FLOOD PLAN
COORDINATION
ORGANIZATION
(FPCO)

KREDITANSTALT FUER
WIEDERAUFBAU (KfW)

CAISSE CENTRALE DE
COOPERATION ECONOMIQUE (CCCE)

(12)

BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT FAP 21/22

INCEPTION REPORT

20th March 1992

CONSULTING CONSORTIUM FAP 21/22

RHEIN-RUHR ING.-GES.MBH, DORTMUND/GERMANY
COMPAGNIE NATIONALE DU RHONE, LYON/FRANCE
PROF.DR. LACKNER&PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS

In association with:

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD. (BETS)
DESH UPODESH LIMITED (DUL)

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- Inception Report -

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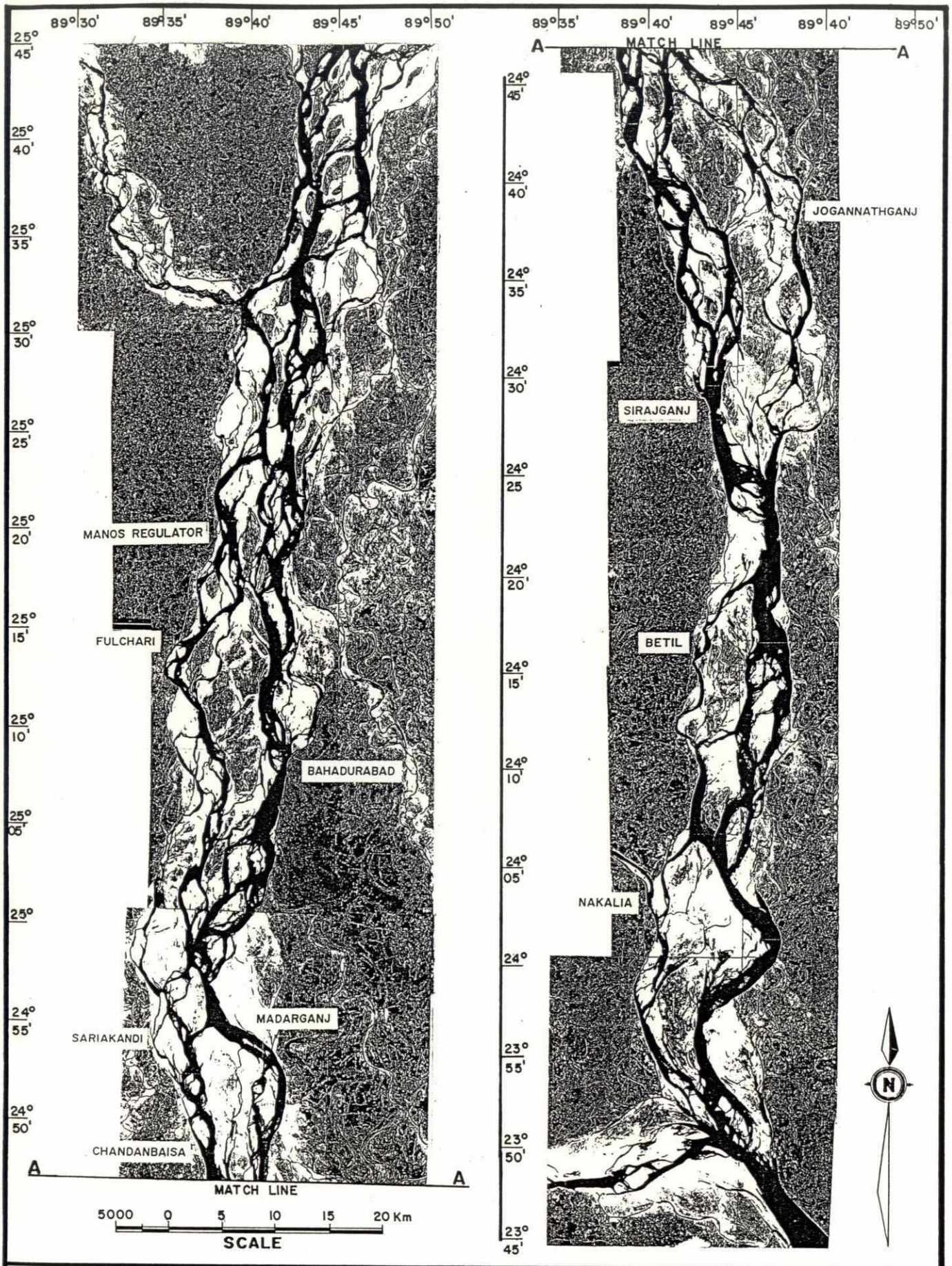

PROJECT AREA
JAMUNA RIVER
BASED ON SPOT IMAGE MAP, MARCH 1989

FAP - 21/22

Bank Protection and River Training/
AFPM Pilot Project

Figure - 1

March 20, 1992

1 INTRODUCTION

1.1 BACKGROUND

The Project was awarded by the Flood Plan Coordination Organization (FPCO) represented by the Kreditanstalt für Wiederaufbau (KfW) to the Joint Venture Rhein-Ruhr Ingenieur-Gesellschaft mbH as lead partner, Compagnie Nationale du Rhone, Prof.Dr. Lackner & Partners and Delft Hydraulics in association with Bangladesh Engineering and Technological Services Ltd. (BETS) and Desh Upodesh Ltd. (DUL).

The Consultancy Agreement was signed on October 14, 1991. The date of commencement was fixed on December 1, 1991.

The Agreement calls for a strictly limited period for undertaking the consultancy services for the Project with the intention to start the physical implementation of the first test structure immediately after the monsoon period 1993. To achieve that deadline the Draft Planning Study Report has to be submitted in January 1993.

Hence only 13 months are available to perform the Planning Study, including the mobilization period. That made it necessary to modify the contractual time schedule, mainly by reducing the period available for mobilization and preselection of test areas, in order to finalize the field surveys of the Planning Study before the beginning of the monsoon period 1992.

It is without doubt that already a short delay of say one to two months would result in postponing the implementation by one full year. The Consultant is fully aware of that time constraint.

As a consequence, in a special effort, the preselection and proposition of test areas (Task 7) was further anticipated and a special report on that issue was circulated for review and discussion on March 2, as a draft. The final version of that Technical Report No.1 was issued on March 14, 1992 for approval.

1.2 PURPOSE OF THE INCEPTION REPORT

The report's main objectives are

- to inform of the progress achieved in the initial phase particularly the mobilization and the collection/review of data
- to present the results so far gained in the studies
- to revise and if found necessary, to reassess the scope of works and the Project's work programme.

One important aspect of the Inception Report to be included according to its original scope, namely the Consultant's recommendation on the selection of the test areas, has been separated and submitted earlier in the Technical Report No.1 in order to allow for a faster and earlier review and approval, as said above.

As per the Consulting Agreement, the administrative and financial aspects will be informed of in a separate report, with a different distribution and including the first quarter of 1992

i.e. having March 1992 as a dead line. That Administrative and Financial Report No.1 will also include the staff employment, subcontracts awarded, etc.

1.3 IMPORTANT DATES AND EVENTS

06.05.1991	Presentation of Proposal
14.10.1991	Signature of Consulting Agreement
01.11. to 09.11.1991	Premobilization mission by the Project Director
05.12. to 14.12.1991	Mobilization mission by the Project Director
13.01.1992	Start of expatriate staff deployment in Bangladesh
24.02. to 05.03.1992	Visit of representatives of KfW and CCCE in Bangladesh
29.02.1992	Joint KfW/CCCE meeting with the Project staff
02.03.1992	Circulation and discussion of the draft of the Technical Report No.1 on Preselection of Test Areas
01.03. to 05.03.1992	2nd GOB-WB Conference on Flood Action Plan
14.03.1992	Official handing over of the Technical Report No.1
19.03.1992	General Meeting in FPCO on the Preselection of Test Areas

Due to the reduction of the inception phase and the postponement of the Study tour to the Yellow river and the Mississippi a report on the state-of-the art in river training works will be submitted as Technical Report No.2 between the Inception Report and the Interim Report.

2 OBJECTIVES AND SCOPE OF THE PROJECT

2.1 GENERAL

After Bangladesh has in 1987 and 1988 experienced two most severe floods on record, several initiatives have been launched for finding solutions to mitigate the worst affects of such floods. In 1989 it was decided to coordinate all individual approaches and major projects on water resources, drainage, flood protection and river training works by the Flood Action Plan (FAP) in order to arrive at a comprehensive plan for future decisions.

