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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MEGHNA ESTUARY STUDY

DRAFT DEVELOPMENT PLAN

VOLUME 2 : PART 1
FEASIBILITY STUDY
HAIMCHAR EROSION CONTROL PROJECT

September 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE

DEVELOPMENT DESIGN CONSULTANTS
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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	Struture 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

The proposed Haimchar Erosion Control Project is located south of Chandpur where the left bank of the Meghna river has been eroding freely for many years and near Haimchar has moved some 6 km eastwards during the last 40 years. The bank continues to erode freely along this length, except where some bank protection works installed by the local authorities have a retarding effect and threatens villages and infrastructure. The proposed project aims to protect the bank from erosion using the same type of low cost measures planned and designed as part of the MES. Halting the present erosion will protect agricultural land, settlements and associated infrastructure and the livelihoods of people living in the area.

Data for the study has been obtained from hydro-morphological, engineering and socio-economic investigations of the project area as well as from published secondary sources. The economic and environmental assessments are in conformity with the relevant FAP Guidelines.

Morphology

In the past 25 years the coastline has shifted over a distance of a few hundred metres just to the south of Chandpur to around 3,000 metres about 20 km south of Chandpur. From the early 1980s new chars started to develop in the river while the bank of the old land has continued to be eroded. Except for the retarding effect of some bank protection works installed by the local authorities near Haimchar village, the bank over these 20 km freely erodes year after year. This erosion threatens settlements along the river as well as the main embankment of the successful Chandpur Irrigation Project. Without protective measures, the present erosion will continue and may increase at some locations.

Present situation in the project area

The area is principally rural and had an estimated population in 1996 of about 98,000. The embankment and related facilities of the Chandpur Irrigation Project (CIP) constitute the most important physical infrastructure in the area, but there are also significant investments in roads, transmission lines and buildings as well as schools and clinics and facilities for the provision of other services. Production includes rice and other crops, livestock and tree crops, with cropping intensities of about 200 per cent inside the CIP and about 140 to 150 per cent outside the embankment.

Future without the project

Without any intervention, the river bank in the project area will continue to erode freely. The boundary of the project area has been defined by the expected line of the river bank in 2025 if no action is taken to halt the erosion and stabilise the bank. All infrastructure and productive capacity to the west of this line, including the land and its production as well as all existing physical and social infrastructure, dwellings and other privately owned property, will erode away in the intervening period. The protection of these assets and the production in the project area constitutes the benefit of the proposed project.

Proposed interventions

Previous studies carried out have shown that protection of the river bank using conventional bank protection methods is not economically viable. For example, protection for the Haimchar area using conventional methods was investigated under FAP 9B. Costs for the options considered ranged from US$ 18.3 to 29.3 million and the EIRR was found to be only 1.7 per cent. Alternative protection measures have been developed under the Meghna Estuary Study. These measures are relatively cheap and differ from conventional methods by the use of geotextile materials and construction methods using prefabricated elements. The following methods have been considered:

- permeable spurs or groins made of steel A-frames embedded in a low under water dam consisting of concrete blocks; the spurs are placed on geotextile bed protection and the tip of the spurs is protected by geotextile bed protection, ballasted with geobags filled with sand and concrete blocks;

- bottom screens consisting of a sheet of woven geotextile, floats to keep the geotextile screen upright and an anchor beam with anchor blocks to fix the position of the screen in the river bed

- cross dams consisting of steel A-frames embedded in a low under water dam of concrete blocks.

The Haimchar Erosion Control Project consists of a combination of permeable spurs and bottom screens. Initially, it was envisaged to include two cross dams in the design. However, it appears that the chars are still deeply inundated during the flood season and the risk of outflanking of the cross dam at the char end would be considerable. At a later stage installation of permeable cross dams may be reconsidered because closing of the secondary channel will surely accelerate accretion in this channel. The project will provide erosion control works at six locations (Sakhua north, Sakhua south, Hanarchar north, Hanarchar south, Haimchar north and Haimchar south) consisting of a total of 34 permeable spurs and 1,140 bottom screens.

Because the existing embankment of the CIP is very close to the present river bank at several locations, it is necessary as a matter of safety that the embankment be retired to the predicted without intervention 2010 bank line, even if the proposed interventions are successful, as expected. For those households that will be outside the retired embankment, a programme of flood proofing is proposed to reduce the risk of damage from flooding.

Future with the project

The proposed Haimchar Erosion Control Project consists only of the engineering interventions described above. There are no associated development activities in any other sector.

It is expected that the proposed interventions will limit and eventually halt erosion once the six "soft hard points" have fully developed.

After implementation of the erosion control works, regular monitoring of the performance of the works is required in order to ensure that they continue to provide the protection as envisaged. Additional works may be needed in case the river attacks heavily in between the "soft hard points". Periodical under water inspections will be required to check the condition of the bed protection of the spurs as well as the screens.

With successful implementation, the project will protect existing physical and social infrastructure in the area and existing agricultural and other production will be able to continue as at present.

Environmental assessment

An Initial Environmental Examination (IEE) was carried out for the project. It was concluded that an IEE was sufficient for the project in this case and a full EIA is not required. It is apparent that the benefits of successful implementation far outweigh the potential negative impacts, all but one of which can be mitigated for at an acceptable cost, should they occur.

The main potential negative impact is possible induced erosion to the large island char in the main river channel. However, even the people with land rights in this area agree that preventing erosion on the mainland is of a much higher priority.

Economic assessment

The proposed project will be implemented over a period of three years. Total base costs of the proposed interventions amount to Tk 387.2 million (US$ 8.2 million). Including physical and price contingencies the estimated total cost is Tk 464.2 million (US$ 9.4 million).

Project benefits are the value of assets and production that will be saved from erosion if the project is successfully implemented. All residents of the project area will be beneficiaries of the project. Benefits quantified for the economic analysis are:

- agricultural land and production
- aquaculture production
- trees and tree crops
- infrastructure
- buildings, including dwellings.

Due to lack of data a number of potential benefits have not been quantified for the analysis. These non-quantified benefits include irrigation infrastructure in the Chandpur Irrigation Project, capital costs of fish ponds, non-agricultural land and relocation costs, apart from building costs, for public services.

The EIRR for the project is 15.6 per cent and the NPV is Tk 79.9 million.

This result is relatively robust to changes in both costs and benefits. Switching values for the EIRR, at which it would be reduced to the opportunity cost of capital of 12 per cent, are +25.3 per cent for costs and - 20.2 per cent for benefits.

There is a risk that the proposed interventions will fail, but in view of the outcome of recent trials in the project area, this risk is considered to be small. It is also noted that the interventions will not reduce the risk of damage being caused in the project area outside the CIP embankment by major flood events.

1. INTRODUCTION

1.1 Background of the project

The proposed Haimchar Erosion Control Project is located in Chandpur Sadar and Haimchar thanas of Chandpur district (see Figure 1.1). South of Chandpur, the left bank of the Meghna river has been eroding freely for many years. Opposite Haimchar village, the left bank of the river has moved some 6 km eastwards during the last 40 years. In the past 25 years, the left bank has shifted eastwards over a distance of a few hundred metres just to the south of Chandpur to about 3 km in the area about 10 to 20 km south of Chandpur. The bank erodes freely along this length, except where some bank protection works installed by the local authorities have a retarding effect.

It is expected that this erosion will continue unless protective measures are taken. Continued erosion of the left bank in this area, apart from threatening villages and cultivated areas as it has in the past, also threatens the Chandpur Irrigation Project (CIP), parts of the embankment of which have already been retired because of the encroaching river.

The erosion of the bank leads to the loss of agricultural land, villages and physical and social infrastructure. Effective measures to control or halt the erosion will provide benefits by protecting existing infrastructure and agricultural production. Bank protection for part of this area has previously been investigated under FAP 9B (Meghna River Bank Protection Short Term Study). For this investigation the study area was only that part of the river bank from 3 km north to 7 km south of Haimchar thana centre. The proposed interventions were of conventional type and the project was found not to be viable, with an EIRR of only 1.7 per cent.

1.2 Objectives and scope of the study

This feasibility study for the proposed Haimchar Erosion Control Project is prepared as part of the Development Plan of the Meghna Estuary Study (MES). The project aims to protect the bank from erosion using the same type of low cost measures planned and designed by the consultants for use elsewhere in the MES area. A principle of the MES is to increase the security and safety of the population living in the estuary area. The proposed project at Haimchar would be consistent with these objectives.

The goal of the proposed project is to protect the agricultural land, settlements and associated infrastructure and thereby the livelihoods of people living in the areas within 3 or 4 km of the river bank in Chandpur Sadar and Haimchar thanas south of Chandpur town.

The scope of the study is to test the economic feasibility and assess the hydro-morphological, socio-economic and environmental impacts of the proposed project. This consists of the interventions to halt river bank erosion as well as the necessary retirement of the embankment of the CIP (since it is currently under threat from the river in Haimchar and Nilkamal unions) and flood proofing measures for households located outside the embankment. The proposed project contains no other measures.

1.3 The project area

The project area is located within Chandpur Sadar, Haimchar and Raipur thanas of Chandpur district and extends from about 3 km south of Chandpur to about 8 km south of the present Haimchar thana headquarters, a total north-south distance of some 21 km (see Figure 1.2).

The landward extent of the project area is determined by the erosion expected in the period to 2025 if no preventive measures are taken. In the north, the area is very narrow, extending only about 500 metres inland from the present bank. In the southern 10 to 12 km, however, the area extends some 3 km inland. This area includes the western boundary and embankment of the CIP, which at its nearest point is now less than 50 metres from the river bank.

Figure 1.1: Project Location Map

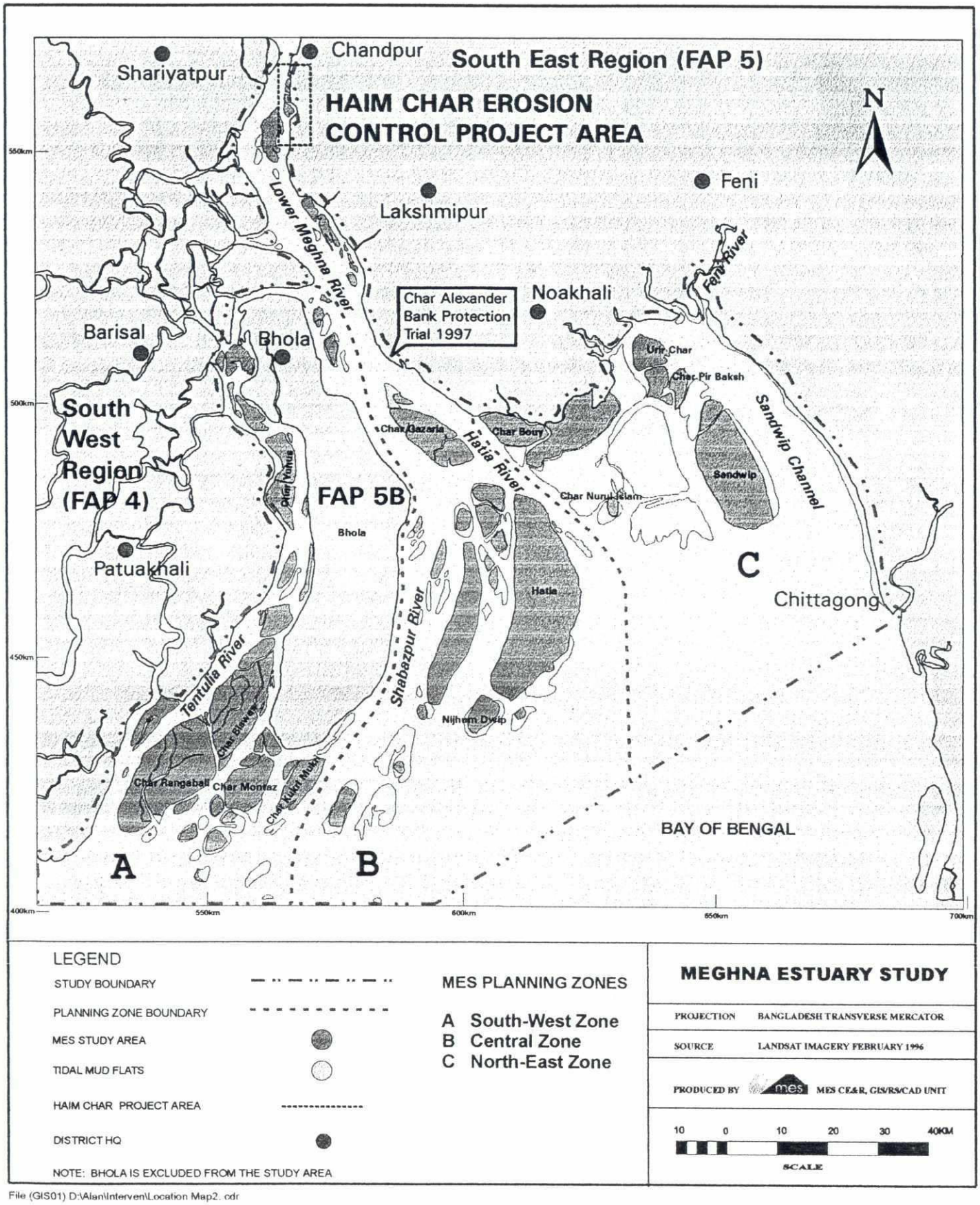

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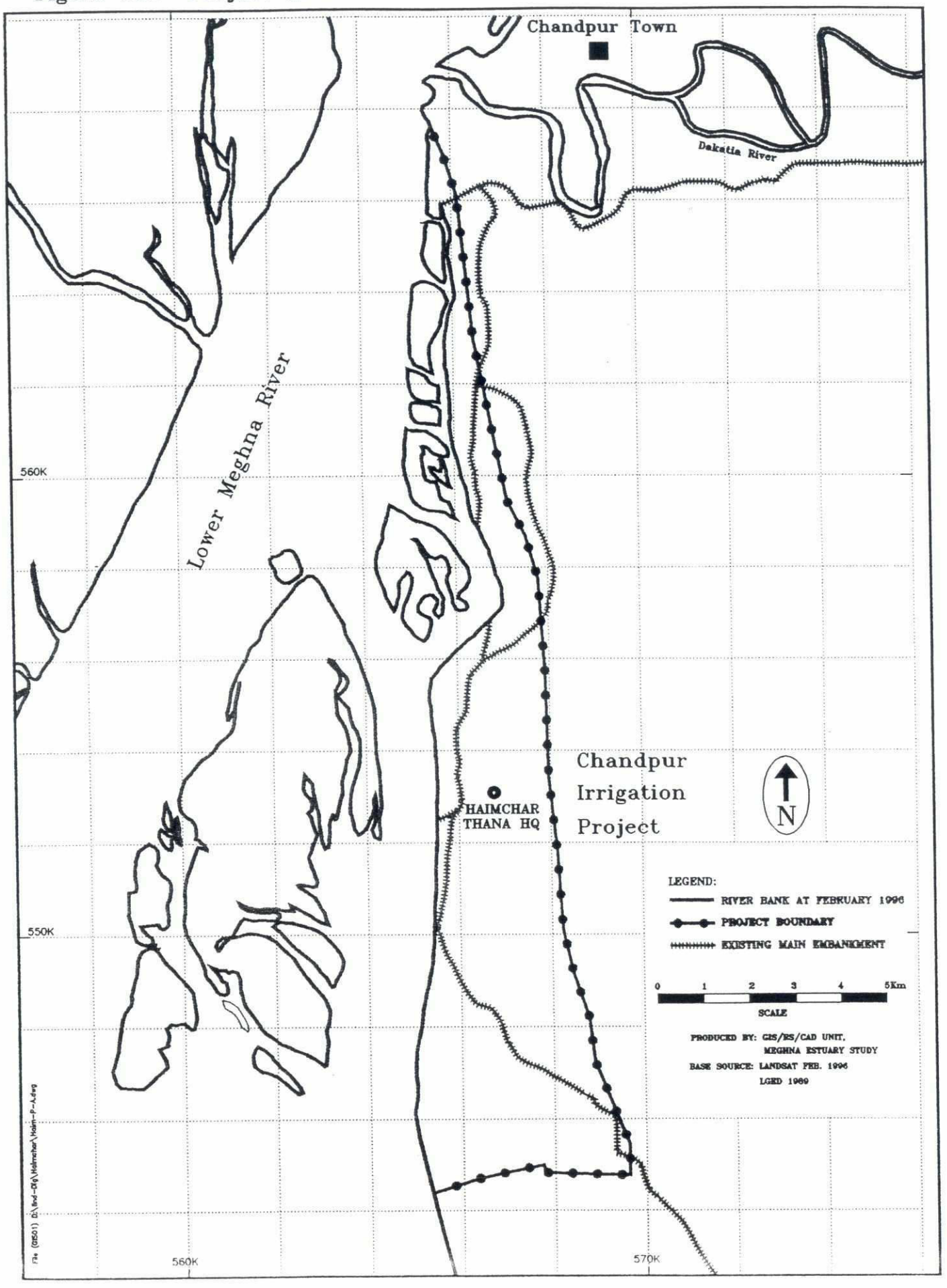
Figure 1.2: Project Area



1.4 Approach and methodology

Data for the study has been obtained from hydro-morphological, engineering and socio-economic investigations of the project area as well as from published secondary sources. The economic evaluation and the environmental assessment of the proposed project are in conformity with the relevant FAP Guidelines.

Previous studies carried out have shown that protection of the river bank using conventional bank protection methods is not economically viable. Alternative protection measures have been developed under the Meghna Estuary Study. These measures are relatively cheap and differ from conventional methods by the use of geotextile materials and construction methods using prefabricated elements.

1.5 Key assumptions

The feasibility study is based on the assumption that without intervention the defined project area will be completely eroded by 2025. It is also assumed for the economic analysis that this erosion occurs at an "average", steady rate, although in practice actual erosion would vary in extent and location from year to year.

1.6 Structure of the report

The subsequent chapters of this report contain descriptions of the morphological situation (chapter 2) and the interventions proposed to halt the erosion in the project area (chapter 5). A description of the project area, its population and economic activities is included (chapter 3) as well as a brief assessment of the future without with project (chapter 4) and the expected outcome if the project is implemented (chapter 6). A summary of the environmental assessment is included in chapter 7 and the economic evaluation of the project is in chapter 8. A brief description of project implementation is given in chapter 9.

Appendices are provided with detailed information on different aspects of the feasibility study, including surveys and studies, physical and social Infrastructure, agriculture, livestock and forestry, engineering designs, project costs and the economic analysis of the project. An initial environmental examination is presented in a separate volume as Part 2 of this report.

2. MORPHOLOGY

2.1 Introduction

In the past 25 years the coastline has shifted over a distance of a few hundred metres just the South of Chandpur to about 3,000 metres about 20 km south of Chandpur. From the early 1980's new chars started to develop in front of the coast while the river bank of the old land continued to be eroded. Except for the retarding effect of some bank protection works installed by the local authorities near Haimchar village, the coast over these 20 km freely erodes year after year.

Opposite of the project area, the right bank also has eroded in the order of 2,500 metres in the past 25 years. The main course of the lower Meghna shifted in a westerly direction, vast chars were left in the old more easterly course of the Meghna.

The Meghna also changed its course due to the natural morphological processes upstream of Chandpur. However the bank protection works at Chandpur and further upstream are hard points in the river and in particular the hard point at Chandpur will influence the flow pattern downstream of the city for years to come. Around 1985 a vast char emerged opposite and a little upstream of Chandpur, apparently this char induced the westerly shift of the main Meghna Channel.

The land near to and away from the left bank of the Lower Meghna River downstream of Chandpur near Haimchar coastline remains above tidal high water levels, probably except during storm surges. Close to the Haimchar coastline, there is the main embankment of the successful Chandpur Irrigation Project.

2.2 Development of coastlines and chars, 1973 -1996

The development of coast lines and chars has been based on old maps collected from the Survey of Bangladesh and the time series analysis of erosion and accretion in the Meghna Estuary by MES/EGIS, as reported in Technical Note MES-009, dated June 1997. For each of the five periods under consideration a brief description is given of the changes as well as the probable consequences of these changes in a later period. First the changes upstream of Chandpur are discussed, then the changes along the western bank of the lower Meghna are elaborated and finally the changes in the project area are discussed.

Period 1955 - 1973

During this period the Meghna River downstream of Chandpur changed its course completely. Around the year 1955 the river course in this section ran in a south south west direction. In 1973 the river course had turned in a southerly direction.

These changes have been caused by the morphological alterations further upstream, moving chars and sand banks in the river. In the same period the channel of the lower Meghna south of Noakhali silted up, in particular after construction of the two cross dams.

Opposite of Haimchar Bazar the left bank of the river shifted over a distance of more than 6 km in an easterly direction.

Period 1973 -1979

The left bank of the river downstream of Chandpur was eroded. On the right bank erosion was taking place upstream of Chandpur while downstream some accretion took place. South of the project area the river bifurcated into two channels. In this period the east channel developed considerably while the west channel reduced its capacity.

Period 1979 -1984

The left bank eroded more in this period albeit less fast than in the previous period.

The right bank opposite of Chandpur was severely eroded, further to the South the right bank was more or less stable. At the bifurcation, South of the project area, the East channel increased in capacity while the West Channel became smaller again.

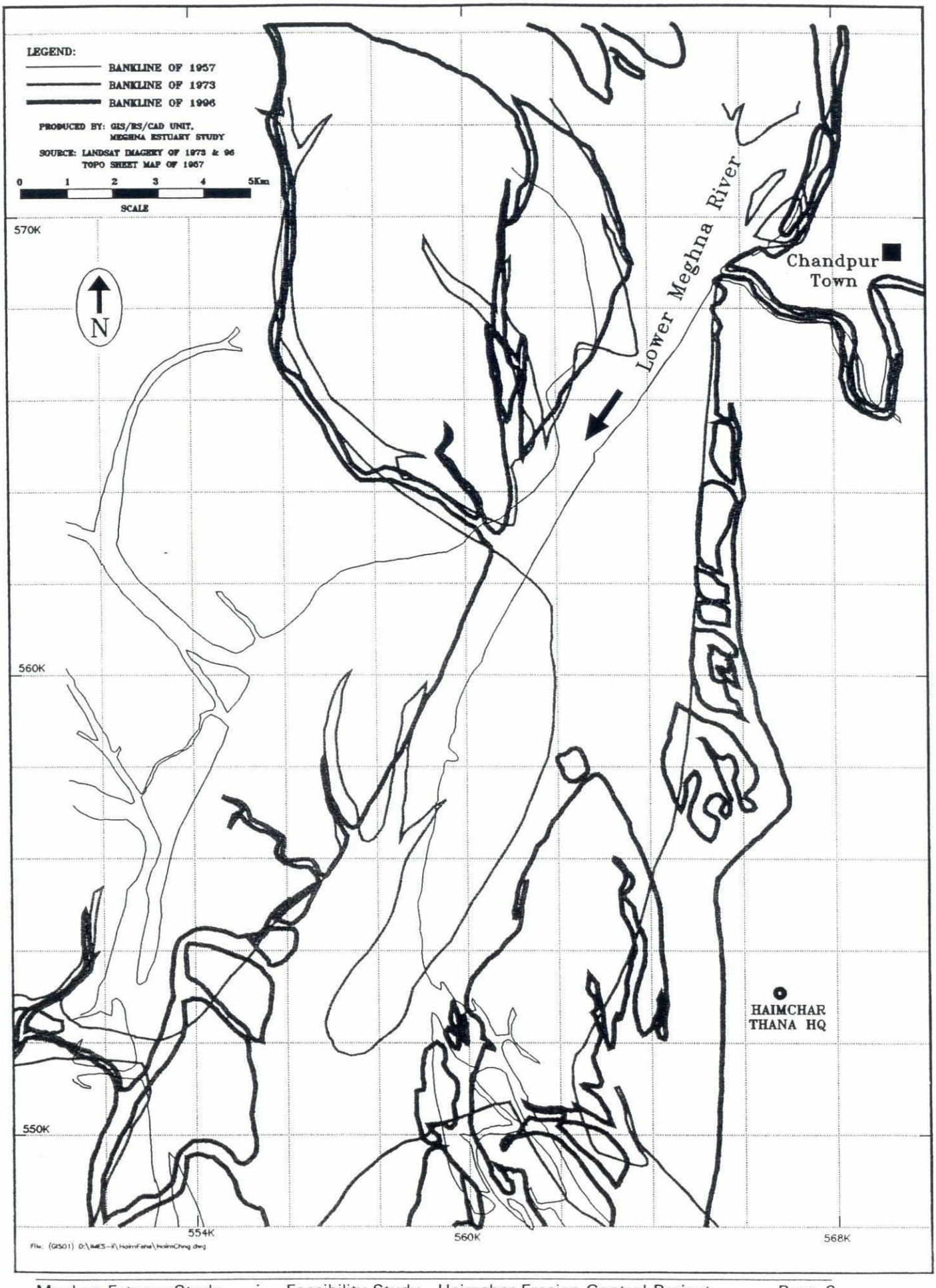
Period 1984 -1990

Severe erosion occurred at Haimchar Bazar. However, new chars emerged along the left bank between Chandpur and Haimchar Bazar.

Upstream of Chandpur new chars emerged on the right bank, most probably causing severe erosion further downstream.

The east channel downstream of the original bifurcation point was widened considerably on the right side while the west channel completely disappeared.

Figure 2.1: River Bank line Change Map 1957–1996



Period 1990-1993

Apparently the left bank upstream of Chandpur was eroded in this period while downstream erosion also continued. New chars emerged along the project area. Severe erosion took place along the right bank.

Period 1993 -1996

Erosion along the left bank was limited compared to previous periods as was the erosion on the right bank. The chars in the river were extended, a bifurcation point seems to have been created about 10 km south of Chandpur.

A detailed comparison of coastlines of 1957, 1973, and 1996 shows that the coastlines shifted considerably (see Figure 2.1). There is a major change in the location of the coastline between 1957 and 1973. At the location of 560000 m northing (BTM), between 1957 and 1973 and between 1973 and 1996, the left bank line of the Lower Meghna River downstream of Chandpur migrated towards the country side by about 2,300 metres and 1,400 metres, respectively. The erosion rate is about 144 metres per year and 61 metres per year between 1957-73 and 1973-96, respectively. The erosion rate has been less in the last few decades than it was in the sixties.

To identify the trends in the movement of the left bankline of the Lower Meghna River from just downstream of Chandpur to downstream of Haimchar, the project area was divided into two reaches and eastings of the bank for each image were averaged for each of the two reaches. The average eastings of the banklines plotted against the image year are shown in Figure 2.1.

The average easting of the left bank of the Lower Meghna moved by about 2.5 km towards the east between 1957 and 1973 and by about 1 km between 1973 and 1996 i.e. the bank was eroded by the flow. The coastline eroded near Haimchar due to the formation of chars in the channel and near the banks and also due to the formation of secondary channels close to the banks.

2.3 Bathymetric surveys

bathymetric surveys have been executed within the project area on 21 June 1997 (Cruise 10) and on 28 July 1997 (Cruise 11). The survey on 21 June 1997 was done GPS without reference station and therefore the results are less accurate. The bed levels have not been related to PWD. The results of the surveys are shown in Figure 2.2 and more details are given in Appendix I.

Compared to the coastline found on the 1996 satellite imagery, the situation near the village of Bakharpur has changed already. Erosion has continued and the channels in between the newly emerged chars have changed position. The satellite imagery to be acquired in early 1998 will provide the actual situation prevailing at the time of finalising the feasibility study for the Haimchar Erosion Control Project.

2.4 Future changes

From study of the river bank lines and the position of (newly emerging chars) in the project area during the past 50 years, it is obvious that changes occur continuously. During this period the left bank of the Meghna River at a distance of some 10 km south of Chandpur has shifted more than 6 km in an eastward direction.

As long as the protective works at Chandpur City remain intact, this bank protection will form a "hard point" along the river. Such a hard point will have a strong effect on future morphological developments upstream and downstream. The left bank of the Meghna river upstream of Chandpur has been relatively stable in the past.

Figure 2.2 : Depth contours map of the project area, December 1997

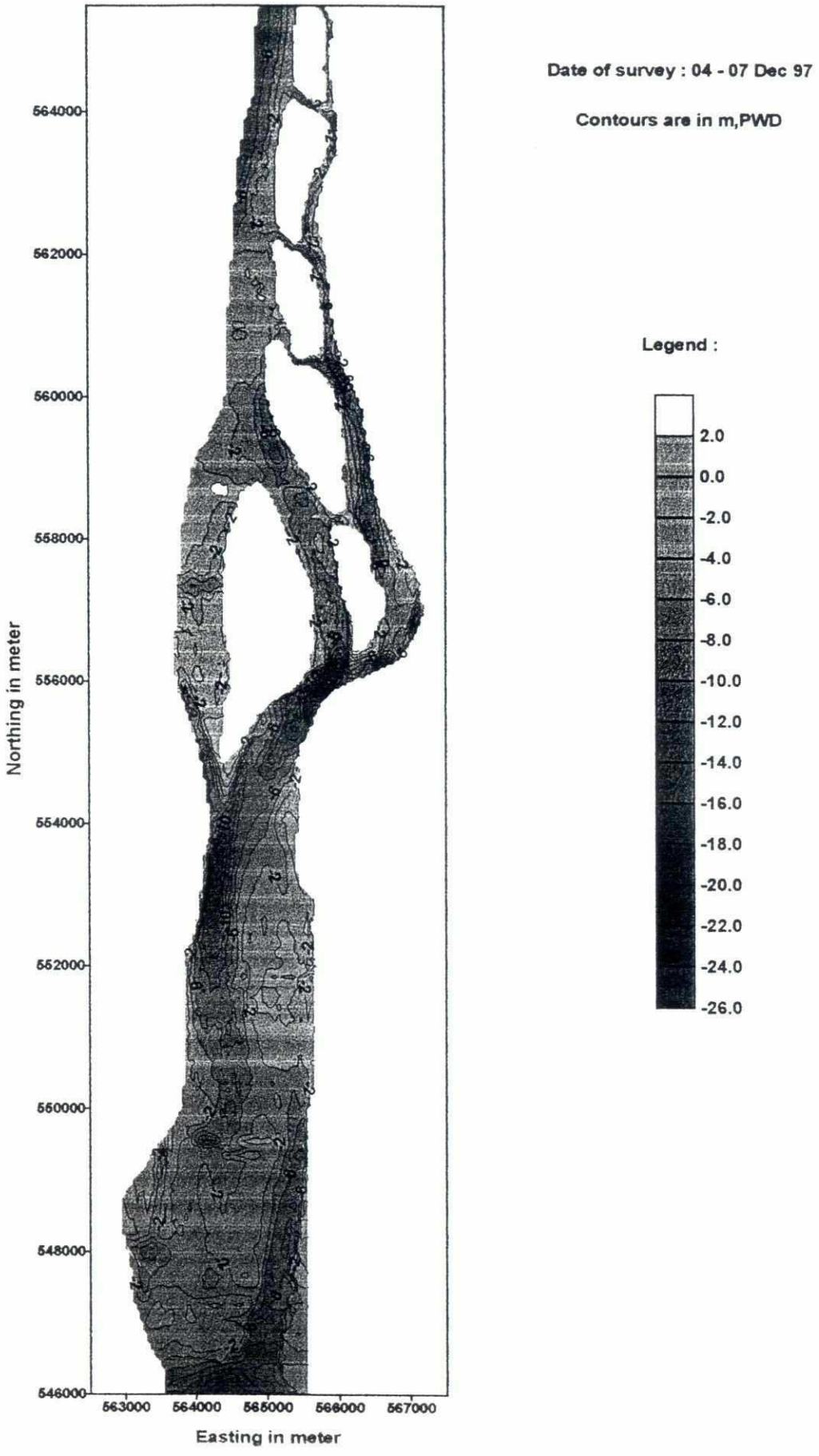


Figure 2.3: Predicted banklines in 2010 and 2025, without interventions

At Chandpur the river has eroded very deep scour holes, water depths of 50 -70 m have been measured during MES surveys. Strengthening and extending of the protective works will be required to safeguard Chandpur City. Downstream of Chandpur the left bank of the Meghna River has shifted in an eastward direction over the past 50 years or so. This process still continues, but about 12 years ago chars started to emerge in front of the bank. This phenomenon can be observed at several locations in the Meghna Estuary.

Based on the formation of these chars it is concluded that the main river channel has stabilised at the western side of these chars. Erosion in the secondary river channels may continue as long as preventive measures are not taken.

It is difficult to predict where bank erosion in this parallel secondary channel will be severe and where the bank will remain stable. In the near future the heavy erosion of the mainland, 10 to 12 km south of Chandpur, near Bakharpur, will continue.

It appears that to the southwest of this point, the main river bifurcates once again. In the past 3 years the east channel seems to have increased its capacity while the west channel appears to have stabilised.

As a consequence the present bank erosion at Haimchar Bazar will continue unless protective measures are taken. The rate of erosion at this location will accelerate since the tendency of increasing capacity of the east channel is expected to remain in the near future. The predicted bank lines in 2010 and 2025 are indicated in Figure 2.3.

Since the west channel is still shifting in a westerly direction, the thalweg between the bifurcation and the confluence points becomes longer and longer. As a result the capacity of the west channel will gradually reduce while the capacity of the east channel will increase.

3. PRESENT SITUATION IN THE PROJECT AREA

3.1 Physical features

The project area is situated south of Chandpur town in Chandpur and Haimchar thanas of Chandpur district and a small part of Raipur thana. It extends along the left bank of the Meghna River from about 2 km south of Chandpur town to about 7 km south of Haimchar village. In the north, the area is about 500 metres wide but in the southern part it extends inland between 2.5 and 4.5 km from the existing river bank. (see Figure 1.2)

The area is within the Meghna flood plain and the relief is generally low, with adjoining ridges and basins varying less than 1.5 metres in elevation. The area has a gentle slope towards the south. Very low lying, flood prone land is, nevertheless, relatively uncommon. The distribution of land flood classes is indicated in Table 3.1.

Table 3.1: Land flood classes in Chandpur and Haimchar thanas

unit: ha

Thana	High Land (F0)	Medium High Land (F1)	Medium Low Land (F2)	Low Land	Very Low Land
Chandpur	453	4293	7108	149	0
Haimchar	917	2493	4419	1	0

Average rainfall in the area is some 2820 mm per year, with the highest monthly rainfall in July. The annual average maximum temperature is 36°C and the annual average minimum is 8°C.

3.2 Socio-economic setting

Demography

The basic BBS demographic data for the area, down to mauza level for both 1981 and 1991, are given in Table 3.2 and the location of the mauzas are shown in Figure 3.1. The trends over the ten year period clearly show the effects of river bank erosion, with people being displaced and forced to crowd into the remaining part of their mauza or on a nearby embankment. The overall annual mean change in human population between 1981 and 1991 was +1.57 per cent, well below the national average, even for rural areas of the country. However the variation in rate between mauzas is dramatic, part of the change being due to natural increase (bearing in mind increased life expectancy and reduced infant mortality over the period), and the rest because of migration. All the mauzas suffering major erosion show reductions in population, the most extreme being a fall of 18 per cent, while the greatest population increase is 5 per cent, which occurs in the adjacent stable land where erosion displacees crowd on the embankment.

The predicted 1996 population numbers have been calculated by extrapolating the 1981 to 1991 rate. The land areas for each mauza for 1996 have been measured from the satellite imagery of that time and the population densities calculated. The calculated density of human population for 1996 is presented in mapped form as Figure 3.2. The conclusion is that the mean density of 2,314 people per km^2 is significantly higher than the national rural average. However the areas of severe erosion have exceedingly high densities (theoretically over 10,000 per km^2, but this assumes that people leave the mauza at the past linear rate), whereas in the stable land away from the river bank densities are between 936 and 1,234 per km^2. In the whole of Haimchar thana the 1991 density was calculated by BBS to be 649 per km^2.

Settlement pattern

An indication of general settlement pattern can be seen from the homestead vegetation visible in red on the 1996 satellite imagery of the area. In addition the LGED map (see Figure 3.3) gives the locations of the main service centres. There is considerable settlement of erosion displacees on the Chandpur Irrigation Project embankment, in places two or three households deep on the landward side and also on the river side, despite the risk of annual inundation. There are also a significant number of households which, due to erosion of the embankment, now find themselves prone to damaging annual floods of their homesteads, sometimes for periods of up to three months a year.

Household size

From the BBS data the overall mean 1991 household size was 5.43, but with significant variations across the project area. The largest households are found in the mauzas not subject to erosion, with the notable exception of the very South East corner. It may be the case that households of erosion displacees fragment as members leave to seek alternative economic activities outside the mauza. However the overall trend in mean household size between 1981 and 1991 is a rise of 6 per cent, contrary to both the national and regional trend which show a significant fall. The greatest increases in household size occur in stable mainland (perhaps as a result of erosion displaced relatives moving into the area) and also in the three mauzas which have experienced the heaviest erosion but still retain the remnants of relocated service centre provision, namely, Sakhua, Haimchar and Gazipur Union headquarters

Agricultural land tenure

Key socio-economic BBS data are given in Table 3.3 from which it can be seen that 46 per cent of households in the study area owned agricultural land in 1991. However there is considerable variation, with the highest levels of 70 per cent being found in stable mainland away from the river bank and the lowest (less than 35 per cent) in the mauzas which suffer erosion. The overall trend in agricultural land holding is a fall of 12 per cent in the 1981-1991 period. Whilst the direction of the trend is consistent with both the national and regional picture, the size of the fall is very high. As should be expected the greatest falls are in the erosion prone areas but there are also significant falls well inland.

