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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

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MEGHNA ESTUARY STUDY

A-17
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DRAFT DEVELOPMENT PLAN

VOLUME 3 : PART 1
FEASIBILITY STUDY
NIJHUM DWIP INTEGRATED DEVELOPMENT PROJECT

September 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE

DEVELOPMENT DESIGN CONSULTANTS
SURFACE WATER MODELLING CENTRE
AQUA CONSULTANTS AND ASS. LTD.

MINISTRY OF WATER RESOURCES
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MEGHNA ESTUARY STUDY

A-34

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LIST OF ABBREVIATIONS

ADP	Annual Development Plan
BADC	Bangladesh Agricultural Development Corporation
BIWTA	Bangladesh Inland Water Transport Authority
BWDB	Bangladesh Water Development Board
CDSP	Char Development and Settlement Project
CERP	Coastal Embankment Rehabilitation Project
CIP	Chandpur Irrigation Project
CMG	Canal Maintenance Group
CPP	Cyclone Protection Project
DAE	Department of Agricultural Extension
DDCC	District Development Co-ordination Committee
DLS	Department of Livestock Services
DOE	Department of Environment
DOF	Department of Forestry
EIA	Environmental Impact Assessment
EMG	Embankment Maintenance Group
FAP	Flood Action Plan
FD	Forest Department
FPCO	Flood Plan Co-ordination Organisation
GOB	Government of Bangladesh
GPP	Guidelines for People's Participation
HYV	High Yielding Variety
LAED	Land Accretion and Estuary Development Division (of BWDB)
LCS	Landless Contracting Society
LGED	Local Government Engineering Department
LRP	Land Reclamation Project
MES	Meghna Estuary Study
MHW	mean high water
MLW	mean low water
MWR	Ministry of Water Resources
O&M	Operation and Maintenance
PMU	Project Management Unit
RIDP	Remote Island Development Programme
RRI	River Research Institute
SDE	Sub Divisional Engineer
SMG	Structure Maintenance Group
SO	Sectional Officer
SRP	Systems Rehabilitation Project
TDCC	Thana Development Co-ordination Committee
TNO	Thana Nirbahi Officer
WARPO	Water Resources Planning Organisation
WMB	Water Management Board
WMC	Water Management Committee
WUA	Water User Association
WUG	Water User Group

SUMMARY

This feasibility study for the Nijhum Dwip Integrated Development Project has been prepared as part of the Meghna Estuary Study. The proposed project is centred around the promotion of accretion through the construction of cross dams between the southern end of Hatia Island and Nijhum Dwip and Damar Char. Previous studies of these potential interventions have concluded that they would not be economically viable. However, the development of low cost construction methods under MES together with recent data suggesting that accretion after construction of the cross dam between South Hatia and Nijhum Dwip would be much more rapid than has previously been supposed has positive implications for the viability of the project.

Morphology

As a part of the feasibility study for the construction of cross dams, a morphological study has been carried out to ascertain the effects of cross dam construction on the morphological development of the area. The objectives of this study were:

- to draw up an inventory of all relevant reports and data
- to describe the morphological development of the project area during recent decades
- to improve the understanding of the morphological behaviour in the area with the aid of remote sensing imagery, historical bathymetric and field data on the processes of land formation
- to assess long term changes of land formation and char development
- to predict the morphological impact of cross dam construction over the next 10 to 30 years.

Based on the development of land in the area over the last 25 to 30 years it is concluded that without the construction of any cross dam the natural gain of new land at the +2.2 m PWD level, the minimum level at which land should be embanked in this area, will be approximately 68 ha per year. The impact of the cross dams on land accretion to the +2.2 m PWD level is summarised below:

ha at or above +2.2 m PWD			
Year	No intervention	Nijhum Dwip cross dam	Nijhum Dwip + Damar Char cross dams
5	340	1,983	1,983
10	680	2,721	3,261
5	1,020	3,237	4,219
20	1,360	3,683	5,024

Present situation in the project area

The estimated 1996 population of the project area is some 17,000 persons, made up almost entirely of fishermen and farmers with small holdings. Fishing constitutes the largest single source of income for most households, although crop and livestock production are important for many of them.

The area has very limited existing infrastructure. The embankment of polder 73/2 on south Hatia marks the northern boundary of the project area. Inside the embankment there is a reasonably good network of roads, but outside the embankment in the project area there are at present no roads.

Agriculture in the area is typified by low yields (often less than 1 mt/ha for rice) and low cropping intensities. Major constraints are soil salinity, the low organic content of soils and the vulnerability of the area to damage from high tides and storms and a lack of inputs and extension support. These constraints can only be mitigated by the construction of embankments to keep out tides and storms and permit proper water management. Cattle, goats and poultry are a common feature of the household economy, but productivity is low. Aquaculture is very

limited in extent and also experiences low productivity. The marine fisheries of the area are important to the local population and annual production is estimated to be about 18,000 mt.

Based on the analysis of satellite imagery, mangrove forests were estimated, in 1996, to cover over 4,400 ha of the project area on Nijhum Dwip and south Hatia.

Future without the project

With no intervention, land area will continue to accrete at a rate similar to the past, i.e. about 68 ha per year. Without the project the development of both physical and social infrastructure in the project area is expected to be much slower than with the project. In particular, embankments and roads are less likely to be constructed.

Without project interventions, including the embanking of existing and newly accreted land, the existing constraints to production would decline only very slowly or not at all since the land would remain vulnerable to saline intrusion from high tides. The risk of damage to crops from tides and floods would be unchanged. Agricultural yields and cropping intensities are unlikely to change significantly.

Without the project, allocation of agricultural land to landless and functionally landless households is unlikely to occur and newly accreting land is likely to be claimed by existing powerful interests in the area rather than being entrusted to the Forest Department for mangrove forestry.

For both livestock and aquaculture, some expansion will occur without the project, in line with growth of the local human population and the accretion of land area, but improvements in productivity are likely to occur only very slowly.

Some of the accreting area will be planted in mangroves. Based on the assumptions used in the feasibility study, after 30 years the total area of mangroves would be about 1,300 ha more than at present.

Proposed interventions

The interventions proposed under the project are grouped into two options - Options 2 and 3. In addition the situation without any interventions is designated as Option 1. Option 2 would be implemented first and Option 3 may be implemented commencing in year 6 of the project, subject to the positive outcome of a review in year five.

Option 2 includes:

- construction of the Hatia - Nijhum Dwip cross dam in year 1
- emploting existing land above +2.2 m PWD in years 1 and 2 of the project, totalling 2,495 ha on south Hatia and 660 ha at the southern end of Nijhum Dwip
- empoldering, in years 5 and 6, additional land which will have reached +2.2 m PWD, including newly accreted land, totalling 4,080 ha
- construction of a road between the existing embankment on south Hatia and the southern end of Nijhum Dwip as part of the polder developments in years 5 and 6.

Option 3 would include option 2 plus the following:

- construction of the Hatia - Damar Char cross dam in year 6
- construction of further embankments after additional land has accrued to the appropriate level, but this would be outside the time frame of the proposed project.

On newly accreted land in the estuary, mangrove forests have an important role to play. For the Nijhum Dwip Integrated Development Project, the following sequence of land development has been adopted:

- except for land which will accrete very rapidly to +2.2 m PWD in the first five years after completion of the South Hatia - Nijhum Dwip cross dam, all new land reaching the level of +1.5 m PWD will be planted in mangroves;
- mangrove forest which has reached the age of 15 years may be cleared for agriculture and other uses provided that a minimum depth of 1 km of forest is maintained all along the future coast at all times as an essential part of the protective barrier providing security to the population against storms;
- existing forest which will be inside the proposed new polders will be cleared for agriculture after construction of the embankments.

Integrated development

The economic viability of interventions to promote land accretion, such as the cross dams proposed in this project, is severely restricted by the long period between the intervention and the start of the flow of benefits. Furthermore, because of such problems as soil salinity, low soil fertility and flooding from tides and storms, levels of production initially achieved in newly accreted areas are low. Interventions to promote accretion, therefore, constitute only one component of an integrated approach to the development of a project area, the aim of which will be to maximise the benefits that can be achieved from land accretion. Integrated development for the Nijhum Dwip project area, includes:

- promoting the safety of the population
- embanking areas to protect against tides and storms when the land has reached an appropriate level
- providing adequate infrastructure for drainage and water management
- providing appropriate infrastructure for transport and communications
- establishing coastal forests as part of the protection system for the local population and to promote the stability of the land
- promoting measures to reduce soil salinity and increase agricultural production
- promoting improved aquaculture and livestock production systems
- supporting the development of settlement and village infrastructure
- improving the access of the population to the education and health services provided by government.

Impact of the project

Construction of the Hatia - Nijhum Dwip cross dam will result in the accretion of an estimated 3,237 ha of new land at +2.2 m PWD by year 15. With implementation of the project the additional net area available for agriculture will be almost 4,100 ha. At full development, rice production is estimated to be 8,900 mt per year greater than without the project. The construction of embankments and improvement of water management will lead gradually to increases in crop yields and cropping intensities and the replacement of salt tolerant by non-salt tolerant crops and varieties. The livestock component of the project will lead to substantial increases in the production of livestock and livestock products. Aquaculture development will lead to an increase in production of fish, at full development, of about 350 mt per year. The area of mangrove forest will increase by about 500 ha.

Under the project, an estimated 2,400 landless and functionally landless households established in the project area will be allocated agricultural land and land will also be available for an additional 420 households to be resettled in the project area from other areas.



Environmental assessment

An EIA has been carried out for one cross dam, assessing the likely impacts over a 15 year period, and is presented as a separate report. It is concluded that there are not major impacts that cannot be mitigated for, although the monitoring of the impacts of cross dam construction on fisheries habitats is vital.

Under the Department of the Environment classification the proposed intervention would appear to be in the highest Class D (Red) under Section 66 (flood control embankment, polder, dike etc). Before the project can go ahead the DOE will need to review and approve the EIA in order to grant a Site Clearance Certificate. Before a full Environmental Clearance Certificate can be granted a No Objection Certificate will be required from the Local Authority. However, there is little experience in the implementation of these procedures so far in Bangladesh and the process should only commence when firm funding is available for project implementation. Under World Bank Operational Directive 4:01 the proposed intervention would probably be classified as Class A (the highest), although it could possibly be down graded to Class B as the extent of the effected area is relatively small by international standards.

Economic assessment

The proposed project will be implemented over a period of seven years. Total base costs with only the Hatia - Nijhum Dwip cross dam amount to Tk 525.9 million (US\$ 10.9 million). Including physical and price contingencies the estimated total cost is Tk 697.1 million (US\$ 13.1 million). If both cross dams are constructed, the base costs will amount to Tk 656.1 million (US\$ 13.7 million), while with physical and price contingencies the estimated total cost is Tk 892.4 million (US\$ 16.6 million).

Project benefits quantified for the economic analysis are increases in agricultural, aquacultural and livestock production and the net value of forestry production. All residents of the project area will be beneficiaries of the project; the present population of the area is projected to reach about 30,000 by year 10 if the project is implemented.

For Option 2 (Nijhum Dwip cross dam only) the EIRR is 12.2 per cent and the NPV is Tk 6.8 million. For Option 3 (both cross dams) the EIRR is only 10.4 per cent, but this calculation does not take into account benefits that will eventually accrue from the Hatia - Damar Char cross dam. Although the EIRR of Option 2 is only marginally above the opportunity cost of capital, account must be taken, in the overall assessment of the project, of the long lag between investment and the accrual of benefits as well as the accrual of non-quantified benefits such as improved safety and well being of this most vulnerable section of the Bangladeshi population and the positive impacts of expanded areas of mangroves.

This result is relatively sensitive to changes in both costs and benefits, but significantly more so to benefits than to costs. A 10 per cent increase in costs combined with a 10 per cent decrease in benefits would reduce EIRR for Option 2 to 9.1 per cent.

Project implementation

Because of the limited cross dam experience currently available within BWDB and because of the new design and installation technology proposed, it is strongly recommended that there is some involvement of foreign experts in the planning and supervision of the implementation of the Nijhum Dwip cross dam. However, this should not be necessary for the Damar Char cross dam since the experience of government agencies and local consultants will have grown in the intervening period.

It is important that an effective institutional structure be established for the implementation of the project's integrated development activities.

1. INTRODUCTION

1.1 Background of the Project

This feasibility study for the Nijhum Dwip Integrated Development Project has been prepared in the context of the Meghna Estuary Study (MES) (FAP Study 5B). The proposed project is centred around the construction of cross dams between Nijhum Dwip and the southern end of Hatia Island and between Damar Char and south Hatia.

The possibility of constructing these cross dams has been studied on previous occasions under the auspices of the Land Reclamation Project (LRP). The first study was in 1984 and subsequently there were pre-feasibility and feasibility studies in 1988 and 1989. These were limited in scope, comparing only the cost of the cross dams with potential benefits from increased agricultural production. Despite the low IRR obtained in these studies (between 4 per cent and 8 per cent) both the Governments of Bangladesh and the Netherlands expressed an interest in proceeding with the project, but lack of available funds forced a postponement. Early in 1990, the feasibility study was reviewed with additional data being collected and the scope of the study being expanded to include different options for land use in the outer embankment area of South Hatia. This final report of this study was completed at the end of 1990. Despite the expanded scope of the project, the IRR obtained were still only in the range of 7 per cent to 9 per cent.

Interest in the project arises from the situation on Hatia Island where significant areas have been eroded in recent years, especially in the north of the island. Some poor families, made homeless or landless by this process, have moved to South Hatia and Nijhum Dwip and there is pressure to identify and develop areas for settlement for these (and other) people. Furthermore, enhancing the accretion of land and improving land use as well as increasing the safety and security of the population are important objectives of the MES.

This present study of the proposed Nijhum Dwip cross dams arises from the continued interest of the Government in the constructing of the dams and the proposed new method of construction which is significantly cheaper than the more traditional method assessed in the previous studies. Furthermore, recent data suggest that accretion after construction of the cross dam between South Hatia and Nijhum Dwip will be much more rapid than has previously been supposed. This has implications for land development in the area and for the benefits that will accrue from the proposed interventions.

A number of relevant studies done under FAP (FAP 1 and 9B) confirm the general conclusion that at the present stage of socio-economic development of Bangladesh, works to protect agricultural land are generally not feasible from an economic point of view. Only if urban centres also benefit from such works, or if there are other related benefits, could the necessary investments be justified. It may safely be assumed that this situation also applies in the estuary areas where agricultural productivity is lower than the national average. However, the use of low cost methods to promote accretion and protect against erosion may, as in the present case, lead to different conclusions.

1.2 Objectives and Scope of the Study

The overall development objectives of the MES are:

- to increase the physical safety of the population living in the south eastern coastal areas of Bangladesh
- to promote sustainable development in these areas
- to increase the social security for the population in the coast areas and on the islands.

Among the immediate objectives of the Study is the preparation of a development plan with priority projects and programmes for flood protection, agricultural and socio-economic

development prepared for early implementation. This feasibility study for the Nijhum Dwip Integrated Development Project is one of these priority projects. The study assesses the technical, socio-economic and environmental viability and the economic feasibility of the proposed project.

1.3 Project area

The project area consists of that part of southern Hatia Island that is outside the existing embankment, Nijhum Dwip to the south of Hatia Island, the small island of Damar Char to the east of Nijhum Dwip and the surrounding areas. The area is located between longitude 90° 55' and 91° 10' east and latitude 22° 00' and 22° 10' north (see Figure 1.1). The total existing land area is some 9,400 ha. The area is low lying and flat and much of it can be submerged by high spring tides, especially during the monsoon season.

1.4 Project approach

Interventions, such as cross dams, which accelerate the accretion of new land, present a dilemma from the economic point of view. Newly accreted land is saline, subject to tidal intrusions and low in fertility. For land to accrete to a sufficient level so that it can be successfully embanked and so that effective drainage and water management can gradually eliminate soil salinity takes a considerable number of years. While salinity prevails, agricultural yields are low. There is thus a long delay between investment in a cross dam and the commencement of a significant flow of benefits.

For these reasons it is appropriate to adopt an integrated development approach to the proposed development activities for chars in the Meghna estuary. By combining land accretion with land development and designing projects that incorporate cross dams, embankments, drainage and water management together with measures to increase the productivity and production of agriculture, livestock and aquaculture and other activities it is possible to design feasible development projects for these areas.

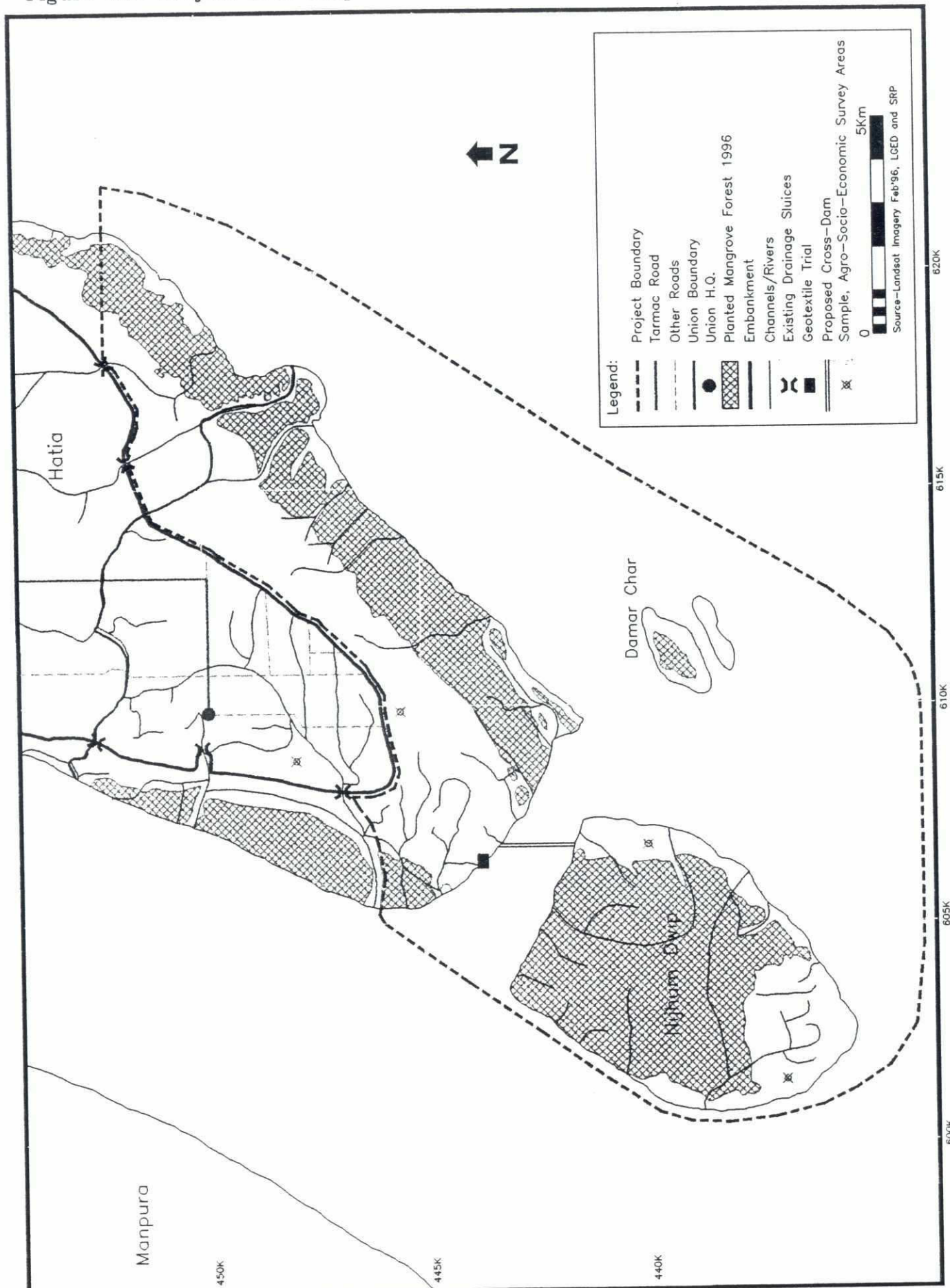
1.5 Key Assumptions

The preparation of a feasibility report inevitably requires the making of assumptions, especially with regard to the reliability and processing of data. For this study, however, the most critical assumptions refer to the sequence of land development on newly accreted land and the role of mangrove forests on the estuarine chars. In particular, it is assumed that:

- except for land which will accrete very rapidly to +2.2 m PWD in the first five years after completion of the South Hatia - Nijhum Dwip cross dam, all new land reaching the level of +1.5 m PWD will be planted in mangroves
- mangrove forest which has reached the age of 15 years may be cleared for agriculture and other uses provided that a minimum depth of 1 km of forest is maintained all along the future coast at all times as an essential part of the protective barrier providing security to the population against storms;
- existing forest which will be inside the proposed new polders will be cleared for agriculture after construction of the embankments.

Without these assumptions, an integrated development project would hardly be possible in the project area and the feasibility of cross dam construction would be in doubt.

Figure 1.1: Project area map



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1.6 Structure of the Report

Subsequent chapters of this report describe the present situation in the project area (chapter 2) and the expected future situation if the project is not implemented (chapter 4). The morphology of the area is discussed (chapter 3) and engineering interventions for the development of the area are proposed (chapter 4). Taking into account the proposed engineering interventions, a package of measures for the integrated development of the area is proposed (chapter 6) and the expected future developments in the area with the implementation of these various measures are estimated (chapter 7). An environmental assessment of the project area is included in chapter 8 and the economic assessment of the project is included in chapter 9. Implementation issues are presented in chapter 10.

The appendices to the main report contain technical and other information not presented in the main report on morphology, engineering design, project costs, economic analysis and production activities. The Environmental Impact Assessment is presented in a separate volume as a stand alone report.

2. MORPHOLOGICAL DEVELOPMENTS

2.1 Introduction

Within the framework of the Meghna Estuary Study, the possibility of implementing the Nijhum Dwip and Damar Char cross dams has been declared a priority. The project area is shown in Figure 1.1.

The construction of cross dams will accelerate accretion because flow velocities in the closed channel section will be drastically reduced. Bank erosion due to the current will also stop in the channels. During the LRP project much effort was spent on feasibility studies for these cross dams. So far these proposed projects have not been developed beyond the feasibility study phase because of the relatively high cost of dam construction and the uncertainty with regard to the adequacy of the design and construction methodology.

As a part of the reassessment of the feasibility study for the construction of cross dams, a morphological study has been carried out to ascertain the effects of cross dam construction on the morphological development of the area. Three options have been studied:

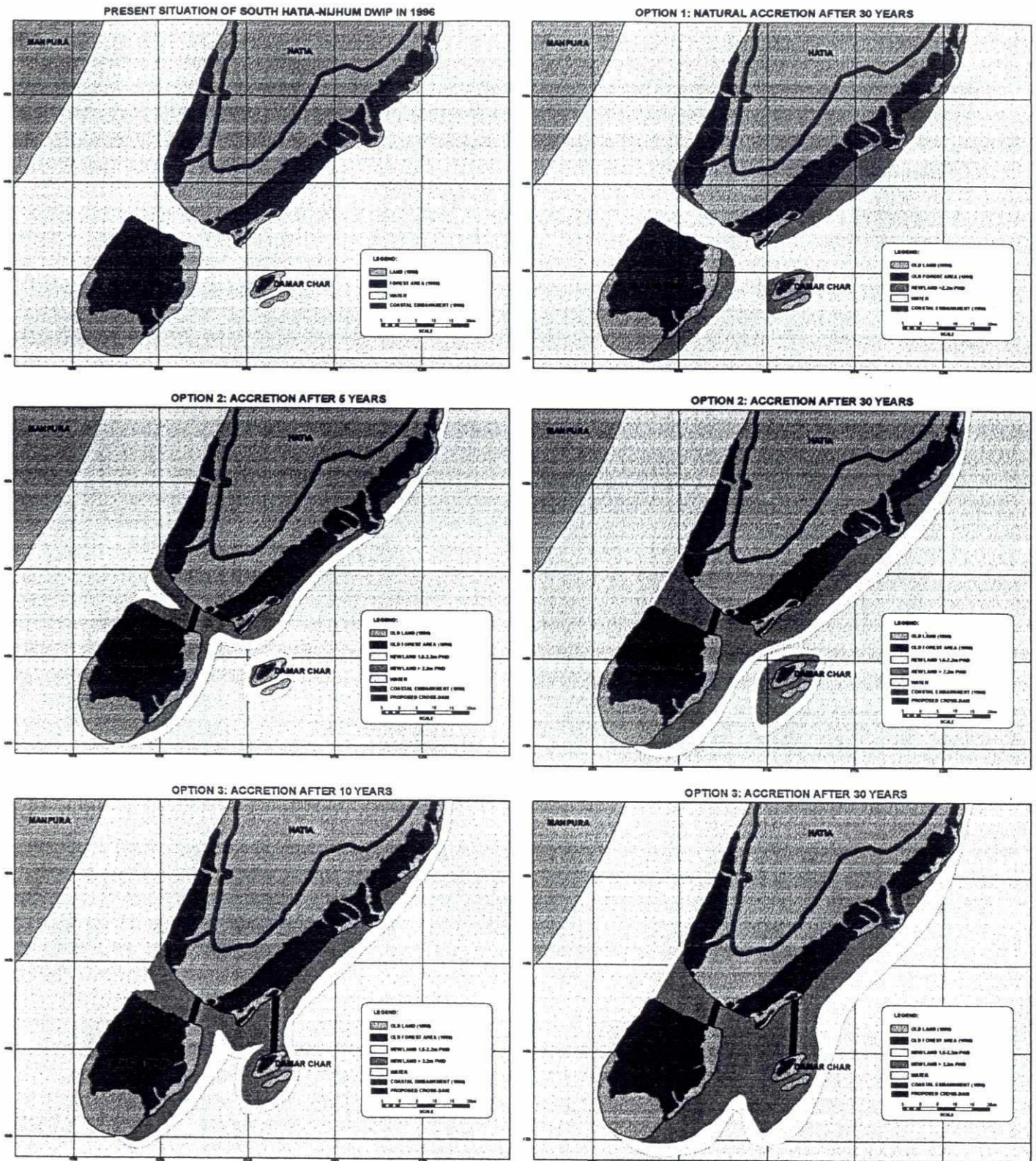
- Option 1: Future without Intervention
- Option 2: Construction of the Nijhum Dwip cross dam (cross dam 1)
- Option 3: Construction of the Nijhum Dwip cross dam and after five years construction of the Damar Char cross dam (cross dam 2).

2.2 Objectives of the morphological study

The objectives of the present morphological study, carried out as a part of the feasibility study, are as follows:

- to draw up an inventory of relevant reports, bathymetric maps, aerial photographs, satellite imagery, cross-sectional soundings, water levels, flow velocities, discharges, sediment concentration and grain size distribution
- to describe the morphological development of the project area during the last decades (in terms of accretion and erosion and land levels)
- to improve the understanding of the morphological behaviour in the area with the aid of remote sensing imagery, historical bathymetric and field data on the processes of land formation

Figure 2.1: Effect of cross dam construction on accretion



Option 1 = No Intervention
 Option 2 = One Cross Dam at Year 0
 Option 3 = One Cross Dam at Year 0, Second Cross Dam at Year 5

MEGHNA ESTUARY STUDY

Effect of cross dam construction on accretion

PROJECTION BANGLADESH TRANSVERSE MERCATOR

SOURCE LANDSAT IMAGERY FEBRUARY 1996



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 Meghna Estuary Study

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- to assess long term changes of land formation and char development
- to predict the morphological impact of cross dam construction for an intermediate time-scale (10-30 years).

2.3 Physical features

The complex changes in the system's driving forces: the tides, the river discharges and the waves are responsible for the morphological changes in the Hatia - Nijhum Dwip channel and adjacent channels and islands. The combination of these forces induces a complicated mechanism of water and sediment displacements, moving continuously via the tidal inlet of the Hatia - Nijhum Dwip channel to and from the Shahbazpur channel. The net changes are very small and often difficult to measure.

2.3.1 Tidal movement

The water movement in the Hatia - Nijhum Dwip Channel and Hatia - Damar Channel is governed by various phenomena. Generally, the tidal motion dominates during pre-monsoon and post monsoon periods. However, fresh water from the river plays a very important role, especially during the monsoon. During storms and cyclones, the short waves and storm surges are important morphological factors.

The tide in the area of interest is semi-diurnal with the M2 tide and the S2 tide as the major tidal constituents. The tidal range varies between about 1.4 and 3.1 metres. The mean water level (CD) is about 0.87 metres (PWD = CD - 1.17 metres). The mean high water level varies due to spring-neap tide conditions between + 1.60 and + 2.60 m PWD.

The HHW level is about + 3.10 m PWD and the LLW level is about -1.40 m PWD. The maximum water level is 6.0 to 9.0 metres above PWD due to severe cyclone surge (for example in 1970 and 1991).

2.3.2 Currents and discharges

Currents and discharges in the channels are tide dominated, even in the monsoon season when large quantities of fresh water from the Shahbazpur Channel pass through the Nijhum Dwip Channel. During spring tide in the pre- and post-monsoon periods, the tidal volume amounts to some 40 million m³ during flood and 60 million m³ during ebb. The tidal volume during flood and ebb counterbalance more or less during neap-tide conditions at circa 30 million m³.

Generally, the channel is ebb dominated. Current measurements in the dry season (pre- and post-monsoon) indicate that the maximum ebb velocity in the deeper parts of the channel is about 1.1 to 2.2 m/s and maximum flood velocity 1.1 to 2.4 m/s.

2.3.3 Waves

Waves often have an important influence on the erosion and deposition processes. Waves generate an orbital velocity which is superimposed on the normal velocities in an area, thus stimulating erosion from the bottom and preventing settling of suspended sediment. In shallow areas the waves may break thus generating a lot of turbulence in the water which is even more effective for generating erosion. Calculations of the significant wave height indicate that the average significant wave height near Nijhum Dwip is 0.3 to 0.9 metres. The prevailing wave and wind direction is S-SE with average wind speed of 8 to 12 m/s.

2.3.4 Sediment concentration

Sediment concentration measurements during pre-monsoon and post-monsoon indicate that the maximum depth averaged sediment concentration during spring and neap tide varies between 600-1,000 mg/l and 1,000-2,800 mg/l respectively. During the monsoon the depth averaged sediment concentration reaches up to 3,000 mg/l. The sediment concentration data indicate

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that the time mean sediment content of the water in the Hatia - Nijhum Dwip channel amounts to about 1,650 mg/l. Field surveys indicate that the sediment concentration tends to increase towards Damar Char.

2.4 Morphological development

The Hatia - Nijhum Dwip channel and the adjacent islands of Damar Char and Nijhum Dwip are part of a dynamic morphological system in which practically nothing is fixed by measures like bank protection or embankments. Hence channels can freely migrate resulting in loss of land on one side and gain on the other.

Construction of a cross dam between south Hatia and Nijhum Dwip and also between south Hatia and Damar Char will change the water movement in the vicinity of the Shahbazpur and Hatia channels. This will interfere with the dynamic (equilibrium) conditions between water movement and sediment transport and the dimensions of the channels and tidal flats. Consequently, changes in the morphology of the area have to be taken into account. To evaluate the stability of the area, different sounding maps and satellite imagery over the last decades have been studied.

2.4.1 Migration of the coastline of Nijhum Dwip

Comparison between aerial photography of 1957 and satellite imagery from 1973 till 1996 distinctly show the dynamic behaviour of the coastline as well as the channels in the area of interest (Figure 2.2). Imagery shows that Nijhum Dwip is a relatively young island which started to emerge in the 1950s. During the 1970s and 1980s the higher parts of Nijhum Dwip, as well as south Hatia, silted up to about MHW line (+2.2 m PWD). The coastline development during the last decades shows a natural tendency to shift in an eastward direction.

Satellite imagery indicates that the total area of Nijhum Dwip has increased from 1,105 ha to 3,108 ha over the period 1973-1984. In 1996 the total area of Nijhum Dwip was 3,272 ha. This means that the natural gain of newly accreted land over the period 1973-1984 is about 182 ha per year. Over the period 1984-1996 the formation of new accreted land is circa 15 ha per year. A recent satellite image of November 1997 indicates that the rate of formation of intertidal areas is high. The coastline of south Hatia shows a tendency to shift in a south-easterly direction.

2.4.2 Net sedimentation rate

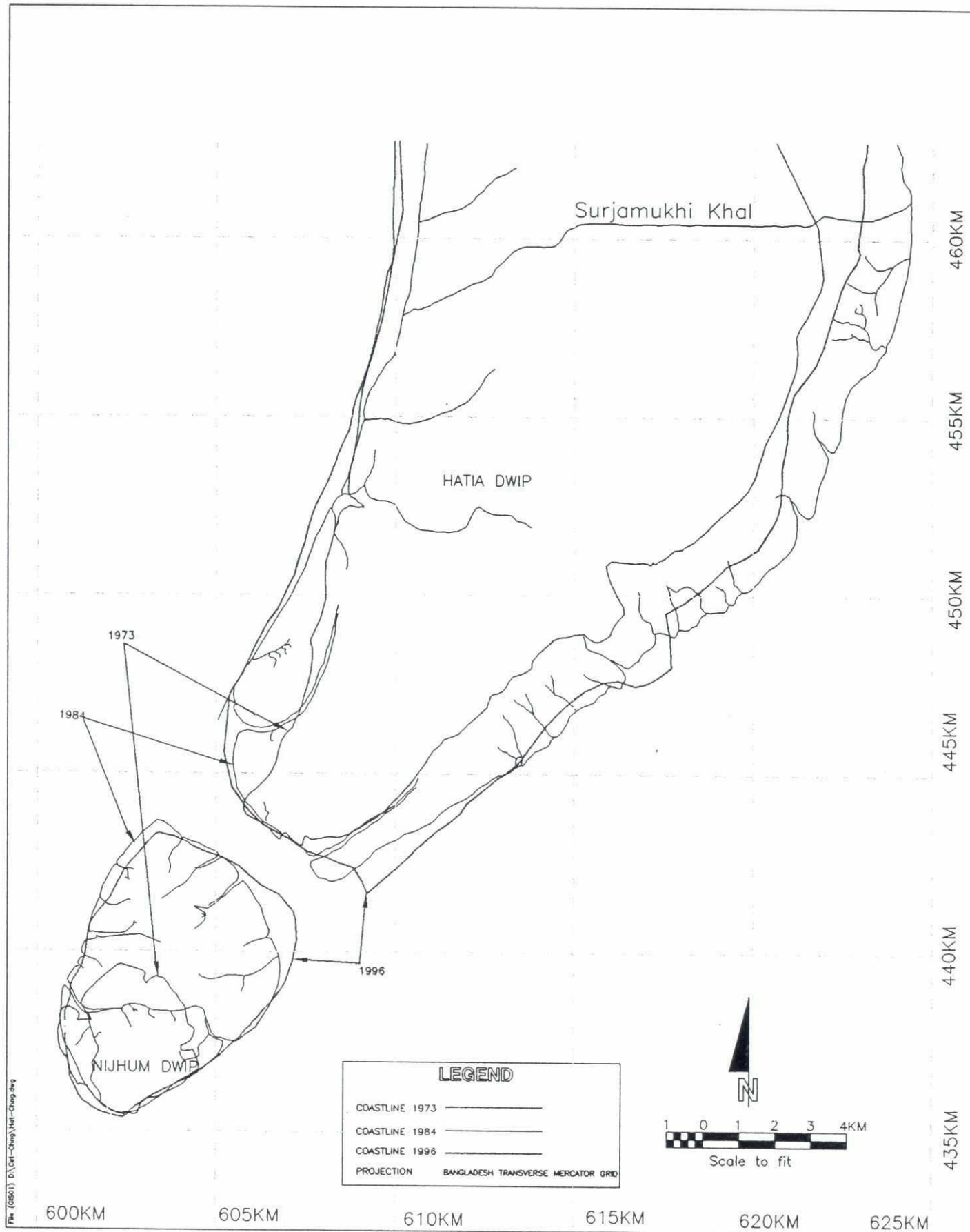
The bathymetric maps of 1990 and show that sedimentation is dominant near Damar Char and the southern part of the Nijhum Dwip channel. Erosion is found at the inlet of the Nijhum Dwip channel from the Shahbazpur channel side. Changes in the bathymetry over the period of 1988-1993 indicate that the net natural sedimentation rate in the project area is 0.1 to 0.2 metres per year.

2.4.3 Stability of the Hatia - Nijhum Dwip channel

Comparison of contour lines and depth contour lines of bathymetric maps of 1988, 1990, and 1993 distinctly show the dynamic behaviour of the Hatia - Nijhum Dwip Channel and adjacent shallow areas. The width of the Hatia Nijhum Dwip Channel decreases in an easterly direction. The maximum depth of the channel shows a tendency to increase in an easterly direction. In the vicinity, the maximum depth of the channel is -6 m to -8 m PWD.

The development of the Hatia - Nijhum Dwip channel, is illustrated by changes in cross-sectional area over the period 1987-1993. Although there is variation in size and shape of the cross-section between 1986 to 1993, the cross-sectional area did not change significantly. The cross-sectional area below MSL is about 4,000 m². This means that the channel is more or less in equilibrium with respect to discharge. The shape and size of the channel, however, is still changing.

Figure 2.2: Coastlines of south Hatia and Nijhum Dwip, 1973, 1984 and 1996



2.4.4 Land levels

Land levels of south Hatia

The topography of the area is generally flat and closely related to the accretion and reclamation history of the land. Land levels of the low lying land located outside the existing embankment vary from +1.5 m PWD at approximately the HW line up to +2.9 m PWD near the existing embankment. Outside the embankment about 3,500 ha of the land area lies above +2.4 m PWD. The higher area is unprotected and is inundated seasonally by shallow to moderate floods and suffers severely from storm surges. The rest of the land outside the embankment consists of low lying land (below +2.2 PWD) which is frequently inundated.

Land levels of Nijhum Dwip

Analysis of Landsat data of Nijhum Dwip island for the years 1973 to 1996 indicates a significant process of sediment accretion. These uncovered accreted intertidal areas have been gradually rising over the course of time. In 1996, Nijhum Dwip covered an area of about 3,272 ha. The island is unembanked. The land elevation of Nijhum Dwip varies between +2.0 to +3.4 m PWD. The higher southern part of Nijhum Dwip covers some 670 ha and is +3.0 to +3.4 m PWD. The rest of the island is lower and consists mainly of mangrove forest and low lying land, shoals and drying mudflats.

Land levels of Damar Char

Damar Char is still very low and consists of some 900 ha of mangrove forest and low lying land only. The tidal channels and shallow intertidal area between Hatia, Nijhum Dwip and Damar Char cover an area of about 5,100 ha. The channel between Hatia and Damar Char is very wide and shallow.

Characteristic land levels for land use

Areas with a level of +2.2 m PWD are used as agricultural land and suitable for embanking. Land above the level +2.2 m PWD remains inundated for less than 10 per cent of the time. Land levels which reach a level of about +1.1 to +1.5 m PWD can be used for mangrove forest. This land level will remain inundated for about 50 per cent of the time.

2.4.5 Land formation and char development

Land formation and char development over the period 1973/74-1996 has been estimated from satellite imagery. The net rate of newly accreted land is about 68 ha per year. The net average gain of intertidal area is about 114 ha per year.

2.5 Morphological impact of cross dams

2.5.1 Estimation of accretion rate due to cross dam construction

To predict the accretion rate due to the construction of the cross dams, a number of parameters have to be determined, such as the ultimate area of accretion, the coefficient 'n' and the characteristic accretion time. The impact of the cross dam on the flow velocities is estimated by using 2D-hydraulic model computations with and without cross dams. From the simulations it is known that the cross dams will accelerate accretion because flow velocities in the closed channel section will be drastically reduced. Near the dam the flow reduction will be more than 60 per cent.

For accretion at dam sites, a mean sediment content of 1,650 mg/l is taken. It is assumed that in the areas with very low flow velocities about 50 to 70 per cent of the sediment in the water settles out and the dry bulk density of the deposits will amount to about 1,200-1,300 kg/m³.



A summary of the morphological impact due to construction of the cross dams is given in Figure 2.3.

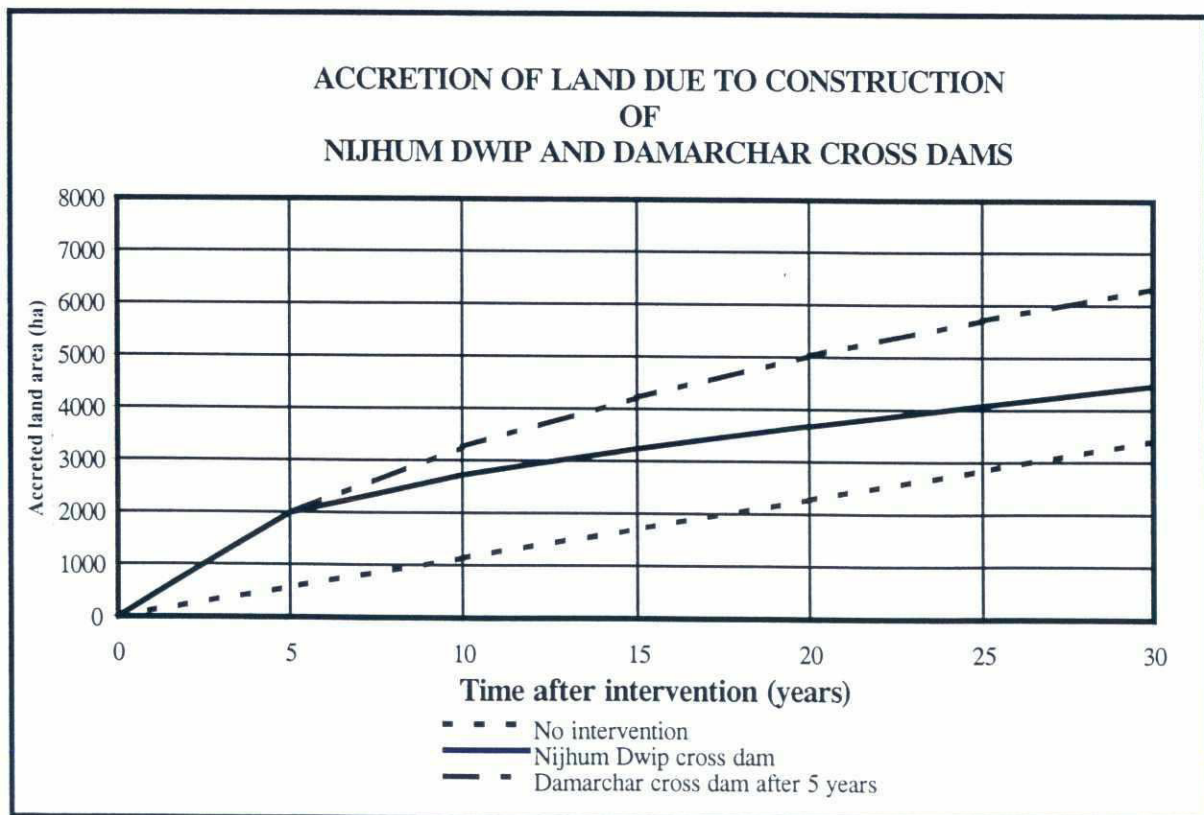
2.5.2 Option 1: Future without intervention

In the Option 1 future without intervention, no cross dam(s) will be constructed and consequently the nature will take its own course. In this case, the rate of natural gain of new land in the project area will be approximately 68 ha per year. According to the natural shift of the coastline over the last decades, formation of newly accreted land (to approximately level +2.2 m PWD) and Char development can be expected, especially at the eastern and north-eastern sides of the Nijhum Dwip. Expected new accreted land at an intermediate time-scale has been estimated based upon the long term rate of natural gain of land. Based upon the analysis of satellite imagery over the period 1973/4 to 1996, the average rate of gain of intertidal area is about 114 ha per year.

The potential net sedimentation rate of channels and shallow areas around the Nijhum Dwip - Damar Char area is 0.1 to 0.2 metres per year. The net sedimentation rate is calculated based upon bathymetric data of 1988-1993.

Bathymetric data of the cross-sections of the Hatia - Nijhum Dwip channel over the last 10 years indicate that the cross-sectional area is more or less constant. This means that the Nijhum Dwip channel is in equilibrium with respect to discharge. So, it is expected that the channel will remain open in the near future without any intervention.

Figure 2.3: Accretion of land due to construction of cross dams



2.5.3 Option 2: Cross dam 1

The channel between south Hatia and Nijhum Dwip will be fully accreted due to the construction of the cross dam 1. The closure of the Hatia - Nijhum Dwip Channel will initiate an

abrupt change in hydraulic conditions and in the morphology of the tidal channel and shallow tidal flats, as well as the adjacent islands (Hatia, Nijhum Dwip and Damar char).

The morphological development of the SE coast of Nijhum Dwip and the shallow areas around the vicinity of the Hatia - Nijhum Dwip channel are assumed to be related to the exchange of sediment between the Shahbazpur channel and the Hatia channel.

Due to the construction of the cross dam, the in-going and outgoing tides will be partially blocked and the exchange of sediment between the Shahbazpur and Hatia channels will be disturbed. Under the prevailing wave (dominant direction SW-SE) and tidal conditions, the landward directed wave and tide induced sediment transport will no longer be compensated by the seaward directed sediment transport from the Hatia - Nijhum Dwip channel.

The exchange of sediment from the Hatia - Nijhum Dwip channel toward the shallow areas will be negligible. The dominant tide induced sediment transport in a SE direction from the channels, towards the shallow areas, will decrease. The net tide induced sediment transport towards the islands will increase relatively. The expansion of shallow area in a SE direction will continue.

The strong reduction of tidal current velocities in the Hatia - Nijhum Dwip Channel and near the vicinity will initiate a reduction of the sediment transport capacity in the channels. Consequently the deeper parts of the tidal channels will function as effective sediment traps. From such conditions it can be assumed that in particular the deeper tidal channel between Nijhum Dwip and Damar Char will rapidly decrease in size due to the construction of the cross dam.

2.5.4 Option 3: Cross dam 1 and after five years construct cross dam 2

The construction of both cross dams will stimulate accretion of new land by blocking the flood flow entering the area between Nijhum Dwip and Damar Char completely, thus creating a funnel in which sediments will be trapped. The dams will also trap the incoming flood water. From the 2D-hydraulic model computations it can be concluded that the flow velocity reduces, especially on the north side of cross dam 2.

3. PRESENT SITUATION IN THE PROJECT AREA

3.1 Physical Setting

3.1.1 Topography

A topographic survey was carried out along the peripheral band of Nijhum Dwip in April 1997 to determine the gradients of the char into the river. Bathymetric surveys of the surrounding area also give a general picture of the gradient around the island. Data is also available for the southern part of Hatia Island.

The land outside the embankment on south Hatia, slopes down from about +3 m PWD (3 m above PWD datum) to the mud flats of about 1.1m PWD. In Nijhum Dwip the north-eastern side is comparatively low while the southern part is higher and gently slopes down towards the north. Along the mean spring high water line (+2.6 m PWD) in the south broken dunes of +3.5 m PWD and less are found while the area inside the dunes is lower, averaging 1.8 m PWD. Damar Char is barely +2.0 m PWD in some places. The unripened mud flats around south Hatia, Nijhum Dwip and Damar Char are below +1.2 m PWD.

3.1.2 Climate

The mean annual rainfall in the area is about 2500 mm, with July and August receiving the highest rainfall. However, annual variations can be significant. The mean annual temperature is 25.7° C.

Variations in temperature during the year range between a recorded low of 11.8°C and a recorded maximum of 35.1°C. Monthly evapotranspiration is highest in April and May and lowest in January and February.

3.1.3 Soils

Nijhum Dwip and South Hatia are part of the young lower Meghna estuarine flood plain. The soils are seasonally flooded, poorly drained and have been developed from moderately fine textured silt loams.

The soils of Nijhum Dwip are mainly undeveloped and slightly developed Meghna alluvial deposits. The surface soil is mostly medium textured silt loam. However, detailed investigations of the characteristics of different groups of soils of Nijhum Dwip have not yet been carried out.

The soils are olive-grey to olive, finely stratified, usually slightly calcareous, silt loam to silty clay loam affected by salt to varying degrees. They are flooded to less than 30 cm for 3 to 4 months in the monsoon season. The land outside the embankment on Hatia has generally poor fertility. South Hatia has somewhat older soils, finely stratified usually calcareous and slightly alkaline (pH 6.6 to 8.3) whereas Nijhum Dwip has younger, much more poorly developed soils that are more calcareous and alkaline. The pH of the surface soil is lower than of the subsurface soil.

These soils are generally poor in organic matter and low in nitrogen. Crop yields are generally low. The Hatia Thana Guideline of SRDI gives the following analysis of south Hatia soils for areas outside the embankment: nitrogen 12-25 ppm, phosphorus 20-40 ppm and potassium 0.50-0.84 milliequivalent/100 gm.

3.1.4 Land use

Of the total of 9,200 ha at present in the project area (Nijhum Dwip - 3,640 ha; South Hatia - 5,560 ha), 48 per cent is forested. The remainder is either cultivated, in fish ponds (about 100 ha) or is low lying mudflat and grassland used for the grazing of cattle and goats.

Crops on Nijhum Dwip and south Hatia are subject to damage by storm surges. Salinity and lack of water in the dry season are limiting factors for cultivation, especially of Aus and Rabi crops. Storm surges during cyclones may also damage standing crops. On both Nijhum Dwip and South Hatia, a single crop of the local salt resistant T. Aman is usual in most of the area. On about 20 per cent of the area, the rice crop is followed by Rabi crops such as khesari, chilly, sweet potato and groundnut.

3.1.5 Flooding

The normal high tide in the project area reaches a level of about +1.5 m to +2.0 m PWD, but spring tides, especially during the monsoon season, can reach +2.6 m PWD and more. These peak tides inundate land outside the existing embankments and also sometimes inside through the drainage system which is not always managed effectively to stop saline intrusion. The higher lands are also flooded during cyclones which are generally accompanied by tidal surges. The large river discharge in the monsoon period dilutes the salinity of the sea water in the estuary, but in winter the sea water remains sufficiently saline for the intrusion of sea water in this season to cause more serious damage to crops than in the monsoon. For successful crop production, flooding by saline water during the dry season requires rain to leach residual salt from the soil in the following monsoon.

3.1.6 Cyclones

The area is in one of the most cyclone hazard prone parts of the Bay of Bengal. In the past, major cyclones have taken a large toll of both human life and livestock. In particular, on Nijhum Dwip cluster settlements have been established on the exposed, southern part of the island,

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unprotected by any embankment. For the population of this area there are now four cyclone shelters and a number of killas for livestock.

3.2 Socio-economic setting

The socio-economic setting of the project area is profoundly influenced by the dynamic physical environment in which communities are living. The tides, flooding, storms and processes of erosion and accretion are major parameters of existence.

A household survey was carried out in January 1997 to provide background information on the socio-economic setting of the project area and information for three aspects of project formulation: economic viability, social desirability and possible development strategies. This survey was implemented only on Nijhum Dwip: households on south Hatia were not included. The survey investigated settlement patterns, demography, occupations, land ownership, credit and indebtedness, income and sources of income, communications, literacy, education and health.

3.2.1 Demography

At the time of the 1991 census, the population of Jahajmara union was 33,135 with an average household size of 5.39. For that portion of the union which constitutes the project area, the estimated population was 12,970, with an average household size of 5.3 (see Table 3.1).

In the survey sample of 160 households the total population was 1,158, with an average household size of 7.24. Almost 50 per cent of this sample population was under 15 years of age, resulting in a dependency ratio of 2.8 (see Appendix IV.4).

The BBS data imply significant in-migration to Nijhum Dwip and south Hatia between 1981 and 1991 since growth rates are well above the national average. The estimated overall population density of the project area rose from 280 per km² to 479 per km² during the period.

Many of the inhabitants of Nijhum Dwip moved to the area under Ministry of Land settlement programmes when land they occupied in north Hatia was eroded away. For this reason, over 70 per cent of households are in cluster villages established under these programmes.

3.2.2 Land ownership

The families resettled by the Ministry of Land were each allocated 2 acres (0.81 ha) of agricultural land plus a basic house. Later migrants did not come under these programmes and were not able to obtain land. This has resulted in an unusually stratified landholding pattern on Nijhum Dwip with 33 per cent being (functionally) landless and 63 per cent being small farmers with up to 1 ha of land (see Appendix IV.4).

BBS data show 37 per cent of households in Jahajmara union owning land in both 1981 and 1991, but with some significant differences among mauzas (see Table 3.2). Throughout the project area, many landless, marginal and small farmers operate land of absentee land owners who live in northern and central Hatia and Noakhali. Usually the crop is distributed 50:50 between the landowner and sharecropper.

3.2.3 Credit and indebtedness

Most surveyed households (81 per cent) expressed a need for credit, but in the year prior to the survey only 54 per cent of them had received any. Credit is principally used for income related purposes - either agriculture or fishing. Sources of credit are mostly non-institutional, with money lenders providing about three quarters of all credit to surveyed households (see Appendix IV.4). The high cost of credit is a major reason inhibiting households from actually taking loans, as is the risk that they will not be able to repay the principal on time.

Table 3.1: BBS Demographic Data 1981 and 1991 by Mauza

THANA	UNION	MAUZA	BBS CODE	Mapped Area ha	Human Population 1981	Population Density per km ² 1981	Human Population 1991	Population Density per km ² 1991	Change in Pop Density 81-91 (%)	Population Growth 81-91 (%)	Estimated Population 1996	A 2/	B 3/	2000 5/	Households 1981	Mean HH Size 1981	Households 1991	Mean HH Size 1991
Hatia	Jahajmura	Char Birbiri	753657142	775	2,363	305	4,999	645	112	7.78	7,271	6,539	8,106	396	396	5.97	864	5.79
Hatia	Jahajmura	Char Hare	753657227	297	1,957	659	2,283	769	17	1.55	2,466	2,986	3,702	346	346	5.66	416	5.49
Hatia	Jahajmura	Char MacPherson	753657426	799	2,743	343	3,535	442	29	2.57	4,013	4,624	5,732	514	514	5.34	763	4.63
Hatia	Jahajmura	Char Osman	753657430	670	721	108	4,372	653	506	19.75	10,766	5,719	7,089	99	99	7.28	855	5.11
Hatia	Jahajmura	Jahajmura	753657682	953	6,464	678	8,008	840	24	2.17	8,913	10,475	12,985	1,154	1,154	5.60	1,444	5.55
Hatia	Jahajmura	Mohammadpur	753657761	470	3,194	680	4,251	904	33	2.90	4,904	5,560	6,893	553	553	5.78	769	5.53
Hatia	Jahajmura	Muktaria	753657767	257	181	70	295	115	63	5.01	377	386	478	10	10	18.10	79	3.73
Hatia	Jahajmura	Nutan Sukhchar	753657909	687	1,912	278	3,030	441	58	4.71	3,814	3,963	4,913	388	388	4.93	533	5.68
Hatia	Jahajmura	Purba Birbiri	753657928	798	2,857	358	2,362	296	-17	-1.88	2,148	3,090	3,830	478	478	5.98	427	5.53
Total	Jahajmura			5,706	22,392	392	33,135	581	48	4.00	44,672	43,342	53,728	3,938	3,938	5.69	6,150	5.39
Total	Project Area 4/			2,706	7,578	280	12,966	479	71	5.52	20,601	16,960	21,025	1,322	1,322	5.73	2,457	5.28

Source: BBS 1985 and 1992

Notes: 1/ The area of Char Osman is the cleared and cultivated area, i.e. not including the forested area

2/ Projection of population based on individual mauza growth rates 1981 - 1991

3/ Projection of population based on average project area growth 1981 - 1991

4/ The project area consists of Char Osman, Muktaria, Nutan Sukhchar plus Char MacPherson (30%), Mohammadpur (59%) and Purba Birbiri (72%)

5/ Assumed first year of project. Projection of population based on average project area growth 1981 - 1991

Table 3.2: BBS Key Data for Mauzas in South Hatia and Nijhum Dwip

THANA	UNION	MAUZA	BBS CODE	% HH Owning Agr Land 1981	% DU Owning Land 1991	Change in % Land Owning 1981-1991	% Pop Age 10-29 in Cultiv 1981	% Pop Over 10 in Agri 1991	Change in % Pop in Agr 1981-1991	Literacy Rate 1981	Literacy Rate (7yrs) 1991	Change in Literacy 1981-1991	% HH with potable Water 1981	% DU Safe Drinking Water 1991	Change in Safe Water 1981-1991	% DU with Sanitation 1991
Hatia	Jahajmara	Char Birbiri	753657142	51	49	-2	14	66	52	7	17	10	46	56	10	2
Hatia	Jahajmara	Char Hare	753657227	32	17	-15	24	55	31	14	15	1	40	80	40	1
Hatia	Jahajmara	Char Mcpharson	753657426	37	35	-2	20	42	22	6	17	11	65	59	-6	0
Hatia	Jahajmara	Char Osman	753657430	36	46	10	13	66	53	22	8	-14	74	49	-25	0
Hatia	Jahajmara	Jahajmara	753657682	40	37	-3	15	47	32	15	21	6	38	42	4	1
Hatia	Jahajmara	Mohammadpur	753657761	39	37	-2	25	45	20	7	17	10	39	53	14	0
Hatia	Jahajmara	Muktaria	753657767	60	5	-55	12	32	20	8	7	-1	0	18	18	0
Hatia	Jahajmara	Nutan Sukhchar	753657909	11	26	15	15	37	22	3	8	5	9	79	70	1
Hatia	Jahajmara	Purba Birbiri	753657928	42	38	-4	17	53	36	8	14	6	19	38	19	2
	Jahajmara			37	37	0	18	52	34	10	16	6	38	54	16	1

Source: BBS 1985 and 1992
Notes: 1/ The definitions used by BBS for household in 1981 and dwelling unit in 1991 are not the same.

3.2.4 Income and sources of income

Households typically have income from a number of different sources. Of the various sources, fishing is the most important. This is clearly shown in the household survey data. Fishing is the principal occupation of 51 per cent of heads of households interviewed and is the secondary occupation of another 10 per cent - only a quarter of households have no fishing income, but this is a higher proportion than those households with no cash income from agriculture or livestock. These latter two activities, however, make much smaller contributions to the average cash income of households than does fishing in the waters around the island (see Appendix IV.4).

3.2.5 Communications

Communications from Nijhum Dwip are entirely by water transport to south Hatia and other areas. The restricted nature of the communications system hampers transport for goods both into and out of the area. Improved accessibility would have a beneficial effect on production as well as on services available to the population.

On Hatia Island there is a relatively good road network inside the existing polders, but this does not extend across the embankment into the project area.

3.2.6 Education and literacy

The 1991 census found the literacy rate in the area to be 16 per cent, compared with only 10 per cent at the time of the 1981 census. However, on Nijhum Dwip (Char Osman) there was a reported fall from 22 per cent to 8 per cent over the 10 year period. This is unexplained, but may be related to the influx of migrants from other areas. The data is also at variance with the results of the household survey on Char Osman which found literacy rates among the sample households, for those over 5 years, of 54 per cent for males and 42 per cent for females. These rates may reflect differing definitions of literacy but also relatively high rates of primary school attendance among young children. On Char Osman 73 per cent of children in the 5 to 12 age group were reported to be attending primary school.

There are only two registered primary schools and no high school on Nijhum Dwip. As a result, the student drop-out rate is very high. It is difficult to attract teachers to such remote areas and the lack of teachers is one reason for the generally poor state of education in the study area.

There are no schools in the area of south Hatia outside the embankment. However, the population in this area has access to primary schools within the embankment and to the high school at Jahajmara.

3.2.7 Health

According to records from the Hatia Thana Health Complex (see EIA in Part 2 of this report) diarrhoeal and skin diseases and the most commonly reported health problems. Field work on Nijhum Dwip also indicated that malaria was being reported as a significant problem. Certainly, fevers of various types are common.

There are no health facilities on Nijhum Dwip. On south Hatia there is a Family Welfare Centre at Jahajmara and the Thana Health Complex further away at Oskhali.

3.3 Physical infrastructure

The physical infrastructure of the project area, apart from the embankment on south Hatia which marks its northern boundary, is very limited. On the southern populated part of Nijhum Dwip there are four cyclone shelters. There is also a fishing ghat on south Hatia, facing the channel between Hatia and Nijhum Dwip. There are no roads in the project area and no other physical infrastructure is recorded.

Within Hatia Island, there is a good tarmac road from the north Hatia ferry ghat to southern Hatia, ending in Jahajmara. Away from this there is a network of brick paved and unpaved roads. Access to Nijhum Dwip is entirely by boat and there are no roads on the island itself.

The main ferry route between Hatia and the mainland is the service from Char Batta in south Noakhali and the ghat at the northern end of Hatia. There are no BIWTA registered routes in the project area, but there are irregular services to the area from trawlers and passenger boats.

3.3.1 Hydraulic infrastructure

The only existing hydraulic infrastructure is that of polder 73/2 on South Hatia. This polder was constructed by BWDB between 1964 and 1966 under CEP and has been rehabilitated recently, between 1996 and 1997, under SRP. Sea embankments are constructed where the ring embankment faces open water and elsewhere a marginal embankment is used. Most of the embankment crests are not provided with a hard road surface.

The works carried out for the latest rehabilitation comprised resectioning and retirement of the ring embankment, the rehabilitation of existing sluices and the construction of new additional sluices. A remarkable difference with other polders is the absence of vertical lift gates on the country side of drainage sluices. These gates are used for water retention, which is therefore not possible in this polder. Excavation of drains has been planned, but most was not carried out before 1997 when SRP ended and ADP funds were no longer available.

Although compartments are shown and discussed in SRP reports about polder 73/2, these compartments only exist on paper and have been used to distinguish catchment areas of the main sluices. No compartment embankments exist or have been constructed in polder 73/2.

3.4 Water management

Water management can only be implemented with the help of hydraulic infrastructure such as embankments, sluices and other structures. Therefore water management is limited to the empoldered area of South Hatia, as described hereafter.

3.4.1 Polder management

The overall polder water management is a task of BWDB. Polder 73/2 falls under the Hatia O&M Subdivision, headed by a Subdivision Engineer (SDE) stationed at Hatia, and the Noakhali O&M Division, headed by the Executive Engineer (XEN). The activities of BWDB are limited to rehabilitation programmes and emergency maintenance (retirement of embankments). No data are collected about operation, water levels, local rainfall, salinity and the effects of drainage congestion.

3.4.2 Operation

Under SRP a start should have been made with the implementation of the Guidelines for People's Participation and improved O&M concepts for polder 73/2. However, according BWDB officials at Hatia, nothing has been realised in this respect and SRP activities stopped in December 1997. The operation of sluices is very much limited to manipulation of flap gates fixed on the seaward side. Since no lifting device exists for these flap gates, operation is rare. On paper, sluices are operated by sluice committees, but in practice by influential members of the local community. Farmers complain about misuse of sluices (opening of flap gates), mostly for fishery purposes (shrimp). As a result saline water enters the drains, e.g. in March and April, and damages the standing crops.

3.4.3 Drainage

The farming population of polder 73/2 has reported drainage congestion during the monsoon, affecting crop production, at various places. In 1996 additional new sluices and rehabilitated sluices have improved the drainage situation, but nothing was really done to remove bottlenecks in the existing drains. Farmers explained that excavation of drains is done every 10 to 15 years with local Government funds (Union Council). However, in the last 18 years not much has been done to improve the drains.

3.4.4 Salinity

Despite the construction of the ring embankment in 1964, saline floods have occasionally entered the polder through breaches in the embankment and sluices with damaged or missing flap gates. Lack of maintenance and severe storms are the main causes of failing flood protection.

A soil survey conducted by LRP in the post-monsoon period of 1990 on south Hatia and Nijhum Dwip showed EC_e values of 5 to 8 dS/m for soil moisture in unprotected areas. A more recent survey in 1994 of the same area by SRDI in the pre-monsoon period showed similar EC_e values ranging from 3 to 9 dS/m outside the coastal embankment of south Hatia.

So far, soil salinity data tend to show less difference between salinity levels inside and outside the polder than may be expected from the findings of LRP. Although the available soil salinity data is insufficient to confirm this situation, resalinisation due to local saline floods (broken sluices) and the existing drainage congestion are two factors that may have contributed to a slower desalinisation of soils of protected land.

3.5 Agriculture

Agriculture in the project area is typified by low yields and low cropping intensities. To a large extent, these are the result of soil salinity and a low level of soil fertility combined with damage from floods, storms and tides. Crop losses can be as high as 50 per cent or more. In extreme cases, a whole crop may be lost.

The project area is at present without embankments and the intrusion of saline water at certain times cannot be prevented. In the dry season, the salinity of the water in the surrounding channels is relatively high and spring high tides can lead to the intrusion of salt water in agricultural areas. Also in the dry season, the salinity of surface soils can increase due to the capillary rise of saline ground water. The rains of the next monsoon season are required to leach this salt from the soil. Salinity is not such a serious problem during the monsoon season, but flooding from tides or storm surges can damage crops.

The potential for irrigation in the project is very limited. It is possible during the monsoon to provide supplementary irrigation by LLP from the khals for the aman crop. Ground water sources for dry season irrigation are at a depth of about 30 metres. The extent of this resource, which is used for domestic water supply, is unknown. However, pumping from this depth, given the conditions in the project area, would not be viable for crop production.

Most households involved in agriculture have only small holdings. The table compares data on farm sizes from the household survey on Nijhum Dwip and from the Hatia thana office.

Table 3.3: Farm sizes

Farm Size (ha)	Unit: per cent of farms	
	Nijhum Dwip	Hatia thana
0 - 0.02	33	24
0.02 - 0.2	2	-
0.02 - 0.4	-	17
0.02 - 1.0	62	-
0.4 - 1.0	-	28
1.0 - 3.0	2	29
> 3.0	1	1

An agro-economic survey for the project was undertaken in March 1997 in Nijhum Dwip, Char MacPherson (outside the embankment on south Hatia) and Char Hare (inside the embankment on south Hatia). Char Hare is outside the project area, but was included to provide useful comparative information. This survey provides some background information on agricultural production in the area (see Appendix IV.1). The small sample size means the survey provides indicative information only. Differences in yields between those inside and those outside the embankment appear to be slight at present, but farmers inside the embankment grow more Rabi crops and have a higher cropping intensity.

Because detailed data is not available, the present cropped area in the project area has estimated as 70 per cent of the total non-forested area, or about 3,300 ha. Based on data from the household survey and the agro-economic survey the main cropping patterns in the area have been identified. These are summarised in the table.

Table 3.4: Cropping patterns and intensities

Cropping Pattern	unit: per cent of cultivated area		
	Nijhum Dwip	Char MacPherson	Char Hare
B.Aus - fallow - fallow			37
fallow - LT Aman - rabi			40
fallow - LT Aman - fallow	69	69	23
fallow - LT Aus - rabi	22	17	
rabi - fallow - fallow	9	9	
Cropping Intensity	122%	117%	140%

Rabi crops grown typically include chilli, groundnut, khesari, mung, and sweet potato. The conditions in the chars result in generally low crop yields. Crops are regularly damaged by flooding, salinity and pests. Yields actually achieved for rice, for example, may often be below 1 mt/ha.

Among the constraints to production in the project area are the lack of extension services (there is no Block Supervisor assigned to Nijhum Dwip, for example) and the lack of access to markets, either local markets or to wider, regional markets. Both of these constraints are linked to the isolation of the area and the poor transportation links to outside areas. The limited transportation links also make agricultural inputs difficult to obtain and relatively expensive (compared to areas with better and cheaper transportation links) and tend to reduce the prices that can be obtained for any surpluses farmers produce.

3.6 Livestock

Livestock are an integral part of the household economy in the project area, being kept for draft purposes, to provide food and as a source of income. On newly accreted land, the first plant species to establish itself is usually uri grass. This provides fodder and the basis for supporting cattle, goats and sheep.

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The cattle in the area are usually of the zebu type, fairly well adapted to the local climate and environment, but with low productivity. The average cow produces only about 1-2 litres of milk per day during lactation.

The buffaloes are the Indian water buffalo type and are preferred by farmers as tough draft animals that can survive on the coarser roughage available on chars and in forest undergrowth. The milch buffaloes produce a little more milk than cows.

The cattle and buffaloes of large and medium farmers are usually grazed on the newly accreted chars and in the forests or in the fields after harvest. Cattle owning landless and marginal farmers, who have less access to land and crop residues, face more difficulty in obtaining fodder. The availability of fodder may be especially a problem during July to November when the fields are in crops and during the dry season from November to March when weed production is at a minimum. Marginal farmers typically tether their animals on the river banks, fallow lands and pond dykes or stall feed them to avoid the risks of theft or loss on the chars or in the forest.

The chicken and ducks are of the deshi type, are raised around the homestead and are usually the responsibility of the women. The chickens typically produce 40-45 eggs and the ducks 60-80 eggs per year.

The spending on feed supplements or veterinary care for livestock is virtually zero. However, the household survey on Nijhum Dwip indicated that around 10 per cent of household cash income is generated from the sale of livestock and livestock products. Household consumption of livestock products and the use of draft animals in crop production provide additional benefits.

The estimated livestock population of the project area is given in the following table.

Table 3.5: Estimated livestock population in project area, 1996

Mauza	No. Households	Cattle	Goats	Poultry
Char MacPherson	300	534	486	5,860
Char Osman	1,119	1,992	1,813	21,850
Muhammadpur	593	1,056	961	11,580
Muktaria	103	183	167	2,010
Natun Sukchar	698	1,242	1,131	13,630
Purba Bir Biri	402	716	651	7,850
Total	3,215	5,723	5,209	62,780
Average / household		1.78	1.62	19.53

Source: BBS; Cyclone Shelter Preparatory Study 1996.

The Cyclone Shelter Preparatory Study conducted surveys of livestock populations in Hatia in 1996 and estimated the growth rates for livestock populations given in the table.

The socio-economic household survey covering 160 households conducted in 1996 in Nijhum Dwip recorded average per household cash income of Tk 2,195 per annum from the sale of livestock and livestock products. Ninety-eight percent of surveyed households reared some type of livestock and farmers desired to rear more productive animals. There were also indications that the livestock is a relatively important source of the demand for credit (see Appendix IV.4).

The loss of animals during cyclones is a constant danger. In the 1991 cyclone, livestock deaths were high: almost the entire sheep, goat and poultry population perished and only the relatively few cattle and buffaloes that took shelter on the killas survived. After the tidal surge, the remaining livestock suffered from starvation and disease because of lack of emergency sources of fodder.

Animal health is a constraint to livestock production. The services of the Thana Livestock Development Centre do not extend to the area and animal diseases are generally not reported. Accurate data on the mortality and morbidity or economic impact of animal diseases are not available. But according to the farmers, animal diseases adversely affect livestock and poultry productivity.

The main diseases of cattle and buffaloes reported by DLS and observed during field investigations include various worms and parasites, anthrax, black quarter, haemorrhagic septicaemia and foot and mouth disease. Rinderpest caused a huge loss of cattle in the early sixties but is now reported to be well under control. Most of these diseases could be prevented by routine vaccination or treated with antibiotics and other medicines.

Among chickens Newcastle Disease (NCD) is common and takes the heaviest toll. Outbreaks of fowl pox sometimes occur in young chickens and coccidiosis, intestinal worms and lice infestations are also common. There is a relatively low incidence of disease among ducks but the duck population is not increasing. According to farmers, during the dry spell and intrusion of saline water in the fields and canals the common species of snails cannot survive and there is a shortage of duck feed in the winter months.

The availability of fodder, especially during the dry season, is a major constraint to livestock production in the project area. This may lead to the sale of livestock at low prices, especially by marginal and non-farm households. Fodder availability may also constrain potential future expansion of livestock production.

3.7 Fisheries

Fisheries is an important activity in the project area and has a vital role in nutrition, income generation, as well as in export earning. Approximately 60 per cent of the households depend on fishing for a major part of their livelihoods. There are two types of fisheries in the project area:

- *Capture fisheries*:, carried out at sea in the inshore and offshore waters and in inland water bodies such as beels, khals, rivers and the flood plain.
- *Aquaculture*: which comprises the pond raising of carp *spp* and shrimps in respectively fresh and brackish water.

A preliminary survey executed by the MES indicated an annual production in the Nijhum Dwip project area of 18,640 mt of fish,¹ of which the major portion is contributed by marine fisheries. A breakdown among the different categories is presented below in Table 3.6.

Table 3.6: Fish Production in the Nijhum Dwip Study Area.

Category	Annual Production (mt)	Percentage of Total Production
Aquaculture	136	0.7
Inland capture fisheries	254	1.4
Marine inshore fisheries	8,125	43.5
Marine offshore fisheries	10,125	54.3
Total	18,640	100.0

3.7.1 Fisheries production and fish consumption

In the last decade the fish production in Bangladesh increased annually by approximately 3 per cent, from 790,000 mt in 1985 to 1,170,000 mt in 1996² and a similar growth has been

¹ The production is based on secondary data obtained from Thana fisheries officers and on a RRA survey and is therefore indicative only.

reported for the project area by thana fisheries officers. All three components of the sector - aquaculture and inland and marine fisheries - have contributed to this growth.

Even if the statistical data reflect the trends in the field,³ it does not mean that the fisheries are in a healthy state. Growth is most likely due to the increased number of fishermen, while at the same time the catch per fisherman is decreasing. The latter is the first sign of over-exploitation of fish stocks.

Total protein availability in Bangladesh has been estimated at around 40 g/person/day, of which 27 g is provided by fish, the remainder coming from meat, eggs and milk. This may be compared with a recommended daily protein requirement of 45.3 g/person/day. In the project area fish is the main and cheapest source of animal protein. Approximately 6 per cent of the fish production is consumed locally, indicating protein availability of 66 g/capita/day.

3.7.2 Marine fisheries

Four main types of gear are being used by fishermen in the project area.

- **Push nets.** The rapid expansion of shrimp culture in Bangladesh has resulted in a tremendous demand for the seed of tiger shrimp (Bagda). Within the project area a large number of push nets are operated for seed fishing by part-time fishermen. The income generated by this activity is seasonal and varies between Tk 60 and Tk 2,000 per month.
- **Drift gill nets** are placed in the river to catch Hilsha (95 per cent of the catch). Other species caught include pomfret, Spanish mackerel, croaker, and snapper.
- **The estuarine set bag net** (behundi) is a traditional gear, operated year round, which is fixed by wooden poles in the river in areas with water depth less than 5 metres. The fish enter through the mouth and end up in the bag. This type of net is rather destructive as it catches a large number of juvenile fish and shrimp, but it is the most widely used because investment costs are low.
- **The marine set bag net** is an enlarged version of the estuarine set bag net and is operated offshore in areas with a depth of 10 to 30 metres. The fishing season is during the dry season when fresh water run off is low.

The marine fishing village survey of 1984/85 indicated that 30 per cent of households in the whole area⁴ were fisher households and 95 per cent of the fishermen were living in only four villages. At present no information is available for the whole study area but for Nijhum Dwip a comparison of the status of fisheries in 1984 and 1997 is presented in Table 3.7. The data indicate the very large increase in fishermen living and working in the project area.

Table 3.7: Fisheries in Nijhum Dwip in 1984 and 1997

	1984/1985 (DoF/FAO)	1997 (MES)
Total population	721	6,035
Total no. of households	99	1,181
No. of fishing households	81	815
Percent of fishing households	82%	69 %

² Bangladesh Fisheries Resources Survey System (BFRSS), 1996.

³ A number of studies (MIS, FAO, FAP 17, etc.) indicated that the BFRSS is hampered by its small sample size, an outdated frame and logistic problems in analyses of data.

⁴ Inside and outside the embankment.

Fish Marketing

There are two (private sector) fish landing stations in the project area, one is located at Char Muktaria (south Hatia) and the other on Nijhum Dwip. Both the ghats are used by fishermen for off loading, icing, drying and selling their catch. Marketing of fish is mainly done at the two fish landing sites, or alternatively at sea to collecting vessels.

Fish marketing is poorly developed in the area and transport costs to major market centres are relatively high. These factors depress the prices and those received by fishermen are generally low (see Appendix IV.3).

Fisheries Ecology and Migration

Biologically, the estuary provides spawning and nursery areas for a large number of fish and crustaceans which spend the remainder of their life cycles at sea or in fresh water. Further the estuary provide avenues of entry and exit for the migration of anadromous and catadromous fishes.

Within the Meghna estuary the species known to be estuarine dependent, that is for which the passing of a portion of their life cycles in the estuary is obligatory for the completion of their life cycles include hilsha, golda (fresh water prawn), shrimp species and catfish (*Pangasius spp.*) These are important species with a total annual catch valued at about US\$ 125 million. Hilsha accounts for over 90% of this value.

3.7.3 Inland Fisheries

Some fishing is carried out in the inland water bodies of the study area during the monsoon, i.e. in the Khals and flooded land. The principal species caught are taki, shing, puti and chingri. The total catch of the inland waters was estimated by the Hatia Thana Fisheries Office at 250 mt/year.

3.7.4 Aquaculture

The most common aquaculture practices in Bangladesh are the rearing of Indian carp in fresh water ponds and the raising of tiger shrimp in brackish water ponds. According to the Hatia Thana Fisheries Officer there are 520 fish ponds for the rearing of Indian carp located inside and outside the embankment of the project area. Within the project area, there are an estimated 104 ha of ponds, 78 ha of cultured ponds and 26 ha of culturable ponds.

The present production was estimated at 136 mt/year or 824 kg/ha/year. The latter is comparable with the average production rate of 800-1000 kg/ha/year for non-managed ponds in the whole of Bangladesh. The number of ponds most likely covers only the large ponds and the number of ponds suitable for aquaculture development could be higher.

Shrimp and prawn culture is rare in the project area although some shrimp ghers have recently been constructed nearby in south Hatia (Char Hare and Char MacPherson).

3.8 Forestry

The systematic establishment of mangrove plantations in coastal areas started in 1965 as part of the Government's programme of cyclone protection measures. The original aims of the programme were to provide protection against tidal surges and to improve the stabilisation and extension of coastal land through increased accretion.

Nijhum Dwip started surfacing in the 1950s and the Forest Department started planting mangroves there from the 1973 and continued up to 1988. A total area of 2,822 ha. was planted, of which an area of 498 hectares has been eroded up to June, 1997 leaving a balance

of 2,324 hectares. The annual areas planted are given in Table 3.8 together with an estimate of the present standing volume of usable wood.

On South Hatia, the mangrove plantation was started in 1975 and planting continued until 1990. An area of 6,326 ha. was planted, of which 1,887 ha has been eroded up till June 1997. Of the remaining area, 713 ha of existing plantation is outside the project area, leaving, in principle, 3,726 ha. However, the existing forest within the project area, from satellite imagery, is only 2,119 ha. The discrepancy is not explained.

Table 3.8: Existing forest stock

Year	Nijhum Dwip		South Hatia		Total		
	Area (ha)	Volume (m ³ x 10 ³)	Area (ha)	Volume (m ³ x 10 ³)	Area (ha)	Volume (m ³ x 10 ³)	Area (%)
1973	12.1	1.3					
1974	91.1	9.5			180.3	18.8	3.0
1975	77.0	8.0					
1976	202.4	21.0	173	18.0			
1977	338.7	35.2	296	13.8			
1978	427.1	44.4	187	19.5	2,849.2	279.2	47.1
1979	233.0	24.2	198	20.6			
1980	435.0	45.2	359	37.3			
1981	155.0	16.1	494	51.4			
1982	58.9	8.9	530	79.5			
1983	35.5	5.0	515	72.1	2,224.9	287.1	36.8
1984	50.0	6.5	134	17.4			
1985	70.0	8.4	182	21.8			
1986	16.0	1.8	223	24.5			
1987	32.4	3.2	211	21.1			
1988	89.3	8.0	104	9.4	795.7	77.4	13.2
1989			100	8.0			
1990			20	1.4			
Total	2,324	246.7	3726	415.8	6,050.0	662.5	100.0

Sources: Forest Department

Notes: Volume estimates based on Forest Resource Management Project Preparation Mission Report, 1991

The principle species planted in both the sites are Keora (about 80 per cent) and Baen (15 per cent). Gewa and others make up the remainder.