FAP 21/22 Project is the by far largest single project in the Flood Action Plan utilizing about 30% of the total funding. Being part of the supporting study type of projects in the FAP, both the reasons and the objectives of FAP 21/22 are different from the case study type projects within the FAP or of the projects executed before that plan existed. Whereas the regional or case study type projects like FAP 1 - Brahmaputra Right Bank Strengthening or FAP 9B - Meghna River Bank Protection Study aimed at finding fast and effective solutions to pressing problems in order to prevent further erosion of banks e.g. in the towns of Sirajganj and Chandpur, respectively, the main objective of FAP 21/22 is to develop strategies for the future. The Project will, building on the experience gained by the past projects, investigate ways of refining the design criteria and improving the construction and maintenance of bank protection works and, on the other hand, investigate methods of possibly employing the river's own fluvial processes to stabilize its course and to reduce the risk of sudden channel displacements.

The two pilot project components

- o FAP 21 : Bank Protection Pilot Project and
- o FAP 22 : River Training and Active Flood Plain Management Pilot Project

are quite different in their characters being interrelated to and independent from each other at the same time.

Whereas the first project component is directed towards the practical design and actual implementation of test works in prototype scale the second one is more kind of an applied research programme and directed to find out wether or not large scale river training/active flood plain management is likely to be feasible and or desirable for the Jamuna river.

2.2 FAP 21

The final objective of the Bank Protection Pilot Project is to develop and optimize design criteria as well as cost-effective construction and maintenance methods. They shall serve as future standards which will be most appropriate for the prevailing conditions at the Jamuna and other rivers of Bangladesh. Such solutions shall be found by designing and specifying different types of protective works, at different safety levels, applying different geometries of structures, using different materials and protective layers, and by investigating into the most suitable construction methods by which the work execution can be ensured. Special emphasis will be put on the investigation of the suitability of local materials and construction methods. Subsequently test structures in accordance with such designs shall be implemented at selected locations on the Jamuna River and the behaviour of these structures be monitored under load conditions for a period of several years.

The scope of services to be performed during the Study Phase initially requires detailed field inspections and a general review of all project relevant data in order to take care of the prevailing conditions of the project area, of the history of bank protection and of river training works in Bangladesh in general and on the Jamuna River in particular.

Based on this knowledge and further morphological analyses, potential test areas were selected and recommended in Technical Report No.1 where bank protection pilot works may be executed during the implementation phase. Subsequent field investigations comprising topographic/hydrographic surveys and subsoil investigations should then provide the basic data for the mathematical and physical models for the test works, the results of which will in turn provide the necessary data and information for the preliminary design of the test structures. The design study shall be supplemented by individual investigations on local construction materials, construction methods and costs as well as by a work programme and budget estimate for the implementation phase.

The Consultant's scope of work during the Test and Implementation Phase will comprise detailed design work and preparation of tender documents for all pilot works, followed by construction management and site supervision of construction works, as well as by monitoring of the behaviour of the test structures, and review and adaption of designs and repair of structures in case structural damages have been observed during and after a flood season.

Manuals and guidelines for the design, the construction and the maintenance of bank protection works will consolidate the findings of the Project and serve as reference for future works.

2.3 FAP 22

Whereas the Bank Protection Pilot component (FAP 21) deals with local defence works where measures are locally taken to prevent the river from eroding valuable areas, the River Training/AFPM Pilot component (FAP 22) comprises a more "active" approach trying to divert the river away from the threatened reaches and, in due time, to change the characteristics of the river.

Since the major threat along of the Jamuna river is due to the rapid changes in the location of channels and sand banks, sometimes causing erosions of up to 1 km in one flood season, a possible option for improving the conditions is by changing the planform of the river. One classical approach would be to narrow the river bed by applying river training works on a large scale. This could finally lead to transform the now braided river either into a river with one meandering channel which is kept in place by training works at the end-locations of the expected amplitudes of the bends or into a more or less straight channel continuously fixed along his total length. In both alternatives the structures required would probably be too costly for the near future and on the other hand, they could also be more than questionable because of their adverse side effects.

Besides this the risk that river training works may lay idle for quite some time (due to the relatively unpredictable behaviour of the braiding Jamuna River) is too high. Therefore it is decided to consider the possible technical feasibility of a probably more promising approach. This approach aims at the modification of the river's planform by applying "softer" recurrent measures at a wide scale, for example by closing or deferring particularly aggressive channels. This would finally result not in changing the river planform from a multi-channel (braided) into a single-channel (meandering or fixed bed) river but in reducing the braiding index (given by the number of channels in a cross-section) and finally resulting in a branched river which in other cases proved to be a rather stable multi-channel planform.

In any case such modifications require the thorough understanding of the river on its whole length and by employing the river's own fluvial processes. It could be said that the river shall be "convinced not forced" to reduce its now-a-days often threatening and unpredictable behaviour into a more gentle and predictable one.

Eventual recommendations for a long-term and large-scale development will not be based on technical and morphological aspects only but include the findings of a thorough assessment of the socio-economic aspects of such measures as well as their impact on the natural environment.

In the event of FAP 22 proving the technical feasibility of a large-scale development of the active Jamuna flood plain a tentative budget requirement will be estimated as well as the approximate period for its implementation. The latter will be rather in the tune of several generations than decades.

2.4 INTERRELATIONSHIP BETWEEN FAP 21 AND FAP 22

Whereas the Bank Protection Pilot Project (FAP 21) is directed towards the practical design and actual implementation of pilot works, the River Training and Active Flood Plain Management Pilot Project (FAP 22) is directed towards the preparation of medium and long-term strategies.

Despite the rather different characters and envisaged time scales of the two components there exists such a clear correlation that the required tasks cannot always be separated, but they are interlinked in many aspects.

For example, the construction of groynes, cross bars, guide bunds etc. are river training measures which intervene in the active flood plain with the aim to control bank erosion and to achieve channel stabilization. On the other hand if recurrent training measures would succeed in reducing channel migration or even changing the character of the river then the impact on the planning and design of bank protection schemes could not be ignored. In any case, a close interrelation between both project components is necessary in order to investigate into a coordinated approach for bank protection and river training works.

An interesting possibility is the use of the FAP 22 pilot project to assist FAP 21 in reaching its objective: the testing of the bank protection structures to be built. Even though the test sites will be selected with extreme care and using the latest insights in the morphology (task of FAP 22), of the Jamuna River, the possibility exists that near one or even more of the test sites the morphological development is such that over the test period of FAP 21 no testing may occur because of the absence of flow attack. In that case the Consultants will consider the possibility of using the FAP 22 pilot project, if it would materialize, for the "on purpose deteriorating" of the conditions at this particular test site. This can e.g. be achieved by closing a cutoff channel that has occurred and that reduces the "aggressiveness" of any channel near the test structures. The closing off itself could be the pilot project for FAP 22. Before deciding on such a measure the Consultant will investigate the legal consequences of such an action, including the liability for forcing bank erosion on a location where otherwise the bank erosion would have been less. If this would turn out to be too risky from a legal and/or a financial point of view this line of action will not be pursued any further.

Another important interrelationship between FAP 21 and FAP 22 is found in one of the objectives of the FAP 22 component. This particular objective is the formulation of possible river training measures and/or strategies including some preliminary findings on effectivity, reliability, sustainability and cost effectiveness. The analysis to achieve these objectives within FAP 22 will greatly depend on the thorough analysis on permanent structures to be carried out within the FAP 21 component under Task 16, 17 and 18 (see Annex II).

2.5 RELATION OF FAP 21/22 WITH OTHER FAP COMPONENTS

Relation with FAP 1
The objective of the FAP 1 component is to study the long term protection of the Brahmaputra right embankment and the design of short term measures for protection of critical sections along the right bank of Jamuna River.

In this connection 10 locations have been investigated and as per the latest report of FAP 1 detailed designs and draft tender documents have been completed for 6 priority locations for which also surveying works, geotechnical investigations and model tests were carried out.

From the Interim Reports and discussions with the team leader of FAP 1 it is obvious that close relations between FAP 1 and FAP 21/22 would be important in order to make use of experiences gained in FAP 1 and to check and compare the results of various investigations, as well as their approach to river training and bank protection problems.

