;

(b) an internationally recruited social scientist with expertise in the participatory approach, who will be capable of identifying any lacunae in the information gathered and in the methodology identified for promoting local participation.

3. The consultants are expected to:

(a) undertake a thorough study of the society and communities in the area.

The content of the study should include a description of the characteristics of the different social strata, their social and cultural prerogatives, their control of the resources necessary for project implementation, and how they interact within the project area. It should include an analysis of the modes of existing community participation (under what circumstances does it occur, for what types of activities, who are the actors, their roles and so forth).

(b) owing to the complexity of women's status in Bangladesh, to their relative lack of viability, and to their vulnerability to the negative effects of technological change; the study should pay special attention to the analysis of their roles in the project areas and to the identification of the resources required to promote their full participation in the project from its inception.

Women's roles in the division of labor, and the manner in which they may be affected directly and indirectly by the project should be explored in detail. As such the study should identify the women in their different social categories, their spheres of activities, their roles in the various units of production, and the areas in which they have authority and decision making power. This analysis should be applied to women's roles in all strata of the society. (The objective is to avoid the portrayal of women as a single group to which inappropriately uniform methods of eliciting participation are applied.)

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(c) undertake a social soundness analysis to identify the effects o the project on the different segments of the communities.

A social soundness analysis, which usually completes the socio-economic study, provides the basis for identifying the specific interests of the different segments of the communities in the proposed intervention. It will show who the winners and losers are what is at stake in each case, and therefore the motivation to promote, block or ignore the project.

(d) conduct a test for motivation amongst the different segments of the population in the project area.

One of the most useful tools for defining the methods of eliciting local participation is the test for motivation. It should follow the social soundness analysis and corroborate the findings therein. Because of the nature of the information sought, an accurate test for motivation requires a well thought out design based on the social structure and the values of the communities in question. As such it will disclose the extent to which people are informed about the proposed project, their eagerness to achieve the goals envisioned by the project, their objections to it and so forth. The test will provide the first clues as to what should be done to promote local participation.

(e) define the minimum resources required for project participation and how they are distributed among the potential participants.

At any level of implementation, participation requires of the population a minimum amount of resources. Thus participation in this project will require the investment of land, labor, time, skills, and so forth. It is important to define the minimum resource base required for participation and which segments of the population do or do not have it.

(f) Identify the decision makers in the communities and associate them to the process of the definition of how the members of the communities should participate in project implementation.

Participation, if it is to be effective, should occur at all stages of the project from its definition to the final evaluation. It should occur within the boundaries of socially acceptable behavior and not contribute to the existent antagonisms in any community. Thus the study should provide the basis for the identification of those who play the determinant role of decision makers in each area (of production, allocation of land, allocation of labor, distribution of goods and so forth) that will be affected by the project. It is these decision makers that should be associated to the process of defining the who, how, where, and why of participation. Involving the decision makers will help to insure that they do not block participation of those who they influence, especially women.

It is also important that potential participants define the manner in which they believe they should participate. It will be on this basis that the level of participation will be evaluated in the future; during the implementation phase. Thus the different segments of the population will participate in the definition of needs, the identification of blocks to, and of the types of participation appropriate to the resources of which they dispose.

(g) Appraise the national resources available to guarantee minimum levels of local participation in the project, and subsequently analyze the amount and types of resources which the project must bring to the area to promote local participation.

Setting the stage for participation requires an active feed back and information structure as well as the organization of groups and cooperatives. This is crucial in eliciting the participation of certain segments of the population which are not visible and who have a limited sphere of activity and authority. (This is usually the case of women and the poor.) Thus one of the tasks of the study team will be to identify the structures available nationally and locally for disseminating information, obtaining feedback, fostering the creation of groups and monitoring participation. As such the study should identify NGO's, local associations and so forth, their location, their resources (human and other) and their expertise in the participatory approach. These organizations should function as the implementators of the participatory program at least at the inception of the project.

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Benchmark Survey

4. The benchmark survey should be undertaken with the objective of providing or verifying data on engineering, agricultural, economic and socio-cultural (Attachment A) aspects prevailing prior to project implementation. The engineering data would include existing flood control, drainage and irrigation infrastructure, the flooding condition in the project area and adjacent areas, impact of floods on road accessibility, on buildings and homesteads. The agronomic and socio-economic data collection would cover crops, livestock, fisheries, minor irrigation equipment, surface water irrigation, population, land tenure, land acquisition for project infrastructure, marketing, transport and communication, prices and agricultural and institutional support services. More specifically the survey would cover the following.

Engineering Aspects

5. The various Engineering aspects are:

(a) Inventorying the existing infrastructure, such as embankments, regulators, water control structures, irrigation inlets and comments on their operative condition. The structures shall be located on a plan;

(b) minor irrigation equipment (STW, DTW and LLP) fielded and the areas actually commanded under each type of equipment;

(c) the preparation of a plan indicating the shallow, medium and deeply flooded areas for normal annual floods and above normal floods experienced over the last 10 years;

(d) information on present flooding conditions including overbank spill (average and maximum height above bank level), discharge through in-operative or non-existent regulators of khals, damage due to flooding, the level of existing embankments (average), breaches or reaches of embankment not yet constructed and structured to be completed;

(e) the road network, accessibility condition during the wet and dry season (usability by car, four-wheeled drive, rickshaw, bicycle and pedestrains). Condition of the bridges, culverts, foot bridges. The plan prepared for item (a) above should include the road network;

(f) assessment of damages to educational buildings, markets and homesteads caused by normal annual floods and above normal floods. The report should include years of abnormal floods, height and duration; and

(g) assessment of cost of relief work needed for rehabilitation of roads, resectioning of embankments, desilting of khals, etc.

Agro-Socio-Economic Aspects

3. Data would have to be collected through sample surveys. These surveys would include information on representative farms in different flood zones on cropping patterns, yields, cultivation practices, production, employment, cost of production income levels for various classes of project beneficiaries. This information would serve as a basis for an assessment of the present agricultural and socio-economic conditions and of agricultural potentialities in the project area. The surveys would also seek information on marketing channels used by various categories of farmers, characteristics of the local population (family size, family labor), land tenure system, land fragmentation, relative importance of crops, livestock and fisheries activities as a source of income/subsistence, local institutions serving agriculture and their effectiveness, the extent of development of rural infrastructure, and the quality of soils. The following approach to data collection is provided by way of example:

(a) total number of village in the project area is stratified, for example, on the basis of population, predominant topography, land tenure system;

(b) a weighted sample of 10% of villages would be selected by random sampling method without replacement;

(c) a sample of 25% of the household in each selected village would be chosen by random sampling; and

(d) the modes of participation by beneficiaries including landless and women in planning, construction and O&M.