Thinning operations were carried out in these plantations during 1988 to 1990 in all areas where the trees were up to the age of 9 years. Because of the high cost and relatively low returns, thinning has been discontinued as a regular activity in the plantations. Moreover, since the coastal afforestation project's central aim has been land stabilisation and protection, very little attention has been paid to management and silviculture. Trees have simply been planted in close spacing, protected and left to grow.

It is estimated that the total present standing volume of timber on the existing plantations in the project area is about 660,000 m³. This volume represents both firewood and millable timber, in an assumed ratio of 40 : 60.

No further mangrove planting has been undertaken in either Nijhum Dwip or south Hatia since 1989 and 1990, respectively. Furthermore, a sizeable proportion of the Keora trees have been infested by stem borer causing trees to die and creating blank spots inside the plantation areas. Existing plantation forests are also being guarded by local forest staff against encroachment and pilferage.

4. FUTURE WITHOUT PROJECT

4.1 Land Accretion and Land Development

With no intervention, land area will continue to accrete at a rate similar to the past. A study of land formation and char development between 1973/74 and 1996 shows the net rate of accretion for new land in the project area has been about 68 ha per year at the +2.2 m PWD level (see Appendix I, section 5). To estimate future accretion with no project intervention, this rate has been projected forward for the life of the project. Accretion at the +1.5 m PWD and +2.0 m PWD levels has been estimated by applying the long term ratios (i.e. at 30 years) between these levels for the future with project options to the accretion without the project at +2.2 m PWD. Table 4.1 gives the cumulative totals accreted to or above the indicated level at year end.

Table 4.1: Estimated accretion without the project

Year	unit: ha		
	+ 1.5 m PWD	+ 2.0 m PWD	+ 2.2 m PWD
5	455	416	341
10	908	830	681
15	1,363	1,246	1,022
20	1,817	1,662	1,363
25	2,272	2,078	1,704
30	2,725	2,493	2,044

Based on Appendix I, Tables I.4, I.8 and I.9

The general land development sequence recommended by MES for newly accreted land is for it first to be planted in mangroves. This helps to stabilise the land, promotes further accretion and the development of the soils and provides protection from tides and cyclones. After 15 years, forest may be cleared for agriculture provided a coastal belt of at least one km depth is retained.

However, without the project interventions, land development is likely to follow more closely the existing pattern which places less emphasis on afforestation. The development of newly accreted land at Nijhum Dwip is, in this case, assumed to proceed as follows:

- 50 per cent of land reaching the level of +1.5 m PWD will be planted in mangrove
- there will be no clearing of mangrove forest after 15 years
- 40 per cent of land reaching +2.2 m PWD will be developed for agriculture
- remaining land will be used for the grazing of livestock.

4.2 Physical and Social Infrastructure

Without the project, physical infrastructure in the project area will develop only slowly. Embanking of areas on south Hatia outside the existing embankment and on Nijhum Dwip will not occur in the foreseeable future but may occur eventually.

Improvements in transport and communications will be slow to materialise. There are no BIWTA registered routes in the area and none are expected. Nijhum Dwip will continue to be dependent on boats for all communications. Areas on south Hatia outside the embankment may be connected to the road network inside. There may be a gradual improvement in the frequency and regularity of private boat services from south Hatia to northern Hatia and to other areas.

The existing fishing ghat may have to move because of the natural accretion in the area, but if so, it will be entirely a matter for the existing operators.

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The safety and security of the population is a relatively high priority and additional killas and cyclone shelters are likely under either government or NGO programmes in the coming years.

Other social infrastructure in the area will continue to expand gradually in accordance with Government's regular programmes. The area is relatively well provided with primary schools, but there is a shortage of high schools. Health services in the area are also very limited.

4.3 Water management

Water management is only possible within an embanked area. Without empoldering, there will be no opportunity for water management in the future. Without protection, it is not possible for desalinisation of soils to take place since they will be subject to periodic saline flooding. The present salinity levels will not change in the future if no project is implemented. Periodic damage by storms will also continue to occur.

4.4 Agriculture

Agriculture in the project area is constrained by exposure to high tides and storms, saline intrusion and soil salinity, low soil fertility and a lack of inputs and extension support. Without project interventions and unless new embankments were built, salinity would decline only very slowly or not at all, since the land would remain vulnerable to saline intrusion from high tides. The risk of damage to crops from tides and floods would be unchanged. Fertility may gradually rise as the organic content of soil increases. Farmers' access to information and technical support would improve only slowly although the possibility of gradually improving communications may provide some stimulus to production through better access to markets.

Overall, it is unlikely that yields or cropping intensities would increase significantly from those obtained at present. In particular, expansion of Rabi crops would continue to be inhibited by the saline conditions.

Newly accreted land devoted to agriculture will amount to some 800 ha. after 30 years. On these areas, once the level of +2.2 m PWD is reached, a single salt tolerant rice crop can be grown. At first, because of high salinity and low fertility, only a very low yield will be obtained. The yield is assumed to be initially 50 per cent of the normal yield achieved at present and to rise to the full level over at least 15 years. Cropping intensity would start at around 75 per cent and rise over the same period to reach present average level of 120 per cent for areas outside the embankment. Rabi crops can usually begin after about 5 or 6 years and initially would be only keshari, from which a crop can be obtained when conditions are still relatively saline.

4.5 Livestock

Although livestock and poultry at present contribute only modest amounts to household cash income they are nevertheless an important component of the household economy, contributing draft power and dietary supplements in the form of milk, eggs and meat.

As new land accretes, the land available for the grazing of large and small ruminants will increase. The livestock population of the project area is already relatively large and the average number of livestock owned per household is not expected to increase in the future. Increases in livestock population will be related to the increasing numbers of households in the area. Successful livestock production in the project area depends on the safety of the animals, especially during cyclones. Unless, the number of killas in the area increases or owners are able to move livestock on to or inside the embankments in times of danger, then it is unlikely that livestock populations would increase very significantly, or at least that investments will be made to improve livestock productivity.

Gradually improving communications with the area and better access to markets may act as a stimulus for livestock production in the area. However, the lack of veterinary and extension

services are not likely to change significantly in the near term without the project and this will inhibit livestock production.

Overall, without the project, livestock populations will increase, but current levels of productivity are expected not to change significantly. Rates of growth for livestock owner per household are based on 1984 Livestock Census Data and surveys carried out for the Cyclone Shelter Preparatory Study in 1996. This data is used to estimate current per household ownership of livestock in the project area and in Hatia thana as a whole. Per household ownership is not expected to change significantly in the future as the carrying capacity of the area will impose restrictions on total livestock numbers. Future growth in livestock populations is therefore dependent on the future number of households. Estimated livestock populations in the future without the project are given in Table 4.2.

Table 4.2: Livestock population, without project

Year No.	Year	Cattle & Buffaloes	Goats	Chickens
1	2000	7,098	6,045	77,770
5	2004	8,097	7,358	88,710
10	2009	9,125	8,292	99,980
15	2014	9,990	9,078	109,450

4.6 Fisheries

Marine fisheries are at present the single most important source of income for households in the project area. There are early signs, however, that the resource is being over fished and that there will eventually be a decline in total output and falling incomes. If this occurs, agriculture and livestock will assume relatively more important roles in the local economy.

At present there are about 100 ha of fish ponds in the project area. Fish ponds located outside the embankment face the same risk from floods, tides and storms as other crops, but a production cycle is possible between the end of October and May or June when the risk of damage is low. Without implementation of the project, there will be a gradual expansion in the area of ponds as new land accretes, but the adoption of improved production methods, at least on any significant scale, is not expected.

Fish ponds will occupy about three per cent of newly accreted land, about the same proportion as they occupy on existing land in the project area. This will mean an additional 25 ha of ponds over the next 30 years. However, with no project interventions, production conditions in these ponds will be similar to those prevailing at present.

4.7 Forestry

Past afforestation programmes on Nijhum Dwip and south Hatia have resulted in the present forest cover in the area. Without the project, similar programmes may be implemented in the future, although in a less regular manner than is expected with the project. It is assumed that, on average, 50 per cent of new land accreting to or above the +1.5 m PWD level will be planted in mangroves. In the future without the project, it is not expected that any forest will be cleared for agriculture after 15 years and there will be no clearing of existing forest on south Hatia or Nijhum Dwip. The forest will provide fuel wood for local communities but there will be no, or only minimal, harvesting for timber.

After 30 years, the forest on newly accreted land will amount to some 1,360 ha, in addition to the existing area of 4,443 ha.

5. PROPOSED INTERVENTIONS

The interventions proposed under the project are grouped into two options - Options 2 and 3. In addition the situation without any interventions is designated as Option 1. Option 2 would be implemented first and Option 3 may be implemented commencing in year 6 of the project, subject to the positive outcome of a review in year five.

Option 2 includes:

- construction of the Hatia - Nijhum Dwip cross dam
- empoldering, in stages, of Nijhum Dwip and the areas of south Hatia outside the existing embankment
- construction of a road between the existing embankment on south Hatia and the southern end of Nijhum Dwip.

Option 3 would include option 2 plus the following:

- construction of the Hatia - Damar Char cross dam
- construction of further embankments after additional land has accrued to the appropriate level.

5.1 Cross Dams

The objective of the proposed cross dams is to reduce and eventually block the tidal currents in the channels between Hatia, Nijhum Dwip and Damar Char. Cross dams are proposed between Hatia and Nijhum Dwip and between Hatia and Damar Char. These dams will reduce the tidal flow between Hatia and both islands and thus enhance accretion on both sides of the dams eventually creating one united land mass.

5.1.1 Basic Data

The basic data for the present study on the closure dam between South Hatia and Nijhum Dwip were obtained from LRP reports:

- the Nijhum Dwip Pre-feasibility Study Report
- results of surveys and hydraulic and morphologic studies
- Feasibility Study on South Hatia Cross Dams
- Bangladesh tide tables, 1997.

The design of the dam is based on the experience of a pilot schemes executed at Haimchar and Khorki in the period March till June 1998.

Reference levels

The following reference levels have been adopted in this study:

Public Works Department Datum (PWD)

General horizontal reference datum defined by the Public Works Department. This datum is applied in the whole of Bangladesh.

Chart Datum (CD)

A local datum used as reference for tide levels. Chart datum is a plane below which tide seldom falls. The relationship between the Chart datum used on Hatia and Public Works datum is :

$$CD = PWD - 1.17 \text{ m}$$

Topographic data

A topographic survey has been carried out of the Nijhum Dwip coastline area in March 1997. Analysis of the coast line development from 1973 to 1996 show a reasonably stable coastline (see Figure 2.2). The land levels on the coast of South Hatia are approximately +1.5 m PWD and on Nijhum Dwip and Damar Char approximately +1 m PWD.

Bathymetric data

From 1987 on, various bathymetric surveys have been carried out in the Nijhum Dwip channel. The most recent surveys were carried out in February 1997. Analysis of these survey data show a continuous fluctuating bed level (see Appendix I, Figures I.1a - I.1c). The 1997 survey results show maximum bed levels per cross-section varying from -3 m PWD to -11 m PWD and channel width varying from 700 to 2,000 metres.

The channel between Hatia and Damar Char was last surveyed in 1987. The survey results show a relative shallow channel with bed levels in some cross-sections not exceeding -2 m PWD.

Water levels

Tidal information is obtained from the Bangladesh Tide Tables 1997, published by the Department of Hydrography of the Bangladesh Inland Water Transport Authority. The tidal station relevant for the Nijhum Dwip area is Char Changa on the west coast of Hatia. The tidal levels for this station are given in the table.

Table 5.1: Tidal Levels at Char Chenga

	Unit: metres	
	Level with respect to:	
	CD	PWD
Lowest Astronomical Tide	- 0.375	-1.55
Mean Low Water Spring	0.256	- 0.91
Mean Low Water Neap	1.060	- 0.11
Mean Low Water	2.037	0.87
Mean High Water Neap	3.014	1.85
Mean High Water Spring	3.818	2.65
Highest Astronomical Tide	4.449	3.28

Currents

Information on currents prevailing in the Nijhum Dwip channel has been obtained from model simulations performed in 1998. The results of the model runs give a sufficient insight in the hydraulic conditions to be expected at the closure site, prior to and during the closure operations (see Appendix I).

Soils

In June 1989, a geotechnical survey was executed in the vicinity of the Nijhum Dwip cross dam. Four bore holes were drilled, two at each side of the channel. The soil found is classified as "stiff silt". In general the survey indicated:

- densities around 1.9 mt/m³
- moderate SPT values and results of unconfined compression tests which agree with the classification of "stiff silt"
- consolidation Cc values are normal but the shear test values are lower than expected.

Construction materials

In the immediate vicinity of the channel separating Nijhum Dwip and south Hatia, the only available construction material is earth. For construction of an earthen dam one should preferably use clayey soil, with 15 per cent clay particles. Technically this requirement would qualify the soil as a medium plasticity clay - a lower boundary of 10 per cent could be accepted.

"Hard" materials, such as rock or boulders are not available near the closure site and would, if required, have to be imported from elsewhere. Local sand (with the required grain size) and sylhet sand to be used for filling synthetic bags and geobags, has to be brought from elsewhere.

Bamboo and bullah poles, which may be used for cross dam elements or for temporary works, is available on Hatia.

5.1.2 Cross dam design

Previous feasibility studies carried out during LRP showed that constructing dams using conventional methods is not really economically viable. Moreover it is judged that the earthen dam with a core of gunny bags, as designed by LRP for the Nijhum Dwip cross dam, would not be able to withstand prolonged attack by waves. When overtopping of the dam occurs, for example during cyclone conditions, the relatively local fill material of the dam, which has not much cohesion and would anyhow be loosely packed, would easily be washed away, as can be observed throughout the Meghna Estuary. Protection of the embankment with concrete slabs on a geotextile/sand filter, similar to the protection of the Feni dam and the Sandwip cross dam, would be required to ensure that the cross dams at Nijhum Dwip and Damar Char would not be eroded either by current or wave erosion. Such protection would further increase the cost of these cross dams.

An alternative design and construction method for cross dams has been developed under the Meghna Estuary Study. This type of cross dam differs from conventional methods by the use of geotextile materials and construction methods using prefabricated elements. Based on the findings and lessons learned during implementation and monitoring of Haimchar and Khorki erosion control pilot schemes, MES has developed the concept of a permeable cross dam consisting of a geotextile bed protection, a low under water dam of concrete blocks, A-frames made of GI pipe, anchored in the low dam and geotextile screens, fixed to the A-frames, for partial closure of the cross section of the channel.

A comparison between the cross dam of conventional design and the innovative design of MES is indicated in Figure 5.1. It is estimated that taking into account current rates for materials and labour as well as the need for concrete slab protection, the cost of the permeable cross dam would be about 50 per cent of the conventional cross dam with adequate protective measures. A section and side view of the permeable cross dam is indicated in Figure 5.2.

Figure 5.1: Conventional and MES cross dam design

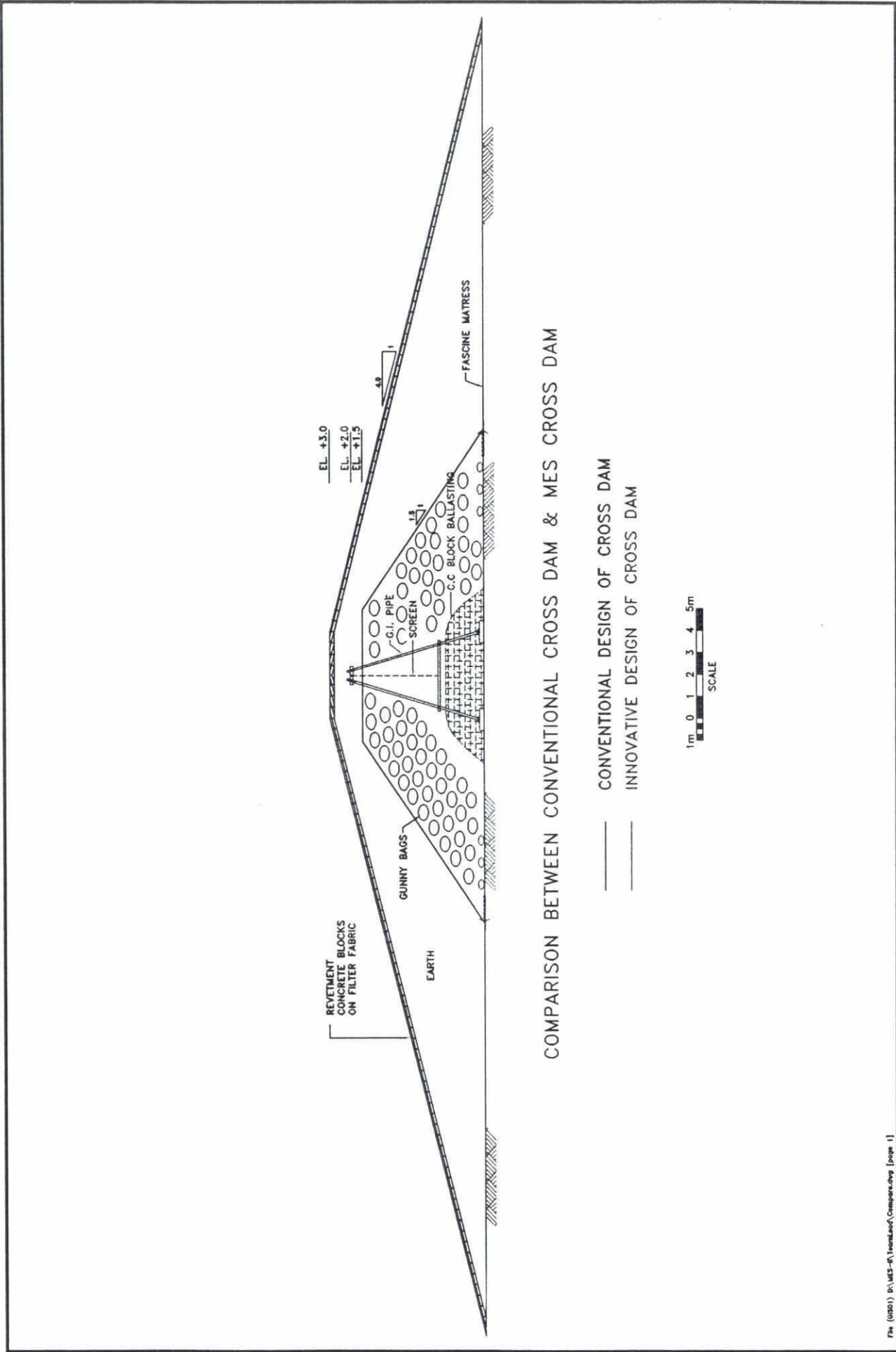
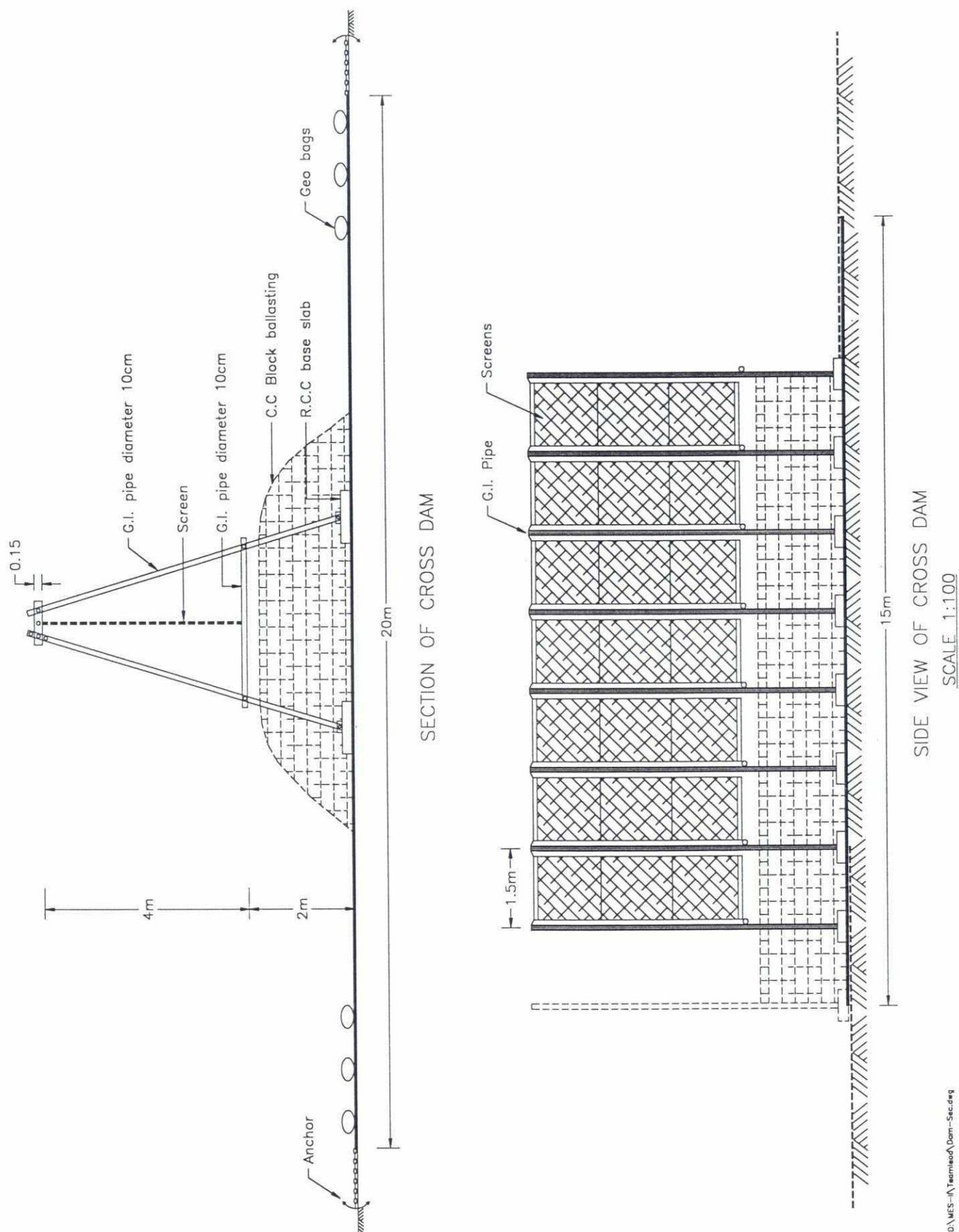


Figure 5.2: Cross-section and side view of a permeable cross dam



The screens of the cross dam are manufactured with a very heavy woven geotextile that will be able to transfer the dynamic loading from waves and flowing water to the A-frame. The A-frames consist of 5 or 6 inch GI pipe; the c.o.c distance between A-frame depends on the actual loading by the screens and will be 1.5 to 2.0 metres. The ratio between screen area and total area above the low under water dam will vary between 0.60 and 0.90. It will be possible to adjust this ratio by narrowing the gap in between screens as well as between a screen and the under water dam.

The loading of the concrete blocks on the foot slab of the A-frames has to be sufficient to ensure the stability of the A-frame under the combined loading by water pressure and waves. Based on computer calculations of water levels after full closure, it may be assumed that the maximum head difference at the permeable cross dam will be about 0.30 metres.

The waves will exert dynamic forces on the screens, since the screens are flexible and have gaps in between individual screens, it is estimated that a static head of 0.20 metres in addition to the 0.30 metres water pressure, or 0.50 total static head, will be a reasonable assumption for the horizontal loads that have to be transferred by the A-frame in to the under water dam and channel bed. By providing sufficient slack in the screens, the loading will be mostly on the downstream leg of the A-frame; the pulling force on the upstream leg of the A-frame will be relatively small. The legs of the A-frame have to be designed for buckling, some stiffeners may be required to ensure the stability under all loading conditions.

The size of the concrete ballast blocks will have to be adequate to withstand the forces of the current passing through the permeable cross dam. The maximum velocities will be about 2.5 m/sec. Concrete blocks 0.4 x 0.4 x 0.4 metres will be stable under these conditions.

The bed of the channel at the alignment of the Nijhum Dwip cross dam consists of silty sand/sandy silt. This material has a low resistance to scouring, therefore bed protection of adequate width has to be provided to ensure that the under water dam of concrete blocks will not be undermined by scouring. The total width of the bed protection will be 25 metres and on each side of the under water dam the bed will be protected over a width of about 9 metres. This width may be increased, if required. The Char Montaz cross dam pilot scheme will provide valuable data to establish the design criteria for the bed protection of cross dams.

The cross dam configuration as described above can be optimally be applied given the following site conditions:

- water depths at low water not exceeding five metres
- tidal flow conditions with a considerable period of slack water.

5.1.3 Proposed cross dams

Two cross dams are proposed.

Cross dam 1 connects south Hatia with Nijhum Dwip. The dam has a length of approximately 1,250 metres. Part of the dam (300 metres) is located in the deeper part of the channel between Hatia and Nijhum Dwip, requiring A-frames of 6metresheight and part of the dam (850 metres) is located in a shallower channel requiring A-frame with a height of 4 metres.

The lowest bed level of the channel is approximately -4 m PWD. The land level on the Hatia side is approximately +1.5 m PWD and the land level on the Nijhum Dwip is also about +1.5 m PWD. The top of the dam is projected at +2 m PWD. This implies that during the wet season the cross dam will be overtopped. However this will not be harmful to the cross dam.

Cross dam 2 is located about five km east of cross dam 1. The cross dam connects Hatia with Damar Char and has a length of approximately 2,500 metres. Part of the dam (1,000 metres) is located in the deeper part of the channel and will require A-frames with a height of 4 metres.

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The other part of the dam (1,500 metres) is located in relatively shallow waters and will be constructed as an embankment protected with concrete slabs on a filter layers of sand and a composite geotextile filter.

The lowest bed level of the channel is approximately -2 m PWD. The land level on the Hatia side is about +1.5 m PWD and the land level at Damar Char is about +1.5 m PWD. The top of the dam is projected at +2 m PWD.

5.1.4 Implementation of the cross dams

Cross dam 1 will be constructed during project year one. The accretion expected after the construction of this dam is relatively rapid (see Chapter 2). In year five a review of the situation will be undertaken and if cross dam 2 is still expected to have a sufficiently positive impact on land accretion in the area, it will be scheduled for construction in year six.

The Nijhum Dwip channel is located near open sea. During part of the year weather and sea conditions are not suitable for off-shore construction activities. It is advisable to carry out main construction activities from November to March. The optimum period to carry out the actual closure of the dams is the month February.

An implementation schedule for the construction of the Nijhum Dwip cross dam is given in Figure 5.3.

The actual requirements for execution of the works depend on the channel depth prior to the start of the works. If the channel falls dry over its full length during low tide, installation of the bed protection and A-frames will be relatively easy. Under the present conditions waterborne equipment like a Twin Hull Pontoon, an auxiliary pontoon, tug boats etc. will be required for installation of the bed protection and A-frames in the deeper part of the channel.

5.1.5 Cost estimates of the cross dams

The layout, design and the estimate of quantities of work of the cross dams have been based on surveys during MES. During the 1998 extreme flooding, substantial changes may have occurred along the proposed alignments of the two cross dams. In the period before the start of the implementation the situation will change again. A fresh estimate of quantities will be required at the time the amount involved for a construction loan has to be determined.

The unit rates are based on current rates of the BWDB O&M circles of Chandpur and Bhola. These unit rates will also have to be adjusted at a later stage. Table 5.2 provides the detailed cost estimate for the Nijhum Dwip cross dam and Table 5.2 provides the same for the Damar Char cross dam.

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Table 5.2 : Cost estimate Nijhum Dwip cross dam (base cost)

Cross dam section with A-frame 6 m height	300	meter length
Cross dam section with A-frame 4 m height	850	meter length
Embankment, protected	100	meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	34,850	3,171,350
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	14,950	1,711,775
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	18,250	1,519,313
4	Propex 6088 Screens	m2	78	4,188	324,531
5	Sewing yarn	kg	1,125	740	832,500
6	Transport cost of geotextile materials	L.S.			300,000
	Sub-total				7,859,469
7	Local Sand (F.M = 1.3)	m3	550	7,650	4,207,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	730	730,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,530	764,750
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 0.5 m x 0.125 m), slope protection	nos	120	5,600	672,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	132,500	26,500,000
14	G.I. Pipe, 6" diameter	m	2,200	0	0
15	G.I. Pipe, 5" diameter	m	1,600	9,800	15,680,000
16	G.I. Pipe, 4" diameter	m	700	0	0
17	G.I. Pipe, 3" diameter	m	600	2,300	1,380,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	2,268	226,750
21	Shil-Barak Bamboo, 3" diameter	nos	192	21,850	4,195,200
22	Synthetic Bag	nos	18	188,750	3,397,500
23	Steel anchor (15 kg)	nos	550	575	316,250
24	Steel chain	m	250	2,530	632,500
25	Hardware material	m	3,500	1,150	4,025,000
	Sub-total				62,727,450
26	Labour cost	m	3,340	1,170	3,907,800
27	Equipment cost	m	4,000	1,150	4,600,000
28	Earth work	m3	50	5,600	280,000
29	Mobilization/demobilization	L.S.			2,500,000
	Sub-total				11,287,800
	Total				81,874,719
30	Contingencies 10 % and rounding				8,187,281
	Total, including contingencies				90,062,000
	Sub-total foreign cost USS				167,000
	Sub-total local cost Taka				82,203,000

Note : These costs exclude taxes, duties and DVA on geotextiles

Table 5.3 :Cost estimate for Damar char cross dam (base cost)

Cross dam section with A-frame 6 m height	50	meter length
Cross dam section with A-frame 4 m height	1000	meter length
Embankment, protected	1500	meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	72,625	6,608,875
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	13,650	1,562,925
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	30,750	2,559,938
4	Propex 6088 Screens	m2	78	3,488	270,281
5	Sewing yarn	kg	1,125	1,380	1,552,500
6	Transport cost of geotextile materials	L.S.			300,000
	Sub-total				12,854,519
7	Local Sand (F.M = 1.3)	m3	550	13,100	7,205,000
8	Sylhet Sand (F.M = 2.1)	m3	1,000	1,230	1,230,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,397	698,250
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 0.5 m x 0.125 m), slope protection	nos	120	84,000	10,080,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	122,750	24,550,000
14	G.I. Pipe, 6" diameter	m	2,200	0	0
15	G.I. Pipe, 5" diameter	m	1,600	8,500	13,600,000
16	G.I. Pipe, 4" diameter	m	700	0	0
17	G.I. Pipe, 3" diameter	m	600	2,100	1,260,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	1,880	188,000
21	Shil-Barak Bamboo, 3" diameter	nos	192	19,950	3,830,400
22	Synthetic Bag	nos	18	164,500	2,961,000
23	Steel anchor (15 kg)	nos	550	525	288,750
24	Steel chain	m	250	2,310	577,500
25	Hardware material	m	3,500	1,050	3,675,000
	Sub-total				70,143,900
26	Labour cost	m	3,340	1,350	4,509,000
27	Equipment cost	m	4,000	1,050	4,200,000
28	Earth work	m3	50	84,000	4,200,000
29	Mobilization/demobilization	L.S.			2,500,000
	Sub-total				15,409,000
	Total				98,407,419
30	Contingencies 10 % and rounding				9,840,551
	Total, including contingencies				108,247,970
	Sub-total foreign cost USS				274,000
	Sub-total local cost Taka				95,393,000

Note : These costs exclude taxes, duties and DVA on geotextiles

5.2 Embankments, sluices and drains

Interventions are proposed to a) protect old unprotected land and newly accreted land, b) improve the natural drainage system of newly protected land and c) stimulate desalinisation of protected land. In the case of this feasibility study, which is dealing with land accreting in the future, field data are limited and therefore, key-data have been used in a temporary design. These key data are presented in Appendix III. Hence, detailed drainage design studies are required before the implementation of works is taken up. Furthermore, the physical interventions presented here do not stand on their own, but are part of a water management component described hereafter in chapter 6.5.

5.2.1 Option 2: Construction of Nijhum Dwip cross dam only

The physical interventions related to the hydraulic infrastructure will be realised in two steps. The first step is the empoldering of existing land and the second step is the empoldering of new accreted land, stimulated by the construction of a cross dam, which will be constructed in the first year.

Empoldering existing land, years 1 and 2

A considerable part of old, but still unprotected land of southeast Hatia and southern Nijhum Dwip is above +2.2m PWD, which is the minimum level considered appropriate for empolderment in this area. This level is approximately mean high water level (MHWL) and implies that about 90 per cent of the time this land is no longer inundated. In principle land at MHWL provides sufficient scope for drainage by gravity. On south Hatia the total area above +2.2m is estimated at 3,400 ha and for Nijhum Dwip around 900 ha.

The physical safety in polders facing the Bay of Bengal can be further improved through the construction of secondary protection embankments. If properly planned, these embankments will have multiple purposes as:

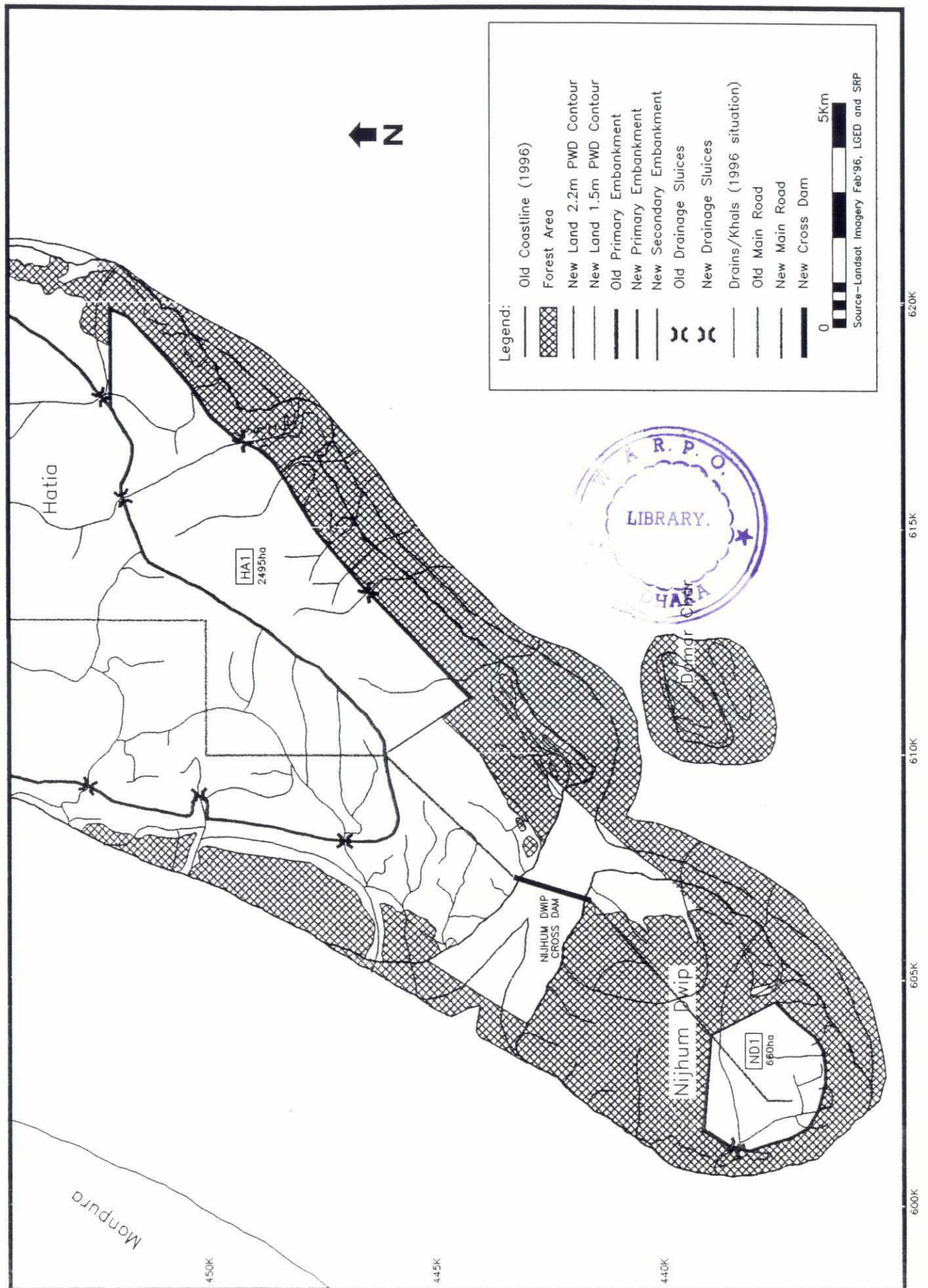
- secondary protection embankments
- rural roads
- catchment boundary of drainage sluices.

In case of a breach in a primary embankment, the intrusion of saline floods will be limited to one polder compartment only. The secondary protection embankments, like primary embankments can also be used as roads if designs take this function into consideration. Roads that follow catchment boundaries of sluices require a minimum number of culverts and bridges, reducing costs of a rural road network.

In year one and two, a total of 2,495 ha on southeast Hatia will be empoldered and will form a compartment adjacent to the existing polder 73/2, named HA-1. The location of this compartment is shown in Figure 5.4 (Option 2, year 5). On Nijhum Dwip the area earmarked for empolderment, located in the south of the island, is estimated at 660 ha. This initially isolated compartment is named ND-1.

In the case of this compartment, a strip of land about 700 metres wide at the southern tip of the island, currently under cultivation, will be cleared in favour of the construction of a primary embankment and to allow sufficient foreshore for a protecting forest of about one kilometre width. A small part of the forest land of south Nijhum Dwip, which is above +2.2 m PWD, will be cleared and will form a part of compartment ND-1. This forest land will be converted into agricultural land to resettle families who had to give up their land at the southern tip of Nijhum Dwip. The compartment embankments, in the north of compartment ND-1 and in the south of compartment HA-1, will also function as unpaved R-2 roads.

Figure 5.4: Option 2, empoldering after 5 years



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Empoldering of new land, years 5 and 6

The cross dam between Nijhum Dwip and South Hatia will stimulate accretion of new land. Based on accretion forecasts, it is expected that after four years sufficient newly accreted land and parts of the still unprotected land of Nijhum Dwip and South Hatia will have reached a level of + 2.2 m PWD or more.

By the construction of two primary embankments and a secondary embankment cum road, which will incorporate the cross dam, two additional compartments, ND-2 and ND-3 will be created in years five and six. The road will form a link between Hatia and Nijhum Dwip. The total gross area of the two compartments ND-2 and ND-3 is estimated at 4,080 ha, with 2,360 ha for compartment ND-2 and 1,720 ha for ND-3.

Construction of primary and secondary embankments

As shown in Figure 5.5, the outer embankment will be a primary embankment facing the sea. Primary embankments have a crest width of 4.25 metres to accommodate an inspection road. Primary embankments are wide enough to serve as an unpaved rural road of type R-2, which needs a minimum crest width of 3.60 metres. To ease drainage congestion which often exists near the embankment, a minor drain is planned along the new primary embankments, duly separated by a berm (see Figure 5.6).

The secondary embankments of the compartments HA-1 and ND-1, constructed in year 1 and 2, can accommodate an R-2 type of road, which requires a crest width of 3.60 metres. The road linking south Hatia with Nijhum Dwip will function as a compartment embankment in the future. Given the importance of this road, a paved R-1 type of road will be required. Therefore the crest width of this secondary embankment will be 4.90 metres to allow the construction of a paved R-1 road (see Appendix III, Figure III.1)

A cost estimate for these embankments is given in Table 5.4.

Table 5.4: Primary and secondary embankments

Compartment Code	Embankment Type	Length (km)	Rate (Tk '000 / km)	Cost (Tk '000)
ND-1	Primary	4.98	3,788	18,864
	Secondary	3.68	1,689	6,216
HA-1	Primary	14.85	3,788	56,252
	Secondary	2.48	1,689	4,189
ND-2 and ND-3	Primary	19.88	3,788	75,305
	Secondary cum R-1 Road	9.09	2,207	20,062
Total Cost				180,888

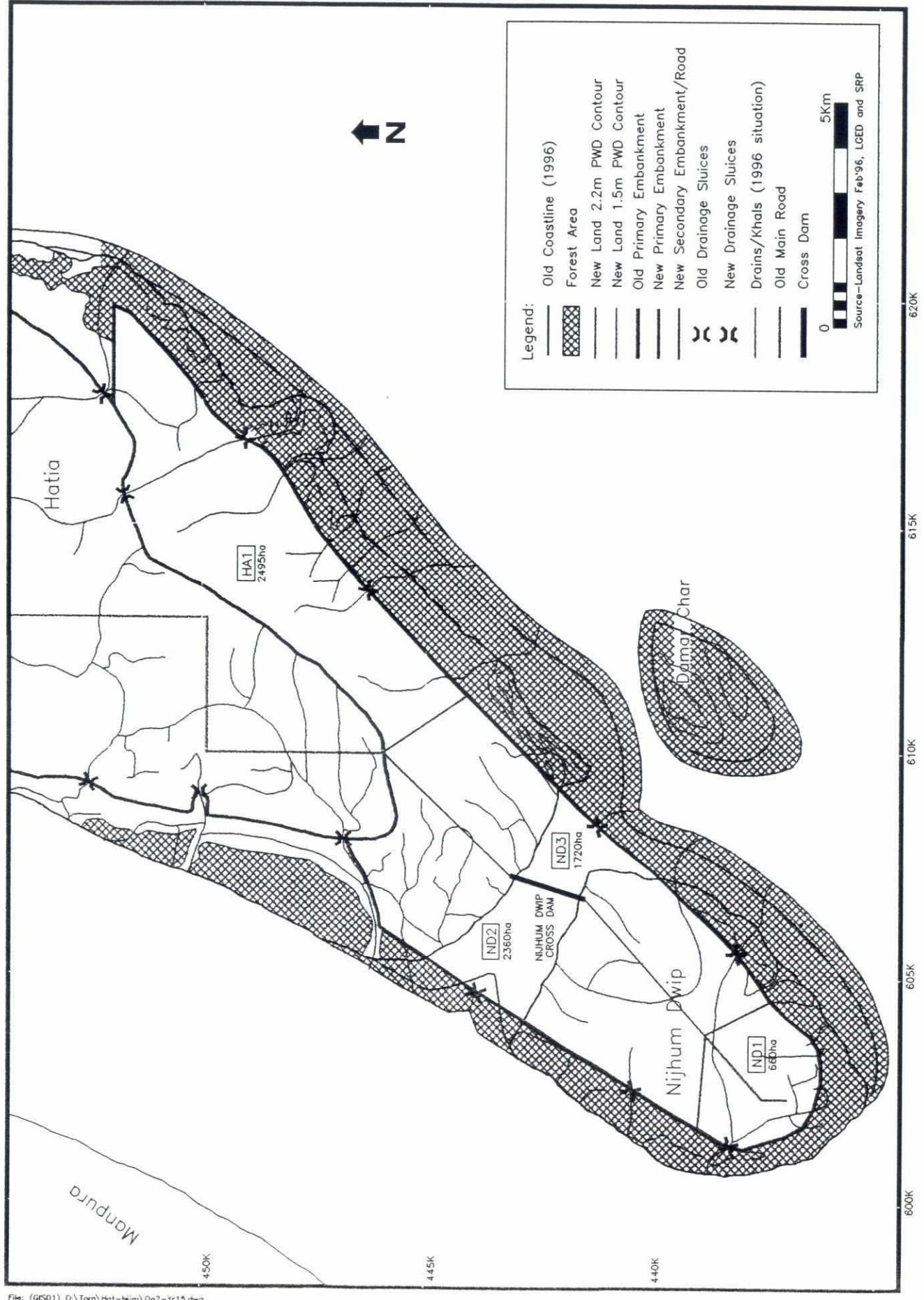
Construction of New Sluices

For the total protected area of 7,235 ha, a total of seven new box culvert drainage sluices are required, applying the drainage criterion explained in Appendix III. The drainage sluices will be equipped with vertical lift gates on the countryside to allow water retention. A typical design for this drainage sluice is shown in Appendix III, Figure III.3.

One drainage sluice (D/S-1) of the new HA-1 compartment will be provided with 2 additional vents to handle also the discharge of an existing sluice DS-37 (2 vents) of polder 73/2.

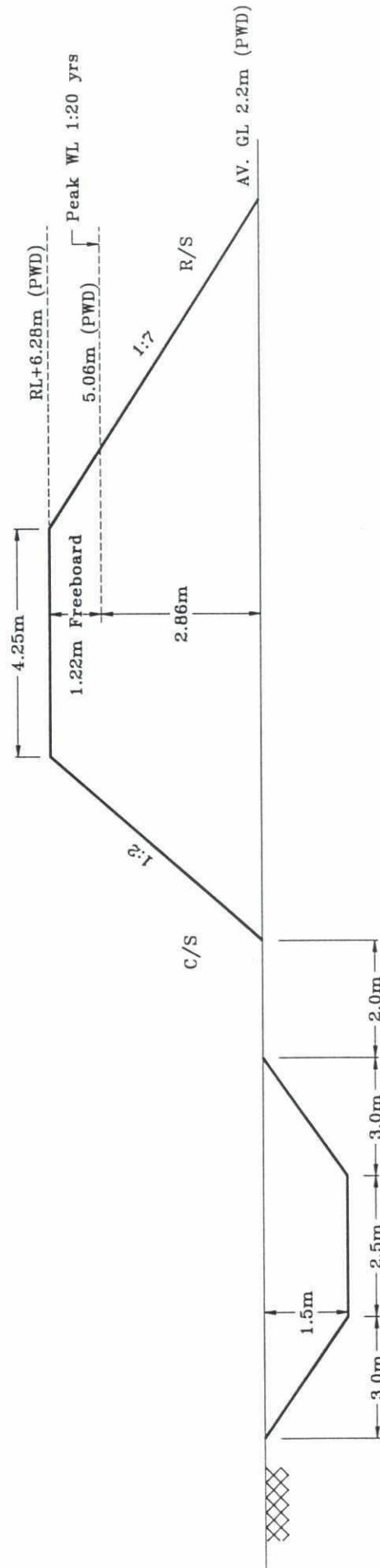
Further, a provision will be made for surface sluices to solve local pockets of drainage congestion near the embankment, on average every 2.5 km. For surface sluices a standard pipe diameter of 1.22 metres will be used with flap gates on the country side and the river side. A typical design of a surface sluice is presented in Appendix III, Figure III.4.

Figure 5.5: Option 2, empoldering after 15 years



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Figure 5.6: Primary embankment with minor drain



(not to scale)

A costs estimate for the required sluices is given in Table 5.5.

Table 5.5: New drainage and surface sluices

Comp. Code	Catchment Area (ha)	Required Sluice Capacity ⁵ (m ²)	Type of Sluice	Quantity	Cost (Tk '000)
ND-1	660	4.40	Box Culvert (1.52x1.83m), 2 vents	1	6,000
			Surface Sluices	2	1,544
HA-1	2,496	16.64	Box Culvert (1.52x1.83m), 3 vent Box	11	9,000
			Culvert (1.52x1.83m), 5 vents(incl. 2 vents for discharge of DS-37)	6	15,000
			Surface Sluices		4,632
ND-2	2,360	15.73	Box Culvert (1.52x1.83m), 3 vents	2	18,000
			Surface Sluices	4	2,888
ND-3	1,720	11.64	Box Culvert (1.52x1.83m), 2 vents	2	12,000
			Surface Sluices	4	2,888
Total					71,952

Re-excavation of primary and secondary drains

Drainage is ensured by a natural system of creeks (khals). A drainage plan for each compartment will be made when accretion is completed. Such a plan will indicate which creeks will form the primary and secondary drains in each compartment.

A minor drain will be constructed along the primary embankments during the construction of these embankments. The function of this drain is to solve the typical drainage congestion along the embankment. Such a drain may also improve the effectiveness of surface and drainage sluices.

To stimulate deep drainage, the depth of primary drains will be kept at a minimum of 2.00metres. A provision for re-excavation of 2.4 km primary drain per 1,000 ha has been made as well as a provision to link drains where required. The estimate of the costs is in Table 5.6.

Table 5.6: Excavation and re-excavation of drains

Compartment Code	Catchment Area (Ha)	LS Cost (Tk '000)
ND-1	660	896
HA-1	2,495	3,358
ND-2	2,360	3,212
ND-3	1,720	2,341
Total		9,807

Construction of rural bridges and culverts

Where roads cross khals which are earmarked as drains in a drainage plan, a culvert or bridge needs to be provided. So far the road network follows hydrological boundaries, without obstructing future drains, hence no bridges and culverts are required. However, a more dense road network of minor roads will be developed over a period of time. It is important to maintain a free, undisturbed flow of surface water through the drainage system. Therefore, road constructing agencies (LGED) and Union Councils should work in close collaboration with BWDB and local representatives of stakeholders to ensure and maintain the drainage capacity of protected land.

⁵ Based on an average drainage ratio of 150 ha/m², see Appendix WM/ND.

Construction of Roads

As mentioned above, no new roads will be constructed at this stage. Maximum use of embankments is made to combine roads and embankments. The only additional cost in this case is a pavement of 12.2 km for the R-1 road on top of the compartment embankment between the compartments ND-2 and ND-3.

Table 5.7: R-1 road pavement

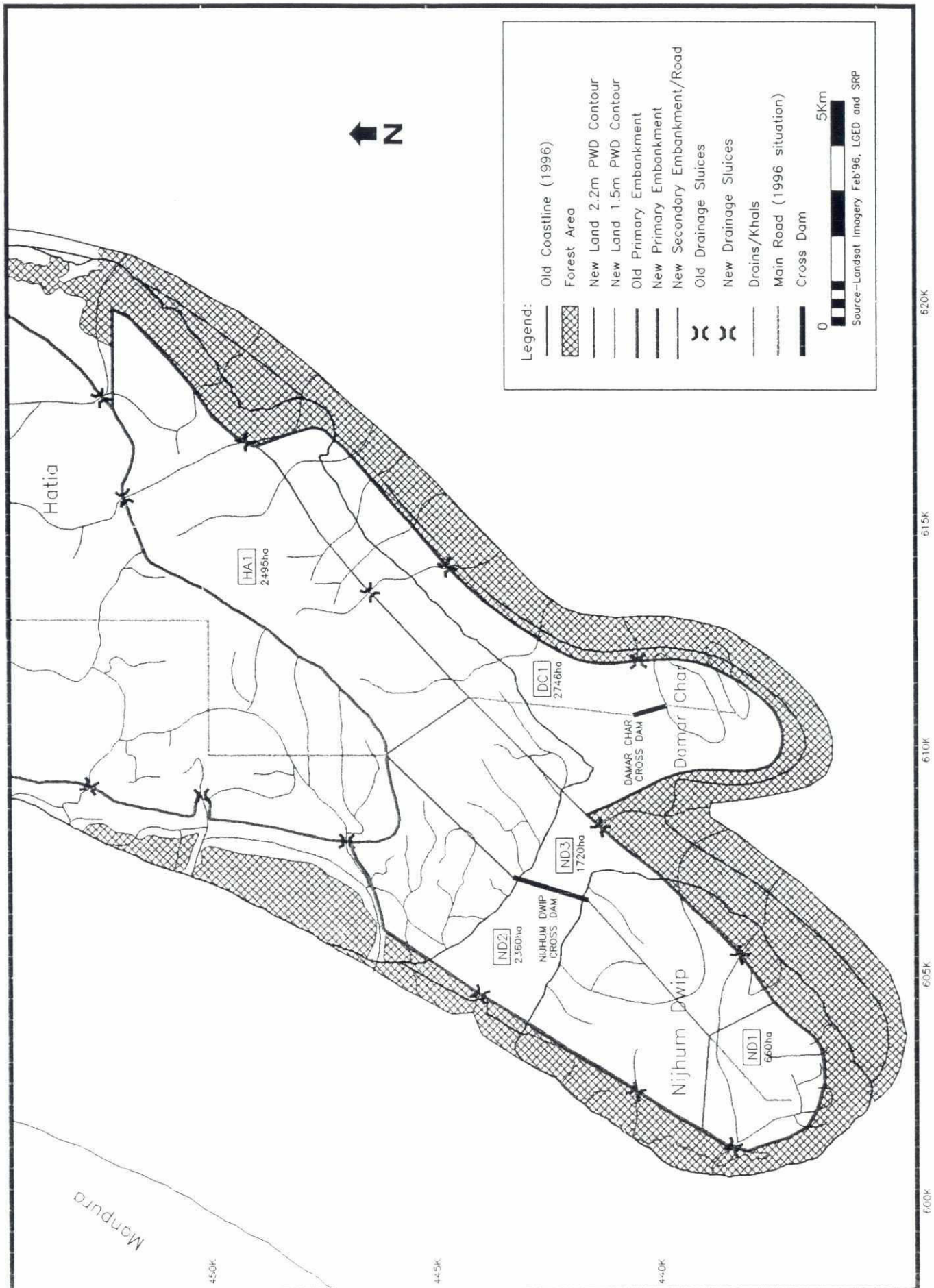
Type of pavement	Rate per Km (Tk '000)	Length (km)	LS Cost (Tk '000)
Herring bone bond bricks	1,043	12.2	12,723
Total			12,723

5.2.2 Option 3: Construction of the Nijhum Dwip - Damar Char cross dam

The construction of a second cross dam to Damar Char is an additional option, which can be treated independently from option 2, only one cross dam. The decision for the Damar Char cross dam will be taken in year five after the construction of the Nijhum Dwip cross dam. New insights gained from detailed hydraulic and morphological studies will play an important role in the decision concerning a second cross dam.

The aim of the Damar Char cross dam is to further stimulate and accelerate accretion in the area. Preliminary predictions about accretion show the possibility of reclaiming another 2,746 ha and the possibility to link Damar char to the mainland of Hatia. A possible result 10 years after the construction of the second cross dam (project year 15) is shown in Figure 5.7.

Figure 5.7: Option 3, empoldering after 15 years



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6. INTEGRATED DEVELOPMENT FOR THE PROJECT AREA

6.1 Development concept

Interventions to promote land accretion, such as the cross dams proposed in this project, generally cannot be shown to be economically feasible because of the long lapse between the intervention (and the investment) and the start of the flow of benefits. Furthermore, because of such problems as soil salinity, low soil fertility and flooding from tides and storms, levels of production initially achieved in newly accreted areas are low.

For this reason, interventions to promote accretion must be included as one component of an integrated package of development measures for a project area. An integrated approach to development, in this context, will aim to maximise the benefits that can be achieved from land accretion. This will be done by such measures as:

- promoting the safety of the population (including the providing of cyclone shelters and killas where appropriate)
- embanking areas to protect against tides and storms when the land has reached an appropriate level
- providing adequate infrastructure for drainage and water management
- providing appropriate infrastructure for transport and communications
- establishing coastal forests as part of the protection system for the local population and to promote the stability of the land
- promoting measures to reduce soil salinity and increase agricultural production
- promoting improved aquaculture and livestock production systems
- supporting the development of villages and village infrastructure
- improving the access of the population to education and health services, where necessary.

For the Nijhum Dwip project area, this integrated approach is followed in order to maximise benefits from the expected land accretion and from the area as a whole.

6.2 Land accretion

The accretion of land with and without the proposed cross dams is discussed in detail in Chapter 2 and Appendix I. The areas expected to accrete for each of the two future with project scenarios are given in Appendix I, Tables I.8 and I.9. These future scenarios or options are designated as follows:

- F1 one cross dam between South Hatia and Nijhum Dwip (constructed in year 1)
F2 two cross dams, between South Hatia and Nijhum Dwip (year 1) and between south Hatia and Damar Char (year 6).

F1 and F2 are future with project scenarios. Tables 6.1a and 6.1b give the areas expected to accrete under each of these intervention options as well as in the future with no intervention, together with an estimate of the availability of land for different purposes.

The incremental areas that will accrete with the project - i.e. the differences between with and without project accretion - are given in Table 6.2. Since it is necessary to assess which of the two future with project options, F1 and F2, is preferred, the difference in accretion between these two options is also given.

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Table 6.1a: Accretion of land for development options

No	Year	F0 = Future without Project - No Cross Dam					F1 = Future with Project - Hatia-Nijhum Dwip Cross Dam				
		Accretion Level (m PWD) 1/		Annual Increments		Cumulative Totals		Annual Increments		Cumulative Totals	
		+1.5	+2.0	Forestry	Agriculture	Fish	Land Use	Forestry	Agriculture	Fish	Land Use
1	2000	91	83	45	27	1		124	396	12	
2	2001	181	166	45	27	2		124	396	12	
3	2002	272	249	45	27	3		123	397	12	
4	2003	363	332	45	27	4		123	397	12	
5	2004	455	416	46	28	5		123	397	12	
6	2005	545	499	45	27	6		182	800	1983	59
7	2006	636	582	45	27	7		182	800	1983	59
8	2007	727	665	45	27	8		182	800	1983	59
9	2008	817	748	45	27	9		182	800	1983	59
10	2009	908	830	45	27	10		182	800	1983	59
11	2010	999	913	45	27	11		147	1967	1983	59
12	2011	1,089	996	45	27	12		147	1967	1983	59
13	2012	1,180	1,079	45	27	13		147	1967	1983	59
14	2013	1,271	1,162	45	27	14		147	1967	1983	59
15	2014	1,363	1,246	46	28	15		147	1967	1983	59
16	2015	1,453	1,329	45	27	16		128	2,014	2,014	60
17	2016	1,544	1,412	45	27	17		128	2,014	2,014	60
18	2017	1,635	1,495	45	27	18		128	2,014	2,014	60
19	2018	1,725	1,578	45	27	19		128	2,014	2,014	60
20	2019	1,817	1,662	46	28	20		128	2,014	2,014	60
21	2020	1,908	1,745	45	27	21		113	2,014	2,014	60
22	2021	1,999	1,828	45	27	22		113	2,014	2,014	60
23	2022	2,089	1,911	45	27	23		113	2,014	2,014	60
24	2023	2,180	1,994	45	27	24		113	2,014	2,014	60
25	2024	2,272	2,078	46	28	25		113	2,014	2,014	60
26	2025	2,363	2,161	45	27	26		99	2,014	2,014	60
27	2026	2,453	2,244	45	27	27		99	2,014	2,014	60
28	2027	2,544	2,327	45	27	28		99	2,014	2,014	60
29	2028	2,635	2,410	45	27	29		99	2,014	2,014	60
30	2029	2,725	2,493	45	27	30		99	2,014	2,014	60

Notes: 1/ Cumulative total accreted to or above indicated level at year end. Derived from 5 yearly accretions in

Annex II, Tables 8 and 9, with interpolation for intervening years.

2/ Agricultural areas are gross areas. The area actually available for cultivation is 80% of gross area to allow for khals, drainage canals and other infrastructure and settlement areas.

3/ Land designated for agriculture may be used for grazing livestock when not in crops.

4/ Future without project, no forest clearing after 15 years.

5/ New fish pond area equal to 3.5% of new, non-forested area at or above +2.2 m PWD.

6/ Minimum forest area on newly accreted land in year 30, for coastal forest margin, approximately 3,000 ha.

Table 6.1b: Accretion of land for development options

Unit: ha.

No	Year	Accretion Level (m PWD) 1/		F2 = Future with Project - 2 Cross Dams				Land Use			Cumulative Totals	
		+ 1.5	+ 2.0	Annual Increments		Forestry		Fish		Fish	Forestry	Agriculture
1	2000	520	434	397	124	396	12	396	12	12	396	12
2	2001	1,040	867	793	124	396	12	248	12	24	792	24
3	2002	1,561	1,301	1,190	123	397	12	372	12	36	1,189	36
4	2003	2,081	1,734	1,586	123	397	12	495	12	48	1,586	48
5	2004	2,601	2,168	1,983	123	397	12	618	12	59	1,983	59
6	2005	2,973	2,451	2,239	372			990		59	1,983	59
7	2006	3,344	2,734	2,494	372			1,361		59	1,983	59
8	2007	3,716	3,018	2,750	372			1,733		59	1,983	59
9	2008	4,087	3,301	3,005	372			2,104		59	1,983	59
10	2009	4,459	3,584	3,261	372			2,476		59	1,983	59
11	2010	4,738	3,799	3,453	279			2,755		59	1,983	59
12	2011	5,018	4,015	3,644	279			3,035		59	1,983	59
13	2012	5,297	4,230	3,836	279			3,314		59	1,983	59
14	2013	5,577	4,446	4,027	279			3,594		59	1,983	59
15	2014	5,856	4,661	4,219	279			3,873		59	1,983	59
16	2015	6,074	4,840	4,380	218	87	3	4,004	3	62	2,070	62
17	2016	6,291	5,019	4,541	218	87	3	4,134	3	65	2,157	65
18	2017	6,509	5,197	4,702	218	86	3	4,266	3	67	2,243	67
19	2018	6,726	5,376	4,863	218	86	3	4,397	3	70	2,329	70
20	2019	6,944	5,555	5,024	218	86	3	4,528	3	72	2,416	72
21	2020	7,114	5,706	5,163	170	260	8	4,439	8	80	2,676	80
22	2021	7,285	5,857	5,302	170	260	8	4,349	8	88	2,936	88
23	2022	7,455	6,009	5,440	170	260	8	4,259	8	96	3,196	96
24	2023	7,626	6,160	5,579	170	260	8	4,170	8	104	3,456	104
25	2024	7,796	6,311	5,718	170	260	8	4,080	8	111	3,716	111
26	2025	7,929	6,439	5,839	133	196	6	4,017	6	117	3,912	117
27	2026	8,062	6,567	5,960	133	196	6	3,955	6	123	4,107	123
28	2027	8,196	6,696	6,080	133	196	6	3,893	6	129	4,303	129
29	2028	8,329	6,824	6,201	133	196	6	3,830	6	135	4,499	135
30	2029	8,462	6,952	6,322	133	196	6	3,768	6	141	4,694	141

Notes: 1/ Cumulative total accreted to or above indicated level at year end. Derived from 5 yearly accretions in Annex II, Tables 8 and 9, with interpolation for intervening years.

2/ Agricultural areas are gross areas. The area actually available for cultivation is 80% of gross area to allow for khals, drainage canals and other infrastructure and settlement areas.

3/ Land designated for agriculture may be used for grazing livestock when not in crops.

4/ Future without project, no forest clearing after 15 years.

5/ New fish pond area equal to 3.5% of new, non-forested area at or above +2.2 m PWD.

6/ Minimum forest area on newly accreted land in year 30, for coastal forest margin, approximately 3,000 ha

Table 6.2: Differences in areas accreting for options 1, 2 and 3

Unit: ha

Year	F1 - F0		F2 - F0		F2 - F1	
	+ 1.5	+ 2.2	+ 1.5	+ 2.2	+ 1.5	+ 2.2
5	2,146	1,642	2,146	1,642	0	0
10	2,602	2,040	3,551	2,580	949	540
15	2,880	2,215	4,493	3,197	1,613	982
20	3,066	2,320	5,127	3,661	2,061	1,341
25	3,175	2,385	5,524	4,014	2,349	1,629
30	3,219	2,421	5,737	4,278	2,518	1,857

Note: Cumulative areas accreting to or above indicated level at year end.

6.3 Land development

Newly accreted land is saline, has low fertility and is usually still subject to frequent flooding from tides and storms. In the MES area it is generally recommended that all newly accreted land be planted in mangroves for an initial 15 year period. Placing the land under forest cover helps to increase stability, promotes further accretion and helps to increase the organic matter content of the soils. After 15 years, the forest can be harvested and the land turned over to agriculture and other activities, except that the mangrove forest is an important element in the cyclone protection system for these char areas and a minimum forest depth of 1 km all around the coasts of the islands should be retained permanently.

This is the principal sequence for land development in the area. However, in the case of the Nijhum Dwip project area several modifications are proposed. The development sequence for new land in the with project options is as follows:

- because of the very rapid accretion in the years immediately after the installation of the first cross dam, all land accreting to +2.2 m PWD by the end of year 5 will go directly to agricultural use, except for the area at the western end of the existing channel between south Hatia and Nijhum Dwip which must be planted in forest to establish a protective belt in this area;
- all other land is planted in mangroves as it accretes and is left in forest for 15 years;
- starting in year 16, new land that has been in forest for 15 years may be cleared, provided always that a minimum 1 km depth of mangrove forest is retained along all coasts at all times;
- existing forest that will be inside new embankments proposed under the project will be cleared for agriculture
- land not in forest and not under cultivation may be used for the grazing of livestock - this includes cultivated land when it is not under crops;
- based on the current situation in the area, fish ponds are assumed to occupy 3 per cent of gross agricultural area.

6.4 Development strategy

The strategy to be adopted for the development of the existing and future land in the project area will focus on:

- promoting land use appropriate to the stages of land accretion and the development new land
- providing support for income generating activities

- promoting more effective delivery systems for government services.

6.5 Needs assessment

A needs assessment was carried out on Nijhum Dwip (two areas) and in areas outside and inside the embankment on south Hatia. Overall, the highest priorities of the people in the area are accretion of more land, the construction of embankments and the establishment of new cluster settlements. Health, sanitation and cyclone shelters also rank highly. For those on south Hatia, the construction of access roads was also a relatively high priority (see Appendix IV.4, Tables IV.4.41 and IV.4.42).

The rankings are evaluated by location of respondent and by social group. While there are minor variations among the groups, there is a notable consistency of ranking regardless of group. The interventions proposed for the project are consonant with the needs expressed by beneficiaries in this assessment.

6.6 Project interventions

In addition to the physical interventions described in Chapter 5, a number of other interventions are proposed to support productive activities in the project area.

6.6.1 Safety of the population

The improved safety and security of the population is a major objective of the MES project. The embankments proposed for construction as part of the Nijhum Dwip Integrated Development Project will be the principal measure for increasing the safety of the population. It is not proposed to construct more cyclone shelters or killas under the project as any additional requirements are expected to be met from other government and NGO projects.

6.6.2 Fishing ghat

The existing fishing ghat at the southern end of Hatia Island will no longer be usable once the cross dam between south Hatia and Nijhum Dwip is constructed as this area will silt up quite rapidly. The fishing ghat will have to be moved. Since investments in the existing ghat are minimal and the ghat has no official sanction, no compensation is provided for. It is expected that the operators of the ghat will move to a new location of their own accord. There should be liaison with the ghat operators so that they are informed of the expected consequences of cross dam construction. It might also be suggested that a location on the west coast of south Hatia would be least likely to be disrupted in the coming years by further accretion of land.

6.6.3 Roads and transport

As discussed in Chapter 5.2, provision has been made for all embankments constructed under the project to carry roads along their crests. The embankments will then become part of the growing road network in the project area. This road network will have a positive impact, not only on the safety and security of the population, but also on all types of economic activity. By improving access to markets for inputs and outputs, roads will especially benefit agricultural production.

6.6.4 Settlements

New agricultural land in the project area, whether from newly accreted land or from the clearing of existing forest will first be allocated to landless families already in the area. According to BBS census data for 1991, 63 per cent of households in the area are landless. This will amount to some 2,400 households in 2000, the assumed starting year of the project. These households, although they have no land, do have homesteads and it is therefore assumed that settlement activities for these households will not be required. Settlements will be required for households

moved into the area from outside to settle on surplus land. The estimate of the number of households for which land will be available is based on the following assumptions:

- existing cultivated land in the project area is all occupied and not available for redistribution
- cultivated area is estimated at 80 per cent of gross non-forested area
- land available for allocation to households goes first to landless households already living in the project area
- available land is allocated at the rate of 0.8 ha of cultivable land per household
- settlements are only constructed inside the future embankments.

Furthermore, only land available by the end of year 6 is considered for inclusion in possible settlements under the project. This includes all land that will be inside the proposed polders (for both the F1 and F2 scenarios) and land available in future outside the embankments will not be ready for agriculture and settlement in significant amounts until about year 20 of the project. The estimate of the number of households that may be settled in the project area is as follows:

Table 6.3: Estimate of settlement requirements

Net Cultivated land available in polders in year 6	ha	5,027
Cultivated area belonging to existing population	ha	2,432
Compensation for forestation, south Nijhum Dwip	ha	338
Total area for allocation	ha	2,257
Estimated households in 2000	HH	4,000
Of which, landless households (60 per cent)	HH	2,400
Land for project area landless households	ha	1,920
Land available for non-project area households	ha	337
Number of settler households	HH	421

Cluster settlements will be constructed for these new settler households, including housing, ponds, water supply and sanitation and access roads, if needed. The exact location of settlements and the precise model to be used for their development can be decided by year 4 of the project.

6.6.5 Agriculture

The most important project interventions aimed at improving agricultural production will be the rehabilitation and construction of embankments and the associated drainage infrastructure. The main impact of establishment of an embankment and drainage systems is that the tidal inundation with saline water is terminated and the process of desalinisation will take place during the monsoon season when the high rainfall will leach the salt from the soil. After establishment or rehabilitation of the embankment and the drainage system the main benefits for the empoldered area will be:

- reduced risk of damage from saline intrusion
- reduced risk of damage from flooding during high tides or cyclones
- improved water management.

Specific support for the improvement of agricultural production is not proposed under the project. Rather as salinity declines over the years it will be possible for the farmers to grow higher yielding less salt tolerant varieties of rice and to gradually expand the area of Rabi crops. Rehabilitation and construction of embankments and the drainage system will also reduce the frequent losses due to

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either saline intrusion or water logging. Improved water management might also provide a source, however limited, of water for irrigation during the Rabi season.

Although soil salinity and cyclone damage are the major problems for farming development, attention should also be given to other constraints for farming. At present the availability of seed, fertiliser and pesticides is low and the extension service is inadequate with too few extension officers who have a generally low level of training. Due to the remoteness of the area there is limited access to markets or larger trade centres. Problems of crop losses caused by pests, loss of animals due to diseases and low health status, lack of appropriate credit facilities, land use conflicts, insecure land tenure, market access and low income generation are other problems that have been reported in surveys and observations from the field.

Integrated pest management, homestead development and programmes for women, micro-credit support, income generating activities, livestock fodder development and special focused agricultural research to address problems identified during the MES surveys could be relevant components of an integrated char development project but have not been included in this feasibility study.

It is also important to note that development of subsistence level farming often is a slow process with a relatively low rate of adoption of 'improved' methods. Farming systems in the coastal chars and islands of MES area are adapted to the high risk of crop damage by flooding, salinity and pest attack and the general low level of resources. Change of practice might provide potentially higher yields, but might also involve higher risks. Crops and animals often have a multipurpose use. Therefore, a change of practice might have wider consequences than initially expected. A typical example is the lack of straw particularly for fodder in some areas in Bangladesh as a result of the introduction of HYVs which produce higher grain yield but only small amounts of straw. Introduction of methods or varieties that produce a higher yield from an individual crop might reduce production of other crops. HYVs require higher levels of inputs which might represent too high a risk for the resource-poor farmer, or the farmer might not have the resources or credit to purchase fertiliser to obtain the potential higher yields.

Establishment and rehabilitation of embankments and drainage systems provides the basis for the development of the farming system. Farmers will benefit from the improvements to the extent that their resources allow. An integrated farming system development programme focused on the needs of the farm household and an improved management of the resources will enable farmers to benefit to a higher extent from the improved farming conditions. Such a programme for the estuary area should be within the responsibility of the relevant ministries and is, however, beyond the scope of the feasibility study.

6.6.6 Fisheries

Project interventions in the fisheries sector are restricted to the promotion and upgrading of production in existing and new ponds. There are no activities for the marine fisheries sector.

Experience elsewhere in Bangladesh has indicated that a major bottleneck for the development of carp rearing and the overcoming of the relatively low production rates is poor management, caused by lack of knowledge on the part of the pond owners and operators. A carp rearing development programme and extension programme should include the existing cultured, culturable ponds as well as any new ponds in the accreted land.

Carp culture is a well known activity in Bangladesh and therefore the husbandry techniques are not further described.

The present production rate in the area of around 825 kg/ha/year for cultured ponds can be increased to an average of about 2,000 kg/ha/year if proper husbandry techniques are applied. This production rate will be less than the average of 2,200 kg/ha/year obtained elsewhere in Bangladesh due to the physical properties of soil and water in the coastal area. Increasing the production of existing ponds and introduction of carp rearing in the newly accreted land can

only be achieved if an aquaculture extension programme is carried out in the project area. The present and future yields that can be achieved as a result of the proposed aquaculture extension programme are summarised in Table 6.4.

Table 6.4: Present and future aquaculture yields

	Carp		Unit: kg/ha
	Culturable Ponds	Cultured Ponds	Shrimp
present & without project	250	800 - 825	130
with project	-	2,000	400

The basis of an aquaculture development programme is the transfer of knowledge through extension officers. Experience in FAP 20 indicates that the availability of credit is not a prerequisite for a successful programme. Interested pond owners and operators are given a basic training after which the extension officer visits each pond operator once a month at the pond site and provides further on site training. Experience with similar programmes in Bangladesh (FAP 20, MAEP) indicate that one extension officer can cover 60 ponds (12 ha) per year and that it takes two years to bring the pond to the proposed production level of 2000 kg/ha/year.

The costs of a 5 year aquaculture extension programme are presented in Table 6.5. This programme should be implemented through a suitably qualified and experienced NGO.

Table 6.5: Cost for aquaculture development programme

Operating Costs		No./Unit Cost	Monthly Tk	Annual Tk
Extension officers		3	9,000	360,000
Supporting staff		1	7,000	84,000
Administration		1	9,000	72,000
Petrol	litres	35	3,675	44,000
Training	lump sum	60,000		60,000
Logistic support/office	lump sum	125,000		125,000
Office costs	lump sum	185,000		185,000
annual fish fortnight	lump sum	10,000		10,000
Miscellaneous + O&M (15%)				94,000
TOTAL				1,034,000
Equipment (for 5 years)				
Motor cycles	No.	4		616,000
Training material	lump sum			44,000
Office equipment	lump sum			220,000
Miscellaneous (10%)				88,000
TOTAL				968,000
Total Cost (5 year Programme)				6,138,000

Shrimp culture

A major bottleneck of shrimp farming at present is the ravaging impact of the White Spot disease which has reduced production levels and the average size of shrimps produced. Future development of shrimp production will only be possible when the present non-sustainability of shrimp farming is overcome through the production of pathogen free post-larvae. Nevertheless, it is proposed to include shrimp production in the aquaculture programme, although for only a

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limited number of ponds. Provided the current disease problem is overcome, yields can be increased from 130 kg/ha to 400 kg/ha.

6.6.7 Livestock

The project area has good potential for livestock development, for cattle and goats as well as for poultry. The further development of livestock production in the area, however, will depend upon improved safety and security for animals, in the form of killas or embankments where livestock can be kept during floods and cyclones, as well as on improved access to markets as the remoteness of the area is a serious constraint to the development of production. Without these, the risks of loss may outweigh any incentives to invest in this sector.

To promote livestock development in the area, a two part programme is proposed that will:

- provide general training for livestock owners in improved husbandry methods, improved animal health and other topics
- provide intensive training and credit for selected farmers wishing to adopt a more intensive approach to livestock production.

The second part of this programme will provide for the development of more intensive methods of raising and managing draft cattle, milch cows, beef cattle, goats and chickens (either for egg or broiler production). The programme should be implemented by a suitably qualified and experienced NGO working in co-operation with DLS.

Service delivery for the livestock sector would be improved through a participatory approach. Interested youths, nominated by their communities, would be trained as Livestock Field Workers (LFW). The LFW would reside in his own community and would earn his livelihood through selling his services to the community and maintaining liaison with DLS and other input suppliers. The LFW would also act as a model livestock operator, would assist with demonstrations and support livestock activities taken up by the farmers with credit support. The LFW in co-operation with DLS field staff would vaccinate animals against prevalent diseases and offer basic veterinary services.

Similarly, for poultry development, Women Poultry Workers would be trained to work within their communities advising women on improved husbandry practices and providing vaccination services for chickens and ducks. The WPW would also be a model poultry operator, would assist with demonstrations and support poultry activities taken up with credit support. Where practicable, destitute women would be selected for this training.

The implementing NGO would arrange training and support for the LFWs and the WPWs in co-operation with DLS. The DLS would support with continuous training facilities in the Thana Veterinary Hospital to improve skills and with inputs free of cost or at cost price as made available by the Government on a priority basis. The project would assist in the establishment of demonstration farms with improved animals and chickens. The farmers participating in project activities will be expected to bear the cost of inputs and the services of LFW and WPW so as to avoid any dependency culture for free inputs and services.

The LFW and WPW will be trained so that they are able to provide advice on feeds and feeding, preservation of crop residues, green grass and crop by-products for fodder during lean months and inclement periods. They are also expected to maintain close collaboration with the DLS for routine disease surveillance, preservation and dispatch of samples for laboratory diagnosis and to call on expert services needed from the DLS from time to time by the farmers of the area.

The LFW at a later stage may be encouraged to maintain a good quality breeding bull to improve the milk production potential of cattle or buffaloes. The farmers would be encouraged to pay for the bull's services and maintenance of the bull. Similarly destitute women may be encouraged to rear good quality breeding bucks and charge for the coverage to the farmers.

The NGO, together with the LFWs and WPWs will also explore the opportunities in the area for feasible activities such as mini-milk processing and marketing and the marketing of eggs, chicken and other livestock products.

Livestock Credit Projects

In addition to the training and demonstration activities aimed at all livestock operators, the programme would provide specific training and support to men and women interested in taking up more intensive livestock and poultry production activities with credit support. Training on improved management and health care should be provided to the selected farmers prior to the provision of credit. Monitoring and follow up support would be provided through the implementing NGO and its staff. Liaison with the local Livestock Officer would be maintained for speedy and effective solution of any problems of general importance.

The total cost of the Livestock Programme is estimated to be Tk 4.4 million over 5 years (see Table 6.6). In addition, the credit requirements of the initial five year programme will be part of project funding and amount to an estimated Tk 3.2 million.

Table 6.6: Estimate of cost for livestock development programme

Item	No.	Monthly/Unit Cost	Annual Cost	Total Cost
Extension Officers	2	18,000	216,000	1,080,000
Support/Admin. Staff	2	14,000	168,000	840,000
Logistics Support & Office			250,000	1,250,000
Fuel		2,450	29,400	147,000
Training for Farmers	100	200	20,000	100,000
Demonstrations	12	5,000	60,000	300,000
Training for LFWs	3	3,000	9,000	45,000
Training for WPWs	5	1,500	7,500	37,500
Field Equipment for WPWs	5	1,000	5,000	25,000
Bicycles for LFWs	3	4,000	12,000	60,000
Materials & Equipment				
Motorcycles	2	154,000		308,000
Training Materials				30,000
Office Equipment				200,000
TOTAL (Five Year Programme)				4,422,500

The credit programme would have the capacity to assist 400 livestock owners during its initial five year period (Table 6.7). Loan funds will be recycled when loans are repaid by livestock operator borrowers, allowing more livestock owners to participate in the programme. This should provide the financial basis for an on-going livestock support programme in the project area.

Table 6.7: Credit requirements - annual additions during project years

Type of Project	Unit Cost (Tk)	Number of Additional Units in each Year					Total
		1	2	3	4	5	
Draft Cattle	15,000	6	9	9	12	12	720,000
Milch Cow	6,300	6	9	9	12	12	302,400
Beef Fattening	9,500	12	12	18	24	24	855,000
Goat Fattening	5,000	12	12	18	24	24	450,000
Goat Rearing	3,000	12	12	18	24	24	270,000
Chickens - layers	18,000	4	4	5	5	6	432,000
Chickens - broilers	5,100	4	4	5	5	6	122,400
Annual Credit Input		430,200	494,100	622,200	791,100	814,200	3,151,800

6.6.8 Forestry

Afforestation on newly accreted land is an important component of the proposed project activities. Mangrove forests have important functions in the char lands:

- they are an important component in the protection system surrounding these islands, moderating wave action during storms;
- they provide fuel wood (and eventually timber) for the population and forage for livestock
- they promote further land accretion and help to stabilise newly accreted land
- they improve the organic matter content of newly accreted soils.