The exchange of opinions and experiences in connection with the preselection of test areas proved already to be very efficient and useful.

Relation with FAP 3
The objective of the North Central Regional Study is the planning of flood control and drainage options and the preparation of a Regional Water Development Plan. Although FAP 3 and FAP 21/22 have a common project boundary not many relations exist because of their different objectives. Opinions have been exchanged in connection with the preselection of test areas on the left bank of the Jamuna River and cooperation in the studies on environment and socio-economics has been arranged for.

Relation with FAP 3.1
The strengthening of the Jamuna left embankment between Bahadurabad and Jagannathganj and all works in connection with this task of FAP 3.1 are also of interest to FAP 21/22. This applies to the preselection of test areas for FAP 21/22 for which useful discussions were held with the team leader of FAP 3.1 as well as to the results of geotechnical investigations, presently executed along the Jamuna left embankment. Furthermore also individual studies on environmental and socio-economic issues may be of interest when assessing the impacts of FAP 21/22 schemes.

Relation with FAP 9B
Similar to FAP 1 also the Meghna Left Bank Protection Project is of special interest to FAP 21/22 since it deals with bank protection measures, viz for 7 locations on Meghna and 1 location on Dhaleswari River.

The services of FAP 9B comprise optimum bank protection designs, risk analysis, probabilistic designs, construction methods and cost estimations for the protection of special locations other than the Jamuna River and would therefore serve as a comparison with regard to the applicability of their approach with regards to the objectives of FAP 21/22.

Relation with FAP 16

FAP 16 has initiated a number of special studies concerning the environment in relation to the proposed Flood Action Plan, and some of them are relevant to FAP 21/22 Environmental Assessment. They are :

(1) Nutritional consequences of bio-diversity of fisheries resources: Jamuna floodplain (Tangail area)

(2) Important disease vectors such as mosquitoes and sand flies: Shahzadpur Upazila (Sirajganj District) and Tangail District

(3) Resource inventory of charlands, including GIS : study area not specified.

It may be mentioned that information pertaining to other studies and in the "Guidelines for Environmental Impact Assessment" and "Manual for Environmental Impact Assessment (EIA) Vol.1" will not exactly suit to FAP 21/22 Environmental Study.

Relation with FAP 18

The main objective of this FAP component (FAP 18) is to obtain up-to-date aerial photographs and accurate maps as basis for various projects. The works include comprehensive geodetic surveys (GPS) and long distance 2nd order levelling as well as aerial photography and photogrammetric techniques.

There would be quite a large benefit to FAP 21/22 from this surveying and mapping programme, since the most recent results of terrestrial surveys and aerial photographs of the Jamuna area are available at FAP 18.

Of benefit for FAP 21/22 would be the aerial photographs, taken in December 1990, and resulting revised topo maps 1:50,000.

For the connection of the envisaged topographical and hydrographic surveys of the test sites to the overall co-ordinate and height system of Bangladesh the new GPS stations along the Jamuna and the new heights of the Bench Marks (BM) are most useful. The connection to these control points would avoid uncertainties and the probability of errors which are to be expected when using unchecked figures.

It has to be pointed out that the aerial photographs have been asked for on February 16, 1992. Unfortunately they are not available to FAP 21/22 at the time of issue of this report.

According to information from the Surveying and Mapping Specialist of FPCO co-ordinate figures and BM elevations will unfortunately not be available before June 1992.

Relation with FAP 19

The main objective of FAP 19 is the introduction of Geographical Information Systems (GIS) in Bangladesh including the analysis and use of satellite images (see: Inception Report FAP 19, August 1991).

From the Inception Report of FAP 19 and discussions with the FAP 19 team leader it may be concluded that 9 candidate GIS projects have already been defined. From these 9 projects 5 pilot projects will be selected for implementation up to April 1993. Considering the time span of the FAP 21/22 planning study, two of the preliminary pilot projects are of interest:

(i) Channel Morphology and Char History Project with specific interest for FAP 21. This project can be briefly described as follows:

The GIS application uses remote sensing and digital analysis for change detection, and will contribute to the understanding of river behaviour and channel morphology. It should be of particular interest to those working along the Jamuna river. The study will help to document changes in channel positions of the Jamuna River over the last 20 years. Although satellite image prints from Landsat and SPOT are available and show channel configurations on a year-by-year basis, presentation and analysis can be enhanced by using GIS. With GIS, georeference control and differing scales can be accommodated. Also, water, sandbars, and vegetated chars, all important components of river morphology, will be traced through time using georeferenced digital maps.

(ii) National Overviews and Planning Project with specific interest for FAP 22. This project can be summarized as follows:

The primary activity will be to construct a national database using small-scale inputs such as administrative boundaries, elevation data at a coarse level, rainfall isohyets, and upazila-level attributes. The database and analysis results will be useful for overview and planning, for graphic display of national databases and for general display and presentation of FAP activity locations and status.

During the discussions it became clear that FAP 19 has analysed black-and white prints of satellite images, geometrically corrected them and used them for a study of bank line changes. Now they have embarked on an analysis of the digital material, which is comparable with the analysis carried out in 1988 by one of the partners of the FAP 21/22 consortium with respect to the Jamuna Bridge Project. Due to these findings it is recommended to combine activities as much as possible and to include also the results of the FINNMAP activities on the basis of the following actions :

(1) continuous exchange of information between FAP 21/22 and FAP 19,
(2) re-consideration of approach of additional remote sensing study of FAP 22.
(3) discussions on the use of the National Data Base for FAP 22.

Relation with FAP 25

The flood hydrology study of component 25 of the Flood Action Plan is the basis for the hydrology study in FAP 21/22. Within the framework of the flood hydrology study a database covering 25 years has been set up with a calibrated general model. This database has been transferred to the FAP 21/22 Project computers. The approach for the hydrologic analysis, which is proposed and recommended by FAP 25, is adapted completely in FAP 21/22.

The Coordination Advisory Team of FAP 25 has the task to coordinate the supply of models as tools to the various FAP projects and the feedback of relevant data and information from various FAP projects to the Surface Water Modelling Centre. Regular informal discussions are held with the resident model coordinator of FAP 25 to fill in this task.

2.6 CO-OPERATION WITH RESEARCH INSTITUTES AND UNIVERSITIES

Both FAP 21 and FAP 22 are dealing with studies and investigations that can be of quite some interest to research institutes and universities. The Consultants will explore possibilities for co-operation with such institutes and universities both inside Bangladesh and abroad. This co-operation could be shaped in different forms, roughly to be classified according to the extent of involvement in the following possibilities:

(1) participation of students in the surveys and tests to get practical experience,

(2) analysis of data obtained according to the test programme, as part of B.Sc. or M.Sc. thesis works,

(3) special studies initiated by these research institutes and universities, also if this implies modifications or additions to the test structures (as long as any additional funding, if required, is made available).

Possibilities for cooperation will be explored with at least the following institutes and universities:

(1) Bangladesh:
- BUET (Bangladesh University of Engineering and Technology), Dhaka
- River Research Institute, Faridpur

(2) Federal Republic of Germany:
- Franzius Institut, Hannover
- Bundesanstalt für Wasserbau, Karlsruhe
- Technische Universität, München
- Universität der Bundeswehr, München
- Institut für Wasserbau und Wasserwirtschaft, Aachen

(3) France:
- Université de Toulouse, Toulouse
- Laboratoire Hydraulique de France, Grenoble
- Sogreah, Grenoble
- Laboratoire Nationale d'Hydraulique, Chatou

(4) The Netherlands:
- Delft University of Technology, Delft
- International Institute for Hydraulic and Environmental Engineering, Delft
- Delft Geotechnics, Delft
- Rijkswaterstaat, Dienst Weg-en Waterbouw, Delft
- CUR (Civieltechnisch Centrum Uitvoering Research en Regelgeving), Gouda.

Possible subjects which could be dealt with in such cooperation would include:

(1) physical model testing
(2) mathematical model testing
(3) morphological investigations in the field and in the laboratory
(4) establishing bank protection design criteria
(5) testing of filter material and top layers.

3 ACTIVITIES UNDERTAKEN

3.1 GENERAL

This chapter describes the activities as undertaken by the Consultant from the date of Commencement of Services until the submittance of this Inception Report. According to the Consulting Agreement that inception period including the mobilization phase, was to take 5 months. Due to the change of the date of commencement that period had to be reduced to between 3 months for the preselection of the test areas and about 3.5 months for the presentation of the Inception Report.