Table 3.2: BBS demographic data 1981 and 1991, by mauza

No	District	Thana	Union	Mauza	BBS Code	LGED Code	Total Mauza Human Population 1981	Total Mauza Human Population 1991	Annual Population Change 81-91	Total Mauza Estimated Human Population 1996	Mauza Land Area 1996 HA	Population Density per KM2	Area of Mauza in 2025 Erosion	Estimated 1996 Population in 2025 Area	Total Mauza Households 1981	Mean HH Size 1981	Total Mauza Households 1991	Mean HH Size 1991	% Change in Mean HH Size 81-91
1	Chandpur	Chandpur S	Sakhua	Lakshipur	132290624	116	7,312	10,250	3.44	12,136	462	2,627	81	2,128	1,323	5.53	1,819	5.63	2
2	Chandpur	Chandpur S	Sakhua	Baharia	132290047	117	3,744	2,898	-2.53	2,550	18	14,165	15	2,125	811	4.62	530	5.47	18
3	Chandpur	Chandpur S	Ibrahimpur	Sakhua	132263920	118	2,607	1,878	-3.23	1,594	53	3,007	26	782	467	5.58	360	5.22	-7
4	Chandpur	Chandpur S	Hanar Char	Gobindia	132258423	166	6,267	9,229	3.95	11,200	225	4,978	203	10,105	1,042	6.01	1,657	5.57	-7
5	Chandpur	Chandpur S	Chandra	Bakharpur	132254063	168	7,356	10,013	3.13	11,682	466	2,507	171	4,287	1,521	4.84	1,862	5.38	11
6	Chandpur	Chandpur S	Chandra	Dakshin Balia	132254322	167	4,965	7,444	4.13	9,115	411	2,218	14	310	988	5.03	1,387	5.37	7
7	Chandpur	Haim Char	Gazipur	Baziepti	134759002	161	6,068	5,442	-1.08	5,154	37	13,929	37	5,154	1,500	4.05	977	5.57	38
8	Chandpur	Haim Char	U. Algi Durgapur	Chhota Lakshipur	134711040	157	2,083	2,902	3.37	3,425	133	2,575	48	1,236	366	5.69	537	5.40	-5
9	Chandpur	Haim Char	U. Algi Durgapur	Lamchari	134711072	160	1,598	2,206	3.28	2,592	61	4,249	61	2,592	280	5.71	400	5.52	-3
10	Chandpur	Haim Char	U. Algi Durgapur	Mazampur	134711075	158	1,335	2,089	4.58	2,613	110	2,376	105	2,494	268	4.98	354	5.90	18
11	Chandpur	Haim Char	U. Algi Durgapur	Nayani Lakshipur	134711087	170	3,251	4,180	2.55	4,740	221	2,145	148	3,174	550	5.91	751	5.57	-6
12	Chandpur	Haim Char	D. Algi Durgapur	Char Bhanga	134723010	151	4,260	5,611	2.79	6,440	522	1,234	435	5,366	774	5.50	942	5.96	8
13	Chandpur	Haim Char	D. Algi Durgapur	Char Poramukhi	134723035	152	1,631	2,232	3.19	2,611	279	936	15	140	340	4.80	362	6.17	29
14	Chandpur	Haim Char	D. Algi Durgapur	Pach. Char Krishnapur	134723090	159	6,454	9,611	4.06	11,728	456	2,572	456	11,728	928	6.95	1,635	5.88	-15
15	Chandpur	Haim Char	D. Algi Durgapur	Pur. Char Krishnapur	134723092	154	1,751	2,320	2.85	2,670	252	1,060	48	509	298	5.88	398	5.83	-1
16	Chandpur	Haim Char	Char Bhairabi	Char Bhairabi	134735007	349	17,599	28,737	5.03	36,721	1,679	2,187	1,679	36,721	3,409	5.16	5,461	5.26	2
17	Chandpur	Haim Char	Haim Char	Haim Char	134747017	348	11,199	1,520	-18.10	560	4	14,000	4	560	2,196	5.10	295	5.15	1
18	Chandpur	Haim Char	Haim Char	Charpakshidia	134747032	371	NA	NA	0.00	0	22	0	22	0	0	0.00	0	0.00	0
19	Chandpur	Haim Char	Haim Char	Char Koralia	134747030	347	NA	NA	0.00	0	65	0	65	0	0	0.00	0	0.00	0
20	Chandpur	Haim Char	Nilkamal	Char Saladi	134771037	150	7,652	7,593	-0.08	7,564	150	5,042	150	7,564	1,655	4.62	1,379	5.51	19
21	Chandpur	Haim Char	Nilkamal	Gazipur Manipur	134771055	143	2,415	573	-13.40	279	38	734	38	279	514	4.70	113	5.07	8
22	Lakshmipur	Raipur	Char Ababil	Char Ababil	515823162	1	12,737	14,524	1.32	15,509	857	1,810	430	7,782	2,653	4.80	2,969	4.89	2
TOTAL							112,284	131,252	1.57	150,883	6,521	2,314	4,251	98,360	21,883	5.13	24,188	5.43	6

Source: BBS 1985 and 1992

NOTES:

1. Order and spelling are according to 1991 BBS Census
2. NA indicates that no population figures are given in the BBS census data, this is likely to be zero as the Mauzas have eroded away
3. 1996 land area is the actual land area in the mauza as shown on the satellite image of February 1996
4. The population densities for 1996 assume that erosion displacees remain in their mauza, in reality a minority leave the area completely and those who remain move east to the nearest embankment

Estimated HH in 2025 area = 18114
Gross Measurement of 2025 Area is 2.1% greater than its parts.
2025 area from master map is 4689 ha, 10.3 % greater than the parts

Table 3.3: BBS key data 1981 and 1991 by mauza

No	District	Thana	Union	Mauza	BBS Code	LGED 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 Agr 1991	Change in % Pop in Agr 1981-1991	Literacy Rate (7 yrs) 1981	Literacy Rate (7 yrs) 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
1	Chandpur	Chandpur S	Sakhua	Lakshipur	1.32E+08	116	42	35	-7	13	15	2	18	30	12	25	61	36	1
2	Chandpur	Chandpur S	Sakhua	Baharia	1.32E+08	117	30	21	-9	16	6	-10	14	16	2	9	63	54	1
3	Chandpur	Chandpur S	Ibrahimpur	Sakhua	1.32E+08	118	22	9	-13	8	8	0	12	20	8	26	21	-5	3
4	Chandpur	Chandpur S	Hanar Char	Gobindia	1.32E+08	166	52	30	-22	16	16	0	23	23	0	40	42	2	1
5	Chandpur	Chandpur S	Chandra	Bakharpur	1.32E+08	168	74	53	-21	18	16	-2	23	36	13	24	56	32	4
6	Chandpur	Chandpur S	Cnandra	Dakshin Balia	1.32E+08	167	75	61	-14	19	18	-1	23	31	8	20	65	45	3
7	Chandpur	Haim Char	Gazipur	Baziepti	1.35E+08	161	63	32	-31	20	15	-5	20	18	-2	22	51	29	4
8	Chandpur	Haim Char	U. Algi Durgapur	Chhota Lakshipur	1.35E+08	157	77	70	-7	21	25	4	13	14	1	13	20	7	0
9	Chandpur	Haim Char	U. Algi Durgapur	Lamchari	1.35E+08	160	54	36	-18	19	11	-8	11	32	21	19	57	38	2
10	Chandpur	Haim Char	U. Algi Durgapur	Mazampur	1.35E+08	158	68	60	-8	22	20	-2	16	27	11	15	13	-2	9
11	Chandpur	Haim Char	U. Algi Durgapur	Nayani Lakshipur	1.35E+08	170	77	60	-17	17	15	-2	19	31	12	15	39	24	3
12	Chandpur	Haim Char	D. Algi Durgapur	Char Bhanga	1.35E+08	151	88	70	-18	7	22	15	16	26	10	40	62	22	2
13	Chandpur	Haim Char	D. Algi Durgapur	Char Poramukhi	1.35E+08	152	85	71	-14	21	20	-1	20	34	14	30	48	18	2
14	Chandpur	Haim Char	D. Algi Durgapur	Pach. Char Krishnapur	1.35E+08	159	68	47	-21	23	18	-5	18	29	11	16	66	50	3
15	Chandpur	Haim Char	D. Algi Durgapur	Pur. Char Krishnapur	1.35E+08	154	78	56	-22	23	20	-3	22	30	8	15	44	29	8
16	Chandpur	Haim Char	Char Bhairabi	Char Bhairabi	1.35E+08	349	62	49	-13	18	15	-3	15	24	9	74	82	8	3
17	Chandpur	Haim Char	Haim Char	Haim Char	1.35E+08	348	40	15	-25	7	4	-3	18	39	21	54	92	38	13
18	Chandpur	Haim Char	Haim Char	Charpakshidia	1.35E+08	371	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19	Chandpur	Haim Char	Haim Char	Char Koralia	1.35E+08	347	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20	Chandpur	Haim Char	Nilkamal	Char Saladi	1.35E+08	150	54	28	-26	17	12	-5	19	35	16	41	56	15	12
21	Chandpur	Haim Char	Nilkamal	Gazipur Manipur	1.35E+08	143	54	58	4	19	16	-3	17	24	7	10	55	45	0
22	Lakshmipur	Raipur	Char Ababil	Char Ababil	5.16E+08	1	52	47	-5	20	13	-7	11	22	11	78	54	-24	3
TOTAL							58	46	-12	17	16	-1	17	27	10	42	60	18	4

Source: BBS 1985 and 1992

NOTES:
1. Order and spelling are according to 1991 BBS Census
2. NA indicates that no population figures are given in the BBS census data, this is likely to be zero as the Mauzas have eroded away
3. The data are for the whole Mauza, not just the piece which falls within the 2025 erosion line

Figure 3.1: Administrative Boundaries

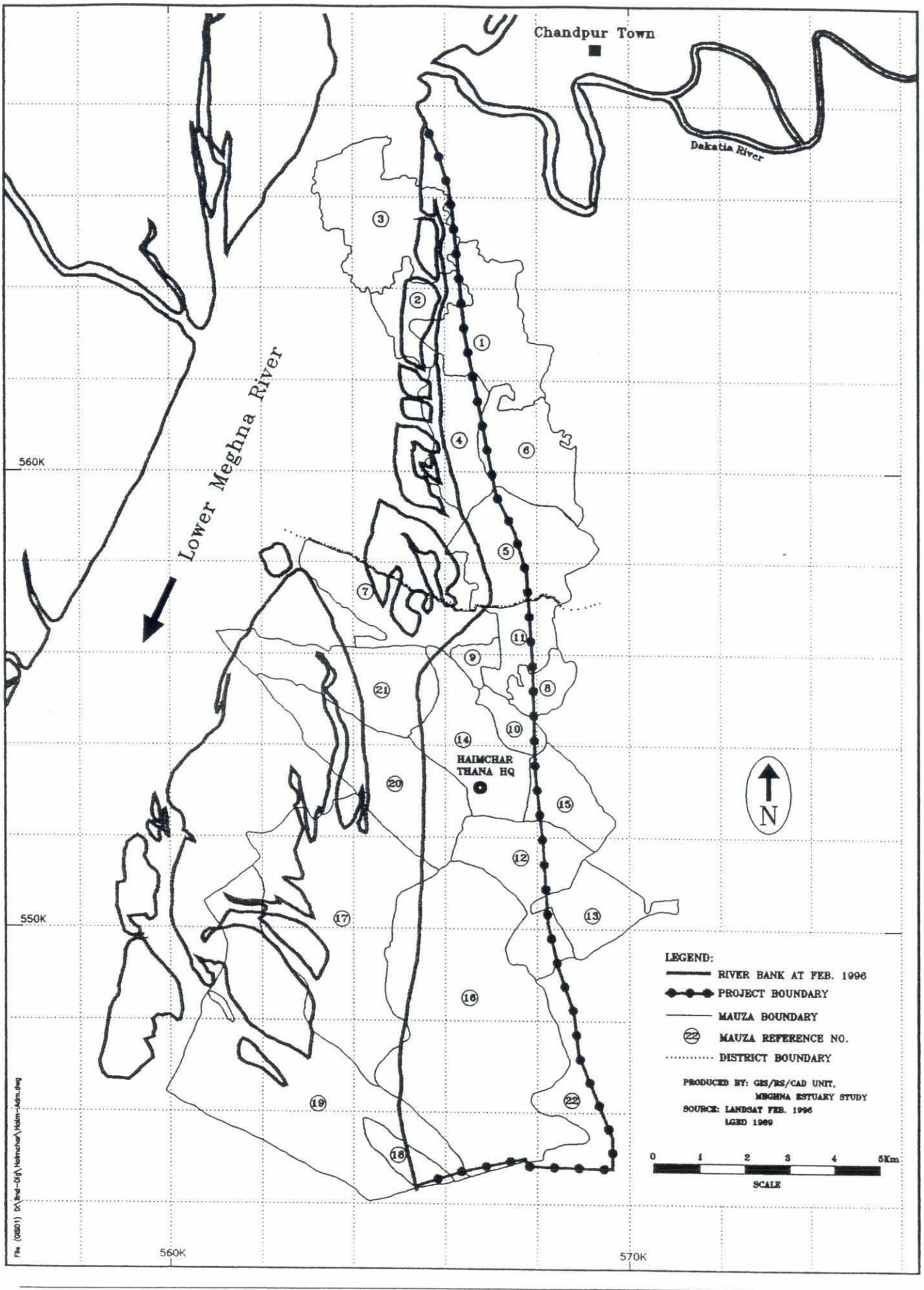


Figure 3.2: Calculated Human Population Density 1996

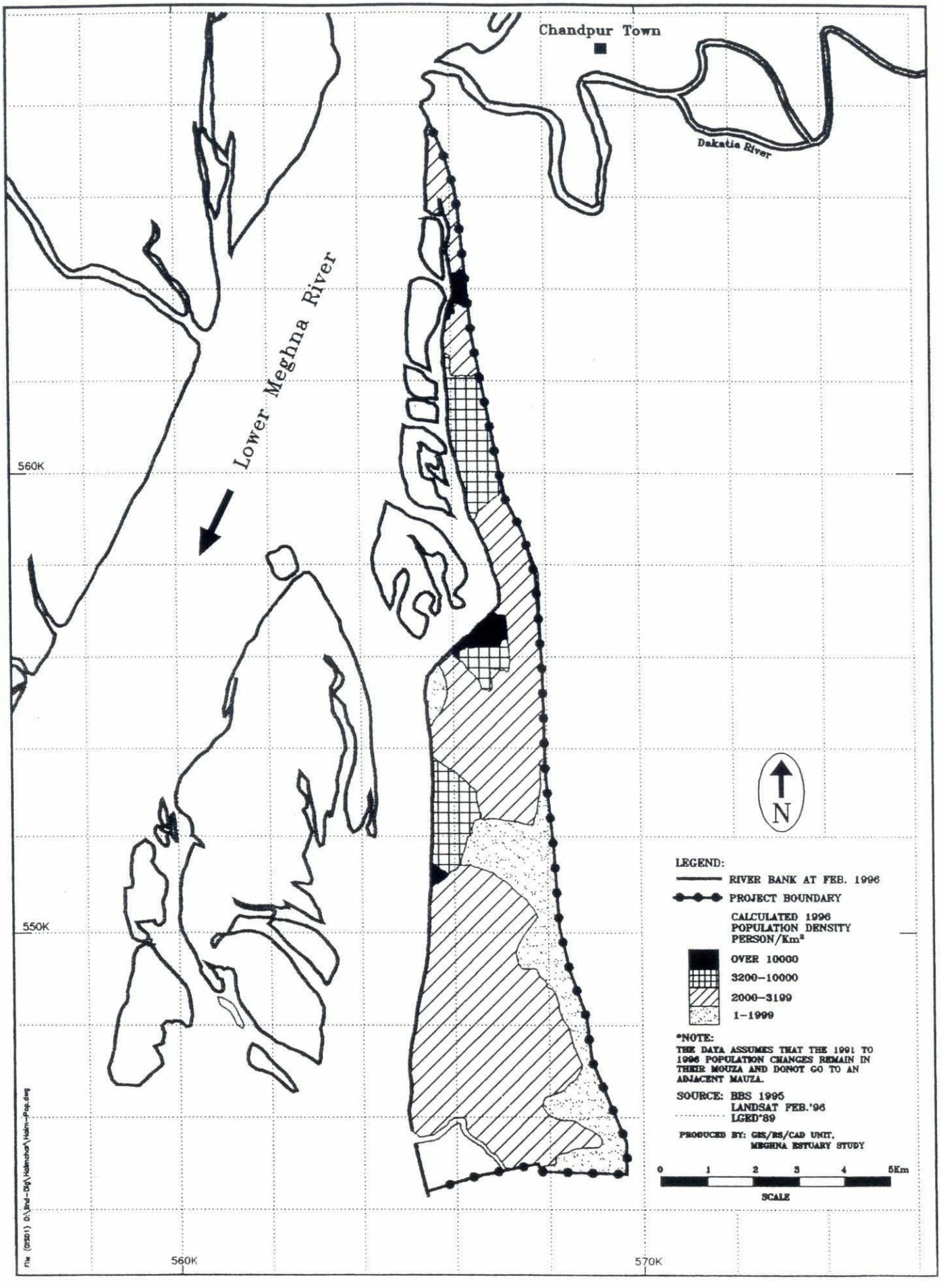
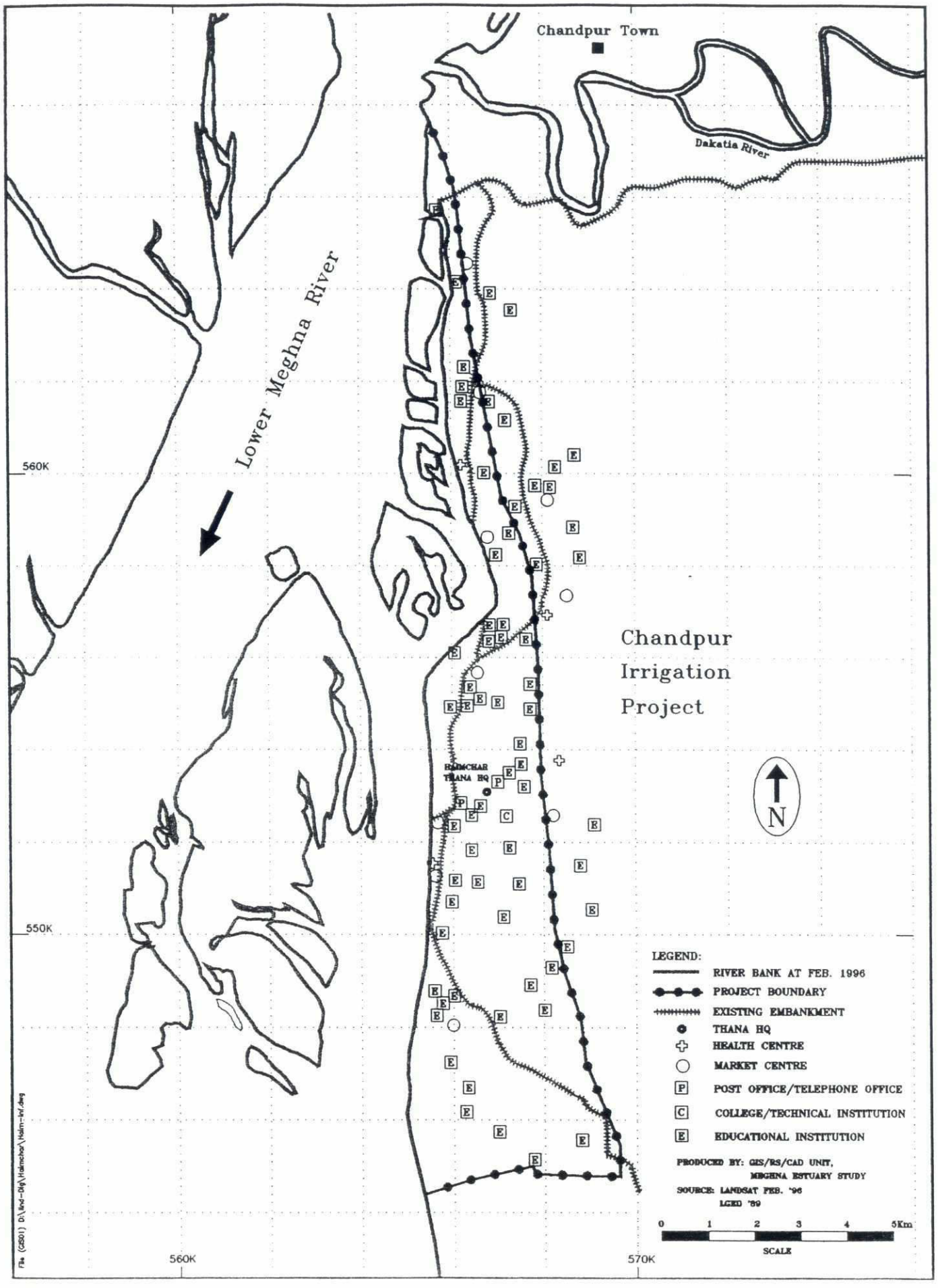


Figure 3.3: LGED Infrastructure Map



Agricultural activity

The proportion of the population having agriculture as their main economic activity in 1991 is greatest inland and lowest in the erosion prone parts of the project area. During the period 1981 to 1991 there was an overall fall in the proportion of households having agriculture as their main economic activity with significantly higher rates in the erosion prone areas.

Literacy

The mean literacy rate for the area was 27 per cent in 1991 with significant variations, the highest rates being in the more densely populated mauzas where distance to education provision is shorter. There was an overall increase in literacy rates between 1981 and 1991 of 10 per cent but this is very uneven across the area, some of the highest increases in literacy are in the erosion prone areas where access to provision is presumably easier in areas of concentrated population.

Water supply and sanitation

The overall level of provision of safe drinking water in 1991 was 60 per cent of all households, the lowest rates being further inland where the population is more dispersed. Between 1981 and 1991 the provision of safe drinking water increased by 18 per cent, the greatest rises being in those mauzas with concentrated urbanised centres and lowest in inland areas. The main source of "safe" drinking is deep ground water. However, recent data from DPHE indicates that the area south of Chandpur has some of the highest incidence of natural arsenic content in the country.

Sanitation provision in the area is very low and is a major cause of ill health.

Human health

The monthly recorded disease data from Chandpur Thana Health Centre for the period between May 1994 and December 1996 shows that diarrhoeal disease is the most significant health problem for which people in the area seek help. The highest incidences occur in June to August, the height of the flood season indicating that the reason is likely to be poor access to safe drinking water during flood times.

3.3 Physical infrastructure

Physical infrastructure in the project area includes roads, bridges, culverts, electricity transmission lines, telephone lines and the embankment of the Chandpur Irrigation Project (CIP) and associated water management infrastructure. The single most important item is the embankment of the CIP which, in parts of Haimchar thana, is within 50 metres of the present river bank. Damage to this and other infrastructure is a major potential loss from the continued erosion of the river bank.

Physical infrastructure identified in the project area is specified in the tables in Appendix II. A summary of the principle items is given in Table 3.4. The location of key items of infrastructure is indicated in Figure 3.3.

Table 3.4: Physical infrastructure

Type	Unit	Quantity
Embankment	km	21.0
Bridges and Culverts	metres	95.5
Roads - FR-A	km	16.2
- FR-B	km	6.0
- village roads	km	56.5
Telephone lines	km	37
Electricity transmission lines	km	40.4

Source: Thana and union offices and LGED

3.4 Social infrastructure

Dwellings are the most important component of social infrastructure in the project area and, apart from land, are the most significant private assets. For this study a simple three way classification by type of roofing material has been used to provide the basis for the valuation of the housing stock. The number of dwellings has been estimated from than and union records, pro-rated for the proportion of each union in the project area. Table 3.5 summarises the result. Details of the number in each union are given in Appendix II, Table II.9.

Table 3.5: Dwellings in the project area

Roof Type	Estimated Number
Thatch	7,244
CI Sheet	15,868
Cement	27
Mixed materials	945

Source: Thana and union records

Other social infrastructure includes schools, religious buildings, health centres, markets and their associated facilities and other community and commercial buildings. Details of the number of these in each union are given in Appendix II. Approximate locations of some of these structures are indicated in Figure 3.3. The union data has been pro-rated taking into account the area of each union in the project area and information from LGED and other sources regarding the location of specific structures to obtain the totals summarised in Table 3.6.

Table 3.6: Other social infrastructure

Type	Number
Thana and union offices	5
Primary schools and madrashas	92
High schools	8
Mosques	196
Community centres	64
Markets	15
Other public and commercial buildings	43

Source: Thana and union records; MES survey

3.5 Agriculture

Agriculture is the most important economic activity in the project area and is the principal source of income of the population. Based on the 1991 population census, an estimated 46 per cent of households in the area own land. In addition many landless families are also engaged in agriculture.

Data from thana and union offices suggest that some 26 per cent of farm households in the area are (functionally) landless, about 50 per cent have marginal or small farms, 15 per cent have medium farms and only some 8 per cent have large farms (see Appendix III.1, Table III.1.1).

The pattern and practice of agricultural production in the area may be distinguished according to whether farms are located within the Chandpur Irrigation Project or whether they are located outside the irrigation project command area in the area between the embankment and the river bank.

3.5.1 Crop production

Some data on crop production is available from thana and union offices. This has been supplemented with information gathered during the survey of the project area carried out for this feasibility study.

The total cropped area is estimated at 3,832 ha of which 2,131 ha are inside the embankment and 2,252 ha are outside. The cropping pattern inside the embankment is principally LT and HYV Aman or B. Aus followed by Boro and other Rabi crops, with an average cropping intensity of about 200 to 220 per cent. Outside the embankment, where the risk of flooding and erosion is higher during the Kharif I and II seasons, local Aus and Aman varieties are grown and there is less emphasis on HYV than inside the embankment. Farmers also focus more on the Rabi season when the risks to production are fewer and more manageable. Crops include Boro, chilli, potato, sweet potato, pulses and oilseeds. This season is proportionately more important outside the embankment than inside. Cropping intensity outside the embankment is estimated to average around 130 to 150 per cent.

The cropping patterns of the two areas are presented in Table 3.7. This table is based on union office data and the results of a survey carried out as part of the investigations for this feasibility study.[1]

Table 3.7: Average cropping patterns and intensities

Unit: per cent of cultivated area

Crop	Inside Embankment	Outside Embankment
B. Aus / T. Aus	68	15
B. Aman / LT Aman	35	55
HYV Aman	50	15
Boro	30	6
Rabi crops	28	54
Cropping intensity	211%	145%

Yields of rice, chilli, pulses and oilseeds are higher in the Chandpur Irrigation Project than they are outside the embankment. This reflects the lower risks and better water control inside the embankment which in turn favours the use of high yielding varieties as well as fertilisers and other inputs. Vegetables and other Rabi crops are reported to achieve higher average yields in the areas outside the embankment. The yields and estimated production of the principal crops in the area are summarised in Table 3.8. These estimates are based survey information and data on crop production and yields obtained from thana and union offices (see Appendix III.1).

[1] This survey was intended to provide some background information on the project area and was purposively and not randomly selected; the data from the survey is therefore only used as a guide to the situation in the project area.

Table 3.8: Yields and production of principal crops

Crop	Outside Embankment		Inside Embankment	
	Yield (mt/ha)	Output (mt)	Yield (kg/ha)	Output (mt)
B. Aus	1.2	405	1.5	1662
T. Aus	-		1.8	614
B. Aman	1.5	1351	-	-
LT. Aman	1.8	608	2.0	1343
HYV Aman	2.4	810	2.8	2983
L. Boro	1.8	122	2.1	134
HYV Boro	4.4	297	4.5	2589
Jute	1.4	??	1.4	??
Potato	10.0	3153	10.0	1918
Chilli (dried)	0.8	360	0.8	153
Pulses	0.8	144	0.8	85
Oilseeds	0.8	22	0.8	85

3.5.2 Constraints to production

Respondents in the survey of farm households undertaken for the study were asked to rank a range of potential constraints to production. (The potential risk of land erosion was not included in the list.) Those farmers with land inside the embankment indicated that water logging from rain, inadequate irrigation and crop pests were the three most important constraints. Soil fertility, salinity and input availability were lesser constraints. Outside the embankment, consensus on the principal constraints was less clear-cut except that all respondents cited water logging from rain as the main problem. The effects of storms, pests and the lack of irrigation were named as important constraints and in one village salt water intrusion was named as a problem.

These farmers' priorities for interventions focused on the construction and embankments, drainage and irrigation, with some farmers outside the embankment also mentioning land accretion as desirable.

Some data from union offices on constraints to production indicates a somewhat different order of priorities. In this case, those farmers with land inside the embankment indicated that low soil fertility, bank erosion, pest attacks, lack of irrigation water and credit were the main constraints to production. Those outside the embankment cited bank erosion, lack of irrigation, pest attacks and the lack of credit as important constraints. (see Appendix III.1, Table III.1.6)

3.6 Livestock

Livestock is an important element of small holder farming system in the project area. For the poorer households the animals are relatively important assets. The animals provide draft power, high quality food, cash income, year round employment and security in case of emergency cash needs. Medium and large farmers pay more attention to draft power needs while poorer households are better able to acquire and manage small ruminants and poultry which require small investments and can be reared using very little land and other resources. Backyard poultry and small ruminants are managed by women and the children. Women are also often responsible for the feeding and watering of large ruminants when they are kept in the stall.

In the project area crop production and livestock are closely linked. The draft animals are essential for ploughing and field preparation and crop residues account for a large proportion of large ruminant feed resources. The vulnerability of farmers to floods, cyclones and erosion has led to a strong element of risk aversion in the farming system. Livestock and poultry production represent a reliable source of cash income for small and landless farmers who have been marginalised from crop production because of erosion. In erosion affected areas livestock are

moveable assets which can be sold to meet immediate cash needs for food, transfer and the construction of temporary shelter.

The livestock population of the project area unions, based on the 1983-84 Livestock Census, is given in Table 3.9. The estimate for 1998 is based on annual growth rates derived from the Cyclone Shelter Preparatory Study, viz. 2.8 per cent for cattle, 5.3 per cent for goats and sheep and 5.2 per cent for poultry. These growth rates comprise growth in the number of households at 2 per cent per year plus a rate for the increase in average livestock owned per household. (See also Appendix III.2, Table III.2.1)

Table 3.9: Livestock population in the project area in 1997

Union	Cattle and Buffaloes	Goats and Sheep	Chickens	Ducks	Pigeons
Sakhua	240	195	2,015	340	75
Hanarchar	1,190	880	11,450	1,930	415
Chandra	450	370	3,180	540	115
Haimchar	2,120	1,260	9,620	1,620	350
Nilkamal	6,860	4,625	17,380	2,930	630
Char Bhairabi	5,215	2,995	21,040	3,550	760
Uttar Algi Durgapur	1,100	970	7,115	1,200	255
Dakhin Algi Durgapur	2,325	1,765	9,380	1,580	340
Gazipur	2,530	1,600	8,260	1,390	300
Char Ababil	1,050	785	7,350	1,340	265
Total	23,080	15,445	96,790	16,420	3,505

Source: Livestock Census 1983-84 and Cyclone Shelter Preparatory Study

Further background information on livestock in the project area is given in Appendix III.2.

3.7 Forestry

The project area falls within the non-forest zone of the country but it is very rich in homestead (village) trees. These village forests are a very important and valuable resource and are the most important source of wood, bamboo and other non-wood tree products in the country. Supported by strong tradition and conventional wisdom, trees and other crops are grown under an intensive and efficient system of agro-forestry, combining multipurpose trees, food and forage plants, bamboo, palms, medicinal plants and spices. The village forests are an important component of the mixed subsistence cash crop household economy.

The latest inventory of the village forest resources of the country was done in 1992 for the Forestry Master Plan. [2] Because of the high population densities in the project area, the results of this survey cannot be used directly to obtain a realistic estimate of the tree stock in the project area. Rather, the average population density for the survey stratum V, within which the project area lies, has been applied to the project area. The estimate of stocks of mature trees thus obtained is given in Table 3.10. The survey also estimated the stocks of immature trees but these are not included in the estimate below. More detailed results from the survey are given in Appendix III.3.

[2] Statistical Report, Village Forest Inventory, Forestry Master Plan (ADB TA 1355-BAN; UNDP/FAO BGD 88/025), 1992

Table 3.10: Estimate of stock of mature trees

Species	Estimated Number
Mango	23,360
Jackfruit	9,828
Koroi	11,172
Tal	5,095
Khejur	24,306
Coconut	25,845
Areca (betel nut)	145,614
Bamboo (all varieties)	97,516
All others	58,461

Source: Village Inventory Survey, 1992 ; Consultants' estimates.

3.8 Fisheries

The fisheries sector accounts for 3.5 per cent of the country's GDP and contributes 60-80 per cent of the animal protein intake of the population. In principle fisheries in Bangladesh can be divided in two types:

- **Capture fisheries**: carried out by professional, occasional or subsistence fishermen in open water such as rivers, flood plains, beels, etc.;
- **Cultured fisheries or aquaculture**, which comprises the pond raising of carp *spp.* and shrimps in fresh or brackish water, respectively.

Capture fisheries is an important economic activity in the project area and is estimated to provide a important source of income for about 7,000 households. The main fishing ground is the Meghna river. Fishing inside the beels and canals of the Chandpur Irrigation Project area is negligible as the fishing habitats were altered in the late 1970's due to the construction of the embankment. The objective of the project is erosion control and no negative impact on migration routes, spawning and nursing areas of fish species living in the Meghna are expected and consequently no negative impacts are expected on the total fish catch of the area. The project interventions may lead to the accretion of chars in front of the river bank, which may have a small negative social impact in that some fishermen may no longer be able to land their boats and catches close to their homesteads.

Aquaculture in the area mainly consists of the raising of Indian carp and the Chinese silver carp in ponds. It is estimated that about 1,700 ponds comprising cultured[3], culturable[4] and derelict[5] ponds are located in the project area. Details of the number, area and production are presented in Table 3.11.

Table 3.11: Fish pond distribution and production rates

	No	Total Area (ha)	Production Rate (kg/ha)	Total Production (mt/year)	Per cent of Total production
Culture pond	788	97.4	800	77.9	69%
Culturable pond	894	114.3	300	34.3	31%
Derelict pond	9	1.2	50	0.1	< 1%
Total	1691	213.0	1150	112.3	100%

Source: MES Survey; Union councils

About a third of the ponds are located outside the CIP embankment, the remainder are inside. All are will be threatened in the long run if no erosion control is undertaken. The average rates of production of the different categories of pond are similar regardless of their location. The distribution of the ponds and their production inside and outside the CIP embankment is presented in Table 3.12.

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3 Stocked ponds under reasonable management

4 Ponds which could be stocked

5 Ponds not suitable for aquaculture

Table 3.12: Fish ponds inside and outside the CIP embankment

	Inside		Outside	
	Area (ha)	Production (mt/year)	Area (ha)	Production (mt/year)
Culture	67.8	54.2	29.6	23.7
Culturable	79.5	23.9	34.8	10.4
Derelict	0.9	0.1	0.4	-
Total	148.2	78.2	64.8	34.1

Source: Consultant's estimate based on Thana Fisheries Office data.

3.9 Other activities

There are a number of small scale, private sector industrial and commercial activities in the project area. These include rice mills, small local sawmills, repair workshops of various types, bakeries, ice cream factories and retailing activities in the local markets. The number of these establishments reported for the project area unions is given in Table 3.13. Faced with the prospect of erosion, the owners of most of these businesses will be able to move to new locations and re-establish their activities. The buildings in which they are currently housed will be lost to the erosion but, depending on individual circumstances, many would probably suffer few other business losses.

Table 3.13: Other economic activities in project area unions

Union	Markets	Rice Mills	Sawmills	Repair Shops	Other
CHANDPUR					
Sakhua	3	5	2	1	-
Chandra	3	2	1	-	1
HAIMCHAR					
Haimchar	2	-	-	3	-
Nilkamal	3	5	-	1	-
Char Bairabi	2	4	3	-	1
Uttar Algi Durgapur	6	12	2	5	1
Dakhin Algi Durgapur	5		2	-	1
Gazipur	-	-	-	-	-

4. FUTURE WITHOUT THE PROJECT

If the future without the project - i.e. if no measures to stabilise the river bank are taken - the bank will continue to erode freely as at present. Erosion expected in the future has been estimated and the boundary of the project area has been defined by the expected line of the river bank in 2025 if no action is taken to halt the erosion and stabilise the bank (see Figure 1.2). The map also shows the expected bank line in 2010.

Without the implementation of measures to protect and stabilise the existing river bank, the whole of the project area will be eroded away over the next 26 years. This implies the loss of the land and its production as well as all existing physical and social infrastructure, dwellings and other privately owned property. The protection of these assets and the production in the project area constitutes the benefit of the proposed project.

4.1 Physical and social infrastructure

The physical and social infrastructure in the project area is described in sections 3.3 and 3.4 and, where possible, its location is indicated in Figures 3.3.

Without the project, the continued erosion will eventually destroy all the infrastructure in the project area. All embankments, roads, culverts and bridges, transmission lines and buildings of all types within the defined project area will be destroyed over the next 26 years. This refers to structures: equipment, machinery of all sorts and other contents will be removed before structures are destroyed.

4.2 Socio-economic conditions

Erosion of the project area will have significant socio-economic consequences, arising from the need for the population to move to other areas. In the first instance, the erosion will create more landless households and reduce agricultural production. It affects settlement patterns as people are forced to move, leading, in particular, to ever higher population densities in the areas close to the river bank. By destroying schools, health clinics and other facilities it strains the ability of local authorities to provide services to the population and places additional strains on the services in areas to which people move. It disrupts economic activities and adds to unemployment and under-employment in the area.

4.3 Agriculture, aquaculture and forestry

All land and production in these sectors will be lost without the project. Furthermore, awareness of the risk of erosion will inhibit households near to the embankment from taking measures that would improve productivity in the medium to long term. This might include, for example, improvements to on-farm water management by affected farmers within the CIP, investment in mechanisation to raise productivity, investment in tube wells to increase and improve dry season irrigation by farmers outside the embankment, re-excavation and improvement of fish ponds and various other possible measures. Those farmers further away from the present bank, for whom erosion may not be a threat for 10 or even 20 years, might be expected to make some improvements where a reasonable return could be expected before land is lost to the river.

Overall, the threat of eventual erosion will inhibit farmers' adoption of improvements in production that would otherwise occur over the next 25 years (as they will in neighbouring areas not subject to the high risk of erosion). However, the situation is complex and for simplicity in the analysis, it has been assumed that in the future without the project the existing cropping patterns and yields in agriculture, fisheries and tree crops will continue on remaining land without significant change for the project period. Since any of these improvements (and possibly more) would also occur in the future with project situation, they may, in the case of this project, be disregarded in the analysis.

4.4 Livestock

Because livestock are mobile assets, it is assumed that the future erosion of the river bank will have little impact on either livestock populations or production. If land is eroded, livestock previously living or grazing on that land will simply be moved elsewhere. Because any benefits or disbenefits that may arise from the livestock sector are very small, whether the project is implemented or not, they are disregarded.

It is possible that households that lose land to erosion may be forced to sell livestock to meet cash needs or because they no longer have the ability to provide for them. The loss in this case is the land: sale of livestock is only a transfer of assets from one form to another.

5. PROPOSED INTERVENTIONS

The objective of the proposed interventions is to stop erosion of the eastern bank of the lower Meghna river at Haimchar. The area to be protected is located south of Chandpur and North of Char Bhairabi between northing co-ordinates 564000 and 546000.

5.1 Basic data

Basic data for the present study have been obtained from:

- report on Meghna River Bank Protection Short Term Study, March 1990
- bathymetric survey carried out by MES in December 1997
- topographic Survey carried out by MES during January 1998
- landsat imagery, February 1996
- water levels recorded by BWDB
- Bangladesh Tide Tables, 1997.

The designs of the permeable spurs and the geotextile bottom screens are based on those already made for the pilot schemes for halting river bank erosion at Mollakandi in Haimchar Thana, Chandpur and at Khorki, northeast Bhola. These pilot schemes have been monitored during the 1998 flood season and the lessons learned have been incorporated in the design of the Hanarchar Erosion Control Pilot Scheme that will be implemented in the 1998/1999 winter season as well as in the designs for the Haimchar Erosion Control Project.

5.1.1 Reference levels

Public Works Department Datum (PWD) This is the general horizontal reference datum defined by the Public Works Department. This datum is applied in the whole of Bangladesh.