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Attachment C

REFERENCES AND BIBLIOGRAPHY

1. Study of Tipperale-Chittagong Multipurpose Project by ACE Ltd., 1961.

2. Study of Meghna-Muhuri Water Transfer Planning by IECO-RAAL, 1972.

3. Inception Report on Noakhali Irrigation Project, Directorate of Planning, BWDB, January 1983.

4. Bangladesh Land and Water Resources Sector Study (9 volumes), 1972.

5. GOB/IDA Review of BWDB, April 1979, and 1986.

6. Medium-Term Food Production Plan, Feb. 1981.

7. Draft National Water Master Plan, 1986.

8. Barisal Irrigation Project Completion Report, FAO/CP, 1985.

9. Gumti Project, World Bank Staff Appraisal Report, April 1985.

10. Feasibility Report on Noakhali Project Phase I, Nedeco, 1980.

11. Little Feni and Noakhali Regulator, IECO, 1961.

12. Coastal Embankment Project, LDL, 1968.

13. Upazila Statistics, Bangladesh Bureau of Statistics.

14. Soil and Agriculture Report on Noakhali North, Directorate of Land and Water Use, BWDB, 1981.

15. Surface Water Simulation Modelling Programme, Final Report.

South East Regional Study
Proposed Amendments to TOR

Page 5 of 20

Add to paragraph 10(f) the following:

iv) The final Regional Plan will incorporate upgraded proposals for development of a Dakatia/Little Feni project using available data. The approach to the treatment of local sediment and drainage problems in the headwater areas of the catchments will be empirical with different assumptions being made to assess the sensitivity of the development scenarios to possible sediment transport/deposition situations. Recommendations will be made for the formulation of draft Terms of Reference for follow up studies and suggestions presented for the establishment of a sediment and hydrometric gauging programme by the BWDB/Surface Water Modelling Centre or other appropriate agency.

Page 6 Para 11 - Feasibility Studies

The overall objective of the feasibility study is to examine in detail ways in which flooding and drainage problems can be alleviated and to formulate proposals for development of the Noakhali North project area. This will also be of relevance to both upgrading the Regional Planning Report and to future project planning studies elsewhere.

The study will involve an examination of a range of technically feasible project options for alleviating the problems in the Noakhali North area, including non-structural and complementary flood proofing measures where appropriate. The study will take full account of the O&M implications of the options, and will include an assessment of their economic viability and social and environmental acceptability. The level of analysis will be that expected of a feasibility-level study. At each stage there will be close consultation between all the disciplines involved.

The second interim progress report will be submitted at the end of September 1992, outlining programming and methods of study to be used and a draft feasibility study report will be submitted at the end of May 1993. The outcome of the study will be presented in sufficient detail and in an appropriate format in order to arrive at an investment decision to be taken by the Government of Bangladesh and external funding agencies.

The consultants are required to perform all the work necessary to attain the above objectives. Specific tasks will include the following:

Hydraulic Studies

- Develop the hydrodynamic model for the area, based as appropriate on the SERM and using additional survey, topographic and hydrological data as and when it comes available.

- Calibrate and verify the developed model as necessary.

277

- Run the model for the past 25 years data with the current geometry to set the baseline conditions for the comparison of the effects of project proposals. Carry out appropriate statistical analysis of results.

- Run the model for selected years to determine design conditions for proposed measures.

- Run the model for 25 years historic data for proposed option or options.

- Assess the impact of the proposals and impacts of possible upstream projects on the option.

- Assess the morphological, sediment and salinity implications of the proposals.

Engineering

- Carry out topographic survey for design to feasibility level of civil works and structures needed for flood control/drainage options.

- Assess the present status of existing flood control and drainage structures including the drainage system in the project area.

- In conjunction with other disciplines, assess the capacity for, and effectiveness in, operating and maintaining flood control and drainage systems, taking account of the findings of other components of FAP and of other current projects in particular social, institutional and financial aspects of O&M to be fully covered.

- In conjunction with other disciplines, identify realistic measures for flood proofing covering both structural and non-structural components and systems for flood preparedness, including embankment patrolling, materials stockpiles and contingency action plans for embankment repair, orderly embankment retirement, and responses to flood forecasts.

- In conjunction with other disciplines, identify project options which are technically feasible for alleviating flooding and drainage problems. Attention should be given to the multiple use of borrow pits and the disposal and use of spoil. Assess the cost of works for each component, including the requirement of land and rights of way, based on the hydrological and hydraulic studies as well as the topographic data obtained above.

- In conjunction with other disciplines, evaluate as far as possible the feasible options, taking a full account of operation and maintenance constraints, and make recommendations where appropriate.

- Prepare the design to feasibility study level of all the main engineering works for the recommended option or options and refine cost estimates where necessary.

- Formulate an implementation programme for the recommended option or options including phased construction and the establishment of the required operation and maintenance capacity.

Agriculture

- Establish the present status of agriculture in the project area, including identification of current cropping patterns in relation to flood depths, yields, input use, land tenure and distribution, irrigation, livestock, agricultural institutions etc.

- Identify farmers' current responses to flooding and their priorities for flood reduction.

- Assess likely changes in cropping patterns, yields, input use, livestock numbers etc. and timing of such changes due to each of the project options.

- Assess the likely constraints to development e.g. seasonal labour shortages, and any supporting programmes needed to bring about project benefits. This is to be carried out in consultation with other specialists especially the social scientist.

Fisheries

- Assess the present status of culture fisheries in the project area, including existing management systems, with special reference to any benefits or disbenefits from FCD and constraints to further development such as technology transfer, availability of credit and pond ownership problems.

- Assess the present status of the capture fisheries, including existing management systems, both inside the project area, e.g. in khals, beels and other internal waters, and outside in the adjacent sections of the Lower Meghna river. The impact of FCD to data on all these fish stocks and the dependent fishing communities is of particular concern.

- Assess the project options in the light of experience, i.e. FAP 12 evaluations of past FCD projects and conclusions from earlier FAP 5 studies in order to determine the likely beneficial and or adverse consequences for fisheries within and in the vicinity of the project area.

- After consultation with local informed opinion, prepare fisheries options for the area aimed at mitigating any identified negative consequences and optimising the beneficial effects of the different project options on the fisheries sector.

Environmental Impact Analysis

- Carry out necessary field work and survey to create an environmental database for the EIA. It is acknowledged that, in certain areas such as aquatic ecology, data collected during the feasibility studies will be limited owing to the duration of the studies.

- Carry out detailed analyses of probable beneficial and adverse impacts which the project options will have on the environment. These will include a comparison of the impacts of the different options. The analyses will focus on both direct and indirect impacts. Where these impacts would be adverse or would involve irretrievable commitment of resources, they will be so indicated.

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- Identify and recommend the possible means of environmental safeguard, minimising detrimental impacts, enhancing beneficial impacts and suggest practical solutions to environmental problems which might arise as a result of project implementation.

- Prepare a holistic, multidisciplinary EIA which embraces all important aspects of the physical, social, economic, and ecological interactions in the living and non-living environment. The depth of analyses and length of description of each environmental resource should be commensurate with the magnitude of the probable impact on that resource.

Social Impact Studies

- In conjunction with other disciplines, identify a range of project options potentially acceptable in the study area. Define the criteria by which "acceptability" is judged.

- Make a detailed examination of household economies and survival strategies in relation to local social, ecological and institutional factors. Experiences of and responses to floods should be assessed within this framework.

- Define within the context of the study, the role and importance of the household as a unit of social analysis, paying attention to gender differentials. Describe and analyze, where appropriate, alternative social institutions which are influential.