On the other hand, the activities undertaken within the inception period have not been changed substantially, the exception being the reconnaissance of major rivers in Bangladesh (others than the Jamuna) being postponed for the time after the presentation of the Inception Report.

Hence, the major activities during the inception period have been

- the mobilization of the team, the office and the equipment
- the collection and review of data
- the various field visits
- the installation of the 1-dimensional mathematical model (Mike 11)
- the hydrologic study
- the study on the presentation and recommendation of the test areas, submitted in the Technical Report No. 1 which preceded this Inception Report.

In February/March 1992 three numbers of the Consultant's Advisory Board paid a visit to the Project. After making themselves familiar with the area, the problems and the Project, they could already give important advice from their respective fields of experience. This holds particularly for :

- specific problems related to modelling techniques
- aspects on and experiences in river training and active flood plain management of various Chinese rivers, especially the Yellow River and the Yangtsekiang.

The findings and recommendations of the members of the Advisory Board will be compiled in a separate report.

3.2 MOBILIZATION

For a project like this which is characterized by an input of more than 200 professional man months in little more than one year and which includes a variety of mathematical and physical model simulations, several field surveys, an efficient and rapid mobilization and start up is a must.

The time available from the date of Commencement of Services to the first important study result viz the preselection of test areas, was 3 months including the Christmas and New Year period. Since that time was quite short for intensive mobilization and start up of the Project the Consultant went for a premobilization mission to Bangladesh, before the date of Commencement. At that time the basic requirements were discussed and agreed upon with the local partners and sort of terms were set for the most important matters to be arranged

in Bangladesh such as :

- o office requirement and preliminary analysis of available buildings: the office had to fit about 45 persons half of which professionals
- o specification of 8 vehicles, request for proposals
- o request for proposals for office equipment like computers, printers, copiers, telephone, office furniture, etc.

During the proper mobilization mission, immediately after the date of Commencement, the proposals received were evaluated and the results compared to the cost of similar equipment imported from Europe. The decision was not only made according to the lower cost but also putting strong stress on the maintenance and repair facilities. At the end the majority of the equipment was either bought in Bangladesh or imported through the Bangladeshi dealers and representatives. This holds e.g. for the vehicles, the computers, printers and copiers. Only very special equipment was purchased in Europe, mainly the equipment related to field surveys like: the working boat, the echo sounder and current meter, the optical, opto-electronic and electronic survey equipment.

At that time the deed of lease for the office building was concluded, and the occupancy of the rooms determined according to working groups and either FAP 21 or FAP 22 components. The building was ready to be occupied from January 1, 1992, when the necessary modifications started and the first office furniture was installed according to the layout prepared during the mobilization mission.

The important day-to-day work, including administrative tasks like application and follow up of the project pass book were carried out by the (local) Deputy Project Manager and the Office Manager who took up their permanent assignment on the date of Commencement of Services.

Hence, when arriving mid January 1992, the expatriate professional staff together with their local counterparts could start (nearly) immediately. Since mid February the office is fully operable.

One negative aspect, however, should not be omitted: between the period of preparing the Proposal and the Commencement of Services the delivery periods for vehicles had doubled from about 2 months to about 4 months, irrespective of the brand and wether bought in Bangladesh or Europe. This fact will possibly lead to an increase of the number of vehicle rental months.

3.3 MEETINGS

Soon after the arrival of the professional staff members from Europe the collection of all necessary project relevant data and information commenced and in this connection meetings were held with FPCO, with members of the international and local Panel of Experts, with representatives of various government organizations in Dhaka and in the project area, and last not least, with team leaders of other FAP components.

The following offices had been visited and discussions were held with
- Secretary, Ministry of Irrigation

- Bangladesh Water Development Board

  o Chairman
  o Member Implementation
  o Chief Engineer Planning, Design I/II
  o Director RRI
  o Superintending Engineer, Bogra; Executive Engineers Gaibanda, Bogra, Sirajganj, Bera, Tangail, Mynmensingh
- Surface Water Modelling Center
- Member Engineering BIWTA
- Jamuna Bridge Authority
- Survey of Bangladesh
- Joint Secretary, Ministry of Land
- Deputy Commissioner Sirajganj and Tangail
- Settlement Officer, Bogra
- Director General Land Revenues & Surveys
- Soil Research Institute (SRDI)
- UNO's at various places
- Team Leaders and staff of FAP's 1,2,3,3.1, 8B, 9B, 16, 18, 19 and 25
- etc.

In connection with the Second Conference on the Flood Action Plan representatives of the donors KfW/CCCE visited Bangladesh. They also met the Consultants professional staff members and had detailed discussions on all technical and organizational subjects.

In order that the Client and all professional staff members of the Consultant are kept informed of the latest status of work progress and necessary actions, regular weekly meetings have been introduced which are held in the Consultant's office every Sunday at 10.00 am. The minutes of such project meetings are also distributed to the Client and the donors. Copies of minutes of project meetings held so far are attached to this report in ANNEX IV.

3.4 COLLECTION AND REVIEW OF EXISTING DATA

3.4.1 Maps

Maps and other scale reproductions of the Jamuna River areas form one of the most important prerequisite for the tasks of FAP 21/22 and thus are required by the Consultant for the various disciplines. Inquiries were made first about available maps and other documents of similar nature in Bangladesh. The documents were assessed concerning their suitability for the project, and the considered numbers were ordered. The result is shown in Table 3.4.1-1.

Brief descriptions of the maps are as follows :

Topographic Maps
The actually available topographic maps on the scale 1:50,000 are published between 1988 and 1991, most in 1991. They are topographic maps only, i.e. they do not show contour lines. Only a few approximate spot heights are indicated. The maps are compiled from air photographs on the scale 1:30,000 of January 1975. The maps were verified on the ground

several times. The latest revision is from 1985 to 1990. Most of the maps were revised during 1988/89. The maps are based on geographical co-ordinates of longitude and latitude but they show also grid co-ordinates given in hundreds of yard.

It is unsatisfactory that the maps are not up-to-date and that they do not show even the status of the aerial photographs made by FAP 18 in December 1990. The actual line of the river embankment cannot be derived from these maps.

Contour Maps

Large scale contour maps are available on the scales 4"/1 mile (1:15,840) and 8"/1 mile (1:7,920). The maps are sometimes called "irrigation map", because they serve mostly as basis for irrigation projects. The 4"-maps cover the higher areas between Jamalpur and Tangail, the 8"-maps are available from all flood areas. The maps are based on surveys done before 1962.

The embankments, shown on these maps ought hardly the same as in the actual state. The maps are of minor benefit for FAP,21/22.

SPOT Image Maps

These maps derived from satellite imaging of February/March 1989 and digital mosaicing were contributed by the French Government to the Bangladesh Flood Action Plan (FAP) as part of the FAP 18 activities. The scale is 1:50,000. The numbering and the map index is the same as for the topographic maps. The projection is a Transverse Mercator Projection with a 5,000 m-grid. Longitude and latitude are also indicated in the maps.

The maps have a good resolution and are quite a good source of information for the different tasks in the Project.

More recent SPOT images were promised by the representatives of the French donors, thus allowing a comparison for morphological assessment.

Aerial Photographs 1990

The photographs were taken by Finnmap in December 1990 on the scales 1:20,000 and 1:50,000. The photographs are very useful with respect to various information needs, but they are not (yet?) available to FAP 21/22. Photogrammetric techniques should be applied as soon as possible from these aerial photographs in order to update the topographic maps 1:50,000 particularly concerning the shape of the Jamuna river.