The principal pioneer species planted on the chars is Keora, which reaches maturity after 15 years and harvesting is then possible. (After this time it needs to be replaced, often by other species.)

The forestry strategy for the Nijhum Dwip project takes into account experience with mangrove forests elsewhere in the estuary area. The steps in the strategy are stated in section 6.3, above.

The implementation of this strategy, in particular the clearing of forest after 15 years, will require a firm policy commitment on the part of government and effective co-ordination between the Ministry of Lands and the Forest Department.

The project has proposed the construction of new embankments on South Hatia and Nijhum Dwip. Since the embankments will halt tidal intrusions, any existing mangrove forest inside the new polders will have to be cleared or the species will have to be changed. The project proposes the clearance of these areas to make way for agricultural production. These forests will, in effect, be replaced by new forested areas on newly accreted land. With the construction of one cross dam, the total net new forest area after 30 years (i.e. excluding existing forest that will not be cleared) will be 1.5 times greater than the existing forest area proposed for clearing from inside new polders (see Table 7.9).

Specific forest interventions under the project include:

- afforestation of the western coastal area between South Hatia and Nijhum Dwip (from year 1)

- afforestation of the southern coast of Nijhum Dwip to provide a protective barrier for the population and clearing an equivalent area of the existing forest for households currently cultivating the areas to be forested (year 1 and 2)
- clearing existing forest inside the new polder on the eastern side of South Hatia (year 1 and 2)
- afforestation of all areas reaching +1.5 m PWD except the central, rapidly accreting area mentioned above (from year 1)
- clearing of forest inside the new polder on Nijhum Dwip (years 5 and 6)
- clearing forest outside the embankments provided it is at least 15 years old and a coastal forest margin of at least 1 km is maintained at all times (from year 10).

Clearing forest generates revenue from the sale of timber and fuel wood. The thinning of new forest after 8 years also generates a small amount of revenue. Because of the combination of clearing of existing forest inside polders and planting new forest on newly accreted land, the forestry activities proposed for the project are expected to be self-financing (see Appendix VI, Table VI.27).

6.7 Integrated water management

6.7.1 Project formulation and planning

In the case of major interventions such as cross dams and empoldering, the participation of the local population and local organisations is a pre-requisite. In project planning, the following steps are distinguished; a) needs assessment, b) preliminary design, c) impact assessment; d) (pre-)feasibility study and e) detailed design.

The construction of a cross dam and empoldering of new land will have a strong impact on water management. To ensure that the infrastructure fulfils the needs expressed as well as the sustainability and proper use of the infrastructure, participation of the local population and organisations is required. In 1997-1998 SRP developed a methodology named Rapid Water Management Appraisal (RWMA) for ascertaining the needs and opinions of local participants.

Needs assessments have been carried out by the MES team during the study. Preliminary designs have been made along with impact assessments and their feasibility has been studied. However, due to delays in the collection and processing of hydraulic and morphological data, the formulation of the MES master plan has been delayed. Finalisation of the formulation of possible major interventions for Nijhum Dwip and south Hatia took place at the end of the MES study. At this stage, too little time was left for a RWMA and a more thorough consultation of the local population and organisations on interventions proposed in this feasibility study. It is therefore recommended to undertake consultation and a RWMA before final and detailed design studies are carried out.

During the planning process of cross dams and polders consultation took place with the local population and local organisations. In the future, the following representatives and organisations should be consulted (anticipating the new GPP):

- a) Thana Development Co-ordination Committee (TDCC). Possible conflicts with existing land and water use plans and practices, potential inter-agency conflicts and co-ordination will be discussed in these committees. The TDCC should be kept informed about the progress and outcome of the study.
- b) Project Committee (PC). In the case of MES, no project committee has been established. It is recommended to set up such a committee to assist further studies. The PC will comprise locally elected representatives such as the Union Parishad members and chairmen, who

represent the interest of all stakeholders. The PC should ensure that all stakeholders are heard and are represented in the final need assessments and RWMA. The PC will decide for or against a final proposal for the construction of cross dams and empolderment and their decision may be binding.

- c) After the identification of stakeholders, consultation of stakeholders can take place at Parishad or Gram level. The main function is to hear the opinion of the various stakeholders such as farmers, fishermen, boat owners, traders, town dwellers etc. about their needs and comments on proposed interventions.

6.7.2 Participation in water management

Effective drainage, operation and maintenance programmes require the involvement and co-operation of stakeholders and other relevant organisations. Issues that need to be addressed include, for example:

- what will be considered a primary or secondary drain?
- what will be the policy regarding fishing in main drains and near sluices?
- which drainage channels should remain accessible for country boats?
- when should sluices be opened and closed?
- what are the target water levels for drains? What will be the yearly routine and periodic maintenance programme,
- what will be the amount for a flood protection fee (local cost recovery)?

All these questions are related to water management, but cannot be answered by BWDB only. The involvement of stakeholders, local government bodies like DOF, LGED and also NGOs is required.

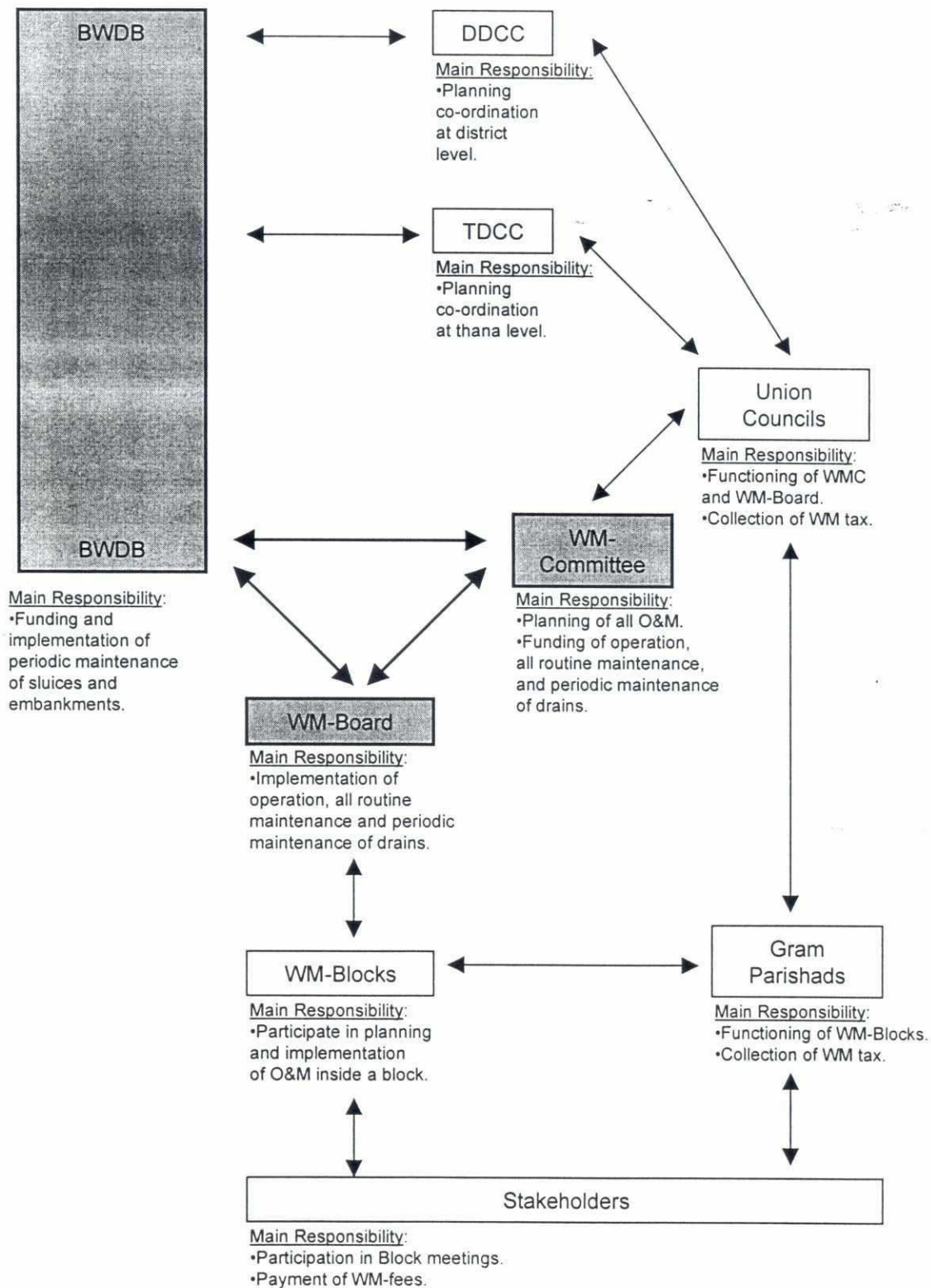
Water management of the four new compartments, HA-1, ND-1, 2 and 3, cannot be dealt with in isolation. These compartments will form part of polder 73/2 and management of these compartments will therefore be part of the water management of polder 73/2.

To involve stakeholders and to ensure representation of the interest groups, the organisation of stakeholders such as farmers, fishermen, boat owners, traders etc. is needed. Experience with the present GPP, which focuses more on irrigation projects, has not always been successful. Recent national workshops on people's participation in water management have revealed a number of shortcomings of the present GPP concerning FCD schemes, such as polders. Other water user groups, committees and associations created under the present GPP have no decision and formal power and are rather inactive. Polder Councils depend on the (low level) willingness and resources of TNOs and other GOB officials. Moreover, the present institutional set-up for water management ignores the role of local elected government bodies and existing co-ordination committees such as the DDCC and TDCC. The BWDB's role under the current GPP, is more than engineering only, but is (unfortunately) not sufficiently understood by BWDB officers.

As mentioned earlier, under SRP water management institutions such as a Project Council, Water User Association, Water User Committees and Groups, in line with the present GPP could not be formed in polder 73/2. Anticipating past experiences and expected changes in the GPP, it is recommended to propose a new institutional set-up for water management in polder 73/2.

In line with the most likely modifications of the GPP, it is envisaged that water management will involve three important parties, a) BWDB, b) the so called Water Management Committee (WMC) and c) the Stakeholder's Organisation of which the local Water Management Board (WM-Board) is the most relevant. Figure 6.1 shows an institutional framework. This set-up, which is subject to approval of the new GPP, may prove to be workable and capable of dealing with issues related to water management.

Figure 6.1 : Institutional Framework for Water Management in Polders



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The role of the Hatia O&M Subdivision for polder 73/2 will be mainly limited to planning and implementation of periodic maintenance of embankments and sluices, involving stakeholders and local government representatives. Further, BWDB will participate in the Hatia Thana and Noakhali District level Co-ordination Committee to discuss issues related to maintenance in the context of overall land and water use.

Polder 73/2 encompasses three Unions, Jahajmara, Sonadia and Burir Char. The new Water Management Committee (WMC) will comprise local politicians and advisers. In the case of polder 73/2, a WMC at multiple union level will be sufficient. One of the Union Chairmen will be the chairman of the new WMC. The Union Chairmen in consultation with the Gram Parishad Chairmen will appoint the advisers of this committee. The role of the WMC is basically limited to planning and decision making in operation and maintenance, arbitration in water management conflicts, cost recovery, the formulation of an annual and seasonal water management plan for the polder and defining the function of infrastructure in the context of a land and water use plan.

The stakeholders will be organised in two tiers only. In the case of polder 73/2, one tier will be at block level, named Water Management Block (WM-Block) and a second tier at polder level, the Water Management Board (WM-Board). The blocks are areas that can be considered a hydrological unit. In the case of compartments, each compartment will be a block. Where compartments do not exist, blocks may be defined by the earlier mentioned RWMA. The members of the WM-Board are proposed by the Blocks, but are subject to approval by the WMC. The members of the WM-Board are the chief executives of O&M and will receive remuneration and a (modest) office facility from the Union Council.

WMC, BWDB, WM-Blocks and the WM-Board will meet seasonally and annually. O&M plans and budgets will be prepared and finalised with participation of the stakeholders and implemented by the BWDB (periodical maintenance) and WM-Board (operation and routine maintenance).

It is expected that the present GPP idea of a "Project Council" or "Polder Council" will be discontinued under the new GPP. The TDCC is the most appropriate platform to co-ordinate the inter-linked activities of BWDB, LGED, DOF and DAE and other GOs and NGOs. In the already existing TDCC, a water management plan will be presented by the WMC. After discussion of eventual consequences, the plan will be endorsed by the TDCC. The water management plan should be in line with a land and water use plan of the TDCC (if any such plan exists).

The institutional framework for water management as described above will be subject to a final version of a revised GPP, which is expected to become effective in 1999.

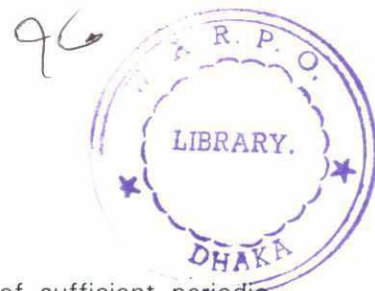
6.7.3 Management, operation & maintenance

The WMC will formulate an operation plan that describes water level targets to be met in drainage channels on a monthly basis and a set of instructions for the operation of sluices. The WM-Board will appoint a sluice operator and ensure the daily operation of sluices and monitor the water levels in the drainage channels through gauge readers.

BWDB has to build up skills and experience in preparing a sound periodic maintenance plan. Based on an inventory of the hydraulic infrastructure and period maintenance criteria, a periodic maintenance plan can be prepared and implemented. Periodic maintenance plans are based on actual field inspections, surveys and needs expressed by the WM-Blocks and WM-Board. The periodic maintenance plan requires approval from the WMC.

Based on the operation plan and formulated targets, financial and physical indicators need to be identified and data will be collected and used to evaluate the yearly performance of polder 73/2, including the four compartments. This will be a task of the WMC.

The implementation of an O&M programme requires the regular presence of a SDE of BWDB, trained in periodic maintenance planning, budgeting, implementation and monitoring.



6.7.4 O&M budget

One of the conditions for successful implementation is the availability of sufficient periodic maintenance funds under the heading "works" of the revenue budget allocated to BWDB. (This should be about 1 to 2 per cent of the estimated new price of the infrastructure.) Stakeholders such as landowners, farmers, fishermen, house owners, shopkeepers and traders will pay a (small) water management fee. This fee should cover the budget requirement for the implementation of a routine maintenance plan for sluices and embankments as well as the routine and periodic maintenance plan for drains. It should also cover establishment costs such as the remuneration of WM-Board members and their employees such as sluice operators and gauge readers. The Union Council through their local tax system will be entitled to collect a water management fee. BWDB will continue to provide funds for periodic and emergency maintenance as well as their own establishment.

6.7.5 Involvement of landless and destitute women

Routine maintenance can be carried out by Embankment Maintenance Groups (EMG) and Channel Maintenance Groups (CMG) consisting of destitute women and landless, eventually supported by NGOs. Funds will be provided by the Union Council. For periodic maintenance on embankments, BWDB will employ local Labour Contracting Societies (LCS), which has the status of D Class contractor.

There is no guarantee that with the above described institutional set-up O&M will improve. However, transparency and accountability are clearly increased. Moreover, the physical safety has now become the shared responsibility of the local population, local Government, and BWDB.

7. IMPACT OF THE PROJECT

7.1 Physical infrastructure

The major impacts of the project will result directly from the physical infrastructure to be constructed, including:

- either one or two cross dams, depending on project option;
- 55 km of new embankments, all of which will be designed to accommodate roads along their crests;
- 12.2 km of other roads.

The cross dams will result in the accretion of large amounts of new land which can be used for forestry, agriculture and grazing. The predicted accretion is summarised in Table 7.1, which shows the total areas expected to accrete to or above particular levels for given years (see also Chapter 2).

Table 7.1: Accretion of land with the project

unit: ha.

Year	F1: One Cross Dam			F2: Two Cross Dams		
	+ 1.5	+ 2.0	+ 2.2	+ 1.5	+ 2.0	+ 2.2
5	2,601	2,168	1,983	2,601	2,168	1,983
10	3,510	2,940	2,721	4,459	3,584	3,261
15	4,243	3,510	3,237	5,856	4,661	4,219
20	4,883	4,010	3,683	6,944	5,555	5,024
25	5,447	4,465	4,089	7,796	6,311	5,718
30	5,944	4,883	4,465	8,462	6,952	6,322

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The proposed embankments will increase the security of the population living in the area and will lead to improved conditions for agriculture and the raising of livestock.

Although designed to carry roads eventually, there will initially be no hard surface roads on the embankments. Nonetheless, access along the embankments, together with the proposed south Hatia - Nijhum Dwip road will contribute to productive activities by facilitating access to local and thana level markets. Roads will also facilitate access to education and health services, facilitate the provision of other government services and allow people to move more easily to safety when there are cyclones.

7.2 Social infrastructure

The project will construct an estimated 15 cluster settlements for 450 households: the number is the same for both future with project options since additional settlement opportunities that may be created by construction of the second cross dam will be relatively far in the future. These settlements will be for households from outside the project area who will be settled on land that is surplus after landless households already in the area have been allocated land.

The project will have no other direct impact on social infrastructure, but as already noted, the construction of a basic road network will facilitate access to social services for all households living in the area.

7.3 Water management

Improved physical safety

The interventions and development activities implemented under water management will apply the prevailing design standards for primary and secondary protection of polder areas. The expected impact will be improved and more sustainable physical safety.

Reduced drainage congestion

A second impact is the reduction of drainage congestion. This will create more favourable conditions for the improvement of crop production, such as the introduction of HYV Aman rice varieties, the introduction of a second, Aus, rice crop and production of Rabi crops.

Reduction of soil salinity

Proper operation of drainage sluices and improved protection from resalinisation by intrusion of saline floods will allow, although slowly, a further reduction of soil salinity levels.

Improved internal transport

Water management will increase accessibility of the polder area. Compartment and sea embankments form flood free roads. Open main and secondary drains, provided with low cost bridges (steel structure), will form a reliable and cheap opportunity for farmers to transport of farm inputs and outputs.

7.4 Agriculture

Implementation of the project will lead to a significant increase in the land available for agriculture in the project area and over time there will be gradually rising yields and cropping intensities as salinity declines and security from storm and other damage increases.

7.4.1 Land area

The existing land available for agriculture in the project area is estimated at 80 per cent of the gross non-forested land above +2.2 m PWD. The proportion not included covers homestead

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areas, khals, drainage canals and other non-cultivated areas. With the project, existing forest areas inside new polders will be cleared for agriculture and some newly accreted land also becomes available. Net areas available for agriculture are given in Table 7.2.

Table 7.2: Net areas available for agriculture

Source	unit: ha		
	F0	F1	F2
Existing agricultural land	3,490	3,490	3,490
New, from forest (net)	-	2,309	2,309
Newly accreted land	654	1,768	3,485
	4,144	7,567	9,284

Source: Appendix VI, Table VI.1

In the F0 case, it is assumed that 40 per cent of newly accreted land reaching the +2.2 m PWD level will be available for agriculture. If either one or two cross dams are constructed, all land between South Hatia and Nijhum Dwip accreting to +2.2 m PWD by the end of year 5 is assumed to be assigned directly to agriculture - the gross area is 1,011 ha. In addition, in the case of one cross dam (F1), 25 per cent of newly forested land is cleared for agriculture after 15 years and for two cross dams (F2), 70 per cent of such land is cleared for agriculture. The proportion that can be cleared for agriculture is limited by the requirement to maintain a 1 km coastal forest margin at all times.

Crop yields

Crops yields in the project area are low because of the saline conditions and low nitrogen levels. With improved conditions as a result of project implementation, yields will rise slowly, partly as a result of changes to non-salt tolerant varieties and partly as a result of more secure conditions. The changes in crop yields for major crops, expected as a result of the project, are given in Table 7.3. Crop budgets are given in Appendix VI, Tables VI.2 and VI.3. (Some additional information from survey data is available in Appendix IV.1.)

Table 7.3: Crop yields

Crop	Inside Embankment		Outside Embankment	
	Present	With Project	Present	With Project
B. Aus	1.0	1.2	1.0	1.0
T. Aus	1.1	1.4	1.1	1.2
LT Aman	1.4	2.0	1.3	1.5
Ground nut	0.9	1.4	1.0	1.2
Pulses	0.5	0.7	0.5	0.7
Chilli (dried)	0.4	0.6	0.4	0.6

Cropping Intensity

Cropping intensities will also increase gradually from the present average of about 120 per cent recorded in the survey carried out by MES staff. (For areas inside the existing embankment on South Hatia, the cropping intensity is around 140 per cent). It is expected that for areas inside embankments, cropping intensity will rise slowly to an average 165 per cent and for areas outside embankments to about 135 per cent over the coming 15 to 20 years.

For newly accreted areas, both yields and cropping intensities will initially be at much lower levels than those currently achieved for existing land. Yields are expected to start at about 50 per cent of present levels and the initial cropping intensity is 75 per cent. Rabi crops (usually just keshari to begin with) are started on a small scale after about 5 or 6 years. Present and future cropping intensities and cropping patterns are indicated in the farm budgets in Appendix VI, Tables VI.4 to VI.11.

In the project analysis, the transition from present production conditions or initial conditions on new land to those expected with implementation of the project is expected to take about 20 years. At full development, rice production will be some 8,925 mt per year greater than without the project.

7.5 Livestock

With additional areas available for grazing and fodder production and greater security from flooding and cyclones, livestock populations will increase although the total number will be constrained by the carrying capacity of the available grazing land. The proposed Livestock Improvement Programme, although it will directly affect only a minority of livestock owners, is expected to have an impact on livestock production in the area generally, gradually improving production methods and raising productivity.

Livestock populations are projected to increase in line with increases in the number of households in the project area. Average livestock ownership per household is not expected to increase greatly. Estimates of future livestock numbers in the project area are based on data for Hatia thana, since once the area is empoldered it will be similar to this area, including with respect to grazing potential. Livestock ownership per household is estimated on the basis of data from the Cyclone Shelter Preparatory Study (see Chapter 3.6) and BBS (Table 7.4).

Table 7.4: Livestock per household

	Cattle & Buffaloes	Goats & Sheep	Poultry
No. per household, 1984	1.62	1.11	8.20
Rate of growth, 1984-1996	0.8%	3.2%	7.5%
No. per household, 1996	1.78	1.62	19.53

The estimate of the human population of the project area is based on the estimate for 2000 (see Table 3.1), projected forward with a declining growth rate. The rate of decline of the growth rate in the with project situation is 5 per cent and 7 per cent for the without project case. However, the growth of the human population is assumed not to fall below 2 per cent per annum with the project or below 1.8 per cent per annum in the without project case. The average number of persons per household is 5.3. Taking all these factors together results the estimated future livestock populations given in Appendix VI, Table VI.12.

Changes in livestock productivity will be reflected in declining mortality rates, increasing average size of animals due to more and better fodder and better animal health and increased output of milk and eggs. Some key livestock production parameters, with and without the project are given in the following table. In addition, based on data from the livestock census, it is estimated that 30 per cent of cattle and buffaloes and 50 per cent of goats are breeding females. These proportions are expected to rise over the life of the project to 35 per cent and 60 per cent, respectively.

Table 7.5: Livestock production parameters

	Cattle & Buffaloes		Goats & Sheep		Poultry	
	without	with	without	with	without	with
Adult mortality (%)	5	4	8	3	60	30
Juvenile mortality	13	8	25	5		
Conception rate (%)	50	60	120	160		
Average live weight	200	250	20	20		
Milk (litres/lactation)	150	200				
Eggs (per year)					40	60

Note: Parameters for without project situation are the same as the present.

With project implementation, the transition from the present to the future situation is assumed to occur over 10 to 12 years. These changes, combined with increasing populations, have a significant impact on livestock production.

Based on this data, the annual offtake of animals (cattle and goats) can be calculated and the output of milk and eggs. Broiler chicken production is not included because of the difficulty of estimating production. Production estimates for years 5, 10 and 15 of the project are given in Table 7.6 (details are in Appendix VI, Table VI.13).

Table 7.6: Livestock production

Year	Cattle (head)	Goats (head)	Milk (‘000 litres)	Eggs (‘000)
5	363	3,994	499	2,187
10	1,175	6,965	679	3,117
15	1,536	9,130	817	3,839

The direct benefits of the Livestock Improvement Programme are relatively small. The programme is expected to benefit some 400 livestock owners during its initial 5 year period and further owners in subsequent years if the programme is maintained. The pool of credit built up will provide the means for an ongoing programme, albeit at a less intense level, under the supervision of the implementing NGO. Over time the numbers will gradually decline as needs change. Production models for the various programme components are also in the annex (see Appendix VI, Tables VI.14 to VI.17).

7.6 Fisheries

The project is expected to lead to an increase in the area of fish ponds and to significant improvements in productivity. Some shrimp culture is also expected to develop.

The area of ponds currently estimated to be in the project area is 104 ha. which represents almost 2.5 per cent of the gross non-forested area. In new areas it is assumed that 3 per cent of the gross new agricultural land area will be converted to ponds. A high proportion of these ponds will be in borrow pits created by the construction of new embankments. At present, there is almost no shrimp cultivated in the project area. This will change in the future and it is assumed that one third of new ponds will be devoted to shrimp.

The areas with and without project implementation is summarised in the table.

Table 7.7: Fish ponds

	Culturable	Cultured	Shrimp	Total
Present	26	78	-	104
Future without project - F0	26	94	8	128
Future with 1 cross dam - F1	-	213	54	267
Future with 2 cross dams - F2		256	75	331

unit: ha

The proposed fisheries development programme will increase productivity of fish ponds, with average annual yield in properly managed cultured fish ponds rising to 2,000 kg/ha from the average of about 800 kg/ha under present operating systems. Shrimp yields will depend on resolving the White Spot disease issue, but this is expected in the medium to long run. Yields are expected to rise from about 130 kg/ha currently achieved in the MES area to about 400 kg/ha without the disease and with improved technology and management. (see Appendix VI, Tables VI.18 to VI.22)

Full transition to with project productivity levels is expected to take up to 10 years.

The estimated present production of fish from ponds is some 69 mt/year. The impact of the increased pond area and the improvement of productivity through the improvement programme will be a significant increase in aquaculture outputs. These are summarised in Table 7.8.

Table 7.8: Aquaculture output at full development

	Unit: mt per year		
	F0	F1	F2
carp	68.9	416	512
shrimp	0	21.6	30

7.7 Forestry

The project will promote the expansion of forest on Nijhum Dwip and South Hatia, especially as an essential component of the protective system for increasing the security of the population in the area. Forested area increases significantly with implementation of either project option. Forested area is also expected to increase without the project, although it is not expected that all accreting land would be forested and there would be no clearing of existing forest areas or of forest on newly accreted land once it has reached 15 years of age.

Without the project, the area under forest will be larger in 30 years time than in either the F1 or F2 cases. This must be offset, however, against the large increase in land available for agriculture with the project. The situation is summarised in Table 7.9 (see also Tables 6.1a and 6.1b).

Table 7.9: Impact of the project on forested areas

	unit: ha.			
	Present	Cleared	New Forest	Total
Present	4,446	-	-	4,446
Future without project - F0	4,446	-	1,363	5,809
Future with 1 cross dam - F1	4,446	(2,886)	3,396	4,956
Future with 2 cross dams - F2	4,446	(2,886)	3,768	5,328

With either project option the clearing of existing forest inside the new polders will produce significant amounts of timber and fuel wood in the early stages of the project. This benefit is not obtained in the without project case. The estimated volume of timber to be harvested is some 150,000 m³ and of fuel wood is about 160,000 m³.

8. ENVIRONMENTAL ASSESSMENT

8.1 Aims and objectives of the environmental assessment

The Nijhum Dwip Integrated Development Project is one of the three selected priority projects of the Meghna Estuary Study to be taken to Feasibility Study. The aim of the environmental assessment component of the Study is to ensure environmentally sound project planning and implementation takes place. The assessment procedures to be followed are those given in the FPCO/WARPO EIA Guidelines (Ref: FPCO, 1992). These EIA Guidelines follow the spirit of World Bank Operational Directive 4:01 (Ref: World Bank, 1991) which have become the international standard for such work.

The recently enacted Environmental Conservation Rules of Bangladesh (Ref: Abdus, 1998, Chapter III of which contains a translation into English of the Rules which are published in Bangla in the Government Gazette) contain the Ministry of Environment and Forest legal procedures for EIA as allowed under the Environmental Conservation Act of 1995. These procedures include the criteria for grading different types of proposed interventions and the steps required for granting of Environmental Clearance Certificates. Further details are given in the Department of Environment EIA Guidelines for Industries (DoE, 1997).

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These Environmental Rules have primarily been drawn up for dealing with the construction of new industrial operations. Under the classification outlined in the Rules, the proposed cross dam intervention at Nijhum Dwip would appear to fall into Category D (Red) under item number 66 (Flood Control Dam, Polder, Dyke etc). The procedure since August 1997 for such classified projects is for an Initial Environmental Examination (IEE) to be carried out and submitted to the Department of Environment for granting of Location Clearance. Once this clearance is given then a full EIA is to be carried out, again for submission to the Department of Environment, for granting of an Environmental Clearance Certificate. In addition a No Objection Certificate is required from the Local Government authorities before an Environmental Clearance Certificate can be issued. The Certificates are valid for twelve months and then have to be renewed. As these Rules and procedures are very recent, there has been little experience with their operation.

An IEE for the Nijhum Dwip cross dam was drafted in May 1997, (prior to the Environmental Rules being made public), as the project was at that stage expected to be implemented as a priority trial under the MES. However it was eventually decided not to implement such a trial and the IEE was not submitted. In view of the recent changes in the legislation and following the WARPO EIA Procedures it has now been decided to produce a full EIA. This has used the May 1997 IEE as a basis, but with additional field data and sedimentation model outputs, along with more detailed knowledge of what the proposed intervention will actually entail.

It must be remembered that the primary aim of the intervention is to speed up the natural accretion process that will happen even without human intervention, working with natural trends rather than against them.

A full EIA has thus be carried out for the proposed intervention and is presented as a self standing document as Volume 3 Part 2 of the Development Plan. A summary of the results is given below.

The delineated project area for the Feasibility Study is given in Figure 1.1 and includes the unembanked parts of southern Hatia and the offshore island of Nijhum Dwip plus the surrounding tidal mudflats.

8.2 Proposed interventions

The nature of the proposed intervention has been outlined in chapters 5 and 6 above. The intervention has been drawn up bearing in mind the results of the needs assessment for the area which sampled people's views by four different locations in the area and also by various social groups. The results of the needs assessment are given in Tables IV.4.1 and IV.4.2. Environmental considerations have also been incorporated into project design to minimise possible negative impacts and reduce the need for specific mitigation programmes.

8.3. Baseline environmental conditions and future trends

An outline of the present environmental conditions in the project area has been given in Sections 2, 3 and 4 above. A more detailed description following the systematic order given in the EIA Guidelines is given in Section 2 of the EIA Report.

Baseline data collection for both the natural and human environment has been carried out for the area to allow identification of the existing environmental constraints and also likely future trends so that an appropriate set of interventions can be drawn up for the area, as well as for assessing impacts in with and without intervention conditions. This baseline data provides the framework to identify likely impacts due to the proposed intervention, assess their importance and then set up data collection programmes to allow quantification, valuation and also monitoring of Important Environmental Components (IEC's) and variables.

The main processes that have been identified are erosion and accretion patterns, with the primary risks and constraints being cyclones (causing loss of life and destitution), saline water intrusion and soil salinity, including problems of capillary rise in the dry season. The principal environmental

conditions and constraints to economic development in the area have been identified and include the following issues with respect to the proposed cross dams and utilisation of their predicted benefits:

- the nature of the system for allocating land rights and managing land use on newly accreted land.
- the present pattern of surface water quality, and particularly soil salinity, caused by saline inflow and how this changes as land accretes.
- groundwater quality and availability for drinking water.
- rainfall drainage in embanked areas.
- low agricultural yields and poor marketing systems for agricultural production as well as fisheries, primarily due to poor communications.
- crop losses due to pest attack.
- large areas of unembanked land which support a significant number of grazing animals.
- over-exploitation of the in-shore fisheries which are at an unsustainably high level.
- human food intake and nutrition levels which are relatively good at present, probably because a lot of what is produced is eaten rather than sold.
- poor health facility provision, a lack of sanitation facilities and no secondary schooling availability in the area.
- relative high levels of malaria, probably due to the forest vegetation cover.
- the present low economic returns to mangrove forestry and the conflicting aims of conservation and sustainable development for planned human in-migrants. However the area has one of the most favourable rural energy balances in the country.

A simple needs assessment has been carried out in four different parts of the intervention area and including five social groups. A major conclusion is that by far the majority of people interviewed feel that creation of new land is the highest priority intervention. The major exceptions are land owning farmers who desire embankment construction for preventing saline inflow as a highest priority and land accretion as the second. There was also a significant request for the provision of income generation activities for women.

As part of the environmental assessment process, the EIA work carried out for the Brahmaputra Right Embankment (Ref: Halcrow, 1992), the FAP 21/22 Bank Protection Project (Ref: Rhein-Ruhr Ing, 1993) and the Coastal Embankment Rehabilitation Project (Ref: Bird, 1993) was reviewed. The issues raised by these projects were born in mind when considering the proposed Nijhum Dwip intervention.

8.4 Scoping of important environmental components

The delineation of likely environmental impacts created by the proposed interventions, (known by the term "bounding" in the FPCO/WARPO EIA Guidelines and Manual), has been made based upon the outputs of the hydro-dynamic model. The model indicates that the impacts are likely to be in the mudflats and in-shore areas (defined as within 5km of the coast) south of the northern limit of the defined project area as shown in Figure 1.1. Any possible impacts and constraints outside these areas are considered to be external issues and are dealt with as a separate item in the analysis.

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A scoping exercise was carried out using the field data from the needs assessment, and also amongst the study team, to identify the Important Environmental Components (IEC's). A master environmental checklist compiled for all work in the MES was used as outlined in the MES Interim Development Plan, (Ref: DHV, 1997, the environmental assessment matrix given in Tables 8.1 and 8.2 gives the full listing of the checklist).

The identified IEC's are listed systematically in the left hand column of the scoping matrix given as Figure V.2.15 in Appendix V.2 of the EIA report. The second column shows those issues considered to be important by the study team and the third column those identified by local people. The rating has fixed the present situation at zero for all issues to allow a comparative assessment to be carried out for the future situation at year 30. This time period is the economic return period for the study and also that by which most impacts are expected to be apparent, as well as being the time horizon for which sedimentation predictions have been made. Three scenarios have been assessed:

- construction of one cross dam at year zero
- construction of one cross dam at year zero followed by a second at year 5
- the without intervention situation at year 30 assuming present trends continue

The feasibility of a second cross dam should be re-evaluated at year 5 following detailed monitoring of the results of the first cross dam.

The EIA work was then focused on the impacts of construction of one cross dam at year zero, followed by the integrated land development programme as outlined in Section 8.2 above. A matrix extracting the Important Environmental Components (IEC's) for the impacts of one cross dam has been constructed and is given as Table 8.1. The matrix indicates the priority issues from a technical standpoint and also those from the local people, ranked by the results of the needs assessment. The local people's priority column in the table forms the basis for a Public Response document that is often produced as part of an EIA.

8.5 Impact identification, quantification and valuation

The comparative assessment given in Table 8.1 allows the significant impacts of the proposed intervention, (both positive and negative) to be identified. In addition, the comparison to a without project situation allows the impacts of the project to be separated from future trends. The need for mitigation can also be identified and the effectiveness of mitigation can be assessed. The final column allows the overall residual impact to be seen. Of concern are those residual impacts which are negative, i.e. those impacts for which mitigation is either impossible or unable to prevent the post project situation being worse off than that before it caused as a result of the intervention.

The primary conclusions from the analysis are given below, split between positive and negative impacts. The direction of the impact is viewed from the perspective of long term sustainable human use of resources and where significant and possible these have been quantified:

8.5.1 Identified positive impacts

Land accretion

From the morphological modelling it is estimated that land accretion is accelerated to the point where the area of land at level 2.2 metres (2,044ha) is reached by year 6 instead of year 30, as shown in Table 6.1. The total area of land accreted to level 2.2 metres after 30 years with one cross dam is almost twice that (4,465ha) as in the without intervention situation. At year 15 it is predicted that there will be 4,243 ha of land above 1.5 metres (the level at which forestry planting can commence), 2,880 ha of which are attributable to the intervention. In addition the low flow channel between the two islands will be closed by the cross dam, which would not happen under natural conditions.

Table 8.1: Important environmental components matrix for one cross dam at year 15 - 16

IMPORTANT ENVIRONMENTAL COMPONENTS	Technical Priority	Local Priority Ranking	Now	Future Without Intervention	Future With Successful Intervention	Difference Due to Intervention	Future With Project With Mitigation	Residual Impact
NATURAL ENVIRONMENT								
Natural Physical Environment								
Climate								
Storm Surges	*	*5	0	0	0	0	0	0
Cyclones	*	*5	0	0	0	0	0	0
Hydrology								
Surface Water:								
Quantity:								
Rainfall flooding			0	-1	+1	+2	+1	+2
Tidal/Sea flooding	*	*5	0	0	+2	+2	+2	+2
Drainage		*11	0	-1	0	+1	0	+1
Quality:								
Salinity	*	*2	0	-1	+1	+2	+1	+2
Erosion			0	-1	0	+1	0	+1
Sedimentation		*9	0	+1	+2	+1	+2	+1
Accretion	*	*1	0	+1	+2	+1	+2	+1
Groundwater:								
Availability:								
Domestic water supply	*	*10	0	-1	0	+1	0	+1
Land								
Soil:								
Quality:								
Chemistry	*		0	0	+1	+1	+1	+1
Capability	*		0	0	+1	+1	+1	+1
Natural Biological Environment								
Terrestrial Habitats:								
Fauna	*		0	0	+1	+1	+1	+1
In-Shore Marine Habitats:								
Fauna	*		0	0	-1	-1	-1	-1
Fish	*		0	-1	-2	-1	-2	-1
Natural Risks and Hazards								
Storms/Cyclones	*	*5	0	-1	+1	+2	+1	+2
Rainfall Flooding		*11	0	-1	0	+1	0	+1
HUMAN ENVIRONMENT								
Social Environment								
Human Population	*	*3	0	+1	+2	+1	+2	+1
Gender Issues		*	0	0	+1	+1	+1	+1
Settlement Pattern and History	*	*3	0	+1	+2	+1	+2	+1
Land Holding and Tenure	*	*1	0	-1	+1	+2	+1	+2
Common Resource Rights:								
Fish	*		0	-1	-2	-1	-2	-1
Domestic Water Supply	*	*10	0	0	+1	+1	+1	+1
Sanitation	*	*6	0	-1	0	+1	+1	+1
Health								
Waterborne Disease	*	*4	0	-1	+1	+2	+1	+2
Insect-borne Disease	*	*4	0	-1	-1	0	-1	0
Nutrition			0	0	+/-	+/-	?	+/-
Education and Literacy	*		0	+1	+2	+1	+2	+1
Economic Environment								
Agriculture	*	*	0	+1	+2	+1	+2	+1
Agricultural Wage Paid Labour			0	0	0	0	0	0
Homestead Production			0	+1	+2	+1	+1	+1
Livestock			0	+1	+2	+1	+2	+1
Forestry	*	*7	0	+1	+2	+1	+2	+1
Fisheries	*	*	0	-1	-1.5	-0.5	-0.5	-0.5
Industry	*	*	0	0	0	0	0	0
Other Non-Farm Wage Paid Employment	*	*	0	0	0	0	0	0
Infrastructure and Communications								
Roads and Embankments	*	*8	0	0	+2	+2	+2	+2
Navigation			0	0	-1	-1	0	0
Social Risk and Hazards								
Storms/Cyclones	*	*5	0	0	+2	+2	+2	+2
Erosion			0	-1	0	+1	0	+1
Disease	*	*4	0	-1	-1	0	-1	0
Crop Pest Attack	*	*	0	-1	0	+1	0	+1
EXTERNAL ISSUES								
Upstream Constraints and Impacts			0	0?	0?	0?	0?	0?
Downstream Constraints and Impacts			0	0 (+/-)	(+/-)?	(+/-)?	(+/-)?	(+/-)?
DIRECT CONSTRUCTION IMPACTS								
Land Acquisition			0	0	0	0	0	0
Compensation			0	0	-0.5	-0.5	0	0
Resettlement			0	0	0	0	0	0
Construction Operations			0	0	-0.5	-0.5	+0.5	+0.5
Construction Employment			0	0	+1	+1	+1	1

LEGEND:

- * Identified Significant Component
- *1 Rank Number of IEC
- RATING OF IMPACTS**
- +3 Significant positive impact/trend
- +2 Moderate positive impact/trend
- +1 Slight positive impact trend
- 0 Present baseline condition
- 1 Slight negative impact trend
- 2 Moderate negative impact/trend
- 3 Significant negative impact/trend
- ? Unknown
- +/- Simultaneous positive and negative impacts

NOTES:

1. Local Priorities are ranked from the needs assessment.
2. It is assumed that the new drainage provision is completely effective.
3. The existing and future government infrastructure provision levels are assumed to be adequate to take account of predicted population increases.
4. The settlement/Char development component includes adequate infrastructure provision (domestic water supply, sanitation, health centres, schools and cyclone shelters) to keep pace with additional planned in-migration as part of a managed programme.
5. Present NGO activities are assumed to be expanded to include income generating activities for women.
6. The analysis is at year 15 for one cross dam constructed in year zero

Table 8.2: Quantification matrix for significant impacts for one cross dam at year 15 - 16

IMPACTS (BENEFITS AND DISBENEFITS)	YEAR 15 Without Intervention	YEAR 15 With Successful Intervention	Difference Due to Intervention
Accreted land area 1.5m	1,363 ha	4,243 ha	2,880ha
Accreted land area 2.0m	1,246 ha	3,510 ha	2,264 ha
Accreted land area 2.2m	1,022 ha	3,237 ha	2,215 ha
Human settlement (hh)	5,604	6,590	986
Additional human settlement programme (hh)	0	780	780
Land available for agricultural development (ha)	409 ha	1,983 ha	1,574 ha
Cleared forest land available for agriculture (ha) at year 16	0	1,911 ha	1,911 ha
Livestock - large	9,990	11,747	1,757
Livestock - small	9,078	10,675	1,597
Livestock - poultry	109,455	128,705	19,250
Forestry planting area (ha)	681 ha	2260ha	1,579 ha
Forestry clearing area (ha) at year 16	0	1911ha	1,911 ha
Forestry net area (ha) at year 16	681 ha	349ha	-332 ha
Aquaculture fish (ha and tonnes)	100 ha; 80 mt	207ha 414t	107 ha; 214 mt
Aquaculture shrimps (ha and tonnes)	4,ha; 0.5 mt	27ha 10.8t	23 ha; 9.2 mt
In-shore fisheries (can not quantify)	-	--	-
Human nutrition (can not quantify) 60% of hh depend on fish	+/-	+/-	+/-
Embankment with road	0	48.9 km	48.9 km
Local road	0	12.5 km	12.5 km

Source: MES 1998

Note: The analysis includes the option of clearing forest land at year 16

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Embanking of land for agricultural use and human settlement

The additional accreted land allows embankments to be constructed earlier and to enclose a larger area of land. In turn this new land allows those households resident in the area, (and also the predicted increase based upon past trends, together estimated to be 6,590 households by year 15), many of whom have no agricultural land, to be allocated a cultivable plot. In addition a further 450 households can be settled into the area by year 6/7, with both a house plot and an agricultural land allocation.

Reduction in cyclone damage

The effects of cyclone surges will be reduced as waves are dissipated by the kilometre wide forestry belt and also by the seaward side run-up slope of the newly built embankments. Analysis carried out by the CPP project indicated that such planting can dissipate 2 metres of wave energy in a 1991 type cyclone and this is equivalent to increasing the protection of an embankment designed to stop a 1 in 30 year event to a 1 in 50 situation.

Reduction in rainfall flooding

Assuming that the constructed drainage system operates fully as intended, then there will be less rainfall flooding in embanked areas with resulting reductions in agricultural crop losses.

Reduction in surface water salinity

Surface water salinity inside the new embankments will be reduced as sea water intrusion will be prevented by the embankments and appropriate operation of the drainage system.

Reduction in soil salinity

Soil salinity inside the new embankments will be reduced as there will be less saline intrusion and the drainage system should allow flushing of the soils with monsoon rainfall fresh water. However capillary rise is still likely to remain a significant problem for many years.

Change in bank edge erosion risk

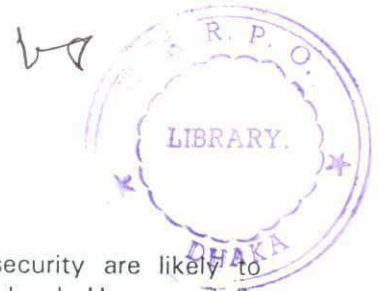
The small length of bank edge erosion that presently occurs on the north west corner of Nijhum Dwip could be slightly reduced as the inter-island channel accretes. The erosion may be pushed further downstream but is unlikely to be worse than it is at present.

Improvement in terrestrial bio-diversity

The multi-purpose use of the new embankments, including possible linear settlements and social forestry, is likely to improve bio-diversity of terrestrial flora and fauna. The overall area of forestry outside the embankments will be significantly greater than without the project (although it will be in a corridor strip rather than a concentrated block), with benefits for terrestrial ecology.

Increase in agricultural production

Increased agricultural production is likely to occur as a result of accreted land being embanked and used for all year cropping within the constraints of irrigation water availability. In addition some land which will be forested and by year 15 is over 2.0 metres and lies more than 1km from the sea (estimated to be up to 1,911ha), could be cleared for seasonal agricultural use and grazing. In addition it is proposed to try and introduce an integrated pest management programme in an attempt to address the serious problem of losses from pest crop attack.



Increase in homestead production

The settlement programme, allocation of cultivable land and increased security are likely to produce a significant increase in homestead production at the household level. However it is difficult to quantify this at present, although it has been estimated that an additional 19,200 poultry could be produced. Socio-economic monitoring at household level would be required to quantify and value this benefit.

Increase in livestock production

It has been estimated that the additional accreted land available outside the new embankments and cleared of forestry after 15 years growth would allow an additional 1,750 large livestock and 1,600 small livestock to be reared. In addition the proposed livestock extension programme would increase the quality of the livestock.

Increased forestry area

The area that could be put under forestry with a sustainable management system is estimated to be 2,260 ha by year 15, 1,579 ha of which are attributable to the project. The economic and financial analysis of the project has assumed that the forestry component will be self funded by the Forest Department and thus no benefits and costs have been put into the project calculations. At year 16 1,911 ha of this planting could be progressively cleared and turned over to agriculture. The overall result would be that an additional 349 ha of forest cover would exist at year 16 than is there at present, but this would be 332 ha less than at year 16 with no cross dam, assuming the Forest Department were to continue planting all newly accreted land.

Increased aquaculture production

As part of the targeted aquaculture programme using the borrow pits from embankment construction and also bringing the presently under-used ponds into full production, an extra 146 ha of ponds could be cultivated by year 15. In the with project situation it is estimated that 416 mt of fish would be produced, 347 mt of which would be attributable to the intervention. There would also be a targeted shrimp aquaculture programme.

Income generation opportunities

Homestead production would be further increased as a result of the proposed income generation programme for women implemented under an NGO. such a programme would be linked to community forestry and maintenance on the embankments.

Improved access

As a direct result of cross dam and embankment construction there would be significantly better road access from Nijhum Dwip to Hatia. This would allow better marketing with secondary benefits to agricultural production. In addition there has been a strongly stated desire by women in Nijhum Dwip for improved access to northern Hatia as many are erosion victims from there who have close family relations still residing there. Whilst the reduction in social isolation that this creates can not be easily quantified, let alone valued, it is a significant benefit.

8.5.2 Identified negative impacts

Changes in in-shore marine habitats

There are likely to be changes in the extent and location of in-shore marine habitats in the area, some of which are likely to happen despite the intervention. However there is little doubt that this process would be accelerated by the construction of the cross dam and in particular movement through the channel between Nijhum Dwip and Hatia would cease. From the sedimentation analysis is also apparent that similar new habitats will appear further off-shore. The crucial

question is if the fauna (including fish) using the present tidal mudflats will move to the new locations as replacement habitats. Monitoring of the situation over the next five years would be required to obtain an understanding of the situation. These habitats include those of wading birds, for the which the area is a significant area (Ref: Thompson P and Johnson D, 1996) and also Gangetic Dolphins. The Gangetic Dolphin is classified as threatened under the IUCN Red Book (the world-wide register of threatened and endangered species). However dolphins are relatively common in the Nijhum Dwip area, where its presence is not disturbed by human persecution, unlike further inland where it is caught for medicinal use. Like fish resources and wading birds, monitoring is required to see if the dolphin populations will move to the natural replacement habitats that are likely to emerge. The fish resources are under serious threat of over-fishing, irrespective of project interventions, and this process is likely to increase in the future even without the proposed intervention. It is not possible to quantify the future situation or additional effects of the proposed intervention without a significant period of study to investigate long term trends rather than seasonal fluctuations.

Conservation management

The increased intensity of human use of resources on Nijhum Dwip, which is likely to increase as a result of the proposed project, will put further stress on the Forest Department's attempts to manage the place as a conservation area. Such a policy (which has included the stocking of the area with deer, monkeys and pythons) has already been seriously undermined by the past establishment of the seven cluster villages on Nijhum Dwip. The overall conclusion is that since the establishment of the cluster villages, it is not now possible to manage Nijhum Dwip as a conservation area and such strategies would be best reserved for more important national designated areas such as the Sundarbans, Hill Tracts and forest areas near Sylhet. It is now necessary to achieve a mixed sustainable management strategy which balances human needs and use of resources with maintenance of significant forested habitats. The proposed intervention will result in a larger area of forest being in existence than at present, even if a full clearance programme were to be instigated after year 15. However the forested area would be in a coastal strip rather than a consolidated block.

Fisheries

The predicted trend is that fisheries in the area are now likely to decline in the future, irrespective of the project, due to over-fishing. It is not possible to quantify this trend without a significant data collection programme, which is considered an urgent priority if the project were to go ahead. The proposed cross dam is likely to cause a further change in fish habitat and an additional reduction in fisheries catch. Again it not possible to quantify this without a baseline catch assessment and monitoring.

In addition there is likely to be some temporary disruption to fishing operations by the closure of the channel and the need to relocate the fish landing station and drying operation.

Human nutrition

The declining fish resources, a trend which will happen irrespective of the project, when combined with increasing human populations and a possible change in fish marketing patterns, is likely to result in a reduction in human protein intake. The population at present has surprisingly high levels of nutrition, partly due to the fact that a large number of households catch and directly consume fish, (per capita consumption of fish in the area is estimated to be 66 grams per day compared with a minimum protein requirement of 45 grams per day and an average consumption of protein of 40 grams per day in all Bangladesh, 27 grams per day of which comes from fish). Improved access to the area could cause more fish to be sold rather than directly consumed. It is not possible to quantify this impact and there could be complex two-way trends with some households improving their nutrition and others suffering a reduction. A monitoring programme for human nutrition will be required to identify and quantify any change.

Malaria

The baseline studies of the area have indicated a significant existing problem with falciparum malaria, probably as a result of the large forested areas creating a habitat for the mosquito carrier. As the proposed intervention involves planting larger areas of forest cover than exist at present, the malaria risk could increase. It has been assumed that a health centre will be provided on Nijhum Dwip as part of on-going government service provision but monitoring of malaria will be required and appropriate steps will need to be taken if it is found to be an increasing problem.

Navigation

The closing of the navigable channel will obviously prevent waterborne navigation through it and also close the fish landing ghat. Discussions with local people indicate that the improved access offered by a direct road connection is considered superior to navigation. Negotiations would need to take place to arrange a suitable re-location site for the Ghat that was seen to be an acceptable replacement. It is likely that a location on the western side of the island would be preferable as there would be less risk of siltation impeding access at a later date.

Changes in access

Whilst the improved access to Nijhum Dwip from Hatia that is likely to result from the construction of a road on top of the cross dam will be considered a benefit, there are also likely to be some simultaneous negative impacts. These include additional induced in-migration which would put more pressure on existing resources and facilities. There may also be a risk of more social conflict as a result. Careful management, including fair and transparent procedures for new land allocation are critical in handling such conditions.

Direct construction impacts

Whilst, unusually for embankment construction projects in Bangladesh, there are few problems with land acquisition, compensation and involuntary resettlement, there are likely to be direct construction issues which if well managed can be overcome and in many cases increase potential benefits, particularly employment opportunities. There are also likely to be issues linked to the collection and handling of construction materials. A checklist of these issues has been prepared and included as Appendix E of the EIA report and is further discussed under mitigation issues below.

8.5.3 Impact quantification

Impact quantification has been carried out as far as is possible at this stage of the study and is summarised in Table 8.2. The main problems are the lack of data on in-shore fisheries and the uncertainty of complex two way trends with human nutrition. The quantification is for year 15 but also show the effect of a forestry cutting programme at year 16 which would reduce the forested area but increase that for seasonal cultivation and livestock grazing areas.

8.5.4 Impact valuation

Impact valuation has been carried out where possible and is given in Table 8.3. The main problems include the impossibility of giving land valuations based upon their traded value and the lack of data on in-shore fisheries and human nutrition. The benefits of land accretion have been valued by use of the land, both for agriculture and forestry. The agricultural benefits have also been expressed as a value per household. The valuation is purely in financial terms up to year 15/16, assuming thinning and cutting of forestry at year 15. Benefits of the livestock programme are also given, both in terms of value of surplus animals and animal products, as well as expressed as a per household benefit. The broad conclusions of the analysis are that returns to the livestock programme are greater per household than for agriculture inside the embankment at year 15. The returns to forestry are positive but low and it has not been included in the project economic and financial analysis, the assumption being that it will be carried out on a self-funding basis by the forest Department.

Table 8.3: Valuation matrix for significant impacts for one cross dam at year 15 - 16

IMPACTS	Year 15 Without Intervention	With Successful Intervention	Difference Due to Intervention	1997 prices	
				Total Value of Benefits due to intervention ('000 Tk)	
Accreted land Area 1.5m (Note 1)	+	++	+		+
Accreted land area 2.0m (Note 1)	+	++	+		+
Accreted land area 2.2m (Note 1)	+	++	+		+
HH net agricultural benefit inside embankment (Tk/hh/yr)	5,700	11,400	5,700	781,140	
Agricultural net benefit existing land outside embankment (Tk/ha/yr)	5,209	8,756	3,547	All Forested	
Agricultural net benefit existing land inside embankment (Tk/ha/yr)	6,509	13,681	7,172	339,092	
Agricultural net benefit new land outside embankment (Tk/ha/yr)	5,209	8,756	3,547	All Forested	
Agricultural net benefit new land inside embankment (Tk/ha/yr)	0	13,681	13,681	837,277	
Surplus livestock - large ('000 Tk)	3,278	9,733	6,455	6,455	
Surplus livestock - small ('000 Tk)	3,068	9,918	6,850	6,850	
Milk production ('000 Tk)	5,395	9,867	4,472	4,472	
Egg production ('000 Tk)	6,567	11,583	5,016	5,016	
HH net benefit from livestock improvement (Tk/hh/yr)	0	6,240	6,240	689,832	
Mangrove forestry planting costs (Tk/ha)	(13,775)	(13,775)	(13,775)	see below	
Mangrove forestry thinning and clearing net revenue (Tk/ha)	19,500	19,500	19,500	see below	
Mangrove forestry net revenue year 16 (Tk/ha)	5,725	5,725	extra area	29,390	
Aquaculture fish (cultured pond) (Tk/ha/yr)	14,144	47,329	33,185	53,261	
Aquaculture shrimps (without intervention assumes disease) (Tk/ha/yr)	8,625	44,484	35,859	12,371	
In-shore fisheries (can not quantify or value)	-	--	-	-	
Human nutrition (can not quantify or value)	+/-	+/-	+/-	+/-	

Source: MES 1998

Notes:

1. Accreted land can not be valued directly (tradeable/intrinsic value), only by its economic use, see agricultural benefit section
2. The economic and financial analysis assumes that the forestry programme is to be self financing by the Forest Department
3. Assumes thinning of forestry at year 8 and cutting of mature forestry at year 16

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The overall economic analysis indicated that the proposed project is not very attractive, the fundamental problem is that the costs of infrastructure construction are relatively high (the embankments, roads, water control structures and drainage system are 73 per cent of project costs at Tk 359 million although the cross dam is relatively inexpensive) and the returns to agriculture are long term, particularly because of the slow rate of soil salinity reduction even after construction of the embankments.

The total capital costs are estimated to be Tk 501 million (US\$ 10.6 million). The crucial question is if a donor can be found who will be prepared to fund such a programme and under what conditions. If no donor can be found then does the Government of Bangladesh consider the project to be of such importance that it is prepared to fund it itself? If this were to be the case then careful consideration would need to be made as to the alternative use such money could be put to. Based on population projections for year 15 with the project, the capital costs amount to some Tk 76,000 per benefited household and this should be considered against other water sector possible interventions in the country [Tk 23,000 per household for flood proofing and Tk 9,851 per household for flood management at Jamalpur (Ref: SOGREAH et al, June 1997), Tk 6,900 per head (equivalent to Tk 38,709 per household) for cyclone shelter provision or Tk 13,710 per household for both drainage and irrigation provision at Noakhali North (Ref: Sir M MacDonald and Partners, October 1993) for instance].

It must also be recognised that there are limitations of a purely economic analysis to project analysis. The Guidelines for Project Assessment address this by using a multi-criteria analysis, ranking likely benefits (particularly those which can not be easily quantified or valued) against policy objectives. The results of this analysis follow in Section 9.

8.5.5 External impacts and constraints

There are no obvious upstream impacts created by the proposed intervention, however any future upstream development, particularly that in the planning unit of north Hatia, presently being considered for a pre-feasibility study, would need to bear in mind possible induced impacts downstream on the Nijhum Dwip area. As such the construction of the Nijhum Dwip cross dam may pre-empt possible development options in Northern Hatia.

As discussed above, the outputs of the sedimentation analysis indicated that accretion of tidal mudflats is likely to occur to the east and south of Nijhum Dwip. Whilst this may provide replacement in-shore marine habitats, the ability of species to quickly colonise these areas is unknown, although the past morphological development of the area has followed these trends, if at a slower rate.

8.6 Environmental mitigation

The predicted effects of environmental mitigation programmes can be seen in the matrix of Figure 8.1 by deducting column six from column eight. Due to the fact that the interventions have been carefully designed there is little need for specific targeted mitigation programmes. These are indicated below:

8.6.1 Fish ghat relocation

It will be necessary to relocate the fish ghat presently found adjacent to the channel on southern Hatia. This could be done with careful negotiation with the affected parties to come to an acceptable equivalent location. It would seem best to have a new site on the main channel to the western side of the area as this will not be subject to accretion. There are not expected to be any major costs associated with this relocation. However consideration could be given to establishing a boat centre at the new site based upon the ideas as recommended and costed in the BIWTA study (Ref: BIWTA, 1994).

8.6.2 In-shore marine habitats

It is expected that re-placement in-shore marine habitats will be naturally formed, but monitoring of this will be required and in particular the extent to which dolphins, fish and wading birds are able to re-locate to these areas. The degree to which this natural habitat replacement mitigates the negative impacts of the intervention will also need to be monitored, along with investigations to identify the locations of fish spawning and breeding sites, specifically to discover if these are on tidal mudflats or in the deeper inter-island channels.

8.6.3 Fisheries

Irrespective of the project there is a need for fisheries management programme aimed at keeping fish catch levels within sustainable limits to prevent serious future decline. A detailed baseline catch assessment is needed plus studies into fish ecology to fully understand the present situation, followed by a monitoring programme to see the effects of sedimentation on fish habitat change and how this affects fisheries production. Once this is done then the need for and nature of a specific mitigation programme for in-shore fisheries can be decided. The proposed fisheries management programme would encompass optimisation of gear use, destructive gear replacement and alternative income generation programmes for fisherfolk, as well as continuous monitoring of fish catch and stocks. The proposed aquaculture intervention may act as partial mitigation for some fish dependant households, however the techniques and experience required are very different from open water fisheries.

8.6.4 Malaria

Mitigation of malaria is possible by the treatment of cases with appropriate drugs and also a health education programme which helps eradicate mosquito habitats and reduces the risk of humans being bitten. It is assumed that a health centre will be constructed in Nijhum Dwip as part of on-going government programmes. Following monitoring of malaria cases then suitable programmes can be drawn up and implemented to address any increase that may occur.

8.6.5 Direct construction impacts

An environmental management component for construction operations will need to be set in place so that potential problems can be identified in advance and steps taken to avoid or minimise negative impacts. A master checklist for such work has been prepared and is given as an Appendix to the EIA report. With care a well implemented construction management plan can provide additional benefits.

8.7 Residual impacts

The possible residual environmental impacts can be seen in the last column of the matrix given as Table 8.1. It can be seen that the positive residual impacts far outweigh the negative, however there are some negative impacts which are unlikely to be fully mitigated for:

- reduction in in-shore marine habitats, particularly for fish and a lesser extent gangetic dolphins, with implications for common good fishing and professional fishing household livelihoods.
- the human nutrition implications of the change in fish availability are uncertain at present but the negative impacts on nutrition from changes in fish consumption patterns could outweigh the benefits from greater agricultural production.

8.8 Environmental risk

The following basic assumptions have been made when assessing the proposed intervention:

- the procedures for land allocation will be improved to ensure that they are systematic, fair, equitable and timely. If this is not done then full potential benefits of the intervention are unlikely to be attained.
- the proposed drainage system will be fully effective in preventing saline intrusion and also disposing of monsoon rainfall flooding.

It should also be remembered that the proposed technology for cross dam construction using geotextiles has not been tried in Bangladesh and should thus be seen as a trial with an underlying risk that it may not be successful.

It is also assumed that if the project goes ahead then it will be in the fully integrated form as proposed. However if a more limited intervention of just cross dam construction were to be implemented then specific mitigation measures (presently incorporated in the many components of the integrated programme), may need to be implemented.

Evidence from the 1991 cyclone indicates that the overall risk of cyclone damage will be reduced by dissipation of waves due to suitably designed embankments and forestry planting. In addition there would likely to be a reduction in loss of human and livestock lives, although this would be greatly enhanced by construction of suitable cyclone shelters and raised earthworks platforms (Killas).

8.9 Environmental monitoring and management

As part of an EIA it is normal to draw up an Environmental Management Plan (EMP) which includes the appropriate mitigation measures and also a suitable monitoring programme which allows data collection for feedback into decision taking. Assuming that the project goes ahead then the following items will need to be monitored:

- accretion and erosion patterns using time series satellite imagery. Such work will indicate the effectiveness of the intervention and also any induced impacts on in-shore marine habitats and navigation. The outputs will be crucial in assessment of the viability of constructing a second cross dam at year five.
- water salinity and soil salinity using the same sample sites established during the Feasibility Study.
- in-shore fish catch assessment, a study of fish ecology (specifically on spawning and breeding grounds) and assessment of stocks, as well as monitoring of the impacts of changed accretion patterns on fish habitats and stocks.
- incidence of malaria
- human nutrition levels in relation to fish consumption.
- household socio-economics related to predicted project benefits.
- external issues, particularly induced accretion and any proposed upstream developments.

In addition monitoring of construction management should be carried out using the checklist given as Appendix E of EIA report as a basis for data collection and analysis.

It would be necessary to re-run the feasibility of construction of one cross dam after 5 years based upon the observed benefits and also the predicted benefits of construction of a second cross dam.

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A further review will be required at year 15 - 16 when a decision is required as to the cutting of forestry and possible construction of a second coastal embankment.

The main mitigation step would be relocation of the fisheries ghat. Other mitigation measures may be necessary depending upon the results of monitoring programmes.

Details of environmental monitoring are given in Figure V.2.17 in the EIA report. The implementation of the monitoring programmes could be carried out by the proposed locally based project management unit. Alternatively the Environmental Cell that is presently being established at WARPO, as part of the National Water Management Plan, could take responsibility for the work within the framework of the proposed coastal area management unit at WARPO. The Department of Fisheries already have plans to carry out a major fish resource assessment for the area which with appropriate institutional liaison could carry out the required fisheries monitoring for the proposed intervention.

8.10 Conclusions of the environmental assessment

The EIA has been carried out for one cross dam, assessing the likely impacts over a 15 year period. The philosophy is to construct the one cross dam and then closely monitor the impacts for a five year period, before taking a decision about construction of a second cross dam.

Under the Department of the Environment environmental classification the proposed intervention would appear to be in the highest Class D (Red) under Section 66 (flood control embankment, polder, dike etc). Before the project can go ahead the DoE will need to review and approve the EIA before they can grant a Site Clearance Certificate. Before a full Environmental Clearance Certificate can be granted a No Objection Certificate will be required from the Local Authority. However there is little experience in the implementation of these procedures so far in Bangladesh and it is therefore considered unwise to embark upon this process until agreed arrangements are in place for the funding of the project.

Under World Bank Operational Directive 4:01 the proposed intervention would probably be classified as Class A (the highest), although it could possibly be down graded to Class B, as the extent of the effected area is relatively small by international standards.

The fundamental problem with the proposed intervention is that whilst the cross dam significantly speeds up land accretion, the predicted positive economic impacts of utilising such land are long term (years 15 to 30) and the construction costs are relatively high at Tk 74,000 per beneficiary household. A case could be made on social benefit grounds for going ahead with the project, but this would need to be considered against other development priorities in the country. There are likely to be some residual negative impacts, but for one cross dam these are not considered to be serious enough to prevent such a trial type of intervention to be tested. However monitoring of these negative impacts would be required to allow quantification and valuation to take place and feed this information into the assessment of a possible second cross dam at year five.

8.11 Future environmental work programme

It is considered ill-advised to continue with any further field studies for the project until a firm undertaking has been given, including commitment of the necessary funds for implementation (estimated total US\$ 9 million for direct construction costs), that the first phase cross dam will go ahead. In addition a suitable, locally based inter-disciplinary and decentralised institutional structure will need to be established for detailed project planning and implementation. The procedures for allocation of new land through the Ministry of Land will also need to be streamlined to be operational in a transparent, fair, equitable and timely manner at local level.

Following such undertakings, then a programme of detailed public consultation will be required to obtain local people's views on the proposed intervention, the outcome of which should be a public response document and the granting of a No Objection Certificate by the Local Authority. This

could then be followed by a formal application to the Department of Environment for an Environmental Clearance Certificate.

The monitoring programmes established under the project need to be continued:

- monitoring of erosion and accretion from satellite imagery, including the effects of the first cross dam if it is built.
- water and soil salinity monitoring at least two times a year and preferably increased to four times.

In addition the following new monitoring will need to be established:

- studies of in-shore marine habitats, fish ecology (particularly the fish spawning and breeding grounds), along with a baseline survey of fisheries catch and a stock assessment.

Assuming that the project goes ahead then the following programmes would need to be implemented:

- construction management assessment, including drawing up environmental criteria for detailed engineering design and environmental management clauses for construction contracts. A monitoring programme should also be implemented during the construction period based upon the prepared check list given in Appendix E of the EIA report.
- a baseline human nutrition survey should be instigated prior to construction, which should be repeated five years after construction of the first cross dam.
- a negotiated arrangement for relocation of the fisheries Ghat on south Hatia.
- an evaluation of the impacts of the project on household livelihoods five years after the construction of the cross dam, using the existing baseline study as a comparison.
- monitoring of the incidence of malaria in the area.

9 ECONOMIC ASSESSMENT

9.1 Project costs

9.1.1 Cross dams

The cost estimate for construction of the cross dams for the Nijhum Dwip Integrated Development Project has been made in accordance with the relevant FAP Guidelines for Project Assessment. The base costs are divided into:

- materials
- labour
- equipment
- other costs.

Costs of materials and local labour is based on the BWDB Standard Schedules of rates for the Feni and Bhola W.D. Circles (1998). These rates include site overheads, profit and risk of the contractor and taxes.

As some labour will have to be hired from outside of the project area, costs for transport and accommodation of labour have been included in the cost item for mobilisation/demobilisation.

The costs for transport of materials to the project location, if materials have to be acquired from outside of the area, are not included in the rates.

The rates for hiring equipment are based on experience gained during the Haimchar and Khorki Bank Protection Pilot Schemes.

The main construction materials are:

- geotextile for screens, bed protection and ballast bags
- PVC pipes for screen floats
- local sand and sylhet sand
- concrete blocks and slabs
- concrete for beams and anchors
- G.I pipes for A-frames
- earth filled gunny bags
- bamboo
- hardware materials

Three types of person power can be distinguished:

- management and supervision
- skilled labour
- unskilled labour.

The main equipment to be used will be

- an installation pontoon
- auxiliary pontoons
- tugboats
- engine boats
- a mobile crane.

The costs for the cross dams are summarised in Table 9.1. Details of the costs for each of the two cross dams are given in Appendix V.

Table 9.1: Cost estimate for cross dams (base costs)

	Nijhum Dwip - Hatia (Tk '000)	Damar Char - Hatia (Tk '000)
Materials	78,950	100,876
Labour	3,908	4,509
Equipment	4,600	4,200
Other	2,500	2,500
Total	89,958	112,085
Contingencies	8,996	11,209
Grand Total	98,954	123,294

9.1.2 Embankments and drainage infrastructure

Details for the costs of embankments and drainage infrastructure are given in Chapter 5 and Appendix III. These costs are summarise in Table 9.2.

Table 9.2: Base costs for embankments, sluices and drainage

Unit: Tk '000 (1998)

	HA-1	ND-1	ND-2 & ND-3
Embankments	60,440	25,080	95,368
Sluices	28,632	7,544	36,176
Drainage	3,358	896	5,552
Total	92,430	33,520	137,096

9.1.3 Roads

The cost of the road from South Hatia to southern Nijhum Dwip, in addition to the embankment cost, is estimated at Tk 12.7 million (12.2 km at Tk 1.04 million per km.) In addition, an allowance is made for the construction of minor bridges and culverts at the rate of Tk 5 million per 1,000 ha.

9.1.4 Settlements

Cluster settlements will be required for an estimated 420 households (see Chapter 6.6). A cost estimate for these settlements has been made based on an estimate of the CDSP made in 1997. There will be 14 villages each of 30 households. This estimate, adapted for the Nijhum Dwip Project, is given in Table 9.3.

Table 9.3: Base cost for 14 cluster settlements

Unit: Tk '000 (1998)

Item	Cost per Village	Total Cost
Cluster villages (ponds, raised homesteads)	560	7,840
Deep Tubewells (2 per village)	100	1,400
Latrines	30	420
Access road	15	210
Land Surveying	5	70
Design and Supervision	70	980
Dwelling materials	720	10,080
Administration, Staff Costs, etc.	85	1,190
TOTAL	1,585	22,190

Source: Communication from CDSP, September 1997

The CDSP model has been followed in order to obtain a cost estimate for the project analysis for this particular project component. It may well be that when the requirements for and design of these settlements is finalised several years into the project, some other settlement model may be found to be more appropriate to local circumstances. This should not present a problem provide it is not more expensive than the present estimate.

9.1.5 Fisheries

The proposed fisheries development programme is described in Chapters 6.6 and 7.7. The programme provides extension and training for pond operators. The cost of this five year programme, estimated at Tk 6.7 million, comprises staff and training costs, administrative support and the cost of essential equipment. The costs are summarised in Table 9.4 (see also Appendix IV.3, Table IV.3.9).

Table 9.4: Costs of the fisheries development programme

Item	Annual Cost	Programme Total
Extension and Support Staff	516,000	2,580,000
Training	70,000	350,000
Office/Logistics Costs	354,100	1,770,500
Miscellaneous Expenses(10%)	94,000	470,000
Equipment & Materials	-	968,000
Contingencies (10%)	-	613,850
TOTAL		6,752,350

9.1.6 Livestock

The proposed development programme is described in Chapters 6.6 and 7.5. The cost of this five year programme, estimated at Tk 8 million, comprising Tk 4.8 million for staff, training and support and Tk 3.2 million for a line of credit for livestock improvement activities. The costs are summarised in Table 9.5

Table 9.5: Base costs of the livestock development programme

Item	Annual Cost	Programme Total
Extension and Support Staff	384	1,920
Training / Demonstrations	114	572
Office/Logistics Costs	279	1,397
Miscellaneous Expenses(10%)	78	390
Equipment & Materials		538
Total Programme Cost		4,817
Line of Credit		3,152
TOTAL		7,969

Tk '000

9.1.7 Analysis of project costs

Project costs have been analysed using COSTAB.⁶ The analysis has used the following parameters:

- the project is implemented over a period of 7 years and the phasing of project costs follows the implementation and manning schedules in Chapter 10.1;
- projections for domestic and international inflation are from World Bank estimates of selected macroeconomic indicators made in July 1997 (see Table 9.6);
- the exchange rate used at report preparation is US\$ 1 = Tk 47;
- the analysis uses constant purchasing parity exchange rates for project years;
- physical contingencies are included at 10 per cent for all civil works and development programmes but no contingencies are included for BWDB project overhead and administration costs;
- the foreign exchange component of costs has generally been assumed at 5 per cent for all items where a specific estimate is not made (see Table 9.7);
- cost estimates include taxes, which are estimated based on currently applicable rates for equipment, materials and contractual services (see Table 9.7);

⁶ Costs analysis programme of the World Bank.

- project financing is calculated on the basis of a Foreign Donor financing 100 per cent of foreign exchange costs and not more than 85 per cent of local costs (excluding taxes), except that the GOB is assumed to finance 100 per cent of land acquisition and project overhead and administration costs.

In addition, BWDB administration and project management cost have been included at 7.5 per cent and 2.5 per cent of base costs, respectively.

Table 9.6: Inflation and exchange rates

	to 00	00/01	01/02	02/03	03/04	04/05	05/06	06/07
Annual rates:								
Domestic Inflation (%)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
International Inflation (%)	2.7	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Compounded rates:								
Domestic Inflation (%)	5.0	7.6	13.0	18.7	24.6	30.8	37.4	44.2
International Inflation (%)	2.7	3.9	6.4	8.8	11.5	14.2	16.9	19.7
CPP Exchange Rates	47.0	49.8	51.1	52.4	53.7	55.1	56.5	57.9

Notes: 1/ CPP = constant purchasing parity

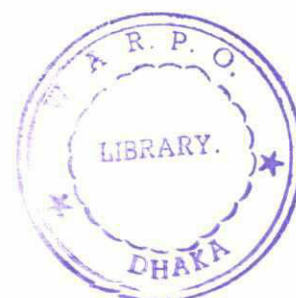
Table 9.7: Taxes, foreign exchange and contingencies

Item	unit: per cent		
	Foreign Exchange	Taxes & Duties	Contingencies
Bank protection works:			
- geotextiles	58	42	10
- other inputs	5	4.5	10
- labour	0	4.5	10
Embankment - materials	5	4.5	10
Land acquisition	0	4.5	10
BWDB overheads	0	0	0

Total project baseline costs are estimated at Tk 525.9 million (US\$ 10.9 million) for the single cross dam option and Tk 656.3 million (US\$ 13.7 million) for the two cross dam option. With physical and price contingencies, the totals come to Tk 697.1 million (US\$ 13.1 million) and Tk 892.4 million (US\$ 16.6 million), respectively. Of this amount, foreign exchange costs are estimated at 5.5 per cent for Option 2 and 7.3 per cent for Option 3.

Summaries of project costs for each option are given in Tables 9.8 and 9.9. Further costs analysis is found in the tables in Appendix V.

Under the financing assumptions mentioned above, Government's contribution to the project would be Tk 147.6 million (US\$ 2.8 million) or 21.2 per cent of total costs for Option 2 and Tk 197.2 million (US\$ 3.7 million) or 22.1 per cent for Option 3. The Donor contribution would be US\$ 10.4 million or US\$ 12.9 million, respectively.⁷ The largest expenditures under the project are expected in the first two and final two years of the project, when cross dams would be constructed.



⁷

Alternative distributions of costs are possible and may be estimated, if required.

Table 9.8: Option 2 - Project cost summary

Bangladesh Nijhum Dwip Integrated Development Project									
	(Local '000)		(US\$ '000)		% Foreign Exchange		% Total Base Costs		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	
I. Investment Costs									
A. Civil Works									
1. Cross Dams									
Geotextiles	8,356	8,028	16,384	174	167	341	49	49	3
Geotextile transportation	331	318	650	7	7	14	49	-	-
Other materials	62,850	3,308	66,158	1,308	69	1,377	5	5	13
Equipment	4,589	242	4,830	95	5	100	5	5	1
Labour	4,103	-	4,103	85	-	85	-	-	1
Mobilisation	2,494	131	2,625	52	3	55	5	-	-
Subtotal Cross Dams	82,723	12,028	94,750	1,721	250	1,971	13	13	18
2. Embankments / Water Management									
Materials & Equipment	262,389	13,810	276,199	5,459	287	5,747	5	5	53
3. Other Civil Works									
Roads	48,777	2,567	51,345	1,015	53	1,068	5	7	80
Subtotal Civil Works	393,889	28,405	422,294	8,195	591	8,786	7	7	80
B. Development of Settlements									
Settlements & Dwellings	20,319	1,069	21,389	423	22	445	5	5	4
Water Supply & Sanitation	1,815	96	1,911	38	2	40	5	-	-
Subtotal Development of Settlements	22,135	1,165	23,300	461	24	485	5	5	4
C. Income Generation									
2. Livestock									
Livestock	4,587	56	4,644	95	1	97	1	1	1
Livestock Line of Credit	3,309	-	3,309	69	-	69	-	-	1
Subtotal Livestock	7,897	56	7,953	164	1	165	1	1	2
3. Aquaculture	6,343	102	6,445	132	2	134	2	2	1
Subtotal Income Generation	14,240	158	14,398	296	3	300	1	1	3
D. Project Management									
BWDB Administration /a	31,458	-	31,458	655	-	655	-	-	6
Project Management /b	10,486	-	10,486	218	-	218	-	-	2
Subtotal Project Management	41,944	-	41,944	873	-	873	-	-	8
Total Investment Costs	472,208	29,728	501,936	9,825	619	10,444	6	6	95
II. Recurrent Costs									
A. Protection Works O&M									
Civil Works O&M	23,937	-	23,937	498	-	498	-	-	5
Total Recurrent Costs	23,937	-	23,937	498	-	498	-	-	5
Total BASELINE COSTS	496,145	29,728	525,873	10,323	619	10,942	6	6	100
Physical Contingencies	45,420	2,973	48,393	945	62	1,007	6	6	9
Price Contingencies	117,099	5,775	122,874	1,138	57	1,195	5	5	11
Total PROJECT COSTS	658,664	38,476	697,139	12,406	737	13,143	6	6	120

/a BWDB administration costs - 7.5% of civil works base costs

/b BWDB overhead costs - 2.5% of civil works base costs

Table 9.9: Option 3 - Project cost summary

Bangladesh Nijhum Dwip Integrated Development Project Expenditure Accounts Project Cost Summary									
	(Local '000)		(US\$ '000)		Total	Foreign Exchange	% Total Base Costs		
	Local	Foreign	Local	Foreign					
I. Investment Costs									
A. Civil Works									
1. Cross Dams									
Geotextiles	22,234	21,362	43,597	463	907	49	7		
Geotextile transportation	663	637	1,300	14	27	49	-		
Other materials	137,008	7,211	144,219	2,851	3,001	5	22		
Equipment	8,778	462	9,240	183	192	5	1		
Labour	8,838	-	8,838	184	184	-	1		
Mobilisation	4,988	263	5,250	104	109	5	1		
Subtotal Cross Dams	182,508	29,935	212,443	3,797	4,420	14	32		
2. Embankments / Water Management									
Materials & Equipment	262,389	13,810	276,199	5,459	5,747	5	42		
3. Other Civil Works									
Roads	48,777	2,567	51,345	1,015	1,068	5	8		
Subtotal Civil Works	493,675	46,312	539,987	10,272	964	11,235	9	82	
B. Development of Settlements									
Settlements & Dwellings	20,319	1,069	21,389	423	445	5	3		
Water Supply & Sanitation	1,815	96	1,911	38	40	5	-		
Subtotal Development of Settlements	22,135	1,165	23,300	461	24	485	5	4	
C. Income Generation									
2. Livestock									
Livestock	4,587	56	4,644	95	97	1	1		
Livestock Line of Credit	3,309	-	3,309	69	69	-	1		
Subtotal Livestock	7,897	56	7,953	164	165	1	1		
3. Aquaculture									
Subtotal Income Generation	14,240	158	14,398	296	3	300	1	2	
D. Project Management									
BWDB Administration /a	39,938	-	39,938	831	831	-	6		
Project Management /b	13,312	-	13,312	277	277	-	2		
Subtotal Project Management	53,250	-	53,250	1,108	1,108	-	8		
Total Investment Costs	583,299	47,635	630,934	12,136	991	13,128	8	96	
II. Recurrent Costs									
A. Protection Works O&M									
Civil Works O&M	25,408	-	25,408	529	529	-	4		
Total Recurrent Costs	25,408	-	25,408	529	529	-	4		
Total BASELINE COSTS	608,707	47,635	656,342	12,665	991	13,656	7	100	
Physical Contingencies	55,546	4,764	60,309	1,156	99	1,255	8	9	
Price Contingencies	162,607	13,134	175,741	1,567	126	1,693	7	12	
Total PROJECT COSTS	826,860	65,533	892,392	15,388	1,216	16,604	7	122	

^a BWDB administration costs - 7.5% of civil works base costs

^b BWDB overhead costs - 2.5% of civil works base costs

9.2 Project benefits

9.2.1 Project beneficiaries

The project beneficiaries are all the present inhabitants of the project area. An estimate of the population has been made based on the 1981 and 1991 mauza level census data pro-rated by area. The 1996 population of the project area is estimated at 17,000 comprising an estimated 3,200 households (see Chapter 3.2).