- Review the findings of other studies on social organisations and institutions in the study area in order to analyse what exists. Prescribe the steps necessary for developing new social institutions capable of engaging in selection, design, operation and maintenance of structural and non-structural options and make recommendations on how to involve disadvantaged groups in these. In doing, so, the following issues should be examined in conjunction with other disciplines, including the institutional specialist:

    - role of social groups in mitigation planning.

    - local institutional resources available to provide assistance to disadvantaged categories of people affected by the project options.

    - identification of rehabilitation packages for those losing land and livelihood.

    - role of local government and NGOs in the area.

    - organisation and operation of relevant local social groups which could be involved in project construction and maintenance works.

    - opportunities for targeting women and children.

- In conjunction with other disciplines, undertake a process of consultation, the aim of which should be to allow local people's views to be incorporated into the development of options and the determination of preferences.

- Assemble and test, where possible, a fully documented methodological approach, to participatory planning for use during the later design stages and project implementation. Where the study identifies that it will be necessary to be prescriptive, a fully documented account of objectives and methods will be required.

- Identify and analyse social institutions which may be mobilised to resolve conflict arising from different options, particularly those arising from modified land or common property access. Propose institutionalised forms of appeal, challenge and resolution to be used when disputes arise.

Economic Appraisal/Project Planning

- Examine and attempt to quantify non-agricultural benefits, for example reduction in flood damage to infrastructure, increased availability of land for housing, increased mobility along embankments etc. for each of the project options.

- In conjunction with other disciplines, discuss alternative project concepts (including non-structural measures) and identify project need with relevant Government agencies and NGOs.

- In conjunction with other disciplines, liaise with other FAP studies to ensure that results of relevance from those studies are taken into account in the project preparation.

- Carry out economic and financial appraisal of the project options, including, where possible, quantification of social and environmental effects and appraisal of components to mitigate adverse impacts on the environment, particularly fisheries.

- In conjunction with other disciplines, make recommendations concerning the preferred option or options, where appropriate.

- Revise the economic and financial appraisal of the recommended option or options.

- Prepare full details of financing requirements for construction and O&M. Cost recovery options should be investigated in conjunction with FAP-13.

Pages 8 and 9

Delete the existing sections and substitute as follows:

(e) determine the capacity of all major regulators for drainage and irrigation as appropriate.

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(f) determine the capacity of main drainage channels.

(g) make adequate provision for new or improved secondary drainage channels with due consideration given to the needs of irrigation requirements where LLPs are to be utilised.

Page 14

Delete the first sentence and replace as follows:

> Yields shall take into account the variations from year to year resulting from floods and the method of calculation shall be clearly set out.

Page 15 para 27(a)

Delete the words "foundation investigations" and in the last sentence change "shall" to "may".

Page 16

Sections V, VI and VII to be replaced as follows:

V. Time Schedule

28. The study period is estimated at 33 months for preparation of the regional plan and the feasibility study. The outline programme for studies is as follows:

Operation or Event	Responsibility	Date
Project start-up	Consultants	November 1990
Inception Report	Consultant/BWDB	February 1991
Draft Regional Plan	Consultant/BWDB	January 1992
Draft Feasibility Study Report	Consultant/BWDB	May 1993
Final Regional Plan and Feasibility Study Report	Consultant/BWDB	July 1993

VI. Duration of Consultancy Services and Composition of Team

29. Based on the above schedule the consultancy will commence about November 1990 and end about July 31, 1993 giving a duration of 33 months. It is estimated that 338 man-months of specialist input will be required, of which 103 man-months would be internationally recruited specialists and 235 man-months of local specialists. In addition, the consultant would provide field staff for the socio-economic survey, benchmark survey, fisheries and navigation studies. The composition of the team will be that agreed between the Bank and the consultants as attached to the contract in Appendices B and C and taking into account the profiles given in section VIII of these terms of reference.

VII. Reporting Requirements

30. The prefeasibility and feasibility report shall generally follow the outlines given in the FAO/IBRD cooperative programme publication "Guidelines for the Preparation of Feasibility Studies" published in December 1970. The report outline shall be agreed with the World Bank. The feasibility report shall be a comprehensive document and shall determine that the project is:

- in conformity with the country's development objectives and immediate priorities;

- technically sound and the best of the available alternatives under existing technical and other constraints;

- administratively workable; and

- economically, financially, socially, environmentally and institutionally viable.

31. The Consulting firm shall work directly with BWDB professionals and keep the SE informed of the progress and problems. They will prepare discussion paper for weekly (or as needed) meetings to be conducted by the SE and monthly meetings by Chief Engineer Planning. In particular, they will submit to the World Bank for subsequent transmittal to GOB and UNDP:

(a) an inception report in 20 copies. This report will include the work plan, along with detailed task specific manpower allocation budget for the whole project team, the program for surveys, investigations and hydrological data collection needed for the prefeasibility study and actions taken and progress to date on these activities. The inception report should also include the program for the feasibility study and the detailed engineering documents. Staffing requirements, transport, office accommodation and other relevant matters should also be discussed.

(b) quarterly progress report in 20 copies. These reports should be utilized by consultants to inform the World Bank, GOB and UNDP on progress, outstanding issues and to suggest solutions to any problems facing them in their work;

(c) the draft final reports in 20 copies for the regional plan in January 1992 and the feasibility study in May 1993.

(d) final feasibility report in 30 copies within 2 weeks after the tripartite meeting is convened to discuss the draft reports or within two months of submittal of the draft report whichever is earlier.

(e) final Regional Plan Report in July 1993.

Page 20

Amend heading of paragraph 40 to read "Environmental Specialist (International)".
Amend heading of paragraph 44 to read "Environmental Specialist (Local)".

ii) Amendments (1992/93)

ATTACHMENT NUMBER ONE

ARTICLE III : Costs and Payments

Section 3.01 line 6 the amount of 'US$2,002,000' shall be deleted and replaced by 'US$2,245,184'

APPENDIX A : Terms of Reference

II Terms of Reference

Clause 10, page 5 of 20, add after 10 (iii)

"vi)The final Regional Plan will incorporate upgraded proposals for development of a Dakatia/Little Feni project using available data. The approach to the treatment of local sediment and drainage problems in the headwater areas of the catchments will be empirical with different assumptions being made to assess the sensitivity of the development scenarios to possible sediment transport/deposition situations. Draft Terms of Reference for follow up studies will be prepared and also suggestions presented for a programme of sediment and hydrometric gauging to be undertaken by the BWDB/Surface Water Modelling Centre or other appropriate agency".

Clause 11, Page 6 of 20, delete whole Clause and replace by:

"**Feasibility Study.** The overall objective of the feasibility study is to examine in detail ways in which flooding and drainage problems of the Noakhali North project area can be alleviated and to formulate proposals for development. This will also be of relevance to both upgrading the Regional Planning Report and to future project planning studies elsewhere.

The study will involve the examination of a range of technically feasible options for alleviating the problems in the area, including non-structural and complementary flood-proofing measures, where appropriate. The study will take full account of the O&M implications, and will include an assessment of economic viability and social and environmental acceptability. The level of analysis will be appropriate to feasibility-level study. At each stage, there will be close coordination between all the various disciplines involved.