Chart Datum (CD) This is a local datum used as a reference for tide levels. Chart datum is a plane below which the tide seldom falls. The relationship between the Chart datum used at Chandpur and the Public Works datum is:

$$CD = PWD - 0.250$$

5.1.2 Topographic data

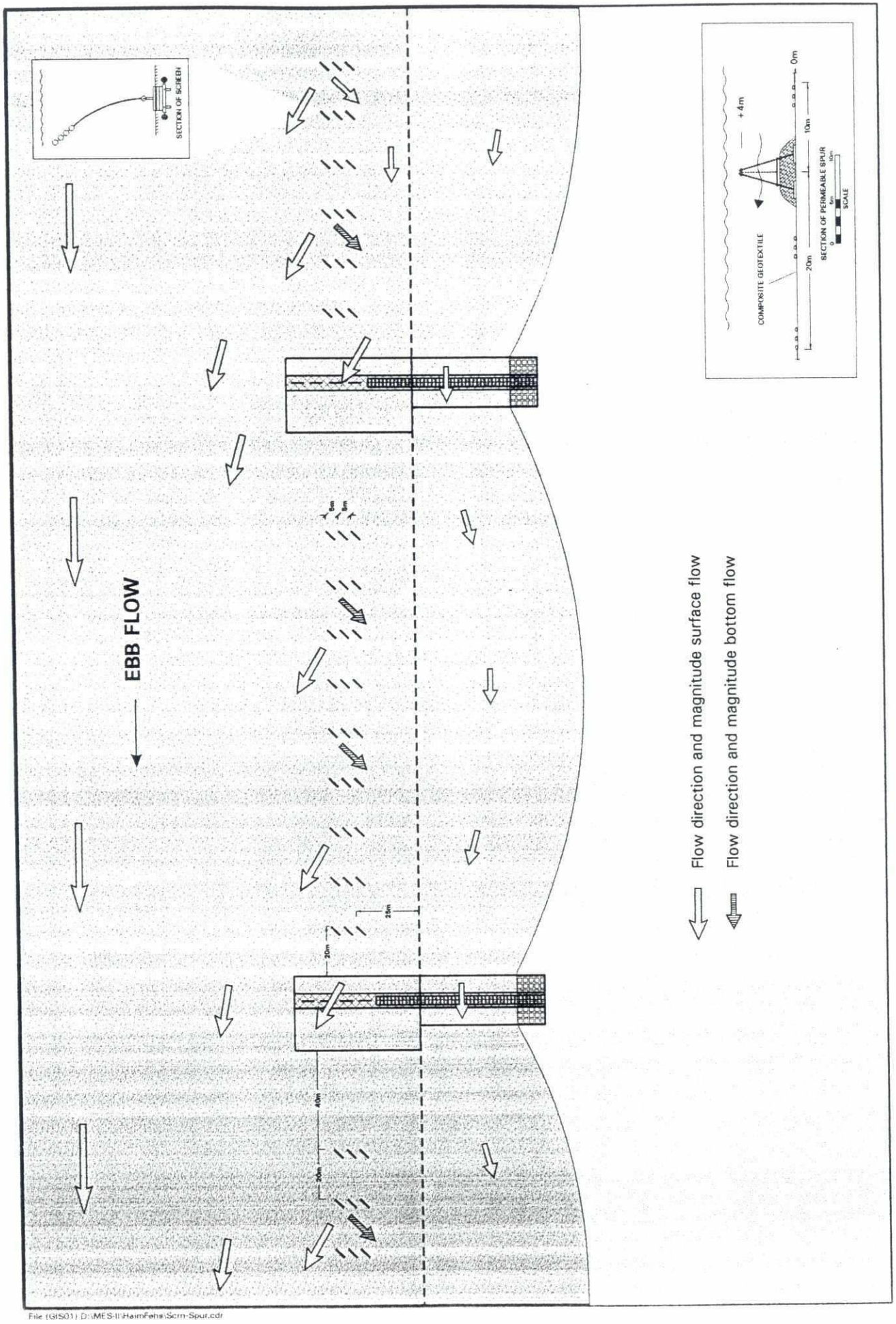
A topographic survey has been carried out at the project location in January 1998. However during the 1998 monsoon severe erosion occurred so that the actual situation will be quite different again. Fresh surveys are planned during MES II.

Landsat images of February 1976 of the project area are available. An analysis of the development of the coastline and chars has been made which shows the shifting of the river bank and development of chars along the left bank of the lower Meghna below Chandpur (see Figure 2.1).

Compared to the coastline found in the 1996 satellite imagery, the situation near the village of Bakorpur has already changed. Erosion has continued and the channels in between the newly emerged chars have changed position.

The satellite imagery of 1997/1998 has also been taken into account during finalising the feasibility study for the Haimchar Erosion Control Project.

Figure 5.1: Flow pattern of permeable spurs and bottom screens



5.1.3 Bathymetric data

A bathymetric survey of the project area has been carried out in July 1997. Analysis of these survey data shows that in the Northern section the lowest bed levels between the newly formed chars and the main land are about -5 m PWD and width of these channels varies from 100 to 400 metres (see Figure 2.2). In the southern section the main river flow has caused scour patterns along the river bank resulting in bed levels up to -15 m and -20 m PWD. An additional bathymetric survey has been of the Hanarchar South area has been carried out in July 1998.

5.1.4 Water levels

Tidal information has been obtained from the Bangladesh Tide Tables 1997.[6] The tidal station relevant for the project area is Chandpur. The tidal levels for this station are given in Table 5.1.

Table 5.1: Tidal levels for Chandpur

Unit: metres

	Mean with respect to	
	CD	PWD
Lowest Astronomical Tide	0.019	0.267
Mean Low Water Spring	0.256	0.506
Mean Low Water Neap	0.493	0.743
Mean Low Water	2.172	2.422
Mean High Water Neap	3.852	4.102
Mean High Water Spring	4.088	4.338
Highest Astronomical Tide	4.326	4.576

Source: BIWTA

Mean water levels vary considerably during the year (see Figure 2.1).During the dry season (December to April) Mean Water Level is about 1.25 m PWD; during the wet season (July to September) mean water level can rise to more than 4 m PWD. Daily fluctuations due to tides are about 1 metre.

5.1.5 Currents

From the table below it is observed that maximum flow velocities at Haimchar occur for Lower Meghna discharges in the range of 100,000 to 110,000 m^3/sec, with a water level gradient of $2.84*10^{-5}$. However, the differences in velocities in a wider discharge range are rather small: for flows in range of 100,000 to 130,000 m^3/s these differences are seen to be less than 5 percent.

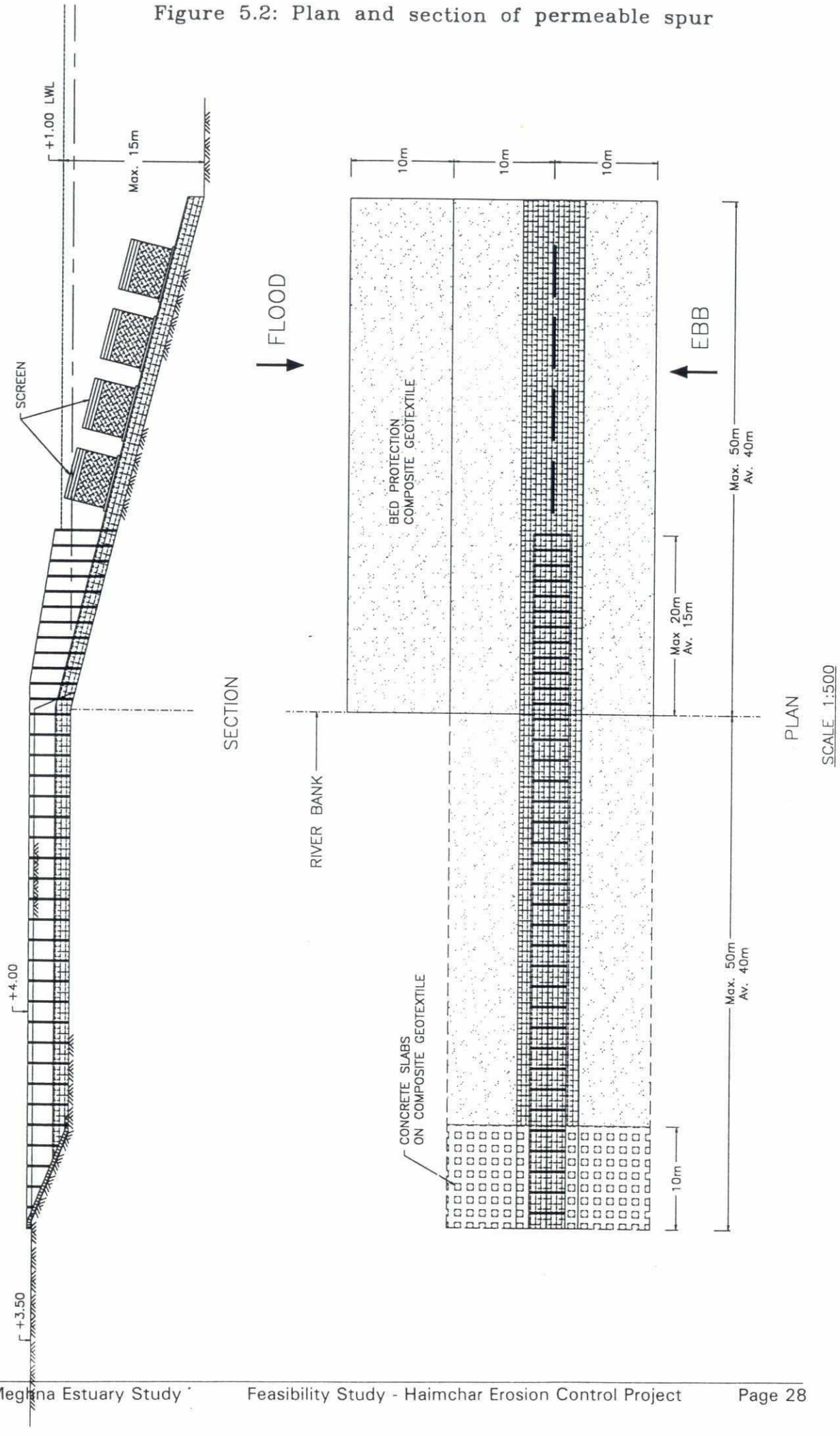
Table 5.2: Depth averaged flow velocities near Chandpur - various flow conditions

Q-Meghna (M^3/s	H-Meghna (m = PWD)	Gradient * 10^{-5}	Velocities (m/s) at bottom level (m + PWD)				
			0(m)	-5(m)	-10(m)	-20(m)	-30(m)
90,000	3.89	2.38	0.72	1.26	1.70	2.43	3.07
100,000	4.12	2.48	0.77	1.30	1.74	2.49	3.14
110,000	4.33	2.42	0.78	1.31	1.74	2.48	3.12
120,000	4.52	2.29	0.78	1.29	1.71	2.42	3.04
130,000	4.68	2.21	0.79	1.28	1.69	2.39	3.00
140,000	4.82	2.16	0.80	1.28	1.68	2.37	2.97
150,000	4.94	2.10	0.80	1.27	1.67	2.35	2.94

Source: FAP 9B, Annex A - Hydrology

[6] Department of Hydrography, Bangladesh Inland Water Transport Authority.

Figure 5.2: Plan and section of permeable spur



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5.1.6 Soils

A sub-soil investigation programme was carried out by GWD-1 at Haimchar and Chandpur for the Chandpur Irrigation Project (CIP) in December, 1977. Two bore holes were made to a depth of 16 metres. The upper layer, to a depth of 6 metres, consists of very loose grey silt with some fine sand and a trace of mica, having N values ranging from 4 to 16. The water table level was only 0.8 metres below ground level. (see Soil Mechanics Division, Hydraulic Research Laboratory, Report No. 5(78), 1978.)

5.2 Bank protection types

Previous studies carried out have shown that protection of the river bank using conventional bank protection methods is not economically viable. In the Meghna River Bank Protection Short Term Study, Final Report, February 1998, the estimated costs for the 4 options that were considered ranged from US$ 18.3 to 29.3 million. The works protected less than half of the length of the bank line that is eroded to the south of Chandpur.

Alternative protection measures have been developed under the Meghna Estuary Study. These measures are relatively cheap and differ from conventional methods by the use of special geotextile materials and construction methods using prefabricated elements.

The following protective measures have been considered:

- permeable spurs
- bottom screens
- cross dams.

5.2.1 Permeable spurs

Permeable spurs or groins consisting of one or several rows of piles are placed perpendicular to the river bank. Conventionally, these piles are driven into the river bed with water borne equipment. Due to high current velocities in the Meghna river this can only be done during slack water and in the low flow season.

MES has developed the concept of spurs made of steel A-frames embedded in a low under water dam consisting of concrete blocks. These frames can be prefabricated on shore. Installation of a set of eight A-frames can be done in the relatively short time during slack water with the help of a Twin Hull Pontoon. The spurs are placed on a geotextile bed protection and the tip of the spurs is protected by geotextile bed protection, ballasted with geobags filled with sand and concrete blocks. This will act as a falling apron in case of bed erosion at the tip of the spurs. The objective of the spurs is to:

- slow down the current velocity along the bank line causing reduction/halting of erosion
- create a "soft hard point" in the river bank
- deflect the main current away from the bank line

The spurs can be optimally applied given the following site conditions:

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

In Figure 5.1, the flow pattern created by the permeable spurs in combination with bottom screens is shown. The main current is deflected away from the bank line by the spurs and in between spurs, bottom screens and the river bank the flow velocities will be reduced. Figure 5.2 shows the plan and section of permeable spurs and Figure 5.3 gives a section and side view of a permeable spur.

Figure 5.3: Section and side view of permeable spur

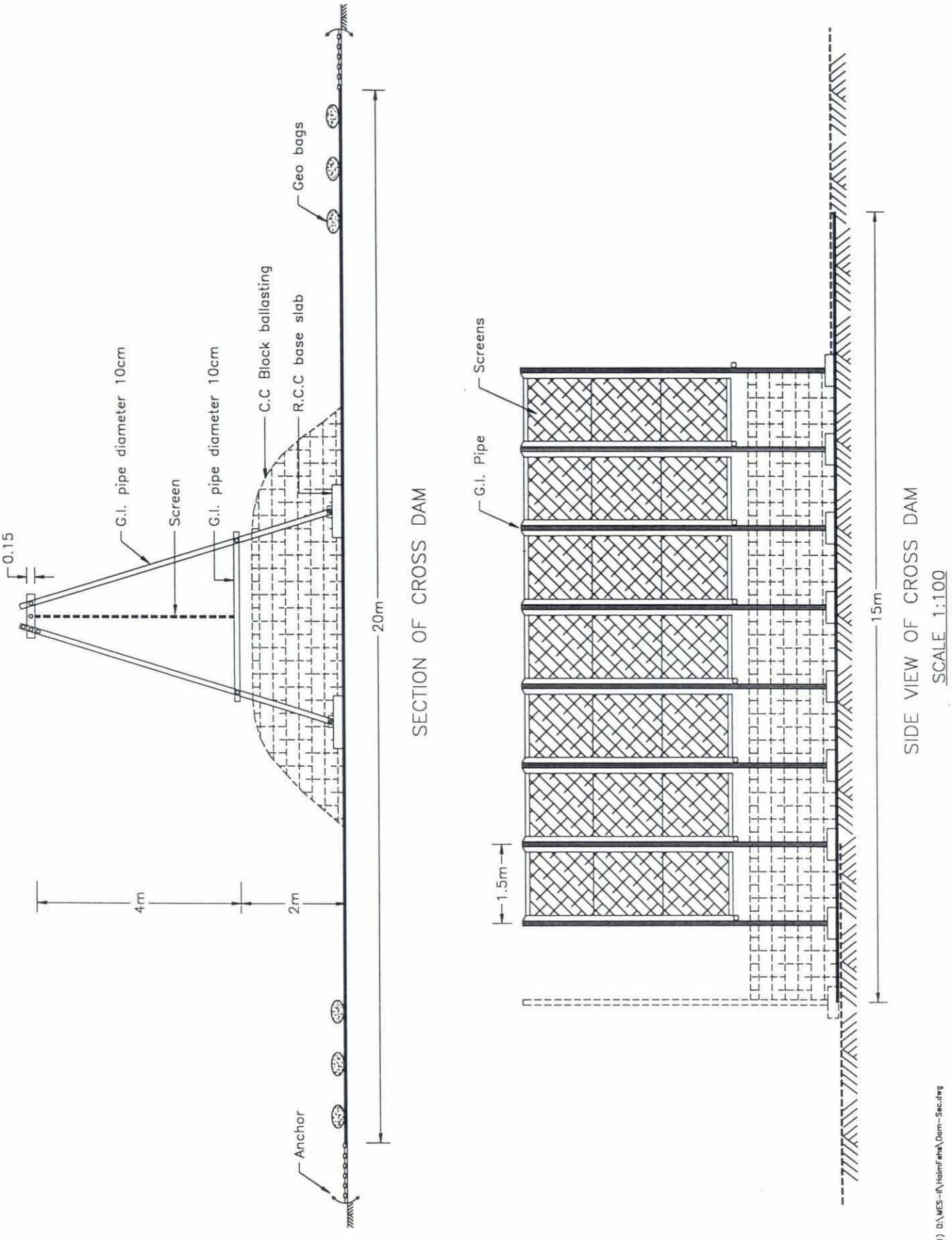

Figure 5.4: Design of bottom screen

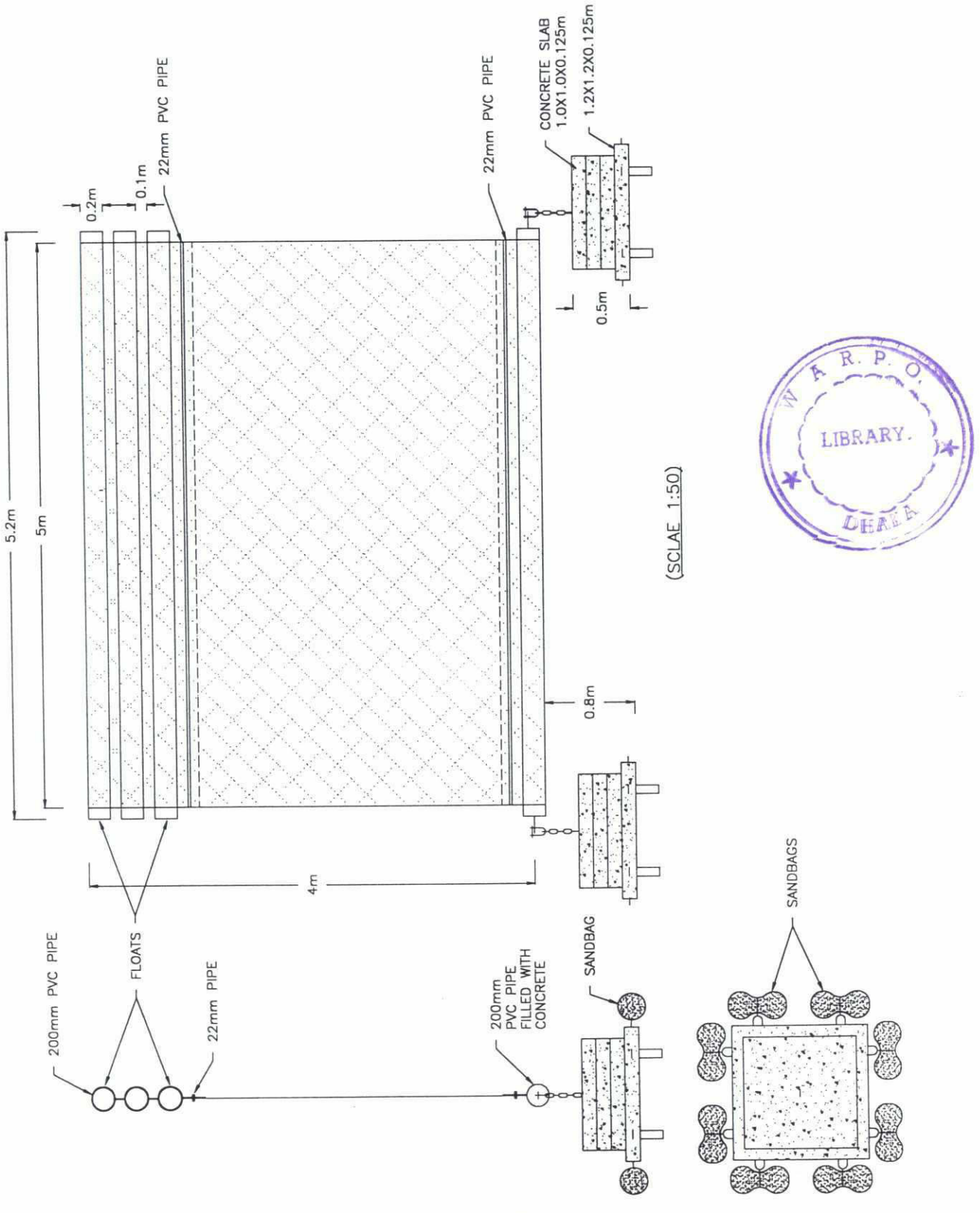

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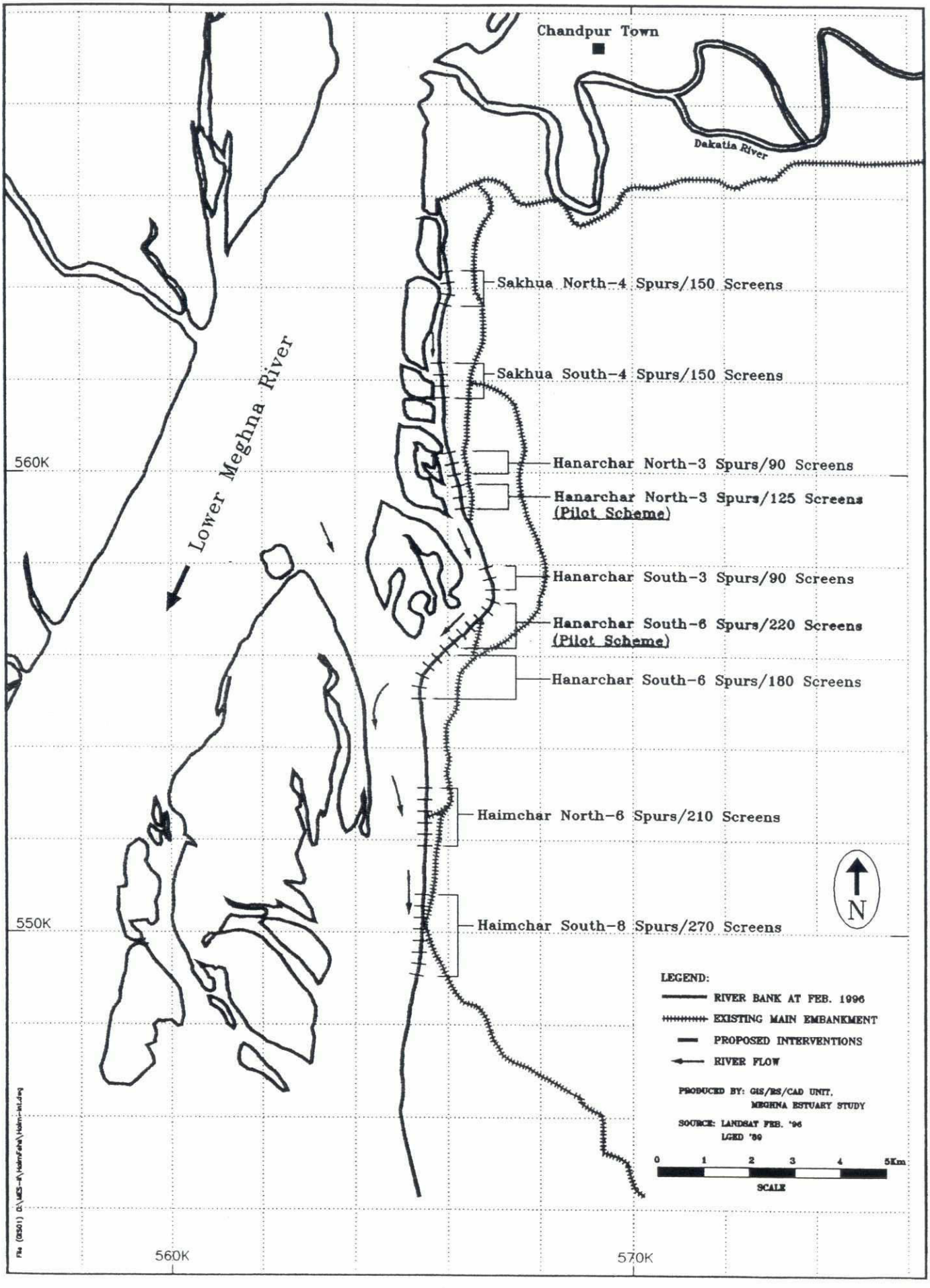
Figure 5.5: Proposed Interventions Haimchar Erosion Control Project



Based on observation of the Haimchar and Khorki erosion control pilot schemes, the distance between the permeable spurs has been set at 250 metres. In between the spurs the bank line will remain unprotected since bottom screens, that are an integral part of the erosion control works, will deflect sandy materials towards the bank, where the sand will be deposited.

At Haimchar pilot scheme erosion continued in between the spurs mainly because the number of bottom screens that could be installed was very limited. However, at Khorki the works have been executed as per design; in between the spurs sand, that apparently was deflected by the bottom screens, has been deposited and erosion of the bank line was completely halted.

For the time being the height of the A-frames has been limited to 6 metres. It is expected that the height can be increased to 8 metres after installation and monitoring of the Hanarchar Erosion Control Pilot Scheme.

This limitation in height limits the distance that A-frames can be installed from the bank line into the river at low water. The length of the river spur with A-frames extending from the bank line into the river may vary between 15 and 40 metres. The river spur may be extended with a sloping spur consisting of an under water dam of concrete blocks. On top of the sloping spur, bottom screens will be installed to reduce velocities and deflect the main current away from the bank line during the flood season.

It is estimated that the length of the spurs has to be about 40 per cent of the distance between the spurs to ensure that erosion of the bank line in between spurs by currents and waves will be halted. Therefore the total required length of the permeable spur is 100 metres.

Since the spur length into the river will be limited to about 50 metres, the permeable spur has been extended inland from the bank line over a distance of 40 metres (land spur) and an additional 10 metres slope protection. In between the spurs a strip of about 50 metres of existing land may be eroded by current and waves before an equilibrium between deposition of sand and erosion may be reached.

The final layout and design of the permeable spurs will have to be based on the actual situation prior to installation of the spurs as well as the lessons learned during the implementation of the Hanarchar Erosion Control Pilot Scheme.

5.2.2 Bottom screens

The purpose of bottom screens is similar to the purpose of bottom vanes. These vanes are well known devices to deflect sediment in a river bed. The effect of bottom vanes is the same as the effect of surface vanes or screens and also similar to the effect of bandals. Bandals are made of local materials, mainly bamboo and are installed in a river channel to maintain sufficient depth for navigation during the low flow season or to induce sedimentation along a river bank.

The aim of installing vanes may be to minimise sediment entry into the intake of a pumping station or an irrigation channel, to reduce erosion along the river bank or to redirect strong currents away from a threatened structure e.g. a bridge abutment. Bottom vanes have also been installed to redistribute the transport of bed load and suspended bed load at the bifurcation point of branches in a canal or natural river.

In order to deflect the bottom layers of river flow in the desired direction (e.g. away from an intake) bottom vanes are installed in the river bed at an angle to the current. Design criteria have been developed through field observation and model testing at the Institute of Hydraulic Research of the University of Iowa, USA.

Quite a number of vane type sediment deflectors are in operation in sand/gravel bed rivers in the USA, Japan, Nepal and elsewhere with good or very good results. Recently vanes have been installed in the Waal River, the Netherlands, to improve the navigability of a curved section in this river.

Vanes have to be designed with a sufficiently deep foundation to ensure the stability and functionality of the vanes in case scouring of the river bed occurs. This requirement may lead to relatively expensive installations that have to be constructed with rather heavy (pile driving) equipment in flowing water.

In order to reduce the cost of vanes and facilitate installation with water born equipment, the consultant has developed the bottom screen; a bottom screen consists of a sheet of woven geotextile, floats to keep the geotextile screen upright and an anchor beam with anchor blocks to fix the position of the screen in the river bed.

Such screens have been installed in the Lower Meghna River south of Chandpur and along the northeast coast of Bhola. So far the screens have performed as anticipated while the design has proven able to withstand strong current velocities during the extreme flooding during the 1998 monsoon. Similar screens or curtains have been used in the Netherlands to reduce the ingress of silt in a harbour basin and to protect pipelines on the sea bottom against scouring.

The objective of the screens arrays is to

- divert the sediment rich bottom flow towards the river bank
- obstruct the current in general.

The screens can best be applied at locations meeting the following conditions:

- water depths at low water exceeding five metres
- river flow with high bed load and suspended bed load content.

The design of a bottom screen is indicated in Figure 5.4.

5.2.3 Cross dams

Before 1985 the course of the Lower Meghna River was in a southerly direction; from that year the river gradually started to move in a south westerly direction, a process that is still continuing. Along the east bank of the river chars started to emerge but a secondary channel remained in between the new chars and the main land.

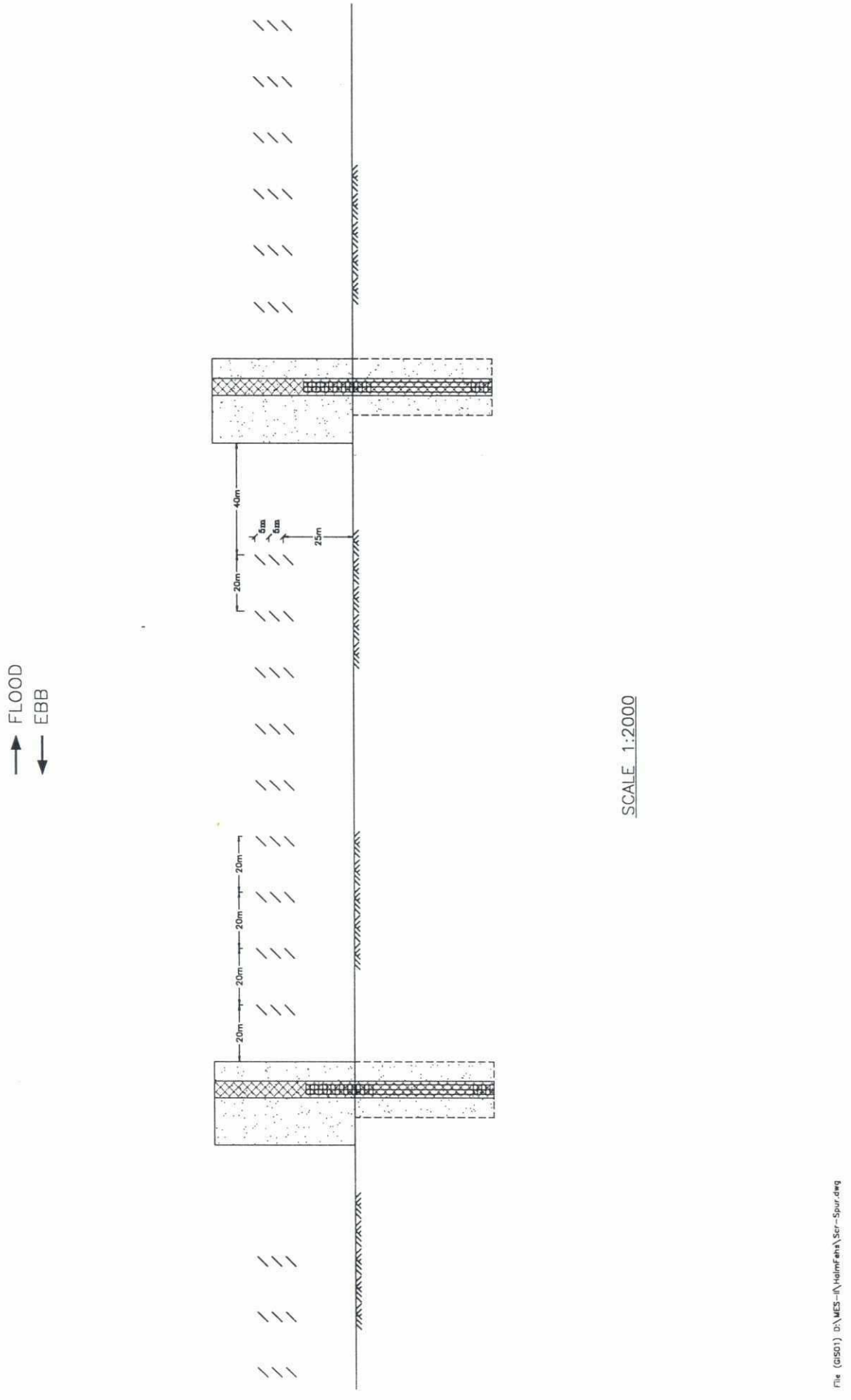
Through gaps in the chars strong currents flow from the main river into the secondary channel, these currents are concentrated along the bank line of the main land and cause severe erosion of the river bank. Since the gaps between chars shift in a southerly direction over the course of time, the section of the mainland bank line that is under attack will also shift. By constructing cross dams across the secondary channel at two or three locations or by closing the gaps in between the chars, the erosion of the bank line of the mainland could be stopped.

A conventional earthen cross dam would in general be relatively expensive and vulnerable to erosion by waves. MES has developed the concept of cross dams consisting steel A-frames embedded in a low under water dam consisting of concrete blocks. These frames can be prefabricated on shore. Installation of a set of A-frames can be done in the relatively short time during slack water with the help of a Twin Hull Pontoon.

The low under water dam and geotextile screens tied to the A-frames are the closing elements of the cross dam, a limited discharge will pass in between the geotextile screens and in between the screens and the concrete block of the under water dam.

The cross dam is placed on a geotextile bed protection that will be ballasted with geobags filled with sand and concrete blocks. Locally fabricated steel anchors will be attached to the edges of the bed protection to ensure that the geotextile will follow the movement of the river bed and not be swept away by the currents.

Figure 5.6: Layout of permeable spurs and bottom screens



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

- sand banks (chars) located in front of the river bank which are fully emerged
- water depths at low water not exceeding five metres
- tidal flow conditions with a considerable period of slack water.

5.3 Proposed protection scheme

The Haimchar Erosion Control Project consists of a combination of permeable spurs and bottom screens. Initially, it was envisaged to include two cross dams in the design. However, it appears that the chars are still deeply inundated during the flood season. As a result the risk of outflanking of the cross dam at the char end would be considerable. At a later stage installation of permeable cross dams may be reconsidered because closing of the secondary channel will surely accelerate accretion in this channel.

The project will provide erosion control works at six locations:

- Sakhua North — 4 permeable spurs in combination with 150 bottom screens
- Sakhua South — 4 permeable spurs in combination with 150 bottom screens
- Hanarchar North — 3 permeable spurs in combination with 90 bottom screens
- Hanarchar South — 9 permeable spurs in combination with 270 bottom screens
- Haimchar North — 6 permeable spurs in combination with 210 bottom screens
- Haimchar South — 8 permeable spurs in combination with 270 bottom screens

The Hanarchar Erosion Control Pilot Scheme will be implemented in the 1998/1999 winter season and consists of the following works:

- Hanarchar North — 3 permeable spurs in combination with 125 bottom screens
- Hanarchar South — 6 permeable spurs in combination with 220 bottom screens

These works are to be fully integrated in the Haimchar Erosion Control Project.

As is shown in the layout of the erosion control works (see Figure 5.5 and 5.6) the protective works at Sakhua, Hanarchar and Haimchar will cover about two thirds of the total length of the bank line. In between the six sections of the protected bank line, erosion of the bank line may continue. However it is expected that this erosion will be limited and will halt once the six "soft hard points" have fully developed.

After implementation of the erosion control works regular monitoring of the performance of the works is required in order to ensure that they continue to provide the protection as envisaged. Additional works may be needed in case the river attacks heavily in between the "soft hard points". Periodical under water inspections will be required to check the condition of the bed protection of the spurs as well as the screens.

Under the present conditions, the erosion is most severe at Hanarchar South and Haimchar South. At both sites, the protective embankment of the Chandpur Irrigation Scheme is in immediate danger of being washed away. For the time being, the erosion at Sakhua North and South and Hanarchar North the rate of erosion is moderate and there is still sufficient distance between the protective embankment and the river bank line. At Haimchar North some protective measures have taken by BWDB and the rate of erosion is also moderate. However, the distance between the embankment is already too small.

In order not to overload BWDB/Chandpur and the contractor with too much work in a relatively short time, the Haimchar Erosion Control Project has been spilt into two phases.

Phase 1 includes the implementation of the remainder of the works at Hanarchar South as well as the works at Haimchar South.

During phase 2 the works at Sakhua, Hanarchar North and Haimchar North will be completed. Some adjustment of the planning may be required if it appears that protective measures are urgently required at Haimchar North.

5.4 Retirement of embankment

Because the existing embankment of the Chandpur Irrigation Project is very close to the river bank, especially in Haimchar union, it is necessary that the embankment be retired, even if the proposed interventions are as successful as expected. Also, successful implementation will not affect the risk of large floods that might damage the embankment. It is therefore necessary that the embankment be retired even if the project is implemented. It is assumed that this retirement will be to the expected bank line in 2010 in the case that the project is not implemented.

5.5 Flood proofing

For those households that will be outside the retired embankment a programme of flood proofing is proposed to reduce the risk of damage from flooding. It is assumed that all households outside the retired embankment will be eligible for the programme. Based on the estimated population for the project area (see Table 3.2), it is estimated that the number of households affected will approximately 2,600. The flood proofing component is based on the designs and recommendations of the Jamalpur Project Refinement Study, Annex F (see Jamalpur Project Refinement Study (FAP 3.1), May 1997).

6. FUTURE WITH THE PROJECT

The proposed Haimchar Erosion Control Project consists only of the engineering interventions described in Chapter 5. There are no associated development activities in any other sector. With implementation of the proposed project, it is expected that the river bank will be stabilised and the erosion halted. The proposed interventions are expected to protect the existing infrastructure and production within the project area.

The methods proposed for the bank protection works are still being developed, although recent trials have been successful. Some erosion may continue, at a much reduced level, in the future. However, for the purpose of this feasibility study it has been assumed that the proposed interventions will effectively halt future erosion. The impact if this assumption is not justified is discussed in the sensitivity analysis in chapter 8.

The proposed interventions will reduce the risk of damage under average and severe flood conditions. However, if extreme flooding occurs as in 1988 and 1998, the damage may be very severe since the protective works have not been designed for such events.

6.1 Morphological aspects

The proposed spurs will control erosion over a certain distance along the coastline. In between the spur arrays bank erosion may continue until an equilibrium is reached. If needed more spur arrays may be added in the course of time, to limit further erosion of the banks.

The proposed stand alone screen arrays will redirect the current away from the section of the mainland that is under attack at present. The actual need for the screen arrays, as well as the most effective layout, will have to be determined after other protective measures have been implemented and their effect on the flow pattern and bank erosion has been assessed in detail.

6.2 Physical and social infrastructure

Successful implementation of the project will have no impact on existing infrastructure. Future infrastructural developments in the project area will become possible and will undoubtedly occur, benefiting the population in the area. Such developments, while made possible by the project, are inherently uncertain and no attempt has been made to estimate potential future benefits accruing to the project from this source.

6.3 Socio-economic impact

Any socio-economic impact of the project will be slight. Implementation will have no direct effects on land holdings, settlement patterns, production and economic activities or social services.

6.4 Agriculture, livestock, aquaculture and forestry

In general, implementation of the project will mean that activities in these sectors can continue as at present. Developments in these sectors over time will be similar to those occurring generally in the region, although now made possible by the project.

Improved practices in agriculture, livestock and fisheries, such as greater use of high yielding varieties or improved aquacultural practices, will gradually be adopted. Any such changes will not be directly supported by the project but are unlikely to occur if the project is not implemented and erosion continues at the present rates. Benefits arising from these sources are also, in principle, among the benefits of the project.