9.2.2 Quantified benefits

The benefits of the Nijhum Dwip Integrated Development Project accrue from the expansion of production in agriculture, livestock, fisheries and forestry that will arise from the project interventions. The benefits quantified for the analysis are:

- agricultural production on existing and new land
- fish pond production
- livestock production
- forest products from the harvesting of mature mangrove forests.

An important feature of any project involving the accretion of new land in the Meghna Estuary is that there is a relatively long time interval between the investment in infrastructure and the commencement of the flow of benefits arising from those investments. In the present case, this problem is partly overcome by adopting an integrated approach to the whole area and through the opportunity to expand production in the area in the short to medium term by clearing mature forest which will be inside future polders. This may be done without impinging on the coastal mangrove margin which is so essential as part of the security system for the population.

Agriculture: Agricultural benefits arise from the increases in crop yields and cropping intensity discussed in Chapter 7.5 together with the increase in total area under cultivation. Total benefits from agriculture (in economic prices) are given in Appendix VI, Table VI.24.

Fisheries: Fisheries benefits included in the analysis are only those from the expansion and improvement of aquaculture in the project area (see Chapter 7.6). Table VI.25 in Appendix VI gives the total benefits from aquaculture.

Livestock: Total livestock benefits are estimated in Appendix VI, Table VI.14.

Forestry: Forestry activities proposed under the project are self-financing - i.e. planting and maintenance activities can be financed from the revenues from the clearing of forest in the proposed new polders. Only net benefits are taken into the analysis. These are in Appendix VI, Table VI.27.

9.2.3 Non-quantified benefits

A number of potential benefits, both quantifiable and non-quantifiable, have not been quantified because data is not available for making the necessary estimates. Several of these may have an impact on overall benefits if quantification were possible. Benefits that are in principle quantifiable but which have not been quantified include:

- potential benefits from improved transportation within the project area and between the area, the rest of Hatia and the wider region have not been specifically quantified
- the effect of the improved safety for the people that embankments will provide

- chicken production has not been included in the livestock benefits because of the difficulties of estimation
- the impact of the construction of cross dams on marine fisheries which may be at least mildly negative, although data is not at present available to estimate the extent of this impact
- the pressure of the increasing population in the area, which is heavily dependent on marine fisheries for its livelihood, on marine fisheries resources and may also have a negative impact.

9.3 Economic analysis

The project life for the economic analysis is 30 years. All prices in the analysis are expressed in constant 1998 US dollars or Taka and an exchange rate of US\$ 1 = Tk 47.00 has been used throughout the analysis. The discount rate is 12 per cent.

A Standard Conversion Factor of 0.902 is used to convert financial to economic prices⁸, for both costs and benefits, except for agricultural labour and the other cases noted below. For agricultural labour, a conversion factor of 0.85 has been used in line with other recent studies.⁹

9.3.1 Prices

Financial and economic import parity prices have been estimated for rice, TSP and potash and export parity prices for urea. These prices are based on World Bank price projections for 2010. The prices are adjusted for quality, transport, handling, marketing, processing and distribution costs to derive both financial and economic farm gate prices. For the economic prices transport, handling, marketing, processing and distribution costs are further adjusted by the standard conversion factor. The relationship between the calculated farm gate financial and economic prices gives a conversion factor for the crop. (see Appendix VI, Tables VI.29 and VI.30)

Where data has been available, prices of other outputs are based on national farm gate price data from the Department of Agricultural Marketing. Current prices have been adjusted to 1997 taka using the food, beverage and tobacco component of the consumer price index published by the Bangladesh Bureau of Statistics. Prices for the four most recently available years have been averaged to obtain the prices used in the analysis. For pulses, a composite price for mung and keshari has been used obtained by weighting the prices of the components according to the relative areas of the respective crops in the project district.

Financial and economic prices for agriculture are summarised in Table 9.10.

For fisheries and forestry, market prices (based on data collected in the project area) have been used.

⁸ Estimated by the World Bank in July 1997 for 1997/98 fiscal year.
⁹ e.g. Kalni-Kushiyara River Management Study, May 1997.

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Table 9.10: Prices for agricultural inputs and outputs (TK/mt)

Crop	Conversion Factor	Financial Price	Economic Price
Traded crops:			
Rice	1.027	6,346	6,515
- aus	1.151	5,658	6,515
- aman	0.967	6,741	6,515
- boro	1.120	5,819	6,515
Wheat	1.022	6,237	6,377
Jute	1.075	9,275	9,968
Non-traded crops:			
Oilseeds (mustard)	0.902	16,712	15,074
Ground nut	0.902	16,793	15,147
Pulses (1)	0.902	11,961	10,789
Chillis (dried)	0.902	51,327	46,297
Sweet Potato	0.902	2,458	2,217
Inputs:			
Urea (2)	0.982	5,860	5,755
Muriate of Potash	0.977	9,277	9,060
TSP	0.978	10,013	9,790
By-products:			
Rice straw	0.902	1,200	1,082
Jute Stems	0.902	2,500	2,255

- Notes: a) Traded crops and inputs based on WB price projections
b) Non-traded crops and inputs (including financial prices for rice) based on four year averages of national farm gate price data.
1) Composite of mung and keshari
2) Existing subsidy on urea assumed to be eliminated in the medium term

9.3.2 EIRR and NPV

The EIRR for Option 2, with only one cross dam, is 12.2 per cent and the NPV is Tk 6.8 million. For Option 3 the EIRR is 10.4 per cent and the NPV is minus Tk 56.3 million. (The calculation is shown in Appendix VI, Table VI.28.)

As currently assessed, Option 3 does not include any additional benefits of the second cross dam since they will accrue too far in the future to have a significant bearing on this analysis. This option must be re-assessed in year 5, prior to its possible implementation. At this time, it should possible to make a more accurate estimate of the expected impact of the Damar Char cross dam on accretion in the project area and therefore of the benefits likely to accrue from this intervention. After 5 years, the dimensions of the required cross dam may also be smaller, which would reduce costs and increase viability.

Several issues need to be noted.

If the case is considered where only the cross dams are constructed and there are no other activities except the planting of mangrove forest - i.e. no construction of embankments, no improvement in agricultural production (because there are no embankments to reduce risks and allow for the gradual reduction in soil salinity), no improvements (or only very limited improvements) in aquaculture or livestock, then the EIRR in both cases is negative. Thus if the only purpose of cross dam construction is to promote accretion (with a significant proportion of the new land being forested) it is not a viable use of scarce resources.

For Nijhum Dwip and South Hatia, cross dam construction can only possibly be viable if it is part of an integrated development package. In the case of the proposed project, the cost of

embankments is a major factor resulting in the low IRR. The project results in an estimated net cultivated area of 5,427 ha. inside polders having 39.7 km of primary and 15.3 km of secondary embankments. This comes to only 99 ha per km of embankment or a per ha embankment cost of about Tk 33,000. Given the low yields that are obtained on these lands, even after quite long periods, this is a high cost. However, without the embankments and the security and potential for improvement that they provide, almost none of the expected project benefits could be achieved.

As has been noted elsewhere in this report, a major issue for any measures to facilitate accretion in the estuary is the long lag between investment and the commencement of a significant flow of benefits. Furthermore, in agriculture and related sectors, improvements in production are inevitably slow because of soil conditions, the isolation of the area and the lack of services and support available to farmers.

Taking these factors together, it might be concluded that a relatively low EIRR (compared with what would be accepted for most projects) is not unacceptable for a project of this type. In such a case, the Nijhum Dwip - South Hatia cross dam can be regarded as viable and could be implemented. The Hatia - Damar Char cross dam should not be implemented unless a review in year 5 shows it then to be economically viable.

9.3.3 Sensitivity analysis

The sensitivity analyses for the two options are given in Tables 9.11 and 9.12. In both cases, the EIRR is relatively more sensitive to benefits than to costs although the impact of individual benefit components, with the exception of agriculture, is rather small. The results also very sensitive to any delay in the benefit flow.

The impact of a combined increase in costs by 10 per cent and shortfall in benefits by 10 per cent reduces EIRR by about 3 per cent for each option. The reverse combination also has an impact at a similar level.

From the tables it is noted that the impact of forestry benefits on EIRR appears to be small. This is because forestry activities are self-financing and only the net benefits are brought into the analysis. This however, does not obviate the previous observation that a project not including integrated development (and the clearing of forests inside future polders) would not be viable.

As mentioned in chapter 10, some foreign technical assistance will most probably be required for the installation of the first, Nijhum Dwip, cross dam. The cost of this possible input has not been included in the analysis. However, it is estimated that it would amount to about US\$ 100,000. Taking into account contingencies and the conversion factor, this comes to just under one per cent of economic costs. This level of additional costs will not have a significant effect on the results of the economic analysis.

9.4 Financial analysis

Implementation of the project is expected to lead to rising household incomes for beneficiaries, although the changes will be relatively slow to appear. Table 9.13 gives the expected changes in household income, based on the assumptions used in the project analysis.



Table 9.11: Sensitivity analysis (EIRR) - one cross dam

	Change in Variable			
	- 20%	- 10%	+ 10%	+ 20%
Base case	12.2			
Total Costs	15.0	13.5	11.1	10.2
O&M Costs	12.3	12.3	12.2	12.1
Total Benefits	7.8	10.1	14.3	16.5
Benefits from:				
- agriculture	9.8	11.0	13.4	14.6
- aquaculture	12.0	12.1	12.4	12.5
- livestock	10.8	11.5	12.9	13.7
- forestry	12.1	12.2	12.3	12.4
Lag benefits 1 year	10.9			
Total Costs & Total Benefits	Costs	Benefits	EIRR	
	+ 20%	- 20%	6.2	
	+ 10%	- 10%	9.1	
	- 10%	+ 10%	15.8	
Switching Values:	EIRR = 12%		Project Life:	
	+ 1.9%		20 years	
Total Costs	- 1.0%		15 years	
Total Benefits			9.5	
			4.6	

Table 9.12: Sensitivity analysis (EIRR) - two cross dams

	Change in Variable			
	- 20%	- 10%	+ 10%	+ 20%
Base case	10.4			
Total Costs	13.0	11.6	9.4	8.5
O&M Costs	10.5	10.4	10.3	10.3
Total Benefits	6.4	8.4	12.3	14.2
Benefits from:				
- agriculture	8.1	9.3	11.5	12.6
- aquaculture	10.1	10.3	10.5	10.6
- livestock	9.1	9.7	11.0	11.7
- forestry	10.3	10.3	10.4	10.5
Lag benefits 1 year	9.3			
Total Costs & Total Benefits	Costs	Benefits	EIRR	
	+ 20%	- 20%	4.9	
	+ 10%	- 10%	7.5	
	- 10%	+ 10%	13.7	
Switching Values:	EIRR		Project Life:	
	-13.3%		20 years	
Total Costs	+8.4%		15 years	
Total Benefits			6.9	
			0.9	

Table 9.13: Agricultural net revenues per hectare (financial)

Unit: Tk/year

		Present & Without Project	With Project 1/
Existing Land	Inside Embankment	6,509	13,681
	Outside Embankment	5,209	8,756
New Land	Year 1	606	606
	Year 5	834	834
	Year 16 - outside	5,209	8,756
	Year 16 - inside	-	13,681

Notes: 1/ With project returns for existing land from project year 16.

2/ For new land, years refer to period from start of cultivation.

Thus, while without the project no major change is expected in the returns to agriculture, with the project, for households inside the proposed polders can expect a doubling in income from agriculture over about 15 years and those outside the polders can expect increases of about 60 - 65 per cent, arising from the impact of improved market access and some effect of the improved protection provided by the coastal forest. Despite the increases, per hectare returns to agriculture will remain modest at best: for households allocated 0.8 ha. by the Ministry of Lands, the increase inside the polders is projected at only Tk 5,700 per year.

Aquaculture will also contribute to rising household incomes. With project implementation, by year 6, the additional area of ponds in the project area is expected to be about 130 ha. Together with the existing 104 ha., this implies a total of 1,150 to 1,200 ponds, or about 1 for every 5 households. Expected per hectare returns for ponds are given in Table 9.14. For those households with ponds, improved aquaculture management and techniques introduced under the project will have a significant impact on incomes.

Table 9.14: Net revenues for aquaculture (financial)

Unit: Tk/year

	Culturable Ponds (carp)	Cultured Ponds (carp)	Shrimp
Per Hectare:			
Present & Without Project	8,500	14,440	8,925
With Project	-	47,630	45,085
Per Pond:			
Present & Without Project	1,700	2,888	1,785
With Project	-	9,526	9,017

Note: Average pond size is 2,000 m².

Improved livestock production under the project will also bring significant benefits to households. For those participating in the intensive livestock activities under the credit programme, annual benefits may range from about Tk 2,300 per year for milch cows to almost Tk 13,000 for intensive broiler chicken production (see Appendix VI, Tables VI.15 to VI.17).

The Livestock Improvement Programme and the improved production and safe conditions in the project area with project implementation will benefit livestock production generally, as already noted. The expected average per household net benefit of this general improvement with the project amount to only Tk 480 per year in year 5 but rise to Tk 6,240 per year in year 15 (see Appendix VI, Tables VI.13).

9.5 Multi-criteria analysis

Relevant data for the multi-criteria analysis is presented in Table 9.15.

If successfully implemented, the project will lead to increases in the production of principal crops. These increases also represent increases in local per capita availability, given the population growth assumptions used in the analysis (see Appendix VI, Table VI.12). However, the full level of increases will only be achieved if water management and drainage infrastructure are properly operated and maintained. Even then, production increases will accrue only over a long period as conditions inside the polders improve.

Table 9.15 : Multi-Criteria Analysis

			Project		
			One cross dam		Two cross dams
1	<u>Economic</u>	Measurable Unit			
	EIRR	Percent (%)	12.2		10.4
	NPV	Million Tk.	6.8		-56.3
2	<u>Financial</u>				
	a. Total Investment Cost	Million Tk.	697		892
	Foreign Ex. Component	Million Tk.	38.5		65.5
	b. O&M Cost (annual)	Million Tk.	5.4		5.4
3	<u>Quantitative</u>		Without	With	Increment
	a. Production	Metric Ton			
	Rice	"	3700	12750	9050
	Wheat	"	-	-	-
	Pulses	"	196	900	704
	Fish (aquaculture)	"	69	445	376
	b. Employment (Farm)	Man-Month	13450	43250	29800

Note: Quantities refer to one cross dam

4. Qualitative		Project	
		With	Without
a.	Physical Environment		
	Accretion	+2	+1
	Erosion	0	-1
	Surface Water Quality	+1	-1
	Reduction in salinity intrusion	+2	0
	Reduction in Cyclone damage	+1	-1
b.	Biological/Ecological		
	Bio-diversity conservation (crop species)	+1	+1
	Bio-diversity (aquatic species)	-1	0
	Fish (Culture)	-2	-1
	Fish (Capture)	-2	-1
c.	Quality of Life		
	Income distribution	+0	0
	Nutrition	+/-	0
	Transport System	+2	0
	Potable Water supply & Sanitation	0	-1
	Housing and settlement	+2	+1
	Health and Disease vectors	+1	-1
d.	Social Impacts		
	Displacement of population/settlement	+1	0
	Impact on women	+1	0
	Impact on Fishermen	-1	0
	Social Conflicts	0	0
	Poverty alleviation	+1	0
	Acceptance by population	+1	0

Rating of Impacts

+ Postive Trend - Negative Trend

0 No change from baseline situation

Note: qualitative impacts are similar for both cross dams

In general, if the project is successfully implemented, the qualitative measures will be either positive or neutral, while if the project is not implemented these measures will tend to be neutral or negative. The social impacts in the with project situation will generally be slightly positive.

9.6 Project risks

If the project is only partially funded, there is a risk that the first cross dam will be implemented and the associated polders will not be developed, or not developed in full, so that sufficient benefits would not be generated to justify the initial investment.

There is also a small risk that the impact of cross dam construction on marine fisheries will be much greater than anticipated, with significant negative consequences. Studies to enhance the knowledge of fisheries in the area have been proposed in volume 6 of the Master Plan report.

There is also a risk that the development of agricultural and livestock production will be less than anticipated and that the benefits accruing to the project will be less than estimated. This could occur because salinity does not decline as quickly as expected (perhaps because of poor water management), access to input and output markets for producers is more slow to develop than expected or for other, unforeseen reasons.

There is a risk of failure associated with the proposed cross dams. However, the design and construction methods proposed for the cross dams are the subject of trials during 1998 at Khorki on Bhola and at Mollakandi near Haimchar. As a result of these trials, the design of components has been modified and additional pilot schemes will be implemented at Hanarchar and Char Montaz. If required, the designs for the project will be further modified on the basis of the performance of these pilot schemes. There is, therefore, reasonable confidence that the interventions will prove to be successful.

9.7 Conclusions and recommendations

With the relatively low cost design and construction approach for cross dams proposed by MES, this feasibility study has demonstrated the economic viability of this type of intervention to promote land accretion in the estuary area. Although the EIRR of Option 2 is only marginally above the opportunity cost of capital, account must be taken of the long lag between investment and the accrual of benefits as well as the accrual of non-quantified benefits such as improved safety for the population and the positive impacts of expanded areas of mangroves.

It is recommended that Option 2 be implemented, including the Nijhum Dwip cross dam, the embankments on south Hatia and Nijhum Dwip and all the associated development activities which are essential to generate the benefits required to justify the interventions.

Implementation of the second cross dam must depend on studies and a review five years after the completion of the first cross dam.

10. PROJECT IMPLEMENTATION

10.1 Time schedule for activities

The proposed schedule of activities for the seven year project is given in Figure 10.1. The major construction activities are foreseen in the first 2 years of the project, these activities will include the construction of the Nijhum Dwip cross dam and the embankments on south east Hatia and southern Nijhum Dwip. In years 6 and 7 the construction of the Damar Char cross dam and the embankment of the remaining parts of South Hatia and Nijhum Dwip has been planned. Activities for fisheries and livestock development are scheduled for the first 5 years of the project.

It is noted that for the implementation of Nijhum Dwip cross dam the procurement and delivery of geotextile materials will be on the critical path. Therefore a separate supply contract will have to be tendered well ahead of award of the civil works contract.

10.2 Technical assistance

Although in the past several cross dams have been constructed in the estuary, recent experience on the part of BWDB staff appears to be very limited. Moreover, the design and installation technology proposed for the closure of the Nijhum Dwip channel have only been used for the Char Montaz Cross Dam Pilot Scheme and as such have not yet been thoroughly tested. The workable period is also very limited compared to the magnitude of the works; strict adherence to a very tight time schedule will be required to ensure timely completion of the closure works.

Therefore, it is strongly recommended to involve foreign experts in planning and supervision of the implementation of the Nijhum Dwip cross dam. The Damar Char cross dam will be implemented 5 years later, since much more experience will have been gained by the Government authorities and local consultants, implementation of this dam should be possible without foreign experts.

Foreign consultancy services may also be required for special studies or projects related to environmental impact assessment, char development and settlement programmes and fisheries. In the medium term this expertise should be made available through WARPO (Estuary and Coastal Zone Management Section) and in the long run through the Integrated Coastal Zone Management Programme.

10.3 Engineering considerations

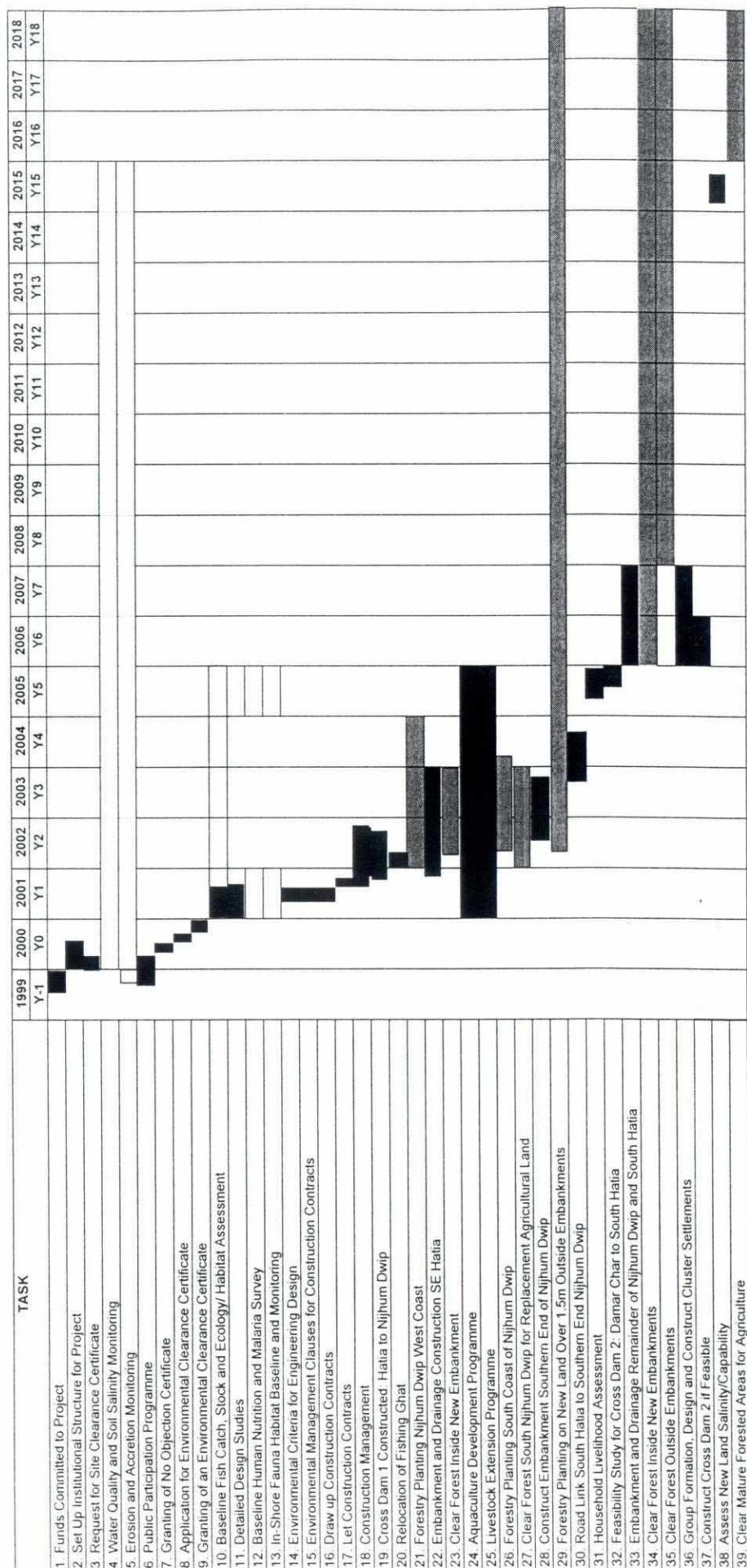
10.3.1 Contractual aspects

Since the Nijhum Dwip cross dam has to be constructed in a mobile channel that is continuously shifting and changing its depth, it is strongly recommended to reimburse the contractor for actual work done and on unit rates as per contract. This implies payment as per progress on the basis of (periodic) re-measurement. Apart from considerations of risk sharing, re-measuring of the works has the advantage that the location of the dam can be shifted without any complication in case morphological changes have occurred.

It is further recommended to pre-qualify only contractors who, besides having the required financial strength, have experience in similar works and, even more importantly, have proven affinity for the type of hydraulic engineering works envisaged.

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Figure 10.1 : Implementation schedule and environmental management programme



LEGEND:
 Full Time Project Activity: ■
 Part Time Project Activity: ▨
 Forest Department Activity: ▤

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If, during detailed evaluation of the tenders for the closure works, it appears that the lowest bidder does not have the required capabilities and manpower, the contract should be awarded to a contractor who has the experience and affinity with the works. Albeit the contractual cost of the cross dams may become higher in case the contract is not awarded to the lowest bidder, the final cost may be far less because the contract could be completed in time, before inclement weather progressively hampers execution of the works.

It is strongly recommended to involve foreign experts, familiar with contracting and execution of engineering works like cross dams, during the process of pre-qualification as well as tender evaluation and award of contract.

10.3.2 Closure operations

The bed levels of the channel vary, in the deepest part of the channel the bed level is approximately - 4.0 m PWD. In the past it was possible to cross the channel at low tide during the winter season, but under the present conditions the minimum water depth will be about 2 metres. However, over a considerable distance the channel bed will be dry or become very shallow.

It is proposed to close the channel between Hatia and Nijhum Dwip with a permeable dam. The permeable dam will consist of A-frames at c.o.c distance of 2.0 m, made of 5 inch diameter G.I steel pipe. The A-frames will be placed on concrete foundation slabs, the slabs will be embedded in a low under water dam of concrete blocks. Between the A-frames geotextile screens will be installed to reduce the flow across the dam. The maximum height of the A-frames will be 6 metres and the permeable dam will have a crest level of +2.0 m PWD.

To prevent scouring close to the under water dam, the bed of the channel will be covered with a geotextile bed protection consisting of a non-woven layer for preventing wash out of bed material and a woven layer to provide the necessary tensile strength to the sheets. The bed protection will be ballasted with concrete blocks and geobags and provided with steel anchors along the edges.

The installation of the bed protection and A-frames will be executed with the help of a special Twin Hull Pontoon that has been design for placing a section of 12 metres bed protection and A-frames during slack water. It should be possible to install two sections of 12 metres per day, taking into account unavoidable delays the weekly progress should be 150 metres. The deeper part of the channel should be closed first. Since the total length of the dam is about 1,100 metres, the time required to install the permeable cross dam with the THP will be 8 weeks.

During installation of the bed protection and A-frames the section of the channel should be reduced as little as possible to avoid scouring of the unprotected bed. Only initial ballasting of the bed protection shall be executed. When the installation by THP has been completed, the under water dam can be completed and finally the geotextile screens will be fixed in between the A-frames.

Besides the THP, auxiliary barges will be required for placing of the under water dam. Two tug boats will be required to handle all waterborne equipment.

Skilled labour (cobblers) will be required for manufacturing of the bed protection and experienced divers have to ensure that all under water connections are properly and securely made.

10.4 Institutional arrangements

The multi-sector nature of the Nijhum Dwip Project, requires it to have an integrated institutional structure for planning and implementation. In the present absence of an authority for carrying out integrated coastal management, it may be necessary to create a special group at project level, rather like that formed for the Jamalpur Refinement Study and the implementation of flood

proofing. Whilst such an institution could come under either WARPO or BWDB, the active participation of LGED, the Ministry of Land, the Forest Department, Ministry of Agriculture, DPHE and the Department of Fisheries would also be required, at the minimum. However, the difficulties experienced by the CDSP in dealing with a large number of government organisations should be borne in mind. In addition such an institution would need to be locally based, probably in south Hatia, to be effective.

10.5 Agriculture, livestock, fisheries and forestry

The implementation of the components of the Integrated Development Project could be carried out directly by the government departments concerned, under the integrated institutional structure outlined in Section 10.4. However, there is a very strong case to be made for using NGO's in this role, due to their experience in operating in such an inter-disciplinary manner and also on Hatia Island.

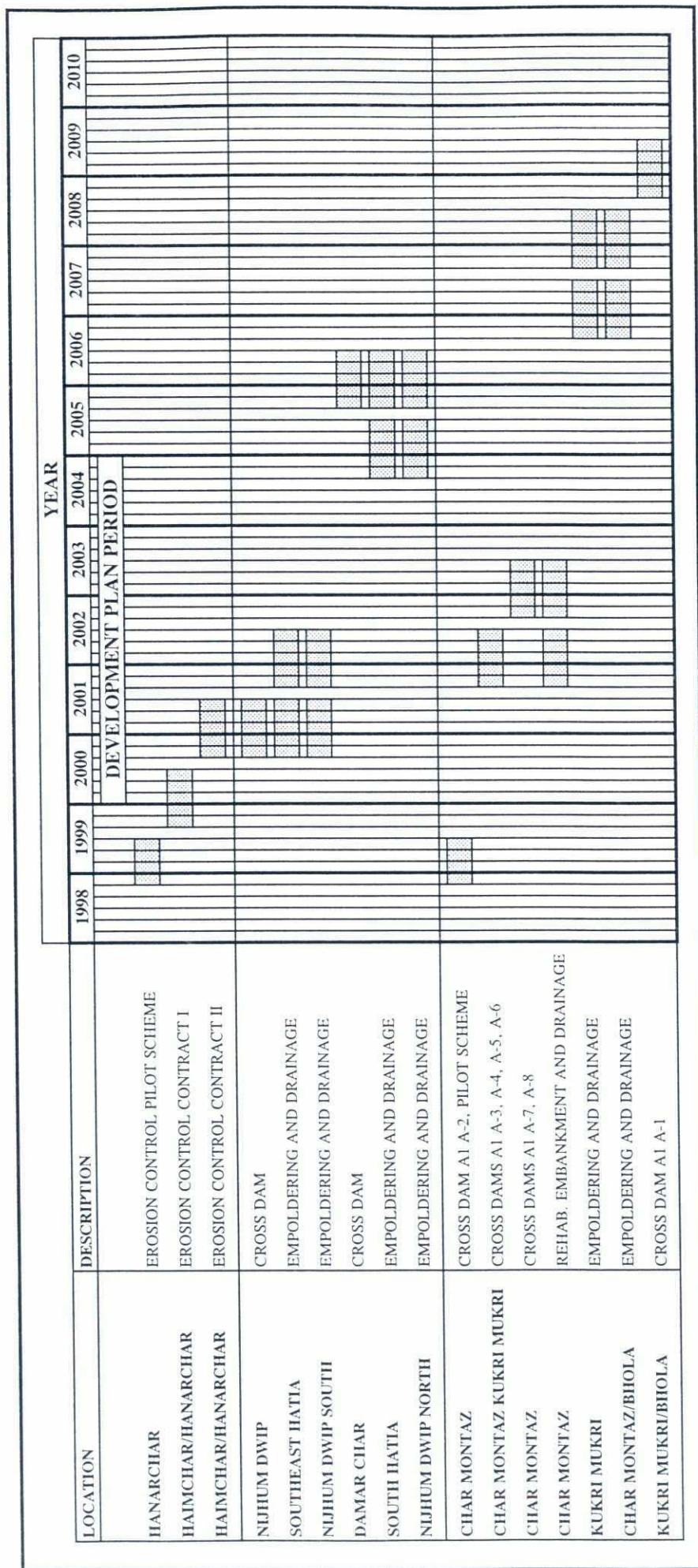
Again the experience of the Jamalpur Refinement Study, where the consultant formed a partnership with local NGO's for some elements of the planning and execution of the works, could be followed. The exception is for forestry, since the Forest Department is very well placed to implement the planting programme as it already has an active presence in the area.

10.6 Beneficiary Participation

As part of the Feasibility Study a needs assessment was made in the project area, covering both different locations within it and different social groups. The results of the needs assessment indicated that the proposed intervention was in line with the priorities of the majority of local people.

It is not now advisable to carry out any more participation work in the area until adequate resources are available and a firm commitment is given to go ahead with implementation of the project. Once this stage is reached an appropriate programme for beneficiary participation can be designed and mobilised.

Figure 10.2 : Overall planning of priority projects



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APPENDICES

MORPHOLOGY

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1. RESEARCH METHODS

1.1 MERIS database and data analysis

For the South-Hatia Nijhum Dwip Feasibility Study the Meghna Estuary Resource Information System (MERIS) has been used to obtain information about morphological and sedimentological, hydraulic and morphometric, hydro-meteorological data, historical bathymetric and coastline maps, and other information regarding the Meghna Estuary system. A substantial portion of the MERIS database is based on data from the field and monitoring surveys, as well as specific project surveys executed by the Survey and Study Division (SSD, a division of LRP) between 1982 and 1994. MERIS also contains data derived from field and monitoring surveys executed by the MES.

Bathymetric data have been used to study cross-sectional developments and changes in sediment volume throughout the period 1988, 1990 and 1993. Estimates of the sediment volume have been based on calculations of interpolated depth values using 100 by 100 metre grid squares derived from the sounding maps. The tides have been studied on the basis of water level data collected over the last decade from the gauge station of Char Chenga. Discharge measurements along the flow transects in the Project Area have provided data on the spatial distribution of discharges and current velocities.

Sediment concentration samples at different heights in the water column, as well as bottom samples, were taken during the flow transect measurements in order to record sediment transport and sediment characteristics.

A time series of satellite images from the period 1973 to 1996 has been used to examine the extent of land and intertidal mudflats for each date and to assess the changes in the Project Area.

To estimate the impact of the cross dam constructions on the hydraulic conditions in the project area a 2D-numerical model has been used. With respect to the Hatia - Damar Char area, it is apparent that the collection of data from 1990 to date are limited and fragmented.

1.2 Estimation of accreted land area

As a consequence of construction of a cross dam, siltation of the channel will occur and accretion of new land will start along the dam and the banks of the closed channels. In such a case, the rate of accretion can be taken as proportional to the instantaneous area which will ultimately emerge:

$$\frac{dA}{dt} = \alpha (A_0 - A) \quad (1)$$

where:

- A = area of accreted land with a certain level above PWD at time t after closure
- A₀ = total area of ultimate accretion
- α = empirical coefficient

Integration yields:

$$A = A_0 (1 - e^{-\alpha t}) \quad (2)$$

At time t=0 dA/dt=α A₀ or α = (dA/dt)/A₀=1/τ where τ is a characteristic accretion time. Thus Equation 2 becomes:

$$A = A_0(1 - e^{(-\frac{t}{\tau})}) \quad (3)$$

1.3 Estimation of characteristic shoaling rate

Once τ and A_0 are known, the initial accretion rate dA/dt of new land can be calculated using Equation 3. The quantity A_0 can be determined from the local situation or from bathymetric maps using results of 2D-hydraulic models. Characteristic shoaling rate 'n' can be determined using the following relationship which describes the shoaling rate due to a cross dam:

$$\frac{dh}{dt} = -\beta * c * T * \left(\frac{u_0 - u}{u_0} \right)^2 h = -n * T * h \quad (4)$$

where

- β = coefficient dependent on dry bulk density, fall velocity, representative value of depth averaged sediment concentration, one representative water depth during relative inundation period
- n = characteristic shoaling rate
- c = average silt content of water
- h = water depth below PWD
- $(\Delta u/u)^2$ = relative reduction of the local flow velocity due to closure
- T = relative inundation time

Equation 4 describes the process of sediment laden water flow in an area with reduced flow. Due to flow reduction, part of the sediment will settle, and will not be eroded again during the next flood or ebb tide. This equation demonstrates that the highest shoaling rate will occur in the deep channels close to the dam where $T=1$ and $(\Delta u/u)^2=1$ and h is the largest. Equation 4 can be solved analytically for channels which are inundated throughout the year ($T=1$) and where there are no tidal flats. Integration of Equation 4 yields:

$$h = h_0 e^{-n*(t-t_0)} \quad (5)$$

where:

- h = reduced water depth below PWD=0 at time t after closure
- h_0 = initial water depth below PWD=0 at t_0

Furthermore, equation 4 indicates that near the dam where the flow reduction is almost 100 per cent, the characteristic accretion time 'n' is equal to:

$$n = \beta * c \quad (6)$$

For intertidal zones where mudflats are present between LLW and HHW, Equation 4 has to be solved numerically. Above LLW (extreme Low Water level) the area is not always inundated which causes a reduction in the relative inundation time per year ($T < 1$). The water depth varies between 0 and HHW-considered bed level (extreme High Water Level). In the case of intertidal areas the relative inundation time T has to be taken into account, which can be derived from long term water level measurements.

Starting at LLW the deposition dh in a certain period can be calculated with Equation 4, taking first estimates of the mean values of T and h in that period. The resulting value should be added to LLW. Starting from the level (LLW+ dh) the deposition in the next period can be calculated and so on. In this way the accretion curve or shoaling curve can be constructed which asymptotically will approach to HHW ($h \rightarrow 0$ and $T \rightarrow \infty$).

The period required for silting up from a certain level at time t_0 to another specified level at time t_1 can be derived from the shoaling curve.

2. PHYSICAL FEATURES

2.1 Tidal movement

The tide in the area of interest is semi-diurnal with the M2 tide and the S2 tide as the major tidal constituents (see Table I.1).

Table I.1: Major tidal constituents of Char Chenga

Constituent Name	Amplitude (m)	Phase (degree)	Remarks
Z0	0.87	-	Mean Water Level (CD)
SSA	0.30	144.9	Half Yearly components
K1	0.10	54.9	Daily components
S2	0.51	100.8	Half daily components
Solar			
M2	1.03	53.9	Half daily components
Lunar			
N2	0.16	9.3	Half daily components
K2	0.17	256.5	Half daily components
M4	0.14	33.2	Shallow Water constituents

Note: Harmonic analysis of observed water level data at Char Chenga during January - July 1997

3. MORPHOLOGICAL DEVELOPMENT

3.1 Net sedimentation rate

The bathymetric maps of 1990 and 1993 (Figures I.1a and I.1b) show that sedimentation is dominant near Damar Char and the southern part of the Nijhum Dwip channel. Erosion is found at the inlet of the Nijhum Dwip Channel from the Shahbazpur Channel side (Figure I.2). Changes in the bathymetry over the period of 1988-1993 indicate that the net natural sedimentation rate in the Project Area is about 0.1 to 0.2 metres per year.

3.2 Stability of the Hatia - Nijhum Dwip channel

Comparison of contour lines and depth contour lines of bathymetric maps of 1988, 1990, and 1993 distinctly show the dynamic behaviour of the Hatia - Nijhum Dwip Channel and adjacent shallow areas (Figures I.1a - I.1c). The width of the Hatia Nijhum Dwip Channel decreases in an easterly direction. The maximum depth of the channel shows a tendency to increase in an easterly direction. In the vicinity, the maximum depth of the channel is about -6 m to -8 m PWD.

The development of the Hatia - Nijhum Dwip channel, is illustrated by changes in cross-sectional area over the period 1987-1993 (Figure I.3). Although there is variation in size and shape of the cross-section between 1986 to 1993, the cross-sectional area did not change significantly (Figure I.4). The cross-sectional area below MSL is about 4000 m². This means that the channel is more or less in equilibrium with respect to discharge. The shape and size of the channel, however, is still changing.

Figure I.1a: Bathymetric survey (depth contours) around South Hatia-Nijhum Dwip in 1988

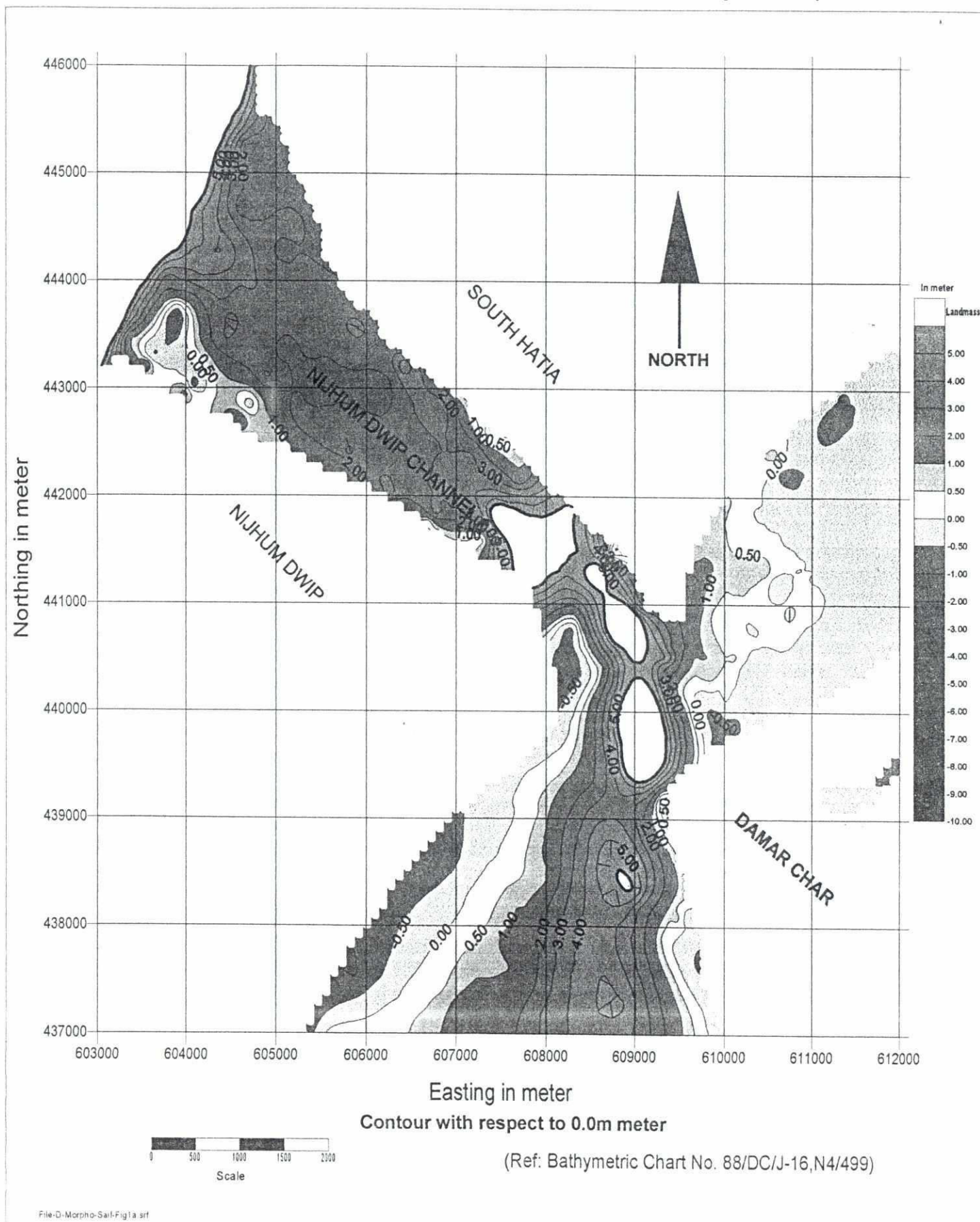


Figure I.1b: Bathymetric survey (depth contours) around South Hatia-Nijhum Dwip in 1990

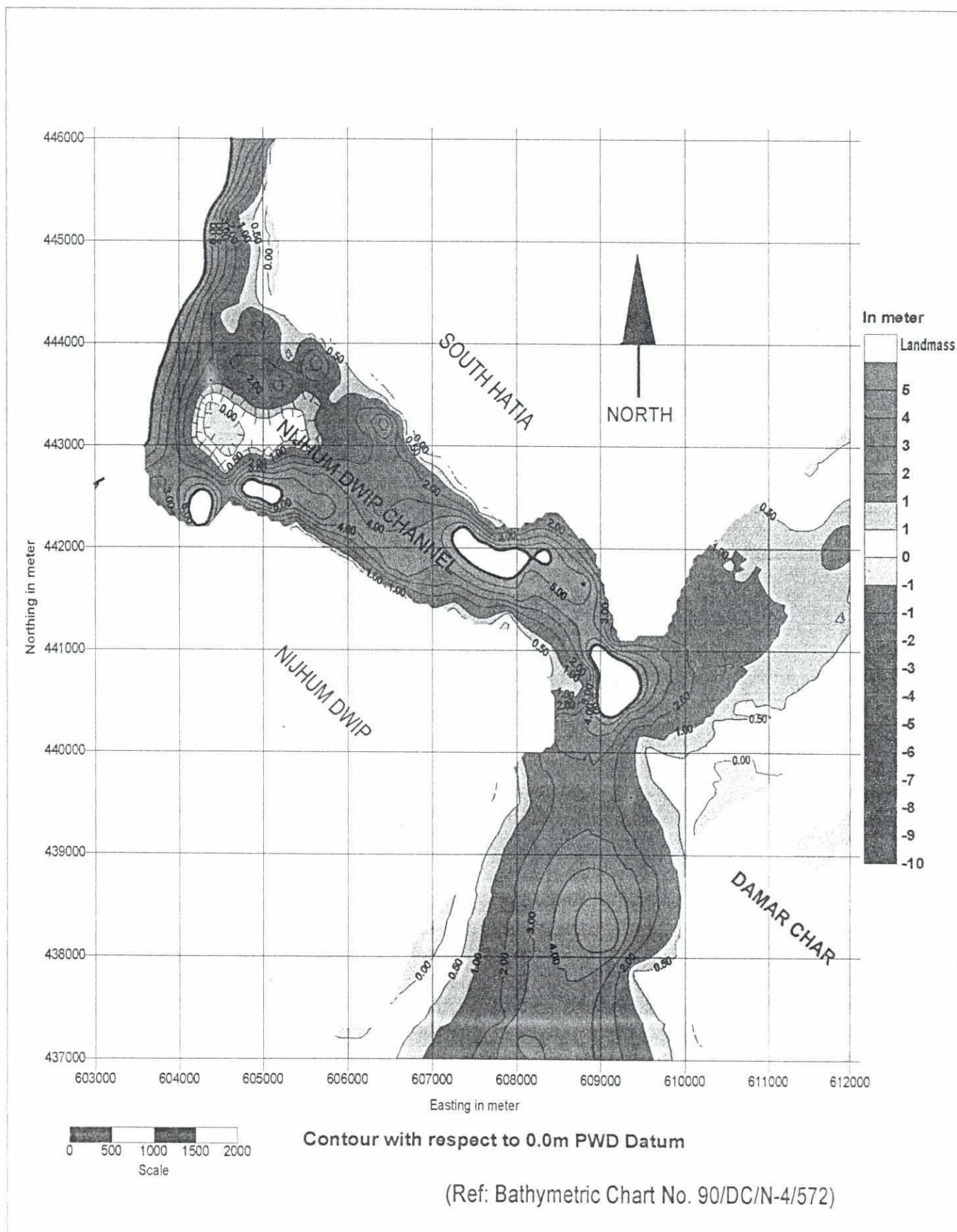
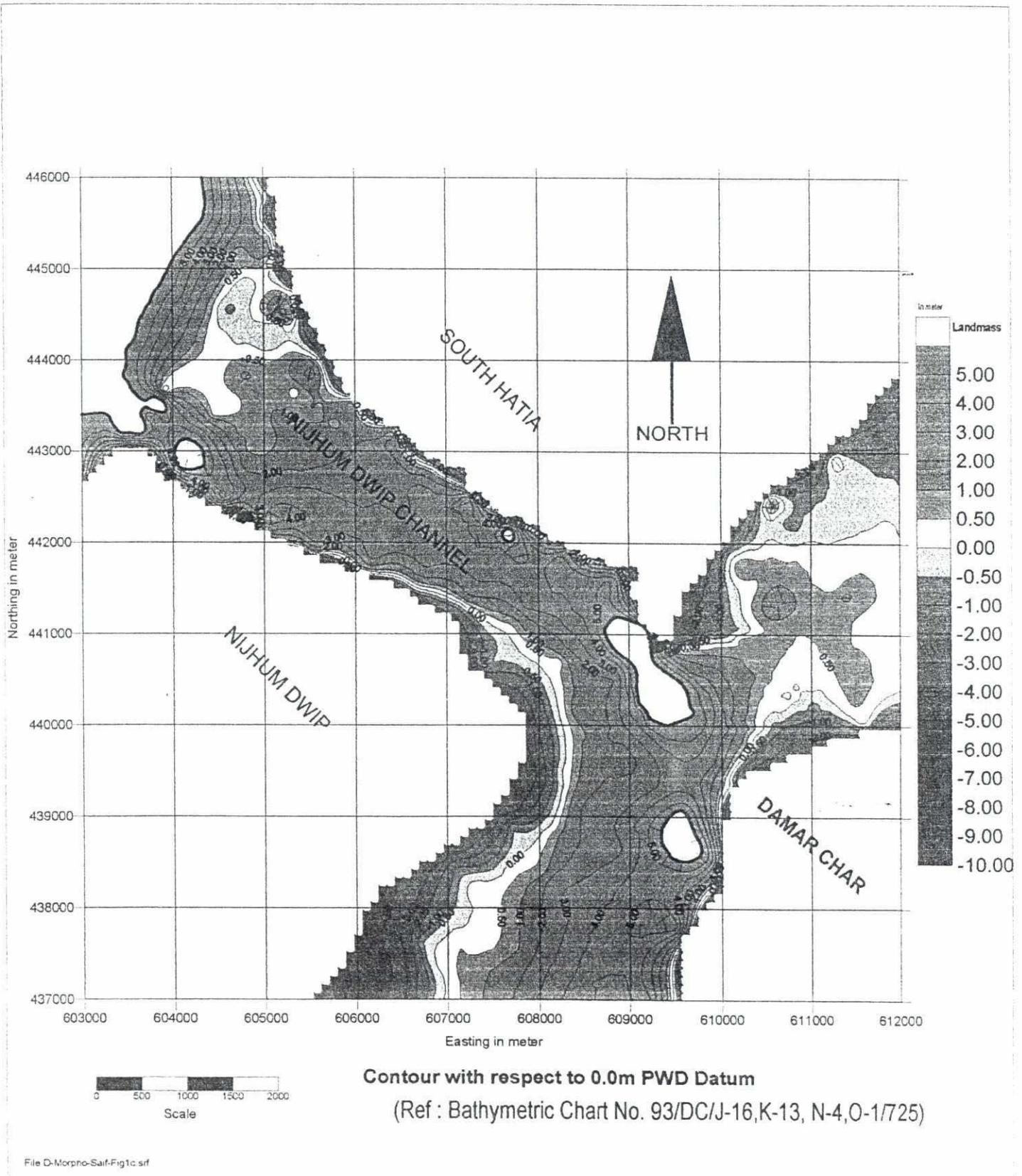


Figure I.1c: Bathymetric survey (depth contours) around South Hatia-Nijhum Dwip in 1993



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Figure I.2: Morphological change around South Hatia-Nijhum Dwip between 1990 and 1993

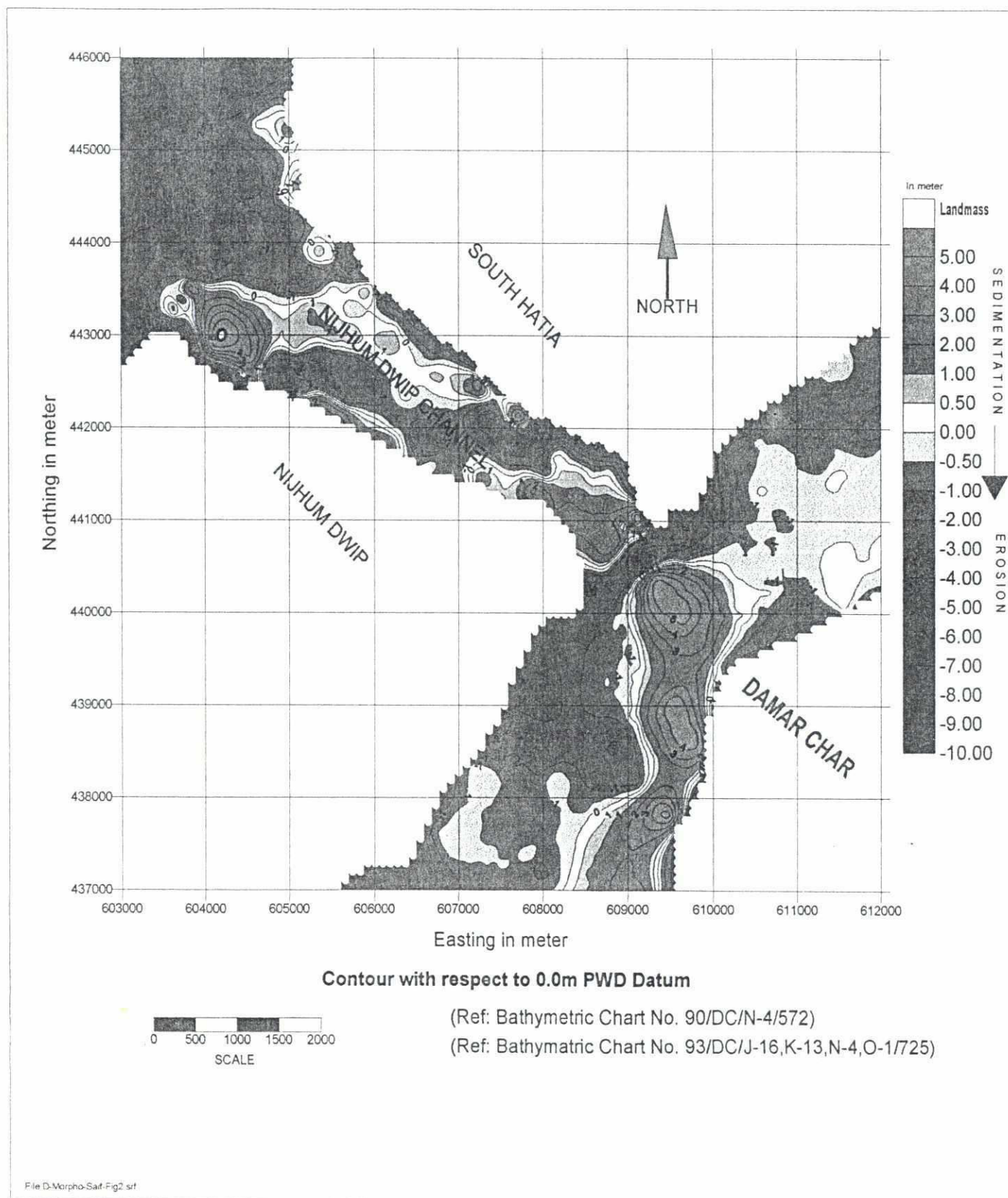
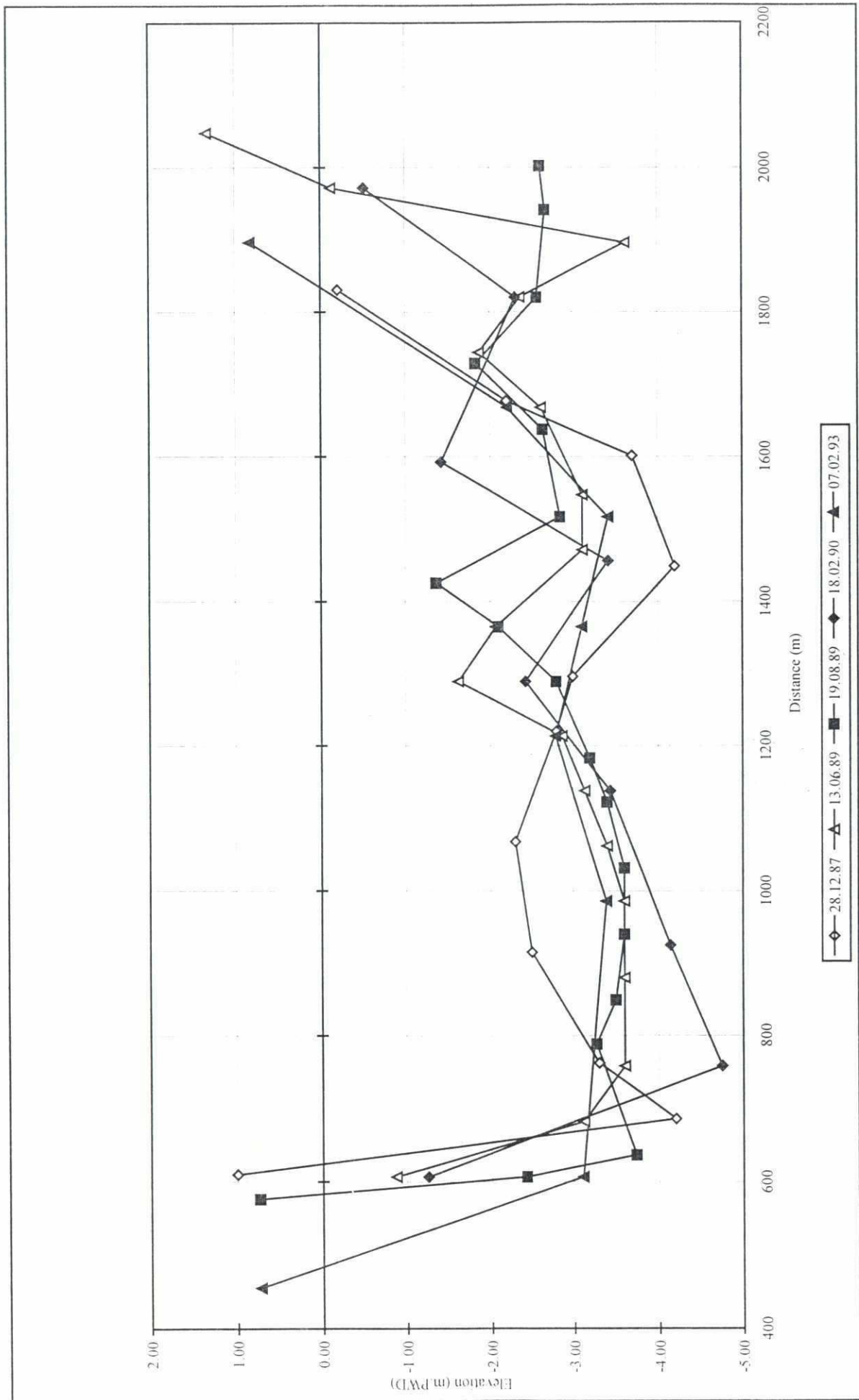


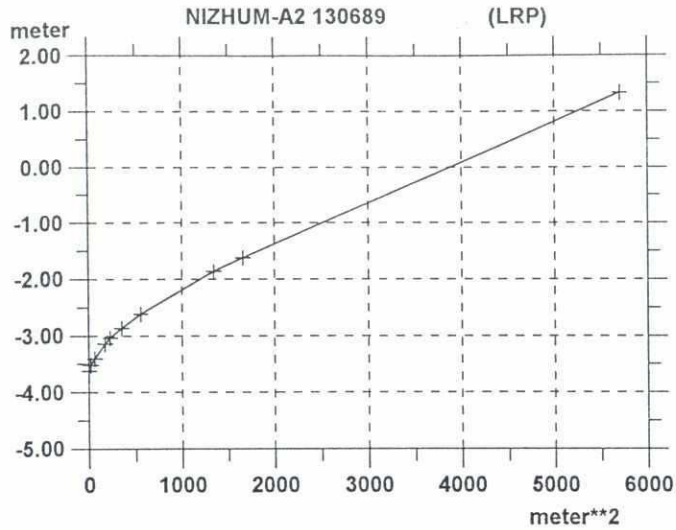


Figure I.3 : Cross-sections between South Hatia and Nizhumdwip during 1987-1993 at cross dam location

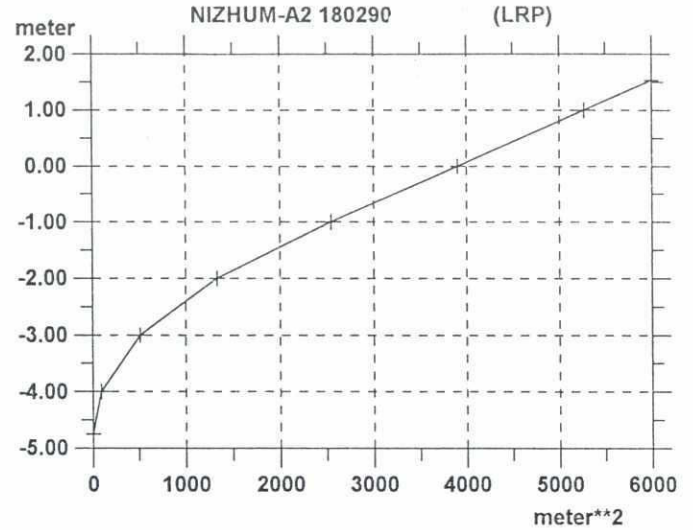


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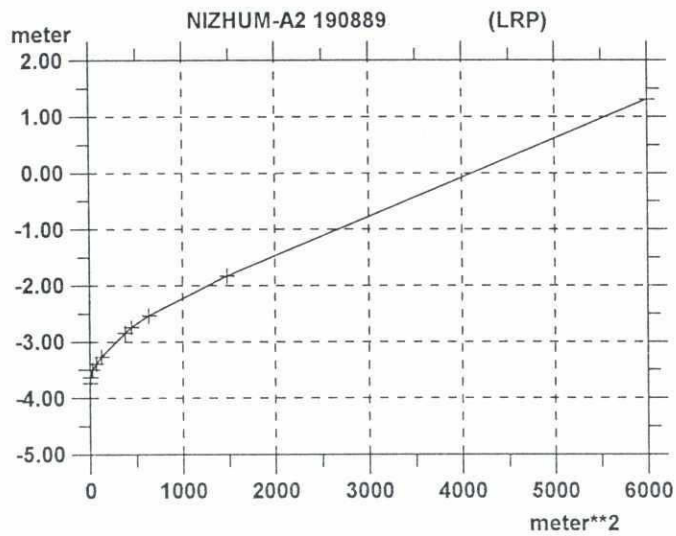
CROSS-SECTIONAL AREA



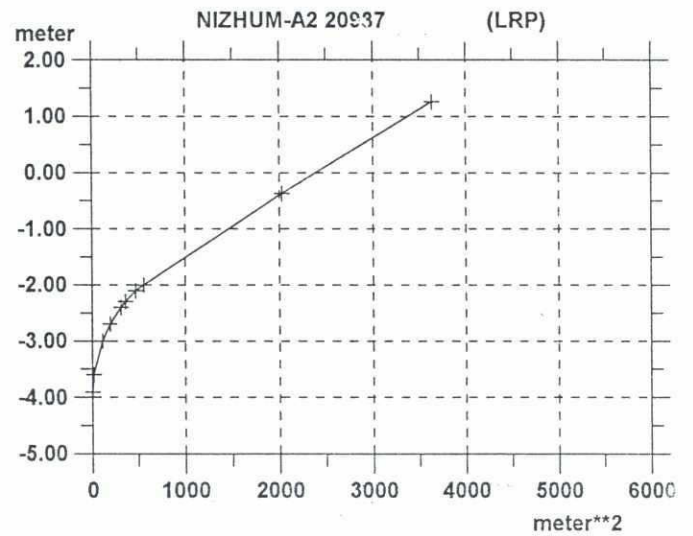
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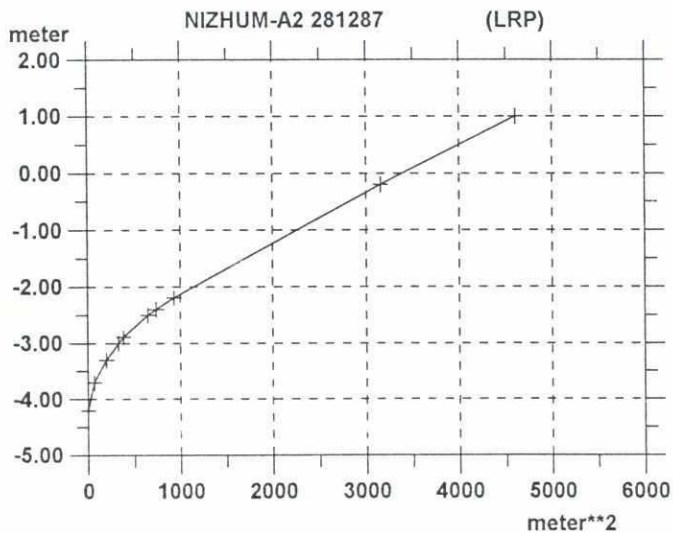
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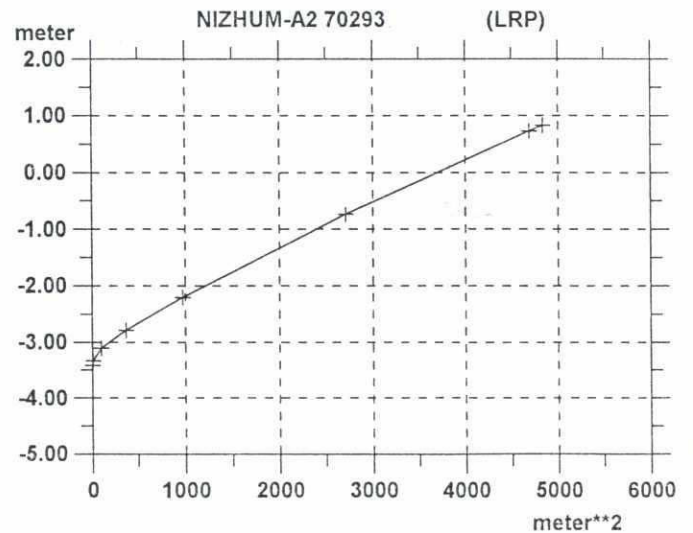
CROSS-SECTIONAL AREA



CROSS-SECTIONAL AREA



CROSS-SECTIONAL AREA



		MIKE 11
		Drawing no

3.3 Land levels

Land levels of south Hatia

The topography of the area is generally flat and closely related to the accretion and reclamation history of the land. Land levels of the low lying land located outside the existing embankment vary from some +1.5 m PWD at approximately the HW line up to some +2.9 m PWD near the existing embankment (Figure I.6).

Characteristic land levels for land use

Table I.2 shows the characteristic land levels for land use in the project area. Areas with a level of +2.2 m PWD are used as agricultural land and suitable for embanking. Land above the level +2.2 m PWD remains inundated for less than 10 per cent of the time (Figure I.5).

Land which reaches a level of about +1.1 to +1.5 m PWD can be used for mangrove forest. This land level will remain inundated for about 50 per cent of the time.

Table I.2: Characteristic land levels for land use

Level rise (m above PWD)		Potential land use		
from	to			
below LLWS	+1.5	A	To	B'
Below LLWS	+2.0	A	To	B''
Below LLWS	+2.2	A	To	C
+1.5	+2.0	B'	To	B''
+1.5	+2.2	B'	To	C

A = channel area and mud flats (<PWD + 1.5 m)

B' = low lying saline land and mangrove forest (>PWD + 1.5m and <PWD + 2.0 m)

B'' = single crop poor agricultural land (>PWD + 2.0 m and <PWD + 2.2m)

C = agricultural land suitable for embanking (>PWD + 2.2 m)

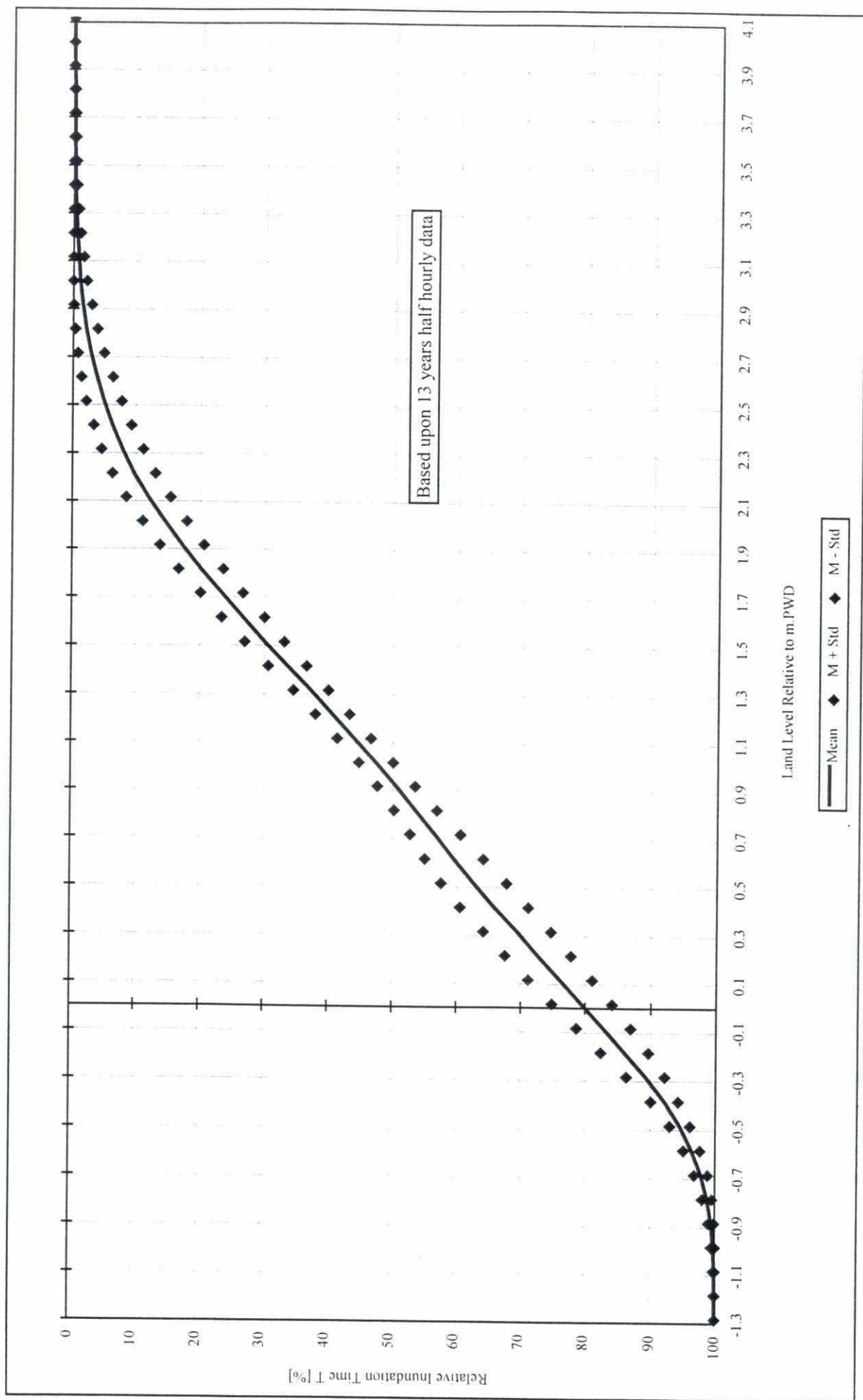
3.4 Land formation and char development

Land formation and Char development over the period 1973/74-1996 has been estimated from satellite imagery (Table I.3). The net rate of newly accreted land is about 68 ha per year. The net average gain of intertidal area is about 114 ha per year.

Table I.3: Land formation and char development, 1973/74 to 1996

	Area (ha)	Rate (ha/year)	Net average rate (ha/year)
Gain of land	3,298	143	68
Loss of land	1,730	75	
Gain of intertidal area	3,457	150	114
Loss of intertidal area	840	37	

Figure I.5 : Exceedence Frequency Curves for Char Chenga



Topographic map of the Nijhum Dwip area in Bangladesh, showing elevation contours, water bodies, and infrastructure. The map includes labels for 'Hatia', 'Damar Char', and 'Nijhum Dwip'. A legend box in the top right corner provides details on the datum, scale, and symbols used. A north arrow is located to the left of the legend. The map is overlaid with a grid with coordinates ranging from 450K to 620K on the horizontal axis and 600K to 620K on the vertical axis.

Legend:

- Levels to PWD Datum, based at Char Chenga = 1.17m above 1992 Mean Sea Level
- Source:
 - X SRP 1994
 - X Finmap 1:10000 1992/94
 - LRP 1990
 - Embankment
 - Canals/Khals

Scale: 0 to 5 Km

Base Map Source—Landsat Imagery Feb'96

4. MORPHOLOGICAL IMPACT OF CROSS DAMS

Expected new accreted land on an intermediate time scale has been estimated based upon the long term rate of natural gain of land (Table I.4). Based upon the analysis of satellite imagery over the period 1973/4 to 1996, the average rate of gain of intertidal area is about 114 ha per year.

Table I.4: Option 1 – Expected morphological development, intermediate time scale

Years	Newly accreted intertidal area (ha)	Newly accreted land* (ha)
0	0	0
5	569	341
10	1,137	681
15	1,706	1,022
20	2,275	1,363
25	2,844	1,704
30	3,412	2,044

* New accreted intertidal area is not included

To predict the accretion rate due to the construction of the cross dams, a number of parameters have to be determined, such as the ultimate area of accretion A_0 , the coefficient 'n' of Equation 4 and 5 and the characteristic accretion time τ of Equation 3.

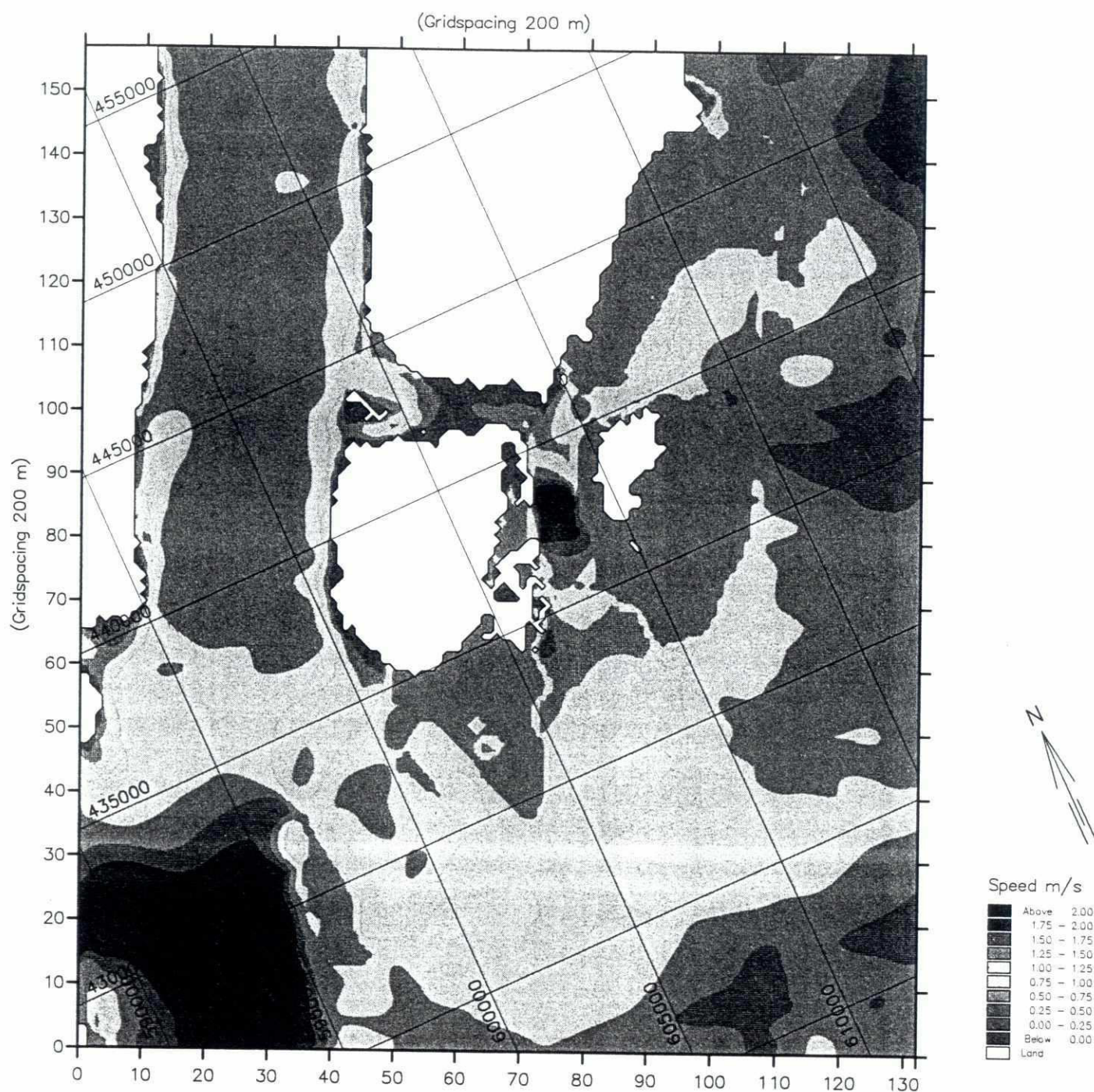
The impact of the cross dam on the flow velocities is estimated by using 2D-hydraulic model computations with and without cross dams (Figures I.7a – I.7c). From the simulations it is known that the cross dams will accelerate accretion because flow velocities in the closed channel section will be drastically reduced. Near the dam the flow reduction will be almost 100 per cent.