The Second Interim Progress Report will be submitted at the end of September, 1992. This will outline the programme and methods to be adopted. A draft feasibility study will be submitted at the end of May 1993. The outcome of the study will be presented in sufficient detail to enable investment decisions to be taken by the Government and external funding agencies.

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The Consultants are required to perform the work necessary to attain the above objectives and specific tasks are described below.

a) Hydraulic Studies

i) Develop the hydrodynamic model for the area, based, as appropriate, on the SERM and using additional survey, topographic and hydrological data as and when it comes available.

ii) Calibrate and verify the developed model as necessary.

iii) Run the model for the past 25 years data with the current geometry to set the baseline conditions for the comparison of the effects of project proposals. Carry out appropriate statistical analysis of results.

iv) Run the model for selected years to determine design conditions for proposed measures.

v) Run the model for 25 years historic data for proposed option or options.

vi) Assess the impact of the proposals and impacts of possible upstream projects on the option.

vii) Assess the morphological, sediment and salinity implications of the proposals.

b) Engineering

i) Carry out topographic survey for design to feasibility level of civil works and structures needed for flood control/drainage options.

ii) Assess the present status of existing flood control and drainage structures including the drainage system in the project area.

iii) In conjunction with other disciplines, assess the capacity for, and effectiveness in, operating and maintaining flood control and drainage systems, taking account of the findings of other components of FAP and of other current projects in particular social, institutional and financial aspects of O&M to be fully covered.

iv) In conjunction with other disciplines, identify realistic measures for flood proofing covering both structural and non-structural components and systems for flood preparedness, including embankment patrolling, materials stockpiles and contingency action plans for embankment repair, orderly embankment retirement and responses to flood forecasts.

v) In conjunction with other disciplines, identify project options which are technically feasible for alleviating flooding and drainage problems. Attention should be given to the multiple use of borrow pits and the disposal and use of spoil. Assess the cost of works for each component, including the requirement of land and rights of way, based on the hydrological and hydraulic studies as well as the topographic data obtained above.

vi) In conjunction with other disciplines, evaluate as far as possible the feasible options, taking a full account of operation and maintenance constraints, and make recommendations where appropriate.

vii) Prepare the design to feasibility study level of all the main engineering works for the recommended option or options and refine cost estimates where necessary.

viii) Formulate an implementation programme for the recommended option or options including phased construction and the establishment of the required operation and maintenance capacity.

c) **Agriculture**

i) Establish the present status of agriculture in the project area, including identification of current cropping patterns in relation to flood depths, yields, input use, land tenure and distribution, irrigation, livestock, agricultural institutions etc.

ii) Identify farmer's current responses to flooding and their priorities for flood reduction.

iii) Assess the likely changes in cropping patterns, yields, input use, livestock numbers etc. and timing of such changes due to each of the project options.

iv) Assess the likely constraints to development e.g. seasonal labour shortages, and any supporting programmes needed to bring about project benefits. This is to be carried out in consultation with other specialists especially the social scientist.

d) **Fisheries**

i) Assess the present status of culture fisheries in the project area, including management systems, with special reference to any benefits or disbenefits from FCD and constraints to further development such as technology transfer, availability of credit and pond ownership problems.

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ii) Assess the present status of the capture fisheries, including existing management systems, both inside the project area, e.g. in khals, beels and other internal waters, and outside in the adjacent sections of the Lower Meghna river. The impact of FCD to date on all these fish stocks and the dependent fishing communities is of particular concern.

iii) Assess the project options in the light of experience, i.e. FAP:12 evaluations of past FCD projects and conclusions from earlier, FAP:5 studies in order to determine the likely beneficial and or adverse consequences for fisheries within and in the vicinity of the project area.

iv) After consultation with local informed opinion, prepare fisheries options for the area aimed at mitigating any identified negative consequences and optimising the beneficial effects of the different project options on the fisheries sector.

e) **Environmental Impact Analysis**

i) Carry out necessary field work and survey to create an environmental database for the EIA. It is acknowledged that, in certain areas such as aquatic ecology, data collected during the feasibility studies will be limited owing to the duration of the studies.

ii) Carry out detailed analyses of probable beneficial and adverse impacts which the project options will have on the environment. These will include a comparison of the impacts of the different options. The analyses will focus on both direct and indirect impacts. Where these impacts would be adverse or would involve irretrievable commitment of resources, they will be so indicated.

iii) Identify and recommend the possible means of environmental safeguard, minimising detrimental impacts, enhancing beneficial impacts and suggest practical solutions to environmental problems which might arise as a result of project implementation.

iv) Prepare a holistic, multidisciplinary EIA which embraces all important aspects of the physical, social, economic, and ecological interactions in the living and non-living environment. The depth of analyses and length of description of each environmental resource should be commensurate with the magnitude of the probable impact of that resource.

f) **Social Impact Studies**

i) In conjunction with other disciplines, identify a range of project options potentially acceptable in the study area. Define the criteria by which "acceptability" is judged.

289

ii) Make a detailed examination of household economies and survival strategies in relation to local social. ecological and institutional factors. Experiences of and responses to floods should be assessed within this framework.

iii) Define within the context of the study, the role and importance of the household as a unit of social analysis, paying attention to gender differentials. Describe and analyze, where appropriate, alternative social institutions which are influential.

iv) Review the findings of other studies on social organisations and institutions in the study area in order to analyses what exists. Prescribe the steps necessary for developing new social institutions capable of engaging in selection, design, operation and maintenance of structural and non-structural options and make recommendations on how to involve disadvantaged groups in these. In doing, so, the following issues should be examined in conjunction with other disciplines, including the institutional specialist:

- role of social groups in mitigation planning.
- local institutional resources available to provide assistance to disadvantaged categories of people affected by the project options.
- identification of rehabilitation packages for those losing land and livelihood.
- role of local government and NGOs in the area.
- organisation and operation of relevant local social groups which could be involved in project construction and maintenance works.
- opportunities for targeting women and children.

v) In conjunction with other disciplines, undertake a process of consultation, the aim of which should be to allow local people's views to be incorporated into the development of options and the determination of preferences.

vi) Assemble and test, where possible, a fully documented methodological approach, to participatory planning for use during the later design stages and project implementation. Where the study identified that it will be necessary to be prescriptive, a fully documented account of objectives and methods will be require.

v) Identify and analyse social institutions which may be mobilised to resolve conflict arising from different options, particularly those arising from modified land or common property access. Propose institutionalised forms of appeal, challenge and resolution to be used when disputes arise.

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g) Economic Appraisal/Project Planning

i) Examine and attempt to quantify non-agricultural benefits, for example reduction in flood damage to infrastructure, increased availability of land for housing, increased mobility along embankments etc. for each of the project options.

ii) In conjunction with other disciplines discuss alternative project concepts (including non-structural measures) and identify project need with relevant Government agencies and NGOs.

iii) In conjunction with other disciplines, liaise with other FAP studies to ensure that results of relevance from those studies are taken into account in the project preparation.

iv) Carry out economic and financial appraisal of the project options, including, where possible, quantification of social and environmental effects and appraisal of components to mitigate adverse impacts on the environment, particularly fisheries.

v) In conjunction with other disciplines, make recommendations concerning the preferred option or options, where appropriate.

vi) Revise the economic and financial appraisal of the recommended option or options.

v) Prepare full details of financing requirements for construction of O&M. Cost recovery options should be investigated in conjunction with FAP:13.