An estimation of what these changes in production and productivity might be could be based on a careful extrapolation of past changes. Many factors could interfere to make such projections invalid. Therefore, to estimate benefits of the project the conservative approach has been adopted and production and yields in these sectors in the future with the project are assumed to be the same as the present. This approach will probably under-estimate total benefits over the life of the project.

6.5 Other aspects

Navigation within the project area will be affected by the proposed interventions. The cross dams will necessitate rerouting of the launches that call at Haimchar and other points along the river bank in the project area.

It will be necessary to forbid boats to throw out anchors in areas with screen arrays.

At low water, fishing may be hampered in areas with submerged screens.

7 ENVIRONMENTAL ASSESSMENT

7.1 Aims and objectives of the environmental assessment

The aim of the environmental assessment component of the study for the Haimchar Erosion Control Project 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.[7] These Environmental Impact Assessment (EIA) Guidelines follow the spirit of World Bank Operational Directive 4:01[8] which have become the international standard for such work.

The recently enacted Environmental Conservation Rules of Bangladesh[9] 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 the granting of Environmental Clearance Certificates.

Under the Rules it is not clear which category the proposed intervention would fall under, as the legislation has been primarily drawn up for dealing with the construction of new industrial operations. The situation is further complicated by the fact that the primary aim of the proposed intervention at Haimchar is to retain the present situation by preventing future bank erosion. However the two most sensitive EIA classes, Category Orange B and Category Red (which refers to flood control infrastructure) both first require an Initial Environmental Examination (IEE) to be carried out and then, depending upon the evaluation of the DOE, it may be necessary to carry out a full EIA for the Red Category. A full IEE has thus been carried out for the proposed intervention and is presented as a separate document as Part 2 of this report. A summary of the results is given below.

7.2 Proposed intervention

The proposed project interventions are described in detail in chapter 5, above.

The predicted erosion lines for 2010 and 2025, which constitute intermediate and final eastern boundary lines for the project, are shown in Figure 2.3. For impact analysis the western boundary of the potential impact area includes the island chars in the main river channel.

7.3 Baseline environmental conditions and future trends

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

The most important environmental factor affecting the area is river bank erosion, which as well as direct land loss and resulting impoverishment, causes flooding of homesteads and agricultural land from the main river. Such flooding occurs in peak flow times during the monsoon season in places where the embankment has been eroded away and not retired. The past bank lines for 1957, 1973 and 1996 are shown in Figure 2.1 and the predicted future bank lines for 2010 and 2025 in Figure 2.3.

The results of a needs assessment carried out in the area indicate that control of erosion was considered by all social groups and in all locations to be the highest priority over other possible interventions.

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7 FPCO, Guidelines for Environmental Impact Assessment, FPCO, Ministry of Irrigation, Water Development and Flood Control, Dhaka, 1992.

8 World Bank, 1991, Operational Directive 4:01 Environmental Assessment, The World Bank, Washington, USA, 1991.

9 Abdus Sattar Syed, Introduction to Environmental Laws of Bangladesh, Ace Data Products, Dhaka, 1998. (Chapter III of which contains a translation into English of the Rules which are published in Bangla in the Government Gazette)

As part of the environmental assessment process, the EIA work carried out for the Brahmaputra Right Embankment,[10] the FAP 21/22 Bank Protection Project,[11] and the Coastal Embankment Rehabilitation Project[12] was reviewed. The issues raised by these projects were born in mind when considering the proposed Haimchar intervention.

7.4 Scoping of important environmental components

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.[13]

The identified IEC's for Haimchar are listed systematically in the left hand column of the scoping matrix given as Figure 7.1. 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. Ratings have been made as to the future situation both without and with a successful proposed intervention.

7.5 Impact identification and quantification

The primary positive impacts of the proposed intervention are preservation of the present situation by preventing bank erosion and some further benefits can be derived from promotion of additional accretion. Thus the future without intervention situation is a decline for most components, whilst the with intervention situation keeps things at their present condition and in some cases improves it as periodic flooding is prevented and residents may have the confidence to invest more in the area. The overall differences due to the intervention are given in column seven of the matrix.

The main negative impacts due to successful intervention are likely to be on navigation. Successful promotion of sedimentation will prevent boats from entering the present ghats which are primarily located at the ends of eroded embankments where the excavated borrow pit cum drain and irrigation storage area creates a very good safe haven for boats and direct interchange with the road network.

There is also a risk that prevention of erosion of the main river bank will cause erosion of the main off-shore islands, particularly the newly accreted char west of Haimchar. Discussion with people who have reclaimed their land rights on this island has indicated that even in their view preservation of the main land is a higher priority than avoiding erosion of the island chars. The island char is of poor productivity being mainly used for seasonal grazing land.

There are also likely to be some minor direct construction impacts. However, as most erection will take place from specially adapted barges in the water such impacts are likely to be significantly less than land based work.

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10 Halcrow, River Training Studies on the Brahmaputra River, Environmental Impact Assessment, for the Bangladesh Water Development Board, Dhaka, 1992.

11 Rhein-Ruhr Ing. et al, Bank Protection and River Training (AFPM) Pilot Project FAP 21/22, Final Report Planning Study, Volume IV, Annex 8, Environmental Assessment, for the Flood Plan Co-ordination Organisation, Ministry of Irrigation, Water Development and Flood Control, Dhaka, 1993.

12 Bird A, Coastal Embankment Rehabilitation Project, Environmental Considerations for Project Implementation, for BCEOM/Kampsax, Cambridge, England, 1993.

13 DHV Consultants BV, Interim Development Plan, Meghna Estuary Study, for Bangladesh Water Development Board, Ministry of Water Resources, Dhaka, 1997. (The environmental assessment matrix shown in Figures 8.1 and 8.2 gives the full listing of the checklist).

Figure 7.1: Important environmental components matrix

IMPORTANT ENVIRONMENTAL COMPONENTS	Technical Priority	Local Priority	Now	Future Without Successful Intervention	Future With Successful Intervention	Difference Due to Intervention	Future With Project With Mitigation	Residual Impact
NATURAL ENVIRONMENT								
Natural Physical Environment								
Climate								
Cyclones			0	0	0	0	0	0
Hydrology								
Surface Water:								
Quantity:								
River Flooding	*	*	0	-	+	+ +	+	+ +
Erosion	*	*	0	-	+	+ +	+	+ +
Accretion		*	0	-	+	+ +	+	+ +
Land								
Soil								
Erosion	*	*	0	-	+	+ +	+	+ +
Natural Risks and Hazards								
Storms/Cyclones			0	0	0	0	0	0
Flood			0	-	+	+ +	+	+ +
HUMAN ENVIRONMENT								
Social Environment								
Human Population	*		0	- -	-	+	-	+
Settlement Pattern and History	*		0	-	0	+	0	+
Land Holding and Tenure	*		0	-	0	+	0	+
Sanitation			0	0	0	0	0	0
Health								
Waterborne Disease			0	-	-	0	-	0
Cultural Sites			0	-	0	+	0	+
Economic Environment								
Agriculture	*		0	-	0	+	0	+
Industry			0	-	0	+	0	+
Infrastructure								
Roads and Embankments	*	*	0	-	0	+	0	+
Navigation		*	0	+	-	- -	-	-
Telecommunications			0	-	0	+	0	+
Social Risk and Hazards								
Storms and Cyclones	*		0	-	0	+	0	+
Floods	*		0	-	0	+	0	+
Erosion	*		0	-	0	+	0	+
Disease			0	-	0	+	0	0
EXTERNAL ISSUES								
Upstream Constraints and Impacts			0	+/-	+/-	0	+/-	0
Downstream Constraints and Impacts	*		0	+/-	+/-	+/-	+/-	+/-?
DIRECT CONSTRUCTION IMPACTS								
Land Acquisition			0	0	+	+	+	+
Compensation			0	0	0	0	0	0
Resettlement			0	-	+	+	+	+
Construction Management			0	0	-	-	0/+	0/+

RATING OF IMPACTS:

- + + Significant Positive Trend
- + Positive Trend
- 0 Present Baseline Condition
- - Negative Trend
- - - Significant Negative Trend

NOTES:

1/ Intervention is erosion control and accretion promotion

2/ Mitigation Required: Boat Centres and Construction Management

3/ Contingency of Multi-Purpose Embankment Construction and flood proofing should still be considered.

4/ Increased positive impacts could come with formalised resettlement strategy on newly accreted land.

5/ Need to monitor erosion/ accretion and construction impacts

7.6 Environmental monitoring, management and mitigation

There will be a need to monitor erosion and accretion patterns in the area regularly using time series satellite imagery. Such work will indicate the effectiveness of the intervention and also any induced impacts on navigation and particularly induced erosion to the mid-channel island chars.

If found necessary, then any induced disruption to navigation can be mitigated by the construction of carefully located boat centres as recommended and costed in the BIWTA study.[14]

An environmental monitoring programme 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 IEE report. With care a well implemented construction management plan can provide additional benefits.

The predicted effects of environmental mitigation programmes can be seen in the matrix by deducting column six from column eight.

7.7 Residual impacts

The possible residual environmental impacts can be seen in the last column of the matrix. The only negative residual impact is likely to be induced erosion of the mid-river char land. There is nothing that can realistically be done to prevent this erosion, if it should occur, and the overwhelming feeling of local people is that it is a small and justifiable price to pay for prevention of main river bank erosion. Consideration could be given to appropriate measures for resettlement and reduction in livelihood loss for the people who are seasonally resident and use the area.

7.8 Environmental risk

As stated in Section 7.2 above, it is considered imperative to retire the existing embankment as a matter of great urgency, irrespective of the proposed erosion control intervention. Such a step will also act as a contingency if the intervention were to prove unsuccessful, bearing in mind that such technology has not be used before in Bangladesh.

7.9 Conclusions of the environmental assessment

The main conclusion of the environmental assessment is that an Initial Environmental Examination is sufficient for the project and a full EIA is not required. It is apparent that the benefits of successful implementation far outweigh the potential negative impacts, all but one of which can be mitigated at an acceptable cost, should they occur. It should be remembered that the primary aim of the intervention is to preserve the present situation.

The main potential negative impact is possible induced erosion to the large island char in the main river channel. However, even the people with land rights in this area agree that preventing erosion on the mainland is of a much higher priority.

7.10 Future environmental work programme

The recommendation from the environmental analysis is for the intervention to go ahead as soon as possible.

Due to the fact that the existing embankment of the Chandpur Irrigation Project is under immediate threat of erosion it is considered imperative that it be retired to the predicted 10 year erosion line,

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14 Bangladesh Inland Water Transport Authority, Experimental Project for Improving the Efficiency and Profitability of Country Boat Operation, National Oceanographic and Maritime Institute, Dhaka, 1994.

preferably by upgrading an existing road alignment so as to minimise the negative impacts of land acquisition. In addition a programme of homestead flood proofing should be instigated in the areas on the non-embanked side of all retired embankments.

A monitoring programme for erosion and accretion patterns should be set up to observe the effectiveness of the intervention and identify the need for mitigation measures, particularly the provision of boat centres for waterborne navigation. The monitoring will also indicate if induced erosion to the large island char is taking place, prevention of which is not possible but consideration may need to be given to the resettlement and livelihood needs of people seasonally resident there.

A construction impact monitoring and management programme should be implemented using the checklist given in Appendix 5 of the Initial Environmental Examination.

8. ECONOMIC ASSESSMENT

This chapter contains the economic and financial analysis of the proposed project. The sensitivity of the results of the analysis to variations in key factors is discussed in detail. A multi-criteria analysis is also presented and potential risks facing project implementation are discussed.

8.1 Project costs

8.1.1 Erosion control works

The cost estimate for construction of the Haimchar Erosion Control 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 Chandpur 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 erosion control works are summarised in Table 8.1. Details of the costs for the various component types and for each year of the construction programme are given in Appendix V.

Table 8.1: Base costs of erosion control works.

Unit: Tk '000

Component	Number Required	Unit Cost	Total Cost
Permeable spur	34	4,781.8	162,581
Bottom screen (3 floats)	650	46.6	30,297
Bottom screen (4 floats)	430	52.8	22,725
Other costs			4,800
Physical contingencies			22,040
Total			242,443

Note: Excludes taxes, duties and DVA on imported geotextiles

O&M costs have been estimated at 5 per cent per year for the first two years after construction and then at 2 per cent per year.

8.1.2 Retirement of Embankment

Because the embankment of the CIP is close to the present bank line, it should be retired. This retirement should be to the expected without project 2010 bank line (see section 5.3.4). The length of the replacement embankment will be 8.75 km. The estimated cost of retirement is Tk 3.5 million per km. The crest of the embankment will be used for a road and a provision of Tk 1.5 million per km is made for road construction. Land acquisition is provided for at the rate of 3.5 ha per km of embankment at an average cost of Tk 300,000 per ha. Some of this cost may be avoided if the embankment follows existing road alignments wherever possible.

8.1.3 Flood Proofing

A provision for flood proofing for households outside the retired embankment is made based on the costs estimated for the Jamalpur Refinement Study (FAP 3.1, May 1997). This amounts to Tk 10,470 per household for works and materials and Tk 5,290 per household for design, management and supervision.

8.1.4 Analysis of project costs

Project costs have been analysed using COSTAB.[15] The analysis has used the following parameters:

[15] Costs analysis programme of the World Bank.

- the phasing of project costs follows the implementation and manning schedules in Chapter 9.1;
- projections for domestic and international inflation are from World Bank estimates of selected macroeconomic indicators made in July 1997 (see Table 8.2);
- the analysis uses constant purchasing parity exchange rates;
- physical contingencies are included at 10 per cent for all inputs, except BWDB project overhead and administration costs, for which no contingencies are included;
- 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 8.3);
- cost estimates include taxes, which are estimated based on currently applicable rates for equipment, materials and contractual services (see Table 8.3);
- project financing is calculated on the basis of the 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 costs have been included at 7.5 per cent and 2.5 per cent of base costs, respectively.

Table 8.2: Inflation and exchange rates

	98/99	99/00	00/01	01/02
Annual rates:				
Domestic Inflation (%)	5.0	5.0	5.0	5.0
International Inflation (%)	2.7	2.7	2.4	2.4
Compounded rates:				
Domestic Inflation (%)	5.0	7.6	13.0	18.7
International Inflation (%)	2.7	4.1	6.7	9.2
CPP Exchange Rates	47.0	48.6	49.8	51.1

Notes: 1/ Data collection and up to start of project implementation at 97/98 exchange rate.
2/ CPP = constant purchasing parity

Table 8.3: Taxes, foreign exchange and contingencies

unit: %

Item	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
Flood proofing	5	4.5	10
BWDB overheads	0	0	0
Design / Supervision	??	4.5	10

Notes: 1/ For bank protection works the principal taxes and duties are those on the import of geotextiles.

Total project baseline costs are estimated at Tk 379.5 million (US$ 8.1 million). With physical and price contingencies, the total comes to Tk 461.4 million (US$ 9.3 million). Of this amount, foreign exchange costs are estimated at 9.4 per cent. A summary of costs by year is given in Table 8.4.

Table 8.4: Project costs by year

Bangladesh
Haimchar Erosion Control Project
Expenditure Accounts by Years -- Base Costs

	Base Cost (Local '000)				Foreign Exchange		Base Cost (US$ '000)				Foreign Exchange	
	99/00	00/01	01/02	Total	%	Amount	99/00	00/01	01/02	Total	%	Amount
I. Investment Costs												
A. Bank Protection Works												
1. Geotextiles												
Geotextiles	22,126	22,001	-	44,127	49.0	21,622	471	468	-	939	49.0	460
Transportation	825	825	-	1,650	49.0	809	18	18	-	35	49.0	17
Subtotal Geotextiles	22,951	22,826	-	45,777	49.0	22,431	488	486	-	974	49.0	477
2. Local Materials	84,036	83,211	-	167,247	5.0	8,362	1,788	1,770	-	3,558	5.0	178
3. Equipment	6,890	6,890	-	13,780	5.0	689	147	147	-	293	5.0	15
4. Labour	6,623	6,573	-	13,196	-	-	141	140	-	281	-	-
5. Mobilisation	1,000	1,000	-	2,000	5.0	100	21	21	-	43	5.0	2
Subtotal Bank Protection Works	121,500	120,500	-	242,000	13.1	31,582	2,585	2,564	-	5,149	13.1	672
B. Embankments & Flood Proofing												
Materials & Equipment	10,889	54,639	5,444	70,972	5.0	3,549	232	1,163	116	1,510	5.0	76
Land Acquisition	-	9,300	-	9,300	-	-	-	198	-	198	-	-
Management & Supervision	5,502	5,502	2,751	13,754	5.0	688	117	117	59	293	5.0	15
Subtotal Embankments & Flood Proofing	16,390	69,440	8,195	94,026	4.5	4,236	349	1,477	174	2,001	4.5	90
C. Project Management												
BWDB Administration /a	9,353	9,353	2,078	20,784	-	-	199	199	44	442	-	-
Project Management /b	3,118	3,118	693	6,928	-	-	66	66	15	147	-	-
Subtotal Project Management	12,470	12,470	2,771	27,712	-	-	265	265	59	590	-	-
Total Investment Costs	150,361	202,411	10,966	363,738	9.8	35,818	3,199	4,307	233	7,739	9.8	762
II. Recurrent Costs												
A. Protection Works O&M												
Operation & Maintenance	-	6,075	12,100	18,175	-	-	-	129	257	387	-	-
Total Recurrent Costs	-	6,075	12,100	18,175	-	-	-	129	257	387	-	-
Total BASELINE COSTS	150,361	208,486	23,066	381,913	9.4	35,818	3,199	4,436	491	8,126	9.4	762
Physical Contingencies	13,789	19,602	2,030	35,420	10.1	3,582	293	417	43	754	10.1	76
Price Contingencies												
Inflation												
Local	10,815	26,442	4,596	41,853	-	-	230	563	98	890	-	-
Foreign	743	1,380	42	2,165	100.0	2,165	16	29	1	46	100.0	46
Subtotal Inflation	11,558	27,822	4,638	44,017	4.9	2,165	246	592	99	937	4.9	46
Devaluation	958	1,844	44	2,847	70.2	1,999	-104	-267	-49	-421	-	-
Subtotal Price Contingencies	12,516	29,666	4,682	46,864	8.9	4,164	142	325	49	516	8.9	46
Total PROJECT COSTS	176,666	257,753	29,778	464,197	9.4	43,564	3,634	5,178	583	9,395	9.4	884
Taxes	16,237	20,253	1,340	37,830	-	-	334	407	26	767	-	-
Foreign Exchange	19,725	23,304	535	43,564	-	-	406	468	10	884	-	-

\a BWDB administration costs - 7.5% of civil works base costs
\b BWDB overhead costs - 2.5% of civil works base costs

Under the financing assumptions mentioned above, Government's contribution to the project would be Tk 115.3 million (US$ 2.33 million) or 25.0 per cent of total costs while the Donor contribution would be US$ 7.0 million or 75.0 per cent.[16] The largest expenditures under the project are expected in the second year (2000/2001) when the second cross dam would be constructed. The estimate of Government's contribution for this year is Tk 48.3 million. This is would amount to less than 0.5 per cent of Government's Development Budget, which is currently around Tk 125 billion per year.

Further detailed information on project costs may be found in the tables in Appendix V.

8.2 Project benefits

Net project benefits are the difference between future benefits if the project is not implemented and the benefits in the future with implementation of the project. In the case of the Haimchar Erosion Control Project, the net benefits are the value of production and assets that are saved from erosion if the project is successfully implemented.

In the future without the project, it is assumed that without intervention to halt the erosion all of the defined project area (see Figure 1.2) will be eroded away, with the complete loss of land, agricultural and other production, infrastructure, buildings and other immovable assets. Losses (disbenefits) occurring if the project is not implemented amount to the value (cumulative over the life of the project) of existing annual production in agriculture, pond fisheries and forestry and the value of existing infrastructure and immovable assets. Not included in the estimate of losses, with the exception of the retired CIP embankment, are buildings and infrastructure that may be constructed between the present and the future erosion of the land in question.

In the future with the project, successful implementation of the proposed interventions will halt the erosion process. For the purposes of this analysis it is assumed that in the future with the project production, infrastructure and immovable assets are the same as in the present (see Chapter 6).

8.2.1 Project beneficiaries

The project beneficiaries are all the present inhabitants of the project area. Based on 1981 and 1991 census data and the estimated project area based on satellite imagery and the estimated river bank in 2025 without project intervention, the 1996 population of the project area is estimated at 98,360.

8.2.2 Quantified benefits

The benefits of the Haimchar Erosion Control Project accrue from the protection of infrastructure, land and production. The benefits quantified for the analysis, which are assumed to accrue immediately from the implementation of the protection works, are:

- agricultural land and production
- aquacultural production
- trees and tree crops
- infrastructure
- buildings, including dwellings

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

Future without project losses are based on the land expected to be eroded each year. These are given in Table 8.5.

Table 8.5: Erosion of land without project

unit: ha

Section	1996 - 2010		2011 - 2024		Total
	OE	IE	OE	IE	
0 - 9 km	261	-	467	-	728
	(18.6)		(33.4)		
9 - 21 km	1381	571	378	1642	3972
	(98.6)	(40.8)	(27.0)	(117.3)	
	1642	571	845	1642	4700

Notes: 1/ OE = outside embankment; IE = inside embankment
2/ Section distances are measured from north to south in the project area.
3/ Numbers in brackets are areas eroded per year.

Agricultural Production: Existing agricultural production is estimated using overall crop and farm budgets for areas inside the existing embankment and those outside (see Appendix VI, Tables VI.1 to VI.3). These are based on data obtained from thana and union offices, a survey of the area by project staff and secondary sources (e.g. the Agricultural Year Books of BBS). Agricultural land is estimated to amount to 85 per cent of the area outside the embankment and 90 per cent of the area inside. Rent has not been deducted from farm budgets and the calculated net revenues therefore include an estimate of the annual value of land. A separate estimate for the value of land lost is not included in the estimate of benefits. The production lost each year is calculated as the value of production lost on land expected to be eroded in that year. Total lost production is the cumulative total of production losses.

In the future with the project, it is assumed that the project interventions are successful and erosion ceases, i.e. with the project there is no further erosion of land. (In practice some erosion may continue in some locations: this possibility is considered in the sensitivity analysis.) Successful implementation of the project will also not eliminate the risks of periodic large floods. The potential damage from this source is not included in the analysis since it would most probably be similar with or without the project.

Aquaculture Production: Production in existing ponds has been estimated for both cultured and culturable ponds and net revenues from production estimated (see Appendix VI, Tables VI.4 and VI.5). The number of ponds in the project area has been estimated from thana and union data, pro-rated according the proportion of a union in the project area. Rates of production are the same for ponds inside and ponds outside the embankment. Ponds are assumed to evenly distributed and are eroded in the same proportion as land. Lost production is cumulative.

Forestry: Trees are concentrated around homesteads in villages forests. However, annual production of major species has been estimated on a per hectare basis (see Appendix VI, Table VI.6), which assumes an even distribution of trees throughout the project area. The erosion rates in Table 8.5 are then applied to obtain (average) annual losses, which are cumulative. In addition an estimate is made of the residual value of trees lost each year to erosion and added to the total loss. This portion of the forestry losses is not cumulative.

Because of the lack of area specific data, the value of forestry losses has been estimated conservatively and may be underestimated. Only major representative species have been included in the calculation and the value of immature trees has not been included.

Infrastructure: Major items of infrastructure in the project area have been valued. Two approaches have been adopted for valuation. For infrastructure that will be replaced - viz. embankments, the road on the crest of the embankment and water management infrastructure - current replacement costs have been applied. For infrastructure that will not be replaced because the land to which it relates no longer exists - viz. roads, bridges and culverts and

transmission lines - it is assumed that its average age is two thirds of the expected life of the particular item and replacement costs are adjusted accordingly.[17]

The location of infrastructure has been identified using LGED maps and information from the project survey. This information is not exact, however, and neither is that about when a particular location may be eroded away by the river. Thus, roads, bridges and culverts are assumed to erode in proportion to the erosion of land (as with other assets that relatively common). Large individual items have been grouped and are "eroded" in five yearly blocks, unless it is possible, as in the case of the retirement of embankments, to have specific expectations about when loss (or expenditure) would occur (see Appendix VI Table VI.7). More detailed estimates of when these items might actually be destroyed would have only a minor impact on the economic analysis.

Dwellings and Other Buildings: This estimate is based on thana and union records of the buildings and dwellings within their respective jurisdictions. Data on costs has been averaged for each class of building and the averages used as a substitute for replacement costs. The same assumption about the average age has been made as for infrastructure. (see Appendix VI, Table VI.8)

For dwellings and classes of buildings that are relatively numerous (mosques, primary schools), losses are assumed in proportion to the erosion of land. Other buildings are assumed lost in five yearly blocks, base on estimates of approximately when loss may be expected. (see Appendix VI, Table VI.9)

8.2.3 Non-quantified benefits

A number of potential benefits, both quantifiable and non-quantifiable, have not been quantified, either for lack of data or because their value is unlikely to be significant in terms of the overall economic viability. However, quantification of any or all of these benefits would have a positive effect on the EIRR. Benefits that are in principle quantifiable but which have not been quantified include:

- irrigation infrastructure in the CIP (although much of this would be in the form of LLPs which would be removed if threatened with erosion);
- the capital cost of fish ponds;
- non-agricultural land;
- relocation and other costs, apart from the costs of buildings, that would be incurred by schools, health clinics, government administration and businesses in the event of erosion;
- the value of buildings and infrastructure constructed between the present and the time when land would eventually be eroded in the future without the project (which could be as much as 27 years away);
- the value of increases in productivity in agriculture, aquaculture and tree crop production between the present and the time when land would eventually be eroded in the future without the project.

The most important non-quantifiable benefit of the project is the avoidance of disruption to the lives and livelihoods of all project beneficiaries.

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[17] This implies that over the life of the project maintenance and necessary replacement of infrastructure maintains this average age. This assumption has been made because detailed data on the age of much infrastructure has not been available.

8.3 Economic analysis

The project life for the economic analysis is 26 years (1999 - 2024). 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 prices,[18] except for labour and for the other cases noted below. For labour, a conversion factor of 0.85 has been used in line with other recent studies.[19]

8.3.1 Prices

Financial and economic import parity prices have been estimated for rice, wheat, sugar cane, TSP and potash and export parity prices for jute and urea. With the exception of jute, for which a price projection has not been available, these prices are based on World Bank price projections for 2010. These 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.10)

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 masur, 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. The calculations are shown in Appendix VI, Tables VI.18 to VI.21.

Financial and economic prices for agriculture are summarised in Table 8.6.

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

Costs and prices used for the valuation of infrastructure and buildings are indicated above in section 8.2.2.

8.3.2 EIRR and NPV

The EIRR for the project base case is 15.6 per cent and the NPV Tk 79.9 million. Since the EIRR is above the discount rate, the project is economically feasible. (The calculation is shown in Appendix VI, Table VI.15)

This result is significantly different from the results obtained for Haimchar protection works in FAB 9B. This is for two main reasons:

a) the methods proposed by MES have much lower cost than the conventional methods proposed previously; the costs included in this feasibility study (including the cost of retirement of the CIP embankment and flood proofing for households outside the future embankment) are about half those of the FAP 9B study;

b) the proposals in this study provide protection for a longer portion of the river bank than the proposal studied in FAP 9B; the greater area protected generates greater benefits.

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18 Estimated by the World Bank in July 1997 for 1997/98 fiscal year.

19 e.g. Kalni-Kushiyara River Management Study, May 1997.

Table 8.6: Prices for agricultural inputs and outputs (Tk/mt)

Crop	Conversion Factor	Financial Price	Economic Price
Traded crops:			
Rice	1.024	6,489	6,645
- aus	1.145	5,803	6,645
- aman	0.961	6,914	6,645
- boro	1.113	5,969	6,645
Wheat	1.019	6,427	6,547
Jute	1.118	9,433	10,541
Non-traded crops:			
Oilseeds (mustard)	0.902	16,712	15,074
Potato	0.902	4,804	4,333
Pulses (2)	0.902	13,099	11,816
Chillis (dried)	0.902	48,352	43,613
Inputs:			
Urea (3)	0.984	5,700	5,611
Muriate of Potash	0.978	9,122	8,921
TSP	0.979	9,858	9,650
By-products:			
Rice straw	0.902	1,200	1,082
Jute Stems	0.902	2,500	2,255

Sources: Derivations of prices are given in Appendix VI Tables VI.16 to VI.21

Notes:

Traded crops and inputs based on WB price projections.

Non-traded crops and inputs based on national farm gate price data.

1. Based on average 1996 world price
2. Composite of masur, mung and keshari.
3. Existing subsidy on urea assumed to be eliminated in medium term.

8.3.3 Sensitivity analysis

The results of the sensitivity analysis are shown in Table 8.7. The EIRR is generally robust to changes in both costs and benefits. If total project costs increase by 20 per cent, EIRR falls to 12.6 per cent, while if benefits fall 20 per cent of the level estimated, the EIRR will be just above 12.0 per cent. The combination of a 20 per cent increase in costs and a 20 per cent fall in benefits would take the EIRR below the discount rate to 9.6 per cent. This is considered a relatively unlikely event, however, since benefits have been conservatively estimated and some potentially significant benefits have not been quantified because of estimation difficulties. Switching values - i.e. the changes in costs or benefits that would reduce the EIRR to the opportunity cost of capital (i.e. 12 per cent) are +25.3 per cent for costs and -20.2 per cent for benefits.

As noted elsewhere, the value of forest resources have most probably been underestimated. An increase of 20 per cent in forestry benefits increases EIRR by about 0.5 per cent. Since not all species have been included in the valuation and immature trees have been excluded, the true value of forestry benefits may be considerably more than that included in the analysis.

If erosion without the project occurs at a faster rate than the estimated levels used in the analysis, then benefits will accrue more quickly and EIRR will be higher. A 10 per cent increase in erosion rate increases EIRR to 17.0 per cent and a 10 per cent decrease would reduce EIRR to 14.3 per cent. It would require a decrease of about 26 per cent in the anticipated without project erosion rate to reduce the EIRR to the opportunity cost of capital.

A lag in the accrual of benefits, which would reflect the situation if there is a delay between the implementation of protection measures and the halting of the erosion, reduces the EIRR. A lag of one year reduces the EIRR to about 13 per cent.

8.4 Multi-criteria analysis

Relevant data for the multi-criteria analysis is presented in Table 8.8.

With regard to quantitative measures of the impact of the project, it is noted that if the project is not implemented, then all existing production will eventually be lost.

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. In particular, the social impacts in the with project situation will be neutral since the project will not address any of these development related issues. However, if the project is not implemented, the consequences of the erosion of land will have negative effects for many groups and aspects of life in the project area. This is, indeed, generally true for this project: non-implementation will have many negative consequences that will be avoided if the project is successfully implemented.

8.5 Project risks

There are two main risks associated with the project:

- that the proposed interventions will partially fail
- that damage will be still be caused to the project area by extreme flood events.

The type of intervention proposed for the erosion control works 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.

Table 8.7: Sensitivity analysis (EIRR)

		Change in Variable			
		- 20%	- 10%	+ 10%	+ 20%
Base case	**15.6**				
Total erosion		12.9	14.3	17.0	18.2
Total Costs		20.0	17.6	14.0	12.6
O&M Costs		15.8	15.7	15.5	15.4
Total Benefits		12.0	13.8	17.4	19.1
Benefits from:					
- agriculture		4.6	15.1	16.1	16.6
- aquaculture		15.5	15.6	15.6	15.7
- tree crops		15.1	15.4	15.8	16.1
- infrastructure a)		15.0	15.3	15.9	16.2
- buildings b)		15.2	15.4	15.8	16.0
- dwellings c)		14.6	15.1	16.1	16.6
- a + b + c		13.7	14.6	16.6	17.7
Lag benefits 1 year	13.3				
	Costs	Benefits	EIRR (%)		
Total Costs & Total Benefit	+ 20%	- 20%	9.6		
	+ 10%	- 10%	12.4		
	- 10%	+ 10%	19.5		
	-20%	+ 20%	24.7		
Switching Values:	EIRR = 12%		Project Life	EIRR	
Total Costs	+ 25.3%		20 years	14.3	
Total Benefits	- 20.2%		15 years	11.6	
Annual Erosion	- 26.3%				

Table 8.8: Multi-Criteria Analysis Format

			Project	
			A	
1	**Economic**	**Measurable Unit**	-	
	EIRR	Percent (%)	15.6	
	NPV	Million Tk.	79.9	
2	**Financial**			
a.	Total Investment Cost	Million Tk.	461	
	Foreign Ex. Component	Million Tk.	43.2	
b.	O&M Cost (annual)	Million Tk.	4.2	
3	**Quantitative**		**Total**	**Incre.**
a.	Production	Metric Ton	-	-
	Rice	"	10450	-10450
	Wheat	"	-	-
	Pulses	"	210	-210
	Fish	"	150	-150
b.	Employment (Farm)	Man-Month	34600	-34600

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

Rating of Impacts

+Postive Trend - Negative Trend

++Significant Positive Trend -- Significant Negative Trend

0 No change from baseline situation.

8.6 Conclusions and Recommendations

The technical feasibility of the proposed interventions for the Haimchar Erosion Control Project have been validated by the ongoing trials at Haimchar and Khorki. With use of these relatively low cost methods of bank protection, this study has shown that intervention to protect the existing bank line south of Chandpur would also be economically viable. Implementation of the proposed project is therefore recommended.

9. PROJECT IMPLEMENTATION

9.1 Brief description of the works

The project will provide erosion control works at six locations: Sakhua North and South, Hanarchar North and South as well as Haimchar North and South. In total 34 spurs and 1140 bottom screens have to be installed. The installation of these structures should be done in the winter season when the water levels are low, the periods of slack water of maximum duration and the current velocities minimal.

In order not to overload BWDB/Chandpur and the contractor with too much work in a relatively short time, the Haimchar Erosion Control Project has been spilt into two phases. Phase I includes the implementation of the remainder of the works at Hanarchar South as well as the works at Haimchar South. During phase II the works at Sakhua, Hanarchar North and Haimchar North will be completed. Some adjustment of the planning may be required if it appears that protective measures are urgently required at Haimchar North.

The works mainly consist of:

- procurement of geotextiles
- procurement of floats for bottom screens
- manufacturing of geotextile bed protection and screens
- manufacturing of pre-fabricated components of spurs and screens
- installation of the bed protection on the river bed and ballasting
- installation of A-frames for river spur by THP
- dumping of concrete blocks for river spur and sloping spur
- excavation and refill of land spur
- placing of bed protection, A-frames and concrete block of land spur
- placing of slope protection
- installation of bottom screens by THP.

The proposed implementation schedule for the erosion protection works is given in Figure 9.1. It has been assumed that the feasibility report will be approved in early 1999 and that financing of the Haimchar Erosion Control Project will be available by August 1999.

In order to complete installation of the spurs and screens during the low flow season as well as ahead of the nor'wester season, it is imperative that the civil works contractor can start the works in the first week of October. A later start will have a negative impact on the quality of the works as well as resulting in cost increases due to weather conditions during which work will be impeded.

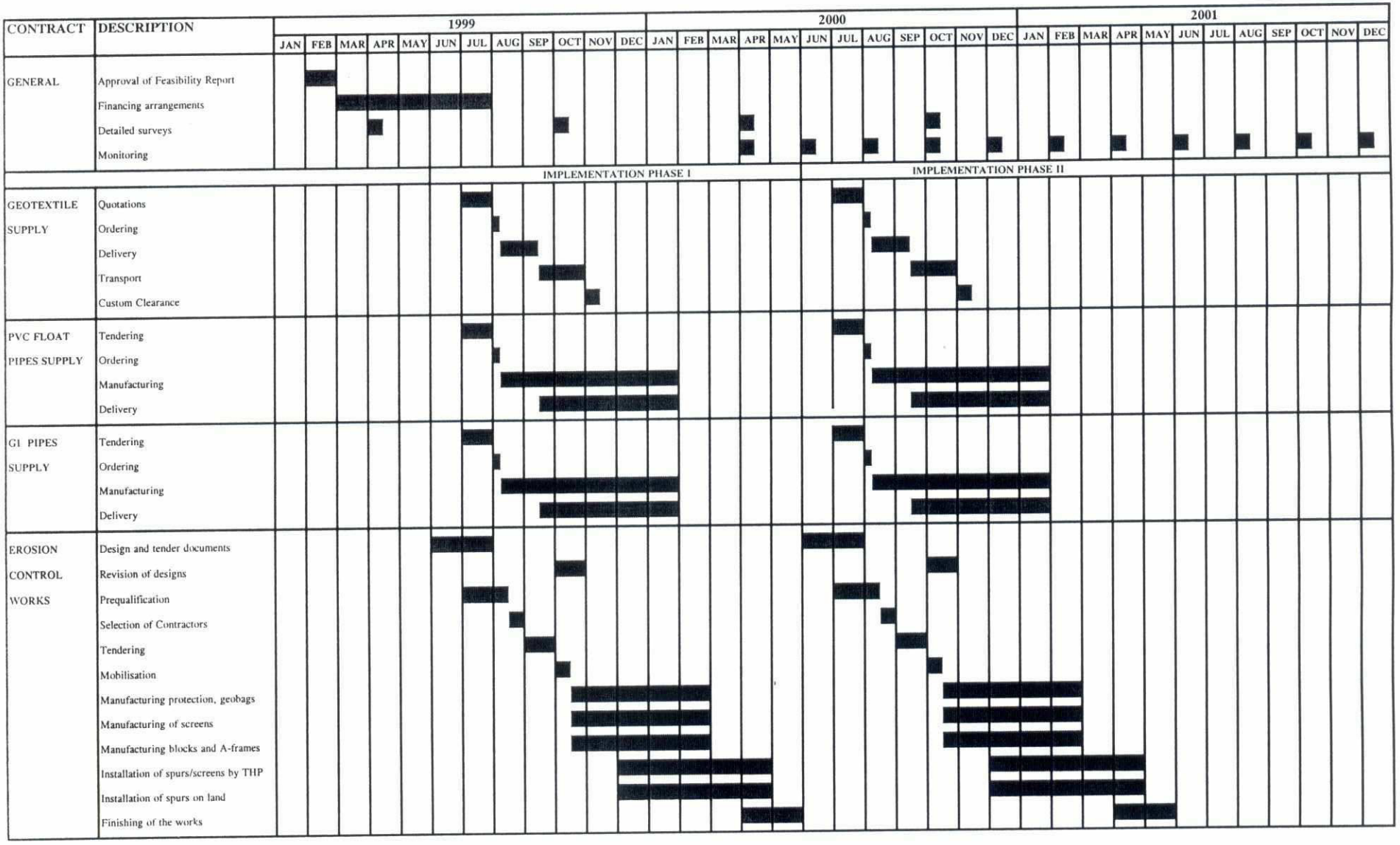
After completion of the implementation phase I, the works will have to be monitored on a regular basis. Monitoring will include bathymetric surveys, current profiling and under water inspections.

The inspection reports will provide information on the performance of the erosion control works and also form the basis for regular maintenance of the works.

The retirement of the CIP embankment should commence as soon as possible, preferably in year one or two in order to minimise any risk of its being breached and of flood damage to the CIP area. (In the cost analysis, the retirement of the embankment has been scheduled for year 2 of the project.)

Flood proofing activities have been scheduled for years 1, 2 and 3 of the project.