For accretion at dam sites, a mean sediment content of 1,650 mg/l is taken. It is assumed that in the areas with very low flow velocities about 50 to 70 per cent of the sediment in the water settles out and the dry bulk density of the deposits will amount to about 1,200-1,300 kg/m³. With 706 tides per year, a shoaling period can be estimated:

$$n = \frac{0.60 * 1.650 * 706}{1250} = 0.55$$

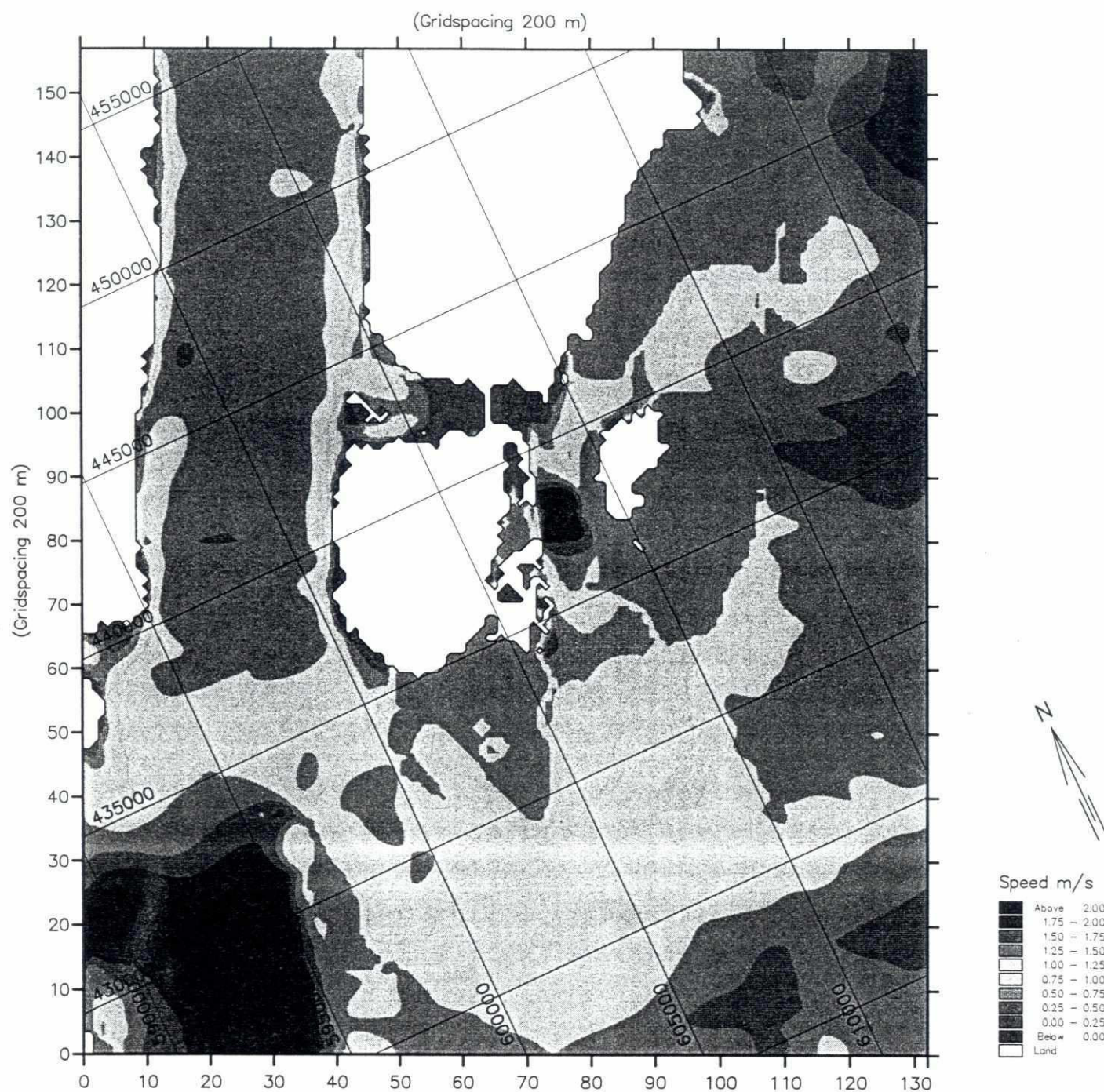
For the calculation of the characteristic periods for land level rise a (conservative) characteristic shoaling rate 'n' of 0.55 per year is taken.

Figure I.7a : Hydraulic model computations – as intervention



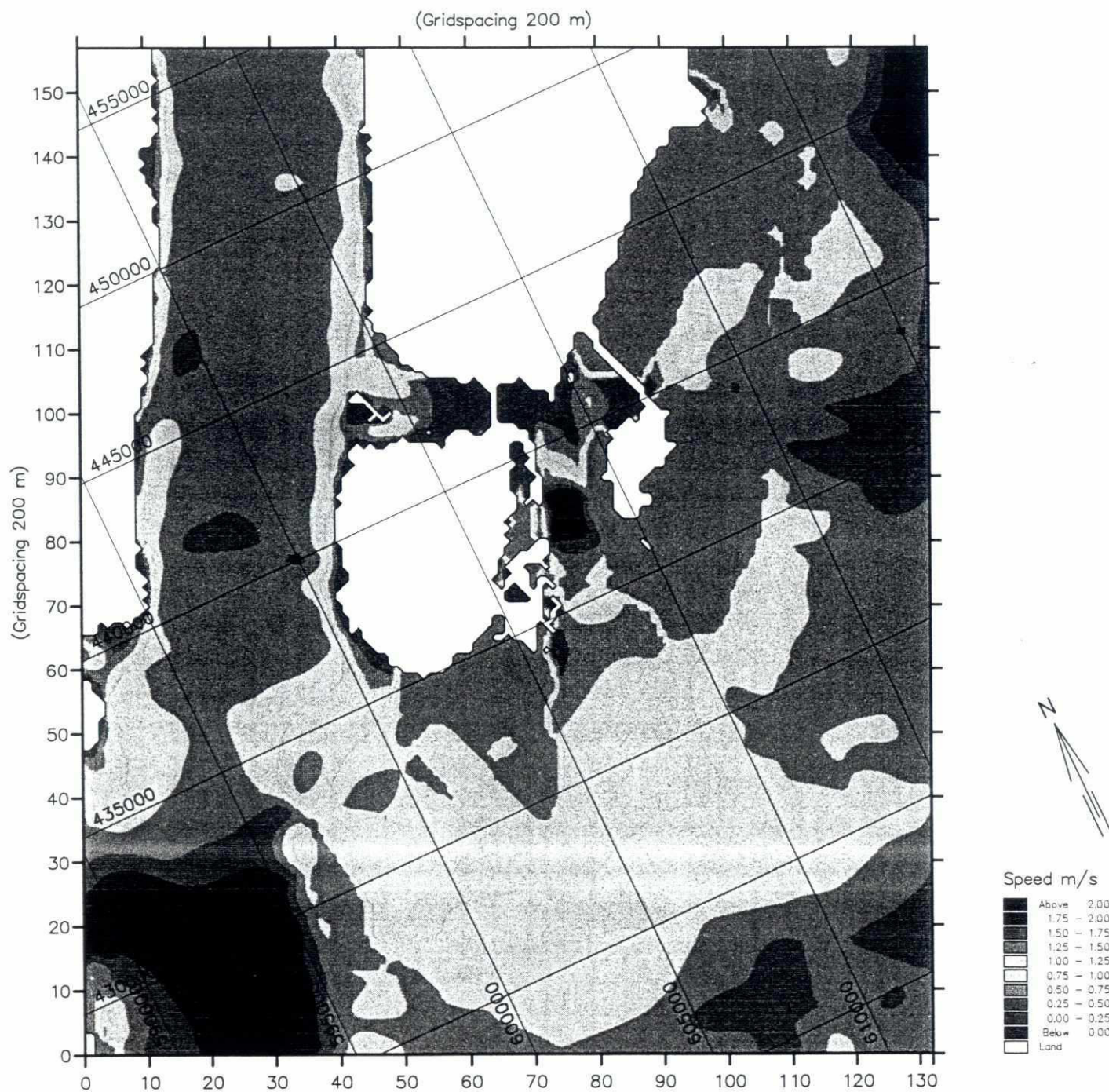
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		Project:	Meghna Estuary Study		
File:	Date: Tue Oct 20 1998	Maximum velocity for base condition Period : 06.02.96 to 08.02.96			Drawing no.
Scale: 1:185000	Init: p5011				

Figure I.7b : Hydraulic model computations – cross dam 1



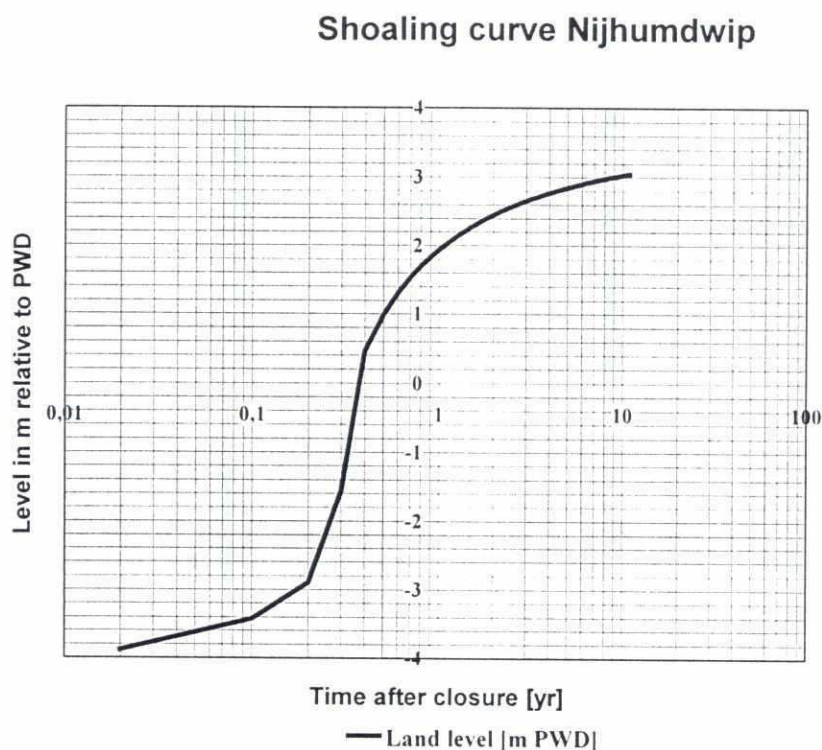
SWMC		Client:	Bangladesh Water Development Board	MIKE 21
		Project:	Meghna Estuary Study	
File:	Date: Tue Oct 20 1998	Maximum velocity with cross dam between South Hatia and Nizhum Dwip		Drawing no.
Scale: 1:185000	Init: p5011			

Figure I.7c : Hydraulic model computations – cross dam 1 and 2



SWMC		Client:	Bangladesh Water Development Board		MIKE 21
		Project:	Meghna Estuary Study		
File:	Date: Tue Oct 20 1998	Maximum velocity with cross dam between South Hatia and Nizhum Dwip & between South Hatia and Damar Char			Drawing no.
Scale: 1:185000	Init: p5011				

Figure I.8: Expected shoaling of channels and tidal flats due to cross dam construction



Note: $n = 0.55 \text{ yr}^{-1}$

In Figure I.8 the bed level rise in areas with strong flow reductions has been plotted which represents Equation 5 with $n=0.55 \text{ yr}^{-1}$ for channel areas and the numerical solution of Equation 4 for the intertidal zone. Figure I.10 shows the time that is required for the bed to rise from a certain level to another higher level in an area with strong flow reduction. Above LLW the area is not always inundated, which causes a reduction in the relative inundation time per year. Relevant time periods related to characteristic levels for land use are shown in Table I.5.

Table I.5: Characteristic periods for land level rise

Level rise (m above PWD)		Period $t-t_0$ (years)	Potential land use		
From	to				
below LLWS	+1.5	1.0	A	to	B'
below LLWS	+2.0	1.5	A	to	B''
below LLWS	+2.2	1.8	A	to	C
+1.5	+2.0	0.5	B'	to	B''
+1.5	+2.2	0.3	B'	to	C

A = channel area and mud flats ($< \text{PWD} + 1.5 \text{ m}$)

B' = low lying saline land and mangrove forest ($> \text{PWD} + 1.5 \text{ m}$ and $< \text{PWD} + 2.0 \text{ m}$)

B'' = single crop poor agricultural land ($> \text{PWD} + 2.0 \text{ m}$ and $< \text{PWD} + 2.2 \text{ m}$)

C = agricultural land suitable for embanking ($> \text{PWD} + 2.2 \text{ m}$)

The areas with strong flow reductions for which the above periods are valid, have been estimated from the bathymetric maps and from the 2D-hydraulic flow model computations with just cross dam 1 and also cross dam 1 and 2 together (Tables I.6 and I.7). These areas with strong flow reductions are preferred areas of accretion after implementation of the cross dams. Tables I.6 and I.7 provide the initial accretion rates in different areas after the construction of closure dam(s). Division of the ultimate accretion area A_0 by the initial accretion rates yields the characteristic accretion time τ . Tables I.6 and I.7 show, for the construction of cross dam options, a number of relevant quantities for the accretion computations derived from applying

Equation 3.

Table I.6: Relevant quantities for accretion computation – Option 2: cross dam 1

Area of ultimate accretion A ₀ (ha)		Initial accretion area* (ha)	Accretion level (m above PWD)	Characteristic shoaling (n = 0.55) period in yr	Average initial accretion rate in ha/yr	Characteristic accretion time in years
A1	850	400	1.5	1.0	400	2.1
			2.0	1.5	267	3.2
			2.2	1.8	222	3.8
A2	500	420	1.5	1.0	420	1.2
			2.0	1.5	280	1.8
			2.2	1.8	233	2.1
A3	405	380	1.5	1.0	380	1.1
			2.0	1.5	253	1.6
			2.2	1.8	211	1.9
A4	5,060	100	1.5	1.0	100	50.6
			2.0	1.5	67	75.9
			2.2	1.8	56	91.1
A5	3,116	100	1.5	1.0	100	31.2
			2.0	1.5	67	46.7
			2.2	1.8	56	56.1
Total Area	9,931					

Note: Initial accretion area based upon 2D-hydraulic model computations with cross dam 1

Table I.7: Relevant quantities for accretion computation, Option 3 – cross dams 1 and 2

Area of ultimate accretion A ₀ in ha		Initial accretion area in ha	Accretion level (m above PWD)	Characteristic shoaling (n = 0.55) period in yr	Average initial accretion rate in ha/yr	Characteristic accretion time t in year
A1	850	400	1.5	1.0	400	2.1
			2.0	1.5	267	3.2
			2.2	1.8	222	3.8
A2	500	420	1.5	1.0	420	1.2
			2.0	1.5	280	1.8
			2.2	1.8	233	2.1
A3	405	380	1.5	1.0	380	1.1
			2.0	1.5	253	1.6
			2.2	1.8	211	1.9
A4	5,060	250	1.5	1.0	250	20.2
			2.0	1.5	167	30.4
			2.2	1.8	139	36.4
A5	3,116	150	1.5	1.0	150	20.8
			2.0	1.5	100	31.2
			2.2	1.8	83	37.4
Total Area	9,931					

Note: Initial accretion area based upon 2D-hydraulic model computations with cross dams 1 and 2

Results of the accretion computation, showing the areas that will be accreted in different years after the construction of the Nijhum Dwip cross dam, are shown in Table I.8.

Results of the accretion computations for the two cross dams (Option 3) are shown in Table I.9. A summary of the morphological impact due to construction of the cross dams is given in Table I.10.

Table I.8: Option 2 Cross dam 1

T ₀ = 2000 Years	West side of cross dam 1 A1 = 850 ha				East side of cross dam 1 A2 = 500 ha				East side of cross dam 1 A3 = 405 ha				East side of cross dam 1 A4 = 5060 ha				East side of cross dam 1 A5 = 3116 ha				Total Area 9930 ha			
	1.5	2.0	2.2	0	1.5	2.0	2.2	0	1.5	2.0	2.2	0	1.5	2.0	2.2	0	1.5	2.0	2.2	0	1.5	2.0	2.2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	769	673	620	620	493	470	452	401	387	375	375	323	476	323	270	462	316	266	266	2,601	2,168	1,983	1,983	
10	842	813	788	788	500	498	495	405	404	403	403	625	907	625	526	855	600	509	509	3,510	2,940	2,721	2,721	
15	849	842	833	833	500	500	500	405	405	405	405	907	1,298	907	768	1,191	855	731	731	4,243	3,510	3,237	3,237	
20	850	848	845	845	500	500	500	405	405	405	405	1,172	1,652	1,172	998	1,476	1,085	935	935	4,883	4,010	3,683	3,683	
25	850	850	849	849	500	500	500	405	405	405	405	1,420	1,973	1,420	1,215	1,719	1,291	1,121	1,121	5,447	4,465	4,089	4,089	
30	850	850	850	850	500	500	500	405	405	405	405	2,263	1,652	1,652	1,420	1,926	1,476	1,291	1,291	5,944	4,883	4,465	4,465	

Note : It is realistic to assume that the part of the accreted land will include small tidal creeks or drainage canals. Therefore, the calculated areas should be reduced by some 10 per cent for the levels of PWD +2.0 and +2.2 m and by some 20 per cent for the level of PWD + 1.5 m.

Table I.9: Option 3: Cross dam 1 and after five years, cross dam 2

T ₀ = 2000 Years	West side of cross dam 1 A1 = 850 ha			East side of cross dam 1 A2 = 500 ha			East side of cross dam 1 A3 = 405 ha			North side cross dam 2 A4 = 5060 ha			South side cross dam 2 A5 = 3116 ha			Total Area 9930 ha			
	1.5	2.0	2.2	1.5	2.0	2.2	1.5	2.0	2.2	1.5	2.0	2.2	1.5	2.0	2.2	1.5	2.0	2.2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	769	673	620	493	470	452	401	387	375	375	476	323	270	462	316	266	2,601	2,168	1,983
10	842	813	788	500	498	495	405	404	403	403	1,584	1,091	919	1,129	778	656	4,459	3,584	3,261
15	849	842	833	500	500	500	405	405	405	405	2,449	1,743	1,485	1,652	1,172	997	5,856	4,661	4,219
20	850	848	845	500	500	500	405	405	405	405	3,125	2,295	1,978	2,064	1,507	1,295	6,944	5,555	5,024
25	850	850	849	500	500	500	405	405	405	405	3,652	2,764	2,408	2,388	1,792	1,557	7,796	6,311	5,718
30	850	850	850	500	500	500	405	405	405	405	4,065	3,162	2,783	2,643	2,035	1,785	8,462	6,952	6,322

Table I.10: Summary results of Options 1, 2 and 3

Unit: ha

T ₀ = 2000 Years	Option 1 2.2	Option 2			Option 3		
		1.5	2.0	2.2	1.5	2.0	2.2
0	0	0	0	0	0	0	0
5	569	2,601	2,168	1,983	2,601	2,168	1,983
10	1,137	3,510	2,940	2,721	4,459	3,584	3,261
15	1,706	4,243	3,510	3,237	5,856	4,661	4,219
20	2,275	4,883	4,010	3,683	6,944	5,555	5,024
25	2,843	5,447	4,465	4,089	7,796	6,311	5,718
30	3,412	5,944	4,883	4,465	8,462	6,952	6,322

5. IDENTIFICATION OF FURTHER INVESTIGATIONS

5.1 Objectives

Within the framework of the MES, three development options for implementing cross dams at south Hatia - Nijhum Dwip, have been described. For each of these options the expected morphological changes around the Hatia - Nijhum Dwip channel and adjacent islands were delineated. With respect to the implementation of these options the following morphological studies and investigations can be identified:

Data collection and field surveys:

- 1a. Topography and bathymetry
- 1b. Hydraulic and morphological data collection
2. Data processing and data analysis
3. Mathematical model investigations
4. Morphological interpretation

5.2 Results

The outcome of the hydraulic and morphological study should be:

1. A quantitative assessment of the accretion and erosion rate along the Hatia - Nijhum Dwip channel and adjacent islands during and after the implementation of the cross dam.
2. An assessment of the closure method and procedures during the various construction stages.
3. To improve the knowledge and understanding of land formation and Char development due to the implementation of cross dams.

5.3 Task description

1. Data collection and field surveys

The morphological and hydraulic impact due to closure and implementation of the cross dam requires data on:

A. *Topography and bathymetry for the whole project area*

It gives an indication of the sediment budget. All bathymetric data and levelling data should be defined with reference to PWD. New information (coastline, land use, infrastructure) derived from recent remote sensing imagery should be incorporated.

B. *Hydraulic and morphological data*

- Land levelling data along the channel and adjacent islands.
- Water levels, flow velocities and discharge measurements along the channel
- Waves
- Cross-sectional profiles
- Sediment concentrations and grain sizes of suspended sediment, grain sizes of bed sediment

2. *Data processing and data analysis*

Data processing and data analysis include:

- Laboratory analysis of sediment data
- Analysis of current velocities, water levels and bathymetry
- Calculation of the discharge and sediment transport
- Assessment of the accretion and erosion rate along the channel and adjacent islands during and after implementation of the cross dams
- Analysis of the accretion and erosion rate using bathymetric information

3. *Mathematical model investigations*

A 2D mathematical model investigation programme should be executed for the Nijhum Dwip-Hatia - Damar Char area to get an insight in the hydrodynamic and morphodynamic behaviour of the channel under various hydraulic conditions during and after implementation of the cross dam.

The mathematical model investigation should be carried out by the Surface Water Modelling Centre (SWMC).

4. *Morphological analysis and interpretation*

Based on the data analysis and the results of the mathematical investigations, the future morphodynamic behaviour has to be studied and the predictions for accretion and erosion in the channels and intertidal zones have to be updated and corrected where necessary.

REFERENCES

- [1] Feasibility study on south Hatia Cross dams, Land Reclamation Project, December 1990.
- [2] Bruun, P. 1978. The stability of tidal inlets; Theory and engineering, Developments in geotechnical engineering, vol 23., pp. 510.

ENGINEERING DESIGNS

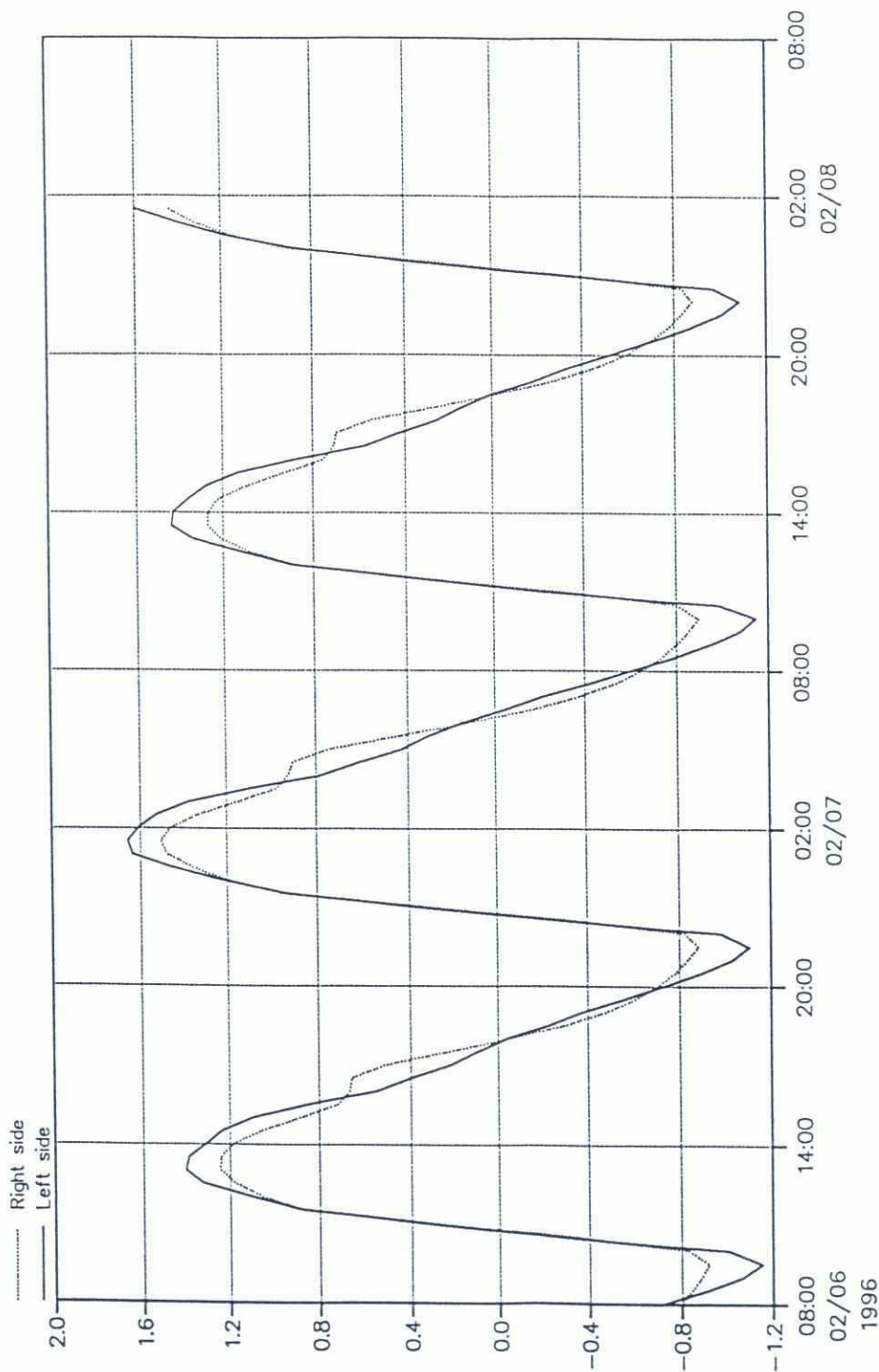
1. RESULTS OF COMPUTER SIMULATION WITH MIKE21

The water levels and discharges in the channel between Hatia and Nijhum Dwip have been simulated with the help of the two-dimensional hydrodynamic model MIKE21 by the Surface Water Modelling Centre. The results of the simulations are given in the next pages.

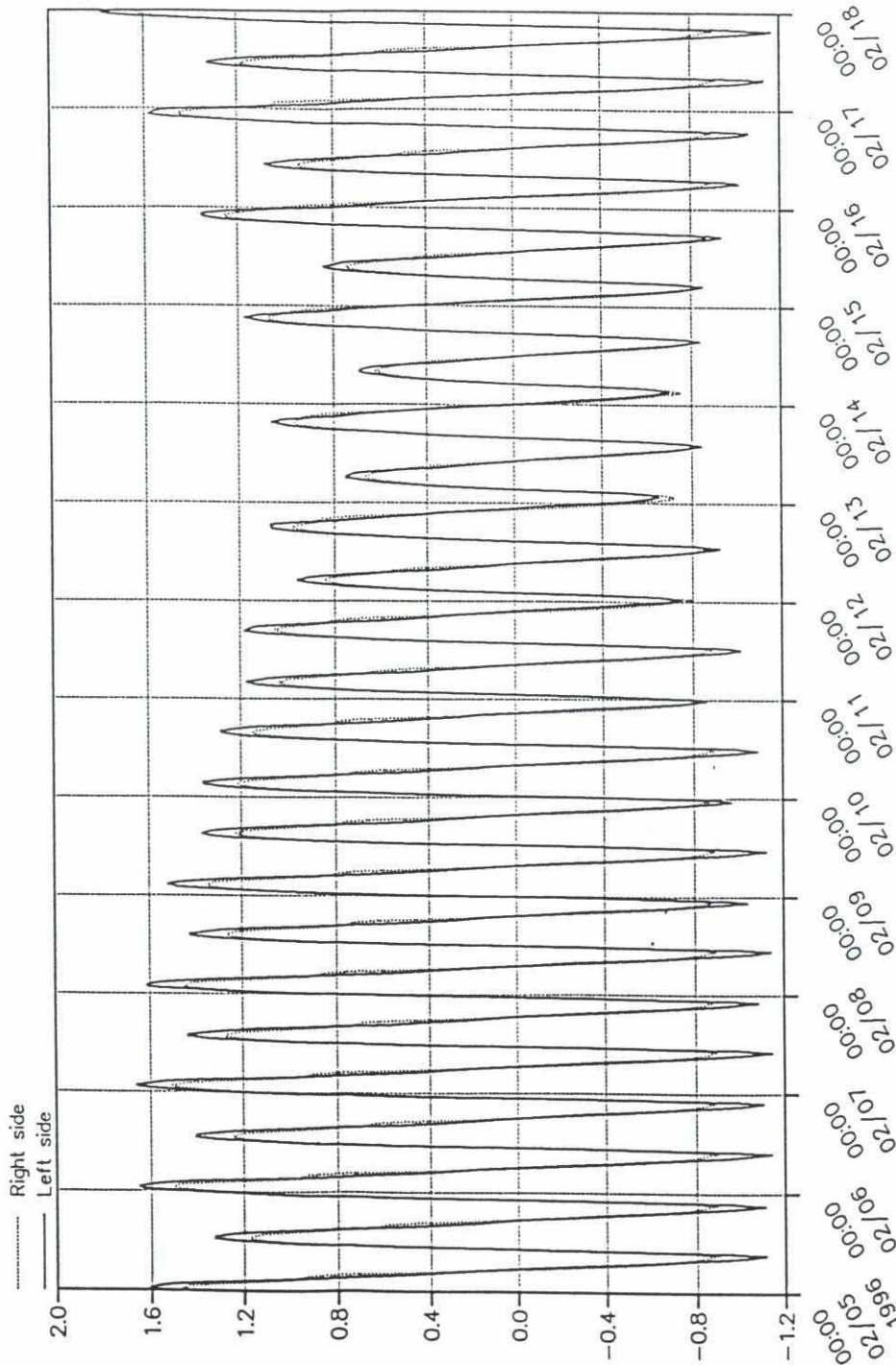
The calculations for the winter season have been performed on the basis of detailed model that has a grid spacing of 200 metres. The results indicate that the maximum head difference after closure of the dam will be about 0.2 metres at high tide and about 0.3 metres at low tide.

For the monsoon season the calculations have been done with the 600 metre grid model. Due to calculated phase differences in the water levels in the main channels east and west of the cross dam, the head differences become unrealistically high. Neglecting the differences in phase, an interpretation of the results of the simulations indicates head differences during the monsoon season in the order of 0.20 - 0.30 metres. These figures have to be confirmed after the model has been updated with the bathymetry of the shallow areas; the calculation should be based on the 200 metre grid model.

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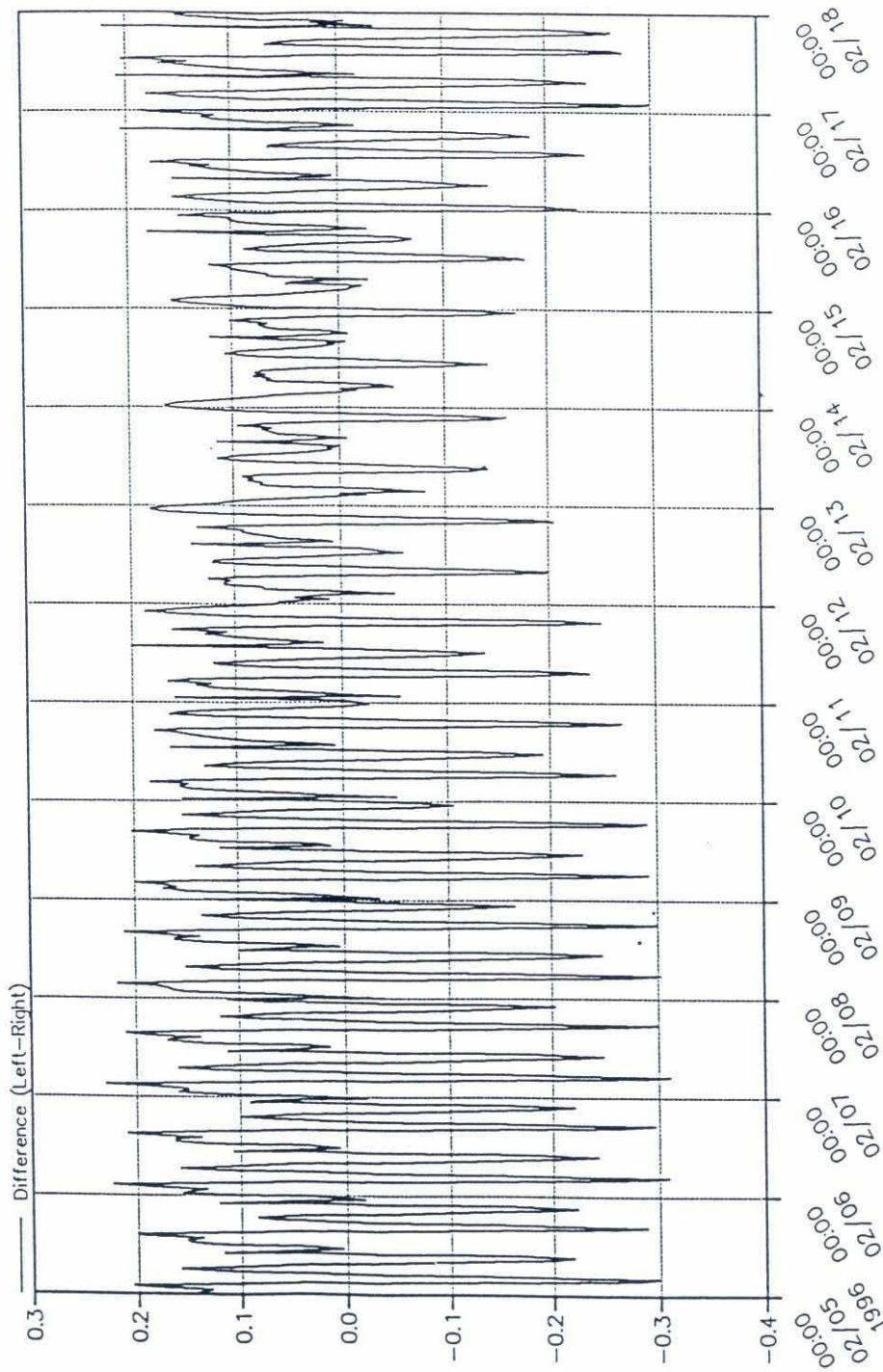


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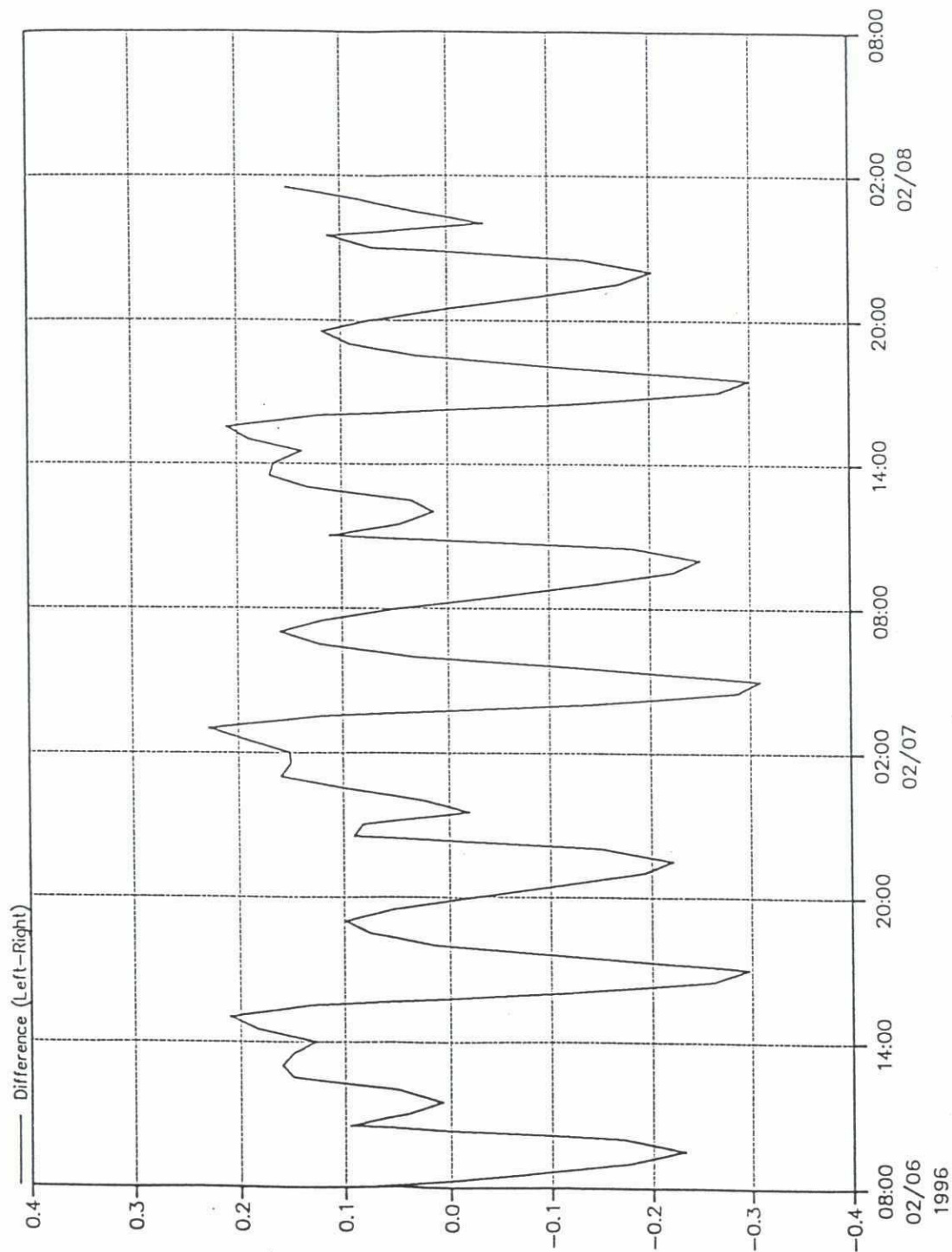
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SWMC		Client: Bangladesh Water Development Board		MIKE 21
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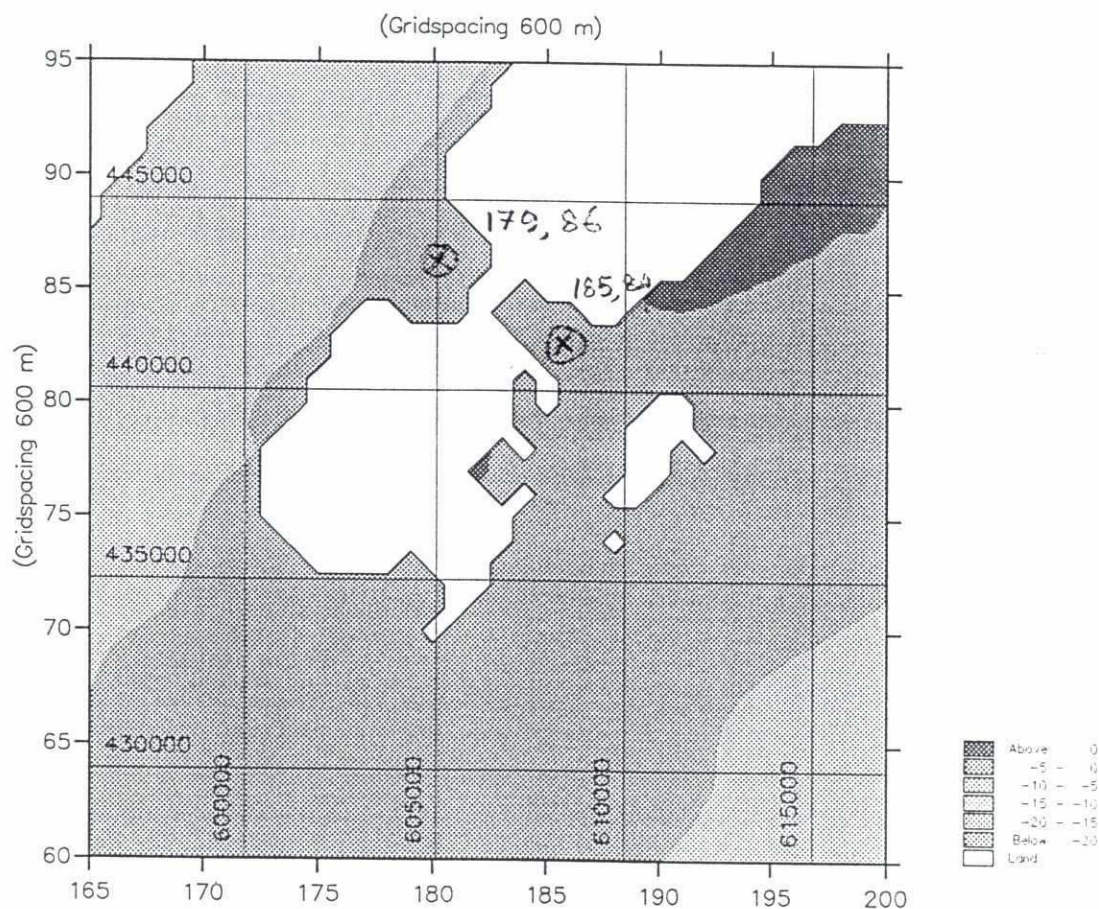
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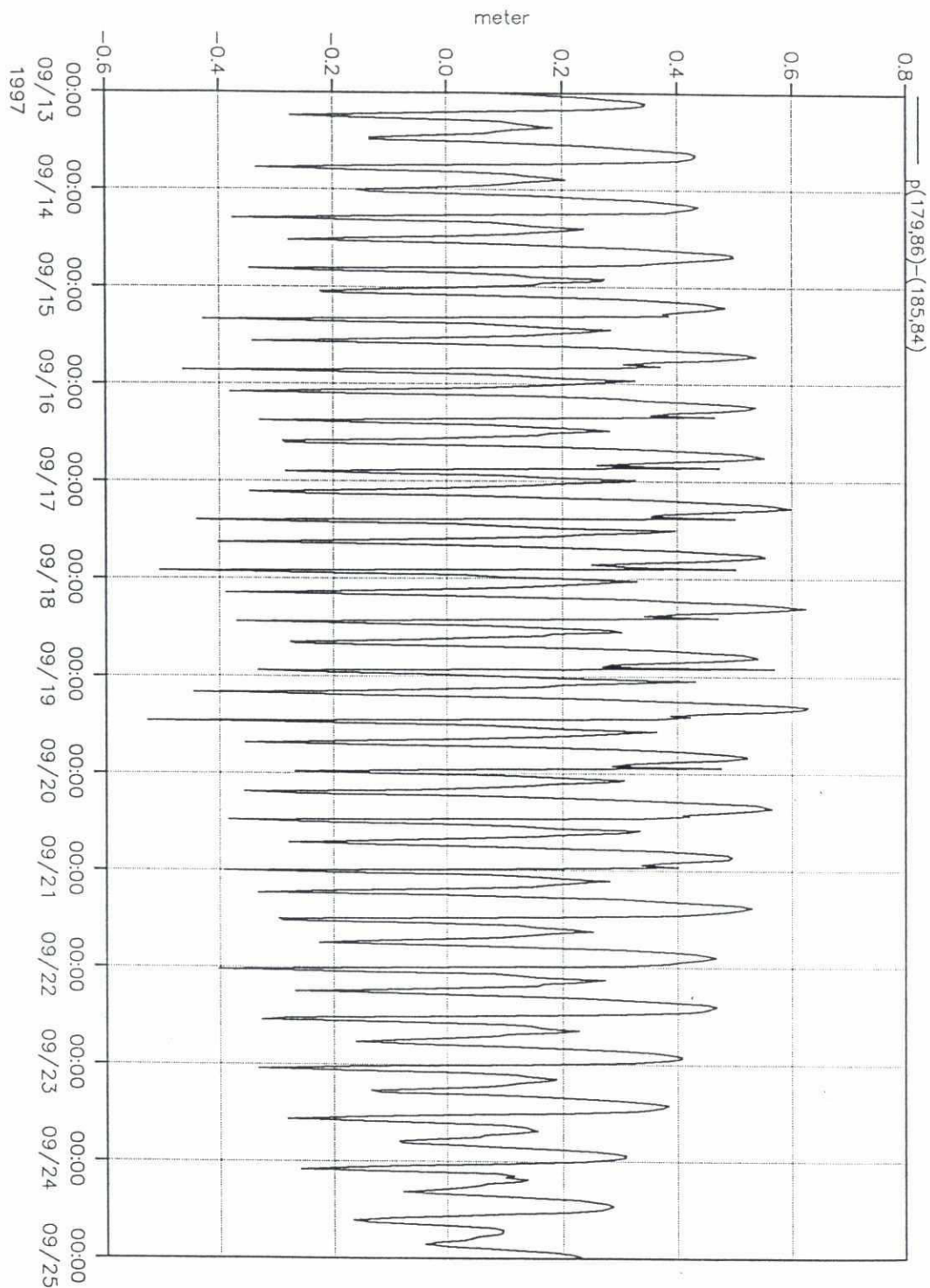
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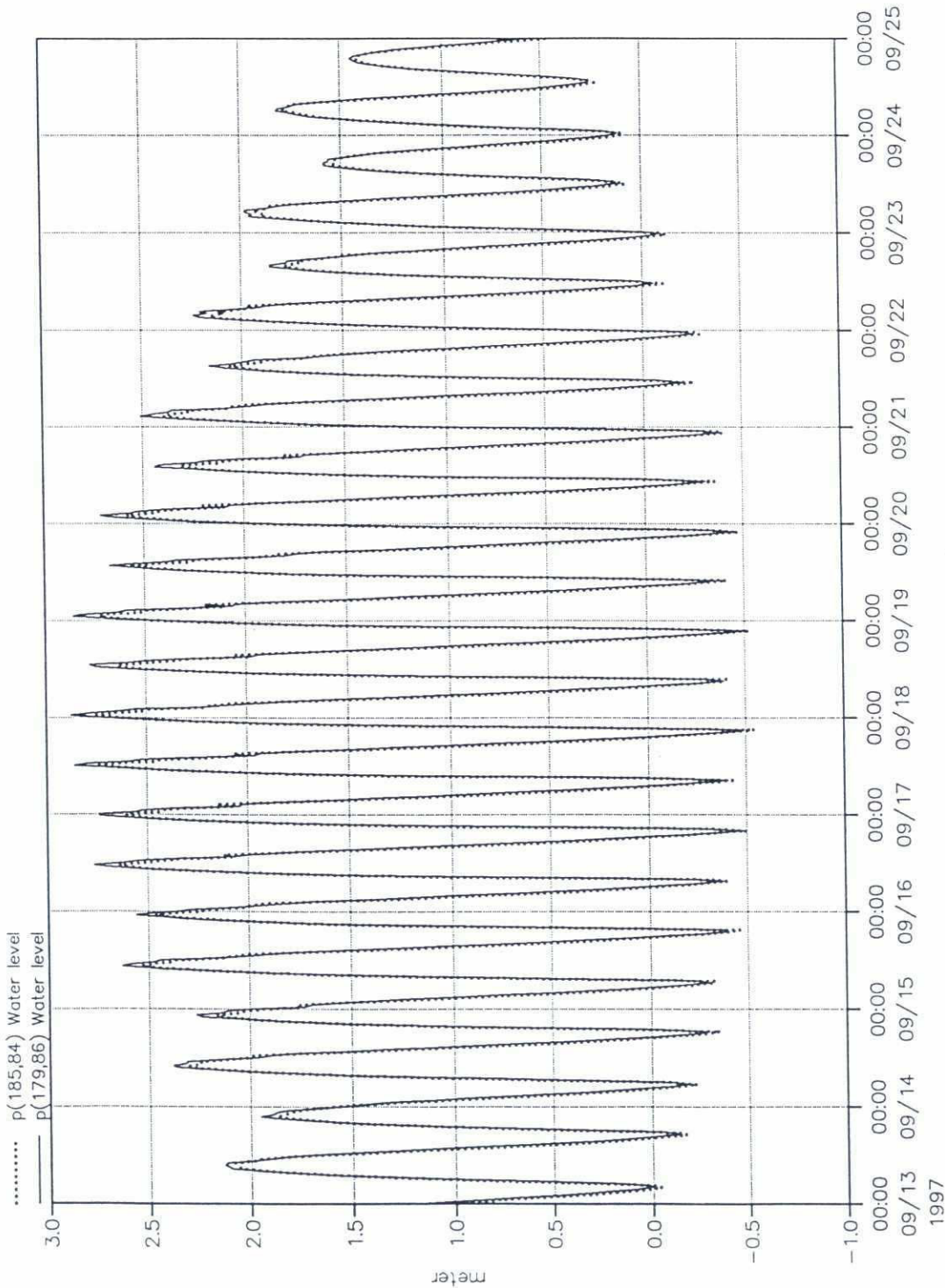


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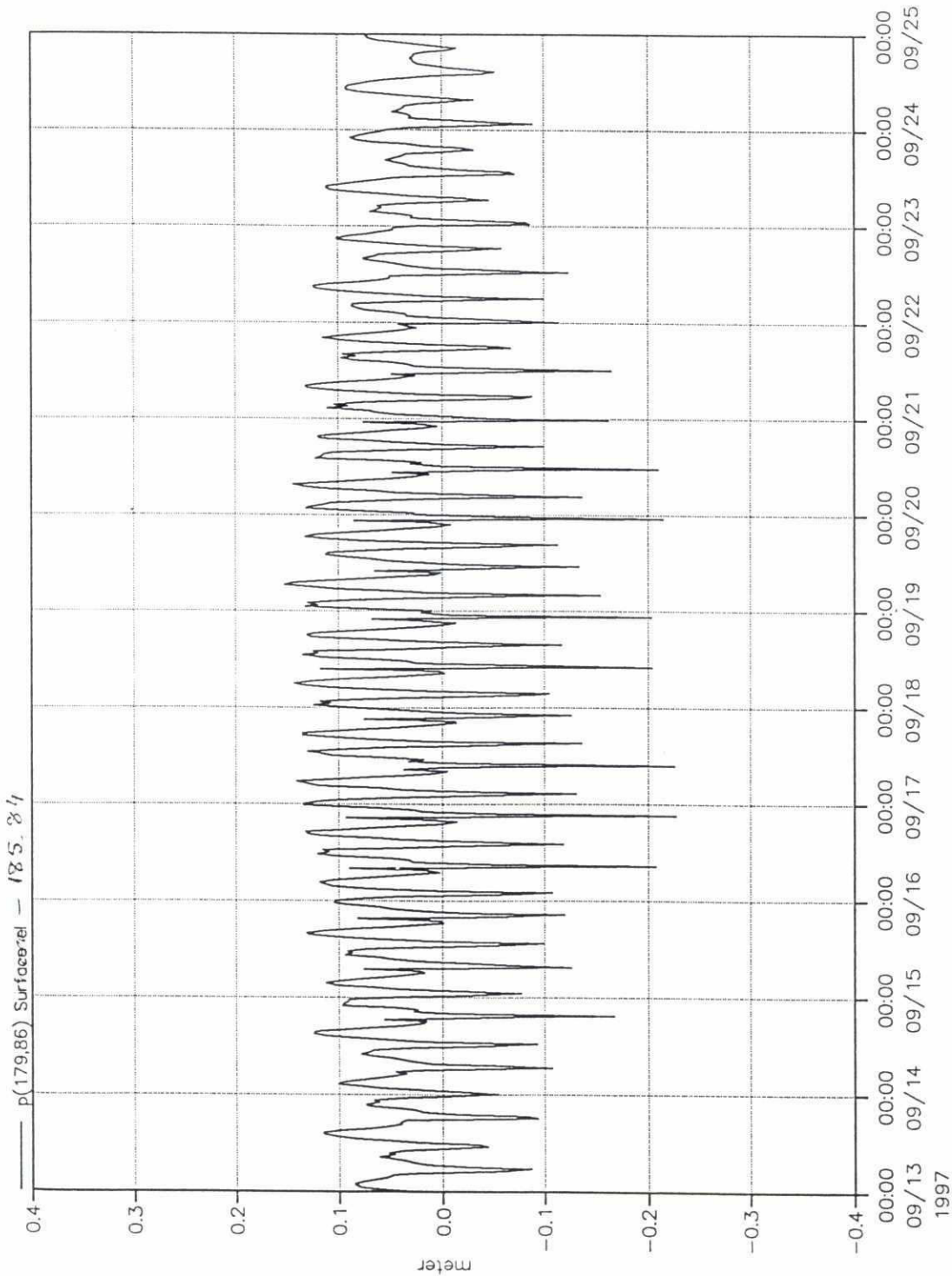


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MIKE 21					

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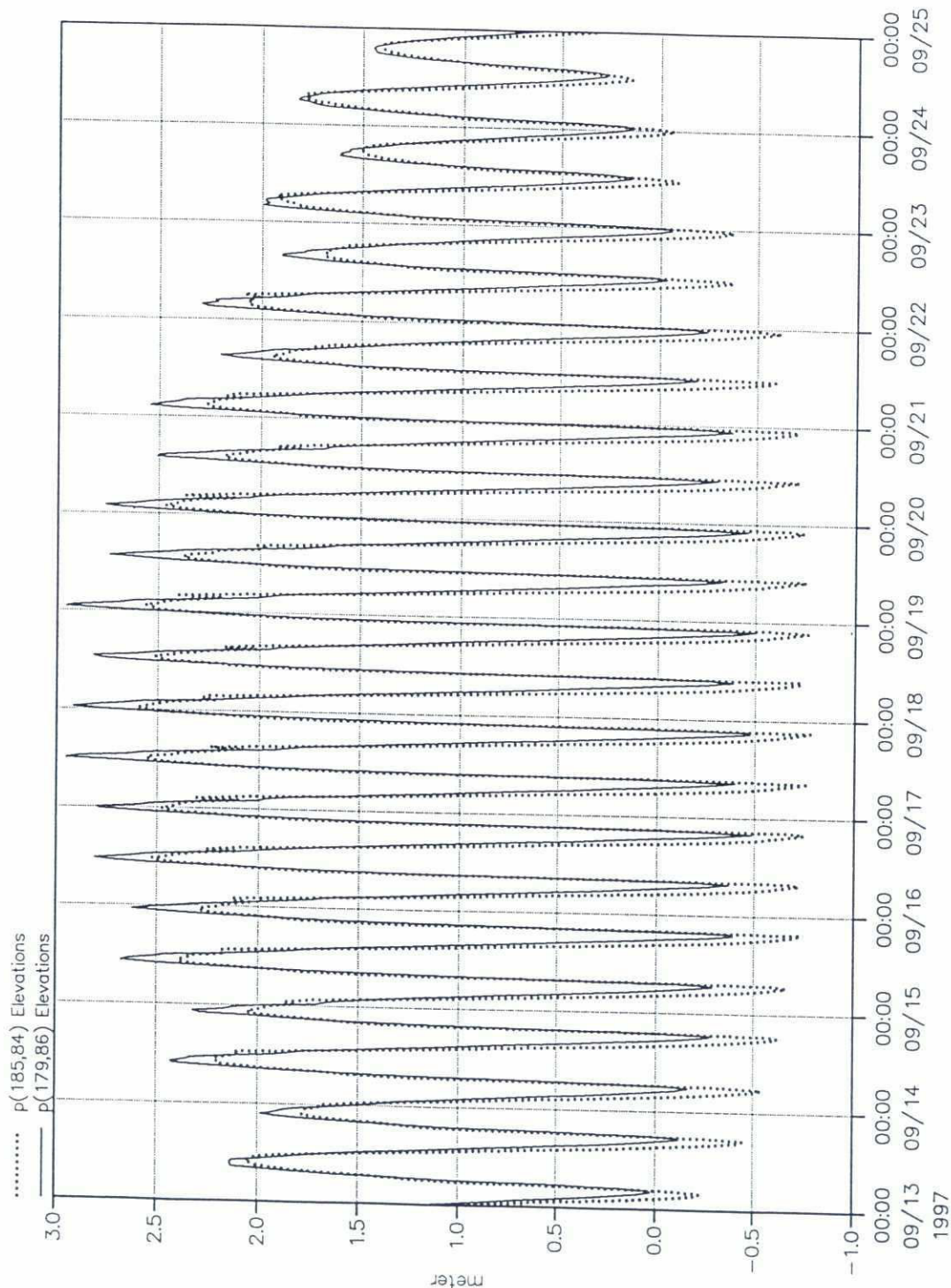


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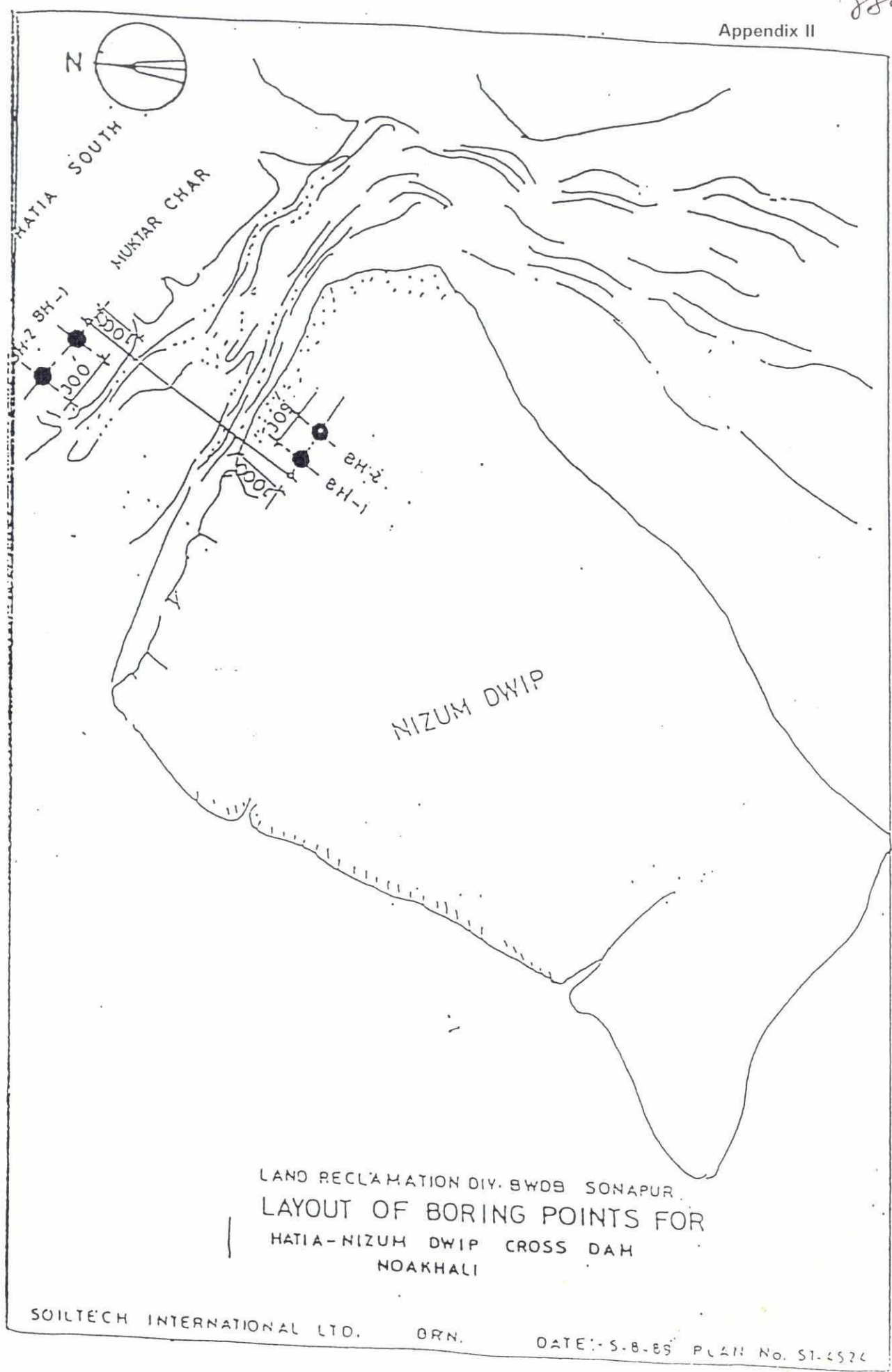
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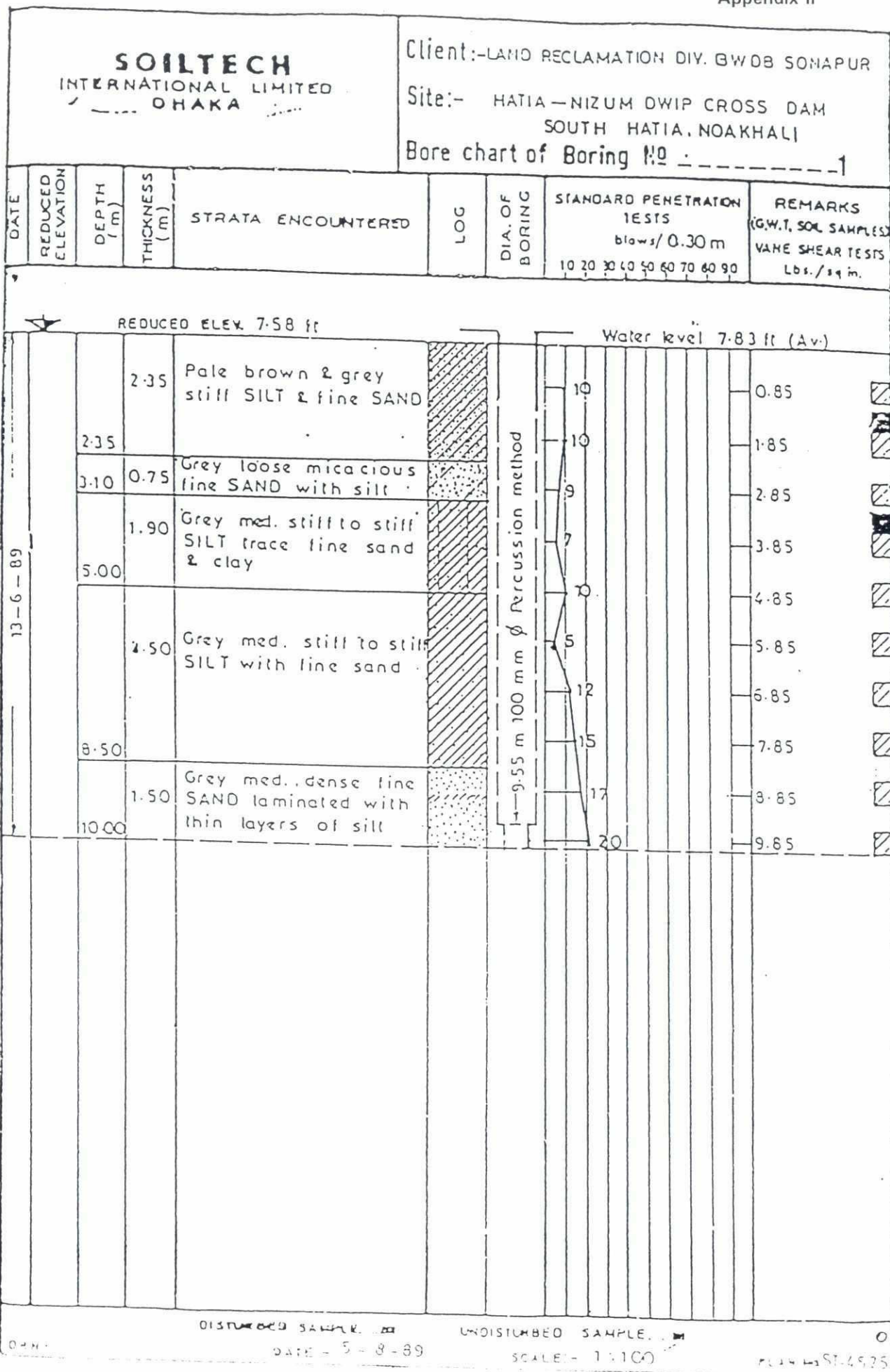
2. SOIL DATA

During the preparations for the South Hatia cross dams (1990), a subsoil investigation was executed on behalf of BWDB at both ends of the proposed cross dam alignment. The location of the borings as well as the boring charts are given in this Appendix. The full report is available in the MES library database.

It may be assumed that the channel bed between Hatia and Nijhum Dwip will have similar soil properties. However, recent deposits will not have consolidated and will therefore be rather soft.

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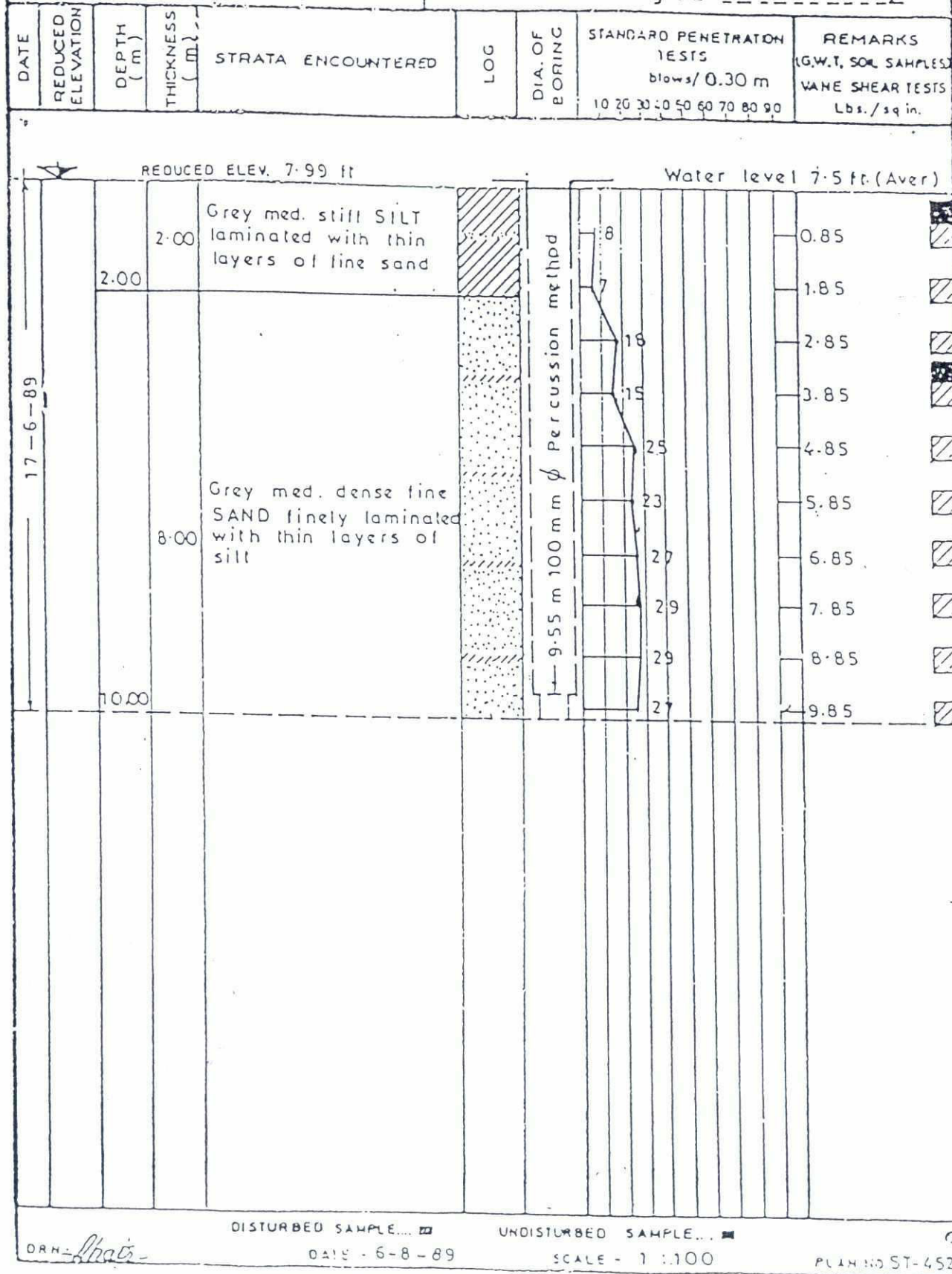
SOILTECH
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DHAKA

Appendix II

Client:-LAND RECLAMATION DIV. BWDB SONAPUR

Site:- HATIA-NIZUM DWIP CROSS DAM
NIZUM DWIP, NOAKHALI

Bore chart of Boring No. 2



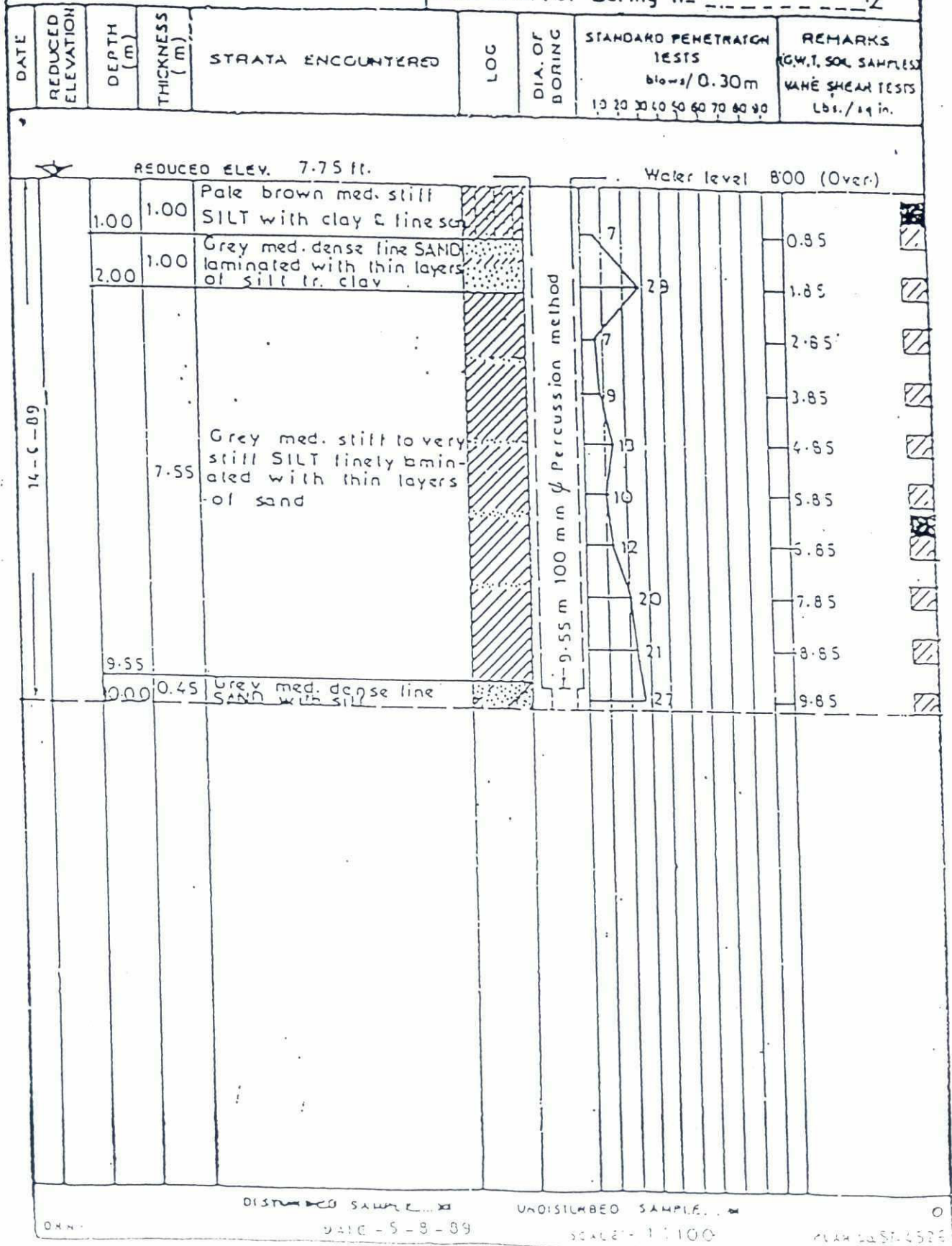
Bore chart of Boring No. 1

SOILTECH
INTERNATIONAL LIMITED
DHAKA

Client:- LAND RECLAMATION DIV. BWDB, SONAPUR

Site:- HATIA - NIZUM DWIP CROSS DAM
SOUTH HATIA, NOAKHALI

Bore chart of Boring No. 2



3. DESIGN CRITERIA

The proposed designs for both cross dams and permeable spurs have been based on the lessons learned from the trials (Nijhum Dwip and Char Alexander) and the pilot schemes (Haimchar and Khorki) implemented by the Meghna Estuary Study in 1998.

The designs for Sandwip and south Hatia cross dams have been studied as well as reports on the implementation of cross dams outside the estuary. As far as applicable, the criteria used in these designs have been taken into account.

Also, the lessons learned during implementation and monitoring of the pilot schemes have been taken to heart. In particular, the use of local natural materials like bullah, bamboo and soil as fill material in synthetic bags has been reviewed carefully. It appears that more durable materials are required for a structure that has to last for a number of years until accretion renders the cross dam redundant. The use of materials like bullah and bamboo in caissons installed at the Haimchar and Khorki pilot schemes limited the water depth to about 5 metres below low tide. The steel pipes for the A-frames will allow construction of permeable cross dams in deeper waters. If necessary the diameter of the G.I. pipes can be increased.

The proposed permeable cross dam at Char Montaz will provide valuable information with regard to the adequacy of the bed protection as well as the erosion pattern and stability of the unprotected river bed on both sides of the permeable cross dam.

The durability and efficiency of the geotextile screens, installed in between the A-frames, will be monitored in detail to establish design parameters for later designs. In particular the behaviour of the screens in waves will be observed very carefully.

Proven design criteria are not available for this innovative design; the performance of the new pilot schemes will provide valuable data for establishing design criteria. Other features such as the area of the bed protection, the size of blocks, the fill material for geobags etc. have been based on experience with the existing pilot schemes.

Special attention will be given to the behaviour and durability of the G.I. pipe A-frame. As an alternative reinforced concrete A-frame may be considered; however, since concrete frames will be much heavier than G.I. pipe A-frames, heavier equipment for installation of the cross dam will be required.

4. ENGINEERING DESIGNS

A standard section and side view of the Nijhum Dwip cross dam is given in Figure II.1

The hydrodynamic forces acting on the permeable cross dam will be water pressure caused by head differences on both sides of the dam and by waves.

As mentioned under section 1 of this appendix, under normal tide conditions, during the winter and monsoon periods, the maximum head difference will be about 0.30 metres at full closure. Since the dam will be permeable, the actual head difference at the dam will be less.

During a cyclone the water levels will be very high and the cross dam will be overtopped over its full length. This additional discharge in the channel will reduce the head difference at the dam.

The wave forces acting on the permeable cross dam cannot be determined accurately. Limited data are available on wave height and wave direction. Moreover, the shallow areas in the channel between Hatia and Nijhum Dwip will have an effect on both wave height and wave direction at the alignment of the dam. During cyclones the wave height will increase, but under those circumstances the dam will be submerged at high tide when the waves are highest.

Wave forces act on the A-frames and on the geotextile screens. The forces on the circular pipes will be quite limited. Since the screens are very flexible and close 70 to 80 per cent of the opening only, it is expected that the dynamic wave forces to be transferred to the channel bed through the A-frames will be relatively small.

For the analysis of the stability and strength of the A-frames and geotextile screens, it has been assumed that the forces exerted by on these components of the cross dam can be represented by a static head of 0.3 metres for the head differences plus a static head of 0.2 metres for wave forces.

The water/wave pressure will cause tensile forces in the geotextile screens. By providing sufficient slack in the screens, the tensile forces can be limited. By using heavy geotextile for the screens (tensile strength 100 kN/m¹) a safety factor in excess of 3 has been assured.

The legs of the G.I. pipe A-frames have to be designed for buckling under the pressure forces exerted by the screens. If required stiffeners in the plane of the A-frame can be provided. The base plate of the A-frames, in combination with the geotextile bed protection, will transfer the loads to the river bed. The concrete blocks or stabilised bags of the under water dam will provide loading of the base plate of the A-frames in case of tensile forces in one of its legs occur.

Since the bed of the channel may consist of rather soft deposits, differential settlement has to be taken into account in the design as well as during implementation of the works. By postponing the final connection of the top of adjacent A-frames until the under water dam has been completed, differential movement of the frames may be limited. In any case the interconnections of frames and screens must allow some movement of the frames.

The bed protection of the cross dam consists of a composite of heavy woven geotextile top layer and a medium thick non-woven under layer. The top layer will provide tensile strength in case of differential settlement of the under water dam and A-frames as well as in case erosion occurs at the edges of the protection and sliding occur. Under these circumstances the bed protection will be loaded by steel anchors and geobags, the related tensile forces will be transferred to the under water dam through the woven component of the bed protection.

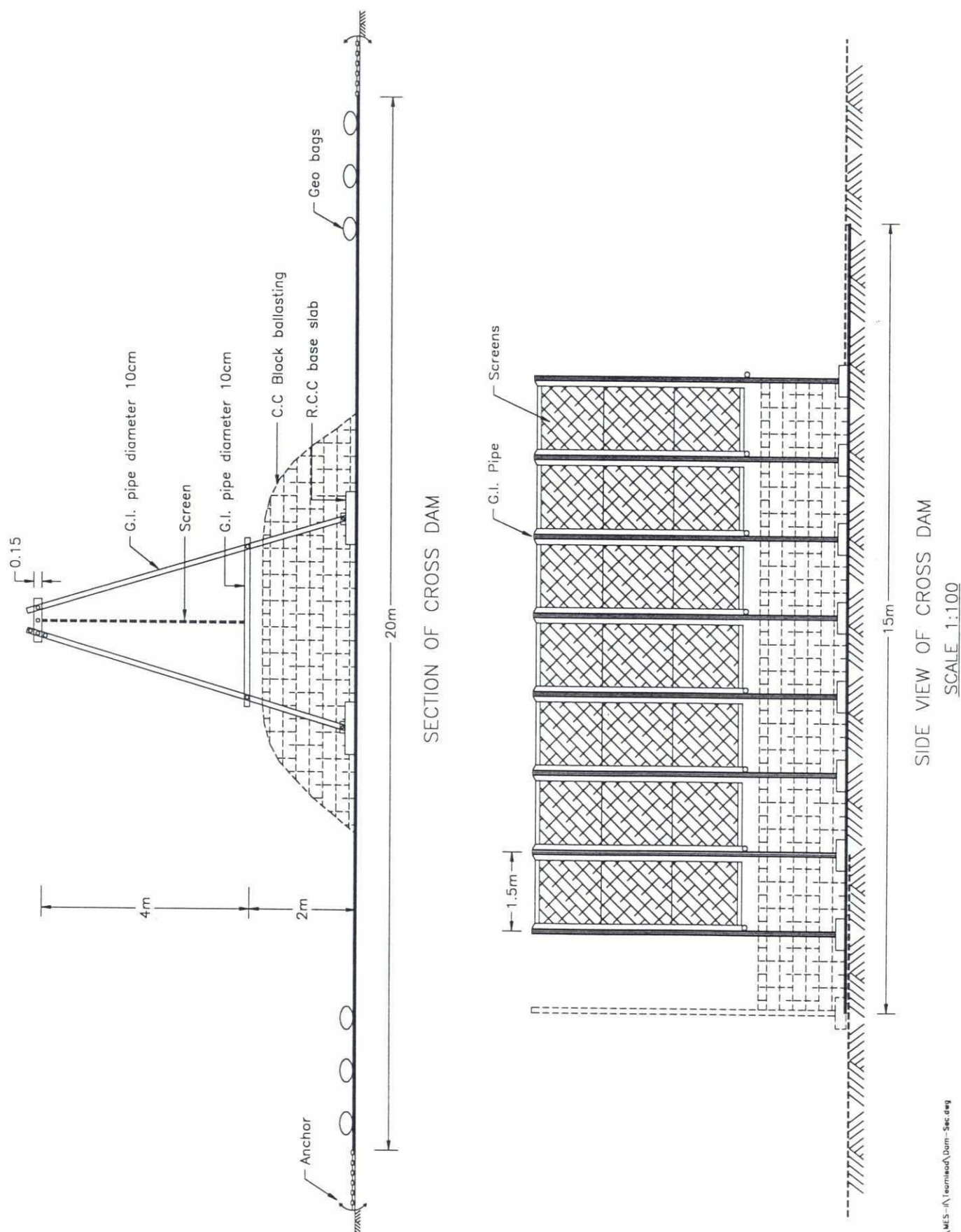
The under layer of non-woven geotextile will, in combination with the woven top layer, prevent wash out of the fine sand and silt of the cross dam foundation.

The bed protection will extend 6 to 8 metres beyond the under water dam, depending on the height of the A-frames. Since the permeable cross dam is based on a new design concept, pertinent design criteria are not available. Some scouring along the edges of the protection has been taken into account.

However, since the flow through the permeable dam will be very much reduced compared to the open channel, the slits in between the geotextile screens will induce strong turbulence in the flow passing through the dam it is expected that the length of the bed protection will be sufficient to prevent deep scour holes along its edges. Moreover, the periods of maximum erosive forces will be relatively limited, while at slack water sedimentation will occur at the cross dam.

The cross dam pilot scheme at Char Montaz will provide the necessary data to refine the assumptions with regard to scour hole depth and required width of the bed protection..

Figure II.1: Section and side view of the cross dam at Char Montaz



WATER MANAGEMENT AND DRAINAGE Design criteria and basic cost data

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1. LAND LEVEL FOR EMPOLDERING

After a ten years of accretion most of the old char land will have reached a land level which is near to the mean high water level (MHWL). In cases where accretion is stimulated, for example by a cross dam, a land level near to MHWL may be reached after 5 years. Land levels equal to MHWL are still inundated approximately 10 per cent of the time during the year. Older char land that has reached MHWL is characterised by a more or less flat surface. Detailed topographical maps show that for about 80 per cent of the area the land level is within a range of 0.30 metres.