III Important Activities

Flood Control and Drainage Improvements, pages 8 and 9 of 20, delete Clauses (e), (f) and (g) and replace with:

"(e) determine the capacity of all major regulators for drainage and irrigation as appropriate"

(f) determine the capacity of main drainage channels.

(g) make adequate provision for new or improved secondary drainage channels with due consideration given to the needs of irrigation requirements where LLPs are to be utilised.

Page 14

Delete the first sentence and replace as follows:

> Yields shall take into account the variations from year to year resulting from floods and the method of calculation shall be clearly set out.

Page 15 para 27(a)

Delete the words "foundation investigations" and in the last sentence change "shall" to "may".

Page 16

Sections V, VI and VII to be replaced as follows:

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Draft Feasibility Study Report	Consultant/BWDB	May 1993
Final Regional Plan and Feasibility Study Report	Consultant/BWDB	July 1993

VI. Duration of Consultancy Services and Composition of Team

29. Based on the above schedule the consultancy will commence about November 1990 and end about July 31, 1993 giving a duration of 33 months. It is estimated that 338 man-months of specialist input will be required, of which 103 man-months would be internationally recruited specialists and 235 man-months of local specialists. In addition, the consultant would provide field staff for the socio-economic survey, benchmark survey, fisheries and navigation studies. The composition of the team will be that agreed between the Bank and the consultants as attached to the contract in Appendices B and C and taking into account the profiles given in section VIII of these terms of reference.

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VII. Reporting Requirements

30. The prefeasibility and feasibility report shall generally follow the outlines given in the FAO/IBRD cooperative programme publication "Guidelines for the Preparation of Feasibility Studies" published in December 1970. The report outline shall be agreed with the World Bank. The feasibility report shall be a comprehensive document and shall determine that the project is:

- in conformity with the country's development objectives and immediate priorities;
- technically sound and the best of the available alternatives under existing technical and other constraints;
- administratively workable; and
- economically, financially, socially, environmentally and institutionally viable.

31. The Consulting firm shall work directly with BWDB professionals and keep the SE informed of the progress and problems. They will prepare discussion paper for weekly (or as needed) meetings to be conducted by the SE and monthly meetings by Chief Engineer Planning. In particular, they will submit to the World Bank for subsequent transmittal to GOB and UNDP:

(a) an inception report in 20 copies. This report will include the work plan, along with detailed task specific manpower allocation budget for the whole project team, the program for surveys, investigations and hydrological data collection needed for the prefeasibility study and actions taken and progress to date on these activities. The inception report should also include the program for the feasibility study and the detailed engineering documents. Staffing requirements, transport, office accommodation and other relevant matters should also be discussed.

(b) quarterly progress report in 20 copies. These reports should be utilized by consultants to inform the World Bank, GOB and UNDP on progress, outstanding issues and to suggest solutions to any problems facing them in their work;

(c) the draft final reports in 20 copies for the regional plan in January 1992 and the feasibility study in May 1993.

(d) final feasibility report in 30 copies within 2 weeks after the tripartite meeting is convened to discuss the draft reports or within two months of submittal of the draft report whichever is earlier.

(e) final Regional Plan Report in July 1993.

Page 20

Amend heading of paragraph 40 to read "Environmental Specialist (International)".
Amend heading of paragraph 44 to read "Environmental Specialist (Local)".

APPENDIX B: Consultants Staffing Schedule

Delete APPENDIX B and replace with attached APPENDIX B

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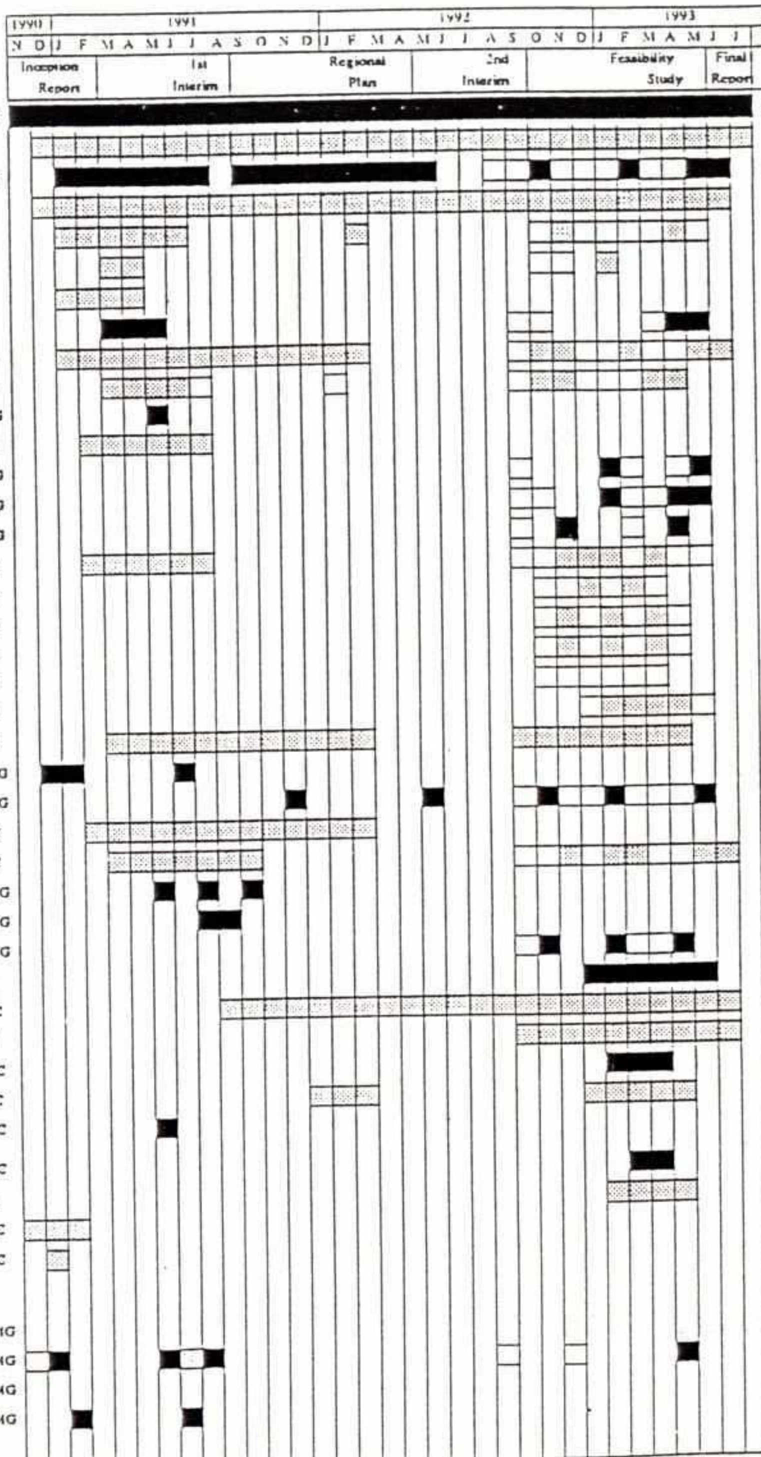
South East Regional Study