Figure 9.1: Implementation schedule of Haimchar Erosion Control Project



9.2 Technical Assistance

The consultant of MES II will assist the BWDB in preparing a programme for detailed surveys of the project area and for monitoring of the performance of the works. The consultant will also assist in preparation of the design and tender documents as well as the revision of the design ahead of the implementation of the works.

During MES II the consultant will be available for advise with regard to execution of the works.

9.3 Institutional Arrangements

It is proposed to implement the Haimchar Erosion Control Project under the direct responsibility of the Chandpur O&M Circle of BWDB, Chandpur. This circle will also be responsible for future monitoring and maintenance of the erosion control works.

The same circle would also be responsible for retirement of embankments and flood proofing of the areas on the river side of the flood embankments.

The Survey Unit Anwesha of LAED/SSD will be available for the hydrographic surveys and under water inspections.

It is recommended to establish a special Erosion Control Division within the O&M Circle of BWDB, Chandpur,

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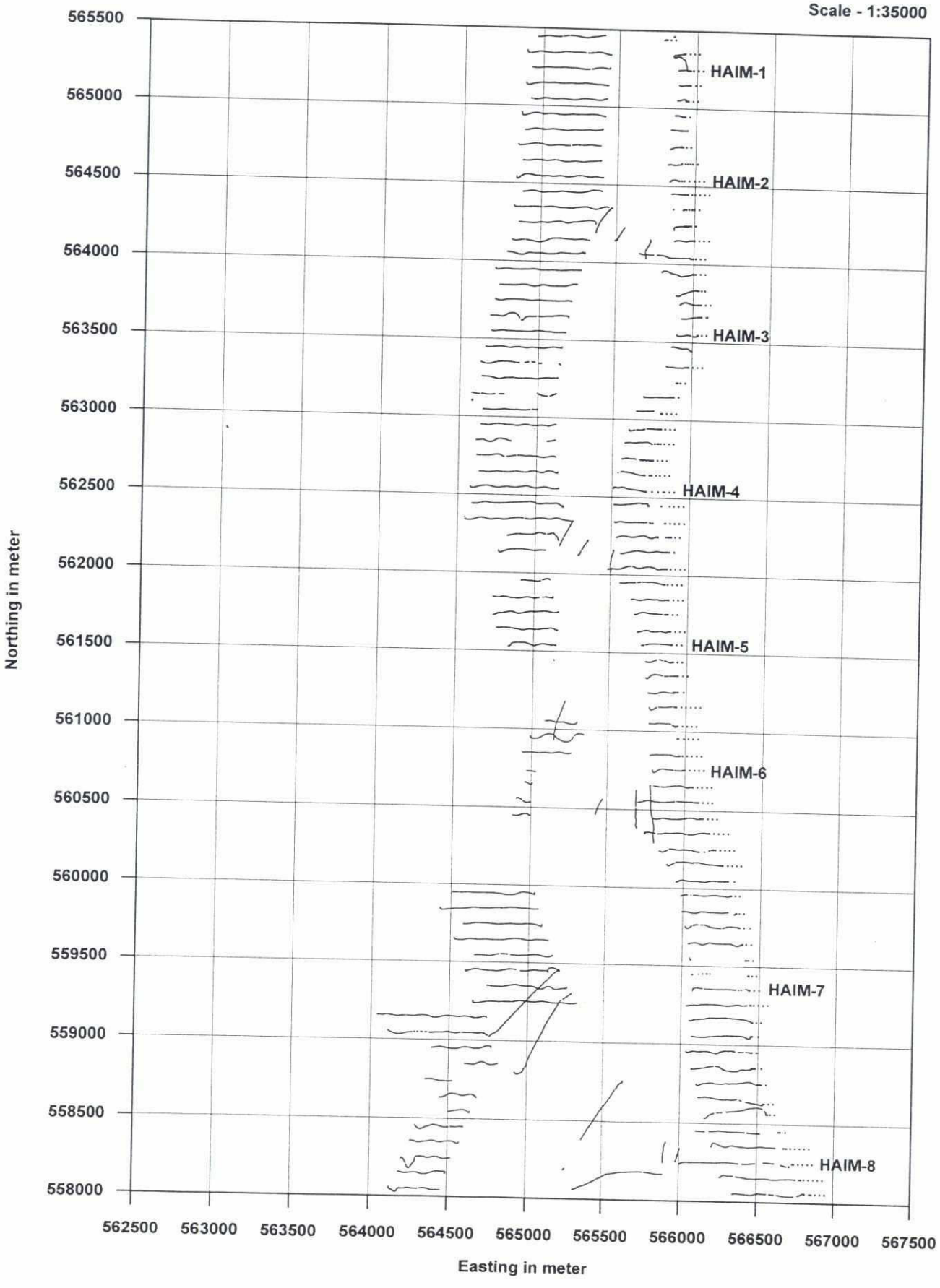
APPENDICES

HAIMCHAR

Bathy survey : 04 - 07 Dec 97
Land survey : 09 - 29 Jan 97



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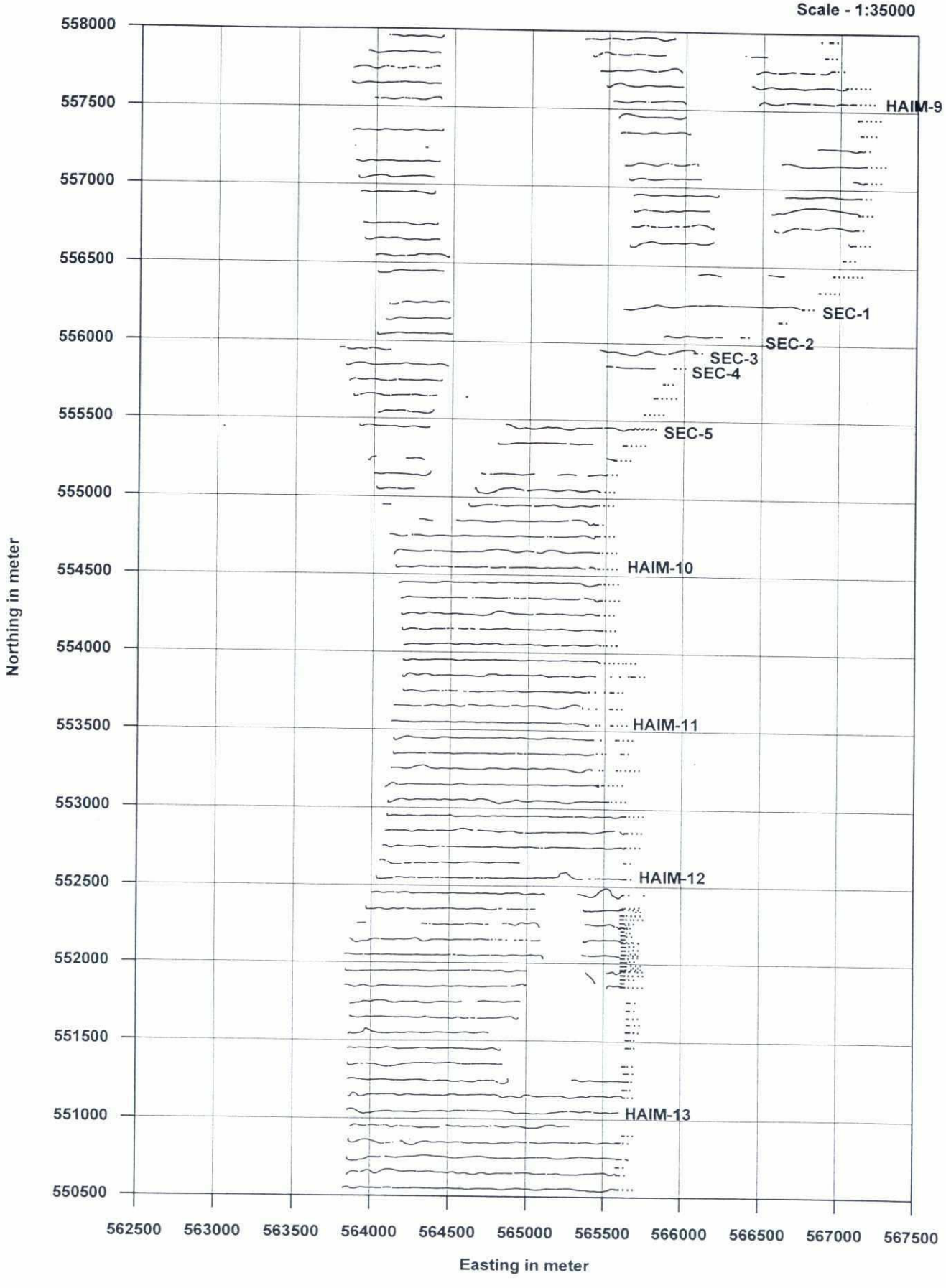

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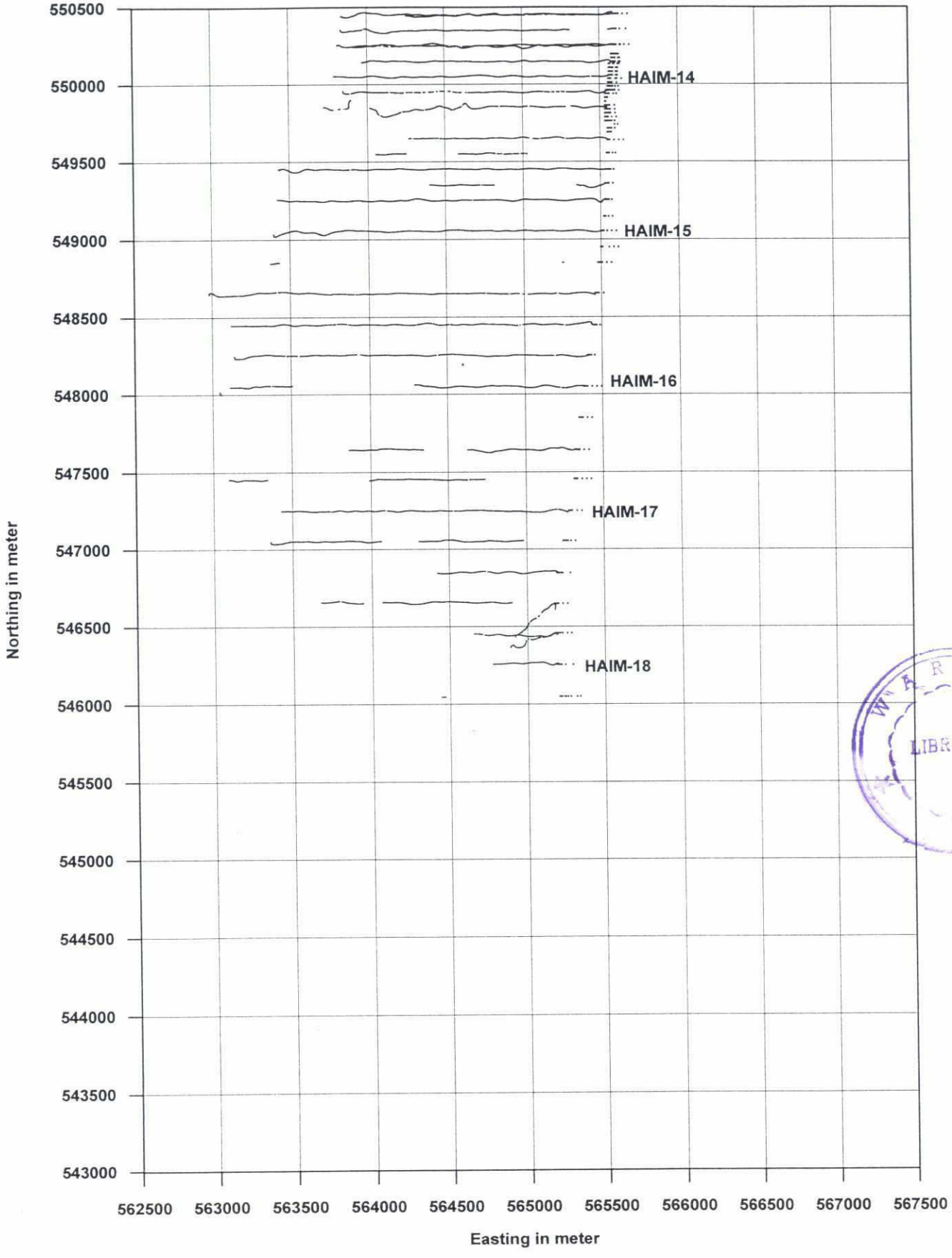

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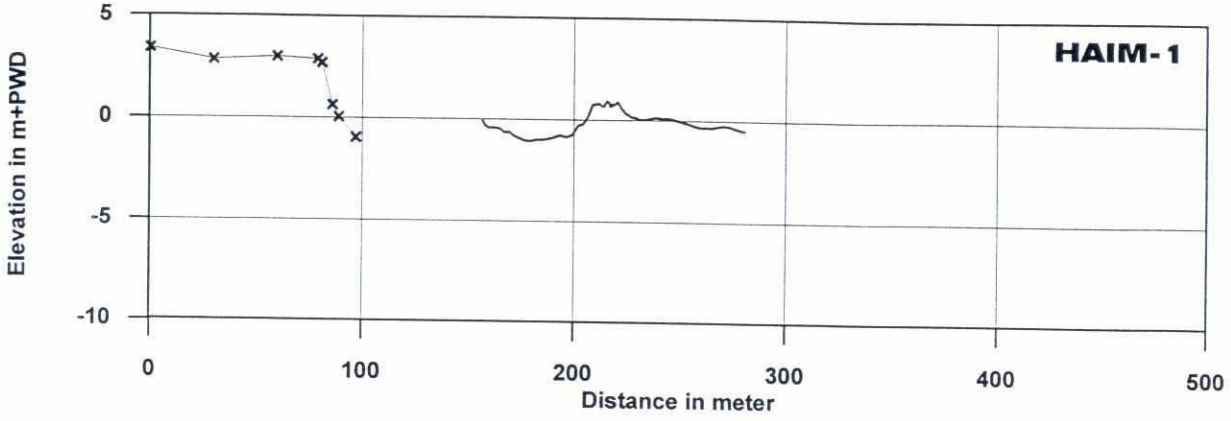

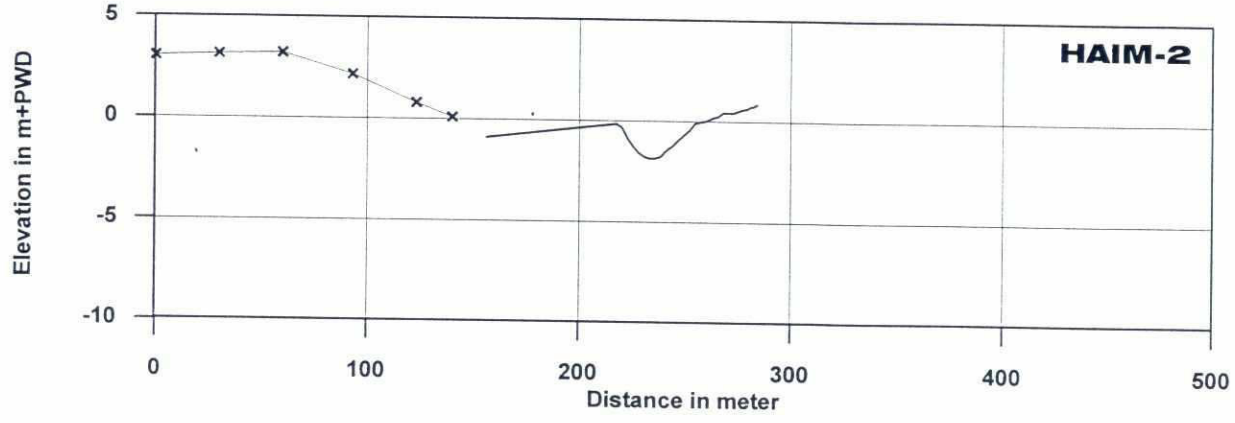

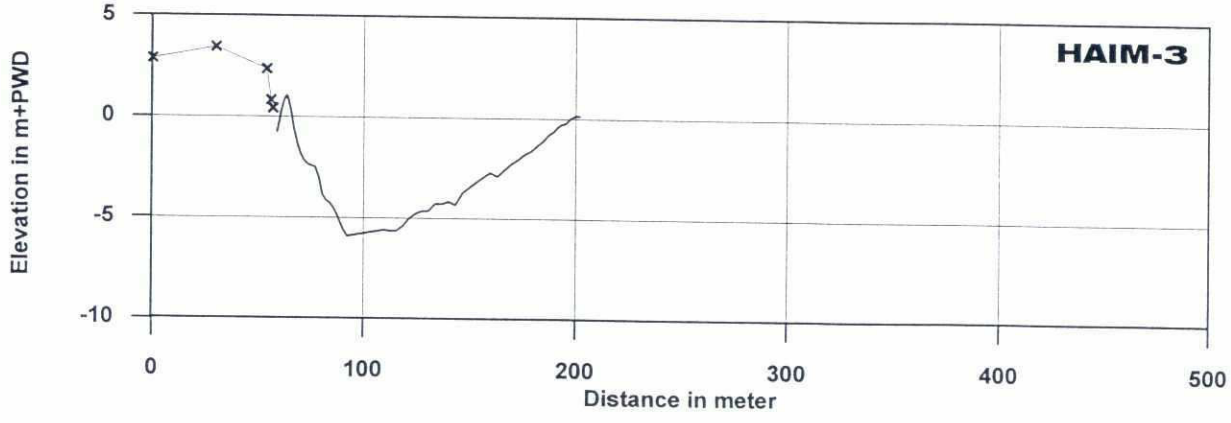

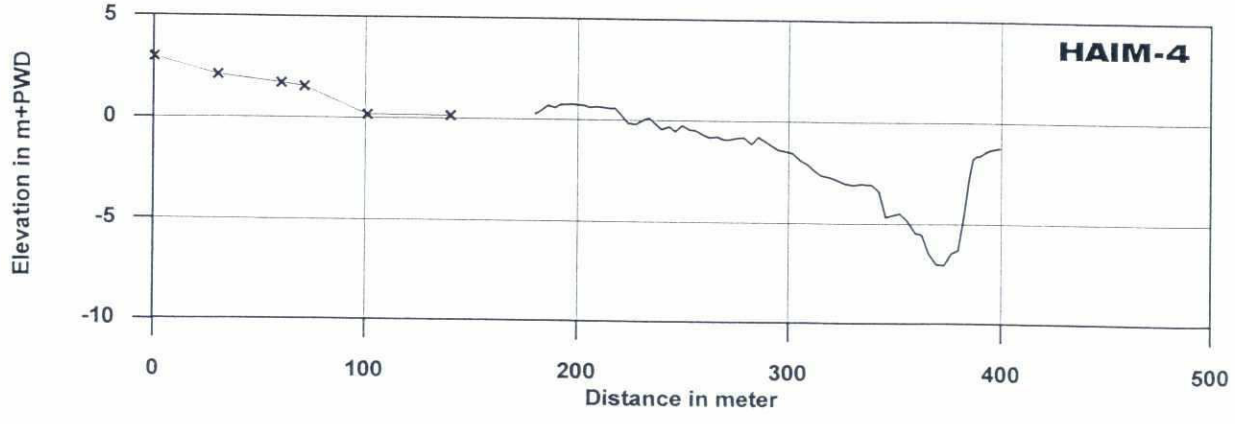

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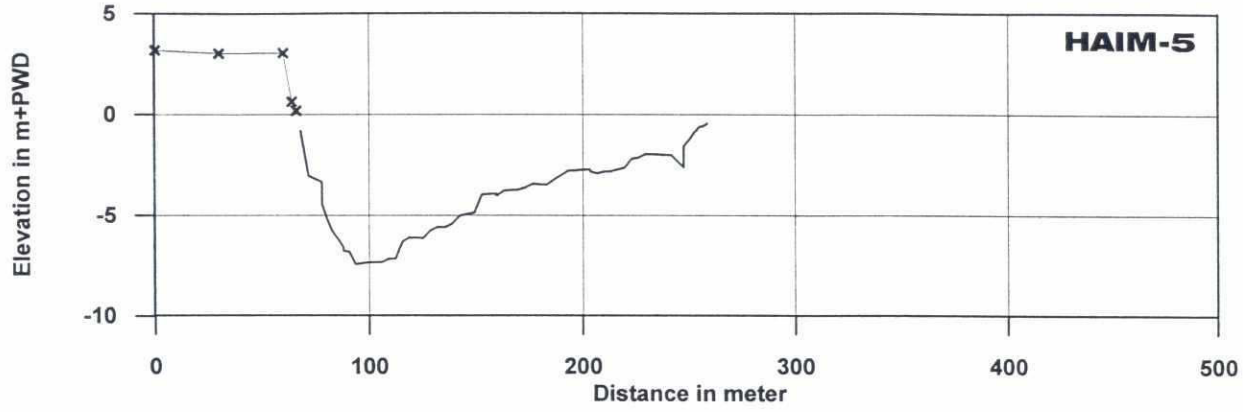

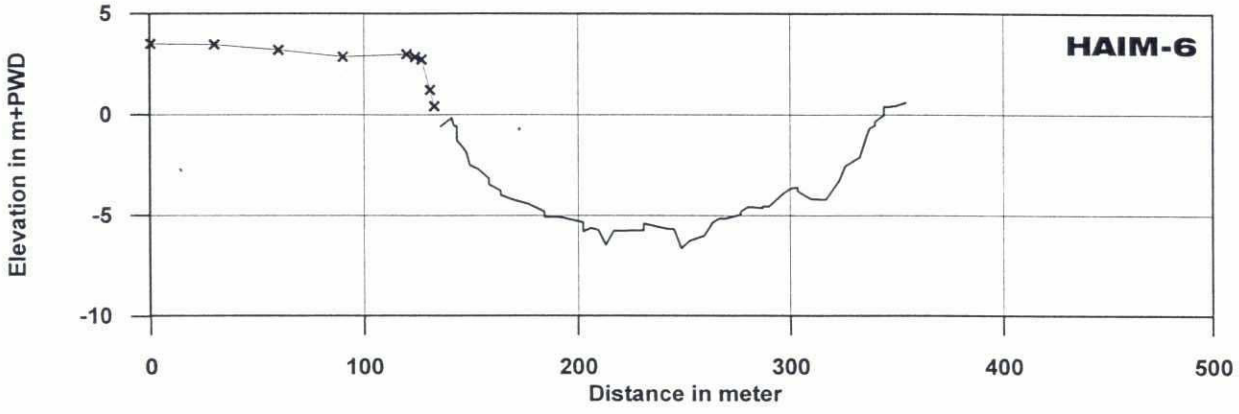

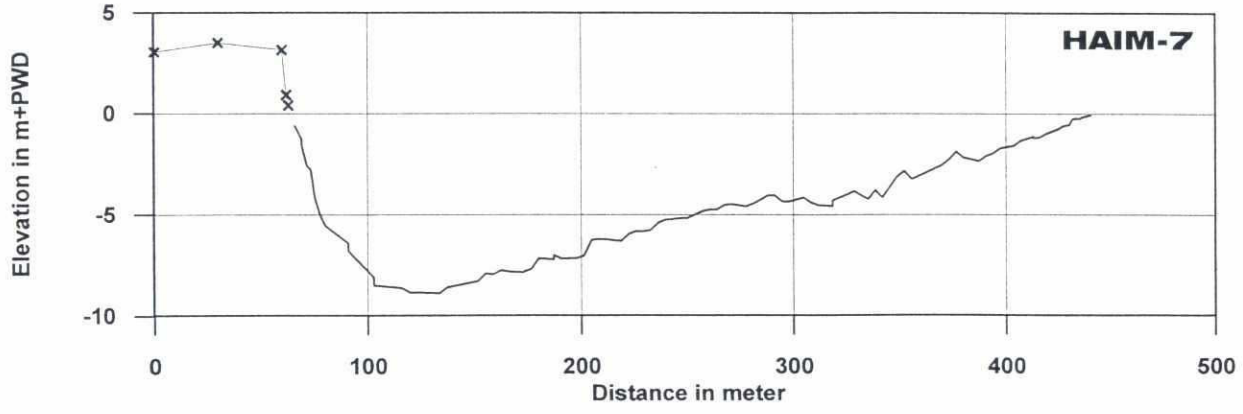

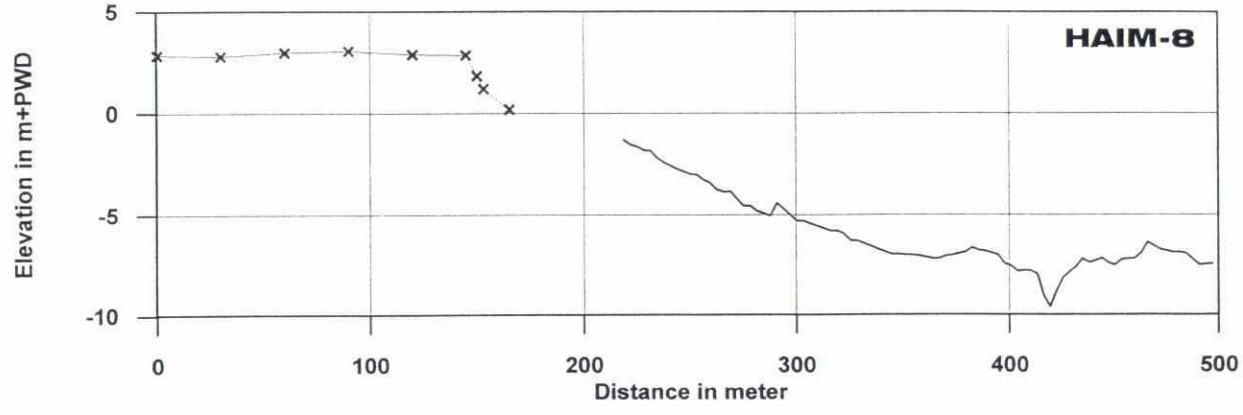

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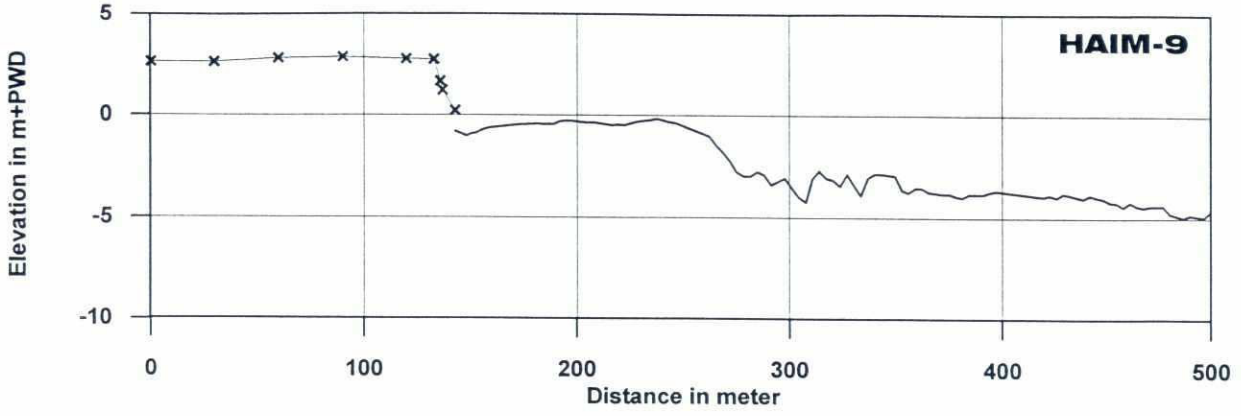

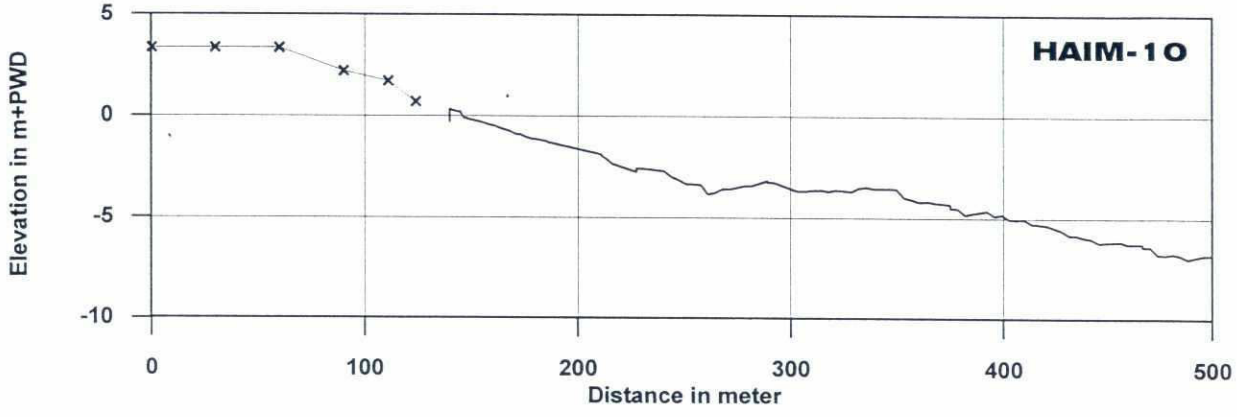

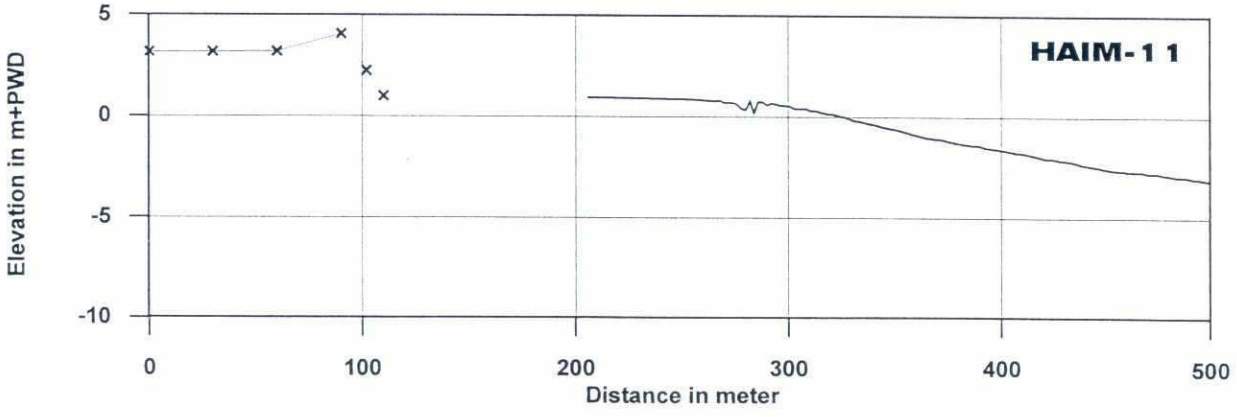

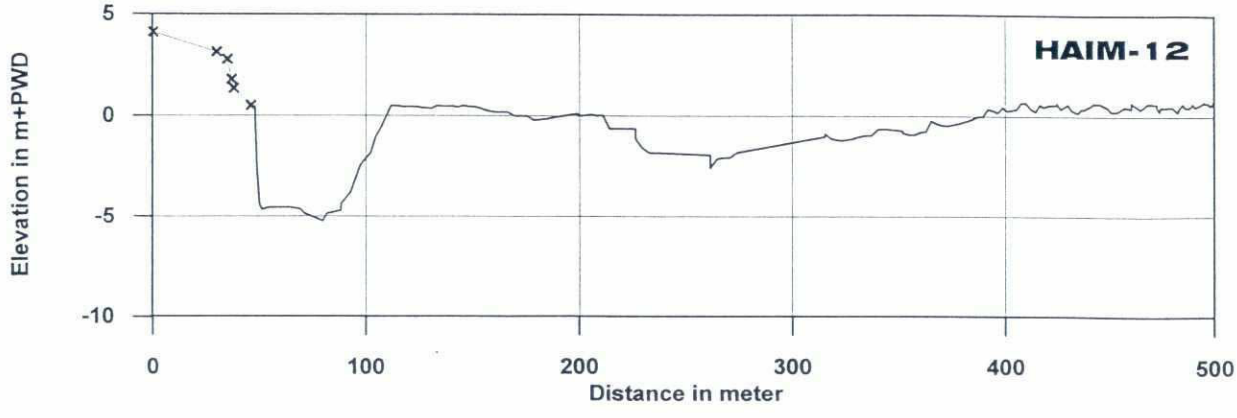

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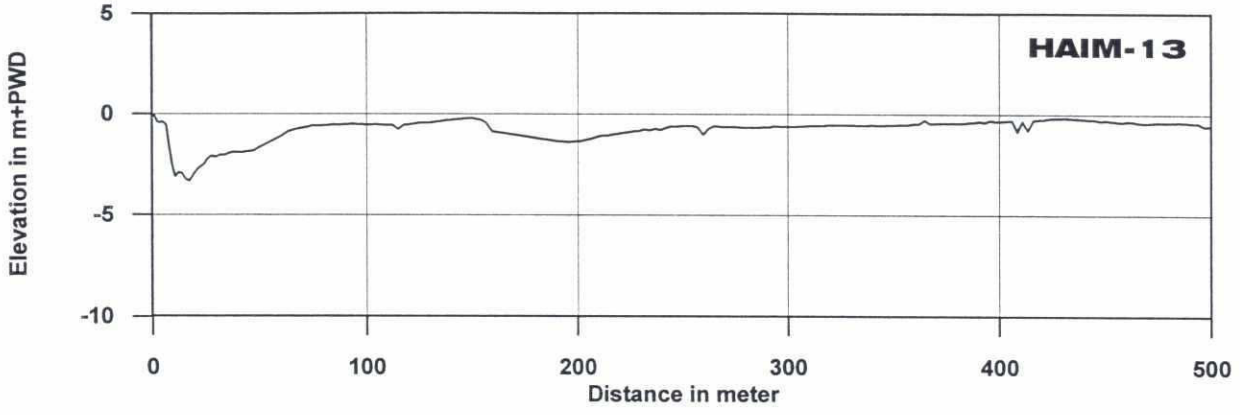

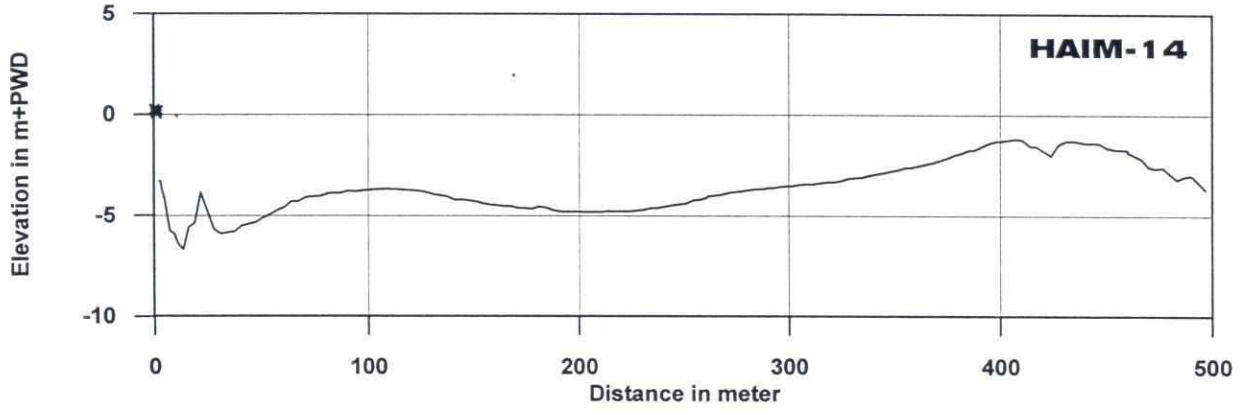

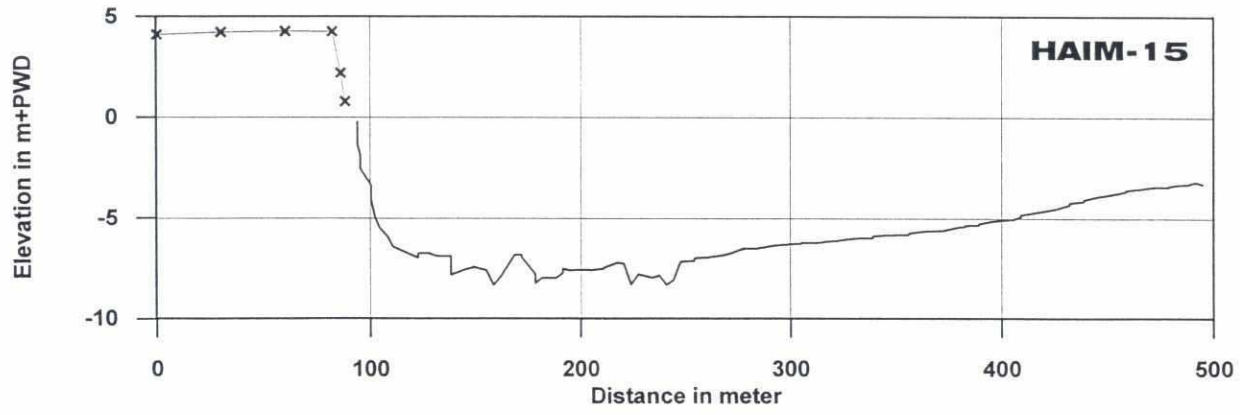

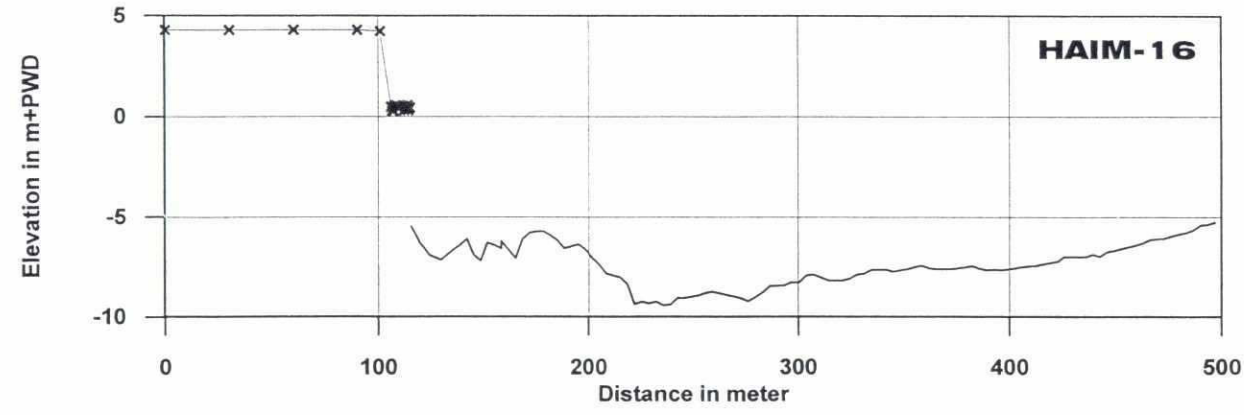

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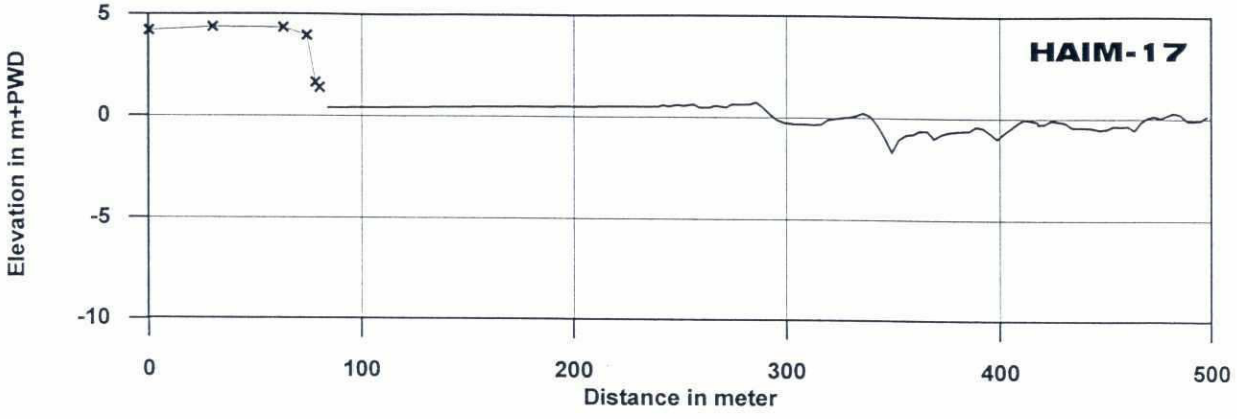