The minimum land level considered for empoldering is important from a drainage point of view. The lower the land, the more problematic drainage by gravity will be. Technically land levels below MHWL can also be empoldered, but with land levels equal to or above MHWL it is expected that flood protection is more likely to be economically feasible. In other words, the height of the embankment, the sluice capacity to be installed and the modifications required to improve the natural drainage network of creeks, as defined in detailed design studies, are expected to be affordable in economic terms. The final decision for empolderment is an economic rather than a technical decision.

MHWL varies from place to place in the estuary and is influenced by overall wind and sea current directions, location of land bodies and differences in gravity. Hence, there is no absolute PWD land level for empoldering, which is valid for the entire estuary. The level for empoldering is always linked to the local MHWL. In case of Nijhum Dwip, the land level of +2.2 m PWD is approximately MHWL and is considered a minimum level for empoldering for this study

2. FLOOD PROTECTION EMBANKMENTS

2.1 Primary (Sea) Embankments

Height

Agricultural damage is always likely and it is assumed that sufficient facilities are available for the local population in case of cyclone storm surge, such as an early warning system, cyclone shelters and killas. In this case the level of a 1:20 year flood frequency (+5.06 m PWD) is considered in the design of embankment heights, with a freeboard of 1.22 metres, in line with CPP-II (FAP-7) and SRP (EC).

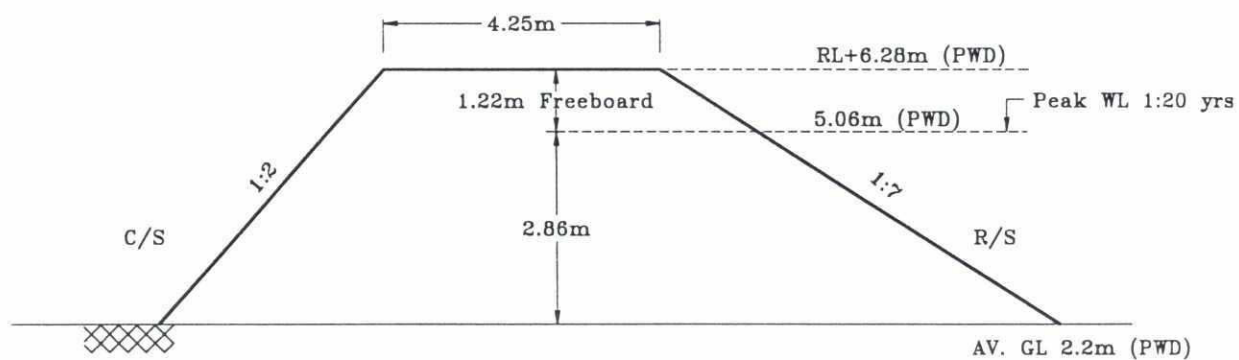
Side Slopes

Unless stability considerations indicate otherwise, a side slope of 1:2 is adopted for the country side and 1:7 for the seaward side of embankments.

Crest Width

In case of sea facing embankments, inspection roads (also used during emergency repairs) are considered a necessity. A minimum crest width of 4.25 metres is therefore maintained. This width is also sufficient for using primary embankments as fair weather R-2 rural roads, which require a crest width of 3.6 metres only.

A typical design of a primary embankment is provided in Figure III.1.



Primary Coastal Embankment
(not to scale)

2.2 Secondary (Compartment) Embankments

Height

Similar to primary embankments, the level of a 1:20 year flood frequency is considered in the design of embankment heights, with a freeboard of 0.91 metres, in line with CPP-II (FAP-7) and SRP (EC).

Side Slopes

Unless stability considerations indicate otherwise, a side slope of 1:2 is adopted for both country and river sides.

Crest Width

The minimum crest is considered 2.5 metres and where embankments are used as or R-2 rural roads, the width is taken 3.7 m. In the case of an inspection road or R-1 rural road, 4.90 metres is taken as the crest width.

Table III.1: Physical features of primary and secondary embankments

Type	Crest Level (m PWD)	Freeboard (m)	Crest Width (m)	Slope R/S	Slope C/S
Primary embankment ¹	6.28	1.22	4.25	1:7	1:2
Secondary embankment cum R-1 Road	5.97	0.91	4.90	1:2	1:2
Secondary embankment cum R-2 Road	5.97	0.91	3.60	1:2	1:2

Based on the above criteria and the BWDB standard schedule of rates the costs of embankments have been calculated.

Table III.2: Estimated costs per kilometre of embankment

Type	Volume (m ³)	Rate ² (Tk/m ³)	Construction Costs (Tk '000)	Land Acquisition ³ Cost (Tk '000)	Turfing Costs ² (Tk '000)	Total Costs (Tk '000)
Primary embankment New Construction	93,000	30.9	2,874	593	321	3,788
Secondary embankment-R-1 Road ⁴ New Construction	55,860	30.9	1,726	285	196	2,207
Secondary embankment-R-2 Road New Construction	42,600	30.9	1,316	217	156	1,689

A typical design for both secondary embankments, with a paved R-1 road and with an unpaved R-2 road, is shown in Figure III.2.

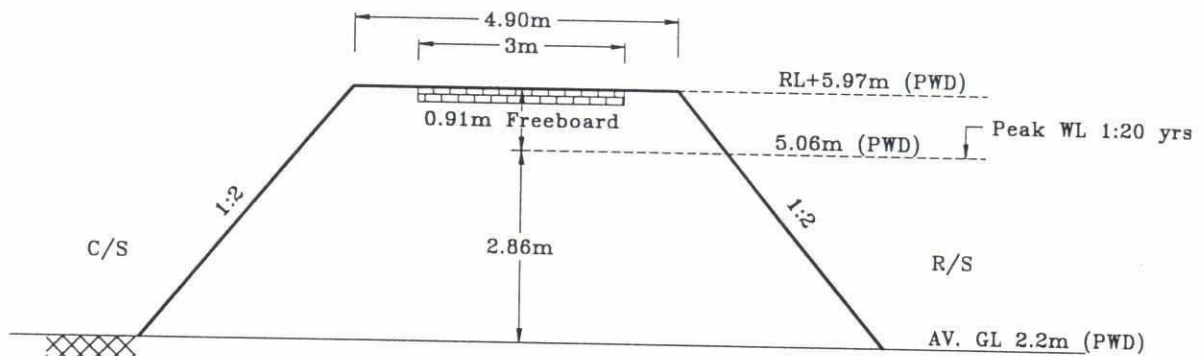
¹ Based of present design used for rehabilitation of polder 73/2, South Hatia (1:20 year annual peak water level is 5.06 m PWD, SRP, 1994).

² Standard Schedule of Rates, converted to 1998 prices.

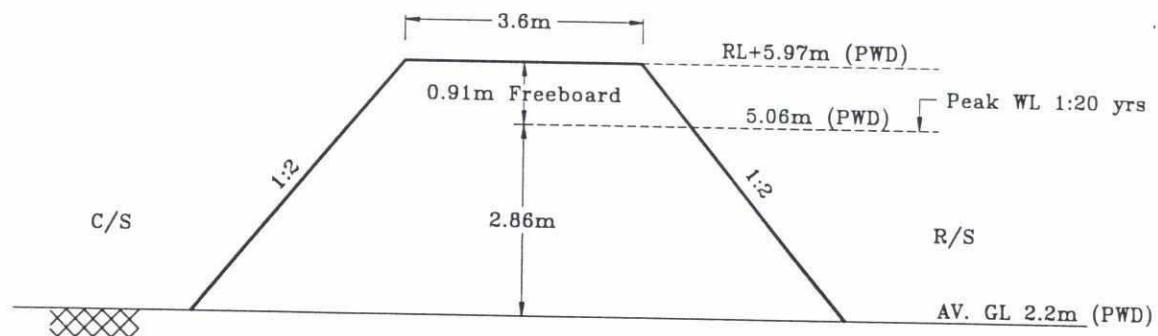
³ A land cost of 114,000 Tk/ha is assumed for this area, 1998 prices (SRP).

⁴ Excluding cost of pavement.

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TYPICAL SECONDARY EMBANKMENT WITH LGED PAVED R-1 ROAD
(not to scale)



TYPICAL SECONDARY EMBANKMENT WITH LGED UNPAVED R-2 ROAD
(not to scale)

3. DRAINAGE CAPACITY

Final detailed drainage design studies can be carried out when accretion has been completed. For the purpose of this study, historical data have been used to define the required sluice capacity with a so-called drainage ratio. The drainage ratio is defined as the inverse of the available drainage sluice cross section for a given catchment area, expressed in ha/m².

In comparing existing and recently rehabilitated polders in the study area, it was found that the average drainage ratio is 162 ha/m². Given the problematic drainage situation in a number of these polders and for purpose of planning in this study only, the design drainage ratio is set slightly higher, at 150 ha/m².

Table III.3: Drainage ratio of existing polders

Polder	Name	Total Catchment Area (ha)	Total Sluice Cross Section (m ²)	Average Drainage Ratio (ha/m ²)
55/1	Galachipa	10,900	85.3	129
55/3	Char Biswas-Kajal	9,850	61.2	161
58/1	Manpura Hazinat	3050	18.0	170
58/2	Shakuchia-Manpura	3250	25.0	130
72	Sandwip	18,700	87.3	214
73/2	South Hatia	12,300	73.2	168
Average				162

Drainage Sluice

Like in most polders, the standard BWDB box-culvert drainage sluice has been selected with a cross section of 2.78 m² (1.51 metres x 1.83 metres) per vent. In most cases such drainage sluices comprise one to five vents. Figure III.3 shows the typical features of such a sluice.

The cost of a standard drainage sluice varies from Tk 4.5 million⁵ to Tk 8.3 million.⁶ The need for pile foundations can increase the cost of a sluice considerably, but also the requirement for improved flap gates and vertical lift gates, which last longer and have a better performance, results in higher costs. For this study an average provision has been taken for pile foundations and is included in the lump sum cost of a typical sluice.

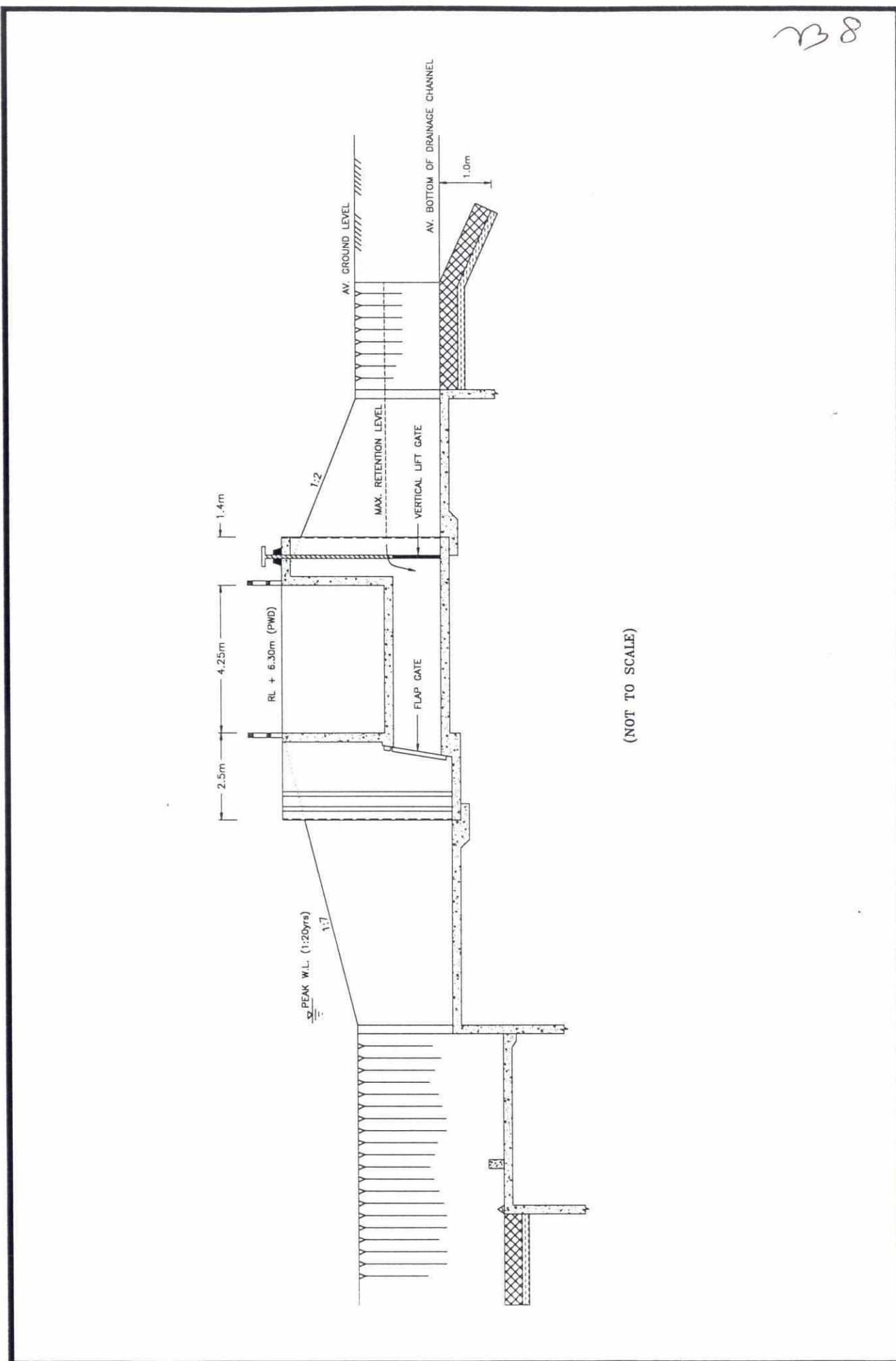
Table III.4: Costs of drainage and surface sluices

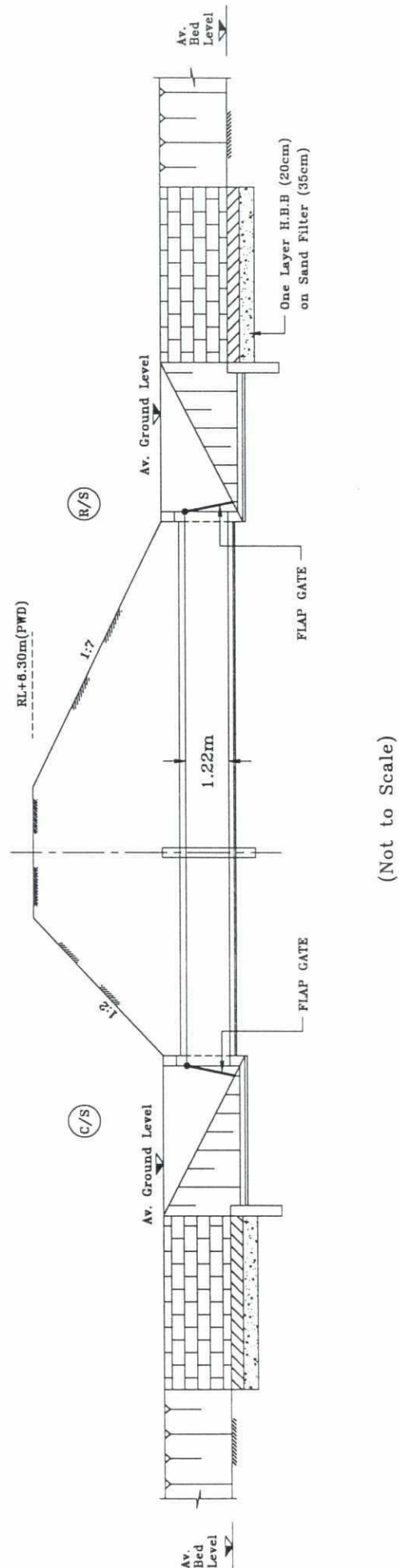
Type of Sluice	LS Costs (Tk '000)
Surface Sluice Pipe diameter 1.22 m provided with two flap gates (c/s and r/s). 1 vent	772
Box Culvert Drainage Sluice Cross section of 1.52x1.83m provided with vertical lift gate (c/s) and improved flap gate (r/s). 2 vent	6,000
3 vent	9,000
5 vent	15,000

⁵ BWDB, 1998, Patuakhali O&M Division.

⁶ CDSP, 1996, Char Bhatir Tek.

Figure III.3: Schematic layout of standard box-culvert drainage sluice





Surface Sluice

The purpose of a surface sluice is to solve local drainage congestion along the flood protection embankment. Land near the coast line of chars may be slightly lower and at the same time a number of minor creeks may be blocked by the primary embankment. Therefore, a provision for four minor drainage sluices per 10 km of primary embankment has been made,⁷ with a pipe diameter of 1.22 m. On both sides of the sluice a flap gate will be provided. This sluice may also be used to flush water into the polder if required. Figure III.4 shows the typical features of such a sluice.

4. DRAINAGE CHANNELS

The starting point is the natural creek system left after accretion is completed. It is expected that primary drains can be selected at an interval of 2 to 3 km and secondary drains with spacing between 1 and 2 km, resulting in average secondary drainage areas of 30 to 40 ha. Additional tertiary drains may be selected or constructed to drain isolated low pockets.

The existing primary and secondary drains are considered sufficient to meet the drainage requirements. The current practice of BWDB is not to modify the existing drainage network. Nevertheless, several rehabilitation design studies show costs to improve the drainage network, varying from Tk 85 to Tk 643 per ha of catchment area.⁸ These costs cover, in most cases, the re-excavation of a small number of primary drain sections. In the case of new polders these costs may be higher (SRP-EC).

For this study, a provision for re-excavation of 30 per cent of primary drains and a lump sum for the excavation of connecting drains (between primary drains and primary drains and sluices) have been taken, based on an average density of drains and historical re-excavation costs. In the case of existing polder land, no provision for connecting drains has been made. Re-excavation of primary drains is expected to maintain a depth of around 2 metres. Depths of 2 metres are recommended for the stimulation of deep drainage, which plays a major role in the desalinisation of the subsoil.

Table III.5: Costs for improvement of drains per 1,000 ha

Description	Length (Km)	Volume ⁹ (m ³)	Rate ¹⁰ (Tk/m ³)	Cost (Tk '000)
Re-excavation Primary Drains (30 per cent)	2.4	26,400	21.8	576
Excavation of Drains	N/A.	38,000	21.8	785
Total				1,361

5. BRIDGES AND CULVERTS

No additional bridges and culverts are planned at this stage. The road networks are expected to develop over time and gradually. Bridges and culverts will be constructed when required.

⁷ Average found in rehabilitated Polder 55/1

⁸ SRP-CE, 1992-4, polder 73/1AB, 58/3, 73/2 and 35/1.

⁹ An average volume of 6000 m³ per km was found for re-excavation of primary drains in polder 73/2, South Hatia, SRP 1994.

¹⁰ Based on 1995 Standard Schedule of Rates.

6. ROADS

Roads are combined with embankments. The cost for a pavement, if required, will be additional.

Table III.6: Physical features of pavement of a R-1 road

Description	Width of Pavement	Width of Shoulder	Side Slope Pavement	Side Slope Shoulder
R-1 Road	3.05 m	0.88 m each	3 per cent	5 per cent

Table III.7: Cost per kilometre pavement of a R-1 road

Type	Earthwork (Tk '000)	Brick on side edging (Tk '000)	Construction of road subgrade (Tk '000)	Brick flat Soling (Tk '000)	Brick Paving HBB (Tk '000)	Total Costs (Tk '000)
R-1 Road	22	58	80	336	547	1,043

AGRICULTURE

The tables contained in this annex contain the results of the agro-economic survey carried out in Nijhum Dwip and South Hatia in March 1997. The number of households included in the survey was small and not selected on a fully random basis. These results have therefore been used as indicative only.

The survey data has been useful for providing a comparison between the present situations inside and outside the existing embankment on South Hatia. It will be noted that, because of current drainage constraints inside the embankment, production outside the embankment, barring major flood or tidal damage, appears to be quite comparable to that inside. Solving these drainage problems would, however, create better production conditions inside the embankment and eventually lead to higher yields and cropping intensities.

Table IV.1.1 : Land tenure and flooded areas of different categories of farmers

Area of Study	Category of farmers (acre)	No. of Farmers	Land tenure				Land flooded by rain - water			Non-flooded land (acre)
			Total land owned. (acre)	Own land cultivated (acre)	Others land cultivated (acre)	Total land cultivated (acre)	Area (acre)	Month of flooding	Duration of flood (days)	
A. Nijhum Dwip	Landless (0-0.3)	6	0.55	0.38	13.50	13.88	13.88	Jy-Ag, Oc-No	7/8	-
	Marginal (0.3-1.0)	1	1.00	0.88	2.00	2.88	2.88	Oc-No	7/8	-
	Small (1.0-2.0)	12	24.00	22.96	50.50	73.46	63.66	Jy-Ag, Oc-No	7/8	9.80
	Medium (2.0-4.0)	3	8.24	7.92	5.50	13.42	6.42	Jy-Ag, Oc-No	7/8	7.00
	Sub Total	22	33.79	32.06	71.50	103.64	86.84			16.80
Bandartila	Landless (0-0.3)	2	0.62	0.58	-	0.58	0.58	Oc-No	7/8	-
	Marginal (0.3-1.0)	1	0.80	0.76	-	0.76	0.76	Oc-No	3/4	-
	Small (1.0-2.0)	1	2.00	1.00	-	1.00	-	-	-	-
	Medium (2.0-4.0)	1	2.50	2.44	-	2.44	2.44	Jy-Ag, Oc-No	7/8	-
	Sub Total	5	5.92	4.78		4.78	3.78			-
B. South Hatia	Landless (Negligible)	3	0.12	-	18.80	18.80	18.80	My-Jn	7/8	-
	Marginal (< 1.0)	2	1.04	0.76	-	0.76	0.76	Jn-Jy, Ag-Se	7/15	-
	Small (1.0-2.5)	1	1.00	0.96	3.50	4.46	4.46	My-Jn	6	-
	Medium (2.5-7.5)	5	12.50	10.85	-	10.85	10.85	Jn-Jy, Ag-Se	5/10	-
	Large (> 7.5)	4	38.20	33.52	-	33.52	33.52	My-Jn, Oc-No	7/10	-
	Sub Total	15	52.86	46.09	22.30	68.39	68.39			-
Char Macpherson (outside embankment)	Landless (Negligible)	3	-	-	20.80	20.80	5.00	Jn-Jy	3	15.8
	Marginal (< 1.0)	2	0.96	0.90	1.80	2.70	2.70	Oc-No	3	-
	Small (1.0-2.5)	5	7.96	6.56	13.20	19.76	17.76	My-Jn, Oc-No	3/5	2.0
	Medium (2.5-7.5)	5	22.70	17.80	18.20	36.00	8.00	Jn-Jy, Oc-No	2/5	28.0
	Sub Total	15	31.62	25.26	54.00	79.26	33.46			45.80

Source: Household Agricultural Survey, MES. March, 1997

Table IV.1.2 : Priority Constraints for crop yield reduction

Constraints	Char Osman (22 farmers)		Bandartila (5 farmers)		Char Hare (15 farmers)		Char Macpherson (15 farmers)	
	Priority No.	Max. responses	Priority No.	Max. responses	Priority No.	Max. responses	Priority No.	Max. responses
Flooding by rainfall	4	11	3	2	5	5	4	7
Entry of saline water by tide	1	20	5(1)	1(2)	8	3	2	9
Cyclone	3	13	2	2	2	10	3	9
Insect-pest attack	2	12	1	3	1	14	1	12
Lack of irrigation	8	18	8	3	3	5	8	10
Lack of input supply	5	14	4	2	4	5	5	8
Soil salinity	6	12	6(5)	1(2)	6	3	4	10
Lack of soil fertility	2	17	7	3	7	4	7	9

Source: Household Agricultural Survey, MES. March. 1997

Table IV.1.3 : Priority Remedy Measures to Remove Constraints

Measures	Char Osman (22 farmers)		Bandartila (5 farmers)		Char Hare (15 farmers)		Char Macpherson (15 farmers)	
	Priority No.	Max. responses	Priority No.	Max. responses	Priority No.	Max. responses	Priority No.	Max. responses
Accretion of land (by cross dam)	2	22	2	3	4	3	2	14
Forestation	4	17	4	3	3	9	3	15
Construction of Embankment	1	22	1	3			1	14
Drainage Improvement	3	17	3	3	1	12	4	14
Irrigation Measure	5	12	5	4	2	9	5	15

Source: Household Agricultural Survey, MES. March. 1997

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Table IV.1. 4 : Crop Productions, their Sales and Values obtained in Different Locations

Study area	Crops	Area Covered (acre)	Production (kg)	Amount sold (kg)	Market Price (Tk/kg)	Total Value (Tk)	Per acre Yield (kg)
Char Osman	Razasail	94.38	24402	4160	5.00-6.50	25120	258
	Kazalsail	13.15	200	-	-	-	15
	Pipper	3.31	445	115	40.00-50.00	5550	134
	Potato	0.45	1440	-	-	-	3200
	S. Potato	3.00	3200	1200	2.50	3000	1066
	Linseed	8.38	660	210	8.00-20.00	4075	78
	Khesari	16.82	1380	220	6.00-9.00	1720	82
	Ground Nut	0.60	280	240	12.50	3000	466
	Mustard	0.12	10	9	10.00	90	90
	Garlic	0.39	68	28	15.00	420	174
	Sub total	140.60	32085	6182	-	42975	
Bandartila	Razasail	3.00	125	-	-	-	41
	Haida (Aus)	0.58	35	-	-	-	60
	Kazalsail	1.00	-	-	-	-	-
	Pipper	0.2	10	8	50.00	200	50
	Garlic	0.2	160	150	15.00	2250	800
	Sub total	4.98	330	158	65.00	2450	
Char Hare	Razasail	18.26	7160	600	6.25	3750	392
	Haida	24.44	8270	1800	5.00	9000	338
	Kazalsail	43.62	10040	480	5.00	2400	230
	BR-8	0.22	360	-	-	-	1636
	BR-11	1.22	640	-	-	-	524
	Pipper	3.72	240	15	50.00	750	64
	Sweet Potato	2.34	2500	870	1.25-2.00	1585	1068
	Khesari	0.80	80	-	-	-	6
	Linseed	1.60	120	120	12.50	1500	75
	Garlic	0.12	-	-	-	-	-
	Mung	10.90	1050	670	15.00	10050	96
	Ground Nut	12.70	4700	3084	10.00-15.00	47975	370
	Sub total	119.94	35160	7639	-	77010	
Char Macpherson	Razasail	72.46	27340	4600	4.25-6.25	26950	377
	Pipper	2.84	220(380)	100	30.00	3000	(211)
	Sweet Potato	3.3	1400(2400)	1000	1.00-1.25	1200	(1151)
	Ground Nut	9.08	1800(1760)	1300	10.00-15.00	18500	(392)
	Khesari	2.8	-(440)	-	-	-	(157)
	Mung	2.00	-(120)	-	-	-	(60)
	Sub total	92.48	30760 (5100)	7000	-	49650	

Note : Figures in brackets are expected yields, not harvested when survey was done
Source: Household Agricultural Survey, MES. March, 1997

Table IV.1.5 : Total crop production and total income of different categories of farmers interviewed

Study area	Farmer		Total cultivated area (acre)	Total cropped area (acre)	Total crop production (kg)	Production consumed (kg)	Production sold out (kg)	Total income (Tk)	Production per farmer (kg)	Income per farmer (Tk)
	No.	Category								
Char Osman	6	Landless	14.54	19.68	2070	1870	2000	1640	345	273
	1	Marginal	2.88	3.4	155	155	-	-	155	-
	12	Small	73.46	98.09	25490	19681	5809	37565	2124	3130
	3	Medium	13.42	19.43	4330	4157	173	3770	1443	1256
Sub total	22		104.30	140.60	32045	25863	7982	42975	1457	1953
Bandartila	2	Landless	0.58	0.58	35	35	-	-	17	-
	1	Marginal	0.76	0.56	45	45	-	-	45	-
	1	Small	1.00	1.00	-	-	-	-	-	-
	1	Medium	2.44	2.84	250	92	158	2450	250	2450
Sub total	5		4.78	4.98	330	172	158	2450	66	490
Char Hare	3	Landless	18.8	32.4	11475(7500)	9175(4600)	2300(2900)	13750(38125)	3825(2500)	4583(12708)
	2	Marginal	0.76	2.28	1340	980	360	11500	670	2300
	1	Small	4.46	15.5	3960	3505	455	4025	3960	4025
	5	Medium	10.85	22.91	6645(840)	5021(240)	1624(600)	18950(4500)	1329(168)	3340(900)
	4	Large	33.52	46.85	11752(600)	8852(0)	2900(600)	28785(6000)	2938(150)	7696 (-)
Sub total	15		68.39	119.94	35172 (8940)	27533(4840)	7639(4100)	77010(48625)	2344	5134(3241)
Char Macperson	3	Landless	20.80	28.72	4600(3460)	3600(1240)	1000(2220)	5400(11864)	1533(1153)	1800(3953)
	2	Marginal	2.70	2.70	640	640	-	-	-	-
	5	Small	19.76	21.56	10460	6060	4400	25950	2092	5190
	5	Medium	36.00	39.50	15060(1280)	13460(120)	1600(1160)	18300(14400)	3012(250)	3660(2880)
Sub total	15		79.26	92.48	30760(5240)	23760(1300)	7000(3940)	49650(34660)	2050(349)	3310(2310)

Note : Figures in brackets indicate expected yields not harvested, sold out and income available from the yields, expected by the farmers
Source: Household Agricultural Survey, MES. March 1997

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Table IV.1.6 : Average per acre costs of cultivation of different crops

Crops	Seed		Urea		TSP		MP		Cowdung		Pesticide		Hired human labour		Hired animal labour		Total Cost per acre			
	Kg	Tk	Kg	Tk	Kg	Tk	Kg	Tk	Kg	Tk	Tk	Tk	man-days	Tk	animal-days	Tk	Char Osman (Tk)	Bandartila (Tk)	Char Hare (Tk)	Char Macperson (Tk)
Razasail	20	160	26	182	-	-	-	-	300	40	100	100	16	800		600	1782			
Razasail	20	245	30	160									24	738		615		1758		
Razasail	27	245	40	245	25	175	10	80			200	200	16	720					1665	
Razasail	24	237	36	198	25	175	10	80			100	100	16	720						1510
Kazalsail	20	175	20	120					300	40			18	900			1235			
Kazalsail	26	257	34	210	20	140	20	160	200	27	80	80	14	700		400			1974	
Haida	10	200	36	252												900		1352		
Haida	37	370	39	236	25	200	20	150			100	100	12	600					1656	
BR-8&BR-11	37	271	15	90			25	210			200	200	30	1500					2271	
Pepper	1	60	15	100			40	320					9	450			930			
Pepper	1	50	20	160	10	100	40	320					15	750					1380	
Pepper	1	60			20	200							20	1000						1260
Sweet Potato	50 ati	200	15	90					400	50			12	600		300	1240			
Sweet Potato	75 ati	300	20	120	20	200							10	500		200			1320	
Sweet Potato	60 ati	220	15	90			10	90					15	750		300				1450
Sweet Potato																				
Mung	12	420											6	300		300			1020	
Garlic	8	320	5	80									12	540		300	1240	1240		
Mustard	5	350											16	800			1150			
Khesari	15	375									50	50	8	480		300	1205			1160
Khesari	12	300											12	660		200				
Ground nut	20	600					10	80					9	450		200	1330			
Ground nut	15	450											15	750						1200
Ground nut	16	480	12	84	9	63							14	720					1347	
Lin seed	8	240											4	200			440			
Lin seed	8	240																	240	

Source : Household Agricultural Survey, MES, March, 1997

Table IV.1.7 : Crop areas, crop productions, per acre yield, maximum price per kg and average per acre cost of cultivation

Study area	Crops	Area covered (acre)	Production obtained (kg)	Production / acre (kg)	Maximum market price (Tk / kg)	Production value/ac (Tk)	Cultivation cost per acre (Tk)
Char Osman	Razasail	94.38	24402	258	6.50	1677	1782
Bandartila	Razasail	3.00	125	41	6.50	266	1758
Char Hare	Razasail	18.26	12124	664	6.25	2450	1665
Char Macpherson	Razasail	72.46	27825	384	6.25	2356	1510
Char Osman	Kazalsail	13.15	200	15	5.00	75	1235
Char Hare	Kazalsail	43.62	10040	230	5.00	1150	1974
Char Hare	BR - 8	0.22	360	1636	5.00	8180	2271
Char Hare	BR - 11	1.22	640	524	5.00	2620	2271
Bandartila	Haida	0.58	35	60	5.00	300	1352
Char Hare	Haida	24.44	8270	338	5.00	1690	1656
Char Osman	Ground nut	0.60	280	466	12.50	5825	1330
Char Hare	Ground nut	12.70	4700	370	15.00	5550	1347
Char Macpherson	Ground nut	9.08	3560	392	15.00	5880	1200
Char Osman	Sweet potat	3.00	3200	1066	2.50	2665	1240
Char Hare	Sweet potat	2.34	2500	1068	2.00	2136	1320
Char Macpherson	Sweet potat	3.30	3800	1151	1.25	1438	1450
Char Osman	Khesari	16.82	1380	82	9.00	738	1205
Char Hare	Khesari	0.80	80	100	9.00	900	1160
Char Macpherson	Khesari	2.80	440	157	9.00	1413	1160
Char Osman	Pepper	3.31	445	134	50.00	6700	930
Bandartila	Pepper	0.20	10	50	50.00	2500	930
Char Hare	Pepper	3.72	240	64	50.00	3200	1380
Char Macpherson	Pepper	2.84	600	211	30.00	6330	1260
Char Osman	Linseed	8.36	660	78	20.00	1560	440
Char Hare	Linseed	1.60	120	75	12.50	937	240
Char Hare	Mung	10.90	1050	96	15.00	1440	1020
Char Macpherson	Mung	2.00	120	60	15.00	900	1020
Char Osman	Garlic	0.39	68	174	15.00	2610	1240
Bandartila	Garlic	0.20	160	800	15.00	12000	1240

Source: Household Agricultural Survey, MES. March, 1997



Table IV.1.8 : Per acre crop productions before and after loss and their values

Study area	Crops	Production Obtained per acre (kg)	Production loss per acre (kg)	Total production with loss per acre (kg)	Maximum market price (Tk / kg)	Production value before loss per acre (Tk)	Production value after loss per acre (Tk)
Char Osman	Razasail	258	597	855	6.50	5557	1677
Bandartila	Razasail	41	1558	1599	6.50	10393	266
Char Hare	Razasail	664	392	1056	6.25	6600	2450
Char Macpherson	Razasail	384	377	761	6.25	4756	2356
Char Osman	Kazalsail	15	380	395	5.00	1975	75
Char Hare	Kazalsail	230	400	630	5.00	3150	1150
Char Hare	BR - 8	1636	Nil	1636	5.00	3180	3180
Char Hare	BR - 11	524	1442	1966	5.00	9830	2620
Bandartila	Haida	60	336	396	5.00	1980	300
Char Hare	Haida	338	284	622	5.00	3110	1690
Char Osman	Ground nut	466	Nil	466	12.50	5825	5825
Char Hare	Ground nut	370	184	554	15.00	8310	5550
Char Macpherson	Ground nut	392	88	480	15.00	7200	5880
Char Osman	Sweet potat	1066	1213	2279	2.50	5697	2665
Char Hare	Sweet potat	1068	341	1409	2.00	2818	2136
Char Macpherson	Sweet potat	1151	242	1393	1.25	1741	1438
Char Osman	Khesari	82	22	104	9.00	936	738
Char Hare	Khesari	100	400	500	9.00	4500	900
Char Macpherson	Khesari	157	142	299	9.00	2691	1413
Char Osman	Pepper	134	368	502	50.00	25100	6700
Bandartila	Pepper	50	190	240	50.00	12000	2500
Char Hare	Pepper	64	86	150	50.00	7500	3200
Char Macpherson	Pepper	211	56	267	30.00	8010	6330
Char Osman	Linseed	78	32	110	20.00	2200	1560
Char Hare	Linseed	75	Nil	75	12.50	937	937
Char Hare	Mung	96	60	156	15.00	2340	440
Char Macpherson	Mung	60	40	100	15.00	1500	900
Char Osman	Garlic	174	102	276	15.00	4140	2610
Bandartila	Garlic	800	400	1200	15.00	18000	12000

Source: Household Agricultural Survey, MES. March 1997

LIVESTOCK

1. THE PRESENT SITUATION

Under Nijhum Dwip Integrated Development Project (NIDP) livestock development appears to be a feasible activity and considerable achievements can be made in this sub-sector through project intervention.

The islanders keep livestock as part and parcel of the household, mainly for draft purposes and the others as followers and sideline income or distress sales. The surplus manpower especially the children are being utilised to tender the animals in the grasslands in the new accredited chars and in the forests. The powerful land grabbers, however, put the animals in the grass lands under the care of employees to establish their preliminary rights over the land.

The peculiarity of local livestock situation is that with the accretion of new lands the Uri grass comes first, the farmers prefer to put their animals in the grass land, if the land is under the control of Forest Department (FD), the FD do not allow free grazing and the farmers then adopt cut and carry system and stall feed the animals. The FD then starts plantation in rows using Uri grass as protective cover against wave action and flushing of seedlings. The FD usually does not restrict the cut and carry system but with the growth of the seedlings the grass production gradually declines and hence carrying capacity is reduced. The FD then allows foraging following the growth of plants to safe height or after first thinning in the 9th year of plantation.

2. LIVESTOCK BREEDS

The cattle are nondescript zebu type, fairly adopted to the local climate and environment, cow produces about one to two litres of milk per day.

The buffaloes are Indian water buffalo type and are preferred by the farmers as tough draft animals and can survive on coarser roughage available in chars and forest undergrowth. The milch buffaloes produce little more milk than cows.

The chicken and ducks are of deshi type and are reared in the back yard as scavengers. The chicken produce 40-45 eggs and ducks 60-80 eggs per year.

The cattle and buffaloes owned by large and medium farmers are usually reared in the free grazing lands in the newly accreted chars and in the forests or in the harvested crop fields. The landless and marginal farmers face most difficulty during the months of July - November when the crop fields are in crops and during the dry spell in November - March when weed production is minimum. The marginal farmers cannot afford to put the animals in the chars for fear of theft or in the forest for fear of loss and going wild. They usually tether their animals in the river banks, fallow lands, pond dikes and stall fed.

The animals are maintained on nearly zero inputs and the farmers spend very little amount on feed supplements and veterinary care on average about 9.8 per cent of household income is generated through sale of livestock and livestock products excluding home consumption and draft animals contribution to crop production

3. LIVESTOCK POPULATION DYNAMICS

According to BBS Agriculture and Livestock Census 1983-84 (Re Vol.-2 Annex-6 Table- LS 1). The six project mauzas with 2,024 households had 4,060 cattle and buffaloes, 3,427 sheep and goats and 15,237 chickens and ducks. The households were found to rear on average 2 cattle, 1.7 goat and sheep and 7.5 poultry indicated that the animal population per household in the area is higher than national average.

The same census also recorded 50 per cent households owning bovines (cattle and buffalo), 32.4 per cent households owning sheep and goat and 83.1 per cent households rear poultry. Per capita availability of cattle / buffalo, goat / sheep and chicken / ducks in the above mauzas of Hatia Thana households are 0.42 cattle, 0.30 sheep and goat and 1.38 chicken and ducks.

The 1983 - 84 Agricultural Census indicates that among the cattle population 38 per cent are adult male, 40 per cent are adult female, 22 per cent young stock. Of them 45 per cent of adult female cattle are in milk, 55 per cent of adult female are dry and 37 per cent of the adult female cattle are used for work. Similarly 58 per cent of the adult buffaloes are male, 33 per cent are adult female and 9 per cent young stock, 27 per cent of adult female buffaloes are in milk and 73 per cent of adult female buffaloes are dry. 72 per cent of adult female buffaloes are used for work.

In sheep and goats 40 per cent are males and 60 per cent are females in the herd.

Among poultry 85 per cent of the flock are chicken and 15 per cent are ducks.

There were loss of animal in April 1991 cyclone, the exact number of cattle, goat/sheep or chicken was not recorded mauza or village wise but according to local informants, reported to be over 3 times higher than human deaths. The entire poultry, sheep and goat population perished, only a few cows, buffaloes survived that took shelter in the earthen mound (Killa) and in the forest and three quarters of the cows/buffaloes were washed out in the sea. The animals survived the tidal surge later on starved and suffered from diseases.

There were severe shortage of draft power following the cyclone and that delayed cultivation for at least 1-2 months or the land remained fallow for the season. The farmers bought animals from the non-affected areas or hired power tillers. The loss suffered in 1991 cyclone is reported to have been compensated over the past few years.

The socio-economic sample survey covering 160 households, conducted in 1996 in Nijhum Dwip recorded average possession of 3.26 heads of cattle and buffalo, 3.88 heads of sheep and goat 31.16 chicken and ducks which indicates a growth over the period 1984-96 and the average recorded in 1983-84 Agricultural Census. During the socio-economic sample survey the average income was recorded Tk 2,195 per household per annum through the sale of livestock and livestock products excluding home consumption and contribution to land preparation and manure.

From the socio-economic survey it is apparent that 98 per cent of household rear some type of livestock and the farmers desire to rear more productive animals. There is indication of high demand for credit in livestock sector especially by the housewives to invest in animal production.

4. GROWTH OF LIVESTOCK POPULATION

Cyclone Shelter Preparatory Study in a survey conducted in 1996 in the central zone covering the Hatia area have found the average 1.76 bovine (cattle / buffalo), 1.12 ovines (sheep and goat) and 18.22 poultry per household. The study also estimated an increase of 0.8 per cent for bovines, 3.2 per cent for ovines and 21.6 per cent for poultry per year. Simultaneously the number of household also increase at the rate of 2 per cent per year, indicating overall increase per year 2.8 per cent in bovines, 5.3 per cent in ovines and 24.1 per cent in poultry.

This indicates that the settlers in the unprotected areas depend more on animals where alternative source of income from crops etc. is limited and more opportunities to rear animals than in the protected areas where farmers can grow more crops with higher cropping intensity.

Although no specific study is carried out in the project mauzas on the real growth but it is observed that over the last few years the project area is developing as an important source of supply of beef, mutton, chicken and eggs to the consumption centres like Noakhali, Chandpur and Chittagong. With the increase of number of households at the rate of 2 per cent per annum, simultaneously there is increase of bovine, ovine and poultry population. This growth trend is expected to continue over the entire project period till saturation is reached. The optimum annual growth rate for bovine is 2.5 per cent, sheep and goat 3 per cent and poultry 9.5 per cent is envisaged with project intervention over the non-project situation of 2.2 per cent for cattle and buffalo, 2.5 per cent for sheep and goat and 5 per cent for poultry.

The island have surplus fish wastes, some varieties are not consumed by human can be dried and profitably used as poultry feed.

The Government encourages milk production and desires the mini dairy farms / units be spread in the rural areas instead of concentrating them in and around the cities and towns causing pollution and inconvenience to the city dwellers, for which the Government promotes organisation of village milk producers' co-operatives, arrange rural collection, processing and finally marketing in cities. With the development of road and transport network in near future it may be feasible to link up the milk producers with the proposed Milk-Vita milk processing plant to be established in Laxmipur.

5. CONSTRAINTS TO LIVESTOCK PRODUCTION AND SERVICE DELIVERY

The farmers are not aware of the facilities available at Thana Livestock Development Centre (TLDC) and the routine use of the services extended by the centre. The animal and poultry diseases are usually not reported by the farmers to the veterinary hospitals and the disease surveillance system is yet to be fielded in the area. Accurate data on mortality and morbidity or economic impact of animal diseases are not available. But according to the farmers, animal diseases are adversely affecting the livestock and poultry productivity and agricultural practice. The present mortality rate as estimated by the local officers of the Department of Livestock Service (DLS) is as follows:

Table IV.2.1: Mortality rates of livestock

Species	Death rate (per cent)
Buffalo	6
Cattle	10
Calves (cow/buffalo)	25
Goat/Sheep	8
Kid/Lamb	24
Chicken	60

The above death rate under similar situation is also estimated by Char Development and Settlement Project (CDSP) without project situation.

6. ANIMAL HEALTH

6.1 Common diseases of bovines and ovines

The main diseases as reported by DLS and observed during field investigation are worms: mainly stomach and intestinal worms, liver fluke and scabies in goats.

Bacterial diseases - anthrax, black quarter (BQ), haemorrhagic septicaemia (HS).

Viral disease - foot and mouth disease (FMD)



Rinderpest caused huge loss of bovines in the early sixties and is reported well under control at present although antibody titre level is known to be below protective level.

Many of the disease are preventable through routine vaccination and curable by chemotherapeutic agents and antibiotics.

6.2 Diseases of poultry

In chicken- New Castle Disease (NCD) is common and takes heaviest mortality and occasional out break of fowl pox is also reported in young chickens. Coccidiosis, intestinal worms and lice infestation are also common.

There is relatively less incidence of disease in ducks but the duck population is not increasing, according to farmers during the dry spell and intrusion of saline water in the fields and canals the common species of snails cannot survive and there is shortage of duck feed in the winter months.

7. FODDER

The second most important constraint in livestock production is the fodder shortage especially during the dry spell when the weed production is at a minimum. The non-farm households including the marginal farmers who do not have access to crop residues live straw etc. are often forced to sell stock often at inconvenient price. The erosion affected landless and marginal farmers expecting to be settled in near future under the Government settlement programme now depend seasonally on fishing and the women and children only earn through rearing animals and chickens.

It is envisaged that under the settlement programme a part of the land would be reserved as community grazing land, sufficient to provide fodder for at least 3 months to the livestock of the settlers. The community grazing land are to be managed by the settlers and would not be converted as crop land.

The embankment and the pond dike would include suitable fodder tree species like Babla (*Acacia nilotica*), Ipil ipil (*Lucaena leucocephala*) and dubla grass (*Cynodon dactylon*) and Arhor (*Cajanus cajan*) to cater to emergency needs during the dry spell and any other eventualities.

The other prospect is to include fodder crops in the cropping pattern, Khesari (*Lathyrus sativa*) is a well adapted species which may be promoted and the farmers encourage to use the same as fodder crop and not for human consumption. The other salinity tolerant varieties are to be explored and introduced in the area.

The urea treatment of straw may be promoted based on experience of DANIDA in the district.

It is expected that livestock owners would be served by a NGO which would assist with various development activities. The NGO, in co-operation with DLS, would arrange short duration training on improved husbandry of cattle, goats, sheep and poultry and would support individual households interested in improved livestock production methods with credit facilities, training and demonstrations.

The present and future average performance parameters for livestock are presented in the tables at the end of this annex.

8. LIVESTOCK DEVELOPMENT

8.1 Manpower development (development of change agents)

The service delivery of the Department of Livestock Service (DLS) is aimed to be improved through participatory approach. A local unemployed youth to be nominated by the community is to be trained as Livestock Field Worker (LFW) who is expected to reside in the island and earn his livelihood through selling his services to the community and maintaining liaison with DLS and other input suppliers. The LFW would also act as model livestock rearer and operate a demonstration farm and specifically serve the livestock activities taken up by the farmers with credit support. The LFW in co-operation with DLS field staff would vaccinate all the animals against prevalent diseases and offer first aid to sick animals and deworm the animals at least twice or thrice a year.

Similarly for poultry development a functionally educated destitute women would be trained as Women Poultry Worker/vaccinator (WPW) and drug dispenser who would be working door to door with housewives, advise them in better poultry husbandry and vaccinate all the chicken and ducks. The WPW is also expected to act as a model poultry rearer and operate a demonstration farm and specifically serve the poultry activities taken up by the housewives / farmers with credit support.

The NGO would arrange for the training for the LFW and the WPW with close co-operation of DLS and their deployment in the village. The project is expected to bear the cost of training, field equipment, bicycle and initial support for their establishment in the trade. The DLS is expected to support with continuous training facilities in the Thana Veterinary Hospital to improve skill and perfection and inputs free of cost and at cost price made available by the Government on a priority basis. The project is likely to assist in the establishment of demonstration farms with improved animals and chicken.

The settler farmers are to be encouraged and expected to bear the cost of the inputs and the services of LFW and WPW and carefully avoid the dependency culture for free inputs and services.

The LFW and the WPW are expected to advise the farmers and the housewives on improved animal and poultry husbandry i.e. feeds and feeding, preservation of crop residue, green grass and crop by products for feeding during lean months and inclement period. They are also expected to maintain close collaboration with the DLS for routine disease surveillance, preservation and dispatch of samples for laboratory diagnosis and call on expert services needed from the DLS from time to time by the farmers of the area.

The LFW at a later stage may be encouraged to maintain a good quality breeding cow bull/buffalo to improve the milk production potential of cattle/buffalo. The farmers would be encouraged to pay for the bull services and maintenance of the bull. Similarly the destitute women may be encouraged to rear good quality breeding bucks and charge for the coverage to the farmers.

The LFW is also to explore other feasible opportunities like mini-milk processing and marketing facilities and profitable marketing of eggs, chicken and other livestock products.

8.2 Farmer training

The farmers interested to take up livestock activities with credit support would be trained by the NGOs in co-operation with the DLS for brief period on improved management and health care of animals prior to access to credit.

Similarly the housewives interested to take up poultry project with credit support would be trained for short period on specific type of activity and health care before sanctioning of credit.

8.3 Monitoring of credit projects

The NGOs operating the credit would monitor the projects as part of their routine activities and take up necessary issues to the notice of local Livestock Officer for speedy and effective solution of any problem.

8.4 Types of livestock projects

The specific type of livestock activities to be taken up by the respective household would strictly depend upon the location and farm specific suitability and the choice of the of the household. Several activities are suggested with estimated profit margin. They are as follows: For details refer to vol. 2, Annex 6, estimated cost and benefits of livestock projects.

- | | |
|-------------------|------------------------|
| A. Draft cattle | E. Goat rearing |
| B. Milch cow | F. Chickens - layers |
| C. Beef fattening | G. Chickens - broilers |
| D. Goat fattening | |

Table IV.2.2: Livestock Population in the Project Area

Mauza/Union	All House-holds	Non farm HH	Farm HH	Cattle & Buffaloes	Sheep & Goats	Poultry
Jahajmara Union	4,054	916	3,138	8,346 (2.05)	5,426 (1.33)	31,790 (7.84)
Char Macpherson	506	92	414	1,175 (2.32)	736 (1.46)	3,858 (7.62)
Char Osman	230	1	229	521 (2.26)	663 (2.88)	1,373 (5.97)
Muhammadpur	647	120	527	1316 (2.03)	719 (1.11)	4,919 (7.60)
Muktaria	8	0	8	108 (3.50)	83 (10.38)	49 (6.13)
Nutan Sukhchar	289	41	248	937 (3.24)	824 (2.85)	3,449 (11.93)
Purba Bir Biri	344	57	287	603 (1.75)	402 (1.16)	1,689 (4.90)
Hatia Thana Total	39,616	11,829	27,787	64,405 (1.62)	44,268 (1.11)	324,717 (8.20)

Sources: The Bangladesh Census of Agriculture Livestock, 1983-84

Zila Series: Noakhali, November 1988, BBS.

Figures in parenthesis indicate average number of animals per household

Table IV.2.3: Estimated livestock population in project area, 1996

Mauza	Number of Households	Average Number per Household			Total Livestock Population		
		Cattle	Goat	Poultry	Cattle	Goat	Poultry
Char Macpherson	300	1.78	1.62	19.53	534	486	5,859
Char Osman	1,119	1.78	1.62	19.53	1,992	1,813	21,854
Muhammadpur	593	1.78	1.62	19.53	1,055	961	11,580
Muktaria	103	1.78	1.62	19.53	183	167	3,570
Nutan Sukchar	698	1.78	1.62	19.53	1,242	1,131	13,630
Purba Bir Biri	402	1.78	1.62	19.53	716	651	7,850
Total	3,357	1.78	1.62	19.53	5,722	5,209	64,343

Sources: BBS; Cyclone Shelter Preparatory Study; Consultants' estimates.

Table IV.2.4: Average Performance Parameters of Livestock

Item	Unit	Cattle	Buffalo	Goat/sheep	Poultry
Adult body weight	kg.	150-180	350-450	16-26	1-2
Milk production (per location)	kg.	200-250	550-600	-	-
Reproduction	%	50	55	120	-
Egg production		-	-	-	40
Mortality	%	25	20	30	60

Table IV.2.5: Technical Parameters for Cattle Model

Item	Unit	Present	With project
Mortality adult	%	5	4
Youngsters	%	13	8
1-3 years	%	7	5
Conception rate	%	50	60
Milk production	kg	150	200

Table IV.2.6: Technical Parameters for Goat Model

Item	Unit	Present	With project
Mortality adult	%	8	3
Youngsters	%	25	5
Conception rate	%	120	160

Table IV.2.7: Technical Parameters for Chicken Model

Item	Unit	Present	With project
Egg production		40	60
Mortality	%	60	30
Supplementary feed	kg/bird	-	2

Table IV.2.8: Estimates of growth in livestock population

			Zone			
			West	Central	East	Overall
Average number per household	1983/4 (census)	bovines	2.43	1.52	1.54	1.70
		ovines	0.84	0.78	0.79	0.80
		poultry	7.72	7.61	8.09	7.79
	1983/4 (census)	bovines	2.29	1.76	1.91	1.91
		ovines	1.06	1.12	1.00	1.00
		poultry	13.66	18.22	19.13	19.13
Increase in number per household (Avg. change per year)		bovines	-1.10%	0.80%	1.25%	0.70%
		ovines	0.10%	3.20%	-0.70%	1.30%
		poultry	16.50%	21.60%	18.50%	19.60%
Increase in No. of household			3.50%	2.00%	2.20%	2.20%
Increase in total number (Avg. change per year)		bovines	2.30%	2.80%	3.70%	2.90%
		ovines	3.60%	5.30%	1.50%	3.50%
		poultry	20.50%	24.10%	21.10%	22.20%

Source: Cyclone Shelter Preparatory Study Stage 1
 Feasibility phase draft final report supporting volume 4 Livestock
 Sener Ingenieria Y Sistemas Sa, Spain, 1996.

Table IV.2.9: Indicative Unit Costs for Livestock Programme

Item	Cost per unit (Tk)
Demonstrations	5,000
Training for farmers	200
Training of one Livestock Field Worker (LFW)	3,000
Training of five Women Poultry Workers	1,500
Field Equipment for LFW	2,500
Equipment for WPW (Vaccination kit box)	600
Bicycle for LFW	4,000

* 1 per cent of the project households will be demonstrated for beef, milk, mutton, goat, sheep, breeding bull, breeding buck and poultry rearing covering day old chicks, egg production, broiler production etc.

Table IV.2.10: Credit projects

Type of Project	Unit Cost (Tk)	No. of Additional Units in Each Year					Total (Tk '000)
		Year 1	Year 2	Year 3	Year 4	Year 5	
Draft Cattle	15,000	6	9	9	12	12	720
Milch cow	6,300	6	9	9	12	12	302
Beef fattening	9,500	12	12	18	24	24	855
Goat fattening	5,000	12	12	18	24	24	450
Goat rearing	3,000	12	12	18	24	24	270
Chickens - Layers	18,000	4	4	5	5	6	432
Chickens - Broilers	5,100	4	4	5	5	6	123
Total (Tk '000)		430	494	622	791	814	3,152

Table IV.2.11: Cost of livestock development programme

Item	No.	Monthly/Unit Cost	Annual Cost	Total Cost
Extension Officers	2	18,000	216,000	1,080,000
Support/Admin. Staff	2	14,000	168,000	840,000
Logistics Support & Office			250,000	1,250,000
Fuel		2,450	29,400	147,000
Training for Farmers	100	200	20,000	100,000
Demonstrations	12	5,000	60,000	300,000
Training for LFWs	3	3,000	9,000	45,000
Training for WPWs	5	1,500	7,500	37,500
Field Equipment for WPWs	5	1,000	5,000	25,000
Bicycles for LFWs	3	4,000	12,000	60,000
Materials & Equipment				
Motorcycles	2	154,000		308,000
Training Materials				30,000
Office Equipment				200,000
TOTAL (Five Year Programme)				4,422,500

FISHERIES

1. PRESENT SITUATION OF FISHERIES AND AQUACULTURE

1.1 Introduction

Fisheries is an important component in the MES project area which contributes vital role in nourishment, income generation, as well as in export earning. Approximately 60 per cent (MES socio-economic survey 1996) of the total households of the project area are engaged in this profession for their livelihood. The statistics of available water bodies with present annual total fish catch, catch/area (kg/ha) of the project is furnished in XXX. The presently available fish fauna of the area is shown in XXX.

There are two types of fisheries in the project area:

- *Capture fisheries*:, carried out at sea in the inshore and offshore waters and in inland water bodies such as beels, khals, rivers and the flood plain.
- *Aquaculture*: which comprises the pond raising of carp spp and shrimps in respectively fresh and brackish water.

1.2 Statistics

A preliminary survey executed under the aegis of MES indicated estimated an annual production of 18,640 Mt.¹ of fish. A breakdown of the annual yield among the different categories is presented below in Table IV.3.1.

Table IV.3.1: Fish production in the Nijhum Dwip study area

Category	Annual production (mt.)	Percentage of total production (per cent)
Aquaculture	136	0.7
Inland captured fisheries	254	1.4
Marine inshore fisheries	8,125	43.5
Marine off shore fisheries	10,125	54.3
Total	18,640	100.0

Source: MES field survey; TFO, 1997

The figures indicate that the major proportion of the fish production is contributed by marine fisheries.

1.3 Fisheries production and fish consumption

In the last decade the fish production in Bangladesh increased annually with approximately 3 per cent, from 790,000 mt. in 1985 to 1,170,000 mt. in 1996 (BFRSS, 1996, see Appendix K) and a similar growth has been reported for the project area (MES, 1996). Major contributors to this growth are:

- the development of aquaculture
- marine artisanal and flood plain fisheries.

¹ The production is based on secondary data obtained from Thana fisheries officers and on a RRA survey and is there fore indicative only. The production will be cross checked with data from other sources in the near future.

Even if the statistical data reflect the trends in the field², it does not mean that fisheries is in healthy stage growth is most likely due to the increased number of fishermen while at the same time the catch per fishermen decreased. The latter is the first sign of over exploitation of fish stocks.

With a total population of 117.5 million the availability of fish protein is 27 g/person/day and total availability is 40 g/person/day with 13 g/person/day available through meat, eggs and milk. A progressive decline in protein intake over the last 30 years has been indicated before (INFS, 1983) and at present we arrived at a situation of protein deficiency.

Table IV.3.2: Average per capita protein intake in Bangladesh.

	1962-64	1975-76	1981-82	1995-96	Requirement
Protein intake (g/capita/day)	57.9	58.5	48.4	40.0	45.3

In the project area fish is the main and cheapest source of animal protein, as it is a fishing area. Approximately 6 per cent of the fish production is consumed locally, indicating protein availability of 66 g/capita/day.

1.4 Marine fisheries

1.4.1 Fishing practices

Four main types of gears are being used, namely, push nets, gill nets, estuarine set bag nets (behundi) and marine set bag nets.

- **Push nets**, the rapid expansion of shrimp culture in Bangladesh has resulted in a tremendous demand for the seed of tiger shrimp (Bagda). Within the project area a large number of push nets are operated for seed fishing by part-time fishermen. The income generated by this activity is seasonal and varies between 60 and 2000 Tk/month.
- **Gill nets** are almost all drift gill nets placed in the Lower Meghna and its estuary. The majority (95 per cent) of the catch consists of Hilsha (Shad). Other species caught are pomfret, Spanish mackerel, croaker, snapper, etc.
- **The estuarine set bag net** is a traditional gear which is fixed by wooden poles in the estuary/river in areas with water depth less than 5 m depth. The fish comes with the current (tide), enters through the mouth and ends up in the bag. The gear is operated throughout the year although there is seasonal variation in the daily catch. The catch mainly consists of Bombay Duck, croaker, brown shrimp and ribbon fish. From a fisheries point of view the ESNB is rather destructive as it catch a large number of juvenile fish and shrimp. But it includes the largest number of fisherfolk as the investments are relatively low, they can be operated throughout the year and the fishing grounds are within reach of their non-motorised boats.
- **The marine set bag net** is more or less an enlarged version of the estuarine set bag net and is operated offshore, in areas with a depth range of 10-30 m where the salinity is 20-30 per cent. The fishing season is during the winter months when there is no fresh water run off and no fishing takes place during the monsoon period due to the weather conditions at sea. The majority of the catch consist of Pomfret, Bombay Duck and Anchovy followed by shrimps

² A number of studies (MIS, FAO, FAP 17, etc.) indicated that the BFRSS is hampered by its small sample size, an outdated frame and logistic problems in analyses of data.

1.4.2 Fishing community

The marine fishing village survey of 1984/85 (DoF, 1986) indicated that 30 per cent of the households (1170) in the area³ were fisherfolk households and 95 per cent of the fishermen were living in 4 villages; Macpherson, Nutan Sukhchar, Jahajmara and Nijhum Dwip. Almost no fishermen were living in the 5 other villages in the study area. At present no information is available for the whole study area but for Nijhum Dwip a comparison of the status of fisheries in 1984 and 1997 is presented in Table IV.3.3.

Table IV.3.3: Fisheries in Nijhum Dwip in 1984 and 1997

	1984/1985 (DoF/FAO)	1997 (MES)
Total population	721	6035
Total no. of households	99	1143
No. of fishing households	81	789
No. of fishermen	131	1120
% of fishing households	82%	69 %

The figures indicate an almost tenfold increase of the total population and the number of fishermen during this period. Within Nijhum Dwip the majority of the population is still depending on fishing for their livelihood.

1.4.3 Fish landing and marketing

Fish landing stations are locally known as "Mach ghat". There are two fish landing stations in the project area one is located in Char Muktaria (south Hatia) and the other is located in Nijhum Dwip. Both the ghats are used by fishermen for off loading, icing, drying and selling their catch. Both landing stations are used year round, but the peak season is from March to September, when daily landings can be as high as 5 to 7 mt. Fish traders visiting the area come from Khulna, Bagerhat, Noakhali and other places.

Fish marketing is poorly developed and as a result the local fishermen tend to receive relatively low prices. Marketing of fish is mainly done at the two fish landing sites. Further a part of the catch is sold at sea to collecting vessels. Some typical prices obtained during the MES survey of the area are indicated in the table.

Table IV.3.4: Local prices for fish, South Hatia

Species	Tk/kg
Chewa	5 - 6
Catfish	10 - 12
Shrimp (large)	90 - 125
Hilsha	30 - 40
Boal	20 - 25
Powa	7 - 8

Source: MES field survey, March 1997

1.4.4 Fisheries ecology and migration

Biologically, the estuary provides spawning and nursery areas for a large number of fish and crustacean which spend the remainder of their life cycles at sea, or in fresh water. Further the estuary provide avenues of entry and exit for migration of anadromous and catadromous fishes.

³ Inside and outside the embankment.

Within the Meghna estuary the following species are known to be “estuarine dependent”, that is that passing a portion of their life cycles in the estuary is **obligatory** for the completion of their life cycles.

- **Hilsha or Indian Shad** (*Tenualosa ilisha*). Hilsha in Bangladesh most likely comprises of a and of a marine/estuarine stock. Adults of the riverine stock migrate from the sea/estuary into the Meghna going further upstream into the Meghna/Pabna/Jamuna and Old Brahmaputra river (anadromous migration). They spawn upstream in these rivers and their larvae are transported downstream with the river flow towards the nursery grounds in the river and estuary/sea (de Graaf *et al.*, in press). A major nursing area is located in the Meghna river in and around Chandpur from Mushiganj to Hazimara. Another important nursing area is located in the estuary/sea from Kuakata (Patuakhali) to Dubla Island. The marine stock spawns in the lower stretches of the Meghna river near Hatia, Sandwip and Bhola. The most important spawning place in the estuary are located south of Hatia and the Hatia main channel, south of Sandwip and South-east of Char Fasson.
- **Golda or fresh water prawn**, *Macrobrachium rosenbergii*. Golda is caught in the inland water of Bangladesh and is a major export product. Golda is depending on the estuary for completion of their life cycle. During the reproduction period berried female migrate downstream towards the estuary (catadromous migration). Larvae of *Macrobrachium* can survive for five days in freshwater but brackish water is required for their development. After nursing in the estuary the juveniles migrate upstream against the river current and grow-out in the inland waters.
- **Shrimps**: Bagda (Tiger shrimp, *Penaeus Monodon*), Horina (Brown shrimp, *Metapenaeus monoceros*) Chaga (White shrimp, *Penaeus indicus*). In general marine shrimp follow a diadromous life cycle involving migration between the sea and the estuary. Adult shrimp reproduce at sea and their post larvae are carried by the tide towards the estuarine mangrove areas and the near shore estuarine waters of Teknaf, Cox's Bazaar, Noakhali and Patuakhali. They feed and grow-out to juvenile stage in the estuary, after which they migrate to the open sea.
- **Pangash or Catfish** (*Pangasius spp*). The major nursing areas for some catfish species are the estuary of the Lower Meghna.

The annual catch and value of these “estuarine dependent” species in Bangladesh is presented in Table IV.3.5.

Table IV.3.5: Annual catch and value major estuarine dependent fish species

Species	Annual catch (mt.)	Value (million US\$)
Hilsha	235,000	117.5
Fresh water prawn	405	1.6
Tiger shrimp	700	3.5
Brown shrimp	2,300	2.3
White shrimp	350	0.7
TOTAL		125.0

2. DEVELOPMENT OF FISHERIES AND AQUACULTURE

2.1 Inland fisheries

Inland fisheries is limited in the project area and will not be impacted by the proposed interventions. Improvement of inland fisheries could however be considered in the frame of a development plan. The installation of “Beel resident fish sanctuaries” for maintaining the

recruitment of these species could be considered. Quantitative figures for such a development can not be given at present as practical experiences with this option in Bangladesh are limited.

2.2 Marine fisheries

The construction of cross dams in principle alters the habitat of fish as water changes to land and impacts on fisheries can be expected. Within the intertidal area, the estuary serves as a nursing and breeding area of a large number of economic important estuarine dependent fish and shrimp species such as: Hilsha, Bagda, Golda, Pangash etc. Reduction of this area will certainly have a negative impact on these species. However quantification of these impacts is difficult as data/knowledge of the system is lacking. The proposed accelerated land reclamation must be treated carefully, but no quantification for this subject are given as;

- 25 per cent of the total fish catch of Bangladesh consists of Hilsha (*Tenualosa ilisha*) and according to FRI three major spawning areas are located in the MES area. Two of them located exactly in the area where accelerated land reclamation is proposed (Nijhum Dwip and Char Mounts). The results of the FRI study however does not allow a conclusion to be drawn as to if Hilsha spawns at the mud flat or in the main channel.
- One cross dam most likely does not have a significant impact. The cumulative impact of a number of cross dams could however have a impact similar to that of FCD/FCDI schemes on the inland fisheries, especially if Hilsha spawns at the mud flat. With the present knowledge we do not know if in the future the spawning places will move with the changing land/water patterns. Considering the economic importance of Hilsha (250,000 mt/year, 100 million US\$/year) and the large number of households depending on it for its livelihood, and the fact that most interventions are irreversible, a very cautious approach is essential.
- The numerous creeks and mud flats in the intertidal area serves as nursing area for three other important economic important species; Bagda, Golda and Pangash. The studied interventions will reduce this specific habitat and will reduce the survival of the post larvae/fry of these species, which are already under heavy pressure due to the earlier mentioned shrimp fry collection

A separate technical note on fisheries in the MES and the coastal area will be written by the consultant.

2.3 Aquaculture

The introduction of aquaculture in the newly accreted land will be a element of the development plan this can be either carp culture, shrimp culture or both.

2.3.1 Carp culture

The rearing of carp in fresh water at present is not positively or negatively impacted by the proposed activities. Experience elsewhere in Bangladesh (FAP 20, MAEP) indicated that a major bottleneck for the development of carp rearing and the relative low production rates is the poor management techniques used. This is caused by "lack of knowledge" of the pond owners and operators.

A carp rearing development programme should include the existing cultured, culturable ponds in the existing area and new ponds to be excavated in the accreted land and a carp culture extension programme.

Carp culture is a well known activity in Bangladesh and therefore the husbandry techniques are not further described. For each activity a production/economic model is made based on the production/development of one hectare of pond production. These models are further used to indicate the costs and benefits obtained through carp culture under the different scenario's.

2.3.2 Further development of existing ponds

The present production rate of 825 kg/ha/year can be increased to 2,000 kg/ha/year if proper husbandry techniques are applied. The production rate will be less than the average production rate of 2,200 kg/ha/year as obtained elsewhere in Bangladesh and is caused by physical properties of soil and water in the coastal area. The production parameters for culturable ponds, cultured ponds and for ponds where the production has increased through an aquaculture extension program are presented in Appendix VI, Tables VI.18 to VI.20

Increasing the production of existing ponds and introduction of carp rearing in the newly accreted land can only be achieved if an aquaculture extension programme is carried out in the project area.

The basis of an aquaculture development programme is the transfer of knowledge through an extension officer. Experience in FAP 20 has indicated that the availability of credit is not a prerequisite for a successful programme. Interested pond owners and operators are given a basic training after which the extension officer visited each pond operator once a month at the pond site and provides further on site training. Experiences with similar programmes in Bangladesh (FAP 20, MAEP) indicated that one extension officer can cover 60 ponds per year and that it takes two year to bring the pond at the proposed production level of 2000 kg/ha/year. The costs of a aquaculture extension programme are presented in Table IV.3.6.

Table IV.3.6: Cost of an aquaculture development project

Area Development Parameters				
Average pond size	2000	m2		
Total pond area	200	ha		
Development time	5			
No of ponds covered per year	200			
No of Ponds/extension officer	60	per year		
Operating costs per ha	7027	Tk/ha	Development of one pond takes two year	
Total area developed in 5 years	200	ha		
Investment cost / ha	4840	Tk/ha	Investment replaced in 5 years	
OPERATING COSTS			Monthly costs Tk	Annual total Tk
Extension officers	3	No.	9,000	360,000
Supporting staff	1	No.	7,000	84,000
Administration	1	No.	9,000	72,000
Petrol	35	litre	3,675	44,100
Training	60000	lump sum		60,000
Logistic support/office	125000	lump sum		125,000
Office costs	185000	lump sum		185,000
annual fish fortnight	10000	lump sum		10,000
Miscellaneous + O&M (15%)				141,015
TOTAL				1,081,115
EQUIPMENT (costs per 5 years)				
Motorcycles	4	No.	616,000	
Training material		lump sum	44,000	
Office equipment		lump sum	220,000	
Miscellaneous (10%)			88,000	
TOTAL			968,000	

2.3.3 Shrimp Culture

A major bottleneck of shrimp farming at present is the ravaging impact of the White spot disease which reduced production levels and average size of produced shrimps. Future developments can only be put in the perspective of solving the present non-sustainability of shrimp farming through the production of pathogen free post larvae, through the integration of proper husbandry techniques and through proper planning.

However in order to get an idea of the future perspective the present production parameters and future production parameters are presented in Appendix VI, Tables VI.21 and VI.22

nd 2

SOCIO-ECONOMIC SURVEY

The annex contains

- results of the needs assessment for Nijhum Dwip and South Hatia
- results of the socio-economic household survey for Nijhum Dwip.

The socio-economic household survey was implemented in Urir Char, Bara Baishdia and Char Majid at the same time as in Nijhum Dwip. The results for all four areas are included here as they provide a useful comparison with the situation in Nijhum Dwip.

For further comment and analysis of these results, reference is made to Volume 4 of the Master Plan report on Rural Development.

Table IV.4.1: Population characteristics of the study area

Population Characteristics	Location					
	Nijhum Dwip		Urr Char		Bara Balshulia	
Total Households Surveyed	160	97	110	50	102	50
Total Population	1158	583	684	306	620	306
Economically Active Population	302	137	217	92	160	92
Average Size of Households	7.2	6.0	6.2	6.1	6.1	6.1
Economic Dependency Ratio	283.4	325.6	215.2	232.6	287.5	232.6

$$\text{Economic Dependency Ratio} = \frac{\text{Total Population} - \text{Economically Active Population}}{\text{Economically Active Population}} \times 100$$

Table IV.4.2 : Sex distribution of the sample households

Age	Location																			
	Nijhum Dwip				Utr Char				Bara Basidia				Char Majid				Char Montaz		Kukri-Mukri	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female		
<5	105	81	65	57	94	83	52	33	109	83	52	33	109	83	32	44	20	17		
	17.2 %	14.8 %	21.6 %	20.2 %	10.9 %	10.6 %	16.7 %	10.7 %	12.1 %	12.1 %	12.1 %	10.7 %	9.4 %	9.4 %	12.1 %	12.1 %	12.1 %	12.1 %		
5-14	199	186	81	101	237	240	237	143	240	143	237	143	240	143	102	105	46	42		
	32.6 %	33.9 %	26.9 %	35.8 %	27.5 %	30.6 %	39.9 %	46.3 %	39.9 %	46.3 %	29.9 %	30.6 %	29.9 %	30.6 %	27.7 %	30.6 %	27.7 %	30.0 %		
15-24	92	93	42	35	176	170	35	35	176	170	70	61	176	170	70	61	41	26		
	15.1 %	17.0 %	14.0 %	12.4 %	20.4 %	21.7 %	11.3 %	11.3 %	20.4 %	21.7 %	20.5 %	11.3 %	20.5 %	11.3 %	24.7 %	17.8 %	24.7 %	18.6 %		
25-34	82	79	37	43	114	109	21	43	114	109	32	45	114	109	18	19	18	19		
	13.4 %	14.4 %	12.3 %	15.3 %	13.2 %	13.9 %	6.8 %	13.9 %	13.2 %	13.9 %	9.4 %	13.1 %	9.4 %	13.1 %	10.8 %	13.6 %	10.8 %	13.6 %		
35-44	41	48	30	21	77	95	38	28	77	95	33	33	77	95	13	12	13	12		
	6.7 %	8.8 %	10.0 %	7.5 %	8.9 %	12.1 %	12.2 %	9.1 %	9.1 %	9.1 %	9.7 %	9.6 %	9.7 %	9.6 %	7.8 %	8.6 %	7.8 %	8.6 %		
45-54	30	22	17	16	73	47	27	24	73	47	28	23	73	47	12	14	12	14		
	4.9 %	4.0 %	5.7 %	5.7 %	8.5 %	6.0 %	8.7 %	7.8 %	8.5 %	6.0 %	8.2 %	6.7 %	7.8 %	6.7 %	7.2 %	10.0 %	7.2 %	10.0 %		
55 >	61	39	29	9	92	41	14	3	92	41	44	16	92	41	16	10	16	10		
	10.0 %	7.1 %	9.6 %	3.2 %	10.7 %	5.2 %	4.5 %	1.0 %	10.7 %	5.2 %	12.9 %	9.3 %	12.9 %	9.3 %	9.6 %	7.1 %	9.6 %	7.1 %		
Total	610	548	301	282	863.0	785	311	309	863.0	785	341	343	863.0	785	166	140	166	140		
	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %		
Sex Ratio	111.3				106.7				109.9				100.7				99.4			

Table IV.4.4 : Main occupation of household heads

Occupation	Location				
	Nijhum Dwip	Urir Char	Bera Baishdia	Char Majid	Char Montaz
Agriculture	38 23.8 %	61 62.9 %	119 44.1 %	62 60.8 %	41 37.3 %
Agricultural Labour	2 1.3 %	17 17.5 %	24 8.9 %	24 23.5 %	10 9.1 %
Business	12 7.5 %	7 7.2 %	38 14.1 %	5 4.9 %	9 8.2 %
Fishing	81 50.6 %	3 3.1 %	55 20.4 %	1 1.0 %	20 18.2 %
Boat Labour	3 1.9 %	0 0.0 %	4 1.5 %	0 0.0 %	21 19.1 %
Service	10 6.3 %	4 4.1 %	13 4.8 %	0 0.0 %	3 2.7 %
Others	14 8.8 %	5 5.2 %	17 6.3 %	10 9.8 %	6 5.5 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %

Table IV.4.5 : Main occupation of household members

Occupation	Location									
	Nijhum Dwip		Urir Char		Bera Baishdia		Char Majid		Char Montaz	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Agriculture	12 2.6 %	2 0.4 %	23 11.2 %	0 0.0 %	90 15.0 %	1 0.1 %	24 10.9 %	0 0.0 %	22 9.4 %	0 0.0 %
Agricultural Labour	7 1.5 %	0 0.0 %	4 1.9 %	0 0.0 %	45 7.5 %	2 0.3 %	28 12.7 %	3 1.0 %	11 4.7 %	2 0.6 %
Business	3 0.7 %	0 0.0 %	4 1.9 %	0 0.0 %	18 3.0 %	0 0.0 %	0 0.0 %	0 0.0 %	14 6.0 %	0 0.0 %
Fishing	84 18.5 %	2 0.4 %	2 1.0 %	0 0.0 %	57 9.5 %	0 0.0 %	2 0.9 %	0 0.0 %	16 6.8 %	1 0.3 %
Boatman	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	1 0.2 %	0 0.0 %	0 0.0 %	0 0.0 %	36 15.4 %	4 1.2 %
Service	10 2.2 %	5 0.9 %	5 2.4 %	0 0.0 %	18 3.0 %	5 0.6 %	0 0.0 %	0 0.0 %	5 2.1 %	0 0.0 %
Student	171 37.7 %	140 25.7 %	73 35.4 %	72 25.7 %	225 37.4 %	223 28.7 %	64 29.0 %	29 9.8 %	63 26.9 %	56 16.5 %
Housewife	0 0.0 %	206 37.9 %	0 0.0 %	103 36.8 %	0 0.0 %	353 45.5 %	0 0.0 %	97 32.7 %	0 0.0 %	152 44.7 %
Dependent	154 33.9 %	185 34.0 %	93 45.2 %	105 37.5 %	141 23.4 %	188 24.2 %	102 46.2 %	168 56.6 %	64 27.4 %	124 36.5 %
Others	13 2.9 %	4 0.7 %	2 1.0 %	0 0.0 %	7 1.2 %	4 0.5 %	1 0.5 %	0 0.0 %	3 1.3 %	1 0.3 %
Total	454 100.0 %	544 100.0 %	206 100.0 %	280 100.0 %	602 100.0 %	776 100.0 %	221 100.0 %	297 100.0 %	234 100.0 %	340 100.0 %

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Table IV.4.6 : Secondary occupation of household heads

Occupation	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Agriculture	62 38.8 %	5 5.2 %	65 24.1 %	6 5.9 %	13 11.8 %	4 8.0 %
Agricultural Labour	11 6.9 %	3 3.1 %	11 4.1 %	28 27.5 %	14 12.7 %	1 2.0 %
Absentee Land Owner	2 1.3 %	0 0.0 %	1 0.4 %	0 0.0 %	0 0.0 %	0 0.0 %
Business	5 3.1 %	6 6.2 %	14 5.2 %	5 4.9 %	8 7.3 %	7 14.0 %
Fishing	16 10.0 %	12 12.4 %	48 17.8 %	23 22.6 %	8 7.3 %	1 2.0 %
Boatman	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	17 15.5 %	5 10.0 %
Service	1 0.6 %	2 2.1 %	1 0.4 %	0 0.0 %	0 0.0 %	0 0.0 %
Others	2 1.3 %	0 0.0 %	0 0.0 %	1 1.0 %	3 2.7 %	1 2.0 %
No Secondary Occupation	61 38.1 %	69 71.1 %	130 48.2 %	39 38.2 %	47 42.7 %	31 62.0 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %	50 100.0 %

Table IV.4.7 : Secondary occupation of household members

Occupation	Location											
	Nijhum Dwip				Urir Char				Bara Baishdia			
	Male	Female	0.0 %	0.0 %	Male	Female	0.0 %	0.0 %	Male	Female	0.0 %	0.0 %
Agriculture	51 11.2 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %	17 2.8 %	0 0.0 %	0.0 %	0.0 %
Agricultural Labour	3 0.7 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %	13 2.2 %	0 0.0 %	0.0 %	0.0 %
Absentee Land Owner	0 0.0 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %
Business	1 0.2 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %	1 0.2 %	0 0.0 %	0.0 %	0.0 %
Fishing	2 0.4 %	2 0.4 %	0.5 %	0.5 %	1 0.5 %	1 0.5 %	0.5 %	0.5 %	41 6.8 %	1 0.1 %	3.6 %	3.6 %
Boatman	0 0.0 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %
Service	0 0.0 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %
Others	1 0.2 %	2 0.4 %	0.4 %	0.4 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %	0 0.0 %	0 0.0 %	0.0 %	0.0 %
No Secondary Occupation	396 87.2 %	540 99.3 %	99.0 %	99.0 %	204 99.0 %	280 100.0 %	100.0 %	100.0 %	530 88.0 %	775 99.9 %	91.9 %	91.9 %
Total	454 100.0 %	544 100.0 %	100.0 %	100.0 %	206 100.0 %	280 100.0 %	100.0 %	100.0 %	602 100.0 %	776 100.0 %	100.0 %	100.0 %

Table IV.4.8 : Settlement pattern of households in sample areas

Population Characteristics	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
% in Cluster Settlement	116 72.5 %	9 9.3 %	195 72.2 %	31 30.4 %	5 4.6 %	18 16.0 %
% in Single Settlement	44 27.5 %	88 90.7 %	75 27.8 %	71 69.6 %	105 95.5 %	32 64.0 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %	50 100.0 %

Table IV.4.9 : Settlement pattern preferences of households

Preference for Settlement Pattern	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	41 25.6 %	8 8.3 %	97 35.9 %	31 30.4 %	15 13.6 %	8 16.0 %
Single	119 74.4 %	89 91.8 %	173 64.1 %	71 69.6 %	95 86.4 %	42 84.0 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %	50 100.0 %

Table IV.4.10 : Household structure in the sample areas

Household Structure	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Average household size	7.2	6.0	6.1	6.1	6.2	6.1
% Female headed households	4 2.5 %	2 2.1 %	9 3.3 %	12 11.8 %	3 2.7 %	4 8.0 %
% of Households with seasonal out-migrant	41 25.6 %	4 4.1 %	14 5.2 %	35 34.3 %	5 4.6 %	1 2.0 %

Table IV.4.11 : Land ownership of households

Land Holding (hectares)	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Functionally Land less 0.00 - 0.02	53 33.1 %	28 28.9 %	28 10.4 %	2 2.0 %	33 30.0 %	11 22.0 %
Marginal farmer 0.02 - 0.20	3 1.9 %	4 4.1 %	53 19.6 %	20 19.6 %	23 20.9 %	12 24.0 %
Small farmer 0.20 - 1.00	100 62.5 %	53 54.6 %	108 40.0 %	73 71.6 %	20 18.2 %	12 24.0 %
Medium farmer 1.01 - 3.03	3 1.9 %	11 11.3 %	55 20.4 %	6 5.9 %	22 20.0 %	10 20.0 %
Large farmer Above 3.03	1 0.6 %	1 1.0 %	26 9.6 %	1 1.0 %	12 10.9 %	5 10.0 %

Table IV.4.12 : Operational holdings of households

Reasons	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri Mukri
	hectares	hectares	hectares	hectares	hectares	hectares
Own land farming	58.9 47.2 %	43.6 58.6 %	129.1 37.5 %	36.3 58.4 %	49.8 33.0 %	27.4 38.4 %
Lease in	7.0 5.6 %	0.0 0.0 %	43.3 12.6 %	0.0 0.0 %	33.4 22.2 %	5.8 8.2 %
Mortgage in	12.8 10.3 %	2.5 3.3 %	7.5 2.2 %	0.8 1.3 %	3.2 2.2 %	0.0 0.0 %
Share Crop in	46.0 36.9 %	28.4 38.1 %	164.3 47.7 %	25.1 40.4 %	64.4 42.7 %	38.2 53.5 %
Others	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %
Total	124.7 100.0 %	74.5 100.0 %	344.2 100.0 %	62.1 100.0 %	150.8 100.0 %	71.4 100.0 %

Note : Land leased, mortgaged or share cropped in will not necessarily equal to the land share cropped, leased and mortgaged out (Table-13) due to household sampling.