APPENDIX B

Consultants Staffing Schedule

Post No	Post	Name	Firm	MM F	MM L
F1	Sr Planning Engineer/Team Leader	J W Dunn/M J Politzer	MMG	33.0	
L1	Sr. Water Res. Eng/Co-Team Leader	M Mohsin Uddin	HoC		32.0
F2	Snr Irr Planning Eng/I&D Eng	R M Dyer	MMG	19.9	
L2	Planning Engineer	D S S Abedin/N Islam	HoC		30.5
L3	Senior Hydrologist	Dr Afzal Hossain	HoC		9.7
L4	Hydro-geologist	Prof. M. Hoque	DU		3.3
L5	Soils Specialist	B K Chowdhury	HoC		4.0
F3	Senior Agronomist	H Thewda	NK	4.8	
L6	Agronomist	A Hossain/Dr Ali Imam	HoC		19.5
L7	Fisheries Specialist	Dr S Shah/Shahadat Ali	HoC		9.0
F4	Environmentalist 1	B Spooner	MMG	1.2	
L8	Environmentalist 2	Prof. S D Shamsuddin	HoC		5.8
FA	EIA Coordinator	A Bird	MMG	2.5	
FB	Senior Ecologist	P C Almeda Villela	MMG	3.0	
FC	Senior Sociologist	J Moore/J L Leterme	MMG	2.3	
L9	Sociologist	Mrs A Duza/Dr Jharna Nath	HoC		10.5
LA	Water Quality Chemist	Dr AKMH Talukder	HoC		2.5
LB	Aquatic Ecologist	Dr M Khondker	HoC		3.0
LC	Terrestrial Ecologist	Dr K K Anam	HoC		3.5
LD	Public Health Sp/Nutrition Sp	Azam Ali	HoC		2.5
LE	Programmer/Field Methodology Sp	M A Latif	HoC		5.0
L10	Local Participation Expert	Dr N U Ahmed/H Patuary	HoC		20.0
F5	Senior Economist	D K V Marsh	MMG	2.8	
F5	Senior Economist	E Mallorie/J Youngman	MMG	4.8	
L11	Senior Agro-economist	Dr. Zizus Shams Haq	HoC		13.0
L12	Economist	Dr M Huq/Dr A Chowdhury	HoC		12.0
F8	Regional Planning Economist	A. Baker	MMG	3.0	
FD	Computer Modeller	C. Karavaedi	MMG	2.0	
FD	Hydrologist/Modeller	P Laurentis	MMG	2.8	
F6	Senior Design Engineer	G N Iglesia	NK	6.0	
L13	Design Engineer 1	Mosaddeq Khan	HoC		23.0
L14	Design Engineer 2	A Zaman	DU		10.0
F7	Senior Hydraulics Engineer	N Karunaratne	RDC	2.5	
L15	Hydraulics Engineer	M Uddin/S M K Rahman	HoC		8.0
F9	Senior Coastal Engineer	P D Chandrawansa	RDC	1.0	
F10	Senior Mechanical Engineer	Dr A P Jayasinghe	RDC	2.5	
L16	Mechanical Engineer	Masih-ur-Rahman	DU		4.0
LIT	Acting Co Team Leader	Solaiman Ali	HoC		3.3
L14	Assistant Engineer	Subash Chandra Roi	HoC		0.8
	Visiting Specialists and Head Office Backup				
	Project Director	M H Khan	MMG	1.2	
	Hydrology & Hydraulic Model Spec.	Dr R Wardlaw/Dr P Samuels	MMG	5.8	
	Planning Adviser	D N Moore	MMG	0.5	
	Groundwater Modelling Specialist	J van Wonderen	MMG	2.0	
		Total		103.5	235.1



Legend: Foreign mm / Local mm / Part time / Other Study

ANNEX XIII

Dakatia/Little Feni Transfer Draft TOR

ANNEX XIII

TERMS OF REFERENCE FOR FEASIBILITY STUDY DAKATIA - LITTLE FENI TRANSFER AND DRAINAGE SCHEME

1. Background

1.1 Introduction

The Government of Bangladesh (GOB) aims to achieve foodgrain self-sufficiency and to maintain it. With this objective in mind GOB undertook a South East Region Water Resources Development Programme (SERS) to assess the resources of the region. One of the projects identified for further study in that programme was the Dakatia/Little Feni Transfer scheme. The Southeast Regional Study presented various options which should from the basis of this study.

The principal elements of the scheme are as follows:

- Improvement of drainage of the Sonaichari, Dakatia and Little Feni basins.
- Incremental irrigation from the Little Feni and Dakatia rivers with the potential for additional areas in the Muhuri catchment and the eastern part of the Noakhali north area.

1.2 The Project Area

The project area has the following approximate boundaries : to the north areas adjacent to the Dakatia river north bank and its principal khal tributaries and the Meller khal, to the east the Indian border, to the south the old coastal embankment from Muhuri to Companyganj and then north to Senbag and from there west to Ramganj and in the west the Chandpur Irrigation Project embankment.

The project area has an extensive and intricate network of khals and natural drainage channels including major channels such as the Dakatia and Little Feni Rivers and several important tributary channels including the Gungiajuri, Sonaichari khals and the Pagli, Boaljuri and Kakri rivers which enter the area from the Tripura hills in India.

Present agricultural development is constrained by flooding in the pre-monsoon and monsoon season and particularly in the Dakatia and Little Feni basins by extreme shortage of water for irrigation in the latter part of the dry season.

1.2.1 Justification for the Project

The project area suffers from problems of flood and drought. During the monsoon (May to October) high concentration of rainfall, high sediment discharges, storm surges and tides in coastal areas create difficult hydrological conditions and lead to silting up of outfall channels. The main rice crops, aus and aman, that are grown in the monsoon season, are frequently subjected to flooding to depths which severely reduce yields.

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These crops are also frequently affected by erratic rainfall and by a late onset or early cessation of the monsoon rains. Increase in cropping intensity, by expanding the area of boro rice and other rabi crops during the dry season, depends upon the provision of irrigation.

1.2.2 Present Situation

Completed and on-going major water resources development activities in the project area include.

a) Muhuri Irrigation Project, which provides flood control, drainage and control of saline intrusion to an area of 27,000 ha and irrigation to 20,000 ha, was completed in June 1986;

b) The Sonaichari irrigation project covering about 4,500 ha served both by surface and groundwater.

c) The Kazirhat Regulator on the Little Feni River.

d) The Noakhali North Drainage and Irrigation Project for which a feasibility study has just been completed (1993).

e) Completed and ongoing Food for Work schemes implemented by BWDB field divisions; mostly involving reexcavation of khals and the desilting of the channel downstream of Kazirhat regulator.