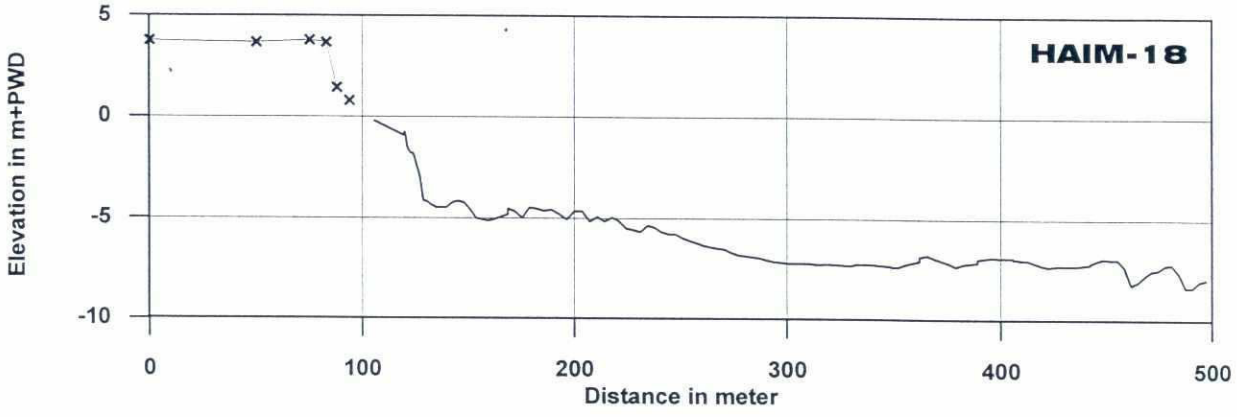

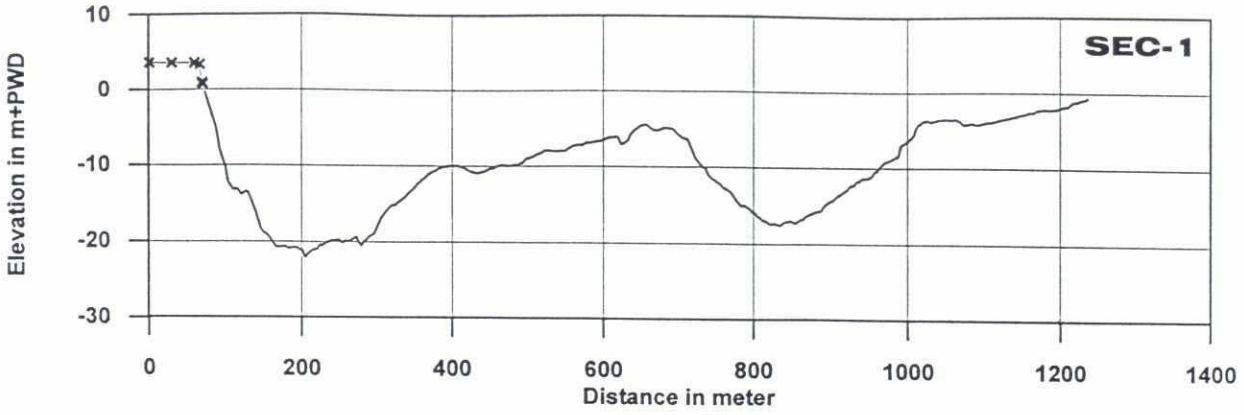
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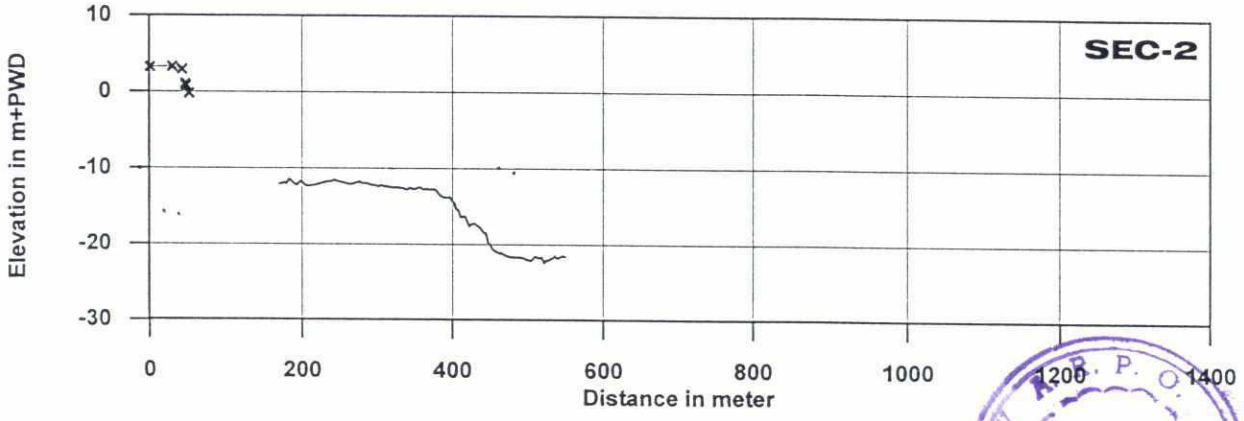
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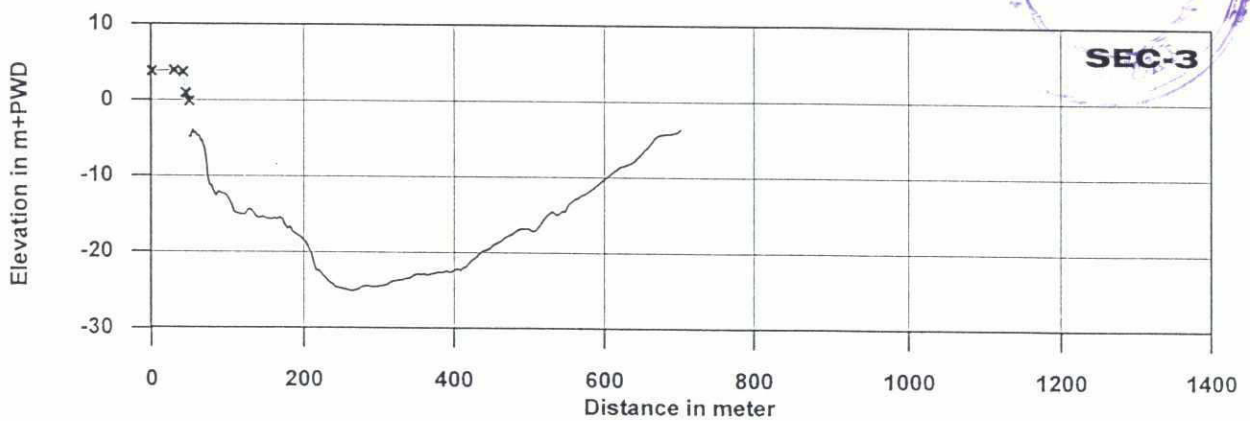
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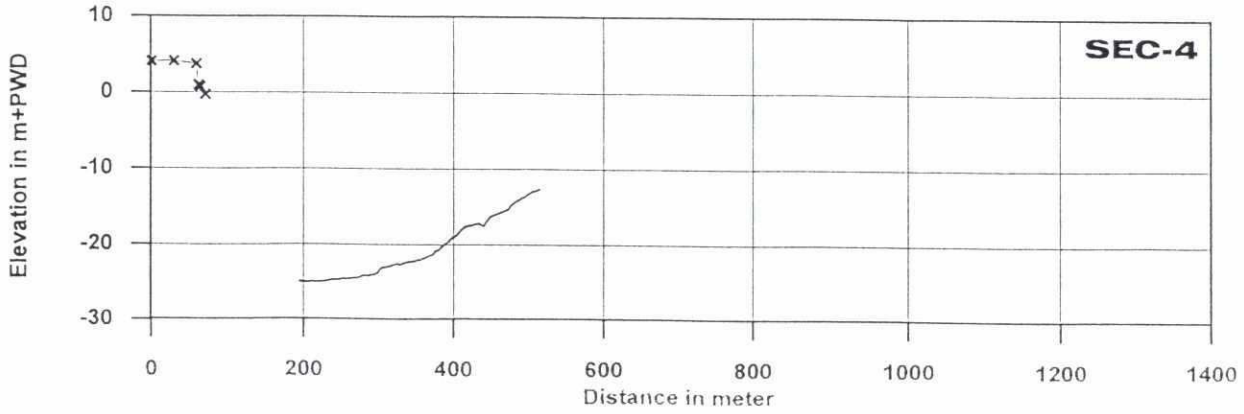
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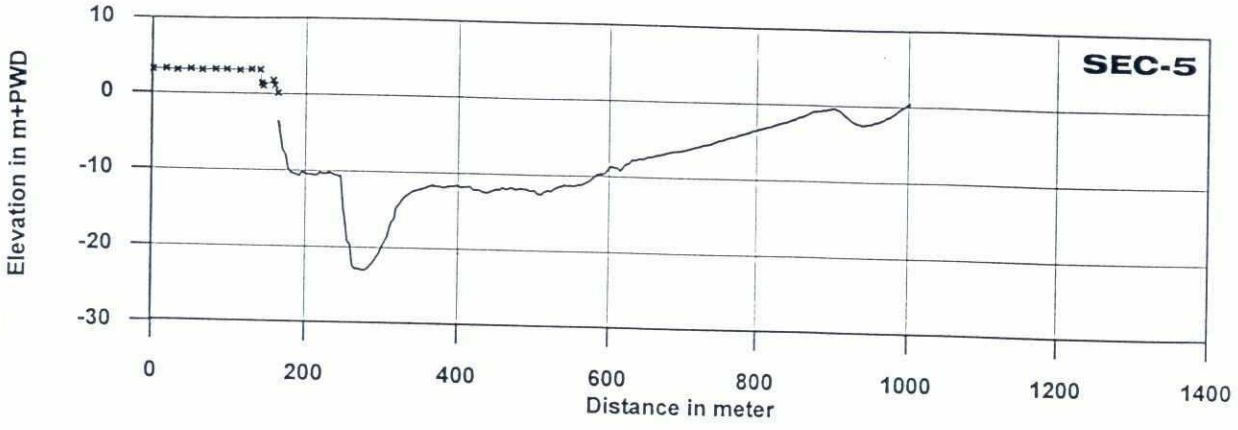
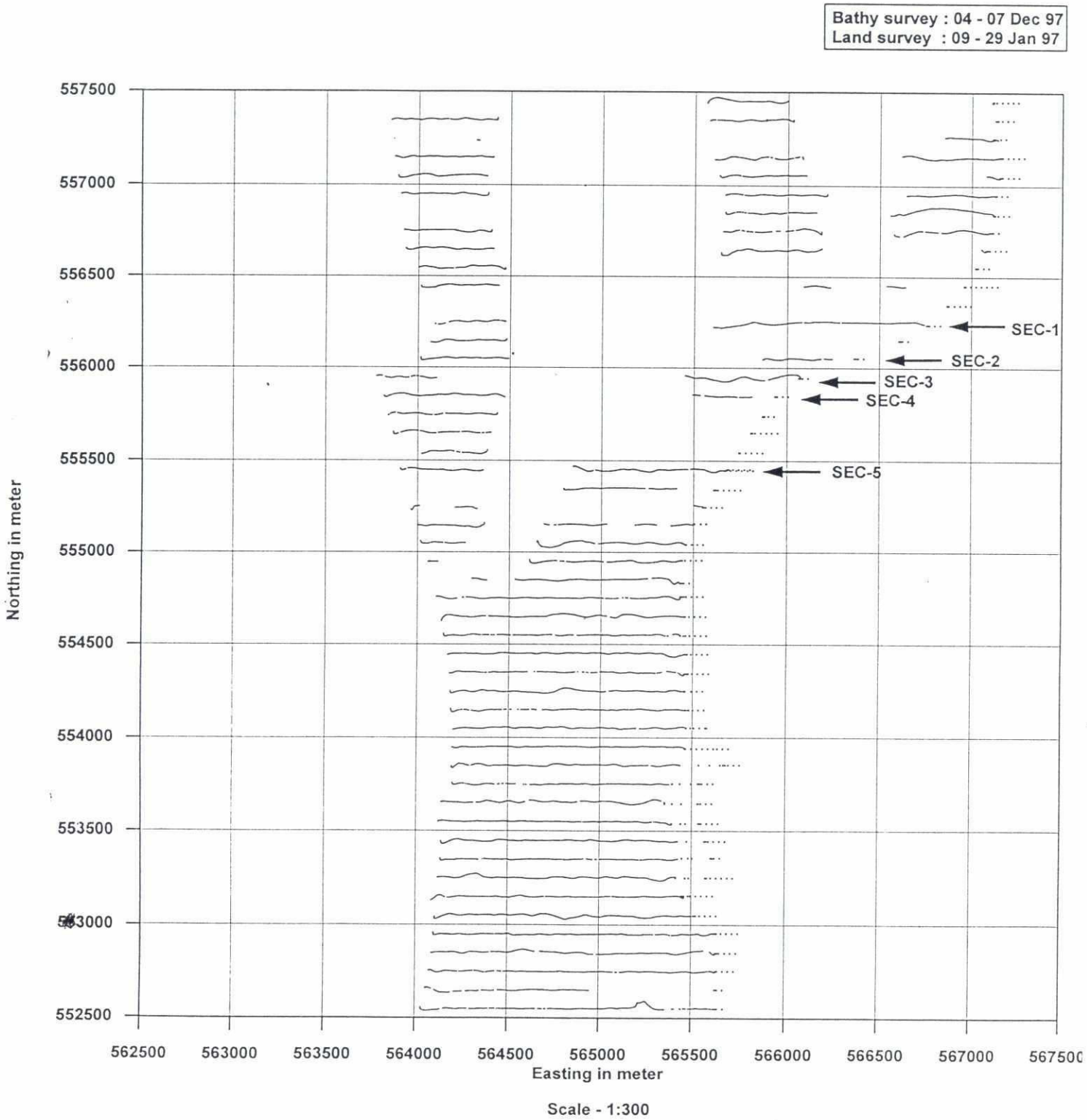
-10
-20
-30
0
200
400
600
800
1000
1200
1400
Distance in meter


SEC-5
Elevation in m+PWD
10
0
-10
-20
-30
0
200
400
600
800
1000
1200
1400
Distance in meter

HAIMCHAR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Land survey : 09 - 29 Jan 97
557500
557000
556500
556000
555500
555000
554500
554000
553500
553000
552500
Northing in meter
SEC-1
SEC-2
SEC-3
SEC-4
SEC-5
562500
563000
563500
564000
564500
565000
565500
566000
566500
567000
567500
Easting in meter
Scale - 1:300

Table II.1 : Embankment

	Location Name Thana/Uioan	Category		Length Km	Year of Construc-tion	Cost per Km	Present condition		
		Original	Replace /New				Good	Partially damage	Badly damaged
A.	CHANDPUR SADAR								
	1. Sakhua	Y	-	2.50	1976-77	215,000	Y	-	-
	2. Hanar Char	-	Y	1.50	1976-77	3,446,000	Y	-	-
	3. Chandra	-	Y	5.00	1976-77	3,446,000	Y	-	-
B.	HAIM CHAR								
	1. Haim Char	-	Y	2.00	1976-77	3,446,000	Y	-	-
	2. Nil Kamal	-	-	-	-	-	-	-	-
	3. Char Bhairabi	Y	-	4.00	1976-77	215,000	-	Y	-
	4. Uttar Algi Durgapur	-	Y	2.50	1976-77	3,446,000	Y	-	-
	5. Dakshin Algi Durgapur	-	Y	3.50	1976-77	3,446,000	Y	-	-
	6. Gazipur	-	-	-	-	-	-	-	-
C.	RAIPUR								
	1. Char Ababil								
	Total			21.00					

Source: Field Survey MES January, 1998.

Table II.2 : Water Management Structures

	Location Name Thana/Uioan	Type	No.	Size feet	Year of Const.	Cost Per Unit	Irrigation canal			
							Length	Width	Yr of cons.	Cost/ Km
A.	CHANDPUR SADAR									
	1. Sakhua	1 vent	1	5/6	1984	6,640,000	-	-	-	-
	2. Hanar Char	-	-	-	-	-	-	-	-	-
	3. Chandra	1 vent	1	5/6	1995-96	3,800,000	-	-	-	-
B.	HAIM CHAR									
	1. Haim Char	-	-	-	-	-	-	-	-	-
	2. Nil Kamal	-	-	-	-	-	-	-	-	-
	3. Char Bhairabi	1 vent	1	5/6	1983	1,569,000	-	-	-	-
	4. Uttar Algi Durgapur	-	-	-	-	-	-	-	-	-
	5. Dakshin Algi Durgapur	-	-	-	-	-	-	-	-	-
	6. Gazipur	-	-	-	-	-	-	-	-	-
C.	RAIPUR									
	1. Char Ababil	-	-	-	-	-	-	-	-	-
	Total		3							

Source: Field Survey MES January, 1998.

Table II.3 : Bridges and Culverts

	Location Name Thana/Uioan	Number	Total span (m)	Condition (Span/m)		
				Good	Poor	Damaged
A.	CHANDPUR SADAR					
	1. Sakhua	-	-	-		
	2. Hanar Char	23	30.53	30.53		
	3. Chandra	-	-	-		
B.	HAIM CHAR					
	1. Haim Char	-	-	-		
	2. Nil Kamal	-	-	-		
	3. Char Bhairabi	7	20	10		10.00
	4. Uttar Algi Durgapur	6	19.5	9.5		10.00
	5. Dakshin Algi Durgapur	7	19.5	12		7.50
	6. Gazipur	-	-	-		
C.	RAIPUR					
	1. Char Ababil	2	6	3		3.00
	Total	45	95.53	65.03		

Source: Inventory of Rural Infrastructures; Infrastructure Maintained System 1997 LGED.
Note: Average cost per meter of road structure is Tk. 1,25,000, LGED Design Section.

Table II.4 : Road

	Location Name Thana/Uioan	FR - A				FR - B				Village Road			
		Length Km	Cost per Km	Yr. of const.	Status *	Length Km	Cost per Km	Yr. of const.	Status *	Length Km	Cost per Km	Yr. of const.	Status *
A.	CHANDPUR SADAR												
	1. Sakhua	0.50	2,000,000	1992-97	2	-	-	-	-	2	70000	1990-97	2
	2. Hanar Char	0.50	2,000,000	1994-97	2	-	-	-	-	9.2	70000	1990-95	2
	3. Chandra		2,000,000	1992-97	2	-	-	-	-	2.45	70000	1990-97	2
B.	HAIM CHAR					-							
	1. Haim Char	2.00	500,000	1992	2	-	-	-	-	-	-	-	-
	2. Nil Kamal	1.20	500,000	1992	2	-	-	-	-	1.25	100000	1985-90	2
	3. Char Bhairabi	5.00	500,000	1976-92	2	-	-	-	-	21.65	95000	1975-90	2
	4. Uttar Algi Durgapur	4.00	500,000	1992	2	3.50	200,000	1988	2	4.75	90000	1975-90	2
	5. Dakshin Algi Durgapur	-	-	-	-	2.50	200,000	1988	2	8.19	90000	1975-90	2
	6. Gazipur	-	-	-	-	-	-	-	-	-	-	-	-
C.	RAIPUR												
	1. Char Ababil	3.00	350,000	1976-77	2					7	80000	1975-92	2
	Total	16.20				6.00				56.49			

Source: Inventory of Rural Infrastructures, Infrastructure Maintenance System, 1997; LGED.

Note: Existing CIP embankment in the project are used as feeder road - A.
Excepting 0.50 Km in Sakhua Union, these are not standaradized as per FRA specification

* Status
1 = Good
2 = Partially damaged
3 = Badly damaged

Table II.5 : Thana and Union Headquarters

	Location Name Thana/Uioan	Union Head quarter area			Buildings / Structure				
		Area (Sq. m)	Length (m)	Width (m)	Type	Number	Size (max.)	Yr. of cons.	Average Cost
A.	CHANDPUR SADAR								
	1. Sakhua	252	18	14	Tin shed	1	13.5 x 6	1920	1,500
*	2. Hanar Char	-	-	-	-	-	-	-	-
	3. Chandra	208	16	13	Building	1	16 x 13	1985	340,000
B.	HAIM CHAR								
	1. Haim Char	288	18	16	Building	1	16 x 13	1993-94	640,000
	2. Nil Kamal	300	20	15	Tin shed	1	13 x 6	1992	95,000
	3. Char Bhairabi	300	20	15	Building	1	16 x 13	1992-93	640,000
	4. Uttar Algi Durgapur	375	25	15	Building	1	16 x 13	1988-89	640,000
*	5. Dakshin Algi Durgapur	-	-	-	-	-	-	-	-
**	6. Gazipur	-	-	-	-	-	-	-	-
C.	RAIPUR								
	1. Char Ababil								
	Total	1723	117	88		6			
	Haim Char Thana	3800	76	50	Tin shed	6	36 x 7	1989	600,000

Source: Field Survey MES, January, 1998.

Note: * = Hanar char and Dakshin Algi Durgapur UP have no office building. They use one room belonging to Union health sub-centre.
** = Gazipur UP runs office in Chairman's residence.

Table II.6 : Telephone Line

	Location Name Thana/Uioan	Length Km	No of Pole/Km	Year of Const.	Cost per Km	Catagory
A.	CHANDPUR SADAR					
	1. Sakhua	3	24	1985	96200	P.C.O
	2. Hanar Char	10	24	1985	96200	P.C.O
	3. Chandra	-	-	-	-	-
B.	HAIM CHAR					
	1. Haim Char (a)	16	24	1985	167692	P.C.O and trunk
	2. Nil Kamal	-	-	-	-	-
	3. Char Bhairabi	4	24	1985	96200	P.C.O
	4. Uttar Algi Durgapur	2	24	1985	96200	P.C.O
	5. Dakshin Algi Durgapur	2	24	1985	96200	P.C.O
	6. Gazipur	-	-	-	-	-
C.	RAIPUR					
	1. Char Ababil	-	-	-	-	-
	Total	37	144			

Source: Field Survey, MES January, 1998.

Note:

(a) = Telephone line recorded in the TT registers have been shifted to Nilkamal and Dakshin Algi Durgapur Union

Table II.7 : Transmission Lines

	Location Name Thana/Uioan	Length Km	No of Pole/Km	Year of Const.	Cost per Km	Catagory
A.	CHANDPUR SADAR	59	14	1982-97	500000	11 KV
		200	23	1982-97	350000	0.4 KV
	1. Sakhua	-	-	-	-	-
	2. Hanar Char	-	-	-	-	-
	3. Chandra	-	-	-	-	-
B.	HAIM CHAR	17	14	1982-97	500000	11 KV
		67	23	1982-97	350000	0.4 KV
	1. Haim Char	-	-	-	-	-
	2. Nil Kamal	-	-	-	-	-
	3. Char Bhairabi	-	-	-	-	-
	4. Uttar Algi Durgapur	-	-	-	-	-
	5. Dakshin Algi Durgapur	-	-	-	-	-
	6. Gazipur	-	-	-	-	-
C.	RAIPUR	14	14		500000	11 KV
		31	23	1982-97	350000	0.4 KV
	1. Char Ababil	-	-	-	-	-
	Total	388	111			

Source: Field Survey, MES January, 1998.

Note: Unionwise distribution of transmission lines is not available.

Table II.8 : Dwelling

Name of Thana / Union		Dwelling Unit							
		Thatch		C. I. Sheet		Cement		Others	
		Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit
A.	CHANDPUR								
1.	Sakhua	2572	7500	7203	35000	60	300000	455	150000
2.	Hanar char	887	5000	2660	25000	-	-	2	150000
3.	Chandra	2052	8000	4250	40000	75	500000	796	180000
B.	HAIMCHAR								
1.	Haimchar	258	6500	172	35000	-	-	-	-
2.	Nilkamal	1246	5000	4673	60000	-	-	311	150000
3.	Char Bhairabi	3250	6500	3100	20000	-	-	150	125000
4.	Uttar Algi Durgapur	1375	6000	3850	40000	4	500000	271	150000
5.	Dakhin Algi Durgapur	1100	6000	3875	27500	25	300000	500	150000
6.	Gazipur	554	6000	2962	45000	-	-	-	-
C.	RAIPUR								
1.	Char Ababil	1525	10000	1396	25000	9	500000	244	300000
	Total	14819	-	34141		173		2729	

Source : Field survey MES January 1998
Note: (1) Union data not adjusted for project area.
(2) Dwellings are categorised by materials of roof

Table II.9 : Estimate of Dwellings and Associated Structures in Proejct Area

Name of Thana / Union		Total Area	Proejct Area	%	Dwellings				Associated Structures		
					Thatch	C. I. Sheet	Cement	Others	Mosques	Tubewells	Latrines
A.	CHANDPUR										
1.	Sakhua	1522	96	0.06	162	454	4	29	3	136	148
2.	Hanar char	203	203	1.00	887	2660		2	15	180	80
3.	Chandra	1485	185	0.12	256	529	9	99	5	19	127
B.	HAIMCHAR										
1.	Haimchar	91	91	1.00	258	172			1	48	75
2.	Nilkamal	188	188	1.00	754	2804		311	20	343	1500
3.	Char Bhairabi	1679	1679	1.00	3250	3100		150	43	550	500
4.	Uttar Algi Durgapur	1260	362	0.29	395	1106	1	78	42	476	900
5.	Dakhin Algi Durgapur	1935	954	0.49	542	1910	12	247	85	489	740
6.	Gazipur	37	37	1.00	554	2962			3	200	175
C.	RAIPUR										
1.	Char Ababil	3521	430	0.12	186	170	1	30	1	31	85
	Total	11921	4225		7244	15867	27	946	218	2472	4330

Note:
1) Based on union and thana records, pro-rated for the project area.
2) Thatch and C.I.S houses in Nilkamal adjusted for houses and buildings on chars.

Table II.10: Water Supply and Sanitation

Name of Thana / Union		Tubewell (DPHE)		Tubewell (Private)		Latrine	
		Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit
A.	**CHANDPUR**						
1.	Sakhua	950	3000	1200	3500	2350	4000
2.	Hanar char	140	4000	40	3500	80	2000
3.	Chandra	60	4000	30	5000	1020	5000
B.	**HAIMCHAR**						
1.	Haimchar	40	3000	5	3000	75	3200
2.	Nilkamal	193	3000	150	4000	1500	2000
3.	Char Bhairabi	150	4000	400	2000	500	3200
4.	Uttar Algi Durgapur	326	3500	150	3500	900	2000
5.	Dakhin Algi Durgapur	542	3000	450	3200	1500	4000
6.	Gazipur	180	2500	20	3000	175	3000
C.	**RAIPUR**						
1.	Char Ababil	180	3000	70	3500	700	2500
	Total	**2761**	.	**2515**		**8800**	

Source : Field Survey, MES January, 1998.

Table II.11 : Social Infrastructures

Name of Thana / Union		Primary School		High School		Madrasha		Mosque		Temple		Club		Others	
		Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit	Total No.	Average cost/unit
A.	CHANDPUR														
1.	Sakhua	10	365000	2	312500	8	143750	40	100500	3	15000	10	15000	A	700000
2.	Hanar char	4	180000	1	200000	5	20000	15	20000	1	10000	-	-	H	3000000
														B	30000
3.	Chandra	13	303846	7	742859	17	349400	44	400000	3	20000	6	15000	A	700000
B.	HAIMCHAR														
1.	Haimchar	1	100000	-	-	1	35000	1	20000	-	-	-	-	E	35000
2.	Nilkamal	11	207727	1	2000000	2	50000	20	35000	-	-	4	15000	F	95000
3.	Char Bhairabi	32	368750	1	1500000	24	143750	43	176744	3	40000	25	10000	C	10000
														G	3000000
4.	Uttar Algi Durgapur	12	395833	3	1900000	7	200000	42	275000	13	10000	25	15000	A	640000
														C	250000
		15	420000	4	650000	3	100000	173	122254	3	10000	30	10000	J	1800000
5.	Dakhin Algi Durgapur													A	550000
														C	10000
														H	50000000
														I	2000000
6.	Gazipur	-	-	-	-	-	-	3	40000	-	-	-	-		
C.	RAIPUR														
1.	Char Ababil	3	252272	1	600000			3	150000	-	-	2	12000		
	Total	101		20		67		384		26		102			

Source : Fields Survey, MES Januar 1998

Note: * Others - Specific

A = Union, B = Tahshil office, C = Community centre, D = Cold Storage, E = Gana Shikkha Kendra
F = Cyclone Shelter, G = Cinema Hall, H = Thana Health Complex, I = College, J = F. P. Centre.

Table II.12 : Market - General Shops

Name of Thana / Union		No of Market	Average Cost Per Market	Total Cost
A.	CHANDPUR			
1.	Sakhua	3	1352000	4050000
2.	Hanar char	2	652000	1304000
3.	Chandra	3	1113666	3341000
B.	HAIMCHAR			
1.	Haimchar	2	601500	1203000
2.	Nilkamal	3	1353666	4061000
3.	Char Bhairabi	2	4190500	8381000
4.	Uttar Algi Durgapur	6	1289333	7736000
5.	Dakhin Algi Durgapur	5	899300	4495500
6.	Gazipur	-	-	-
C.	RAIPUR			
1.	Char Ababil	-	-	-
	Total	26		

Source : Field Survey, MES January, 1998.

Table II. 13 : Market - Miscellaneous Facilities

Name of Thana / Union		Sawmill		Husking Mill		Workshop		Others	
		Number	Total cost	Number	Total cost	Number	Total cost	Number	Total cost
A.	CHANDPUR								
1.	Sakhua	2	500000	5	500000	1	130000	-	-
2.	Hanar char	1	200000	3	750000	-	-	-	-
3.	Chandra	1	230000	2	250000	-	-	1 (A)	100000
B.	HAIMCHAR								
1.	Haimchar	-	-	-	-	3	900000	-	-
2.	Nilkamal	-	-	5	870000	1	100000	-	-
3.	Char Bhairabi	3	700000	4	800000	-	-	1 (B)	100000
4.	Uttar Algi Durgapur	2	450000	12	2900000	5	668000	1 (C)	500000
5.	Dakhin Algi Durgapur	2	450000	5	1300000	-	-	1 (C)	300000
6.	Gazipur	-	-	-	-	-	-	-	-
C.	RAIPUR								
1.	Char Ababil								
	Total	11	2530000	36	7370000	10	1798000		1000000

Source : Field Survey, MES January, 1998.
Note : Others : A = Bakary, B = Godown, C = Ice cream factory

Table II.14 : Market Infrastructure

Name of Thana / Union		No. of Market	*Roads		Tubewells		Toilets		Ghats (Fish)	
			Length (m)	Road Type	No.	Cost Tk/	No.	Cost Tk/U	No.	Cost Tk/m
A.	CHANDPUR									
1.	Sakhua	3	1100	HBB	12	2500	6	20000	-	-
2.	Hanar char	2	-	-	5	4000	2	21000	-	-
3.	Chandra	3	426	Soling	5	3800	3	15000	-	-
B.	HAIMCHAR									
1.	Haimchar	2	-	-	5	3000	2	18000	1	300000
2.	Nilkamal	3	200	HBB	18	2666	6	18333	-	-
3.	Char Bhairabi	2	500	Metal	24	3000	11	9381	-	-
4.	Uttar Algi Durgapur	6	650	Metal	21	3500	9	14833	-	-
5.	Dakhin Algi Durgapur	5	200	HBB	23	3347	10	38000	-	-
6.	Gazipur	-	-	-	-	-	-	-	-	-
C.	RAIPUR									
1.	Char Ababil	-	-	-	-	-	-	-	-	-
	Total	26			113		49		1	

Source: Field Survery, MES January, 1998.
Note : * Paved and metalled road within the market.

Table III.1.1 : Farmers Categories and Number of households

Thana	Union	Cultivated land (ha)	Total number of farm households					Total
			Landless	Marginal	Small	Medium	Large	
Chandpur Sadar	Chandra	1290	81	85	833	357	344	1700
	Hanar Char	670	111	66	650	279	220	1326
	Sakhua	1120	432	96	944	403	47	1921
Haimchar	Haimchar	N/A	324	61	20	8	0	413
	Nilkamal	N/A	202	81	283	40	8	615
	Dakshin Algi Durgapur	848	387	377	348	230	56	1398
	Char Bhairabi	965	831	558	325	85	15	1814
	Total	4893.12	2368.42	1323.48	3403.24	1401.62	690.69	9187.45
	%		26	14	37	15	8	100.00

Source: Thana/Union offices: MES Field Investigations January, 1998.

Table III.1.2 : Cropping patterns during 1996-97 inside and outside the embankment.

Thana	Union	Cultivated area (ha)	Embankment							
			Inside area (ha)				Outside area (ha)			
			Single cropped	Double cropped	Triple cropped	Total	Single cropped	Double cropped	Triple cropped	Total
Chandpur Sadar	Chandra	1290		810	283	1093	100	61	36	197
	Hanar Char	670	142	8	113	263	202	12	193	407
	Sakhua	1120		648	340	988	60	72		132
Haimchar	Haimchar	NA			NA				NA	
	Nilkamal	NA			NA				NA	
	Dakshin Algi Durgapur	848	96	168	551	815	4	28		32
	Char Bhairabi	965		202	181	383	20	486	76	582
	Total	4893.1	238.1	1836.4	1468.4	3542.9	386.6	659.1	304.5	1350.2
	%		4.3	61.9	33.9	100	39.4	44.7	15.9	100
	Cropping Intensity (%)					2.30				1.76

Source: Thana/union office: MES Field Investigations. January, 1998

NA = Not Available

Table III.1.3 : Crop areas in 1996-97 inside and outside the embankment (area in ha)

Thana	Union	B.Aus		T.Aus		B.Aman		LT Aman		HV.Aman		L Boro		HV Boro		Potato		S. Potato		Chilli		Pulse		Oil seed		Vegetable		Others		Total		Grand Total
		IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	
Chandpur	Chandra		24		8		12		8	1012	0	162	0	1134		4	28	0	1	1	1		1	1	2	4	2	121	61	2439	149	2588
Sadar	Hanar Char	40	61		24	16	73	20	40	8	0	12	2	10	4	24	20	28	12		12		10	2	8	1	2			163	269	432
	Sakhua		101	8	0		29	81	0	324				364	2	51	40	1	3		20	1	4	8	20	3	3	2	6	843	230	1072
Haimchar	Haimchar		15		5		5				10						2		2								5		8		52	52
	Nilkamal	14	81		5		52				70					8	10		8							2	6		8	24	240	264
	Dakshin Algi Durgapur	324	8				24	344	4	162				142		192		15		243		65		47	0	20	0	69	0	1622	36	1659
	Char Bhairabi	71	20	73			324	20	121	354	202			101	32	20	12		20	10	304	16	26	45	126	20	36	40	40	771	1266	2037
	Sub Total	449	311	81	42	16	519	466	174	1860	283	174	2	1751	38	300	113	45	47	254	337	82	41	102	157	51	55	232	123	5862	2243	8105
	Total	760		123		535		640		2143		176		1789		413		91		591		123		259		106		356		8105		

Source: Thana/union office: MES Field Investigations. January, 1998

IE = Inside the Embankment

OE = Outside the Embankment

Table III.1. 4 : Crop yields in 1996-97 inside and outside the embankment

Thana	Union	Crop yield (Kg/ha)																													
		B.Aus		T.Aus		B.Aman		LT Aman		HV.Aman		L Boro		HV Boro		Potato		S. Potato		Chilli		Pulse		Oil seed		Vegetable		Others		Total		Grand
		IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	Total
Chandpur Sadar	Chandra		1186		1482		1976		2470	4446		2470		4545		15808	17784	988	15808	790	988		1778	790	988	19760	3952			49598	48412	98010
	Hanar Char	1284	1186	1581	1383	1581	1680	2174	1976	2964		1778	1877	4940	3952	17784	19760	16796	17784		790		988	692	790	17784	19760			69358	71926	141284
	Sakua		1976				2470	2470		4446			1976	4940	3952	19760	18772	11856	10868		1976	1482	1482	1186	1186	14820	14820			60960	59478	120437
Haimchar	Haimchar		1284		1531		1853				3779						22349		35815								6916				73527	73527
	Nilkamal	1087	1099		1482		1877				3767					22354	22354		32110							6422	6175			29862	68864	98726
	Dakshin Algi Durgapur	1186	1186	1482			1976	1581	1581	3952				4940		22230		29640		2964		2470		1186		6916				78546	4742	83288
	Char Bhairabi	1186	1186				1877	1976	1976	3754	3162			4940	5039	22724	23119		27170	2161	2272	1778	1284	1151	1186	3458	3557			43129	71828	114956
	Ave Yield Kg/ha	**1500**	**1199**	**1492**	**1439**	**1581**	**1888**	**1778**	**1990**	**1870**	**4040**	**2697**	**1877**	**4684**	**4867**	**21402**	**17321**	**11721**	**24625**	**2977**	**2997**	**2323**	**1228**	**1434**	**1162**	**7304**	**6545**			**93767**	**74968**	**168735**

Source: Thana/union office: MES Field Investigations: January, 1998

IE = Inside the Embankment

OE = Outside the Embankment

Table III.1.5 : Crop production during 1996-97 inside and outside the embankment in different unions fo the Haimchar Project

Figures in Ton

Thana	Union	Crop production (tons)																															
		B.Aus		T.Aus		B.Aman		LT Aman		HV.Aman		L Boro		HV Boro		Potato		S. Potato		Chilli		Pulse		Oil seed		Vegetable		Others		Total		Grand
		IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	Total
Chandpur	Chandra		28.8		12		24		20	45		400		5152		64	504	0.4	12.8	0.6	1.2		0.9	0.6	2.4	80	8	7200	240	12943	854	13797
Sadar	Hanar Char	52	1.8	12.8	33.6	25.6	121.4	44	80	24		21.6	3.8	50	16	432	400	68	216		9.6		10	1.12	6.4	21.6	40			753	939	1691
	Sakhua		200				72	200		1440		48		1800	8	1000	760	9.6	35.2		40	1.2	6	9.6	24	48	108	4.8	18	4561	1271	5832
Haimchar	Haimchar		15.2		7.6		9.3				37.8						45.2		72.5								34.6		20		246	246
	Nilkamal	154	89		7.4		97.3				263.8					181	226.2		260							13	37.5		190	348	1171	1519
	Dakshin Algi Durgapur	384	9.6	108			48	544	6.4	640				700		4275		444		720		160		55.2		140				8170	64	8234
	Char Bhairabi	84	24				608	40	240	1330	840			500	163.2	460	28.1		550	35	960	28.8	33.8	79.2	149.7	70	129.6			2627	3726	6353
	Sub Total	674	372	121	61	26	980	828	346	3479	1142	470	4	8202	187	6412	1964	522	1147	756	1011	190	51	146	183	373	358	7205	468	29402	8272	37673
	Total	1046		181		1006		1174		4621		473		8389		8376		1669		1766		241		328		730		7673		37673		
	Ave Yield Kg/ha	1500	1199	1492	1439	1581	1888	1778	1990	1870	4040	2697	1877	4684	4867	21402	17321	11721	24625	2977	2997	2323	1228	1434	1162	7304	6545	31003	3790	93767	74968	168735

Source: Thana/union office: MES Field Investigations, January, 1998

IE = Inside the Embankment

OE = Outside the Embankment

Table III.1.6 : Major Constraints to Increased Production

Thana	Union	Priority number of major constraints													
		Poor Soil		Bank-erosion		Water-logging by rainfall		Lack of irrigation		Insect- pest attack		Lack of insecticide		Lack of credit	
		IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE
Chandpur	Chandra	1	7	4	4	5	5	3	1	2	2	7	3	6	6
Sadar	Hanar Char	1	6	5	7	6	5	7	2	4	3	2	5	3	2
	Sakua	1	7	5	5	6	2	3	1	2	4	7	6	4	3
Haimchar	Haimchar				1		5		2				5		
	Nilkamal	5	7	1	6	7	5	6	1	2	3	4	4	3	2
	Dakshin Algi Durgapur	5		2		7		1		4		6		3	
	Char Bhairabi	4		2	1	5	6	1	2		4	6	5	3	3

Source: Thana/union office: MES Field Investigations. January, 1998

IE = Inside the Embankment; OE = Outside the Embankment

Table III.1. 7 : Cropped areas and cropping intensities of sampled households

Farm Categories	No. Hous-holds	Inside embankment			Outside embankment		
		Cultivated area (ha)	Cropped area (ha)	Cropping Intensity %	Cultivated area (ha)	Cropped area (ha)	Cropping Intensity %
Landless	4	0.57	1.38	242	0.91	1.70	187
Marginal	13	1.74	4.62	266	0.85	1.60	187
Small	23	4.95	11.36	229	4.90	8.26	168
Medium	5	2.02	4.86	240	1.82	2.57	141
Large	3				4.33	7.57	174
Total	**48**	**9.28**	**22.22**	**239**	**12.82**	**21.70**	**169**

Source : Thana / Union offices: MES Field Investigations January, 1998

LIVESTOCK

1. Livestock in the farming system

Livestock is an important element of small holder farming system in the project area. For the poorer households the animals are more important assets. The animals provide draft power, high quality food, cash income, round the year employment and security in case of emergency cash needs. The medium and large farmers are more attentive to the draft power needs. However, the poorer households are generally better able to acquire and manage small ruminants and poultry as these require small investment and can be reared using very little land and other resources. Backyard poultry and small ruminants are managed by women and the children. In case of large ruminants when at the stall very often the feeding and watering is done by women.