Table IV.4.13 : Own land not cultivated

Reasons	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
	hectares	hectares	hectares	hectares	hectares	hectares
Share crop out	16.7 66.2 %	9.3 70.3 %	107.4 84.3 %	8.5 84.4 %	8.0 54.7 %	4.7 78.5 %
Lease out	0.0 0.0 %	0.8 5.9 %	11.3 8.8 %	0.0 0.0 %	6.0 41.3 %	1.3 21.5 %
Mortgage out	7.0 27.6 %	1.5 11.6 %	8.8 6.9 %	1.6 15.6 %	0.6 4.0 %	0.0 0.0 %
Others	1.6 6.2 %	1.6 12.2 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %
Total	25.2 100.0 %	13.2 100.0 %	127.4 100.0 %	10.1 100.0 %	14.6 100.0 %	6.0 100.0 %

Note : Land leased, mortgaged or share cropped out will not necessarily equal to that land share cropped, leased or mortgaged in (Table-12) due to household sampling.

Table IV.4.14 : Reasons for settlement in the sample areas

Reasons	Location					Kukri-Mukri
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	
Landless	51 31.9 %	16 16.5 %	34 12.6 %	55 53.9 %	47 42.7 %	11 22.0 %
River erosion	92 57.5 %	80 82.5 %	6 2.2 %	39 38.2 %	13 11.8 %	2 4.0 %
Inheritance	2 1.3 %	0 0.0 %	205 75.9 %	2 2.0 %	21 19.1 %	30 60.0 %
Others	15 9.4 %	1 1.0 %	25 9.3 %	6 5.9 %	29 26.4 %	7 14.0 %

Table IV.4.15 : Land title status

Location	% Title Deed to Homestead			% Title Deed to Agricultural Land			% Applied for Khas land	% Household Settled without Legal Authority
	Husband	Wife	No owner-ship	Husband	Wife	No owner-ship		
Nijhum Dwip	98 61.3 %	94 58.8 %	57 35.6 %	105 65.6 %	96 60.0 %	55 34.4 %	153 95.6 %	38 23.8 %
Urir Char	68 70.1 %	16 16.5 %	29 29.9 %	63 65.0 %	18 18.6 %	34 35.1 %	63 65.0 %	27 27.8 %
Bara Baishdia	234 86.7 %	10 3.7 %	29 10.7 %	204 75.6 %	7 2.6 %	66 24.4 %	172 63.7 %	1 0.4 %
Char Majid	38 37.3 %	0 0.0 %	64 62.8 %	38 37.3 %	0 0.0 %	64 62.8 %	88 86.3 %	63 61.8 %
Char Montaz	67 60.9 %	4 3.6 %	39 35.5 %	51 46.4 %	9 8.2 %	48 52.7 %	57 51.8 %	35 31.8 %
Kukri-Mukri	34 68.0 %	3 6.0 %	13 26.0 %	27 54.0 %	3 6.0 %	23 46.0 %	14 28.0 %	9 18.0 %

Table IV.4.16A : Loss of land by households

Location	Land loss in last 10 years by reasons						
	Area (hectares)						
	Household with less than 1.0 ha			Household with 1.0 ha and over			Total
	A	B	C	A	B	C	
Nijhum Dwip	0 0.0 %	0 0.0 %	7 43.8 %	1 6.3 %	2 12.5 %	6 37.5 %	16 100.0 %
Urir Char	5 7.5 %	1 1.5 %	0 0.0 %	58 86.6 %	2 3.0 %	1 1.5 %	67 100.0 %
Bara Baishdia	98 44.0 %	1 0.5 %	16 7.2 %	87 39.0 %	5 2.2 %	16 7.2 %	223 100.0 %
Char Majid	0 0.0 %	3 11.5 %	21 80.8 %	1 3.9 %	0 0.0 %	1 3.9 %	26 100.0 %
Char Montaz	4 15.4 %	4 15.4 %	6 23.1 %	4 15.4 %	3 11.5 %	5 19.2 %	26 100.0 %
Kukri-Mukri	0 0.0 %	1 50.0 %	1 50.0 %	0 0.0 %	0 0.0 %	0 0.0 %	2 100.0 %

Table IV.4.16B : Gain of land by households

Location	Land gain in last 10 Years by reasons						Total
	Area (ha)						
	Household with less than 1.0 ha			Household with 1.0 ha and over			
	A	B	C	A	B	C	
Nijhum Dwip	1	4	2	74	0	3	84
	1.2 %	4.8 %	2.4 %	88.1 %	0.0 %	3.6 %	100.0 %
Urir Char	0	5	0	4	11	2	22
	0.0 %	22.7 %	0.0 %	18.2 %	50.0 %	9.1 %	100.0 %
Bara Baishdia	0	25	6	4	30	4	69
	0.0 %	36.2 %	8.7 %	5.8 %	43.5 %	5.8 %	100.0 %
Char Majid	1	5	0	20	3	0	29
	3.5 %	17.2 %	0.0 %	69.0 %	10.3 %	0.0 %	100.0 %
Char Montaz	0	8	5	1	5	9	28
	0.0 %	28.6 %	17.9 %	3.6 %	17.9 %	32.1 %	100.0 %
Kukri-Mukri	0	3	3	1	1	2	10
	0.0 %	30.0 %	30.0 %	10.0 %	10.0 %	20.0 %	100.0 %

LOSS (Reason) :

A: Erosion

B: Distribution among family members, gift, matrimonial, other methods of loss

C: Direct sale, mortgage out, sale to buy other asset.

GAIN (Reason) :

A: Khas land

B: Direct purchase, mortgage in, purchase against sale of other asset

C: Inheritance, matrimonial, gift, other methods of gain

Table IV.4.17 : Income and sources of income of households - agriculture

Location	Average Production (kg)						Average self consumption (kg)						Average Cash Income (Tk.)						Total Average Cash Income (Tk.)
	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F	
Nijhum Dwip	1731	0	11	232	19	1	1312	0	3	152	16	0	2436	0	71	119	150	3	2779
Urir Char	1851	3	72	214	42	40	1451	3	43	130	16	3	2179	0	249	260	1046	211	3945
Bara Baishdia	2115	0	0	0	0	0	1441	0	0	0	0	0	3581	0	10	0	0	20	3611
Char Majid	982	0	44	66	14	9	833	0	12	32	9	2	807	0	497	35	167	47	1553
Char Montaz	1437	76	4	0	7	20	629	15	2	39	4	9	3883	649	38	36	39	184	4831
Kukri Mukri	1461	19	1	9	1	16	695	6	0	5	1	6	4603	118	6	1	0	186	4914

Category A : Paddy

Category B : Wheat

Category C : Sunflower
Soyabean
Oil seeds
Groundnut
Pulse

Category D Potato
Sweet Potato
Vegetables

Category E : Onion
Garlic
Chilli

Category F : Fruits
Others

Note: In Char Montaz and Kukri-Mukri B=Pulse

Table IV.4.18 : Income and sources of income of households - livestock

Location	Average number per owning household						Average Cash Income (Tk.)						Total Average Cash Income (Tk.)
	A	B	C	D	E	F	A	B	C	D	E	F	
Nijhum Dwip	484	37	621	5067	1	32534	1356	137	218	134	0	350	2196
Urir Char	338	63	256	1630	20	13050	3095	72	160	253	0	277	3866
	3.5	0.6	2.6	16.8	0.2	134.5							
Bara Baishdia	640	238	691	7026	60	7847	928	564	149	72	0	128	1842
	2.4	0.9	2.6	26.0	0.2	29.1							
Char Majid	160	0	72	1409	0	0	671	0	156	393	0	0	1221
	1.6	0.0	0.7	13.8	0.0	0.0							
Char Montaz	369	123	104	2928	5635	5245	1009	587	54	379	228	37	2294
	3.4	1.1	0.9	26.6	51.2	47.6							
Kukri Mukri	146	32	42	797	1910	302	912	820	92	255	90	6	2175
	2.9	0.6	0.8	15.9	38.2	6.0							

Category A : Bullock
Dry cow
Milk cow
Calves

Category B : Buffalo

Category C : Sheep
Goat

Category D : Poultry

Category E : Milk

Table IV.4.19 : Value of fishing for self consumption and cash sale

Location	Average Per Household in Taka					
	Open Water			Culture Fishing		
	Value of Fish Caught	Self Consumption	Cash Sale	Value of Fish Culture	Self Consumption	Cash Sale
Nijhum Dwip	20,913	3,825	17,088	499	213	179
Urir Char	13,658	2,106	11,552	1,120	622	856
Bara Baishdia	15,549	1,653	13,896	2,542	663	280
Char Majid	1,921	379	1,542	466	542	1,380
Char Montaz			10,043			112
Kukri-Mukri			7,420			20

Foot Note : The table shows only a fragment catch account (25% of the total catch). The rest catch goes to money lender, trader, agent, (Dadan)

Table IV.4.20 : Own farm employment of households

Location	Days Employed		
	< 50	50 - 100	above 101
	% of Households	% of Households	% of Households
Nijhum Dwip	4 4.2 %	32 33.3 %	60 62.5 %
Urir Char	2 2.9 %	19 27.5 %	47 68.1 %
Bara Baishdia	5 5.0 %	8 8.0 %	85 85.0 %
Char Majid	8 12.7 %	26 41.3 %	30 47.6 %
Char Montaz	5 9.4 %	9 17.0 %	39 73.6 %
Kukri-Mukri	1 4.4 %	13 56.5 %	9 39.1 %

Table IV.4.21 : Income transfer from migrant labour working outside

Location	Average Seasonal Yearly Income (Tk)	Average Full Time Yearly Income (Tk)	% of Seasonal Migrant Income Family	% of Full time Migrant Income Family
Nijhum Dwip	4,314	21,840	28.1	3.1
Urir Char	6,571	21,712	24.7	16.5
Bara Baishdia	13,673	42,228	5.6	18.2
Char Majid	3,540	5,743	49.0	14.7
Char Montaz	11,000	18,000	1.8	0.9
Kukri-Mukri	15,000	12,000	2.0	2.0

Table IV.4.22 : Children attending primary school

Location	Total Primary School age (5-12 yrs.) Children	Total Children Attending Primary School	Percentage of attending Primary School
Nijhum Dwip	353	257	72.8
Urir Char	168	116	69.1
Bara Baishdia	394	315	80.0
Char Majid	239	84	35.2
Char Montaz	174	32	18.4
Kukri-Mukri	72	23	31.9

Table IV.4.23 : Number of primary school age children

Location	Number of primary school age children						Mean per household
	% of Households						School-age going children
	0	1	2	3	4	= > 5	
Nijhum Dwip	21 13.1 %	33 20.6 %	37 23.1 %	38 23.8 %	25 15.6 %	6 3.8 %	2.2
Urir Char	20 20.6 %	20 20.6 %	32 33.0 %	17 17.5 %	7 7.2 %	1 1.0 %	1.7
Bara Baishdia	58 21.5 %	90 33.3 %	81 30.0 %	25 9.3 %	13 4.8 %	3 1.1 %	1.5
Char Majid	7 6.9 %	17 16.7 %	31 30.4 %	31 30.4 %	13 12.8 %	3 2.9 %	2.3
Char Montaz	22 20.0 %	33 30.0 %	31 28.2 %	18 16.4 %	5 4.6 %	1 0.9 %	1.6
Kukri-Mukri	12 24.0 %	15 30.0 %	14 28.0 %	7 14.0 %	2 4.0 %	0 0.0 %	1.4

Table IV.4.24 : Diseases the family suffered last year

Location	% of Member suffered from diseases					Treatment received	Hospital or Health centre visit by household
	A	B	C	D	E	Yes	Yes
Nijhum Dwip	343 64.4 %	92 17.3 %	14 2.6 %	4 0.8 %	80 15.0 %	512 96.1 %	50 31.3 %
Urir Char	76 46.1 %	41 24.9 %	16 9.7 %	0 0.0 %	32 19.4 %	163 98.8 %	22 22.7 %
Bara Baishdia	211 35.6 %	104 17.5 %	82 13.8 %	4 0.7 %	192 32.4 %	569 96.0 %	112 41.5 %
Char Majid	117 47.4 %	92 37.3 %	13 5.3 %	0 0.0 %	25 10.1 %	216 87.5 %	8 7.8 %
Char Montaz	85 44.0 %	34 17.6 %	37 19.2 %	0 0.0 %	37 19.2 %	162 83.9 %	25 22.7 %
Kukri-Mukri	34 46.6 %	15 20.6 %	12 16.4 %	0 0.0 %	12 16.4 %	50 68.5 %	9 18.0 %

A. Fever, Cough, Typhoid, Malaria

B. Diarrhea, Cholera, Dysentery

C. Ulcer, Gastric

D. TB

E. Others

Table IV.4.25 : Service received from NGOs

Location	Service received from NGO	Type of Service			
	Yes	Material aid	Credit	Technical aid	Other
Nijhum Dwip	125 78.1 %	123 98.4 %	1 0.8 %	0 0.0 %	1 0.8 %
Urir Char	12 12.4 %	12 100.0 %	0 0.0 %	0 0.0 %	0 0.0 %
Bara Baishdia	4 1.5 %	0 0.0 %	1 25.0 %	2 50.0 %	1 25.0 %
Char Majid	61 59.8 %	29 47.5 %	24 39.3 %	4 6.6 %	4 6.6 %
Char Montaz	52 47.3 %	15 28.9 %	37 71.2 %	0 0.0 %	0 0.0 %
Kukri-Mukri	16 32.0 %	0 0.0 %	16 100.0 %	0 0.0 %	0 0.0 %

Table IV.4.26 : Family planning information received by households

Location	Received Family Planning Information
	Yes
Nijhum Dwip	95 59.4 %
Urir Char	62 63.9 %
Bara Baishdia	246 91.1 %
Char Majid	78 76.5 %
Char Montaz	22 20.0 %
Kukri-Mukri	8 16.0 %

Table IV.4.27 : Availability of fishery and agricultural extension services to households

Location	Service available			
	Agricultural Extension		Fishery Extension	
	Yes	No	Yes	No
Nijhum Dwip	0 0.0 %	160 100.0 %	1 0.6 %	159 99.4 %
Urir Char	0 0.0 %	97 100.0 %	0 0.0 %	97 100.0 %
Bara Baishdia	0 0.0 %	270 100.0 %	0 0.0 %	270 100.0 %
Char Majid	42 41.2 %	60 58.8 %	40 39.2 %	62 60.8 %
Char Montaz	0 0.0 %	110 100.0 %	0 0.0 %	110 100.0 %
Kukri-Mukri	0 0.0 %	50 100.0 %	0 0.0 %	50 100.0 %

Table IV.4.28 : Frequency of services available to households (agriculture and fisheries)

Location	Agricultural Extension Service Available				Fishery Extension Service Available			
	% of Households							
	Weekly	Monthly	Half-Yearly	No visit	Weekly	Monthly	Half-Yearly	No visit
Nijhum Dwip	0	0	0	160	1	0	0	159
	0.0 %	0.0 %	0.0 %	100.0 %	0.6 %	0.0 %	0.0 %	99.4 %
Urir Char	0	0	0	97	0	0	0	97
	0.0 %	0.0 %	0.0 %	100.0 %	0.0 %	0.0 %	0.0 %	100.0 %
Bara Baishdia	0	0	0.0	270	0	0	0	270
	0.0 %	0.0 %	0.0 %	100.0 %	0.0 %	0.0 %	0.0 %	100.0 %
Char Majid	0	15	27	60	0	15	25	62
	0.0 %	14.7 %	26.5 %	58.8 %	0.0 %	14.7 %	24.5 %	60.8 %
Char Montaz	0	0	0	110	0	0	0	110
	0.0 %	0.0 %	0.0 %	100.0 %	0.0 %	0.0 %	0.0 %	100.0 %
Kukri-Mukri	0	0	0	50	0	0	0	50
	0.0 %	0.0 %	0.0 %	100.0 %	0.0 %	0.0 %	0.0 %	100.0 %

Table IV.4.29 : Credit and indebtedness of households last year

Location	Need of Loan			
	Yes		No	Total
	Received	Not received		
Nijhum Dwip	86 53.8 %	44 27.5 %	30 18.8 %	160 100.0 %
Urir Char	52 53.6 %	16 16.5 %	29 29.9 %	97 100.0 %
Bara Baishdia	158 58.5 %	41 15.2 %	71 26.3 %	270 100.0 %
Char Majid	32 31.4 %	60 58.8 %	10 9.8 %	102 100.0 %
Char Montaz	65 59.1 %	10 9.1 %	35 31.8 %	110 100.0 %
Kuk-Mukri	25 50.0 %	0 0.0 %	25 50.0 %	50 100.0 %

Table IV.4.30 : Credit and indebtedness of households last year

Location	Purpose				Total Average Amount	Total Av. Amount Paid	Total Av. Amount Not Paid
	A	B	C	D			
Nijhum Dwip	46 53.5 %	5 5.8 %	12 14.0 %	30 34.9 %	6847	10376	7001
Urir Char	34 65.4 %	3 5.8 %	13 25.0 %	5 9.6 %	4620	4577	2210
Bara Baishdia	55 34.8 %	23 14.6 %	83 52.5 %	8 5.1 %	7986	3117	8215
Char Majid	17 53.1 %	5 15.6 %	7 21.9 %	3 9.4 %	2315	2326	354
Char Montaz	25 38.5 %	17 26.2 %	4 6.2 %	31 47.7 %	5456	1799	3951
Kukri-Mukri	6 24.00 %	14 56.00 %	1 4.00 %	6 24.00 %	5600	1214	2908

Note : Some loans have multiple purposes

A. Agri Input, Agri Implements/Equipment, Animal

B. Debt repayment, Land purchase, Trade

C. Food, Education, Social obligation, Dowry

D. Fishing

Table IV.4.31 : Sources of credit

	Sources	Location					
		Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Non Institutional	Money lender	64 74.4 %	16 30.8 %	129 81.7 %	4 12.5 %	7 10.8 %	3 12.0 %
	Friends/Relatives	11 12.8 %	3 5.8 %	5 3.2 %	7 21.9 %	2 3.1 %	0 0.0 %
	Traders	4 4.7 %	7 13.5 %	3 1.9 %	1 3.1 %	11 16.9 %	4 16.0 %
	Others	11 12.8 %	1 1.9 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %
Institutional	Commercial Bank	1 1.2 %	0 0.0 %	7 4.4 %	0 0.0 %	2 3.1 %	1 4.0 %
	BKB	1 1.2 %	27 51.9 %	27 17.1 %	0 0.0 %	3 4.6 %	3 12.0 %
	Grameen Bank	0 0.0 %	1 1.9 %	0 0.0 %	1 3.1 %	1 1.54 %	0 0.0 %
	Co-operative	1 1.2 %	0 0.0 %	0 0.0 %	2 6.3 %	0 0.0 %	0 0.0 %
	NGO	0 0.0 %	0 0.0 %	1 0.6 %	17 53.1 %	51 78.5 %	16 64.0 %
	Others	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	1 4.0 %

Location	Amount in Taka				Total
	< 2000	2000 - 4000	4000 - 6000	> 6000	
Nijhum Dwip	26 30.2 %	27 31.4 %	14 16.3 %	19 22.1 %	86
Urir Char	14 26.9 %	13 25.0 %	17 32.7 %	8 15.4 %	52
Bara Baishdia	42 26.6 %	27 17.1 %	29 18.4 %	60 38.0 %	158
Char Majid	21 65.6 %	6 18.8 %	5 15.6 %	0 0.0 %	32
Char Montaz	6 9.2 %	37 56.9 %	10 15.4 %	12 18.5 %	65
Kukri-Mukri	14 56.0 %	5 20.0 %	2 8.0 %	4 16.0 %	25

Land Holding Class (hectares)	Location																		
	Nijhum Dwip			Urir Char			Bara Baishdia			Char Majid			Char Montaz			Kukri-Mukri			
	Need			Need			Need			Need			Need			Need			
	Yes	No		Yes	No		Yes	No		Yes	No		Yes	No		Yes	No		
0 - 0.02	47 29.4 %	6 3.8 %		25 25.8 %	3 3.1 %		21 7.8 %	7 2.6 %		1 1.0 %	1 1.0 %		16 14.6 %	17 15.5 %		3 6.0 %	3 6.0 %		8 16.0 %
0.02 - 0.20	3 1.9 %	0 0.0 %		4 4.1 %	0 0.0 %		45 16.7 %	8 3.0 %		15 14.7 %	5 4.9 %		8 7.3 %	15 13.6 %		3 6.00 %	3 6.00 %		9 18.0 %
0.2 - 1.0	83 51.9 %	17 10.6 %		37 38.1 %	16 16.5 %		90 33.3 %	18 6.7 %		43 42.2 %	30 29.4 %		12 10.9 %	8 7.3 %		3 6.0 %	3 6.0 %		9 18.0 %
1.0 - 3.0	2 1.3 %	1 0.6 %		10 10.3 %	1 1.0 %		40 14.8 %	15 5.6 %		3 2.9 %	3 2.9 %		15 13.6 %	7 6.4 %		4 8.0 %	4 8.0 %		6 12.0 %
> 3.0	0 0.0 %	1 0.6 %		1 1.0 %	0 0.0 %		19 7.0 %	7 2.6 %		1 1.0 %	0 0.0 %		10 9.1 %	2 1.8 %		5 10.0 %	5 10.0 %		0 0.0 %

Table IV.4.34 : Reasons for current need for credit

Landholding Class (hectares)	Location																															
	Nigum Deep				Uru Char				Bera Bastidia				Char Majid				Char Montaz				Kakri Mukri											
	A		B		C		D		A		B		C		D		A		B		C		D		A		B		C		D	
0-0.02	13	12	4	18	6	13	3	3	12	0	2	9	1	0	0	0	0	2	6	1	7	0	0	0	2	1	0	0	0	0	2	
	9.6	8.9	3.0	13.3	6.5	9.6	3.3	3.3	1.4	2.8	4.2	1.4	1.6	0.0	0.0	0.0	0.0	3.3	9.8	1.6	11.5	0.0	0.0	0.0	3.3	5.6	0.0	0.0	0.0	0.0	11.1	
0.02-0.20	2	0	0	1	1	2	1	0	7	9	22	7	10	1	2	2	2	4	4	1	1	2	1	0	2	2	1	0	0	0	0	
	1.5	0.0	0.0	0.7	1.1	2.2	1.1	0.0	3.3	4.2	10.2	3.3	15.9	1.6	3.2	3.2	3.2	6.6	1.6	1.6	3.3	0.0	0.0	0.0	6.6	11.1	5.6	0.0	0.0	0.0	0.0	
0.2-1.0	40	18	4	21	18	10	6	3	22	29	33	6	26	13	1	3	3	1	6	0	5	1	2	0	0	1	2	0	0	0	0	
	29.6	13.3	3.0	15.6	19.6	10.9	6.5	3.3	10.2	13.5	15.4	2.8	41.3	20.6	1.6	4.8	4.8	1.6	9.8	0.0	8.2	0.0	11.1	0.0	0.0	5.6	11.1	0.0	0.0	0.0	0.0	
1.0-3.0	0	0	0	2	8	1	0	1	10	16	9	5	2	0	0	1	1	5	8	0	2	1	2	1	0	2	1	0	0	0	0	
	0.0	0.0	0.0	1.5	8.7	1.1	0.0	1.1	4.7	7.4	4.2	2.3	3.2	0.0	0.0	1.6	8.2	13.1	0.0	0.0	3.3	5.6	11.1	5.6	5.6	11.1	5.6	0.0	0.0	0.0	0.0	
>3.0	0	0	0	0	1	0	0	0	4	5	8	2	1	0	0	0	0	3	4	0	3	3	1	1	0	3	1	0	0	0	0	
	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	1.9	2.3	3.7	0.9	1.6	0.0	0.0	0.0	0.0	4.9	6.6	0.0	4.0	5.6	5.6	5.6	16.7	5.6	5.6	0.0	0.0	0.0	0.0	

A. Agri Input, Agri Implements/Equipment, Animal

B. Debt repayment, Land purchase, Trade

C. Food, Education, Social obligation, Dowry

D. Fishing

Table IV.4.35 : Preferred current sources of household loans

Landloading Class (hectares)	Location																																															
	Nijhum Dwip								Utr Char								Bara Bachha								Char Majid								Char Montar								Kukri Mukri							
	Preferred Sources								Preferred Sources								Preferred Sources								Preferred Sources								Preferred Sources								Preferred Sources							
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D																
0 - 0.02	14 10.4 %	0 0.0 %	4 3.0 %	29 21.5 %	7 7.6 %	1 1.1 %	1 1.6 %	16 17.4 %	12 5.6 %	0 0.0 %	0 0.0 %	9 4.2 %	0 0.0 %	1 1.5 %	0 0.0 %	0 0.0 %	1 1.6 %	2 3.3 %	4 6.6 %	9 14.8 %	0 0.0 %	1 5.6 %	0 0.0 %	0 0.0 %	1 5.6 %	0 0.0 %	2 11.1 %	0 0.0 %	1 5.6 %	0 0.0 %	0 0.0 %																	
0.02 - 0.20	1 0.7 %	1 0.7 %	0 0.0 %	1 0.7 %	2 2.2 %	0 0.0 %	2 2.2 %	3 17.1 %	26 17.1 %	1 0.5 %	3 2.3 %	13 6.1 %	3 4.8 %	9 14.3 %	0 0.0 %	3 4.8 %	0 0.0 %	4 6.6 %	0 0.0 %	0 4.9 %	1 5.6 %	1 5.6 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %																	
0.2 - 1.0	32 23.7 %	8 5.9 %	8 5.9 %	35 25.9 %	21 22.8 %	2 2.2 %	12 13.0 %	52 24.2 %	30 24.2 %	0 0.0 %	8 3.7 %	15 14.0 %	30 23.8 %	12 19.1 %	0 0.0 %	16 25.4 %	0 0.0 %	1 1.6 %	2 3.3 %	9 14.8 %	0 0.0 %	1 5.6 %	0 0.0 %	0 0.0 %	1 5.6 %	0 0.0 %	2 11.1 %	0 0.0 %	1 5.6 %	0 0.0 %	0 0.0 %																	
1.0 - 3.0	0 0.0 %	0 0.0 %	0 0.0 %	2 1.5 %	7 7.6 %	1 1.1 %	0 2.2 %	18 8.4 %	2 8.4 %	1 0.5 %	3 1.4 %	18 8.4 %	1 1.6 %	1 1.6 %	0 0.0 %	1 1.6 %	0 0.0 %	5 8.2 %	6 9.8 %	4 6.6 %	1 5.6 %	1 5.6 %	0 0.0 %	1 5.6 %	0 0.0 %	2 11.1 %	0 0.0 %	1 5.6 %	0 0.0 %	0 0.0 %																		
> 3.0	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	1 1.1 %	0 0.0 %	0 0.0 %	10 4.7 %	0 0.0 %	0 0.0 %	2 0.9 %	3 3.3 %	1 1.6 %	0 0.0 %	0 0.0 %	0 0.0 %	2 3.3 %	1 1.6 %	1 6.6 %	3 16.7 %	1 5.6 %	0 0.0 %	1 5.6 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %																	

Table IV.4.36 : Households' need for seasonal loans

Land Holding Class (hectares)	Location							
	Nijhum Dwip		Urir Char		Bara Baishdia		Char Majid	
	Seasonal Loan		Seasonal Loan		Seasonal Loan		Seasonal Loan	
	Yes	No	Yes	No	Yes	No	Yes	No
0 - 0.02	18 11.3 %	35 21.9 %	14 14.4 %	14 14.4 %	7 2.6 %	21 7.8 %	0 0.0 %	2 2.0 %
0.02 - 0.20	0 0.0 %	3 1.9 %	2 2.1 %	2 2.1 %	32 11.9 %	21 7.8 %	7 6.9 %	13 12.8 %
0.2 - 1.0	27 16.9 %	73 45.6 %	35 36.1 %	18 18.6 %	84 31.1 %	24 8.9 %	57 55.9 %	16 15.7 %
1.0 - 3.0	1 0.6 %	2 1.3 %	10 10.3 %	1 1.0 %	49 18.2 %	6 2.2 %	6 5.9 %	0 0.0 %
> 3.0	0 0.0 %	1 0.6 %	1 1.03 %	0 0.0 %	20 7.4 %	6 2.2 %	1 1.0 %	0 0.0 %

Table IV.4.37 : Household purpose of seasonal loan

Location	Purpose of Seasonal Loan							
	A		B		C		D	
	Available	Not available	Available	Not available	Available	Not available	Available	Not available
Farming								
Nijhum Dwip	4 8.7 %	6 13.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0.0 0.0 %	2 4.4 %
Urir Char	13 21.0 %	28 45.2 %	0 0.0 %	1 1.6 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %
Bara Baishdia	3 1.6 %	90 46.6 %	0 0.0 %	4 2.1 %	0 0.0 %	4 2.1 %	1 0.5 %	7 3.6 %
Char Majid	46 64.8 %	6 8.5 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	2 2.8 %	0 0.0 %
Non-Farming								
Nijhum Dwip	3 6.5 %	16 34.8 %	1 2.2 %	3 6.5 %	0 0.0 %	0 0.0 %	2 4.4 %	9 19.6 %
Urir Char	5 8.1 %	10 16.1 %	0 0.0 %	1 1.6 %	0 0.0 %	2 3.2 %	1 1.6 %	1 1.6 %
Bara Baishdia	0 0.0 %	43 22.3 %	2 1.0 %	13 6.7 %	0 0.0 %	6 3.1 %	0 0.0 %	20 10.4 %
Char Majid	9 12.7 %	0 0.0 %	4 5.6 %	0 0.0 %	0 0.0 %	0 0.0 %	4 5.6 %	0 0.0 %

A. Agricultural Input, Agricultural Implements/Equipment, Animal

B. Debt repayment, Land purchase, Trade

C. Food, Education, Social Obligations, Dowry

D. Fishing

Table IV.4.38 : Distribution of households by income from farm production

Yearly Income range (Tk.)	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kuri-Mukri
< 2000	92 57.5 %	37 38.1 %	160 59.3 %	54 52.9 %	38 34.6 %	12 24.0 %
2000 - 4000	16 10.0 %	10 10.3 %	8 3.0 %	18 17.7 %	11 10.0 %	3 6.0 %
4000 - 6000	6 3.8 %	10 10.3 %	6 2.2 %	9 8.8 %	11 10.0 %	3 6.0 %
> 6000	14 8.8 %	14 14.4 %	34 12.6 %	3 2.9 %	22 20.0 %	11 22.0 %
No agricultural income	32 20.0 %	26 26.8 %	62 23.0 %	18 17.7 %	28 25.5 %	21 42.0 %
Mean Income in Tk.	2225	2889	2782	1280	4831	4914

Note : Mean income is base on total samples

Table IV.4.39 : Distribution of households by income from livestock and poultry

Yearly Income range (Tk.)	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kuri-Mukri
< 2000	123 76.9 %	60 61.9 %	205 75.9 %	80 78.4 %	77 70.0 %	40 80.0 %
2000 - 4000	16 10.0 %	12 12.4 %	18 6.7 %	14 13.7 %	12 10.9 %	3 6.0 %
4000 - 6000	7 4.4 %	4 4.1 %	7 2.6 %	5 4.9 %	5 4.6 %	1 2.0 %
> 6000	11 6.9 %	17 17.5 %	22 8.2 %	3 2.94 %	13 11.8 %	5 10.0 %
No livestock and poultry income	3 1.9 %	4 4.1 %	18 6.7 %	0 0.0 %	3 2.7 %	1 2.0 %
Mean Income in Tk.	2196	3866	1842	1221	2361	2185

Note : Mean income is base on total samples

Table IV.4.40 : Distribution of households by income from open water fishing

Yearly Income range (Tk.)	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid
< 5000	18 11.3 %	11 11.3 %	75 27.8 %	86 84.3 %
5000 - 15000	66 41.3 %	10 10.3 %	65 24.1 %	12 11.8 %
15000 - 25000	20 12.5 %	1 1.0 %	23 8.5 %	0 0.0 %
> 25000	14 8.8 %	2 2.1 %	22 8.2 %	0 0.0 %
No fishing income	42 26.3 %	73 75.3 %	85 31.5 %	4 3.9 %
Mean Income in Tk.	12602	2858	9521	1481

Table IV.4.41: Needs Assessment of South Hatia and Nijhum Dwip, ranked by location

Possible Intervention	Nijhum Dwip South Char Osman	Nijhum Dwip North-East Char Tila	South Hatia Outside Embankment	South Hatia Inside Embankment	Overall Intervention Ranking
A. Construction of a cyclone shelter	6	3	7	9	5
B. Construction of livestock Killa	12	12	12	12	12
C. Creation of more accreted land	1	1	1	1	1
D. Reduction in coastal erosion	10	10	9	3	9
E. Planting of mangrove forestry	8	7	4	7	7
F. Construction of an embankment to reduce saline water inflow	2	2	2	2	2
G. Construction of a drainage system to reduce monsoon flooding	11	11	11	8	11
H. Build new cluster settlements	4	6	3	4	3
I. Build new access roads	7	8	5	5	8
J. Provide safe drinking water supplies	9	9	10	11	10
K. Provide sanitation facilities	5	5	6	10	6
L. Build schools	13	13	13	13	13
M. Build health centres	3	4	8	6	4
OTHER SUGGESTIONS:					
Provide postal service	*				
Create employment for women		*	*		
Develop cottage industry		*		*	
Credit for fishing			*	*	
Cold storage for fish				*	
Cross-dam to link Nijham Dwip				*	

Source: MES Field Surveys March 1997, 112 people interviewed

Notes: Ranking is 1 for highest priority to 13 for the lowest

* Suggested intervention by area

Table IV.4.42: Needs Assessment of South Hatia and Nijhum Dwip, ranked by social group

Possible Intervention	Land Owning Farmers	Share Cropping Farmers	Landless Labourers	Full Time Fishermen	Women	Boat Operators	Overall Intervention Ranking
A. Construction of a cyclone shelter	6	4	5	4	10	7	5
B. Construction of livestock Killa	12	12	12	13	13	12	12
C. Creation of more accreted land	2	2	1	1	1	1	1
D. Reduction in coastal erosion	9	9	8	8	8	5	9
E. Planting of mangrove forestry	5	7	7	6	8	10	7
F. Construction of an embankment to reduce saline water inflow	1	1	2	2	2	2	2
G. Construction of a drainage system to reduce monsoon flooding	11	10	11	11	12	11	11
H. Build new cluster settlements	7	5	3	3	5	3	3
I. Build new access roads	4	8	9	9	6	8	8
J. Provide safe drinking water supplies	10	11	10	10	7	9	10
K. Provide sanitation facilities	8	5	6	7	3	6	6
L. Build schools	13	13	13	12	11	13	13
M. Build health centres	3	3	4	5	3	4	4
OTHER SUGGESTIONS:							
Provide postal service	*	*					
Create employment for women					*		
Develop cottage industry					*		
Credit for fishing				*			
Cold storage for fish	*						
Cross-dam to link Nijham Dwip	*						

Source: MES Field Surveys March 1997, 112 people interviewed

Notes: Ranking is 1 for highest priority to 13 for the lowest

* Suggested intervention by social group

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APPENDIX - V
PROJECT COST ANALYSIS



Table V.1 : Unit cost per metre cross dam (4 m a-frame)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	26.00	2,366
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	13.00	1,489
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	15.00	1,249
4	Propex 6088 Screens	m2	78	3.25	252
5	Sewing yarn	kg	1,125	0.60	675
6	Transport cost of geotextile materials	L.S.			
	Sub-total				6,031
7	Local Sand (F.M = 1.3)	m3	550	6.00	3,300.00
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.60	600
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1.33	665
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0.00	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0.00	0
12	C.C. Block (0.5 m x 0.5 m x 0.125 m), slope protection	nos	120	0.00	0
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	100.00	20,000
14	G.I. Pipe, 6" diameter	m	2,200	0.00	0
15	G.I. Pipe, 5" diameter	m	1,600	8.00	12,800
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	2.00	1,200
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0.00	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0.00	0
20	PVC Pipe, 22 mm diameter	m	100	1.75	175
21	Shil-Barak Bamboo, 3" diameter	nos	192	19.00	3,648
22	Synthetic Bag	nos	18	155.00	2,790
23	Steel anchor (15 kg)	nos	550	0.50	275
24	Steel chain	m	250	2.20	550
25	Hardware material	m	3,500	1.00	3,500
	Sub-total				49,503
26	Labour cost	m	3,340	1.00	3,340
27	Equipment cost	m	4,000	1.00	4,000
28	Earth work	m3	50	0.00	0
29	Mobilization/demobilization	L.S.			
	Sub-total				7,340
	Total				62,874

Note : These costs exclude taxes, duties and DVA on geotextiles

Table V.2 : Unit cost per metre cross dam (6 m a-frame)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	32.50	2,958
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	13.00	1,489
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	15.00	1,249
4	Propex 6088 Screens	m2	78	4.75	368
5	Sewing yarn	kg	1,125	0.60	675
6	Transport cost of geotextile materials	L.S.			
	Sub-total				6,739
7	Local Sand (F.M = 1.3)	m3	550	7.00	3,850.00
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.60	600
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1.33	665
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0.00	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0.00	0
12	C.C. Block (0.5 m x 0.5 m x 0.125 m), slope protection	nos	120	0.00	0
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	155.00	31,000
14	G.I. Pipe, 6" diameter	m	2,200	0.00	0
15	G.I. Pipe, 5" diameter	m	1,600	10.00	16,000
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	2.00	1,200
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0.00	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0.00	0
20	PVC Pipe, 22 mm diameter	m	100	2.60	260
21	Shil-Barak Bamboo, 3" diameter	nos	192	19.00	3,648
22	Synthetic Bag	nos	18	190.00	3,420
23	Steel anchor (15 kg)	nos	550	0.50	275
24	Steel chain	m	250	2.20	550
25	Hardware material	m	3,500	1.00	3,500
	Sub-total				64,968
26	Labour cost	m	3,340	1.00	3,340
27	Equipment cost	m	4,000	1.00	4,000
28	Earth work	m3	50	0.00	0
29	Mobilization/demobilization	L.S.			
	Sub-total				7,340
	Total				79,047

Note : These costs exclude taxes, duties and DVA on geotextiles

Table V.3 : Unit cost per metre cross dam (protection embankment)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	30.00	2,730
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	0.00	0
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	10.00	833
4	Propex 6088 Screens	m2	78	0.00	0
5	Sewing yarn	kg	1,125	0.50	563
6	Transport cost of geotextile materials	L.S.			
	Sub-total				4,126
7	Local Sand (F.M = 1.3)	m3	550	4.50	2,475.00
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.40	400
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	0.00	0
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0.00	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0.00	0
12	C.C. Block (0.5 m x 0.5 m x 0.125 m), slope protection	nos	120	56.00	6,720
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	10.00	2,000
14	G.I. Pipe, 6" diameter	m	2,200	0.00	0
15	G.I. Pipe, 5" diameter	m	1,600	0.00	0
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	0.00	0
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0.00	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0.00	0
20	PVC Pipe, 22 mm diameter	m	100	0.00	0
21	Shil-Barak Bamboo, 3" diameter	nos	192	0.00	0
22	Synthetic Bag	nos	18	0.00	0
23	Steel anchor (15 kg)	nos	550	0.00	0
24	Steel chain	m	250	0.00	0
25	Hardware material	m	3,500	0.00	0
	Sub-total				11,595
26	Labour cost	m	3,340	0.20	668
27	Equipment cost	m	4,000	0.00	0
28	Earth work	m3	50	56.00	2,800
29	Mobilization/demobilization	L.S.			
	Sub-total				3,468
	Total				19,189

Note : These costs exclude taxes, duties and DVA on geotextiles

220 Table V.4 : Nijhum Dwip cross dam

Cross dam section with A-frame 6 m height 300 meter length
 Cross dam section with A-frame 4 m height 850 meter length
 Embankment, protected 100 meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	34,850	3,171,350
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	14,950	1,711,775
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	18,250	1,519,313
4	Propex 6088 Screens	m2	78	4,188	324,531
5	Sewing yarn	kg	1,125	740	832,500
6	Transport cost of geotextile materials	L.S.			300,000
	Sub-total				7,859,469
7	Local Sand (F.M = 1.3)	m3	550	7,650	4,207,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	730	730,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,530	764,750
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 0.5 m x 0.125 m), slope protection	nos	120	5,600	672,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	132,500	26,500,000
14	G.I. Pipe, 6" diameter	m	2,200	0	0
15	G.I. Pipe, 5" diameter	m	1,600	9,800	15,680,000
16	G.I. Pipe, 4" diameter	m	700	0	0
17	G.I. Pipe, 3" diameter	m	600	2,300	1,380,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	2,268	226,750
21	Shil-Barak Bamboo, 3" diameter	nos	192	21,850	4,195,200
22	Synthetic Bag	nos	18	188,750	3,397,500
23	Steel anchor (15 kg)	nos	550	575	316,250
24	Steel chain	m	250	2,530	632,500
25	Hardware material	m	3,500	1,150	4,025,000
	Sub-total				62,727,450
26	Labour cost	m	3,340	1,170	3,907,800
27	Equipment cost	m	4,000	1,150	4,600,000
28	Earth work	m3	50	5,600	280,000
29	Mobilization/demobilization	L.S.			2,500,000
	Sub-total				11,287,800
	Total				81,874,719
30	Contingencies 10 % and rounding				8,187,281
	Total, including contingencies				90,062,000
	Sub-total foreign cost US\$				167,000
	Sub-total local cost Taka				82,203,000

Note : These costs exclude taxes, duties and DVA on geotextiles

Table V.5 : Damar char cross dam

Cross dam section with A-frame 6 m height
 Cross dam section with A-frame 4 m height
 Embankment, protected

50 meter length
 1000 meter length
 1500 meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.I Bed Mattresses	m2	91	72,625	6,608,875
2	Propex 6288 + RIG EDY 200.I Bed Mattresses	m2	115	13,650	1,562,925
3	Propex 6282 + RIG EDY 250.I Geobags	nos	83	30,750	2,559,938
4	Propex 6088 Screens	m2	78	3,488	270,281
5	Sewing yarn	kg	1,125	1,380	1,552,500
6	Transport cost of geotextile materials	L.S.			300,000
	Sub-total				12,854,519
7	Local Sand (F.M = 1.3)	m3	550	13,100	7,205,000
8	Sylhet Sand (F.M = 2.1)	m3	1,000	1,230	1,230,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,397	698,250
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 0.5 m x 0.125 m), slope protection	nos	120	84,000	10,080,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	122,750	24,550,000
14	G.I. Pipe, 6" diameter	m	2,200	0	0
15	G.I. Pipe, 5" diameter	m	1,600	8,500	13,600,000
16	G.I. Pipe, 4" diameter	m	700	0	0
17	G.I. Pipe, 3" diameter	m	600	2,100	1,260,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	1,880	188,000
21	Shil-Barak Bamboo, 3" diameter	nos	192	19,950	3,830,400
22	Synthetic Bag	nos	18	164,500	2,961,000
23	Steel anchor (15 kg)	nos	550	525	288,750
24	Steel chain	m	250	2,310	577,500
25	Hardware material	m	3,500	1,050	3,675,000
	Sub-total				70,143,900
26	Labour cost	m	3,340	1,350	4,509,000
27	Equipment cost	m	4,000	1,050	4,200,000
28	Earth work	m3	50	84,000	4,200,000
29	Mobilization/demobilization	L.S.			2,500,000
	Sub-total				15,409,000
	Total				98,407,419
30	Contingencies 10 % and rounding				9,840,551
	Total, including contingencies				108,247,970
	Sub-total foreign cost US\$				274,000
	Sub-total local cost Taka				95,393,000

Note : These costs exclude taxes, duties and DVA on geotextiles

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Table V.6: Option 2 - Detailed costs

Bangladesh										
Nijhum Dwip Integrated Development Project										
Option 2 - Nijhum Dwip cross dam										
(Local '000)										
			Base Cost							
	Unit	Unit Cost	00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total
I. Investment Costs										
A. Civil Works										
1. Hatia - Nijhum Dwip Cross Dam										
a. A-frame section - 6 metre										
Geotextiles	metre	13.9	4,173	-	-	-	-	-	-	4,173
Local materials	metre	65.0	19,490	-	-	-	-	-	-	19,490
Equipment costs	metre	4.0	1,200	-	-	-	-	-	-	1,200
Labour	metre	3.3	1,002	-	-	-	-	-	-	1,002
Subtotal A-frame section - 6 metre			25,865	-	-	-	-	-	-	25,865
b. A-frame section - 4 metre										
Geotextiles	metre	12.4	10,580	-	-	-	-	-	-	10,580
Local materials	metre	49.5	42,078	-	-	-	-	-	-	42,078
Equipment costs	metre	4.0	3,400	-	-	-	-	-	-	3,400
Labour	metre	3.3	2,839	-	-	-	-	-	-	2,839
Subtotal A-frame section - 4 metre			58,897	-	-	-	-	-	-	58,897
c. Protected embankment										
Geotextiles	metre	8.5	852	-	-	-	-	-	-	852
Local materials	metre	11.6	1,160	-	-	-	-	-	-	1,160
Earth works	metre	2.8	280	-	-	-	-	-	-	280
Labour	metre	0.7	67	-	-	-	-	-	-	67
Subtotal Protected embankment			2,358	-	-	-	-	-	-	2,358
d. Other costs										
Geotextile transportation	Tk		619	-	-	-	-	-	-	619
Mobilisation	Tk		2,500	-	-	-	-	-	-	2,500
Subtotal Other costs			3,119	-	-	-	-	-	-	3,119
Subtotal Hatia - Nijhum Dwip Cross Dam			90,239	-	-	-	-	-	-	90,239
2. Embankments										
a. South East Hatia - HA-1										
Primary embankments	km	3,788.0	28,126	28,126	-	-	-	-	-	56,252
Secondary embankments	km	1,689.0	2,094	2,094	-	-	-	-	-	4,189
Sluices - box culvert (3 vents)	unit	9,000.0	-	9,000	-	-	-	-	-	9,000
Sluices - box culverts (5 vents)	unit	15,000.0	-	15,000	-	-	-	-	-	15,000
Surface sluices	unit	772.0	2,316	2,316	-	-	-	-	-	4,632
Drains	ha	1.3	-	1,679	1,679	-	-	-	-	3,358
Subtotal South East Hatia - HA-1			32,536	58,215	1,679	-	-	-	-	92,431
b. Nijhum Dwip (south) - ND-1										
Primary embankment	km	3,788.0	9,432	9,432	-	-	-	-	-	18,864
Secondary Embankment	km	1,689.0	3,108	3,108	-	-	-	-	-	6,216
Sluices - box culvert (2 vents)	unit	6,000.0	-	6,000	-	-	-	-	-	6,000
Surface sluices	unit	772.0	772	772	-	-	-	-	-	1,544
Drains	ha	1.4	-	448	448	-	-	-	-	896
Subtotal Nijhum Dwip (south) - ND-1			13,312	19,760	448	-	-	-	-	33,520
c. South Hatia & Nijhum Dwip - ND-2 & ND-3										
Primary embankments	km	3,788.0	-	-	-	-	37,653	37,653	-	75,305
Secondary embankment / road	km	2,207.0	-	-	-	-	10,031	10,031	-	20,062
Sluices - box culvert (3 vents)	unit	9,000.0	-	-	-	-	9,000	9,000	-	18,000
Sluice - box culvert (2 vents)	unit	6,000.0	-	-	-	-	6,000	6,000	-	12,000
Surface sluices	unit	772.0	-	-	-	-	3,088	3,088	-	6,176
Drains	ha	1.4	-	-	-	-	-	2,776	2,776	5,553
Subtotal South Hatia & Nijhum Dwip - ND-2 & ND-3			-	-	-	-	65,772	68,548	2,776	137,096
Subtotal Embankments			45,848	77,975	2,127	-	65,772	68,548	2,776	263,047
3. Roads										
South Hatia - Nijhum Dwip Road	km	1,043.0	-	-	-	-	12,725	-	-	12,725
Bridges and culverts /a	Tk	5,000.0	-	15,775	-	-	-	20,400	-	36,175
Subtotal Roads			-	15,775	-	-	12,725	20,400	-	48,900
Subtotal Civil Works			136,087	93,750	2,127	-	78,496	88,948	2,776	402,185
B. Project Management										
1. Implementing Agencies										
Project Management /b	unit		1,997	1,598	1,598	1,598	1,598	1,598	-	9,987
BWDB Administration /c	Tk		5,992	4,794	4,794	4,794	4,794	4,794	-	29,960
Subtotal Implementing Agencies			7,989	6,392	6,392	6,392	6,392	6,392	-	39,947
C. Development of Settlements										
Village Development	village	560.0	-	-	-	-	3,920	3,920	-	7,840
Materials for dwelling	village	720.0	-	-	-	-	5,040	5,040	-	10,080
Water supply and sanitation	village	130.0	-	-	-	-	910	910	-	1,820
Access roads	village	15.0	-	-	-	-	105	105	-	210
Surveying, design, supervision	village	160.0	-	-	-	-	1,120	1,120	-	2,240
Subtotal Development of Settlements			-	-	-	-	11,095	11,095	-	22,190
D. Income Generation Support										
1. Fisheries Development										
Extension & Support Staff	Tk		516	516	516	516	516	-	-	2,580
Training of farmers	Tk		70	70	70	70	70	-	-	350
Logistics & Support	Tk		448	448	448	448	448	-	-	2,240
Equipment & Materials	Tk		968	-	-	-	-	-	-	968
Subtotal Fisheries Development			2,002	1,034	1,034	1,034	1,034	-	-	6,138
2. Livestock Development										
Extension & Support Staff	Tk		384	384	384	384	384	-	-	1,920
Training of Livestock Workers	Tk		67	67	34	-	-	-	-	168
Training & Demonstrations	Tk		80	80	80	80	80	-	-	400
Logistics & Support	Tk		279	279	279	279	279	-	-	1,397
Equipment & Materials	Tk		538	-	-	-	-	-	-	538
Line of Credit	Tk		430	494	622	791	814	-	-	3,152
Subtotal Livestock Development			1,779	1,305	1,399	1,535	1,558	-	-	7,574
Subtotal Income Generation Support			3,781	2,339	2,433	2,569	2,592	-	-	13,712
Total Investment Costs			147,857	102,480	10,952	8,960	98,574	106,434	2,776	478,034
II. Recurrent Costs										
Cross Dam 1 /d	Tk.		-	1,128	1,128	1,128	1,128	-	-	4,512
Embankments & sluices /e	Tk.		-	1,217	2,477	2,520	2,520	3,835	5,206	17,775
Roads	Tk.		-	-	-	-	-	255	255	510
Total Recurrent Costs			-	2,345	3,605	3,648	3,648	4,090	5,461	22,797
Total			147,857	104,825	14,557	12,608	102,222	110,524	8,237	500,831

/a Minor bridges and culverts at Tk 5 million / 1,000 ha.

/b BWDB Project Management at 2.5% of civil works base costs.

/c BWDB Administration at 7.5% of civil works base costs

/d O&M for cross dam at 1.25% base costs for 4 years.

/e O&M at 2% of civil works base costs.

Table V.7: Option 2 - Expenditure accounts by years, base costs

Bangladesh Nijhum Dwip Integrated Development Project																

/a BWDB administration costs - 7.5% of civil works base costs

/b BWDB overhead costs - 2.5% of civil works base costs

Table V.8: Option 2 - Expenditure accounts by years, totals including contingencies

Bangladesh Nijhum Dwip Integrated Development Project															
Totals Including Contingencies (Local '000)								Totals Including Contingencies (US\$ '000)							
00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total	00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total
I. Investment Costs															
A. Civil Works															
1. Cross Dams															
Geotextiles	19,397	-	-	-	-	-	19,397	390	-	-	-	-	-	-	390
Geotextile transportation	769	-	-	-	-	-	769	15	-	-	-	-	-	-	15
Other materials	78,323	-	-	-	-	-	78,323	1,573	-	-	-	-	-	-	1,573
Equipment	5,718	-	-	-	-	-	5,718	115	-	-	-	-	-	-	115
Labour	4,858	-	-	-	-	-	4,858	98	-	-	-	-	-	-	98
Mobilisation	3,108	-	-	-	-	-	3,108	62	-	-	-	-	-	-	62
Subtotal Cross Dams	112,173	-	-	-	-	-	112,173	2,253	-	-	-	-	-	-	2,253
2. Embankments / Water Management	56,992	101,775	2,915	-	99,378	108,752	4,625	374,438	1,145	1,994	56	1,805	1,926	80	7,005
Materials & Equipment															
3. Other Civil Works															
Roads	169,165	20,590	2,915	-	19,226	32,365	-	72,181	-	403	-	349	573	-	1,326
Subtotal Civil Works		122,365	2,915	-	118,604	141,116	4,625	558,791	3,398	2,397	56	2,154	2,499	80	10,584
B. Development of Settlements															
Settlements & Dwellings	-	-	-	-	15,389	16,159	-	31,548	-	-	-	280	286	-	566
Water Supply & Sanitation	-	-	-	-	1,375	1,444	-	2,819	-	-	-	25	26	-	51
Subtotal Development of Settlements	-	-	-	-	16,764	17,602	-	34,366	-	-	-	304	312	-	616
C. Income Generation															
2. Livestock															
Livestock	1,676	1,058	1,065	1,070	1,123	-	-	5,992	34	21	20	20	20	-	115
Livestock Line of Credit	535	645	853	1,138	1,230	-	-	4,401	11	13	16	21	22	-	83
Subtotal Livestock	2,211	1,703	1,917	2,208	2,353	-	-	10,393	44	33	37	41	43	-	198
3. Aquaculture															
Aquaculture	2,489	1,350	1,417	1,488	1,562	-	-	8,306	50	26	27	28	28	-	160
Subtotal Income Generation	4,700	3,052	3,335	3,696	3,916	-	-	18,698	94	60	64	69	71	-	358
D. Project Management															
BWDB Administration /a	6,771	5,688	5,972	6,271	6,584	6,914	-	38,201	136	111	114	117	120	122	720
Project Management /b	2,257	1,896	1,991	2,090	2,195	2,305	-	12,734	45	37	38	39	40	41	240
Subtotal Project Management	9,029	7,584	7,963	8,361	8,779	9,218	-	50,935	181	149	152	156	159	163	961
Total Investment Costs	182,893	133,001	14,213	12,057	148,064	167,937	4,625	662,791	3,674	2,605	271	225	2,689	2,975	12,519
II. Recurrent Costs															
A. Protection Works O&M															
Civil Works O&M	-	3,061	4,941	5,249	5,512	6,489	9,097	34,349	-	60	94	98	100	115	624
Total Recurrent Costs	-	3,061	4,941	5,249	5,512	6,489	9,097	34,349	-	60	94	98	100	115	624
Total PROJECT COSTS	182,893	136,062	19,154	17,307	153,576	174,426	13,722	697,139	3,674	2,665	366	322	2,789	3,089	13,143

/a BWDB administration costs - 7.5% of civil works base costs

/b BWDB overhead costs - 2.5% of civil works base costs

Table V.9: Option 2 - Procurement accounts by financiers

	(Local '000)										(US\$ '000)									
	Donor					The Government					Local (Excl. Taxes)					The Government				
	Amount	%	Amount	%	Total	Amount	%	Amount	%	Total	Amount	%	Amount	%	Total	Amount	%	Amount	%	Total
Bangladesh																				
Nijhum Dwip Integrated Development Project																				
A. Civil Works																				
1. Cross Dams																				
Geotextiles	13,108	65.0	7,058	35.0	20,167	2.9	9,882	3,227	7,058	263	65.0	142	35.0	405	3.1	198	65	142		
Materials and Equipment	140,754	85.7	23,433	14.3	164,187	23.6	7,966	148,832	7,388	2,721	85.7	453	14.3	3,174	24.1	154	2,877	143		
Subtotal Cross Dams	153,862	83.5	30,491	16.5	184,354	26.4	17,848	152,059	14,447	2,984	83.4	595	16.6	3,579	27.2	352	2,942	285		
2. Other Civil Works																				
Materials & Equipment	321,080	85.8	53,357	14.2	374,438	53.7	18,722	338,866	16,850	6,007	85.8	998	14.3	7,005	53.3	350	6,340	315		
3. Development of Settlements	29,469	85.8	4,897	14.3	34,366	4.9	1,718	31,102	1,546	528	85.7	88	14.3	616	4.7	31	558	28		
Subtotal Civil Works	504,412	85.0	88,746	15.0	593,158	85.1	38,288	522,027	32,843	9,520	85.0	1,681	15.0	11,201	85.2	733	9,840	628		
B. Income Generating Activities	15,922	85.2	2,777	14.8	18,698	2.7	187	17,868	643	305	85.2	53	14.8	358	2.7	4	342	12		
C. Technical Assistance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D. Project Implementation Costs	-	-	50,935	100.0	50,935	7.3	-	49,216	1,719	-	-	-	961	100.0	961	7.3	-	928	32	
E. Recurrent Costs	29,196	85.0	5,152	15.0	34,349	4.9	-	32,803	1,546	531	85.0	94	15.0	624	4.7	-	596	28		
Total	549,530	78.8	147,610	21.2	697,139	100.0	38,476	621,913	36,751	10,355	78.8	2,788	21.2	13,143	100.0	737	11,706	700		

Table V.10: Option 2 - Local and foreign costs and taxes, by financiers

Bangladesh Nijhum Dwip Integrated Developme												
	(Local '000)						(US\$ '000)					
	Donor		The Government		Total		Donor		The Government		Total	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
I. Foreign	38,476	100.0	-	-	38,476	5.5	737	100.0	-	-	737	5.6
II. Local (Excl. Taxes)	511,054	82.2	110,859	17.8	621,913	89.2	9,618	82.2	2,088	17.8	11,706	89.1
III. Taxes	-	-	36,751	100.0	36,751	5.3	-	-	700	100.0	700	5.3
Total Project	549,530	78.8	147,610	21.2	697,139	100.0	10,355	78.8	2,788	21.2	13,143	100.0

Table V.11: Option 2 - Economic costs

Bangladesh Nijhum Dwip Integrated Development Project Expenditure Accounts by Years -- Base Costs Economic Costs																		
Base Cost (Local '000)										Base Cost (US\$ '000)					Foreign Exchange			
00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total	00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total	%	Amount	
I. Investment Costs																		
A. Civil Works																		
1. Cross Dams																		
10,393	-	-	-	-	-	-	10,393	216	-	-	-	-	-	-	216	77.2	167	Geotextiles
412	-	-	-	-	-	-	412	9	-	-	-	-	-	-	9	77.2	7	Geotextile transportation
57,313	-	-	-	-	-	-	57,313	1,192	-	-	-	-	-	-	1,192	5.8	69	Other materials
4,184	-	-	-	-	-	-	4,184	87	-	-	-	-	-	-	87	5.8	5	Equipment
3,535	-	-	-	-	-	-	3,535	74	-	-	-	-	-	-	74	-	-	Labour
2,274	-	-	-	-	-	-	2,274	47	-	-	-	-	-	-	47	5.8	3	Mobilisation
78,111	-	-	-	-	-	-	78,111	1,625	-	-	-	-	-	-	1,625	15.4	250	Subtotal Cross Dams
2. Embankments / Water Management																		
41,705	70,928	1,935	-	59,827	62,353	2,526	239,274	868	1,476	40	-	1,245	1,297	53	4,978	5.8	287	Materials & Equipment
3. Other Civil Works																		
-	14,349	-	-	11,575	18,556	-	44,480	-	299	-	-	241	386	-	925	5.8	53	Roads
119,816	85,278	1,935	-	71,402	80,909	2,526	361,866	2,493	1,774	40	-	1,486	1,683	53	7,529	7.8	591	Subtotal Civil Works
B. Development of Settlements																		
-	-	-	-	9,265	9,265	-	18,529	-	-	-	-	193	193	-	386	5.8	22	Settlements & Dwellings
-	-	-	-	828	828	-	1,656	-	-	-	-	17	17	-	34	5.8	2	Water Supply & Sanitation
-	-	-	-	10,092	10,092	-	20,185	-	-	-	-	210	210	-	420	5.8	24	Subtotal Development of Settlements
C. Income Generation																		
2. Livestock																		
1,225	733	703	672	672	-	-	4,006	25	15	15	14	14	-	-	83	1.4	1	Livestock
407	468	589	749	771	-	-	2,985	8	10	12	16	16	-	-	62	-	-	Livestock Line of Credit
1,633	1,201	1,292	1,442	1,444	-	-	6,991	34	25	27	30	30	-	-	145	0.8	1	Subtotal Livestock
1,821	935	935	935	935	-	-	5,562	38	19	19	19	19	-	-	116	1.8	2	3. Aquaculture
3,453	2,136	2,227	2,357	2,379	-	-	12,552	72	44	46	49	49	-	-	261	1.3	3	Subtotal Income Generation
D. Project Management																		
5,420	4,336	4,336	4,336	4,336	4,336	-	27,098	113	90	90	90	90	90	-	564	-	-	BWDB Administration /a
1,892	1,513	1,513	1,513	1,513	1,513	-	9,459	39	31	31	31	31	31	-	197	-	-	Project Management /b
7,311	5,849	5,849	5,849	5,849	5,849	-	36,557	152	122	122	122	122	122	-	761	-	-	Subtotal Project Management
130,581	93,263	10,011	8,206	89,722	96,851	2,526	431,160	2,717	1,940	208	171	1,867	2,015	53	8,971	6.9	619	Total Investment Costs
II. Recurrent Costs																		
A. Protection Works O&M																		
Civil Works O&M																		
-	2,121	3,261	3,300	3,300	3,699	4,939	20,619	-	44	68	69	69	77	103	429	-	-	Total Recurrent Costs
130,581	95,384	13,272	11,506	93,022	100,550	7,465	451,779	2,717	1,985	276	239	1,935	2,092	155	9,400	6.6	619	Total BASELINE COSTS
12,327	8,953	742	566	8,717	9,470	746	41,522	256	186	15	12	181	197	16	864	7.2	62	Physical Contingencies
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Price Contingencies
142,908	104,338	14,014	12,071	101,739	110,020	8,211	493,301	2,973	2,171	292	251	2,117	2,289	171	10,264	6.6	680	Total PROJECT COSTS
Taxes																		
Foreign Exchange																		
16,052	5,414	123	-	5,174	5,777	160	32,701	334	113	3	-	108	120	3	680	-	-	

/a BWDB administration costs - 7.5% of civil works base costs

/b BWDB overhead costs - 2.5% of civil works base costs

Table V.12: Option 3 - Detailed costs

Bangladesh										
Nijhum Dwip Integrated Development Project										
Option 3 - Nijhum Dwip and Damar Char cross dams										
(Local '000)										
			Base Cost							
	Unit	Unit Cost	00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total
I. Investment Costs										
A. Civil Works										
1. Hatia - Nijhum Dwip Cross Dam										
a. A-frame section - 6 metre										
Geotextiles	metre	13.9	4,173	-	-	-	-	-	-	4,173
Local materials	metre	65.0	19,490	-	-	-	-	-	-	19,490
Equipment costs	metre	4.0	1,200	-	-	-	-	-	-	1,200
Labour	metre	3.3	1,002	-	-	-	-	-	-	1,002
Subtotal A-frame section - 6 metre			25,865	-	-	-	-	-	-	25,865
b. A-frame section - 4 metre										
Geotextiles	metre	12.4	10,580	-	-	-	-	-	-	10,580
Local materials	metre	49.5	42,078	-	-	-	-	-	-	42,078
Equipment costs	metre	4.0	3,400	-	-	-	-	-	-	3,400
Labour	metre	3.3	2,839	-	-	-	-	-	-	2,839
Subtotal A-frame section - 4 metre			58,897	-	-	-	-	-	-	58,897
c. Protected embankment										
Geotextiles	metre	8.5	852	-	-	-	-	-	-	852
Local materials	metre	11.6	1,160	-	-	-	-	-	-	1,160
Earth works	metre	2.8	280	-	-	-	-	-	-	280
Labour	metre	0.7	67	-	-	-	-	-	-	67
Subtotal Protected embankment			2,358	-	-	-	-	-	-	2,358
d. Other costs										
Geotextile transportation	Tk		619	-	-	-	-	-	-	619
Mobilisation	Tk		2,500	-	-	-	-	-	-	2,500
Subtotal Other costs			3,119	-	-	-	-	-	-	3,119
Subtotal Hatia - Nijhum Dwip Cross Dam			90,239	-	-	-	-	-	-	90,239
2. South Hatia - Damar Char Cross Dam										
a. A-frame section - 6 metre										
Geotextiles	metre	13.9	-	-	-	-	-	695	-	695
Local materials	metre	65.0	-	-	-	-	-	3,248	-	3,248
Equipment costs	metre	4.0	-	-	-	-	-	200	-	200
Labour	metre	3.3	-	-	-	-	-	167	-	167
Subtotal A-frame section - 6 metre			-	-	-	-	-	4,311	-	4,311
b. A-frame section - 4 metre										
Geotextiles	metre	12.4	-	-	-	-	-	12,447	-	12,447
Local materials	metre	49.5	-	-	-	-	-	49,503	-	49,503
Equipment costs	metre	4.0	-	-	-	-	-	4,000	-	4,000
Labour	metre	3.3	-	-	-	-	-	3,340	-	3,340
Subtotal A-frame section - 4 metre			-	-	-	-	-	69,290	-	69,290
c. Protected embankment										
Geotextiles	metre	8.5	-	-	-	-	-	12,774	-	12,774
Local materials	metre	11.6	-	-	-	-	-	17,393	-	17,393
Earth works	metre	2.8	-	-	-	-	-	4,200	-	4,200
Labour	metre	0.7	-	-	-	-	-	1,002	-	1,002
Subtotal Protected embankment			-	-	-	-	-	35,369	-	35,369
d. Other costs										
Geotextile transportation	Tk		-	-	-	-	-	619	-	619
Mobilisation	Tk		-	-	-	-	-	2,500	-	2,500
Subtotal Other costs			-	-	-	-	-	3,119	-	3,119
Subtotal South Hatia - Damar Char Cross Dam			-	-	-	-	-	112,088	-	112,088
3. Embankments										
a. South East Hatia - HA-1										
Primary embankments	km	3,788.0	28,126	28,126	-	-	-	-	-	56,252
Secondary embankments	km	1,689.0	2,094	2,094	-	-	-	-	-	4,189
Sluices - box culvert (3 vents)	unit	9,000.0	-	9,000	-	-	-	-	-	9,000
Sluices - box culverts (5 vents)	unit	15,000.0	-	15,000	-	-	-	-	-	15,000
Surface sluices	unit	772.0	2,316	2,316	-	-	-	-	-	4,632
Drains /a	ha	1.3	-	1,679	1,679	-	-	-	-	3,358
Subtotal South East Hatia - HA-1			32,536	58,215	1,679	-	-	-	-	92,431
b. Nijhum Dwip (south) - ND-1										
Primary embankment	km	3,788.0	9,432	9,432	-	-	-	-	-	18,864
Secondary Embankment	km	1,689.0	3,108	3,108	-	-	-	-	-	6,216
Sluices - box culvert (2 vents)	unit	6,000.0	-	6,000	-	-	-	-	-	6,000
Surface sluices	unit	772.0	772	772	-	-	-	-	-	1,544
Drains	ha	1.4	-	448	448	-	-	-	-	896
Subtotal Nijhum Dwip (south) - ND-1			13,312	19,760	448	-	-	-	-	33,520
c. South Hatia & Nijhum Dwip - ND-2 & ND-3										
Primary embankments	km	3,788.0	-	-	-	-	37,653	37,653	-	75,305
Secondary embankment / road	km	2,207.0	-	-	-	-	10,031	10,031	-	20,062
Sluices - box culvert (3 vents)	unit	9,000.0	-	-	-	-	9,000	9,000	-	18,000
Sluice - box culvert (2 vents)	unit	6,000.0	-	-	-	-	6,000	6,000	-	12,000
Surface sluices	unit	772.0	-	-	-	-	3,088	3,088	-	6,176
Drains	ha	1.4	-	-	-	-	-	2,776	2,776	5,553
Subtotal South Hatia & Nijhum Dwip - ND-2 & ND-3			-	-	-	-	65,772	68,548	2,776	137,096
Subtotal Embankments			45,848	77,975	2,127	-	65,772	68,548	2,776	263,047
4. Roads										
South Hatia - Nijhum Dwip Road	km	1,043.0	-	-	-	-	12,725	-	-	12,725
Bridges and culverts /b	Tk	5,000.0	-	15,775	-	-	-	20,400	-	36,175
Subtotal Roads			-	15,775	-	-	12,725	20,400	-	48,900
Subtotal Civil Works			136,087	93,750	2,127	-	78,496	201,036	2,776	514,273

Table V.12: Option 3 - Detailed costs (cont'd)

Bangladesh									
Nijhum Dwip Integrated Development Project									
Option 3 - Nijhum Dwip and Damar Char cross dams									
(Local '000)									
B. Project Management				Base Cost					
1. Implementing Agencies									
Project Management /c	unit			2,536	1,902	1,268	1,268	2,536	1,902
BWDB Administration /d	Tk			7,607	5,705	3,804	3,804	7,607	5,705
Subtotal Implementing Agencies				10,143	7,607	5,071	5,071	10,143	7,607
C. Development of Settlements									
Village Development	village	560.0	-	-	-	-	-	3,920	3,920
Materials for dwelling	village	720.0	-	-	-	-	-	5,040	5,040
Water supply and sanitation	village	130.0	-	-	-	-	-	910	910
Access roads	village	15.0	-	-	-	-	-	105	105
Surveying, design, supervision	village	160.0	-	-	-	-	-	1,120	1,120
Subtotal Development of Settlements								11,095	11,095
D. Income Generation Support									
1. Fisheries Development									
Extension & Support Staff	Tk		516	516	516	516	-	-	2,580
Training of farmers	Tk		70	70	70	70	-	-	350
Logistics & Support	Tk		448	448	448	448	-	-	2,240
Equipment & Materials	Tk		968	-	-	-	-	-	968
Subtotal Fisheries Development			2,002	1,034	1,034	1,034	1,034	-	6,138
2. Livestock Development									
Extension & Support Staff	Tk		384	384	384	384	-	-	1,920
Training of Livestock Workers	Tk		67	67	34	-	-	-	168
Training & Demonstrations	Tk		80	80	80	80	-	-	400
Logistics & Support	Tk		279	279	279	279	-	-	1,397
Equipment & Materials	Tk		538	-	-	-	-	-	538
Line of Credit	Tk		430	494	622	791	814	-	3,152
Subtotal Livestock Development			1,779	1,305	1,399	1,535	1,558	-	7,574
Subtotal Income Generation Support			3,781	2,339	2,433	2,569	2,592	-	13,712
Total Investment Costs			150,010	103,696	9,632	7,640	102,326	219,738	7,848
II. Recurrent Costs									
Cross Dam 1 /e	Tk.		-	1,128	1,128	1,128	1,128	-	4,512
Cross Dam 2	Tk.		-	-	-	-	-	-	1,401
Embankments & sluices /f	Tk.		-	1,217	2,477	2,520	2,520	3,835	17,775
Roads	Tk.		-	-	-	-	-	255	510
Total Recurrent Costs			-	2,345	3,605	3,648	3,648	4,090	24,198
Total			150,010	106,041	13,237	11,288	105,974	223,828	625,088

1a Excavation and re-excavation of drains.

1b Minor bridges and culverts at Tk 5 million / 1,000 ha.

1c BWDB Project Management at 2.5% of civil works base costs.

1d BWDB Administration at 7.5% of civil works base costs

1e O&M for cross dam at 1.25% base costs for 4 years.

1f O&M at 2% of civil works base costs.