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Particulars of Maps	Date of Ident Placed	No.of Maps Required	No.of Maps Received	Date of Received	Remarks
1. Topographic Maps Scale 1:50,000	-	-	-	-	Maps from 1966, out-dated, not required
2. Updated Topographic Maps Scale 1:50,000	27.01.92	18x2 = 36	36	02.02.92	Maps compiled from air photo-graphs, revised on the ground partly 1986/87 and 1988/89
3. Contour Maps	27.02.92		-	-	Maps from 1962, pending for collection
Scale 4"= 1 mile		92			
Scale 8"= 1 mile		90			Images of March 1989
4. Spot Multispectral Image Maps	19.02.92	18x2 = 36	36	17.02.92	
Scale 1:50,000		2x2 = 4	2	27.02.92	Taken by Finnmap Dec.1990.
5. Aerial Photographs 1990	16.02.92				Demand letter sent to SOB
Scale 1:20,000		328	-		from FPCO
Scale 1:50,000		62	-		on 29.02.92

Table 3.4.1-1 States of Maps, FAP 21/22

3.4.2 Morphology

Regarding the morphology of the Jamuna River and the other major rivers in Bangladesh the following data collection activities were undertaken :

(1) available reports and other literature were reviewed to get an overview of available and processed data

(2) visits were made to a number of governmental agencies to assess the availibility of basic data and to establish the way in which these data were collected

(3) elaborated data available from previous projects in which the Consultant has been involved were assessed as to their applicability for the present project

(4) if and when appropriate, basic data were ordered from the Government agencies referred to under 3.3

(5) the available data were assessed as to whether they are sufficient for the present project, or whether additional data are needed.

Data for other rivers than the Jamuna River were collected and reviewed as well. This was done for two reasons:

- the Padma and Lower Meghna River are considered as continuations of the Jamuna River, and hence some characteristics of these rivers can be used for an interpretation and improvement of the understanding of the Jamuna River.
- the applicability of any results obtained for the Jamuna River to other rivers has to

be assessed (see Section 4.5).

Ad (1) Reports and other literature

The following project reports were reviewed:

(1) JICA study for Jamuna Bridge, 1976
(2) Feasibility Study Rehabilitation Ganges Kobadak Project, 1983
(3) Jamuna Bridge Study, Phase 1, 1987
(4) Jamuna Bridge Study, Phase 2, 1980-1990
    (a) Feasibility Study
    (b) Design River Training works
    (c) Additional Study for River Training Works
(5) FEC (Grench Engineering Consortium), 1989
(6) Brahmaputra River Training Studies, 1989-1992:
    (a) First Interim Report, April 1991
    (b) Second Interim Report, December 1991
(7) Bangladesh-Chinese Study on Flood Control and River Training of the Bhrahmaputra River
(8) Meghna River Short-term Bank Protection Study, Interim Report, November 1991

and a number of relevant articles like Coleman (1969), Bristow (1987) and Klaassen et al (1988-1992) were studied.

Ad (2) Visits

Vistis were made to a.o. the following governmental agencies:

(1) BWDB: Hydrology 1 and 2, Morphology
(2) JMBA
(3) BIWTA

and to a number of project offices.

Ad (3) and (4) Available and additionally ordered data

Table 3.4.2-1 provides an overview of the data available with the Consultant and data to be collected additionally. Regarding the satellite images reference is made to Annex III. Tapes of almost all years between 1973 and 1992 for both the northern and the southern part of the Jamuna River either were available or were ordered with EOS (USA), NRC (Thailand) or MOS (Japan), to be processed under the Additonal Remote Sensing Study.

Ad (5) Assessment of applicability and need for additional measurements

After a review of the available data and the data to be collected additionally, it was assessed that, apart from the satellite images no additional "general" data were needed. There remains of course a need for specific data for the selected test sites (see Section 4.2.3)

Type of data	Data	Years	Where
Maps	not pursued (not too releveant)		
Satellite images	Image 148/138-42 North digital/processed	1984	Netherlands[1])
		1986	Do
		1987	Do
	Image 148/138-43 South digital/processed	1976	Netherlands[1])
		1977	Do
		1978	Do
		1984	Do
		1986	Do
		1987	Do
			2)
	Prints Jamuna	1988	FAP 21/22
	Print Jamuna (Finnmap)	1991	FAP 21/22
	Prints Jamuna	various (see Jamuna phase 1)	Netherlands[1])
	Prints Padma/LM	various (see Meghna, Annex B)	Netherlands[1])
Bed topography	BWDB cross-sections	1965-1986	Available
	Jamuna River	1987-1992	To be collected
	Same (digitized)	1965-1986	Available
		1987	FAP 1 (to be collected)
		1988 onw	Existing? To be colleced
	BIWTA soundings	1964?-1987	Available
	Jamuna River	1988-1992	Collected
	BIWTA soundings	1964-1990	
	Padma/LM River		To be collected

Table 3.4.2-1 Availibility of data

Type of data	Data	Years	Where
Discharge measurements	BWDB (Hydrology) measurements Bahadurabad (original forms with depth and velocities given)	1965?-1992	To be collected, about 4 per year (beginning, peak 44,000 m^3/s, recession)
Bed material	Jamuna River Padma River Lower Meghna River	 1991 1991	Jamuna Report Phase I Meghna, Annex B Meghna, Annex B
Bank material	Jamuna River	1991	FAP 1
Sediment transport measurement (coarse)	Jamuna River BWDB measurements Bahadurabad (original forms with depth and concentrations given)	1965?-1992	To be collected, about 3 per year (beginning, peak and during recession)
Sediment transport (results)	Jamuna River Mawa	1965 onw 1965 onw	Bangladesh/Chinese Report

Table 3.4.2-1 Availibility of data

Notes :

(1) Will be sent from the Netherlands
(2) More to be collected under Additional Remote Sensing Study

3.4.3 Hydrology

3.4.3.1 Introduction

A satisfactory network of hydrological stations in the Brahmaputra catchment in Bangladesh has been established by the BWDB which is the main source of hydrological data. The Directorate of Surface Water Hydrology-I is responsible for hydrological field work, while the Directorate of Surface Water Hydrology-II (SWH II) is responsible for data storage, processing and disbursement.

In general, hydrological data for the Brahmaputra-Jamuna within Bangladesh are available from the early 1960's. A data availability directory has been produced by FAP 25.

Hydrological data required for the hydrological study were collected from several sources and stored in a computer database in the Consultant's office.

3.4.3.2 Data Collected

Different types of hydrological data have been collected, as rainfall data, water levels, and discharge data.

Rainfall Data

The collection of rainfall data was facilitated by the availability of the rainfall data base from

North West Hydraulics Consultants (under SSFCDI: Second Small Scale Flood Control, Drainage and Irrigation Project financed by the Canadian International Development Agency (CIDA)). This database contains daily rainfall from 1964 to 1989 for all the observation stations in Bangladesh. A selection of these stations is shown in Figure (3.4.3-1), and a list of the availability of this data is given in Table 3.4.3-1.

Water Level Data

An extensive network of water level gauging stations on the Brahmaputra and its (dis)tributaries has been established by the BWDB.

A schematization of this network is shown in Figure 3.4.3-2 and the list of the data already collected is given in Table 3.4.3-2. Some secondary stations are still in hardcopy form and will be used only for verification.

Some stations, (outside the scope of the study) have been collected to improve, if necessary the 1-D model and to avoid a new data collection.

The locations of these stations were selected from several sources (see Table 3.4.3-3). A good location file is not available in SWH-II and some big discrepancies were found on the field by various teams using GPS (Global Positionning System) units.

The reliability of the zero datum of these stations, specially between right bank and left bank of the Jamuna river is still pending. The results of the second order benchmarks checks, done by FAP 18, have not yet been published.

The Flood Hydrology Study (FHS), under FAP 25, has made some corrections to the BWDB data. FAP 25 provided the project with the corrected data.

Discharge Data

Discharge data have been collected (see Table 3.4.3-4). Bahadurabad is the most important station, because it is the only station where the Jamuna discharge is currently being measured regularly by BWDB.

Discharge calculated by the FHS using a set of new rating curves with consistent extrapolation characteristics have also been collected and will be used instead of the daily data from BWDB because of the "Shift corrections methods" (see Ref: 1).

It should be mentioned that the accuracy of the discharge measurements has not been assessed by FAP 25, but they estimated that sometime discharge measurements may some 20-30 % in error or even more, specially for the peak estimation.

Computed Data from the General Model

The General Model (GM) has been developed at the Surface Water Modelling Centre (SWMC) of the Water Resources Planning Organization (WARPO).

Based on Mike 11 Software, the FAP 25/GM model is a reduced version of the GM with runs for a long period (1965-89) with a fixed bed. The run 6 of FAP 25/GM model which is the final run for the existing situation with a recalibrated model is carried out jointly by FAP 25 and SWMC and is expected to become available by April'1992. These important

results have been requested by the project.