1.3 Previous and Ongoing Studies

The results of earlier studies should be evaluated and the data base underlying them assessed The Surface Water Simulation Model (SERM) developed under UNDP project BGD/85/045 and refined by the SERS is expected to provide the analytical base for this preparation work. The Consultants will be expected to work closely with teams involved in the implementation of projects and studies in the Region, including the Systems Rehabilitation Project.

2. Terms of Reference

The main output of the study will comprise a feasibility study covering the whole of the Sonaichari, Dakatia and Little Feni catchments in Bangladesh and will also include the Muhuri Irrigation Project area for consideration of augmentation of supplies.

Tasks relating to the feasibility study should take into account the guidelines prepared for the Flood Action Plan Project including those for project appraisal, environmental impact and people's participation. The tasks will include.

(a) discussions/consultations with local officials and potential beneficiaries

(d) discussions with Ministries of Agriculture, Forests, Environment, Shipping and IWT, Fisheries and Livestock, Irrigation, Water Development and Flood Control, Planning Commission, Roads and Highways Department, BADC, NGOS and other institutions involved in promoting local participation:

(c) assessment of the data base, review of topographical surveys, hydrological and morphological data, agro-economic and socio-economic data and assessment of ongoing surveys and data collection activities, with particular reference to their adequacy.

(d) using the results of the SERM and other sources of data for the SE region, obtain information needed for determining design levels and discharge data for fixing capacities for irrigation and environmental drainage structures and for the design of drainage/supply khals or canals;

(e) assessment of the extent of benefitted area, the environmental impact of the proposed project works on the project and adjacent areas and on existing economic activities (fisheries, navigation, etc.); including identification of possible negative effects in the project area and preparation of proposals for possible mitigation measures;

f) Establish design criteria and planning concepts, prepare project layouts, feasibility level engineering designs and drawings of relevant project components. In this respect, due consideration shall be given to:

- the possibility to improve irrigation facilities through pumping water from the Meghna and conveying it though an improved khal system, taking into consideration present and planned use of Meghna waters;

- the design height of embankments and the associated risk of failure;

- the special maintenance requirements of high embankments and the increased damage in case of failure (in particular in those areas where embankments have to be significantly raised and where polder protection is required.

- current groundwater abstractions in the project area and the potential for further development; and

- the need for access and service roads, necessary to construct, maintain and operate the other project facilities;

g) preparation of cost estimates of project works on the basis of recent actual contract rates, including annual expenditure schedules

h) preparation of operation and maintenance schedules, including staff, equipment and budget requirements;

i) preparation of realistic implementation schedules, showing project components in quantitative and monetary terms, equipment and staff requirements and procurement schedules, as well as specifications for engineering and other surveys required for detailed design and implementation;

j) preparation of proposals for improved water management, project implementation, and for improving the institutional infrastructure (.eg., extension, research, credit, marketing, and farmers' organisation) in the area;

k) assessment of benefits for relevant project alternatives and evaluation of project economics, including farm budgets, internal rates of return and sensitivity analysis.

2.1 Technical Aspects of Special Interest.

The SERS has identified several aspects critical to the study.

2.1.1 Drainage

There is a need to establish a hydrometric network data collection programme for at least one and preferably two monsoon seasons during the study. This will require extensive topographical survey, collection of sediment data and channel discharge and water level data.

- All existing structures and embankments must be inventoried
- new gauge boards will be established as necessary
- channel cross sections will be established at 1 km intervals throughout the Little Feni and in the Sonaichari and Dakatia at least as far as Laksham and also in the reach between Chandpur and the Chabagadi pump station. These will be required for revision and upgrading the SERM and for quantity calculations.

2.1.2 Sediment Sampling

The programme shall be designed to obtain sufficient data to analyse the existing situation in terms of quantities and locations of existing silt and sand inflows, outflows and deposition in order to prepare soundly based recommendations for improving or solving the siltation which contributes to the drainage problems in the Sonaichari and Little Feni catchments.

2.1.3 Dakatia Pumping

a) Proposals for pumping Meghna water along the Dakatia and into the Little Feni must take into account the needs of existing users on the Dakatia including CIP and must examine alternative locations and sizes for the pump station considering river capacity, water levels and costs.

2.2 Important Activities

2.2.1 Mapping

(a) Produce a project works plan indicating the project area, embankments, khals and minor drainage channels, rivers, structures, roads, etc. The map should clearly indicate the existing and proposed works.

(b) preparation of a map indicating the pre-project and post project flooding conditions, the proposed drainage arrangement and a schedule indicating the proposed completion dates for each stage of the works.

2.2.2 Flood Control and Drainage Improvement

(a) Flood data should be classified in accordance with MPO flood phases but should be related to time and duration.

(b) determination of the required capacity of regulators. The method of calculation or estimation should be clearly explained.

2.2.3 Irrigation Development

(a) assess water resources of the Lower Meghna River the Dakatia, Little Feni and Muhuri catchment taking into account the present withdrawals by the users and their future requirements and determine the availability of water for use in the project area, as well as that for possible onward transfer to the Muhuri Irrigation Project;

(b) study the development options available, such as primary pumping with the secondary distribution system provided either by low lift pumps or gravity.

(c) study the existing irrigation systems in the project area (LLPs, STWs and) the organisation and management of farm groups and water users associations as a means to improved water distribution and management; the condition of farm canals, designed and actual command areas; identify the constraints and suggest solutions;

(d) propose a strategy for development of irrigation;

2.2.4 Navigation Facilities

Study the existing boat traffic during the wet and dry seasons in khals, major streams and rivers playing within he project area (particularly the Dakatia river) serving the growth centres with special reference to markets, inter connecting feeder roads and the national road network.

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2.2.5 Fisheries Development

Study the existing capture and culture fisheries in floodplain, beels and ponds. Determine the reduction in floodplain area which may result from improved drainage or polder development. Study the possibility of incorporating in the design of the hydraulic structures measures to reduce any adverse effect on the floodplain fisheries and detail the operation of these structures; provide guidelines for intensifying existing fisheries and developing new ones to compensate for unavoidable losses and fully develop the fisheries potential in the area.

2.2.6 Land Acquisition

Assess the land acquisition requirements. Interview land owners and local leaders to identify potential problems and suggest feasible solutions.

2.2.7 Development Support Communications

Study the institutions and facilities available in the project area for development support communications, viz., BWDB field staff capability, KSS and other farmers organisation, Union Council and Thana staff, Deputy Commissioner staff and agricultural support services (extension, research, credit, marketing, input supply) and make proposals for the effective participation of local organisations in the proposed development programme for the Region.

2.2.8 Water Control Structures

(a) list the structures required .

(b) prepare a single line drawing for each structure type . Show dimensions of opening or important features of structure. Indicate the top elevation, floor elevation, length, width, etc.

(c) prepare hydraulic calculations for structures.