In the project area crop production and livestock are inexorably linked. The draft animal carryout most of the cultivation practices and crop residues account for a large proportion of large ruminant feed resources. The vulnerability of farmers to floods, cyclones and erosion has been to a strong element of risk aversion in the farming system. Livestock and poultry raising represent a reliable source of cash income for small and landless farmers who have been marginalised from crop production because of erosion. In the erosion affected area the households largely depend on the livestock assets as movable property which are often force sold to meet the immediate cash needs for food, transfer and construction of temporary shelter. And with the accretion of new land mass, cattle and goats are brought in and grazed even before the land deemed suitable for human settlement. With the growth of livestock assets the surplus animals are sold and invested in housing, settlement and crop culture.

2. Livestock population:

According to BBS Agriculture and Livestock consuls 1983-84 the livestock population in the 13 unions of the project area is given in table 1, and estimated population of 1998 as suggested by the Department of Livestock Services and the local union parishads in given to determine the possible increase or decrease of the population over the last fourteen years.

The average growth rate of cattle population in the study area is estimated at 2.8 per cent, goat 5.3 per cent and poultry 5.2% which includes the growth of households in the area estimated by socio-economic team of MES.

3. Husbandry practices

The bulk of cattle feed comes from the rice straw, goat and sheep scavenge for grass or any other feed that may be available on the non-cultivated areas, along the road sides and rivers banks. Chicken subsist on food scraps, insects, fallen grains and ducks on snails, oysters and duck weeds in the marshes and other closed water bodies.

The surplus and deficit months of animal feeds is given in Table-2, The deficit period is post monsoon months when the fields are under rice plantation, preserved straw depletes to lowest level and animals are confined is the most critical period and intervention is needed to improve feed situation.

With the introduction of short stem HYV rice, the straw production has declined resulting in reduced supply of the item in large animal diet. Increasingly more and more straw is used as fuel which further aggravated the feed shortage and demands immediate attention to plant more fodder trees in the plantation schemes, inclusion of forage crops in the cropping pattern and development of leaf protein banks at village level.

The project area is vulnerable to spread of animal diseases and most major diseases occur causing substantial loses due to mortality and loss of productively both in draft power and

meat, milk and egg production. Common diseases that occur in the project area is given in Table-3. Approximate loss due to livestock diseases as estimated by the thana livestock officials and union parishad members is given in Table 4. Preventive and curative animal health services availability is very limited in the area and provided by the Livestock Department for mulated cattle and poultry feed in not available in the area. Only some of the ingredients are occasionally purchased by the farmer, the price of the items are wheat bran Tk. 8/- pulse bran Tk. 10/--12/-, rice bran Tk 6/- per Kg. Mustard oil cake Tk. 7/- per Kg. Sesame oil cake Tk. 9/- per Kg, Vitamin permix Tk. 30/- for 100 grams. The prices fluctuates with the season by about 25%.

4. Livestock marketing

Live animals and eggs are usually sold through weekly village markets to small traders and these traders take them to major consumption centres. The farm gate price of live animals and products are given in Table 5. The farm gate price is estimated to be 20% to 25% lower than the retail price in the nearest consumption centres which is assumed to cover the cost of transportation, retailers margin and traders benefit.

5. Future without the project

Without project the livestock population is likely to decline due to increased human population pressure and higher cropping intensity, increased disease incidence and malnutrition as has been experienced in some parts of the country. Unabated erosion of the river banks may displace more households and disowning of livestock asset. However, the present growth rate is likely to continue in non-erosion areas with the ongoing livestock development programme of the Department of Livestock Services and credit out lets by the banks and NGOs.

6. Impact of the project

Although no direct intervention is envisaged in this sub-sector the erosion control and accelerated accretion process is likely to have positive impact on the growth of the livestock population, reduction of marginilisation process could help to pay more attention to animal husbandry practices by the non-affected farm households which is difficult to quantify of this stage.

Table III.2.1: Livestock population in the project area

Name of Thana/ Union	Agriculture and Livestock Census 1983-84			MES estimated population 1997-98						
	Cattle/ Buffalo	Goat & Sheep	Poultry	Cattle	Buff-alo	Goat	Sheep	Chicken	Duck	Pigeon
Chandpur										
Shakua	2693	1585	19898	3961	-	3266	-	33580	5664	1213
Hanarchar	810	426	6785	1191	-	707	170	11448	1931	413
Chandra	2360	1385	14504	3471	-	2854	-	24473	4128	885
Haimchar										
Haimchar	1442	611	5702	2121	-	1259	-	9622	1622	348
Nilkamal	4661	2245	10301	6856	-	4626	-	17381	2931	628
Char Bhairabi	3545	1453	12467	5214	-	2744	250	21039	3548	760
Uttar Algi Durgapur	2583	1620	14538	3799	-	3018	320	24534	4137	886
Dakhin Algi Durgapur	3327	1747	11344	4746	-	3092	507	19143	3228	692
Gazipur	1720	777	4896	2530	-	1601	-	8260	1393	298
Raipur										
Char Ababil	5958	3177	36296	8264	500	6546	-	61244	10330	2213
Total	**36634**	**19295**	**177147**	**53236**	**500**	**37609**	**1247**	**298928**	**50415**	**10801**

Table III.2.2: Feeds and fodder situation

Thana / Union	Surplus months	Deficit months	Sources of feeding in deficit months
Chandpur			Different types of concentrated feed e.g. oil cake molasses, bran, etc.
Shakua	Dec - Feb	May - June	
Hanarchar	Dec - Jan	May - July	
Chandra	June - July	Feb - April	
Haimchar			
Haimchar	Nov - Dec	April - Oct	
Nilkamal	Nov - March	June	
Char Bhairabi	Nov - March	June	
Uttar Algi Durgapur	Dec - March	April - Nov	
Dakhin Algi Durgapur	Dec - March	April - Nov	
Gazipur	Nov - Feb	March - Oct	
Raipur			
Char Ababil	June- July		

Source: MES field survey

Table III.2.3: Common animal disease

Type of Animal	Disease
Cattle	Foot and mouth disease, diarrhoea intestinal worms, liver fluke.
Goat	Intestinal worms, liver fluke, Pluro pneumonia, goat pox, diarrhoea, dysentery.
Sheep	Intestinal worms, liver fluke.
Chicken	New castle disease, fowl pox, fowl cholera, worms, ticks, lice, coccidiosis
Duck	Duck plague, duck cholera
Pigeon	Pigeon pox

Source: MES field survey; DLS

Table III.2.4: Livestock production loss due to disease and debility

Thana / Union	Mortality of adult animal (%)	Loss of Production				
		Milk (%)	Meat (%)	Eggs	Draft power (%)	Less calving (%)
Chandpur						
Shakua	0.5	20	25	15	30	20
Hanarchar	0.4	20	15	20	25	15
Chandra	2	20	15	20	25	15
Haimchar						
Haimchar	0.5	20	25	20	30	20
Nilkamal	0.5	15	20	20	30	25
Char Bhairabi	0.4	25	20	20	35	15
Uttar Algi Durgapur	2	15	15	15	15	15
Dakhin Algi Durgapur	2	10	10	10	10	10
Gazipur	1	25	25	20	30	15
Raipur						
Char Ababil	1	20	15	20	25	15

Table III.2.5 : Market price of livestock

Unit: Taka

Thana / Union	A pair of bullock	A pair of Buffalo	A Milck Cow (with calf)	A Milch Buffalo (with calf)	An Ox (60 Kg meat)	A Baffalo 100 Kg meat	Milk per Kg Tk.	A Chicken (weight 1 Kg)	A Duck (weight 1.5 Kg)	Egg (4 pieces)
Chandpur										
Shakua	20000	-	13000	-	5000	-	18	125	80	12
Hanarchar	20000	-	10000	-	4000	-	16	70	100	12
Chandra	25000	-	10000	-	5000	-	16	100	75	16
Haimchar										
Haimchar	25000	-	12000	-	4000	-	18	75	80	15
Nilkamal	20000	-	12000	-	4000	-	14	90	100	12
Char Bhairabi	25000	-	15000	-	4500	-	12	100	100	12
Uttar Algi Durgapur	20000	-	12000	-	4000	-	15	80	80	15
Dakhin Algi Durgapur	25000	-	15000	-	3500	-	15	80	80	15
Gazipur	20000	-	10000	-	3600	-	16	80	80	16
Raipur										
Char Ababil	20000	30000	15000	20000	4500	7500	18	80	100	12
Average cost	**22692**		**12538**		**4330**		**16**	**90**	**87**	**13**

Source: MES field survey

FORESTRY

The project area is in a non-forest zone of the country but is very rich in homestead and village forests. The latest inventory of the village forest resources of the country was undertaken in 1992 a part of the Forestry Master Plan (FMP). The project area falls within StratumV of the FMP study. The estimate of tree resources in the project area has been based on the FMP study. The relevant data is given in the following tables.

Table III.3.1: Stock of bamboo resources by species - FMP stratum V

Species	Mature Culms ('000)	No/Capita	Immature Culms ('000)	No/Capita
Katabash	0	0.00	0	0.00
Bariala	5,059	0.42	2,289	0.19
Barua	2,770	0.23	2,409	0.20
Jai	4,818	0.40	7,348	0.61
Makhal	3,613	0.30	2,409	0.20
Orah	240	0.02	120	0.01
Kaliseri	722	0.06	602	0.05
Tarala	1,806	0.15	964	0.08
Barak	8,431	0.70	6,625	0.55
Mitinga	361	0.03	120	0.01
Muli	2,409	0.20	5,421	0.45
Others	1,806	0.15	1,807	0.15
Total	32,035	2.66	30,114	2.50

Table III.3.2: Stock volume and stand table - FMP stratum V

Species	Stems (000)	Total Volume (000 m^3)	Per Capita (m^3)	Sawlogs (000 m^3)	Fuelwood (000 m^3)
Mango	12,916	3,080	0.217	901	2,179
Jack	3,909	452	0.031	168	284
Rain	3,275	1,283	0.071	343	940
Simul	989	341	0.024	106	235
Bat	172	259	0.018	55	203
Madar	3,685	845	0.059	76	769
Koroi	4,332	1,322	0.093	363	958
Jam	1,451	334	0.023	76	258
Jiul	1,411	215	0.015	29	185
Gab	1,065	128	0.009	20	108
Tetul	412	101	0.007	23	78
Bel	197	34	0.002	6	28
Pitali	251	44	0.003	7	37
Chaatim	248	54	0.004	14	40
Kadam	866	134	0.009	25	109
Debdaru	479	64	0.004	11	53
Jarul	857	121	0.008	18	103
Sal	69	5	0.000	0	5
Segun	150	18	0.001	2	16
Garjan	50	14	0.001	6	8
Lichu	165	47	0.003	12	35
Others	8,303	1,474	0.104	274	1,200
Total	45,252	10,369	0.706	2,535	7,831

Table III.3.3 : Palm stand - FMP 1992

Species with local name	Maturity class	Stratum V
Borassus flabellifera (Tal)	Mature trees	3,366
	Immature trees	1,971
	Total	5,337
	Total / Per capita	0.238
	Mature / per capita	0.139
	Immature / per capita	0.098
Phoenix Dactylifera (Date palm) / (Khejor)	Mature trees	9,395
	Immature trees	1,842
	Total	11,237
	Total / Per capita	0.793
	Mature / per capita	0.663
	Immature / per capita	0.130
Coco nucifera (Coconut)	Mature trees	9,993
	Immature trees	4,060
	Total	14,053
	Total / Per capita	0.992
	Mature / per capita	0.705
	Immature / per capita	0.287
Arla Catechu Mature (Betelnut)	Mature trees	56,288
	Immature trees	22,390
	Total	78,678
	Total / Per capita	5.535
	Mature / per capita	3.972
	Immature / per capita	1.580

Table V.1 : Unit cost permeable spur

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	1,820.00	165,620
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	1,040.00	119,080
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	1,450.00	120,713
4	Propex 6088 Screens	m2	78	231.25	17,922
5	Sewing yarn	kg	1,125	32.50	36,563
6	Transport cost of geotextile materials	L.S.			
	Sub-total				459,898
7	Local Sand (F.M = 1.3)	m3	550	150.00	82,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	50.50	50,500
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	69.95	34,975
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 05 m x 0.125 m), slope protection	nos	120	800.00	96,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	9,825.00	1,965,000
14	G.I. Pipe, 6" diameter	m	2,200	0.00	0
15	G.I. Pipe, 5" diameter	m	1,600	440.00	704,000
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	105.00	63,000
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	92.00	9,200
21	Shil-Barak Bamboo, 3" diameter	nos	192	655.00	125,760
22	Synthetic Bag	nos	18	2,625.00	47,250
23	Steel anchor (15 kg)	nos	550	45.00	24,750
24	Steel chain	m	250	133.00	33,250
25	Hardware material	m	3,500	65.00	227,500
	Sub-total				3,463,685
26	Labour cost	m	3,340	80.00	267,200
27	Equipment cost	m	4,000	77.50	310,000
28	Earth work	m3	50	5,620.00	281,000
29	Mobilization/demobilization	L.S.			
	Sub-total				858,200
	Total				**4,781,783**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table V.2 : Unit cost bottom screen (3 floats)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	0.00	0
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	0.00	0
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	16.00	1,332
4	Propex 6088 Screens	m2	78	34.84	2,700
5	Sewing yarn	kg	1,125	1.00	1,125
6	Transport cost of geotextile materials	L.S.			
	Sub-total				5,157
7	Local Sand (F.M = 1.3)	m3	550	0.00	0
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.50	500
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	1.00	3,450
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	8.00	8,000
12	C.C. Block (0.5 m x 05 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	0.00	0
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	3.00	16,500
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	1.00	3,550
20	PVC Pipe, 22 mm diameter	m	100	20.80	2,080
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	0.20	700
	Sub-total				34,780
26	Labour cost	m	3,340	1.10	3,674
27	Equipment cost	m	4,000	0.75	3,000
28	Earth work	m3	50	0.00	0
29	Mobilization/demobilization	L.S.			
	Sub-total				6,674
	Total				**46,611**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table V.3 : Unit cost bottom screen (4 floats)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	0.00	0
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	0.00	0
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	16.00	1,332
4	Propex 6088 Screens	m2	78	40.04	3,103
5	Sewing yarn	kg	1,125	1.00	1,125
6	Transport cost of geotextile materials	L.S.			
	Sub-total				5,560
7	Local Sand (F.M = 1.3)	m3	550	0.00	0
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.50	500
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	1.00	3,450
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	8.00	8,000
12	C.C. Block (0.5 m x 05 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	0.00	0
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	4.00	22,000
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	1.00	3,550
20	PVC Pipe, 22 mm diameter	m	100	20.80	2,080
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	0.20	700
	Sub-total				40,280
26	Labour cost	m	3,340	1.20	4,008
27	Equipment cost	m	4,000	0.75	3,000
28	Earth work	m3	50	0.00	0
29	Mobilization/demobilization	L.S.			
	Sub-total				7,008
	Total				**52,848**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table V.4 : Year 1 : Hanarchar south and Haimchar south

Number of spurs	17
Number of bottom screens with 3 floats	250
Number of bottom screens with 4 floats	290

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	30,940	2,815,540
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	17,680	2,024,360
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	33,290	2,771,393
4	Propex 6088 Screens	m2	78	24,253	1,879,596
5	Sewing yarn	kg	1,125	1,093	1,229,063
6	Transport cost of geotextile materials	L.S.			400,000
	Sub-total				**11,119,952**
7	Local Sand (F.M = 1.3)	m3	550	2,550	1,402,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	1,129	1,128,500
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,189	594,575
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	540	1,863,000
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	4,320	4,320,000
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	13,600	1,632,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	167,025	33,405,000
14	G.I. Pipe, 6" diameter	m	2,200	0	0
15	G.I. Pipe, 5" diameter	m	1,600	7,480	11,968,000
16	G.I. Pipe, 4" diameter	m	700	0	0
17	G.I. Pipe, 3" diameter	m	600	1,785	1,071,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	1,910	10,505,000
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	540	1,917,000
20	PVC Pipe, 22 mm diameter	m	100	12,796	1,279,600
21	Shil-Barak Bamboo, 3" diameter	nos	192	11,135	2,137,920
22	Synthetic Bag	nos	18	44,625	803,250
23	Steel anchor (15 kg)	nos	550	765	420,750
24	Steel chain	m	250	2,261	565,250
25	Hardware material	m	3,500	1,213	4,245,500
	Sub-total				**79,258,845**
26	Labour cost	m	3,340	1,983	6,623,220
27	Equipment cost	m	4,000	1,723	6,890,000
28	Earth work	m3	50	95,540	4,777,000
29	Mobilization/demobilization	L.S.			2,000,000
	Sub-total				**20,290,220**
	Total				**110,669,017**
30	Contingencies 10 % and rounding				11,066,983
	Total, including contingencies				**121,736,000**
	Sub-total foreign cost US$				**237,000**
	Sub-total local cost Taka				**110,616,000**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table V.5 : Year 2 : Sakhua north, Sakhua south, Hanarchar north and Haimchar north

Number of spurs	17
Number of bottom screens with 3 floats	400
Number of bottom screens with 4 floats	140

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	30,940	2,815,540
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	17,680	2,024,360
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	33,290	2,771,393
4	Propex 6088 Screens	m2	78	23,473	1,819,146
5	Sewing yarn	kg	1,125	1,093	1,229,063
6	Transport cost of geotextile materials	L.S.			400,000
	Sub-total				**11,059,502**
7	Local Sand (F.M = 1.3)	m3	550	2,550	1,402,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	1,129	1,128,500
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,189	594,575
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	540	1,863,000
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	4,320	4,320,000
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	13,600	1,632,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	167,025	33,405,000
14	G.I. Pipe, 6" diameter	m	2,200	0	0
15	G.I. Pipe, 5" diameter	m	1,600	7,480	11,968,000
16	G.I. Pipe, 4" diameter	m	700	0	0
17	G.I. Pipe, 3" diameter	m	600	1,785	1,071,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	1,760	9,680,000
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	540	1,917,000
20	PVC Pipe, 22 mm diameter	m	100	12,796	1,279,600
21	Shil-Barak Bamboo, 3" diameter	nos	192	11,135	2,137,920
22	Synthetic Bag	nos	18	44,625	803,250
23	Steel anchor (15 kg)	nos	550	765	420,750
24	Steel chain	m	250	2,261	565,250
25	Hardware material	m	3,500	1,213	4,245,500
	Sub-total				**78,433,845**
26	Labour cost	m	3,340	1,968	6,573,120
27	Equipment cost	m	4,000	1,723	6,890,000
28	Earth work	m3	50	95,540	4,777,000
29	Mobilization/demobilization	L.S.			2,000,000
	Sub-total				**20,240,120**
	Total				**109,733,467**
30	Contingencies 10 % and rounding				10,973,533
	Total, including contingencies				**120,707,000**
	Sub-total foreign cost US$				**235,000**
	Sub-total local cost Taka				**109,647,000**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table V.6: Detailed costs

Bangladesh
Haimchar Erosion Control Project

	Unit	Quantities				Base Cost (Local '000)				Base Cost (US$ '000)			
		99/00	00/01	01/02	Total	99/00	00/01	01/02	Total	99/00	00/01	01/02	Total
I. Investment Costs													
A. Bank Protection Works													
1. Spurs													
Geotextiles	unit	17	17	-	34	16,137	16,137	-	32,274	343	343	-	687
Local materials	unit	17	17	-	34	58,883	58,883	-	117,765	1,253	1,253	-	2,506
Equipment costs	unit	17	17	-	34	5,270	5,270	-	10,540	112	112	-	224
Labour	unit	17	17	-	34	4,542	4,542	-	9,085	97	97	-	193
Earth works	unit	17	17	-	34	4,777	4,777	-	9,554	102	102	-	203
Subtotal Spurs						89,609	89,609	-	179,218	1,907	1,907	-	3,813
2. Screens (3 floats)													
Geotextiles	unit	250	400	-	650	2,661	4,258	-	6,919	57	91	-	147
Local materials	unit	250	400	-	650	8,695	13,912	-	22,607	185	296	-	481
Equipment cost	unit	250	400	-	650	750	1,200	-	1,950	16	26	-	41
Labour	unit	250	400	-	650	919	1,470	-	2,388	20	31	-	51
Subtotal Screens (3 floats)						13,025	20,839	-	33,864	277	443	-	721
3. Screens (4 floats)													
Geotextiles	unit	290	140	-	430	3,328	1,607	-	4,934	71	34	-	105
Local materials	unit	290	140	-	430	11,681	5,639	-	17,320	249	120	-	369
Equipment costs	unit	290	140	-	430	870	420	-	1,290	19	9	-	27
Labour	unit	290	140	-	430	1,162	561	-	1,723	25	12	-	37
Subtotal Screens (4 floats)						17,041	8,227	-	25,268	363	175	-	538
4. Other Costs													
Geotextile transport	Tk					825	825	-	1,650	18	18	-	35
Mobilisation	Tk					1,000	1,000	-	2,000	21	21	-	43
Subtotal Other Costs						1,825	1,825	-	3,650	39	39	-	78
Subtotal Bank Protection Works						121,500	120,500	-	242,000	2,585	2,564	-	5,149
B. Embankment													
Retirement of Embankment	Tk/km	-	8.75	-	8.75	-	30,625	-	30,625	-	652	-	652
Road on Crest	Tk/km	-	8.75	-	8.75	-	13,125	-	13,125	-	279	-	279
Land Acquisition /a	ha	-	31	-	31	-	9,300	-	9,300	-	198	-	198
Subtotal Embankment						-	53,050	-	53,050	-	1,129	-	1,129
C. Flood Proofing													
Works & Materials	Tk/HH	1,040	1,040	520	2,600	10,889	10,889	5,444	27,222	232	232	116	579
Supervision & Management	Tk/HH	1,040	1,040	520	2,600	5,502	5,502	2,751	13,754	117	117	59	293
Subtotal Flood Proofing						16,390	16,390	8,195	40,976	349	349	174	872
D. Project Management													
BWDB Administration /b	unit					9,353	9,353	2,078	20,784	199	199	44	442
Project Management /c	unit					3,118	3,118	693	6,928	66	66	15	147
Subtotal Project Management						12,470	12,470	2,771	27,712	265	265	59	590
Total Investment Costs						150,361	202,411	10,966	363,738	3,199	4,307	233	7,739
II. Recurrent Costs													
A. Protection Works O&M /d	Tk.					-	6,075	12,100	18,175	-	129	257	387
Total Recurrent Costs						-	6,075	12,100	18,175	-	129	257	387
Total						150,361	208,486	23,066	381,913	3,199	4,436	491	8,126

\a Land acquisition at 3.5 ha/km of embankment.
\b BWDS Administration at 7.5% of civil works base costs.
\c BWDB Project Management at 2.5% of civil works base costs.
\d O&M for bank protection at 5% of base costs per year for 2 years, then 2% per year.

Table V.7: Expenditure accounts by years - base costs

Bangladesh
Haimchar Erosion Control Project

	Base Cost (Local '000)				Foreign Exchange		Base Cost (US$ '000)				Foreign Exchange	
	99/00	00/01	01/02	Total	%	Amount	99/00	00/01	01/02	Total	%	Amount
I. Investment Costs												
A. Bank Protection Works												
1. Geotextiles												
Geotextiles	22,126	22,001	-	44,127	49.0	21,622	471	468	-	939	49.0	460
Transportation	825	825	-	1,650	49.0	809	18	18	-	35	49.0	17
Subtotal Geotextiles	22,951	22,826	-	45,777	49.0	22,431	488	486	-	974	49.0	477
2. Local Materials	84,036	83,211	-	167,247	5.0	8,362	1,788	1,770	-	3,558	5.0	178
3. Equipment	6,890	6,890	-	13,780	5.0	689	147	147	-	293	5.0	15
4. Labour	6,623	6,573	-	13,196	-	-	141	140	-	281	-	-
5. Mobilisation	1,000	1,000	-	2,000	5.0	100	21	21	-	43	5.0	2
Subtotal Bank Protection Works	121,500	120,500	-	242,000	13.1	31,582	2,585	2,564	-	5,149	13.1	672
B. Embankments & Flood Proofing												
Materials & Equipment	10,889	54,639	5,444	70,972	5.0	3,549	232	1,163	116	1,510	5.0	76
Land Acquisition	-	9,300	-	9,300	-	-	-	198	-	198	-	-
Management & Supervision	5,502	5,502	2,751	13,754	5.0	688	117	117	59	293	5.0	15
Subtotal Embankments & Flood Proofing	16,390	69,440	8,195	94,026	4.5	4,236	349	1,477	174	2,001	4.5	90
C. Project Management												
BWDB Administration /a	9,353	9,353	2,078	20,784	-	-	199	199	44	442	-	-
Project Management /b	3,118	3,118	693	6,928	-	-	66	66	15	147	-	-
Subtotal Project Management	12,470	12,470	2,771	27,712	-	-	265	265	59	590	-	-
Total Investment Costs	150,361	202,411	10,966	363,738	9.8	35,818	3,199	4,307	233	7,739	9.8	762
II. Recurrent Costs												
A. Protection Works O&M												
Operation & Maintenance	-	6,075	12,100	18,175	-	-	-	129	257	387	-	-
Total Recurrent Costs	-	6,075	12,100	18,175	-	-	-	129	257	387	-	-
Total BASELINE COSTS	150,361	208,486	23,066	381,913	9.4	35,818	3,199	4,436	491	8,126	9.4	762
Physical Contingencies	13,789	19,602	2,030	35,420	10.1	3,582	293	417	43	754	10.1	76
Price Contingencies												
Inflation												
Local	10,815	26,442	4,596	41,853	-	-	230	563	98	890	-	-
Foreign	743	1,380	42	2,165	100.0	2,165	16	29	1	46	100.0	46
Subtotal Inflation	11,558	27,822	4,638	44,017	4.9	2,165	246	592	99	937	4.9	46
Devaluation	958	1,844	44	2,847	70.2	1,999	-104	-267	-49	-421	-	-
Subtotal Price Contingencies	12,516	29,666	4,682	46,864	8.9	4,164	142	325	49	516	8.9	46
Total PROJECT COSTS	176,666	257,753	29,778	464,197	9.4	43,564	3,634	5,178	583	9,395	9.4	884
Taxes	16,237	20,253	1,340	37,830	-	-	334	407	26	767	-	-
Foreign Exchange	19,725	23,304	535	43,564	-	-	406	468	10	884	-	-

\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: Expenditure accounts by years - totals including contingencies

Bangladesh Haimchar Erosion Control Project	Totals Including Contingencies (Local '000)				Totals Including Contingencies (US$ '000)			
	99/00	00/01	01/02	Total	99/00	00/01	01/02	Total
I. Investment Costs								
A. Bank Protection Works								
1. Geotextiles								
Geotextiles	26,194	27,349	-	53,543	539	549	-	1,088
Transportation	977	1,026	-	2,002	20	21	-	41
Subtotal Geotextiles	27,171	28,374	-	55,545	559	570	-	1,129
2. Local Materials	99,488	103,437	-	202,925	2,047	2,078	-	4,124
3. Equipment	8,157	8,565	-	16,722	168	172	-	340
4. Labour	7,841	8,171	-	16,012	161	164	-	325
5. Mobilisation	1,184	1,243	-	2,427	24	25	-	49
Subtotal Bank Protection Works	143,840	149,790	-	293,630	2,959	3,009	-	5,968
B. Embankments & Flood Proofing								
Materials & Equipment	12,891	67,920	7,106	87,917	265	1,364	139	1,769
Land Acquisition	-	11,561	-	11,561	-	232	-	232
Management & Supervision	6,513	6,839	3,590	16,942	134	137	70	342
Subtotal Embankments & Flood Proofing	19,404	86,319	10,697	116,420	399	1,734	210	2,343
C. Project Management								
BWDB Administration /a	10,066	10,569	2,466	23,101	207	212	48	468
Project Management /b	3,355	3,523	822	7,700	69	71	16	156
Subtotal Project Management	13,421	14,092	3,288	30,802	276	283	64	624
Total Investment Costs	176,666	250,201	13,985	440,852	3,634	5,026	274	8,934
II. Recurrent Costs								
A. Protection Works O&M								
Operation & Maintenance	-	7,552	15,793	23,345	-	152	309	461
Total Recurrent Costs	-	7,552	15,793	23,345	-	152	309	461
Total PROJECT COSTS	176,666	257,753	29,778	464,197	3,634	5,178	583	9,395

\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: Project cost summary

Bangladesh
Haimchar Erosion Control Project

	(Local '000)			(US$ '000)			% Foreign Exchange	% Total Base Costs
	Local	Foreign	Total	Local	Foreign	Total		
I. Investment Costs								
A. Bank Protection Works								
1. Geotextiles								
Geotextiles	22,505	21,622	44,127	479	460	939	49	12
Transportation	842	809	1,650	18	17	35	49	-
Subtotal Geotextiles	23,346	22,431	45,777	497	477	974	49	12
2. Local Materials	158,884	8,362	167,247	3,381	178	3,558	5	44
3. Equipment	13,091	689	13,780	279	15	293	5	4
4. Labour	13,196	-	13,196	281	-	281	-	3
5. Mobilisation	1,900	100	2,000	40	2	43	5	1
Subtotal Bank Protection Works	210,418	31,582	242,000	4,477	672	5,149	13	63
B. Embankments & Flood Proofing								
Materials & Equipment	67,423	3,549	70,972	1,435	76	1,510	5	19
Land Acquisition	9,300	-	9,300	198	-	198	-	2
Management & Supervision	13,066	688	13,754	278	15	293	5	4
Subtotal Embankments & Flood Proofing	89,790	4,236	94,026	1,910	90	2,001	5	25
C. Project Management								
BWDB Administration /a	20,784	-	20,784	442	-	442	-	5
Project Management /b	6,928	-	6,928	147	-	147	-	2
Subtotal Project Management	27,712	-	27,712	590	-	590	-	7
Total Investment Costs	327,919	35,818	363,738	6,977	762	7,739	10	95
II. Recurrent Costs								
A. Protection Works O&M								
Operation & Maintenance	18,175	-	18,175	387	-	387	-	5
Total Recurrent Costs	18,175	-	18,175	387	-	387	-	5
Total BASELINE COSTS	346,094	35,818	381,913	7,364	762	8,126	9	100
Physical Contingencies	31,838	3,582	35,420	677	76	754	10	9
Price Contingencies	42,700	4,164	46,864	470	46	516	9	6
Total PROJECT COSTS	420,633	43,564	464,197	8,511	884	9,395	9	116

\a BWDB administration costs - 7.5% of civil works base costs
\b BWDB overhead costs - 2.5% of civil works base costs

Table V.10: Procurement accounts by financiers

Bangladesh Haimchar Erosion Control Project	(Local '000)									(US$ '000)								
	Donor		The Government		Total		For.	Local (Excl.	Duties &	Donor		The Government		Total		For.	Local (Excl.	Duties &
	Amount	%	Amount	%	Amount	%	Exch.	Taxes)	Taxes	Amount	%	Amount	%	Amount	%	Exch.	Taxes)	Taxes
A. Bank Protection Works																		
1. Other Materials and Equipment	223,881	85.6	37,549	14.4	261,430	56.3	11,104	238,562	11,764	4,539	85.6	761	14.4	5,300	56.4	226	4,836	239
2. Geotextiles	36,104	65.0	19,441	35.0	55,545	12.0	27,217	8,887	19,441	734	65.0	395	35.0	1,129	12.0	553	181	395
Subtotal Bank Protection Works	259,985	82.0	56,990	18.0	316,975	68.3	38,321	247,449	31,205	5,273	82.0	1,156	18.0	6,429	68.4	779	5,016	634
B. Embankments & Flood Proofing																		
1. Materials & Equipment	75,389	85.7	12,528	14.3	87,917	18.9	4,396	79,565	3,956	1,517	85.7	252	14.2	1,769	18.8	88	1,601	80
2. Land Acquisition	-	-	11,561	100.0	11,561	2.5	-	11,040	520	-	-	232	100.0	232	2.5	-	222	10
3. Supervision & Management	14,528	85.7	2,414	14.3	16,942	3.6	847	15,333	762	293	85.8	49	14.3	342	3.6	17	309	15
Subtotal Embankments & Flood Proofing	89,917	77.2	26,503	22.8	116,420	25.1	5,243	105,938	5,239	1,810	77.2	533	22.8	2,343	24.9	106	2,132	105
C. Departmental Costs	-	-	30,802	100.0	30,802	6.6	-	29,416	1,386	-	-	624	100.0	624	6.6	-	596	28
Total	349,902	75.4	114,295	24.6	464,197	100.0	43,564	382,803	37,830	7,082	75.4	2,313	24.6	9,395	100.0	884	7,744	767

Table V.11: Local and foreign costs and taxes, by financiers

Bangladesh Haimchar Erosion Control Project	(Local '000)						(US$ '000)					
	Donor		The Government		Total		Donor		The Government		Total	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
I. Foreign	43,564	100.0	-	-	43,564	9.4	884	100.0	-	-	884	9.4
II. Local (Excl. Taxes)	306,339	80.0	76,464	20.0	382,803	82.5	6,198	80.0	1,546	20.0	7,744	82.4
III. Taxes	-	-	37,830	100.0	37,830	8.1	-	-	767	100.0	767	8.2
Total Project	349,902	75.4	114,295	24.6	464,197	100.0	7,082	75.4	2,313	24.6	9,395	100.0

Table V.12: Expenditure accounts by years (economic costs)

Bangladesh
Haimchar Erosion Control Project

Economic Costs	Base Cost (Local '000)				Base Cost (US$ '000)				Foreign Exchange	
	99/00	00/01	01/02	Total	99/00	00/01	01/02	Total	%	Amount
I. Investment Costs										
A. Bank Protection Works										
1. Geotextiles										
Geotextiles	14,035	13,956	-	27,990	299	297	-	596	77.2	460
Transportation	523	523	-	1,047	11	11	-	22	77.2	17
Subtotal Geotextiles	14,558	14,479	-	29,037	310	308	-	618	77.2	477
2. Local Materials	72,801	72,086	-	144,887	1,549	1,534	-	3,083	5.8	178
3. Equipment	5,969	5,969	-	11,938	127	127	-	254	5.8	15
4. Labour	5,705	5,662	-	11,367	121	120	-	242	-	-
5. Mobilisation	866	866	-	1,733	18	18	-	37	5.8	2
Subtotal Bank Protection Works	99,900	99,063	-	198,962	2,126	2,108	-	4,233	15.9	672
B. Embankments & Flood Proofing										
Materials & Equipment	9,433	47,334	4,717	61,484	201	1,007	100	1,308	5.8	76
Land Acquisition	-	8,011	-	8,011	-	170	-	170	-	-
Management & Supervision	4,766	4,766	2,383	11,915	101	101	51	254	5.8	15
Subtotal Embankments & Flood Proofing	14,199	60,111	7,100	81,410	302	1,279	151	1,732	5.2	90
C. Project Management										
BWDB Administration /a	8,057	8,057	1,790	17,904	171	171	38	381	-	-
Project Management /b	2,686	2,686	597	5,968	57	57	13	127	-	-
Subtotal Project Management	10,742	10,742	2,387	23,871	229	229	51	508	-	-
Total Investment Costs	124,841	169,916	9,487	304,244	2,656	3,615	202	6,473	11.8	762
II. Recurrent Costs										
A. Protection Works O&M										
Operation & Maintenance	-	5,233	10,423	15,656	-	111	222	333	-	-
Total Recurrent Costs	-	5,233	10,423	15,656	-	111	222	333	-	-
Total BASELINE COSTS	124,841	175,149	19,910	319,900	2,656	3,727	424	6,806	11.2	762
Physical Contingencies	11,410	16,441	1,752	29,603	243	350	37	630	12.1	76
Price Contingencies	-	-	-	-	-	-	-	-	-	-
Total PROJECT COSTS	136,251	191,590	21,662	349,503	2,899	4,076	461	7,436	11.3	838
Taxes	-	-	-	-	-	-	-	-	-	-
Foreign Exchange	18,328	20,621	451	39,400	390	439	10	838	-	-

\a BWDB administration costs - 7.5% of civil works base costs
\b BWDB overhead costs - 2.5% of civil works base costs

Table V.13: Inflation anda exchange rates

Bangladesh Haimchar Erosion Control Project	Up to Negotiation	Up to Project Start	99/00	00/01	01/02
Inflation (in %'s) /a					
All goods & services					
Annual rates					
Local	0.0	5.0	5.0	5.0	5.0
Foreign	0.0	2.7	2.7	2.4	2.4
Compounded rates					
Local	0.0	5.0	7.6	13.0	18.7
Foreign	0.0	2.7	4.1	6.7	9.2
Exchange rates (Local/Foreign) /b					
All goods & services					
Rates actually used	47.0	47.0	48.6	49.8	51.1
Constant purchasing parity rates	47.0	47.0	48.6	49.8	51.1
% deviation	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

ECONOMIC ANALYSIS

ESTIMATION OF PROJECT BENEFITS

1 Agriculture

To estimate agricultural production the project area has been divided into two parts: inside and outside the Chandpur Irrigation Project embankment. Cropping patterns and cropping intensities for each area have been based on data from thana and union offices and from the survey of project area households carried out in January 1998.