The results of the so called "run 5" have already been collected, but it should be mentioned that as this run is not the final one, systematic errors in the measured and calculated time series at a station have been observed up to .15 m. Also individual differences between measured and calculated values of the water level up to 0.5 m are possible. But as already mentioned, the location and the datum of some BWDB stations may be not sufficient accurate.

3.4.3.3 Hydrological Data Base

A hydrological data base has been established on a project computer. All individual stations are stored in Lotus files and/or in Mike 11 database.

3.4.3.4 Review of Past Hydrological Studies

In the past, a number of studies in relation to the Brahmaputra river were conducted by different agencies. Some have already been collected (see enclosed list of " References used in Hydrology Assessment")

References used in Hydrology Assessment

(1) KRÜGER,DHI,BCEOM & FPCO, (1992) FAP-25-Flood Hydrology Study, Draft Main Report, vol. 1 & 2.

(2) HALCROW,DHI,EPC,DIG & BWDB,(1991), River Training Studies of The Brahamaputra River, First Interim Report- Annex 1, Data collection & Analysis.

(3) HALCROW,DHI,EPC,DIG & BWDB,(1991), River Training Studies of The Brahamaputra River, First Interim Report- Annex-2, Hydrology.

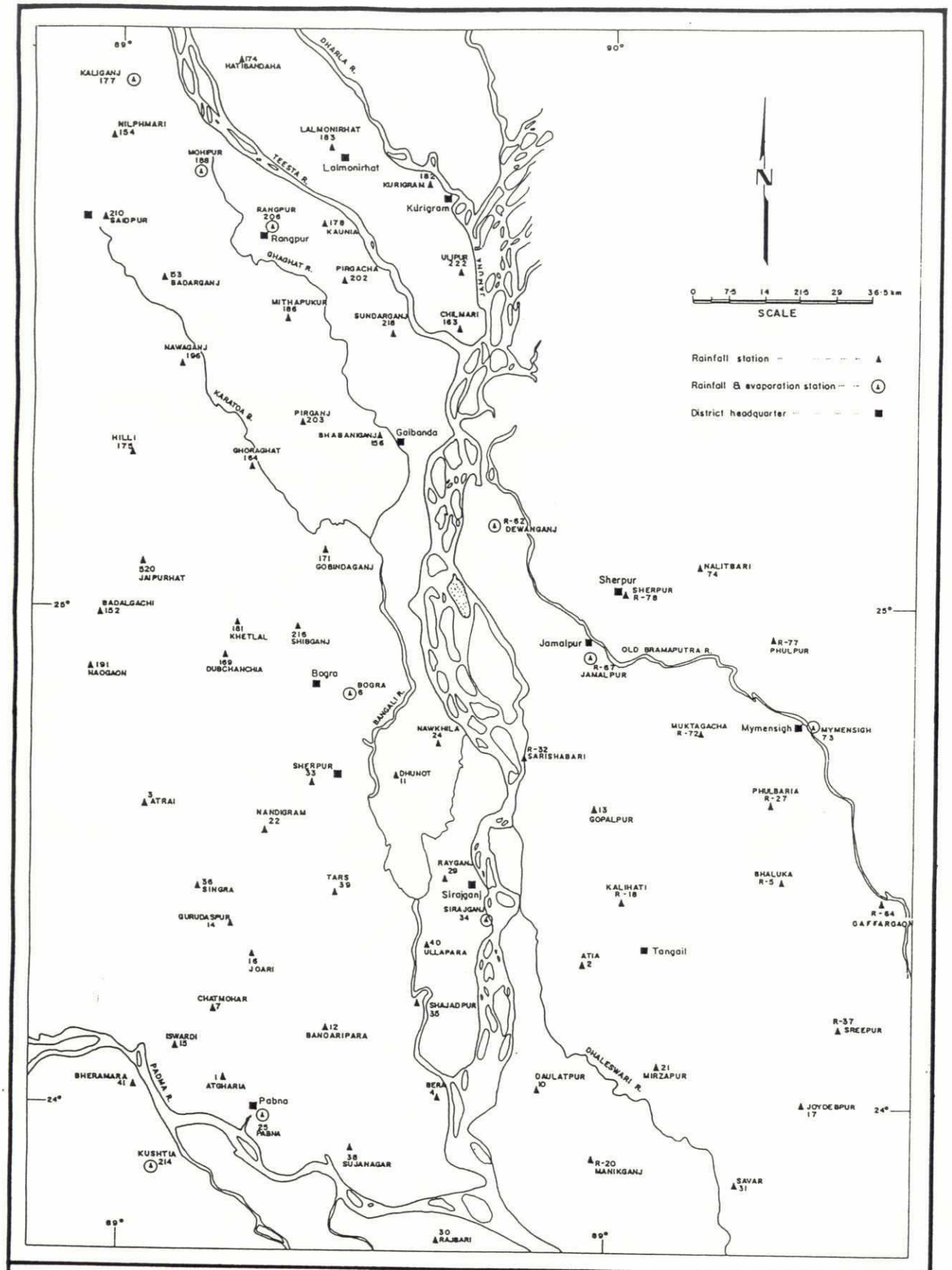
(4) RPT, NEDECO,BCL & GOB (1989),Jamuna Bridge Project, Phase II Study. Feasibility Report vol. II

(5) FEC, BETS & BWDB, (1989) Prefeasibility Study for Flood Control in Bangladesh. Draft Final Report vol. 2 & Annex.

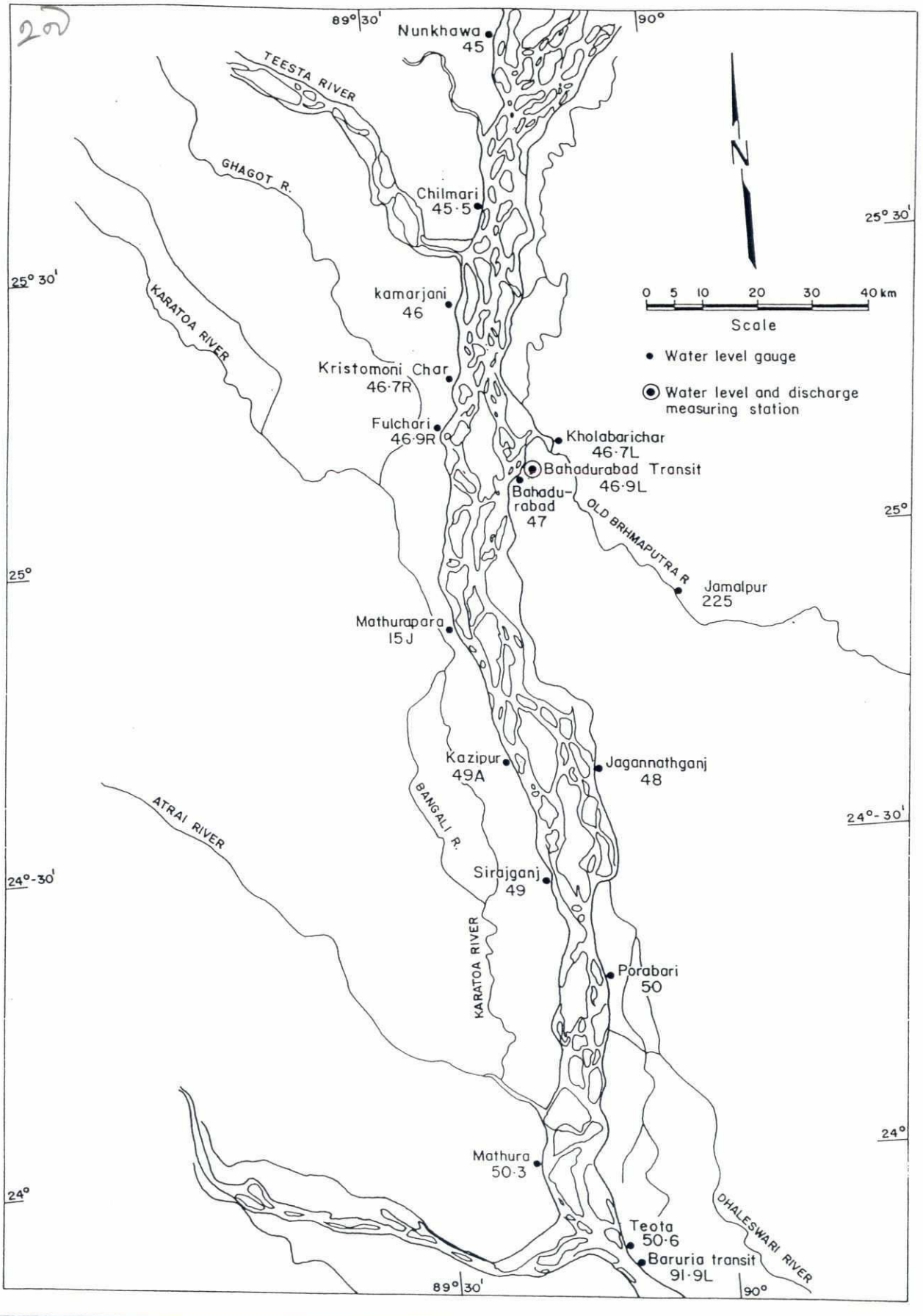
(6) INTERCONSULT & BIWTA, (1990) Determination of Standard Low water & Standard High water levels in Bangladesh vol. II

(7) EPWAPDA, FAO, ITALCONSULT & SOGREAH, (1966), Hydrological Survey in East Pakistan

(8) EPIWTA & NEDECO, (1967) Survey of Inland Waterways and Ports vol.III - Hydrology and Morphology.