(d) for a pumping plant, indicate the number, size and type of pumps. show calculations to substantiate the size and number of pumps. Evaluate and compare diesel and electric power alternatives;

(e) show the cost of each structure and total cost of structures in the scheme,

(f) show the typical cross-section of each existing embankment as designed and built, and for each new embankment to be constructed. Show the elevation of embankment and flood levels (annual and 20-year probability) and describe the present condition of the embankment; estimate quantity of earthwork for new construction required;

g) show the typical cross-sections of each drainage channel as designed, built, to be re-excavated and / or for new excavation. Give bed levels. Show the hydraulic computation for the amount of water required to be removed and the capacity of the drainage channel and describe its present condition; estimate the quantity of earthwork;

2.2.9 Cost Estimates

Estimate capital costs by construction year along the lines of components which would generally follow the undermentioned guidelines:

1. Preconstruction Activities

   a. Land acquisition;
   b. Engineering surveys and foundation investigations;
   c. Preparation of bidding documents for procurement of goods, services and for award of civil works contracts;

2. Civil Works

   Flood Control and Drainage

   a. Embankments

      (1) New
      (2) Resectioned
      (3) Protection works

   b. Drainage Channels

      (1) River and Khal resectioning (including dredging)
      (2) New
      (3) Appurtenant structures:

         (a) Road bridges
         (b) Culverts
         (c) Footbridges

      (4) Hydraulic Structures

         (a) Single vent regulators or sluices
         (b) Multi vent regulators or sluices
         (c) Contingency for additional regulators to be decided at detailed engineering phase
         (d) Navigation locks

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Irrigation Development

(1) Primary pump stations;

(2) Inlet and outlet canals;

(3) Main canal;

(4) Secondary canal;

(5) Canal structures, siphons, flumes, bridges, turnouts, etc.;

(6) Outlets in flood embankment for low lift pumps utilisation.

Access Roads Needed for Construction and O&M

Additional costed items should include:

1. Fisheries Infrastructure
2. Procurement of equipment and vehicles
3. Support services
4. Studies
5. Technical assistance and training
6. Engineering and administration
7. Operation and maintenance during the construction period and after project facilities become operational.

Cost Recovery

Prepare a programme and procedures for recovery of O&M costs, making use of procedures being developed under the BWDB System Rehabilitation Project.

Project Management

Prepare proposals for project implementation and project operation and maintenance.

2.2.10 Production

(a) Yields and Cropping Patterns

Yields shall be considered on a normal year basis with separate assessment for crop damage due to floods or drought. Cropped areas shall be subdivided into irrigated and non-irrigated areas. In accordance with established guidelines the yield and cropping patterns will be assessed for the present, future with and future without project conditions.

(b) Cropping Intensities

Intensities will be assessed in a similar a manner to yields.

(c) Fisheries Production (with and without Project)

(d) Livestock Production (with and without Project)

Describe potential for change in cropping pattern, yields and cropping intensities resulting from the project. The major agricultural production constraints would be identified, the extent of the impact of such constraints would be quantified and cost of production will be estimated. Constraints to intensification/diversification shall be identified and suggestions made as to how they may be addressed.

2.2.11 Farm Budgets

Prepare farm models for representative farm types, including tenants and/or share-croppers and analyse the financial benefits of the project and their distribution between different classes of beneficiaries. Estimate the potential for cost recovery and calculate levels of cost recovery consistent with farmers capacity to pay.

2.2.12 Economic Analysis

Estimate project net economic benefits and rates of return on the investments.

2.2.13 Employment

Analyse the expected impact of the project on employment in the project area, considering male, female and landless employment.

3. BWDB's Responsibility

The consultants shall work with the Planning Schemes Unit headed by a Superintending Engineer (SE) under the Chief Engineer (CE) Planning. The specialised departments of BWDB shall assist the Project Team as required, particularly with regard to the hydrological and morphological aspects of the study. BWDB's Central Designs Organisation shall provide guidance in the design of major structures as required.

The SE shall ensure that the objectives of the study as detailed in the TOR would be achieved within the agreed time schedule and that the contents of the report are acceptable to GOB. He would, in the context of the TOR, direct the planning process and work programming, supervise the execution of the study and monitor progress according to the set objectives. He would have regular meetings with the BWDB professional staff and the consultants to discuss technical and project management issues. Any unresolved issue, technical or otherwise, should be taken up with BWDB's senior staff (Chief Engineer Planning, Chief Engineer Designs, Director General of River Research Institute, Chief Engineer Hydrology etc.) or other GOB agencies as required.

BWDB shall make arrangements for SE's staff and the consultants to meet concerned GOB agencies in Dhaka and the project area to enable these agencies to be aware of the project objectives from its inception and to be involved in adapting it to their needs, particularly in relation to such matters as extension, research, pump irrigation, input supply, credit, farmers organisation, land acquisition, fisheries infrastructure, domestic water supply, environmental impact etc.

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BWDB shall provide or make available the following data, services and facilities:

(a) all hydrological, morphological, meteorological data and records or river stages;

(b) contour maps, mouza maps, aerial photographs and mosaics previous reports on surface and groundwater development of the project area'

(c) results of mathematical modelling studies;

(d) standard design manuals and type plans for hydraulic structures and other civil engineering structures and buildings; and

The consultant's contract shall include, in addition to funding for consultancy services, provision for funding the following items.

(a) additional topographical surveys, foundation investigations and hydrological data collection needed for the feasibility study. These works shall be undertaken through sub-contract or by direct labour.

(b) adequate office space to accommodate Consultant and BWDB staff;

(c) support staff including administrative and financial staff needed for the effective delivery of the consultancy services; and

(d) operation and maintenance of the office, including provision and operation of transport vehicles, office equipment, stationery, printing reproduction, and utilities.

4. Time Schedule

The study period is estimated at 24 months for the feasibility study and 3 months for review and finalisation of the reports. This is a tentative schedule which consultants should feel free to change while preparing their draft proposals to ensure that they can produce an effective feasibility study.

Operation or Event	Responsibility	Date
Project start-up	Consultants	September 94
Inception Report	Consultants/BWDB	November 94
Draft Feasibility Study Report	Consultant/BWDB	August 96
Final Feasibility Study Report	Consultant/BWDB	November 96

5. Duration of Consultancy Services and Composition of Team

The feasibility report shall generally follow the Guidelines for Project Assessment published by the FPCO in May 1992. The report outline shall be agreed with the financing agency. The feasibility report shall be a comprehensive document and shall determine that the project is:

- in conformity with the country's development objectives and immediate priorities;
- technically sound, and the best of the available alternatives under existing technical and other constraints;
- administratively workable; and
- economically, financially, socially, environmentally and institutionally viable.

The Consulting firm shall work directly with BWDB professionals and keep the SE informed of the progress and problems. They will prepare quarterly reports for presentation at meetings to be conducted by the SE and / or by the Chief Engineer Planning. In particular, they will submit.

(a) an inception report in 50 copies. This report, which should be submitted within 3 month after the contract award, will include the work plan, along with detailed tasks, specific manpower allocation, budget for the whole project team, the programme for surveys, investigations and hydrological data collection needed for the feasibility study and actions taken and progress on these activities during the first quarter. Staffing requirements, transport, office accommodation and other relevant matters should also be discussed;

(b) quarterly progress reports in 20 copies. These reports should be utilised by the consultants to inform the GOB on progress, outstanding issues and to suggest solutions to any problems facing them in their work;

(c) the draft final reports in 50 copies for the feasibility study; and

(d) final reports in 50 copies within 3 months of the draft report and after review by the GOB and donor agencies.

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