Forty-eight farm households from the project area thanas were surveyed. At the time of the survey, the potential project area (i.e. the area expected to be affected by erosion over the planning period) had not been defined and consequently some households surveyed were in areas not included in the final project area. Furthermore, the survey was intended to provide background information about the area and was not planned as a statistical baseline survey. The data from the survey is therefore indicative of the situation in the project area. (see Appendix III.1)

The cropping patterns used for the project analysis have been drawn up taking into account the data from the various sources. The cropping patterns in the project area are represented by a reduced number of crops, especially for the rabi season, in order to simplify the analysis. The crops included have been carefully selected to be representative of production in the area. Production in each of the two areas is represented by a single cropping pattern. The cropping intensities are (conservatively) estimated at 210 per cent for areas inside the embankment and 145 per cent for areas outside the embankment.

Crop budgets have been estimated using data from the above sources as well as from other recent studies in similar areas of Bangladesh. The crop budgets are given in Tables VI.1a and VI.1b (for financial and economic prices, respectively). The cropping pattern for each area and the estimated net revenues per hectare are given in Tables VI.2 and VI.3.

Financial and economic import parity prices have been estimated for rice, TSP and potash and export parity prices for urea, based on World Bank price projections for 2010. These prices are adjusted for quality, transport, handling, marketing, processing and distribution costs, based on a recent study by the Department of Agricultural Marketing[1], 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 calculations are shown in **Tables VI.16 and VI.17**. The relationship between the calculated farm gate financial and economic prices gives a conversion factor for the crop.

Prices of other outputs are based on national farm gate price data from the Department of Agricultural Marketing, where available, or on available information on market prices. 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 obtained as a weighted average of prices for masur, mung and keshari has been used, with the weights reflecting the relative areas of these crops in the project district. The calculations are shown in **Tables VI.18 to VI.21.**

Prices for seeds, pesticides, the hire of draught animals and irrigation costs are based on current market prices in the project area, adjusted by the SCF for economic prices.

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[1] Commodity Report on Foodgrain, Department of Agricultural Marketing, August 1997.

Agricultural land amounts to some 85 per cent of the total area outside the embankment and about 90 per cent inside and is assumed to be evenly distributed over the project area - i.e. each unit area eroded contains a constant proportion of agricultural land.

2 Aquaculture

Aquaculture production in existing ponds has been estimated using a single crop budget for each of cultured and culturable ponds (see Tables VI.4 and VI.5). These crop budgets apply to all fish ponds, both inside and outside the embankment.

Output prices are estimated average farm gate prices for fish, taking into account the various species and sizes. Input prices are based on market prices in the project area, except for urea, TSP and potash, the prices of which are derived from world prices (see above).

The number of ponds in the project area has been estimated based on thana and union office data. The estimate is given in Chapter 3 of the main report. Ponds are assumed to be evenly distributed and are lost to erosion at the same rate as land.

3 Forestry

The estimate for trees in the project area has been based on the Village Forest Inventory carried out for the Forest Master Plan in 1992. This study estimates per capita tree stocks for principal species. However, applying these results to the project area is problematic. The estimate of tree stocks in the project area has therefore been made using the average 1991 population density of the relevant stratum of the Village Forest Inventory and the per capita tree stocks for that stratum. Tree stocks have been estimated on an average number per hectare basis for the whole project area, although in practice trees are concentrated around village and homestead areas. For the principle species an estimate of average annual production has been made and lost production is incorporated into the analysis as land is assumed to erode, as for agricultural production (see Table VI.6) Lost production is cumulative over the project life. In addition an estimate is made of the residual value of trees (for timber or fuel wood) at the time the land is eroded. This valued is counted in the year in which erosion occurs and is not cumulative.

4 Livestock

The value of livestock and livestock production is not estimated because livestock can be moved in the event of erosion and stock and production losses will either be minimal or will not occur.

5 Dwellings and Buildings

The number and values of dwellings and buildings are based on data obtained from union and thana offices (see Appendix II). The number of dwellings has been adjusted to be consonant with the estimate of 1996 population of the project area.

Dwellings are divided into four categories according to type of roofing material: thatch, corrugated iron (C.I.) sheet, cement, and mixed materials. An even distribution of dwellings of each type throughout the respective unions is assumed and the number in the project area is therefore in proportion to the area of the union in the project area and the population in that area. Because dwellings are numerous they are removed or destroyed in proportion to the erosion of land.

In principle, the valuation of these assets is based on current replacement values. In practice, for cement and mixed type buildings, available data on the cost of the existing housing stock has been averaged, by category, and the result used as an estimate of replacement value. When houses are destroyed, it is usual that some may not be replaced and some will be replaced by houses of smaller size or quality. To accommodate these factors, 75 per cent of

the estimated replacement value has been used to estimate the total value of houses destroyed. The SCF is then used to convert to economic prices.

Dwellings with thatch or C.I. sheet roofs are normally made of wood, bamboo, thatch and other easily movable materials. For these structures, it is assumed that the building materials will be removed before an area is eroded. Only the cost of labour for removal and reconstruction is included in the losses in the without project case. These labour costs have been estimated at 50 per cent of the average cost for thatch dwellings and 40 per cent for CI Sheet dwellings. The SCF is used to convert to economic prices. (see Tables VI.11 and VI.14)

Water supply and sanitation infrastructure lost or destroyed is valued at 25 per cent of estimated replacement cost since only the fittings would be removed and reused elsewhere.

6 Other Buildings

Other buildings in the project area include schools, mosques, various community centres, health centres, markets and commercial and industrial buildings. These buildings are valued at 75 per cent of estimated current replacement value (based on thana and union data), calculated in a similar way to the values for dwellings. Only the buildings themselves will be lost: all furnishings, equipment and machinery are assumed to be removed before the buildings are destroyed.

Primary schools, madrashas and mosques, which are relatively numerous, are assumed to be destroyed in proportion to the erosion of land. The location of other buildings, including government buildings, has been located (approximately) on LGED maps or from survey information. Buildings have then been grouped and are "eroded" in five yearly blocks, since the exact year in which they will be destroyed is not determined. (see Tables VI.13) Changing the year in which buildings are assumed to be destroyed a few years in either direction has very little impact on the outcome of the economic analysis.

7 Infrastructure

Infrastructure in the project area includes embankments (the embankment of the Chandpur Irrigation Project), water management structures, bridges and culverts, roads and electricity and telephone transmission lines.

Embankments and water management structures

The retirement of the existing embankment will be necessary because in several locations it is already very close to the river bank. In the project analysis the embankment is retired to the projected 2010 bank line in year 2 of the project. The embankment is valued at the current cost of retirement. Since any structures in the embankment to be retired will also have to be replaced, they are valued in a similar way.

Roads, bridges and culverts

Roads, bridges and culverts, if lost to erosion, will not be replaced since the area they serve will no longer exists. They are valued, in principle, at depreciated historical cost. Because data on actual costs and years of construction has been limited, and because many of the structures are relatively new, average current replacement costs have been used and it has been assumed that the average life of these assets is two thirds of their projected useful life. It is also assumed that this average life is maintained over the life of the project. Current replacement costs are therefore multiplied by 0.67 and by the SCF to obtain economic costs. (Tables VI.10 and VI.12)

Electricity and telephone transmission lines

The electricity and telephone lines in the project area are local distribution only and therefore will not be replaced when destroyed by erosion. They are also valued is a similar way to roads and bridges.

Table VI.1: Haimchar Erosion Control Project crop budgets (per ha)

	Crops	IE/OE 1/	Yield (mt/ha) Main Product	Yield (mt/ha) By-product	Labour Mandays	Animal Pairdays	Seed (kg)	Fertiliser (kg) Urea	Fertiliser (kg) TSP	Fertiliser (kg) MP	Pesticides (kg)	Irrigation (unit)	Financial Prices Revenue (Tk)	Financial Prices Input Cost (Tk)	Financial Prices Labour Cost (Tk)	Financial Prices Net Income (Tk)	Economic Prices Revenue (Tk)	Economic Prices Input Cost (Tk)	Economic Prices Labour Cost (Tk)	Economic Prices Net Income (Tk)
1	B.Aus	IE	1.5	2.2	100	35	90	30					11,345	4,436	5,000	1,909	12,348	4,015	4,250	4,083
2	T. Aus	IE	1.8	1.8	110	40	30	60	10	5	0.3	0.5	12,606	5,641	5,500	1,465	13,909	4,986	4,675	4,247
3	LT Aman	IE	2.0	2.0	120	40	30	70	20				16,228	4,851	6,000	5,377	15,454	4,231	5,100	6,123
4	HYV Aman	IE	2.8	2.8	145	44	35	80	20	10	0.5	0.3	22,719	6,142	7,250	9,327	21,636	5,317	6,163	10,156
5	Boro 2/	IE	4.0	4.0	160	40	40	160	60	20	0.5	1.0	28,674	7,776	8,000	12,898	30,908	6,391	6,800	17,717
6	B.Aus	OE	1.2	1.8	90	30	90	30					9,124	3,936	4,500	688	9,922	3,564	3,825	2,533
7	B. Aman	OE	1.5	2.2	105	30	70						13,011	3,595	5,250	4,166	12,348	3,243	4,463	4,643
8	LT Aman	OE	1.8	1.8	120	40	30	70	20				14,605	4,851	6,000	3,754	13,909	4,231	5,100	4,578
9	HYV Aman	OE	2.4	2.4	130	40	35	70	20		0.5	0.5	19,473	5,894	6,500	7,080	18,545	5,171	5,525	7,849
10	Boro 3/	OE	3.1	3.1	140	30	40	100	30	10	0.5	0.8	22,223	5,747	7,000	9,476	23,954	4,882	5,950	13,122
11	Jute	IE & OE	1.4	1.4	150	35	7	45	20	10	0.5		16,706	4,557	7,500	4,648	17,915	3,872	6,375	7,668
12	Potato	IE & OE	10.0		210	60	1000	135	55	75	0.5	0.4	48,037	21,846	10,500	15,691	43,330	18,662	8,925	15,742
13	Pulses	IE & OE	0.8		60	25	30						10,479	3,040	3,000	4,439	9,452	2,742	2,550	4,160
14	Oil seeds	IE & OE	0.8		70	30	10	40	30		0.5		13,370	3,994	3,500	5,876	12,060	3,354	2,975	5,730
15	Chilli (dried)	IE & OE	0.8		150	25	5	40			0.5	0.2	38,681	3,528	7,500	27,653	34,890	3,201	6,375	25,314

Notes 1/ IE = inside embankment; OE = outside embankment

2/ Boro inside the embankment is predominantly HVY

3/ Boro outside the embankment is approximately 50:50 local and HYV.

Table VI.2: Haimchar Erosion Control Project - farm budget (1 ha)

financial prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.52	993	0.15	103
T. Aus	0.16	234	0.00	0
B. Aman	0.00	0	0.40	1,666
LT Aman	0.35	1,882	0.15	563
HYV Aman	0.50	4,663	0.15	1,062
Boro	0.30	3,869	0.06	569
Potato	0.09	1,412	0.14	2,197
Chilli	0.09	2,489	0.20	5,531
Pulses	0.05	200	0.08	355
Oilseeds	0.05	264	0.12	705
Total	2.10	16,007	1.45	12,751

Based on Table VI.1

Table VI.3: Haimchar Erosion Control Project - farm budget (1 ha)

economic prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.52	2,123	0.15	380
T. Aus	0.16	680	0.00	0
B. Aman	0.00	0	0.40	1,013
LT Aman	0.35	2,143	0.15	687
HYV Aman	0.50	5,078	0.15	1,177
Boro	0.30	5,315	0.06	787
Potato	0.09	1,417	0.14	2,204
Chilli	0.09	2,278	0.20	5,063
Pulses	0.05	187	0.08	333
Oilseeds	0.05	258	0.12	688
Total	2.10	19,479	1.45	12,332

Based on Table VI.1

Table VI.4: Crop budget for fish culture (1 ha. pond (cultured pond - present 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	3.0	2.7	300	271
organic fertiliser	kg	8,000.0	0.5	0.5	4,000	3,608
urea	kg	80.0	5.7	5.6	456	449
MP	kg	30.0	9.1	8.9	274	268
TSP	kg	70.0	9.9	9.7	690	676
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					15,820	14,381
Total Inputs + Labour					18,170	16,378
Yield	kg/ha	800.0	60.0	54.1	48,000	43,296
Net Revenue					29,830	26,918

Table VI.5: Crop budget for fish culture (1 ha. pond (culturable pond - present situatio

	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	3.0	2.7	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	300.0	40.0	36.1	12,000	10,824
Net Revenue					10,500	9,497

Notes: 1/ Lower output price for culturable ponds reflects smaller average size of fish.

Table VI.6: Estimate of output and value of homestead trees

Species	Estimated No. in Project Area	No. per Ha.	Output Unit	Annual Output/tree	Farm Gate Price	Labour (days/year)	Net Revenue per ha.		Residual Value	
							Financial	Economic	Financial	Economic
Coconut	25,800	5.5	nuts	50	5.00	1	1,372	1,238	686	619
Betel nut (areca palm)	145,600	31.0	nuts	320	0.25	1	2,478	2,235	1,859	1,677
Mango	33,300	7.1	kg	20	10.00	1	1,417	1,278	546	493
Bamboo (mixed varieites)	97,500	20.7	stems	1	35.00	1	726	655	0	0
Total							5,994	5,406	3,091	2,788

Notes:
1/ Mangoes are local varieties
2/ Inputs are 1 person day per year per hectare at Tk. 50/day for this homestead production. It is assumed no other inputs are used.

Table VI.7: Agricultural benefits

economic prices

Year	Without Project				With Project				Net Benefits from Agriculture
	Areas Lost		Production Loss 1/	Cumulative roduction Los	Areas Lost		Production Loss 1/	Cumulative roduction Los	
	OE (ha)	IE (ha)	(Tk'000)	(Tk'000)	OE (ha)	IE (ha)	(Tk'000)	(Tk'000)	
1999	(99.6)	(34.7)	(1,904)	(1,904)	0.0	0.0	0	0	1,904
2000	(99.6)	(34.7)	(1,904)	(3,808)	0.0	0.0	0	0	3,808
2001	(99.6)	(34.7)	(1,904)	(5,712)	0.0	0.0	0	0	5,712
2002	(99.6)	(34.7)	(1,904)	(7,616)	0.0	0.0	0	0	7,616
2003	(99.6)	(34.7)	(1,904)	(9,520)	0.0	0.0	0	0	9,520
2004	(99.6)	(34.7)	(1,904)	(11,424)	0.0	0.0	0	0	11,424
2005	(99.6)	(34.7)	(1,904)	(13,328)	0.0	0.0	0	0	13,328
2006	(99.6)	(34.7)	(1,904)	(15,232)	0.0	0.0	0	0	15,232
2007	(99.6)	(34.7)	(1,904)	(17,136)	0.0	0.0	0	0	17,136
2008	(99.6)	(34.7)	(1,904)	(19,040)	0.0	0.0	0	0	19,040
2009	(99.6)	(34.7)	(1,904)	(20,944)	0.0	0.0	0	0	20,944
2010	(99.6)	(34.7)	(1,904)	(22,848)	0.0	0.0	0	0	22,848
2011	(51.3)	(99.7)	(2,575)	(25,423)	0.0	0.0	0	0	25,423
2012	(51.3)	(99.7)	(2,575)	(27,999)	0.0	0.0	0	0	27,999
2013	(51.3)	(99.7)	(2,575)	(30,574)	0.0	0.0	0	0	30,574
2014	(51.3)	(99.7)	(2,575)	(33,149)	0.0	0.0	0	0	33,149
2015	(51.3)	(99.7)	(2,575)	(35,725)	0.0	0.0	0	0	35,725
2016	(51.3)	(99.7)	(2,575)	(38,300)	0.0	0.0	0	0	38,300
2017	(51.3)	(99.7)	(2,575)	(40,875)	0.0	0.0	0	0	40,875
2018	(51.3)	(99.7)	(2,575)	(43,450)	0.0	0.0	0	0	43,450
2019	(51.3)	(99.7)	(2,575)	(46,026)	0.0	0.0	0	0	46,026
2020	(51.3)	(99.7)	(2,575)	(48,601)	0.0	0.0	0	0	48,601
2021	(51.3)	(99.7)	(2,575)	(51,176)	0.0	0.0	0	0	51,176
2022	(51.3)	(99.7)	(2,575)	(53,751)	0.0	0.0	0	0	53,751
2023	(51.3)	(99.7)	(2,575)	(56,327)	0.0	0.0	0	0	56,327
2024	(51.3)	(99.7)	(2,575)	(58,902)	0.0	0.0	0	0	58,902
Total	(1,914.2)	(1,812.0)			0.0	0.0			

Notes: 1/ cumulative

2/ IE = inside embankment; OE = outside embankment

Based on Table VII.3 and estimate of future erosion

Table VI.8: Fisheries benefits

economic prices

Year	Without Project				With Project				Net Benefits from Aquaculture
	Pond Areas Lost		Production Loss 1/	Cumulative Production Loss	Pond Areas Lost		Production Loss 1/	Cumulative roduction Los	
	Cultured (ha)	Culturable (ha)	(Tk'000)	(Tk'000)	Cultured (ha)	Culturable (ha)	(Tk'000)	(Tk'000)	
1999	(2.65)	(3.11)	(101)	(101)	0.00	0.00	0	0	101
2000	(2.65)	(3.11)	(101)	(202)	0.00	0.00	0	0	202
2001	(2.65)	(3.11)	(101)	(302)	0.00	0.00	0	0	302
2002	(2.65)	(3.11)	(101)	(403)	0.00	0.00	0	0	403
2003	(2.65)	(3.11)	(101)	(504)	0.00	0.00	0	0	504
2004	(2.65)	(3.11)	(101)	(605)	0.00	0.00	0	0	605
2005	(2.65)	(3.11)	(101)	(706)	0.00	0.00	0	0	706
2006	(2.65)	(3.11)	(101)	(807)	0.00	0.00	0	0	807
2007	(2.65)	(3.11)	(101)	(907)	0.00	0.00	0	0	907
2008	(2.65)	(3.11)	(101)	(1,008)	0.00	0.00	0	0	1,008
2009	(2.65)	(3.11)	(101)	(1,109)	0.00	0.00	0	0	1,109
2010	(2.65)	(3.11)	(101)	(1,210)	0.00	0.00	0	0	1,210
2011	(4.03)	(4.72)	(153)	(1,363)	0.00	0.00	0	0	1,363
2012	(4.03)	(4.72)	(153)	(1,516)	0.00	0.00	0	0	1,516
2013	(4.03)	(4.72)	(153)	(1,670)	0.00	0.00	0	0	1,670
2014	(4.03)	(4.72)	(153)	(1,823)	0.00	0.00	0	0	1,823
2015	(4.03)	(4.72)	(153)	(1,976)	0.00	0.00	0	0	1,976
2016	(4.03)	(4.72)	(153)	(2,129)	0.00	0.00	0	0	2,129
2017	(4.03)	(4.72)	(153)	(2,283)	0.00	0.00	0	0	2,283
2018	(4.03)	(4.72)	(153)	(2,436)	0.00	0.00	0	0	2,436
2019	(4.03)	(4.72)	(153)	(2,589)	0.00	0.00	0	0	2,589
2020	(4.03)	(4.72)	(153)	(2,742)	0.00	0.00	0	0	2,742
2021	(4.03)	(4.72)	(153)	(2,896)	0.00	0.00	0	0	2,896
2022	(4.03)	(4.72)	(153)	(3,049)	0.00	0.00	0	0	3,049
2023	(4.03)	(4.72)	(153)	(3,202)	0.00	0.00	0	0	3,202
2024	(4.03)	(4.72)	(153)	(3,355)	0.00	0.00	0	0	3,355
Total	(88.18)	(103.37)							

Notes: 1/ cumulative

2/ IE = inside embankment; OE = outside embankment

Based on Tables VI.4, VI.5, 3.12 and estimated rates of erosion.

Table VI.9: Tree crop benefits

economic prices

Year	Without Project						With Project						Net Benefits from Forestry
	Areas Lost OE (ha)	Areas Lost IE (ha)	Production Loss 1/ (Tk'000)	Cumulative Production Loss (Tk'000)	Residual Value of Trees	Total Losses	Areas Lost OE (ha)	Areas Lost IE (ha)	Production Loss 1/ (Tk'000)	Cumulative roduction Los (Tk'000)	Residual Value of Trees	Total Losses	
1999	(117.2)	(40.8)	(854)	(854)	(441)	(1,295)	0.0	0.0	0	0	0	0	1,295
2000	(117.2)	(40.8)	(854)	(1,708)	(441)	(2,149)	0.0	0.0	0	0	0	0	2,149
2001	(117.2)	(40.8)	(854)	(2,563)	(441)	(3,003)	0.0	0.0	0	0	0	0	3,003
2002	(117.2)	(40.8)	(854)	(3,417)	(441)	(3,857)	0.0	0.0	0	0	0	0	3,857
2003	(117.2)	(40.8)	(854)	(4,271)	(441)	(4,712)	0.0	0.0	0	0	0	0	4,712
2004	(117.2)	(40.8)	(854)	(5,125)	(441)	(5,566)	0.0	0.0	0	0	0	0	5,566
2005	(117.2)	(40.8)	(854)	(5,979)	(441)	(6,420)	0.0	0.0	0	0	0	0	6,420
2006	(117.2)	(40.8)	(854)	(6,834)	(441)	(7,274)	0.0	0.0	0	0	0	0	7,274
2007	(117.2)	(40.8)	(854)	(7,688)	(441)	(8,128)	0.0	0.0	0	0	0	0	8,128
2008	(117.2)	(40.8)	(854)	(8,542)	(441)	(8,983)	0.0	0.0	0	0	0	0	8,983
2009	(117.2)	(40.8)	(854)	(9,396)	(441)	(9,837)	0.0	0.0	0	0	0	0	9,837
2010	(117.2)	(40.8)	(854)	(10,250)	(441)	(10,691)	0.0	0.0	0	0	0	0	10,691
2011	(60.4)	(117.3)	(961)	(11,211)	(495)	(11,707)	0.0	0.0	0	0	0	0	11,707
2012	(60.4)	(117.3)	(961)	(12,172)	(495)	(12,667)	0.0	0.0	0	0	0	0	12,667
2013	(60.4)	(117.3)	(961)	(13,133)	(495)	(13,628)	0.0	0.0	0	0	0	0	13,628
2014	(60.4)	(117.3)	(961)	(14,093)	(495)	(14,589)	0.0	0.0	0	0	0	0	14,589
2015	(60.4)	(117.3)	(961)	(15,054)	(495)	(15,549)	0.0	0.0	0	0	0	0	15,549
2016	(60.4)	(117.3)	(961)	(16,015)	(495)	(16,510)	0.0	0.0	0	0	0	0	16,510
2017	(60.4)	(117.3)	(961)	(16,975)	(495)	(17,471)	0.0	0.0	0	0	0	0	17,471
2018	(60.4)	(117.3)	(961)	(17,936)	(495)	(18,432)	0.0	0.0	0	0	0	0	18,432
2019	(60.4)	(117.3)	(961)	(18,897)	(495)	(19,392)	0.0	0.0	0	0	0	0	19,392
2020	(60.4)	(117.3)	(961)	(19,857)	(495)	(20,353)	0.0	0.0	0	0	0	0	20,353
2021	(60.4)	(117.3)	(961)	(20,818)	(495)	(21,314)	0.0	0.0	0	0	0	0	21,314
2022	(60.4)	(117.3)	(961)	(21,779)	(495)	(22,274)	0.0	0.0	0	0	0	0	22,274
2023	(60.4)	(117.3)	(961)	(22,740)	(495)	(23,235)	0.0	0.0	0	0	0	0	23,235
2024	(60.4)	(117.3)	(961)	(23,700)	(495)	(24,196)	0.0	0.0	0	0	0	0	24,196
Total	(2,252.0)	(2,131.8)											

Notes: 1/ cumulative

2/ IE = inside embankment; OE = outside embankment

Based on Table VI.6 and estimated rates of erosion.

Table VI.10: Unit costs - infrastructure

	Unit	Financial Prices (Tk '000)	Economic Prices (Tk '000)
Embankment	Tk/km	3,500	3,157
- road on crest	Tk/km	1500	1,353
total for embankment	Tk/km	5000	4,510
Water Management Structure (single vent)	Tk	2,500	2,255
Roads			
- FR-A	Tk/km	2,300	2,075
- FR-B	Tk/km	1,500	1,353
- village roads 1/	Tk/km	193	196
Bridges and Culverts	Tk/m	125	113
Telephone lines		96	87
Electricity lines			
- 0.4 kV		350	316
- 11.0 kV		500	451

Notes: 1/ Equivalent to 30 mt of wheat per km.

Table VI.11: Unit costs - dwellings and buildings

Tk/unit

	Factor	Financial Prices	Economic Prices
Dwellings			
- thatch	0.50	7,000	3,157
- C.I. Sheet	0.40	37,000	13,350
- brick/concrete	0.75	400,000	270,600
- mixed materials	0.75	170,000	115,005
Tubewells	0.75	3,250	2,199
Latrines	0.75	3,360	2,273
Government buildings	0.75	individual costs used	
Primary schools and madrashas	0.75	595	403
High Schools	0.75	920	622
Mosques	0.75	165	112
Community Centres	0.75	13	9
Other major buildings	0.75	individual costs used	
Market places	0.75	individual costs used	

Note: For thatch and CI Sheet dwellings value included represents labour costs only

Table VI.12: Estimate of value of infrastructure lost (without project)

economic prices

No.	Year	Embankment (retirement)		Water Management Structures		Bridges and Culverts		Roads				Transmission Lines					Total Infra-structure (Tk '000)
								FR-A	FR-B	Village	All	Telephone		Electricity			
		quantity (km)	value (Tk '000)	quantity (unit)	value (Tk '000)	quantity metres	value (Tk '000)	quantity (km)	quantity (km)	quantity (km)	value (Tk '000)	quantity (km)	value (Tk '000)	11 kV (km)	0.4 kV (km)	value (Tk '000)	
1	1999									1.90	250						250
2	2000	8.75	39,463	1.00	2,255	7.48	565			1.90	250						42,533
3	2001									1.90	250						250
4	2002								2.00	1.90	2,063						2,063
5	2003					18.71	1,413			1.90	250						1,663
6	2004									1.90	250						250
7	2005									1.90	250	25.00	1,450	3.2	8.5	2,765	4,465
8	2006								2.00	1.90	2,063						2,063
9	2007									1.90	250						250
10	2008					18.71	1,413			1.90	250						1,663
11	2009									1.90	250						250
12	2010	12.00	54,120						2.00	1.90	2,063	7.00	406	3.2	8.5	2,765	59,354
13	2011									2.14	282						282
14	2012									2.14	282						282
15	2013					16.88	1,275			2.14	282						1,557
16	2014									2.14	282						282
17	2015									2.14	282				8.5	1,798	2,080
18	2016									2.14	282						282
19	2017									2.14	282						282
20	2018					16.88	1,275			2.14	282						1,557
21	2019									2.14	282						282
22	2020									2.14	282				8.5	1,798	2,080
23	2021									2.14	282						282
24	2022									2.14	282						282
25	2023					16.88	1,275			2.14	282						1,557
26	2024									2.14	282						282

Included with retirement of embankments

Based on Appendix II

Table VI.13: Estimate of value of public, commercial and industrial buildings lost (without project)

economic prices

Year	Government Offices		Primary Schools & Madrashas		High Schools		Mosques		Community Centres		Market Places 1/		Other Buildings 2/		Total Buildings
	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	(Tk '000)
1999			6	2,415			7	781	4	35					3,232
2000	2	839	7	2,818	1	622	7	781	4	35	3	1,015	4	633	6,743
2001			6	2,415			7	781	4	35					3,232
2002	1	433	7	2,818	1	622	7	781	3	26					4,681
2003			6	2,415			7	781	4	35					3,232
2004			7	2,818	1	622	7	781	4	35			2	2,050	6,306
2005	1	64	6	2,415			7	781	4	35	7	7,502	13	3,467	14,265
2006			7	2,818			7	781	3	26					3,625
2007			6	2,415			7	781	4	35					3,232
2008			7	2,818			7	781	4	35					3,634
2009			6	2,415			7	781	4	35					3,232
2010			6	2,415			7	781	3	26			4	35,530	38,753
2011					1	622	8	893	2	18					1,533
2012			3	1,208			8	893	1	9					2,109
2013					1	622	8	893	2	18					1,533
2014			3	1,208			8	893	1	9					2,109
2015	1	433			1	622	8	893	2	18	5	5,669	20	4,242	11,877
2016			3	1,208			8	893	1	9					2,109
2017					1	622	8	893	2	18					1,533
2018			3	1,208			8	893	1	9					2,109
2019					1	622	8	893	2	18					1,533
2020			3	1,208			8	893	1	9					2,109
2021							8	893	1	9					902
2022							8	893	1	9					902
2023							8	893	1	9					902
2024							8	893	1	9					902

Notes: 1/ Includes fishing ghats.
2/ Includes public, commercial and industrial buildings not elsewhere included.

Table VI.14: Losses of dwellings and related infrastructure (without project)

economic prices

Year	Dwellings												Total Dwellings
	Thatch		CI Sheet		Brick/concrete		Mixed		Tubewells		Latrines		
	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	number	value (Tk '000)	(Tk '000)
1999	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2000	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2001	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2002	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2003	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2004	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2005	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2006	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2007	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2008	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2009	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2010	260	821	571	7,623	0	0	34	3,910	88	193	155	352	(12,899)
2011	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2012	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2013	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2014	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2015	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2016	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2017	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2018	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2019	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2020	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2021	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2022	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2023	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)
2024	294	928	644	8,597	1	271	38	4,370	100	220	175	398	(14,784)

Table VI.15: EIRR and NPV

Year	Project Costs	O&M Costs	Agricultural Benefits	Aquacultural Benefits	Forestry Benefits	Public & Other Buildings	Dwellings	Infrastructure	Total Subproject Benefits	Net Benefits
1999	136,251		1,904	101	1,295	3,232	12,899	250	19,681	(116,570)
2000	191,590		3,808	202	2,149	6,743	12,899	42,533	68,333	(123,257)
2001	21,662		5,712	302	3,003	3,232	12,899	250	25,399	3,737
2002		7,626	7,616	403	3,857	4,681	12,899	2,063	31,520	23,893
2003		4,366	9,520	504	4,712	3,232	12,899	1,663	32,530	28,164
2004		4,366	11,424	605	5,566	6,306	12,899	250	37,050	32,685
2005		4,366	13,328	706	6,420	14,265	12,899	4,465	52,084	47,718
2006		4,366	15,232	807	7,274	3,625	12,899	2,063	41,901	37,535
2007		4,366	17,136	907	8,128	3,232	12,899	250	42,553	38,187
2008		4,366	19,040	1,008	8,983	3,634	12,899	1,663	47,228	42,862
2009		4,366	20,944	1,109	9,837	3,232	12,899	250	48,271	43,905
2010		4,366	22,848	1,210	10,691	38,753	12,899	59,354	145,755	141,389
2011		4,366	25,423	1,363	11,707	1,533	14,784	282	55,091	50,726
2012		4,366	27,999	1,516	12,667	2,109	14,784	282	59,357	54,991
2013		4,366	30,574	1,670	13,628	1,533	14,784	1,557	63,745	59,379
2014		4,366	33,149	1,823	14,589	2,109	14,784	282	66,735	62,370
2015		4,366	35,725	1,976	15,549	11,877	14,784	2,080	81,990	77,624
2016		4,366	38,300	2,129	16,510	2,109	14,784	282	74,114	69,748
2017		4,366	40,875	2,283	17,471	1,533	14,784	282	77,227	72,861
2018		4,366	43,450	2,436	18,432	2,109	14,784	1,557	82,768	78,402
2019		4,366	46,026	2,589	19,392	1,533	14,784	282	84,605	80,240
2020		4,366	48,601	2,742	20,353	2,109	14,784	2,080	90,669	86,303
2021		4,366	51,176	2,896	21,314	902	14,784	282	91,353	86,987
2022		4,366	53,751	3,049	22,274	902	14,784	282	95,042	90,676
2023		4,366	56,327	3,202	23,235	902	14,784	1,557	100,006	95,640
2024		4,366	58,902	3,355	24,196	902	14,784	282	102,420	98,055
									EIRR	15.59
									NPV	79,864

Table VI.16: Financial and economic prices (1997 prices): import parity

			Rice (b)				Wheat				TSP				Muriate of Potash			
			1997		2010		1997		2010		1997		2010		1997		2010	
	Unit	SCF	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic
World Bank price forecast (1, 2)	$/mt	-	330	330	302	302	165	165	136	136	160	160	120	120	118	118	105	105
Quality adjustment (3)	$/mt	-	248	248	226	226	132	132	109	109	160	160	120	120	118	118	105	105
Freight and insurance	$/mt	-	30	30	30	30	54	54	54	54	45	45	45	45	45	45	45	45
CIF Port of Entry	$/mt	-	278	278	256	256	186	186	163	163	205	205	165	165	163	163	150	150
Border price in taka (4)	Tk/mt	-	13,056	13,056	12,054	12,054	8,727	8,727	7,658	7,658	9,629	9,629	7,736	7,736	7,681	7,681	7,069	7,069
Port dues and transport/handling to regional	Tk/mt	0.9	650	586	650	586	650	586	650	586	550	496	550	496	550	496	550	496
Regional centre/wholesale price	Tk/mt	-	13,706	13,643	12,704	12,641	9,377	9,313	8,308	8,245	10,179	10,125	8,286	8,232	8,231	8,177	7,619	7,565
Marketing costs and margins - regional (6)	Tk/mt	0.9	685	618	635	573	469	423	415	375	509	459	414	374	412	371	381	344
Transport and handling to secondary market	Tk/mt	0.9	660	595	660	595	660	595	660	595	450	406	450	406	450	406	450	406
Marketing costs and margins - local	Tk/mt	0.9	865	780	799	720	577	521	506	457	557	502	458	413	455	410	422	381
Price ex-processor	Tk/mt	-	11,496	11,649	10,611	10,752	7,671	7,774	6,727	6,818	11,695	11,492	9,608	9,425	9,547	9,364	8,872	8,695
Adjustment for processing	Tk/mt	-	7,702	7,805	7,109	7,204	7,671	7,774	6,727	6,818	11,695	11,492	9,608	9,425	9,547	9,364	8,872	8,695
Processing cost	Tk/mt	0.9	320	289	320	289	0	0	0	0	0	0	0	0	0	0	0	0
Transport and handling to farm gate	Tk/mt	0.9	300	271	300	271	300	271	300	271	250	226	250	226	250	226	250	226
Farm gate price	Tk/mt	-	7,082	7,245	6,489	6,645	7,371	7,504	6,427	6,547	11,945	11,718	9,858	9,650	9,797	9,590	9,122	8,921
Notes:																		
(1) WB price forecast in constant 1990 dollars (February 97 dat			279	279	255	255	139	139	115	115	135	135	101	101	100	100	89	89
(2) MUV factor for 1997 (January 1997 forecast)			1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842
(3) Quality adjustment			0.75	0.75	0.75	0.75	0.80	0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(4) Exchange rate - Taka:US$			47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00
(5) Processing ratio			0.67	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(6) Marketing costs - regional			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
(7) Marketing costs - local			0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Notes:
(a) Standard conversion factor = 0.902 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.17: Financial and economic prices (1997 prices): export parity

			Jute (a)		Urea			
			1997		1997		2010	
	Unit	SCF	financial	economic	financial	economic	financial	economic
World Bank price forecast	$/mt	-	399	399	189	189	147	147
Quality adjustment	$/mt	-	399	399	189	189	147	147
Freight and insurance	$/mt	-	50	50	45	45	45	45
FOB Port of Entry	$/mt	-	349	349	144	144	102	102
Border price in taka (4)	Tk/mt	-	16,403	16,403	6,790	6,790	4,787	4,787
Port dues and transport/handling to regional	Tk/mt	0.9	650	586	650	586	650	586
Subsidies	Tk/mt		0	0	1,100	0	0	0
Regional centre/wholesale price	Tk/mt	-	15,753	15,817	5,040	6,204	4,137	4,200
Marketing costs and margins - regional (6)	Tk/mt	0.9	1,575	1,421	504	455	414	373
Transport and handling to secondary market	Tk/mt	0.9	660	0	450	406	450	406
Marketing costs and margins - local	Tk/mt	0.9	1,352	1,219	599	541	500	451
Price ex-processor / local market	Tk/mt	-	12,166	13,176	6,594	7,605	5,500	5,430
Adjustment for processing	Tk/mt	-	12,166	13,176	6,594	7,605	5,500	5,430
Processing cost	Tk/mt	0.9	2,433	2,635	0	0	0	0
Transport and handling to farm gate	Tk/mt	0.9	300	0	200	180	200	180
Farm gate price	Tk/mt	-	9,433	10,541	6,794	7,785	5,700	5,611
Notes:								
(1) WB price forecast in constant 1990 dollars (February 97 dat			399	399	160	160	124	124
(2) MUV factor for 1997 (January 1997 forecast)			1.00	1.00	1.1842	1.1842	1.1842	1.1842
(3) Quality adjustment			1.00	1.00	1.00	1.00	1.00	1.00
(4) Exchange rate - Taka:US$			47.00	47.00	47.00	47.00	47.00	47.00
(5) Processing ratio			1.00	1.00	1.00	1.00	1.00	1.00
(6) Marketing costs - regional			0.10	0.10	0.10	0.10	0.10	0.10
(7) Marketing costs - local			0.10	0.10	0.10	0.10	0.10	0.10

Note: Current subsidy on domestically produced urea assumed to be eliminated in medium term.

Table VI.18: Potato price (Tk/mt)

Year	Index 85/86 = 10	current	1997
1990/91	148.05	4,440	5,777
1991/92	157.58	4,410	5,391
1992/93	157.80	4,267	5,209
1993/94	162.74	4,473	5,295
1994/95	176.73	3,657	3,986
1995/96	190.08	4,663	4,726
1996/97	192.63		
5 year average			4,921
4 year average			4,804
yield (mt/ha)		10.8	

Table VI.19: Mustard price (Tk/mt)

Year	Index 85/86 = 10	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	16370
5 year average			16,827
4 year average			16,712
yield (mt/ha.)			

Table VI.20: Chilli price (dried) (Tk/mt)

Year	Index 85/86 = 10	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	
5 year average			52,671
4 year average			48,352
yield (mt/ha)		0.97	