LOCATION MAP OF BWDB RAINFALL STATIONS	FAP - 21/22 Bank Protection and River Training/ AFPM Pilot Project
	Fig. 3.4.3-1



BWDB HYDROMETRIC STATIONS ON BRAHMAPUTRA - JAMUNA RIVER

FAP - 21/22
Bank Protection and River Training/ AFPM Pilot Project

Fig. 3.4.3-2

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Table 3.4.3-1 Status of data collection
BWDB Rain Gauges

STN. NO.	STATION NAME	DATE INSTALLED OR RE-INSTALLED	DAILY DATA PERIOD ENTERED ON COMPUTER	MISSING DATA (Water Years)	RAIN GAUGE POSITION	
					Latitude deg min N	Longitude deg min E
R- 001	Atghoria	1961-11-19	1961 - 1990		24 6.0 N	89 15.0 E
R- 002	Atia (Tangail)	1960-12-01	1954 - 1989	59/60 60/61	24 13.0 N	89 55.0 E
R- 003	Atrai	1962-02-18	1962 - 1990		24 38.0 N	88 58.0 E
R- 004	Bera	1961-12-03	1962 - 1990	82/83 83/84 84/85	24 4.5 N	89 38.0 E
R- 005	Bhaluka	1962-07-13	1962 - 1990	86/87	24 23.5 N	90 24.0 E
R- 006	Bogra	1961-02-01	1954 - 1989		24 51.8 N	89 21.3 E
R- 007	Chatmohar	1963-07-15	1963 - 1990	84/85	24 13.0 N	89 16.0 E
R- 008	Chaugram	1961-05-21	1954 - 1979	59/60 60/61	24 33.0 N	89 10.0 E
R- 010	Daulatpur	1961-11-14	1961 - 1990		23 58.3 N	89 50.4 E
R- 011	Dhunot	1962-01-06	1962 - 1990	81/82	24 41.2 N	89 33.0 E
R- 012	Faridpur (Banwarinagar)	1961-11-23	1961 - 1990		24 10.0 N	89 27.0 E
R- 013	Gopalpur	1961-09-01	1961 - 1990	88/89	24 33.5 N	89 58.2 E
R- 014	Gurudaspur	1961-12-21	1961 - 1990		24 21.0 N	89 12.0 E
R- 015	Ishurdi	1961-02-01	1954 - 1990	59/60 60/61	24 8.0 N	89 2.5 E
R- 016	Joari	1962-01-09	1954 - 1990	59/60 60/61 61/62	24 18.0 N	89 8.0 E
R- 018	Kalihati	1962-02-26	1962 - 1990		24 23.0 N	89 59.5 E
R- 019	Kushtia	1961-01-01	1954 - 1989	59/60 60/61	23 58.0 N	89 2.0 E
R- 020	Manikganj	1961-01-24	1954 - 1990	59/60 60/61	23 51.0 N	90 0.0 E
R- 021	Mirzapur	1961-08-31	1961 - 1990	68/69 76/77 77/78 79/80 80/81	24 6.0 N	90 5.0 E
R- 022	Nandigram	1962-01-08	1962 - 1990		24 38.0 N	89 16.0 E
R- 024	Nawkhila	1961-01-01	1954 - 1990	59/60 60/61 86/87	24 48.0 N	89 37.3 E
R- 025	Pabna	1961-02-08	1954 - 1990	59/60 60/61	24 0.0 N	89 15.6 E
R- 026	Pangsa	1961-02-01	1954 - 1979	59/60 60/61	23 48.0 N	89 23.3 E
R- 027	Phulbaria	1962-06-02	1962 - 1990		24 37.5 N	90 16.0 E
R- 028	Pingna	1961-02-25	1954 - 1979	59/60 60/61	24 40.0 N	89 54.0 E
R- 029	Raiganj	1962-02-20	1962 - 1990		24 30.0 N	89 33.8 E
R- 030	Rajbari	1960-11-27	1954 - 1989	59/60 60/61	23 46.0 N	89 40.3 E
R- 031	Savar	1961-11-23	1961 - 1990	88/89	23 51.0 N	90 16.2 E
R- 032	Sarishabari	1961-02-24	1954 - 1990	59/60 60/61 83/84 87/88	24 44.3 N	89 49.5 E
R- 033	Sherpur (Bogra)	1961-03-15	1954 - 1990	59/60 60/61	24 41.2 N	89 23.0 E
R- 034	Serajganj	1961-03-01	1954 - 1990	59/60 60/61	24 27.5 N	89 43.3 E
R- 035	Shahzadpur	1961-02-15	1954 - 1990	59/60 60/61	24 10.5 N	89 38.0 E
R- 036	Singra	1962-01-25	1962 - 1989		24 30.0 N	89 8.0 E
R- 038	Sujanagar	1963-12-24	1963 - 1990		23 56.0 N	89 24.5 E
R- 039	Taras	1963-10-13	1964 - 1990		24 25.0 N	89 23.0 E
R- 040	Ullapara	1961-02-14	1954 - 1990	59/60 60/61	24 18.5 N	89 34.3 E
R- 041	Bheramara	1960-10-01	1961 - 1990		24 1.0 N	89 0.2 E
R- 062	Dewanganj	1961-03-09	1954 - 1990	59/60 60/61	25 8.5 N	89 45.7 E
R- 066	Islampur	1961-09-01	1961 - 1979		25 3.8 N	89 47.0 E
R- 067	Jamalpur	1961-02-25	1954 - 1990	59/60 60/61	24 56.0 N	89 55.5 E
R- 072	Muktagacha	1961-09-21	1961 - 1990	87/88	24 45.0 N	90 16.0 E
R- 073	Mymensingh	1960-12-18	1954 - 1990	59/60 60/61	24 46.0 N	90 24.0 E
R- 074	Nalitabari (Taragan)	1961-02-28	1961 - 1990	76/77-79/80 81/82-83/84	25 4.5 N	90 11.0 E
R- 077	Phulpur	1962-06-11	1962 - 1990	80/81 81/82 82/83 83/84	24 58.0 N	90 22.0 E
R- 078	Sherpur (Town)	1961-04-14	1954 - 1990	59/60 60/61	25 0.0 N	90 0.8 E
R- 151	Adamdighi	1961-06-02	1954 - 1979	59/60 60/61 68/69 76/77	24 50.4 N	89 3.0 E
R- 153	Badarganj	1962-05-28	1962 - 1989	82/83	25 42.0 N	89 2.0 E
R- 156	Bhawaniganj (Gaibandha)	1961-06-02	1954 - 1988	59/60 60/61 86/87 88/89	25 19.7 N	89 33.0 E
R- 159	Bhurungamari	1963-05-20	1963 - 1990	71/72 75/76	26 6.8 N	89 41. E
R- 163	Chilmari	1962-12-20	1962 - 1990		25 32.3 N	89 42.6 E
R- 164	Ghoraghat	1963-05-26	1963 - 1988	82/83 88/89	25 14.6 N	89 16.4 E
R- 169	Dubchanchia	1961-06-05	1954 - 1990	59/60 60/61	24 51.8 N	89 10.5 E
R- 171	Gobindaganj	1961-06-06	1961 - 1990		25 8.3 N	89 22.5 E
R- 174	Hatibandha	1962-06-14	1962 - 1990	75/76 82/83	26 7.4 N	89 8.7 E
R- 175	Hilli (Hakimpur)	1963-01-01	1963 - 1989		25 16.1 N	89 0.0 E
R- 176	Mohasthan	1967-07-06	1967 - 1979	68/69	24 57.5 N	89 21.7 E
R- 177	Kaliganj	1961-01-01	1961 - 1990	88/89	25 58.6 N	89 12.6 E
R- 178	Kaunia	1962-03-22	1962 - 1990		25 46.1 N	89 24.8 E
R- 181	Khetlal	1961-06-11	1954 - 1990	59/60 60/61	25 2.2 N	89 7.5 E
R- 182	Kurigram	1961-05-21	1954 - 1990	59/60 60/61	25 47.7 N	89 39.0 E
R- 183	Lalmonirhat	1962-04-18	1962 - 1990	88/89	25 54.4 N	89 26. E
R- 184	Lalpur	1961-07-14	1954 - 1990	59/60 60/61	24 0.0 N	88 57.5 E
R- 186	Mithapukur	1962-12-23	1962 - 1988	68/69 88/89	25 35.2 N	89 15.9 E
R- 188	Mahipur	1962-10-29	1962 - 1990		25 52.0 N	89 15.0 E
R- 189	Mohanpur	1962-08-19	1962 - 1982		25 31.0 N	89 43.8 E
R- 191	Naogaon	1961-07-23	1954 - 1990	59/60 60/61	24 48.0 N	88 56.0 E
R- 196	Nawabganj	1961-06-01	1954 - 1990	59/60 60/61 82/83 84/85 88/89	25 24.0 N	89 4.7 E
R- 198	Panchbibi	1961-05-22	1954 - 1979	59/60 60/61 71/72	25 11.5 N	89 2.3 E
R- 199	Parbatipur	1961-05-17	1954 - 1979	59/60 60/61	25 44.7 N	88 59.6 E
R- 201	Phulbari	1962-01-18	1962 - 1989		25 30.0 N	88 58.0 E
R- 202	Pirgacha	1962-05-27	1962 - 1990	82/83	25 39.8 N	89 25.1 E
R- 203	Pirganj	1961-05-08	1954 - 1989	59/60 60/61 87/88	25 25.6 N	89 19.1 E
R- 206	Rangpur	1961-03-01	1954 - 1989	59/60 60/61	25 44.2 N	89 15.8 E
R- 216	Shibganj (Dinajpur)	1962-07-17	1962 - 1990		25 0.7 N	89 18.5 E
R- 218	Sundarganj	1961-09-06	1954 - 1989	59/60 60/61 81/82 82/83	25 33.4 N	89 31.9 E
R- 222	Ulipur	1961-05-21	1954 - 1989	59/60 60/61 71/72	25 38.9 N	89 36.7 E
R- 452	Alamdanga	1962-09-18	1962 - 1990		23 47.0 N	88 57.0 E