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Table V.13: Option 3 - Expenditure accounts by years, base costs

Bangladesh																									
Nijhum Dwip Integrated Development Project																									
Base Cost (Local '000)												Foreign Exchange		Base Cost (US\$ '000)										Foreign Exchange	
00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total	%	Amount	%	Amount	00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total	%	Amount	%	Amount		
I. Investment Costs																									
A. Civil Works																									
1. Cross Dams																									
16,384	-	-	-	-	27,212	-	43,597	49.0	21,362	341	-	-	-	-	-	-	566	-	907	49.0	444				
650	-	-	-	-	650	-	1,300	49.0	637	14	-	-	-	-	-	-	14	-	27	49.0	13				
66,158	-	-	-	-	78,061	-	144,219	5.0	7,211	1,377	-	-	-	-	-	-	1,624	-	3,001	5.0	150				
4,830	-	-	-	-	4,410	-	9,240	5.0	462	100	-	-	-	-	-	-	92	-	192	5.0	10				
4,103	-	-	-	-	4,734	-	8,838	-	85	-	-	-	-	-	-	-	99	-	184	-	5				
2,625	-	-	-	-	2,625	-	5,250	5.0	263	55	-	-	-	-	-	-	55	-	109	5.0	5				
94,750	-	-	-	-	117,693	-	212,443	14.1	29,935	1,971	-	-	-	-	-	-	2,449	-	4,420	14.1	623				
Subtotal Cross Dams																									
2. Embankments / Water Management																									
48,141	81,874	2,234	-	69,060	71,975	2,915	276,199	5.0	13,810	1,002	1,704	46	-	1,437	1,498	-	-	61	5,747	5.0	287				
-	16,564	-	-	13,361	21,420	-	51,345	5.0	2,567	-	345	-	-	-	278	446	-	-	1,068	5.0	53				
142,891	98,438	2,234	-	82,421	211,088	2,915	539,987	8.6	46,312	2,973	2,048	46	-	1,715	4,392	-	-	61	11,235	8.6	964				
Subtotal Civil Works																									
B. Development of Settlements																									
-	-	-	-	10,694	10,694	-	21,389	5.0	1,069	-	-	-	-	-	223	223	-	-	445	5.0	22				
-	-	-	-	956	956	-	1,911	5.0	96	-	-	-	-	-	20	20	-	-	40	5.0	2				
-	-	-	-	11,650	11,650	-	23,300	5.0	1,165	-	-	-	-	-	242	242	-	-	485	5.0	24				
Subtotal Development of Settlements																									
C. Income Generation																									
2. Livestock																									
1,416	851	816	781	781	-	-	4,644	1.2	56	29	18	17	16	16	-	-	-	-	97	1.2	1				
452	519	653	831	855	-	-	3,309	-	-	9	11	14	17	18	-	-	-	-	69	-	-				
1,868	1,370	1,469	1,611	1,635	-	-	7,953	0.7	56	39	28	31	34	34	-	-	-	-	165	0.7	1				
2,102	1,086	1,086	1,086	1,086	-	-	6,445	1.6	102	44	23	23	23	23	-	-	-	-	134	1.6	2				
3,970	2,455	2,555	2,697	2,721	-	-	14,398	1.1	158	83	51	53	56	57	-	-	-	-	300	1.1	3				
Subtotal Income Generation																									
D. Project Management																									
7,988	5,991	3,994	3,994	7,988	5,991	3,994	39,938	-	-	166	125	83	83	83	166	125	-	-	83	831	-	-			
2,662	1,997	1,331	1,331	2,662	1,997	1,331	13,312	-	-	55	42	28	28	28	55	42	-	-	28	277	-	-			
10,650	7,987	5,325	5,325	10,650	7,987	5,325	53,250	-	-	222	166	111	111	111	222	166	-	-	111	1,108	-	-			
157,511	108,881	10,113	8,022	107,442	230,725	8,240	630,934	7.5	47,635	3,277	2,265	210	167	2,235	4,801	171	13,128	7.5	991	-	-				
Total Investment Costs																									
II. Recurrent Costs																									
A. Protection Works O&M																									
Civil Works O&M																									
-	2,462	3,785	3,830	3,830	4,295	7,205	25,408	-	-	-	51	79	80	80	80	89	150	529	-	-	-	-			
-	2,462	3,785	3,830	3,830	4,295	7,205	25,408	-	-	-	51	79	80	80	80	89	150	529	-	-	-	-			
Total Recurrent Costs																									
157,511	111,343	13,899	11,852	111,272	235,020	15,445	656,342	7.3	47,635	3,277	2,317	289	247	2,315	4,890	321	13,656	7.3	991	-	-	-	-		
14,686	10,336	857	653	10,062	22,703	1,012	60,309	7.9	4,764	306	215	18	14	209	472	21	1,255	7.9	99	-	-	-	-		
Physical Contingencies																									
Price Contingencies																									
Inflation																									
11,667	15,105	2,729	3,075	35,759	84,624	7,206	160,165	-	-	243	314	57	64	744	1,761	150	3,332	-	-	-	-	-	-		
627	346	11	-	735	4,313	32	6,064	100.0	6,064	13	7	0	-	15	90	1	126	100.0	126	-	-	-	-	-	
12,294	15,451	2,740	3,075	36,494	88,938	7,238	166,229	3.6	6,064	256	321	57	64	759	1,850	151	3,459	3.6	126	-	-	-	-	-	
836	375	13	-	900	7,347	41	9,512	74.3	7,070	-116	-160	-30	-34	-401	-943	-83	-1,765	-	-	-	-	-	-	-	
13,130	15,826	2,753	3,075	37,394	96,285	7,279	175,741	7.5	13,134	140	162	27	30	359	908	68	1,693	7.5	126	-	-	-	-	-	
185,327	137,504	17,509	15,580	158,728	354,008	23,736	892,392	7.3	65,533	3,723	2,693	334	290	2,883	6,270	410	16,604	7.3	1,216	-	-	-	-	-	
Subtotal Price Contingencies																									
Total PROJECT COSTS																									
Taxes																									
14,338	6,057	678	575	6,931	28,647	982	58,208	-	-	288	119	13	11	126	507	17	1,081	-	-	-	-	-	-	-	
17,276	6,118	146	-	6,768	34,993	231	65,533	-	-	347	120	3	-	123	620	4	1,216	-	-	-	-	-	-	-	-
Foreign Exchange																									

a. BWDB administration costs - 7.5% of civil works base costs
b. BWDB overhead costs - 2.5% of civil works base costs

Table V.14: Option 3 - Expenditure accounts by years, totals including contingencies

Bangladesh Nijhum Dwip Integrated Development Project																
Totals Including Contingencies (Local '000)									Totals Including Contingencies (US\$ '000)							
00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total		00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total
I. Investment Costs																
A. Civil Works																
1. Cross Dams																
Geotextiles	19,397	-	-	-	41,117	-	60,514	390	-	-	-	-	-	728	-	1,118
Geotextile transportation	769	-	-	-	982	-	1,752	15	-	-	-	-	-	17	-	33
Other materials	78,323	-	-	-	117,947	-	196,270	1,573	-	-	-	-	-	2,089	-	3,662
Equipment	5,718	-	-	-	6,663	-	12,381	115	-	-	-	-	-	118	-	233
Labour	4,858	-	-	-	7,154	-	12,011	98	-	-	-	-	-	127	-	224
Mobilisation	3,108	-	-	-	3,966	-	7,074	62	-	-	-	-	-	70	-	133
Subtotal Cross Dams	112,173	-	-	-	177,829	-	290,001	2,253	-	-	-	-	-	3,150	-	5,403
2. Embankments / Water Management																
Materials & Equipment	56,992	101,775	2,915	-	99,378	108,752	4,625	374,438	1,145	1,994	56	-	1,805	1,926	80	7,005
3. Other Civil Works																
Roads	-	20,590	-	-	19,226	32,365	-	72,181	-	403	-	-	349	573	-	1,326
Subtotal Civil Works	169,165	122,365	2,915	-	118,604	318,945	4,625	736,620	3,358	2,397	56	-	2,154	5,649	80	13,734
B. Development of Settlements																
Settlements & Dwellings	-	-	-	-	15,389	16,159	-	31,548	-	-	-	-	280	286	-	566
Water Supply & Sanitation	-	-	-	-	1,375	1,444	-	2,819	-	-	-	-	25	26	-	51
Subtotal Development of Settlements	-	-	-	-	16,764	17,602	-	34,366	-	-	-	-	304	312	-	616
C. Income Generation																
2. Livestock																
Livestock	1,676	1,058	1,065	1,070	1,123	-	-	5,992	34	21	20	20	20	-	-	115
Livestock Line of Credit	535	645	853	1,138	1,230	-	-	4,401	11	13	16	21	22	-	-	83
Subtotal Livestock	2,211	1,703	1,917	2,208	2,353	-	-	10,393	44	33	37	41	43	-	-	198
3. Aquaculture																
Aquaculture	2,489	1,350	1,417	1,488	1,562	-	-	8,306	50	26	27	28	28	-	-	160
Subtotal Income Generation	4,700	3,052	3,335	3,696	3,916	-	-	18,698	94	60	64	69	71	-	-	358
D. Project Management																
BWDB Administration /a	8,597	6,770	4,739	4,976	10,449	8,229	5,760	49,519	173	133	91	93	190	146	99	924
Project Management /b	2,865	2,256	1,580	1,659	3,483	2,743	1,920	16,506	58	44	30	31	63	49	33	308
Subtotal Project Management	11,462	9,026	6,318	6,634	13,932	10,972	7,680	66,025	230	177	121	124	253	194	133	1,231
Total Investment Costs	185,327	134,444	12,568	10,330	153,216	347,519	12,305	855,710	3,723	2,634	240	192	2,783	6,155	213	15,940
II. Recurrent Costs																
A. Protection Works O&M																
Civil Works O&M	-	3,061	4,941	5,249	5,512	6,489	11,431	36,683	-	60	94	98	100	115	197	665
Total Recurrent Costs	-	3,061	4,941	5,249	5,512	6,489	11,431	36,683	-	60	94	98	100	115	197	665
Total PROJECT COSTS	185,327	137,504	17,509	15,580	158,728	354,008	23,736	892,392	3,723	2,693	334	290	2,883	6,270	410	16,604

^a BWDB administration costs - 7.5% of civil works base costs

^b BWDB overhead costs - 2.5% of civil works base costs

Table V.15: Option 3 - Procurement accounts by financiers

Bangladesh																		
Nilgum Dwp Integrated Development Project																		
(Local '000)										(US\$ '000)								
	Donor		The Government		Total		For. Exch.	Local (Excl. Taxes)	Duties & Taxes	Donor		The Government		Total		For. Exch.	Local (Excl. Taxes)	Duties & Taxes
	Amount	%	Amount	%	Amount	%				Amount	%	Amount	%	Amount	%			
A. Civil Works																		
1. Cross Dams																		
Geotextiles	40,472	65.0	21,793	35.0	62,265	7.0	30,510	9,562	21,793	748	65.0	403	35.0	1,151	6.9	564	403	
Materials and Equipment	257,089	85.7	42,828	14.3	299,917	33.6	14,395	272,026	13,496	4,782	85.7	797	14.3	5,578	33.6	268	5,059	
Subtotal Cross Dams	297,561	82.2	64,621	17.8	362,182	40.6	44,905	281,988	35,289	5,529	82.2	1,199	17.8	6,729	40.5	832	5,243	
2. Other Civil Works																		
Materials & Equipment	321,080	85.8	53,357	14.2	374,438	42.0	18,722	338,866	16,850	6,007	85.8	998	14.3	7,005	42.2	350	6,340	
3. Development of Settlements	29,469	85.8	4,897	14.3	34,366	3.9	1,718	31,102	1,546	528	85.7	88	14.3	616	3.7	31	558	
Subtotal Civil Works	648,111	84.1	122,876	15.9	770,987	86.4	65,345	651,956	53,685	12,065	84.1	2,285	15.9	14,350	86.4	1,213	12,141	
B. Income Generating Activities	15,922	85.2	2,777	14.8	18,698	2.1	187	17,868	643	305	85.2	53	14.8	358	2.2	4	342	
C. Technical Assistance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
D. Project Implementation Costs	-	-	66,025	100.0	66,025	7.4	-	63,796	2,228	-	-	1,231	100.0	1,231	7.4	-	1,190	
E. Recurrent Costs	31,180	85.0	5,502	15.0	36,683	4.1	-	35,032	1,651	565	85.0	100	15.0	665	4.0	-	635	
Total	695,213	77.9	197,180	22.1	892,392	100.0	65,533	768,652	58,208	12,935	77.9	3,670	22.1	16,604	100.0	1,216	14,307	

Table V.16: Option 3 - Local and foreign costs and taxes, by financiers

	(Local '000)						(US\$ '000)					
	Donor			The Government			Donor			The Government		
	Amount	%	Total	Amount	%	Total	Amount	%	Total	Amount	%	Total
I. Foreign	65,533	100.0	-	-	-	65,533	1,216	100.0	-	-	-	1,216
II. Local (Excl. Taxes)	629,680	81.9	138,972	18.1	768,652	86.1	11,718	81.9	2,589	18.1	14,307	86.2
III. Taxes	-	-	58,208	100.0	58,208	6.5	-	-	1,081	100.0	1,081	6.5
Total Project	695,213	77.9	197,180	22.1	892,392	100.0	12,935	77.9	3,670	22.1	16,604	100.0

Table V.17: Option 3 - Economic costs

Bangladesh Nijhum Dwip Integrated Development Project Expenditure Accounts by Years -- Base Costs Economic Costs																	
Base Cost (Local '000)								Base Cost (US\$ '000)								Foreign Exchange	
00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total	00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total	% Amount	
I. Investment Costs																	
A. Civil Works																	
1. Cross Dams																	
10,393	-	-	-	-	17,261	-	27,654	216	-	-	-	-	359	-	575	77.2	
412	-	-	-	-	412	-	825	9	-	-	-	-	9	-	17	77.2	
57,313	-	-	-	-	67,625	-	124,938	1,192	-	-	-	-	1,407	-	2,600	5.8	
4,184	-	-	-	-	3,820	-	8,005	87	-	-	-	-	79	-	167	5.8	
3,535	-	-	-	-	4,078	-	7,613	74	-	-	-	-	85	-	158	-	
2,274	-	-	-	-	2,274	-	4,548	47	-	-	-	-	47	-	95	5.8	
78,111	-	-	-	-	95,471	-	173,583	1,625	-	-	-	-	1,986	-	3,612	17.2	
Subtotal Cross Dams																	
41,705	70,928	1,935	-	59,827	62,353	2,526	239,274	868	1,476	40	-	1,245	1,297	53	4,978	5.8	
Materials & Equipment																	
3. Other Civil Works																	
-	14,349	-	-	11,575	18,556	-	44,480	-	299	-	-	241	386	-	925	5.8	
119,816	85,278	1,935	-	71,402	176,381	2,526	457,337	2,493	1,774	40	-	1,486	3,670	53	9,516	10.1	
Subtotal Civil Works																	
B. Development of Settlements																	
-	-	-	-	9,265	9,265	-	18,529	-	-	-	-	193	193	-	386	5.8	
-	-	-	-	828	828	-	1,656	-	-	-	-	17	17	-	34	5.8	
-	-	-	-	10,092	10,092	-	20,185	-	-	-	-	210	210	-	420	5.8	
Subtotal Development of Settlements																	
C. Income Generation																	
2. Livestock																	
1,225	733	703	672	672	-	-	4,006	25	15	15	14	14	-	-	83	1.4	
407	468	589	749	771	-	-	2,985	8	10	12	16	16	-	-	62	-	
1,633	1,291	1,292	1,422	1,444	-	-	6,991	34	25	27	30	30	-	-	145	0.8	
1,821	935	935	935	935	-	-	5,562	38	19	19	19	19	-	-	116	1.8	
3,453	2,136	2,227	2,357	2,379	-	-	12,552	72	44	46	49	49	-	-	261	1.3	
Subtotal Income Generation																	
6,881	5,160	3,440	3,440	6,881	5,160	3,440	34,403	143	107	72	72	143	107	72	716	-	
2,401	1,801	1,201	1,201	2,401	1,801	1,201	12,007	50	37	25	25	50	37	25	250	-	
9,282	6,962	4,641	4,641	9,282	6,962	4,641	46,410	193	145	97	97	193	145	97	966	-	
132,551	94,375	8,803	6,998	93,155	193,435	7,167	536,484	2,758	1,964	183	146	1,938	4,025	149	11,162	8.9	
Subtotal Project Management																	
Total Investment Costs																	
II. Recurrent Costs																	
A. Protection Works O&M																	
-	2,121	3,261	3,300	3,300	3,699	6,207	21,887	-	44	68	69	69	77	129	455	-	
-	2,121	3,261	3,300	3,300	3,699	6,207	21,887	-	44	68	69	69	77	129	455	-	
Civil Works O&M																	
Total Recurrent Costs																	
132,551	96,496	12,064	10,297	96,455	197,134	13,373	558,371	2,758	2,008	251	214	2,007	4,102	278	11,618	8.5	
12,327	8,953	742	566	8,717	19,017	873	51,196	256	186	15	12	181	396	18	1,065	9.3	
Physical Contingencies																	
Price Contingencies																	
144,878	105,450	12,806	10,863	105,172	216,151	14,246	609,567	3,014	2,194	266	226	2,188	4,497	296	12,683	8.6	
Total PROJECT COSTS																	
Taxes																	
16,052	5,414	123	-	5,174	25,476	160	52,399	334	113	3	-	108	530	3	1,090	-	
Foreign Exchange																	

a BWDB administration costs - 7.5% of civil works base costs

b BWDB overhead costs - 2.5% of civil works base costs

Table V.18: Inflation and exchange rates

Bangladesh Nijhum Dwip Integrated Development Project									
	Up to Negotiation	Up to Project Start	00/01	01/02	02/03	03/04	04/05	05/06	06/07
Inflation (in %'s) /a									
All goods & services									
Annual rates									
Local	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Foreign	2.7	2.7	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Compounded rates									
Local	5.0	5.0	7.6	13.0	18.7	24.6	30.8	37.4	44.2
Foreign	2.7	2.7	3.9	6.4	8.9	11.5	14.2	16.9	19.7
Exchange rates (Local/Foreign) /b									
All goods & services									
Rates actually used	47.0	48.1	49.8	51.1	52.4	53.7	55.1	56.5	57.9
Constant purchasing parity rates	47.0	48.1	49.8	51.1	52.4	53.7	55.1	56.5	57.9
% deviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

/a Yearly values are within Each Project Year

/b Yearly values are at Project Year Midpoints



APPENDIX - VI **ECONOMIC ASSESSMENT**

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Table VI.1: Land available for agriculture and fisheries

No	Year	Existing Land not Forested		Existing Forest for Clearing 2/		New Land		Cumulative Net Areas Available 4/		F2: Two Cross Dams	
		IE	OE	Nijhum Dwip	South Hatia	F0: No Intervention	F1: One Cross Dam	F0: No Intervention	F1: One Cross Dam	IE	OE
0											
1	2000	1,810	4,362 (1,979)			27	396	3,490	0	3,490	0
2	2001		(169)	172	343	27	396	3,511	1,448	2,223	1,448
3	2002	311	(311)	173	343	27	396	3,533	1,860	2,405	1,860
4	2003					27	397	3,555	2,522	2,474	2,522
5	2004					27	397	3,577	2,522	2,791	2,522
6	2005					28	397	3,599	2,522	3,109	2,522
7	2006	1,354	(1,354)	728	199	27	(851)	3,620	5,027	1,345	5,027
8	2007			728	200	27	0	3,642	5,770	1,345	5,770
9	2008					27	0	3,664	5,770	1,345	5,770
10	2009					27	0	3,686	5,770	1,345	5,770
11	2010					27	0	3,708	5,770	1,345	5,770
12	2011					27	0	3,729	5,770	1,345	5,770
13	2012					27	0	3,751	5,770	1,345	5,770
14	2013					27	0	3,773	5,770	1,345	5,770
15	2014					27	0	3,795	5,770	1,345	5,770
16	2015					28	0	3,817	5,770	1,345	5,770
17	2016					27	31	3,838	5,770	1,370	5,770
18	2017					27	31	3,860	5,770	1,394	5,770
19	2018					27	31	3,882	5,770	1,419	5,770
20	2019					28	31	3,904	5,770	1,444	5,770
21	2020					27	86	3,926	5,770	1,468	5,770
22	2021					27	260	3,948	5,770	1,505	5,770
23	2022					27	260	3,969	5,770	1,541	5,770
24	2023					27	260	3,991	5,770	1,577	5,770
25	2024					28	260	4,013	5,770	1,614	5,770
26	2025					27	260	4,035	5,770	1,650	5,770
27	2026					27	196	4,057	5,770	1,680	5,770
28	2027					27	196	4,078	5,770	1,709	5,770
29	2028					27	196	4,100	5,770	1,738	5,770
30	2029					27	196	4,122	5,770	1,767	5,770
						27	196	4,144	5,770	1,797	5,770

Notes: 1/ IE = inside embankment; OE = outside embankment
 2/ Location (IE or OE) at time of clearing.
 3/ F0 = option with no interventions; F1 = South Hatia - Nijhum Dwip cross dam
 F2 = F1 + Hatia Damar Char cross dam.
 4/ Adjusted for khals, canals, homestead areas, roads, etc.
 5/ Non-forested land at southern end of Nijhum Dwip forested in years 1 and 2 (408 ha)

Table VI.2: Crop budgets - present and future without project (per ha)

Crops	IE/OE 1/	Yield (mt/ha)		Labour Mandays	Animal Pairdays	Seed (kg)	Fertiliser (kg)		MP	Pesticides (kg)	Irrigation (unit)	Financial Prices			Economic Prices			Net Income (Tk)
		Main Product	By- product				Urea	TSP				Revenue (Tk)	Input Cost (Tk)	Labour Cost (Tk)	Revenue (Tk)	Input Cost (Tk)	Labour Cost (Tk)	
1 B.Aus	IE	1.0	1.5	70	15	90	30					7,458	2,441	3,500	8,139	2,216	2,975	2,948
2 T. Aus	IE	1.1	1.7	90	20	30	40	20				8,264	2,690	4,500	9,007	2,264	3,825	2,918
3 LT Aman	IE	1.4	2.1	100	20	30	50	20		10		11,957	2,841	5,000	11,394	2,322	4,250	4,823
4 HYV Aman	IE	2.0	2.0	120	30	35	80	30		10	0.5	15,882	4,409	6,000	15,195	3,660	5,100	6,435
5 B.Aus	OE	1.0	1.5	70	15	90	30					7,458	2,441	3,500	8,139	2,216	2,975	2,948
6 T. Aus	OE	1.1	1.7	90	20	30	40	20				8,264	2,690	4,500	9,007	2,264	3,825	2,918
7 LT Aman	OE	1.3	1.9	100	20	30	40	20			0.5	11,043	2,940	5,000	10,526	2,490	4,250	3,787
8 Ground nut	IE	0.9		40	10	50						15,114	2,500	2,000	13,633	2,255	1,700	9,678
9 Ground nut	OE	1.0		40	10	50						16,793	2,500	2,000	15,147	2,255	1,700	11,192
10 Sweet Potato	IE & OE	3.0		70	12	200	50	50				7,373	2,594	3,500	6,650	1,911	2,975	1,764
11 Pulses	IE & OE	0.5		40	20	30						5,980	2,540	2,000	5,394	2,291	1,700	1,403
12 Oil seeds	IE & OE	0.5		40	10	5						8,356	1,110	2,000	7,537	1,001	1,700	4,836
13 Chilli (dried)	IE & OE	0.4		80	15	5	10	10		10		20,531	2,002	4,000	18,519	1,636	3,400	13,483
14 Coconuts 2/	IE & OE	200.0										1,000	0	0	902	0	0	902

Notes 1/ IE = inside embankment; OE = outside embankment

2/ Coconuts included at equivalent of 5 trees per cultivated ha., each bearing 40 nuts per year.

Table VI.3: Crop budgets - with project (per ha)

Crops	IE/OE 1/	Yield (mt/ha) Main Product	By-product	Labour Mandays	Animal Pairdays	Seed (kg)	Fertiliser (kg)			Pesticides (kg)	Irrigation (unit)	Financial Prices			Economic Prices				
							Urea	TSP	MP			Revenue (Tk)	Input Cost (Tk)	Labour Cost (Tk)	Net Income (Tk)	Revenue (Tk)	Input Cost (Tk)	Labour Cost (Tk)	Net Income (Tk)
1 B.Aus	IE	1.2	1.8	90	15	90	50	30				8,950	2,858	4,500	1,592	9,767	2,331	3,825	3,611
2 T. Aus	IE	1.4	2.1	100	20	30	60	20				10,442	2,807	5,000	2,635	11,394	2,379	4,250	4,765
3 LT Aman	IE	2.0	3.0	120	25	30	70	40	10	1.0		17,082	4,159	6,000	6,924	16,278	3,339	5,100	7,839
4 HYV Aman	IE	2.4	2.4	140	40	35	80	20	10	1.0		19,058	5,559	7,000	6,499	18,234	4,788	5,950	7,497
5 B.Aus	OE	1.2	1.5	90	15	90	50	30				8,590	2,858	4,500	1,232	9,442	2,331	3,825	3,286
6 T.Aus	OE	1.3	1.8	100	20	30	60	20				9,516	2,807	5,000	1,709	10,418	2,379	4,250	3,789
7 LT Aman	OE	1.5	2.2	100	20	25	60	30	10	0.5		12,752	3,207	5,000	4,544	12,154	2,566	4,250	5,338
8 Ground nut	IE	1.4		55	10	50	50	50	20			23,510	3,479	2,750	17,281	21,206	2,543	2,338	16,326
9 Ground nut	OE	1.2		40	10	50	40	20	5			20,152	2,981	2,000	15,171	18,177	2,485	1,700	13,992
10 Sweet Potato	IE & OE	6.0		100	20	300	70	50	10			14,745	3,904	5,000	5,841	13,300	3,019	4,250	6,031
11 Pulses	IE & OE	0.7		40	20	30	20	20				8,373	2,657	2,000	3,715	7,552	2,406	1,700	3,446
12 Oil seeds	IE & OE	0.7		50	10	5						11,699	1,110	2,500	8,089	10,552	1,001	2,125	7,426
13 Chilli (dried)	IE & OE	0.6		120	15	5	40	10	10			30,796	2,177	6,000	22,619	27,778	1,809	5,100	20,869
14 Coconuts 2/	IE & OE	250.0										1,250	0	0	1,250	1,128	0	0	1,128

Notes 1/ IE = inside embankment; OE = outside embankment

2/ Coconuts included at equivalent of 5 trees per cultivated ha., each bearing 50 nuts per year.

Table VI.4: Farm budget - existing land (1 ha)
(present & without project)

Crop	financial prices		
	Inside Embankment	Outside Embankment	Net
	Cropping Pattern	Revenue	Revenue
B. Aus	0.35	531	0
T. Aus	0.00	0	215
LT Aman	0.65	2,676	2,173
HYV Aman	0.00	0	0
Ground nut	0.10	1,061	983
Sweet potato	0.05	64	51
Chilli	0.05	726	581
Pulses	0.16	230	173
Oilseeds	0.04	210	105
Coconuts		1000	1000
Total	1.40	6,499	5,281

Based on Table VI.1

Table VI.6: Farm budget - existing land (with project) (1 ha)
financial prices

Crop	financial prices		
	Inside Embankment	Outside Embankment	Net
	Cropping Pattern	Revenue	Revenue
B. Aus	0.00	0	0
T. Aus	0.35	922	513
LT Aman	0.35	2,423	3,181
HYV Aman	0.30	1,950	0
Ground nut	0.20	3,456	1,517
Sweet potato	0.12	701	234
Chilli	0.08	1,809	1,357
Pulses	0.20	743	446
Oilseeds	0.05	404	243
Coconuts		1250	1250
Total	1.65	13,659	8,740

Based on Table VI.1

Table VI.5: Farm budget - existing land (1 ha)
(present & without project)

Crop	economic prices		
	Inside Embankment	Outside Embankment	Net
	Cropping Pattern	Revenue	Revenue
B. Aus	0.35	1,032	0
T. Aus	0.00	0	584
LT Aman	0.65	3,135	2,651
HYV Aman	0.00	0	0
Ground nut	0.10	968	895
Sweet potato	0.05	88	71
Chilli	0.05	674	539
Pulses	0.16	225	168
Oilseeds	0.04	193	97
Coconuts		902	902
Total	1.40	7,217	5,907

Based on Table VI.1

Table VI.7: Farm budget - existing land (with project) (1 ha)
economic prices

Crop	economic prices		
	Inside Embankment	Outside Embankment	Net
	Cropping Pattern	Revenue	Revenue
B. Aus	0.00	0	0
T. Aus	0.35	1,668	1,137
LT Aman	0.35	2,744	3,736
HYV Aman	0.30	2,249	0
Ground nut	0.20	3,265	1,399
Sweet potato	0.12	724	241
Chilli	0.08	1,670	1,252
Pulses	0.20	689	413
Oilseeds	0.05	371	223
Coconuts		1,128	1,128
Total	1.65	14,507	9,529

Based on Table VI.1

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Table VI.8: Farm budget - newly accreted land (1 ha)
cultivation year 1 financial prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.45	341
T. Aus	0.00	0	0.20	107
LT Aman	0.00	0	0.10	155
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.00	0
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.75	604

Based on Table VI.1

Table VI.10: Farm budget - newly accreted land (1 ha)
cultivation year 5 financial prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.45	417
T. Aus	0.00	0	0.25	164
LT Aman	0.00	0	0.10	189
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.07	62
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.87	831

Based on Table VI.1

Table VI.9: Farm budget - newly accreted land (1 ha)
cultivation year 1 economic prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.45	663
T. Aus	0.00	0	0.20	292
LT Aman	0.00	0	0.10	189
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.00	0
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.75	1,144

Based on Table VI.1

Table VI.11: Farm budget - newly accreted land (1 ha)
cultivation year 5 economic prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.45	809
T. Aus	0.00	0	0.25	445
LT Aman	0.00	0	0.10	231
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.07	60
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.87	1,545

Based on Table VI.1

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Table VI.12: Estimate of livestock populations

No	Year	Livestock per Household			Without Project		With Project		Livestock (without project)			Livestock (with project)		
		Cattle	Goats & Sheep	Poultry	Population	Estimated Households	Population	Estimated Households	Cattle	Goats & Sheep	Poultry	Cattle	Goats & Sheep	Poultry
0	2000	1.78	1.62	19.53	21,025	3,982	21,025	3,982	7,098	6,450	77,771	7,098	6,450	77,771
1	2001	1.78	1.62	19.53	21,807	4,130	21,832	4,135	7,362	6,690	80,664	7,371	6,698	80,757
2	2002	1.78	1.62	19.53	22,562	4,273	22,637	4,287	7,617	6,922	83,455	7,642	6,945	83,734
3	2003	1.78	1.62	19.53	23,287	4,411	23,438	4,439	7,862	7,144	86,140	7,913	7,191	86,698
4	2004	1.78	1.62	19.53	23,994	4,542	24,343	4,566	8,097	7,358	88,717	8,556	7,775	93,745
5	2005	1.78	1.62	19.53	24,652	4,669	25,343	4,800	8,323	7,563	91,186	9,209	8,369	100,904
6	2006	1.78	1.62	19.53	25,290	4,790	26,133	5,328	8,538	7,759	93,546	9,498	8,631	104,063
7	2007	1.78	1.62	19.53	25,898	4,905	26,778	5,488	8,743	7,945	95,797	9,783	8,890	107,191
8	2008	1.78	1.62	19.53	26,478	5,015	27,279	5,647	8,939	8,123	97,942	10,066	9,147	110,284
9	2009	1.78	1.62	19.53	27,029	5,119	27,841	5,803	9,125	8,292	99,980	10,344	9,400	113,359
10	2010	1.78	1.62	19.53	27,552	5,218	28,133	5,957	9,302	8,453	101,516	10,619	9,650	116,353
11	2011	1.78	1.62	19.53	28,049	5,312	28,553	6,110	9,469	8,605	103,751	10,891	9,897	119,323
12	2012	1.78	1.62	19.53	28,553	5,408	29,067	6,259	9,640	8,760	105,618	11,157	10,139	122,248
13	2013	1.78	1.62	19.53	29,067	5,505	29,591	6,407	9,813	8,918	107,526	11,420	10,378	125,124
14	2014	1.78	1.62	19.53	29,591	5,604	30,123	6,551	9,990	9,078	109,455	11,678	10,612	127,950
15	2015	1.78	1.62	19.53	30,123	5,705	30,665	6,693	10,170	9,242	111,425	11,931	10,842	130,725
16	2016	1.78	1.62	19.53	30,665	5,808	31,217	6,833	10,353	9,408	113,431	12,180	11,068	133,446
17	2017	1.78	1.62	19.53	31,217	5,912	31,779	6,969	10,539	9,577	115,472	12,423	11,289	136,115
18	2018	1.78	1.62	19.53	31,779	6,019	32,351	7,109	10,729	9,750	117,551	12,672	11,515	138,837
19	2019	1.78	1.62	19.53	32,351	6,127	32,934	7,251	10,922	9,925	119,667	12,925	11,745	141,614
20	2020	1.78	1.62	19.53	32,934	6,237	33,526	7,396	11,119	10,104	121,821	13,184	11,980	144,446
21	2021	1.78	1.62	19.53	33,526	6,350	34,130	7,544	11,319	10,286	124,014	13,447	12,220	147,335
22	2022	1.78	1.62	19.53	34,130	6,464	34,744	7,695	11,522	10,471	126,246	13,716	12,464	150,282
23	2023	1.78	1.62	19.53	34,744	6,580	35,370	7,849	11,730	10,659	128,518	13,990	12,714	153,287
24	2024	1.78	1.62	19.53	35,370	6,699	36,006	8,006	11,941	10,851	130,832	14,270	12,968	156,353
25	2025	1.78	1.62	19.53	36,006	6,819	36,654	8,166	12,156	11,047	133,187	14,556	13,227	159,480
26	2026	1.78	1.62	19.53	36,654	6,942	37,314	8,329	12,375	11,245	135,584	14,847	13,492	162,670
27	2027	1.78	1.62	19.53	37,314	7,067	37,986	8,496	12,597	11,448	138,025	15,144	13,762	165,923
28	2028	1.78	1.62	19.53	37,986	7,194	38,670	8,665	12,824	11,654	140,509	15,447	14,037	169,241
29	2029	1.78	1.62	19.53	38,670	7,324	39,369	8,839	13,055	11,864	143,038	15,756	14,318	172,626

NOTES: 1/ Rate of growth of livestock per capita declines by 5% p.a. from 2000 for cattle and goats and by 7.5% for poultry.
2/ Based on current year population and conception and mortality rates.

Table VI.13: Estimate of livestock production

No	Year	Production without Project					Production with Project					Production Differences (with - without project)					Value of Production (without Project)					Value of Production (with Project)					Total	
		Surplus Cattle Sold 2/	Surplus Goats Sold 2/	Surplus Milk Production ('000 litres)	Egg Production ('000)	Production ('000)	Surplus Cattle Sold 2/	Surplus Goats Sold 2/	Surplus Milk Production ('000 litres)	Egg Production ('000)	Production ('000)	Surplus Cattle Sold 2/	Surplus Goats Sold 2/	Surplus Milk Production ('000 litres)	Egg Production ('000)	Production ('000)	Surplus Cattle Tk '000	Surplus Goats Tk '000	Surplus Milk Tk '000	Surplus Egg Tk '000	Surplus Production Tk '000	Surplus Cattle Tk '000	Surplus Goats Tk '000	Surplus Milk Tk '000	Surplus Egg Tk '000	Surplus Production Tk '000	Total Tk '000	Total Benefit Tk '000
0																												
1	2000	307	2,147	319	1,555	373	453	2,719	373	1,555	373	0	0	0	53	0	1,614	2,061	3,833	4,666	4,472	2,855	2,937	3,289	4,472	4,666	14,930	2,757
2	2001	338	2,244	331	1,613	398	512	3,045	398	1,682	404	174	801	66	66	69	1,774	2,154	3,976	4,840	4,773	3,227	3,289	4,773	5,047	5,047	17,336	3,592
3	2002	368	2,338	343	1,669	424	574	3,391	424	1,814	450	206	1,053	81	81	145	1,932	2,245	4,113	5,007	5,082	3,662	3,662	5,082	5,443	5,443	17,804	4,506
4	2003	398	2,430	354	1,723	450	624	3,417	450	1,951	476	(134)	987	135	135	228	2,088	2,332	4,245	5,168	5,401	4,164	3,691	5,401	5,852	5,852	18,607	5,273
5	2004	426	2,518	364	1,774	476	683	3,594	476	2,087	502	(63)	1,076	176	176	315	2,239	2,417	4,372	5,323	5,689	4,313	3,989	5,689	6,316	6,316	19,154	6,027
6	2005	455	2,603	375	1,824	502	743	3,771	502	2,214	528	390	1,163	206	206	450	2,387	2,498	4,494	5,471	5,918	4,313	3,989	5,918	6,547	6,547	20,601	6,547
7	2006	482	2,684	384	1,871	528	802	3,948	528	2,361	553	442	1,258	231	231	500	2,550	2,577	4,613	5,748	6,391	4,313	3,989	6,391	7,022	7,022	21,053	7,022
8	2007	508	2,762	393	1,916	553	861	4,125	553	2,450	578	497	1,356	244	244	553	2,729	2,729	4,721	5,999	6,827	4,313	3,989	6,827	7,460	7,460	21,503	7,460
9	2008	534	2,837	402	1,959	578	917	4,302	578	2,537	603	555	1,453	259	259	578	2,909	2,909	4,827	6,115	7,022	4,313	3,989	7,022	7,651	7,651	21,953	7,651
10	2009	558	2,908	411	2,000	603	972	4,479	603	2,624	628	603	1,553	268	268	603	3,082	2,856	5,023	6,225	7,132	4,313	3,989	7,132	7,761	7,761	22,403	7,761
11	2010	581	2,975	419	2,038	628	1,028	4,656	628	2,711	653	603	1,653	277	277	628	3,165	2,909	5,113	6,337	7,239	4,313	3,989	7,239	7,890	7,890	22,853	7,890
12	2011	592	3,029	426	2,075	653	1,082	4,833	653	2,798	678	603	1,753	286	286	653	3,249	2,960	5,205	6,419	7,316	4,313	3,989	7,316	7,969	7,969	23,303	7,969
13	2012	602	3,084	434	2,112	678	1,137	4,999	678	2,885	703	603	1,853	295	295	678	3,329	3,013	5,299	6,505	7,392	4,313	3,989	7,392	8,028	8,028	23,753	8,028
14	2013	613	3,139	442	2,150	699	1,192	5,155	699	2,972	723	603	1,953	304	304	699	3,409	3,078	5,395	6,591	7,478	4,313	3,989	7,478	8,087	8,087	24,203	8,087
15	2014	624	3,196	450	2,189	719	1,247	5,311	719	3,059	743	603	2,053	313	313	719	3,489	3,137	5,491	6,677	7,564	4,313	3,989	7,564	8,146	8,146	24,653	8,146
16	2015	636	3,253	458	2,229	739	1,302	5,467	739	3,146	763	603	2,153	322	322	739	3,569	3,196	5,587	6,763	7,651	4,313	3,989	7,651	8,205	8,205	25,103	8,205
17	2016	647	3,312	466	2,269	759	1,357	5,623	759	3,233	783	603	2,253	331	331	759	3,649	3,282	5,683	6,849	7,739	4,313	3,989	7,739	8,264	8,264	25,553	8,264
18	2017	659	3,371	474	2,309	779	1,412	5,779	779	3,320	803	603	2,353	340	340	779	3,729	3,365	5,779	6,935	7,826	4,313	3,989	7,826	8,323	8,323	26,003	8,323
19	2018	671	3,432	483	2,351	799	1,467	5,935	799	3,407	823	603	2,453	349	349	799	3,809	3,449	5,875	7,021	7,912	4,313	3,989	7,912	8,382	8,382	26,453	8,382
20	2019	683	3,494	491	2,393	819	1,522	6,091	819	3,494	843	603	2,553	358	358	819	3,889	3,529	5,969	7,107	8,000	4,313	3,989	8,000	8,441	8,441	26,903	8,441
21	2020	695	3,557	500	2,436	839	1,577	6,247	839	3,581	863	603	2,653	367	367	839	3,969	3,611	6,063	7,193	8,087	4,313	3,989	8,087	8,499	8,499	27,353	8,499
22	2021	707	3,621	509	2,480	859	1,632	6,403	859	3,668	883	603	2,753	376	376	859	4,049	3,695	6,157	7,279	8,174	4,313	3,989	8,174	8,558	8,558	27,803	8,558
23	2022	720	3,686	519	2,525	879	1,687	6,559	879	3,755	903	603	2,853	385	385	879	4,129	3,783	6,251	7,365	8,264	4,313	3,989	8,264	8,617	8,617	28,253	8,617
24	2023	733	3,752	528	2,570	899	1,742	6,715	899	3,842	923	603	2,953	394	394	899	4,209	3,871	6,347	7,451	8,351	4,313	3,989	8,351	8,676	8,676	28,703	8,676
25	2024	746	3,820	537	2,617	919	1,797	6,871	919	3,929	943	603	3,053	403	403	919	4,289	3,959	6,441	7,539	8,439	4,313	3,989	8,439	8,735	8,735	29,153	8,735
26	2025	760	3,888	547	2,664	939	1,852	7,027	939	4,016	963	603	3,153	412	412	939	4,369	4,039	6,535	7,627	8,526	4,313	3,989	8,526	8,794	8,794	29,603	8,794
27	2026	773	3,958	557	2,712	959	1,907	7,183	959	4,103	983	603	3,253	421	421	959	4,449	4,119	6,629	7,715	8,612	4,313	3,989	8,612	8,853	8,853	30,053	8,853
28	2027	787	4,030	567	2,760	979	1,962	7,339	979	4,190	1,003	603	3,353	430	430	979	4,529	4,209	6,723	7,803	8,699	4,313	3,989	8,699	8,912	8,912	30,503	8,912
29	2028	802	4,102	577	2,810	999	2,017	7,495	999	4,276	1,023	603	3,453	439	439	999	4,609	4,283	6,817	7,891	8,780	4,313	3,989	8,780	8,971	8,971	30,953	8,971
30	2029	816	4,176	587	2,861	1,013	2,072	7,651	1,013	4,363	1,043	603	3,553	448	448	1,013	4,689	4,367	6,911	7,979	8,866	4,313	3,989	8,866	9,032	9,032	31,403	8,971

Notes: 1/ Rate of growth of livestock per capital declines by 5% p.a. from 2000 for cattle and goats

and by 7.5% for poultry.

2/ Based on current year population and conception and mortality rates.

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Table VI.14: Benefits from livestock improvement programme

No	Year	economic prices										economic prices										Total	
		Draft Cattle	Milch Cows	Beef Fattening	Goat Fattening	Goat Rearing	Chickens Layers	Chickens Broilers	Draft Cattle	Milch Cows	Beef Fattening	Goat Fattening	Goat Rearing	Chickens Layers	Chickens Broilers	Chickens Layers	Chickens Broilers	Chickens Layers	Chickens Broilers	Chickens Layers	Chickens Broilers	Net Revenue (Tk '000)	Net Revenue (Tk '000)
0																							
1	2000	6	6	12	12	12	4	4	23	22	81	67	31	42	42	308							
2	2001	15	15	24	24	24	8	8	58	55	162	133	62	84	84	639							
3	2002	24	24	42	42	42	13	13	92	87	284	234	108	137	137	1,081							
4	2003	36	36	66	66	66	18	18	138	131	446	367	170	190	190	1,634							
5	2004	48	48	90	90	90	24	24	184	175	608	500	232	253	253	2,208							
6	2005	43	43	81	81	81	22	22	166	157	547	450	209	228	228	1,987							
7	2006	39	39	73	73	73	19	19	149	142	493	405	188	205	205	1,789							
8	2007	35	35	66	66	66	17	17	134	128	443	365	169	185	185	1,610							
9	2008	31	31	59	59	59	16	16	121	115	399	328	152	166	166	1,449							
10	2009	28	28	53	53	53	14	14	109	103	359	295	137	150	150	1,304							
11	2010	26	26	48	48	48	13	13	98	93	323	266	123	135	135	1,173							
12	2011	23	23	43	43	43	11	11	88	84	291	239	111	121	121	1,056							
13	2012	21	21	39	39	39	10	10	79	75	262	215	100	109	109	951							
14	2013	19	19	35	35	35	9	9	71	68	236	194	90	98	98	855							
15	2014	17	17	31	31	31	8	8	64	61	212	174	81	88	88	770							
16	2015	15	15	28	28	28	8	8	58	55	191	157	73	79	79	693							
17	2016	14	14	25	25	25	7	7	52	49	172	141	65	72	72	624							
18	2017	12	12	23	23	23	6	6	47	44	155	127	59	64	64	561							
19	2018	11	11	21	21	21	5	5	42	40	139	114	53	58	58	505							
20	2019	10	10	19	19	19	5	5	38	36	125	103	48	52	52	455							
21	2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	2024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	2025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	2026	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	2027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	2028	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	2029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes 1/ Each unit is assumed to participate directly in the programme and require credit for 4 years.
2/ Benefits are only counted for units actually in the programme.

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Table VI.15: Livestock improvement - production models (cattle)

Item	Unit	Unit Cost	Draft Bullocks			Milch Cows			Beef Fattening		
			Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)
Production cycle	days		360			360			360		
Stock	head		2	12,000	10824	1	4,000	3608	2	5,000	4510
Fodder:											
- straw	kg	0.5	2,160	1,080	974	720	360	325	1,440	720	649
- urea	kg	5.9	108	633	622	36	211	207	72	422	414
- molasses block	kg	7.0	180	1,260	1,137	90	630	568	180	1,260	1,137
- other supplements	kg	7.0	288	2,016	1,818	360	2,520	2,273	144	1,008	909
Straw treatment pit		60.0	1	60	54	1	60	54	1	60	54
Veterinary costs				500	451		400	361		500	451
Miscellaneous costs (10%)				555	501		418	377		397	358
Operating costs				6,104	5,556		4,599	4,165		4,367	3,973
Family labour	days	50.0	40	2,000	1,700	40	2,000	1,700	40	2,000	1,700
Interest cost 1/		15%		2,258	2,040		945	852		1,405	1,267
Total costs				10,362	9,297		7,544	6,718		7,772	6,940
Gross revenue											
- labour	days	50	150	7,500	6375						
- draft power		50	150	7,500	6765						
- milk	litres	12				842	10,109	9,118			
- sale of calf 2/	head	1500				0.92	1,380	1,245			
- sale of steers 2/	kg	35							433.92	15,187	13,699
Total Revenue				15,000	13,140		11,489	10,363		15,187	13,699
Net Revenue				4,638	3,843		3,945	3,645		7,415	6,759

Notes: 1/ Interest at 15% p.a. on cost of livestock + 50% of operating costs for draft and milch cattle; + 100% for beef fatteni
2/ Reflects reproduction and/or mortality rates.

Table VI.16: Livestock improvement - production models (poultry)

Item	Unit	Unit Cost	Layers			Broilers		
			Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)
Production cycle	days		360			60		
Stock	head		50	5,000	4510	250	1,750	1578.5
Feed - layers	kg	8.0	2,160	17,280	15,587	0	0	0
Feed - broiler	kg	3.0				600	1,800	1,624
Housing		1,000.0	1	1,000	902	1	500	451
Equipment		1,000.0	1	1,000	902	0	0	0
Heating		250.0	0	0	0	1	250	226
Veterinary costs				500	451		500	451
Miscellaneous costs (10%)				1,978	1,784		305	275
Operating costs				21,758	19,626		3,355	3,026
Family labour	days	50.0	60	3,000	2,550	10	500	425
Interest cost 1/		15%		2,708	1,658		126	388
Total costs				27,466	23,834		3,981	3,839
Gross revenue								
- eggs 2/	egg	3	12600	37,800	32130	0	0	0
- culled layers 2/	head	50	50	2,500	2255		0	0
- broiler chickens	head	30				240	7,200	6494.4
Total Revenue				40,300	34,385		7,200	6,494
Net Revenue (per cycle)				12,834	10,551		3,219	2,655
Net Revenue (per year)				12,834	10,551		12,876	10,620

Notes: 1/ Interest at 15% p.a. on cost of livestock + 60% of operating costs for layers and
 2/ Reflects reproduction and/or mortality rates.

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Table VI.17: Livestock improvement - production models (goats)

Item	Unit	Unit Cost	Goat Fattening			Goat Rearing 3/		
			Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)
Production cycle	days		270			360		
Stock	head		5	2,500	2255	2	1,500	1353
Fodder:								
- straw	kg	0.5	0	0	0	0	0	0
- urea	kg	5.9	0	0	0	0	0	0
- molasses block	kg	7.0	135	945	852	72	504	455
- other supplements	kg	7.0	135	945	852	72	504	455
Straw treatment pit		60.0	0	0	0	0	0	0
Veterinary costs				300	271		300	271
Miscellaneous costs (10%)				219	198		131	118
Operating costs				2,409	2,173		1,439	1,298
Family labour	days	50.0	35	1,750	1,488	35	1,750	1,488
Interest cost 1/		15%		545	491		441	398
Total costs				4,704	4,152		3,630	3,183
Gross revenue								
- sale of goats 2/	kg	60	179.45	10,767	9,712			
- sale of kids 2/	head	1050				6.08	6,384	5,758
Total Revenue				10,767	9,712		6,384	5,758
Net Revenue				6,063	5,560		2,754	2,575

Notes: 1/ Interest at 15% p.a. on cost of livestock + 100% of operating costs.

2/ Reflects reproduction and/or mortality rates.

3/ Production mature kids twice per year. (First year production would be less than 2 full cycles)

Table VI.18: Crop budget for fish culture (1 ha. pond)
(cultured pond - present and future without project situation)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	7.0	50.0	42.5	350	298
labour	mandays	40.0	50.0	42.5	2,000	1,700
Total labour cost					2,350	1,998
Inputs:						
fingerlings	No.	2,000.0	1.0	0.9	2,000	1,804
lime	kg	100.0	6.0	5.4	600	541
organic fertiliser	kg	7,000.0	0.5	0.5	3,500	3,157
urea	kg	60.0	5.9	5.8	352	345
MP	kg	30.0	9.3	9.1	278	272
TSP	kg	70.0	10.0	9.8	701	685
mustard cake	kg	600.0	6.0	5.4	3,600	3,247
rice bran	kg	1,500.0	3.0	2.7	4,500	4,059
Total Inputs					15,531	14,111
Total Inputs + Labour					17,881	16,108
Yield	kg/ha	800.0	40.0	36.1	32,000	28,864
Net Revenue					14,119	12,756

Table VI.19: Crop budget for fish culture (1 ha. pond)
(culturable pond - present and future without project situation)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	5.0	50.0	42.5	250	213
labour	mandays	5.0	50.0	42.5	250	213
Total labour cost					500	425
Inputs:						
fingerlings	No.	1,000.0	1.0	0.9	1,000	902
lime	kg	0.0	6.0	5.4	0	0
organic fertiliser	kg	0.0	0.5	0.5	0	0
urea	kg	0.0	0.0	0.0	0	0
MP	kg	0.0	0.0	0.0	0	0
TSP	kg	0.0	0.0	0.0	0	0
mustard cake	kg	0.0	6.0	5.4	0	0
rice bran	kg	0.0	3.0	2.7	0	0
Total Inputs					1,000	902
Total Inputs + Labour					1,500	1,327
Yield	kg/ha	250.0	40.0	36.1	10,000	9,020
Net Revenue					8,500	7,693

Notes:

1/ Lower output price for culturable ponds reflects smaller average size of fish.

Table VI.20: Crop budget for fish culture (1 h (cultured pond - future situation)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	7.0	50.0	42.5	350	298
labour	mandays	100.0	50.0	42.5	5,000	4,250
Total labour cost					5,350	4,548
Inputs:						
fingerlings	No.	8,000.0	1.0	0.9	8,000	7,216
lime	kg	100.0	6.0	5.4	600	541
organic fertiliser	kg	12,000.0	0.5	0.5	6,000	5,412
urea	kg	100.0	5.9	5.8	586	575
MP	kg	40.0	9.3	9.1	371	362
TSP	kg	100.0	10.0	9.8	1,001	979
mustard cake	kg	800.0	6.0	5.4	4,800	4,330
rice bran	kg	2,000.0	3.0	2.7	6,000	5,412
Total Inputs					27,358	24,828
Total Inputs + Labour					32,708	29,375
Yield	kg/ha	2,000.0	40.0	36.1	80,000	72,160
Net Revenue					47,292	42,785

Table VI.21: Crop budget for shrimp culture (1 ha. pond)
(low output - present situation with disease)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	4.0	50.0	42.5	200	170
labour	mandays	30.0	50.0	42.5	1,500	1,275
Total labour cost					1,700	1,445
Inputs:						
post-larvae	No.	10,000.0	0.8	0.7	8,000	7,216
lime	kg	100.0	6.0	5.4	600	541
feed	kg	500.0	10.0	9.0	5,000	4,510
rice bran	kg	500.0	3.0	2.7	1,500	1,353
MP	kg	20.0	9.3	9.1	186	181
TSP	kg	40.0	10.0	9.8	401	392
Total Inputs					15,686	14,193
Total Inputs + Labour					17,386	15,638
Yield	kg/ha	130.0	200.0	180.4	26,000	23,452
Net Revenue					8,614	7,814

Table VI.22: Crop budget for shrimp culture (1 ha. pond)
(future situation - no disease)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	10.0	50.0	42.5	500	425
labour	mandays	120.0	50.0	42.5	6,000	5,100
Total labour cost					6,500	5,525
Inputs:						
post-larvae	No.	20,000.0	0.8	0.7	16,000	14,432
lime	kg	200.0	6.0	5.4	1,200	1,082
feed	kg	500.0	10.0	9.0	5,000	4,510
rice bran	kg	0.0	3.0	2.7	0	0
MP	kg	150.0	9.3	9.1	1,392	1,359
TSP	kg	300.0	10.0	9.8	3,004	2,937
Organic fertiliser	kg	5,000.0	0.5	0.5	2,500	2,255
Total Inputs					29,096	26,576
Total Inputs + Labour					35,596	32,101
Yield	kg/ha	400.0	200.0	180.4	80,000	72,160
Net Revenue					44,404	40,059

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Table VI.23: Forest - mangrove (per ha.)

Unit	Plantation Establishment			Thinning (year 8)			Harvesting (year 15)		
	Quantity	Unit	Cost (Tk)	Quantity	Unit	Cost (Tk)	Quantity	Unit	Cost (Tk)
Labour	75	days	70	23	70	1,610	1,400	70	98,000
Materials	1	Tk	625	1	3,150	3,150	1	3,150	3,150
Overhead costs	1	Tk	5,000	1	70	70	1	70	70
Maintenance	25	days	70	0	70	0	0	70	0
- labour	3	Tk	150	0	150	0	0	150	0
- materials			450	0			0		0
Total costs			13,075			4,830	4,273		101,220
Revenue									
Firewood		cu.m.		14	450	6,300	57	450	25,650
Timber		cu.m.					52	1800	93,600
Total						6,300	5,683		119,250
Net Revenue		Tk				1,470	1,410		18,030

Notes: 1/ The 40:60 ratio of timber:fuelwood is modified with a 15% reduction in timber to take account of stem borer infestation of Keora in many places.

Table VI.24: Forest - non-mangrove (per ha.)

Unit	Plantation Establishment			Thinning (year 8)			Harvesting (year 25)		
	Quantity	Unit	Cost (Tk)	Quantity	Unit	Cost (Tk)	Quantity	Unit	Cost (Tk)
Labour	165	days	70	20	70	1,400	670	70	46,900
Materials	1	Tk	1,126	1	4,500	4,500	1	4,500	4,500
Overhead costs	1	Tk	5,000	1	70	70	1	70	70
Maintenance	46	days	70	0	70	0	0	70	0
- labour	6	Tk	120	0	150	0	0	150	0
- materials			720	0			0		0
Total costs			21,616			5,970	5,312		51,470
Revenue									
Firewood		cu.m.		14	500	7,000	12	500	6,000
Timber		cu.m.				0	27	4400	118,800
Total						7,000	6,314		124,800
Net Revenue		Tk				1,030	1,002		73,330

Note: Non-mangrove firewood price at 125% mangrove; timber at 140% mangrove.

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Table VI.25: Benefits from agriculture

No	Year	Future without Project						Future with Project (F1 = one cross dam)						Total Benefits	
		Annual Increments (ha)			Benefits (Tk '000)			Cumulative Totals (ha)			Benefits (Tk '000)			F1	
		Existing	New	OE	Existing	New	OE	Existing	New	OE	Existing	New	OE		
0															
1	2000	3,490	22		20,612		22	0	3,490		0	317		8,553	20,176
2	2001	3,490	22		20,612	44	45	1,448	(1,583)	0	1,448	317		11,260	23,455
3	2002	3,490	22		20,612	65	70	412	(135)	0	1,860	634		10,892	27,657
4	2003	3,490	22		20,612	87	95	662	(249)	0	2,522	951		9,726	1,144
5	2004	3,490	22		20,612	109	123	0	0	0	2,522	1,269		10,095	1,565
6	2005	3,490	22		20,612	131	151	0	0	0	2,522	1,586		10,465	29,857
7	2006	3,490	22		20,612	153	181	1,825	(1,083)	681	4,346	906	994	3,124	32,155
8	2007	3,490	22		20,612	174	217	742	0	0	5,089	906		3,231	37,110
9	2008	3,490	22		20,612	196	259	0	0	0	5,089	906	1,052	3,337	44,214
10	2009	3,490	22		20,612	218	308	0	0	0	5,089	906	1,682	3,442	47,919
11	2010	3,490	22		20,612	240	363	0	0	0	5,089	906	2,312	3,549	51,628
12	2011	3,490	22		20,612	261	424	0	0	0	5,089	906	2,942	3,655	55,356
13	2012	3,490	22		20,612	283	491	0	0	0	5,089	906	3,572	3,760	59,080
14	2013	3,490	22		20,612	305	565	0	0	0	5,089	906	4,202	3,867	63,245
15	2014	3,490	22		20,612	327	645	0	0	0	5,089	906	4,832	3,974	67,426
16	2015	3,490	22		20,612	349	731	0	0	0	5,089	906	5,462	4,079	71,590
17	2016	3,490	22		20,612	371	823	0	0	0	5,089	906	6,092	4,185	75,755
18	2017	3,490	22		20,612	392	922	0	0	0	5,089	906	6,722	4,292	79,965
19	2018	3,490	22		20,612	414	1,026	0	0	0	5,089	906	7,353	4,399	83,218
20	2019	3,490	22		20,612	436	1,137	0	0	0	5,089	906	7,983	4,505	86,449
21	2020	3,490	22		20,612	458	1,255	0	0	0	5,089	906	8,613	4,613	89,680
22	2021	3,490	22		20,612	480	1,372	0	0	0	5,089	906	9,243	4,720	92,923
23	2022	3,490	22		20,612	501	1,489	0	0	0	5,089	906	9,876	4,827	96,166
24	2023	3,490	22		20,612	523	1,606	0	0	0	5,089	906	10,509	4,934	99,415
25	2024	3,490	22		20,612	545	1,724	0	0	0	5,089	906	11,142	5,041	102,664
26	2025	3,490	22		20,612	567	1,841	0	0	0	5,089	906	11,775	5,148	105,913
27	2026	3,490	22		20,612	589	1,958	0	0	0	5,089	906	12,408	5,255	109,162
28	2027	3,490	22		20,612	611	2,076	0	0	0	5,089	906	13,041	5,362	112,411
29	2028	3,490	22		20,612	632	2,193	0	0	0	5,089	906	13,674	5,469	115,660
30	2029	3,490	22		20,612	654	2,310	0	0	0	5,089	906	14,307	5,576	118,909

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Table VI.25: Benefits from agriculture

No	Year	Future with Project (F2 = two cross dams)										economic prices		
		Annual Increments (ha)					Cumulative Totals (ha)					Net Benefits		
		Existing	OE	IE	New	OE	Existing	OE	IE	New	OE	F1	F2	F0
0		0	0	0	0	0	0	0	0	0	0	(458)	(458)	
1	2000	1,448	(1,583)	3,490	0	317	1,448	1,906	8,553	0	317	20,176	2,799	2,799
2	2001	412	(135)	1,771	0	634	11,821	10,892	11,821	0	634	23,455	2,799	2,799
3	2002	662	(249)	1,522	0	951	16,788	9,726	16,788	0	951	29,897	9,190	9,190
4	2003	0	0	1,522	0	1,269	18,237	10,095	18,237	0	1,269	32,155	11,421	11,421
5	2004	0	0	1,522	0	1,586	19,684	10,465	19,684	0	1,586	37,110	16,348	16,348
6	2005	1,825	(1,083)	439	681	906	31,903	3,124	31,903	681	906	44,214	23,422	23,422
7	2006	742	0	439	681	906	38,789	3,231	38,789	681	906	47,919	27,091	27,091
8	2007	0	0	439	681	906	41,700	3,337	41,700	681	906	51,628	30,757	30,757
9	2008	0	0	439	681	906	44,614	3,442	44,614	681	906	55,356	34,437	34,437
10	2009	0	0	439	681	906	47,542	3,549	47,542	681	906	59,080	38,106	38,106
11	2010	0	0	439	681	906	50,453	3,655	50,453	681	906	62,804	41,775	41,775
12	2011	0	0	439	681	906	53,367	3,760	53,367	681	906	66,528	45,444	45,444
13	2012	0	0	439	681	906	56,295	3,867	56,295	681	906	70,252	49,113	49,113
14	2013	0	0	439	681	906	59,206	3,974	59,206	681	906	73,976	52,782	52,782
15	2014	0	0	439	681	906	62,120	4,079	62,120	681	906	77,699	56,451	56,451
16	2015	0	0	439	681	975	65,048	4,185	65,048	681	975	80,016	58,674	58,674
17	2016	0	0	439	681	1,045	67,125	4,185	67,125	681	1,045	83,323	61,888	61,888
18	2017	0	0	439	681	1,114	68,979	4,185	68,979	681	1,114	86,410	64,877	64,877
19	2018	0	0	439	681	1,183	70,458	4,185	70,458	681	1,183	89,127	67,489	67,489
20	2019	0	0	439	681	1,252	71,922	4,185	71,922	681	1,252	91,833	69,803	69,803
21	2020	0	0	439	681	1,460	73,395	4,185	73,395	681	1,460	94,716	72,358	72,358
22	2021	0	0	439	681	1,668	73,822	4,185	73,822	681	1,668	97,601	74,671	74,671
23	2022	0	0	439	681	1,876	73,822	4,185	73,822	681	1,876	100,486	76,526	76,526
24	2023	0	0	439	681	2,084	73,822	4,185	73,822	681	2,084	103,371	78,381	78,381
25	2024	0	0	439	681	2,292	73,822	4,185	73,822	681	2,292	106,256	80,236	80,236
26	2025	0	0	439	681	2,449	73,822	4,185	73,822	681	2,449	109,141	82,091	82,091
27	2026	0	0	439	681	2,605	73,822	4,185	73,822	681	2,605	112,026	83,946	83,946
28	2027	0	0	439	681	2,762	73,822	4,185	73,822	681	2,762	114,911	85,801	85,801
29	2028	0	0	439	681	2,918	73,822	4,185	73,822	681	2,918	117,796	87,656	87,656
30	2029	0	0	439	681	3,074	73,822	4,185	73,822	681	3,074	120,681	89,511	89,511

Table VI.26: Benefits from aquaculture

No	Year	Existing Pond Areas	New Pond Areas (ha.)				Total Ponds in Production				Cumulative Areas - F1				Cumulative Areas - F2				Net Benefits											
			F0		F1		F2		New Ponds from Forest		Total Benefit		Existing		New		Total Benefit		New											
			Cultured	No Intervention	Cultured	Shrimp	Cultured	Shrimp	Cultured	Shrimp	Cultured	Shrimp	(Tk '000)	Cultured	Shrimp	Cultured	Shrimp	(Tk '000)	Cultured	Shrimp	(Tk '000)	F1 - F0	F2 - F0							
0	2000	78	0.5	0.3	8	4	8	4	0	78	26	0	0	78	26	8	4	1,196	78	26	8	4	1,210	78	26	8	4	1,210	14	14
1	2001	78	0.5	0.3	8	4	8	4	0	78	26	1	1	78	26	8	13	1,199	84	20	26	13	1,199	84	20	26	13	1,199	353	353
2	2001	78	0.5	0.3	8	4	8	4	10	78	26	1	1	78	26	26	26	1,205	89	15	45	22	1,205	89	15	45	22	1,205	810	810
3	2002	78	0.5	0.3	8	4	8	4	10	78	26	2	2	78	26	15	53	1,213	94	10	53	26	1,213	94	10	53	26	1,213	1,378	1,378
4	2003	78	0.5	0.3	8	4	8	4	0	78	26	2	2	78	26	15	53	1,223	99	5	61	30	1,223	99	5	61	30	1,223	2,012	2,012
5	2004	78	0.6	0.3	8	4	8	4	0	78	26	3	3	78	26	6	61	1,236	104	0	79	39	1,236	104	0	79	39	1,236	3,235	3,235
6	2005	78	0.5	0.3	8	4	8	4	19	78	26	3	3	78	26	9	39	1,249	104	0	98	48	1,249	104	0	98	48	1,249	2,716	2,716
7	2006	78	0.5	0.3	8	4	8	4	19	78	26	4	4	78	26	9	48	1,263	104	0	98	48	1,263	104	0	98	48	1,263	3,511	3,511
8	2007	78	0.5	0.3	8	4	8	4	0	78	26	4	4	78	26	9	48	1,268	104	0	98	48	1,268	104	0	98	48	1,268	4,390	4,390
9	2008	78	0.5	0.3	8	4	8	4	0	78	26	5	5	78	26	9	48	1,276	104	0	98	48	1,276	104	0	98	48	1,276	5,279	5,279
10	2009	78	0.5	0.3	8	4	8	4	0	78	26	5	5	78	26	9	48	1,284	104	0	98	48	1,284	104	0	98	48	1,284	6,149	6,149
11	2010	78	0.5	0.3	8	4	8	4	0	78	26	6	6	78	26	10	53	1,292	104	0	98	53	1,292	104	0	98	53	1,292	7,019	7,019
12	2011	78	0.5	0.3	8	4	8	4	0	78	26	6	6	78	26	10	53	1,300	104	0	98	53	1,300	104	0	98	53	1,300	7,811	7,811
13	2012	78	0.5	0.3	8	4	8	4	0	78	26	6	6	78	26	10	53	1,308	104	0	98	53	1,308	104	0	98	53	1,308	8,611	8,611
14	2013	78	0.6	0.3	8	4	8	4	0	78	26	7	7	78	26	11	58	1,316	104	0	98	58	1,316	104	0	98	58	1,316	9,411	9,411
15	2014	78	0.6	0.3	8	4	8	4	0	78	26	8	8	78	26	11	58	1,324	104	0	98	58	1,324	104	0	98	58	1,324	10,211	10,211
16	2015	78	0.5	0.3	8	4	8	4	0	78	26	8	8	78	26	11	58	1,332	104	0	98	58	1,332	104	0	98	58	1,332	11,011	11,011
17	2016	78	0.5	0.3	8	4	8	4	0	78	26	9	9	78	26	12	63	1,340	104	0	99	63	1,340	104	0	100	63	1,340	11,811	11,811
18	2017	78	0.5	0.3	8	4	8	4	0	78	26	10	10	78	26	13	68	1,348	104	0	100	68	1,348	104	0	101	68	1,348	12,611	12,611
19	2018	78	0.5	0.3	8	4	8	4	0	78	26	11	11	78	26	14	73	1,356	104	0	101	73	1,356	104	0	102	73	1,356	13,411	13,411
20	2019	78	0.6	0.3	8	4	8	4	0	78	26	12	12	78	26	15	78	1,364	104	0	102	78	1,364	104	0	103	78	1,364	14,211	14,211
21	2020	78	0.5	0.3	8	4	8	4	0	78	26	13	13	78	26	16	83	1,372	104	0	103	83	1,372	104	0	104	83	1,372	15,011	15,011
22	2021	78	0.5	0.3	8	4	8	4	0	78	26	14	14	78	26	17	88	1,380	104	0	104	88	1,380	104	0	105	88	1,380	15,811	15,811
23	2022	78	0.5	0.3	8	4	8	4	0	78	26	15	15	78	26	18	93	1,388	104	0	105	93	1,388	104	0	106	93	1,388	16,611	16,611
24	2023	78	0.5	0.3	8	4	8	4	0	78	26	16	16	78	26	19	98	1,396	104	0	106	98	1,396	104	0	107	98	1,396	17,411	17,411
25	2024	78	0.6	0.3	8	4	8	4	0	78	26	17	17	78	26	20	103	1,404	104	0	107	103	1,404	104	0	108	103	1,404	18,211	18,211
26	2025	78	0.5	0.3	8	4	8	4	0	78	26	18	18	78	26	21	108	1,412	104	0	108	108	1,412	104	0	109	108	1,412	19,011	19,011
27	2026	78	0.5	0.3	8	4	8	4	0	78	26	19	19	78	26	22	113	1,420	104	0	109	113	1,420	104	0	110	113	1,420	19,811	19,811
28	2027	78	0.5	0.3	8	4	8	4	0	78	26	20	20	78	26	23	118	1,428	104	0	110	118	1,428	104	0	111	118	1,428	20,611	20,611
29	2028	78	0.5	0.3	8	4	8	4	0	78	26	21	21	78	26	24	123	1,436	104	0	111	123	1,436	104	0	112	123	1,436	21,411	21,411
30	2029	78	0.5	0.3	8	4	8	4	0	78	26	22	22	78	26	25	128	1,444	104	0	112	128	1,444	104	0	113	128	1,444	22,211	22,211

Notes 1/ For areas see Table 6.1

2/ No distinction is drawn between ponds inside or outside the embankments.

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Table VI.27: Benefits from forestry

No	Year	Mangrove Forest Planted		Non-Mangrove F1 & F2	Forest Thinning (year 8)				Forest Harvesting				Planting Costs				Net Revenues from Thinning and Harvesting				Net Benefits from Forestry																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
		Annual Increments			Non-Mangrove F1 & F2	Annual Increments		Existing Forest for Clearing 1/ F2		Annual Increments		F0 F1 F2		F0 F1 F2		F0 F1 F2		F0 F1 F2		F0 F1 F2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
		F0	F1			F0	F1	F0	F1	F0	F1	F0	F1	F0	F1	F0	F1	F0	F1	F0	F1	F2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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Notes 1/ Based on Tables 6.1, VI.23 and VI.24

2/ Existing forest inside south Hatria and Nijhum Dwip polders.

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Table VI.28: EIRR and NPV

No.	Year	Project Costs			Agricultural Benefits		Aquacultural Benefits		Livestock Benefits		Forestry Benefits		Total Benefits		Net Benefits		Net Revenue	
		One Cross Dam Investment	F1 Investment	F2 Two Cross Dams Investment	Future Without Project	Future With Project	Future Without Project	Future With Project	Future Without Project	Future With Project	Future Without Project	Future With Project	Future Without Project	Future With Project	F1 - F0	F2 - F0	F1 dam	F2 two cross dams
1	2000	142,908	0	144,878	0	20,176	1,196	1,210	1,210	12,174	15,239	15,239	33,485	35,205	1,720	1,720	(141,188)	(143,158)
2	2001	104,338	0	105,450	0	20,657	1,199	1,552	1,552	12,744	16,375	16,375	34,082	35,205	1,123	1,123	(90,078)	(91,190)
3	2002	14,014	0	12,806	0	20,681	1,205	2,015	2,015	13,298	18,884	18,884	34,666	35,205	539	539	9,490	10,698
4	2003	12,071	0	10,863	0	20,707	1,213	2,591	2,591	13,834	18,241	18,241	35,235	35,205	-30	-30	2,014	3,222
5	2004	101,739	0	105,172	0	20,734	1,236	3,235	3,235	14,352	21,362	21,362	36,330	35,345	-985	-985	(82,178)	(85,611)
6	2005	110,020	0	116,151	0	20,762	1,249	3,952	3,952	14,850	26,592	26,592	36,853	32,806	-4,047	-4,047	(69,975)	(75,275)
7	2006	8,211	0	14,246	0	20,792	1,249	4,751	4,751	15,329	28,255	28,255	37,426	32,806	-4,620	-4,620	49,809	41,703
8	2007	0	4,975	0	20,828	47,919	1,263	5,653	5,653	15,789	29,899	29,899	37,923	32,806	-5,117	-5,117	39,268	35,835
9	2008	0	4,975	0	20,871	51,628	1,279	6,558	6,558	16,228	31,523	31,523	38,407	32,806	-5,601	-5,601	43,380	41,947
10	2009	0	4,975	0	20,919	55,356	1,295	7,444	7,444	16,647	33,222	33,222	38,878	32,806	-6,072	-6,072	47,803	46,370
11	2010	0	4,975	0	20,974	59,080	1,312	8,331	8,331	17,046	34,921	34,921	39,353	32,806	-6,547	-6,547	51,236	50,232
12	2011	0	4,975	0	21,035	62,845	1,329	9,218	9,218	17,446	36,619	36,619	39,828	32,806	-7,022	-7,022	54,668	53,368
13	2012	0	4,975	0	21,103	67,426	1,347	10,105	10,105	17,846	38,317	38,317	40,303	32,806	-7,497	-7,497	58,100	56,600
14	2013	0	4,975	0	21,176	71,590	1,365	10,992	10,992	18,246	40,005	40,005	40,778	32,806	-7,972	-7,972	61,532	59,992
15	2014	0	4,975	0	21,256	75,755	1,383	11,879	11,879	18,646	41,703	41,703	41,253	32,806	-8,447	-8,447	64,964	63,414
16	2015	0	4,975	0	21,342	79,965	1,401	12,766	12,766	19,046	43,401	43,401	41,728	32,806	-8,921	-8,921	68,396	66,846
17	2016	0	4,975	0	21,435	84,218	1,418	13,653	13,653	19,446	45,100	45,100	42,203	32,806	-9,397	-9,397	71,828	70,278
18	2017	0	4,975	0	21,533	88,908	1,436	14,540	14,540	19,846	46,799	46,799	42,678	32,806	-9,872	-9,872	75,260	73,710
19	2018	0	4,975	0	21,638	93,224	1,454	15,427	15,427	20,246	48,497	48,497	43,153	32,806	-10,347	-10,347	78,692	77,142
20	2019	0	4,975	0	21,749	97,552	1,472	16,314	16,314	20,646	50,196	50,196	43,628	32,806	-10,822	-10,822	82,124	80,574
21	2020	0	4,975	0	21,866	101,880	1,490	17,201	17,201	21,046	51,895	51,895	44,103	32,806	-11,297	-11,297	85,556	84,006
22	2021	0	4,975	0	21,983	106,208	1,507	18,088	18,088	21,446	53,594	53,594	44,578	32,806	-11,772	-11,772	88,988	87,438
23	2022	0	4,975	0	22,101	110,536	1,525	18,975	18,975	21,846	55,293	55,293	45,053	32,806	-12,247	-12,247	92,420	90,870
24	2023	0	4,975	0	22,218	114,864	1,543	19,862	19,862	22,246	56,992	56,992	45,528	32,806	-12,722	-12,722	95,852	94,302
25	2024	0	4,975	0	22,336	119,192	1,561	20,749	20,749	22,646	58,691	58,691	46,003	32,806	-13,197	-13,197	99,284	97,734
26	2025	0	4,975	0	22,453	123,520	1,579	21,636	21,636	23,046	60,390	60,390	46,478	32,806	-13,672	-13,672	102,716	101,186
27	2026	0	4,975	0	22,570	127,848	1,596	22,523	22,523	23,446	62,089	62,089	46,953	32,806	-14,147	-14,147	106,148	104,598
28	2027	0	4,975	0	22,687	132,176	1,614	23,410	23,410	23,846	63,788	63,788	47,428	32,806	-14,622	-14,622	109,580	108,000
29	2028	0	4,975	0	22,804	136,504	1,632	24,297	24,297	24,246	65,487	65,487	47,903	32,806	-15,097	-15,097	113,012	111,412
30	2029	0	4,975	0	22,922	140,832	1,650	25,184	25,184	24,646	67,186	67,186	48,378	32,806	-15,572	-15,572	116,444	114,844
																EIRR	12.22	10.38
																NPV	6,793	(56,281)

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Table VI.29: Financial and economic prices (1997 prices): import parity

	Unit	SCF	Rice (b)		Wheat		TSP		Muriate of Potash	
			1997	2010	1997	2010	1997	2010	1997	2010
World Bank price forecast (1, 2)	\$/mt	-	330	302	165	136	160	120	118	105
Quality adjustment (3)	\$/mt	-	248	226	132	109	160	120	118	105
Freight and insurance	\$/mt	-	30	30	54	54	45	45	45	45
CIF Port of Entry	\$/mt	-	278	256	186	163	205	165	163	150
Border price in taka (4)	Tk/mt	-	13,056	12,054	8,727	7,658	9,629	7,336	7,681	7,069
Port dues and transport/handling to regional	Tk/mt	0.9	650	586	650	586	550	496	550	496
Regional centre/wholesale price	Tk/mt	-	13,706	12,640	9,377	8,245	10,179	8,286	8,231	7,565
Marketing costs and margins - regional (6)	Tk/mt	0.9	685	618	469	423	508	459	412	371
Transport and handling to secondary market	Tk/mt	0.9	810	731	810	731	550	496	550	496
Marketing costs and margins - local	Tk/mt	0.9	855	771	567	511	562	507	460	415
Price ex-processor	Tk/mt	-	11,356	10,471	7,531	6,587	11,800	9,713	9,652	8,577
Adjustment for processing	Tk/mt	-	7,609	7,016	7,120	6,592	11,800	9,713	9,652	8,577
Processing cost	Tk/mt	0.9	320	289	320	289	0	0	0	0
Transport and handling to farm gate	Tk/mt	0.9	350	316	350	316	300	271	300	271
Farm gate price	Tk/mt	-	6,939	7,116	7,181	7,333	12,100	11,857	9,952	9,277

Notes:

- (1) WB price forecast in constant 1990 dollars (February 97 dat
(2) MUV factor for 1997 (January 1997 forecast)
(3) Quality adjustment
(4) Exchange rate - Taka:US\$
(5) Processing ratio
(6) Marketing costs - regional
(7) Marketing costs - local

Notes:

- (a) Standard conversion factor = 0.302 is World Bank July 1997 estimate for 1997/98 fiscal year
(b) Rice processing and marketing costs based on "Commodity Report on Foodgrain" Research & Planning Section,
Department of Agricultural Marketing, September 1997.

Table VI.30: Financial and economic prices (1997 prices): export parity

	Unit	SCF	Jute (a)		Urea	
			1997	2010	1997	2010
World Bank price forecast	\$/mt	-	399	399	189	147
Quality adjustment	\$/mt	-	399	399	189	147
Freight and insurance	\$/mt	-	50	50	45	45
FOB Port of Entry	\$/mt	-	349	349	144	102
Border price in taka (4)	Tk/mt	-	16,403	16,403	6,790	4,787
Port dues and transport/handling to regional	Tk/mt	0.9	650	586	650	586
Subsidies	Tk/mt	-	0	0	0	0
Regional centre/wholesale price	Tk/mt	-	15,753	15,817	5,040	4,137
Marketing costs and margins - regional (6)	Tk/mt	0.9	1,575	1,421	504	455
Transport and handling to secondary market	Tk/mt	0.9	810	731	550	496
Marketing costs and margins - local	Tk/mt	0.9	1,337	1,206	609	510
Price ex-processor / local market	Tk/mt	-	12,031	12,459	6,704	5,610
Adjustment for processing	Tk/mt	-	12,031	12,459	6,704	5,610
Processing cost	Tk/mt	0.9	2,406	2,492	0	0
Transport and handling to farm gate	Tk/mt	0.9	350	316	250	226
Farm gate price	Tk/mt	-	9,275	9,968	6,954	5,755

Notes:

- (1) WB price forecast in constant 1990 dollars (February 97 dat
(2) MUV factor for 1997 (January 1997 forecast)
(3) Quality adjustment
(4) Exchange rate - Taka:US\$
(5) Processing ratio
(6) Marketing costs - regional
(7) Marketing costs - local

Note: Current subsidy on domestically produced urea assumed to be eliminated in medium term.

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Table VI.31: Chilli price (dried) (Tk/mt)

Year	Index 85/86 = 100	current	1997
1990/91	148.05	58,840	76,558
1991/92	157.58	57,220	69,947
1992/93	157.80	26,050	31,800
1993/94	162.74	39,580	46,850
1994/95	176.73	52,260	56,962
1995/96	190.08	57,030	57,795
1996/97	192.63	43,700	43,700
5 year average			47,421
4 year average			51,327
yield (mt/ha)		0.97	

Table VI.32: Mustard price (Tk/mt)

Year	Index 85/86 = 100	current	1997
1990/91	148.05		0
1991/92	157.58	13,730	16,784
1992/93	157.80	14,160	17,285
1993/94	162.74	15,030	17,791
1994/95	176.73	15,300	16,677
1995/96	190.08	15,800	16,012
1996/97	192.63	16,370	16,370
5 year average			16,827
4 year average			16,712
yield (mt/ha.)			

Table VI.32: Groundnut price (Tk/mt)

Year	Index 85/86 = 100	current	1997
1990/91	148.05		0
1991/92	157.58	18,130	22,163
1992/93	157.80	14,250	17,395
1993/94	162.74	15,770	18,666
1994/95	176.73	14,280	15,565
1995/96	190.08	15,340	15,546
1996/97	192.63		
5 year average			17,867
4 year average			16,793
yield (mt/ha)		1.00	

Table VI.33: Sweet potato price (Tk/mt)

Year	Index 85/86 = 100	current	1997
1990/91	148.05	1,820	2,368
1991/92	157.58	1,920	2,347
1992/93	157.80	1,830	2,234
1993/94	162.74	1,930	2,284
1994/95	176.73	2,400	2,616
1995/96	190.08	2,660	2,696
1996/97	192.63		
5 year average			2,435
4 year average			2,458
yield (mt/ha)		8.00	

Table VI.34: Price for pulses crop budget (Tk/mt)

weighting - mung:keshari 1:4						
Year	Index 85/86 = 100	Mung current	Keshari current	Mung 1997	Keshari 1997	Composite 1997
1990/91	148.05	19,800	8,440	25,762	10,981	13,938
1991/92	157.58	18,980		23,202	0	4,640
1992/93	157.80	18,040	8,820	22,022	10,767	13,018
1993/94	162.74	18,750	8,980	22,194	10,629	12,942
1994/95	176.73	19,820	7,510	21,603	8,186	10,869
1995/96	190.08	21,300	8,790	21,586	8,908	11,443
1996/97	192.63	22,260	10,170	22,260	10,170	12,588
5 year average		20,034	8,854	21,933	7,698	12,172
4 year average		20,533	8,863	21,911	9,622	11,961
yield (mt/ha)		0.63	0.76			0.73

These price estimates are based on:

1. Price index for food, beverage & tobacco, Bangladesh Bureau of Statistics & ADB
2. Farm level prices from Department of Agricultural Marketing
3. Weighting based on areas of respective crops in Greater Comilla district.
4. Average areas and yields calculated from Yearbook of Agricultural Statistics 1995, Bangladesh Bureau of Statistics (October 1997)