Source: North West Hydraulics

Table 3.4.3-2 Status of data collection
Daily water level

Date : 10.03.92

River Name	BWDB no.	Station name	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Arialkhan	5	Madaripur										L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Jamuna	15J	Mathurpara																												H	H	H	H	H	H	H	
Jamuna	45	Nunkhawa								L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	
Jamuna	45.5	Chilmari											L	L	L	L	L	L	L	L	L	L	L	L	L	L	–	L	–	–	L	L	L	L	L	L	L	L
Jamuna	46	Kamarjani			H	H				H		H	H	H	H	H	H	H		H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	
Old Brahmapu	46.7L	Kholabarichar											L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Jamuna	46.7R	Kirstomonichar										H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	–	H	H	H	H					
Jamuna	46.9R	Fulchari										L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	–	–	–	L	L	L	L	L	–	L		
Jamuna	46.9L	Bahadurabad Transit	L1	L1	L1	L1	L1	L1	L1	L1		L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Jamuna	47	Bahadurabad								H	–	H	H	H	H	H	H	–	H	H	H	H	H	–	H	H	–	H	H	H	H	H	H				
Jamuna	47.3L	Jognaichar											H	H	H	H	H	H	H	H	–	–	H	H	H	H	H	H	H	H	H	H					
Jamuna	47.3R	Patilbarichar										H	H	H				H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Jamuna	48	Jaganathganj								H	–	H	–	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	–	–	H	H	H	H	H	H	
Jamuna	49	Serajganj		L1	L1	L1	L1	L1	L1	L1	L1	L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Jamuna	49A	Kazipur													L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Jamuna	50	Porabari										L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Jamuna	50.3	Mathura											L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Jamuna	50.6	Teota										H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	
Deonai	65	Bogra						H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	
koratoa	66	Ullapara						H	H	H	H	H	H	H	–	H	H	H	H	H	H	H	H	H	H	H	–	H	–	–	H	H	H	H	H	H	H	H
Dharla	77	Kurigram						H	–	H	–	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	
Dudh kumar	81	Pateswari								H	H	H	H	H	H	H	H	H	–	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H		
Ganges	90	Hardinge Bridge										L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Ganges	91.9R	Goalundo Transit										L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	–	–	–	L	L		
Ganges	91.9L	Baruria Transit										L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Ganges	93.5L	Mawa											L	L	L	L	L	–	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	–	L	L		
Ghagot	97	Gaibanda															H	H	–	H	–	–	–	H	H	H	H	H	H	H	H	H	H	H	H	H		
Modhumati	99	Gorai Rly. Bridge	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	–	–	L	L	L	L	–
Kaliganga	137A	Taraghat										L	L	L	L	L	L	L	–	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	
Koratoa-atrai	151	Baghabari																		H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	
Old-Brahmap	225	Jamalpur										L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Meghna	273	Bhairab Bazar										L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Meghna	277	Chandpur											L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Teesta	294	Kaunia		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	–	

L : Lotus file (from FAP25)
L1 : Lotus file (from FAP1)
H : Hardcopy
: in mike11 database (to be checked)

Station No.	Name of Station	Latitude	Longitude	Source
15j	Mathurpara	24°51'32''	89°36'10''	FAP1,GPS
45	Nunkhawa	25°54.6'	89°46.2'	BWDB(*)
45.5	Chilmari	25°34'26''	89°41'41''	FAP1,GPS
46	Kamarjani	25°25'00''	89°39'00''	BWDB(*)
46.7L	Kholabarichar	25°13.56	89°45.16'	SWMC,GPS
46.7R	Kirstomonichar	25°13.5'	89°39'	BWDB(*)
46.9R	Fulchari	25°11'24''	89°35'56''	FAP1,GPS
46.9L	Bahadurabad Tr	25°08'00''	89°42'30''	FAP1,GPS
47	Bahadurabad	25°8.5'	89°41'	BWDB(*)
47.3L	Jognaichar	25°5.2'	89°40'	BWDB(*)
47.3R	Patilbarichar	25°5.3'	89°38'	BWDB(*)
48	Jaganathganj	24°39'	89°51'	BWDB(*)
49	Sirajganj	24°27'45''	89°43'57''	FAP1,GPS
49A	Kazipur	24°37'18''	89°40'39''	FAP1,GPS
50	Porabari	24°17.35'	89°48.75'	SWMC,GPS
50.3	Mathura	23°57'00''	89°39'14''	FAP1,GPS
50.6	Teota	23°50'07''	89°46'59''	FAP1,GPS

(*) = Approximate Location

Table 3.4.3-3 Global Coordinates of Water Level Stations on Jamuna River

Table 3.4.3-4 : Status of data collection

Daily discharge

River Name	BWDB no.	Station name	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Jamuna	46.9L	Bahadurabad Transit								L	L	L	L	L	–	L	L	L	L	L	L	L	–	L	–	L	L	L	L	L	L	L	L	L
Dharla	77	Kurigram															H	H	H	H	H	H	H	H	H	H	H	–	–	H	H	H		
Ganges	90	Hardinge Bridge		L	L	L	L	L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Ganges	91.9L	Baruria Transit								L	L	L	L	L	–	L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	
Ganges	93.5L	Mawa							L	L	L	L	L	L	–	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L		
Ghagot	97	Gaibandah										H	–	–	H	H	H	H	H	–	H	H	H	H	H									
Ganges	99	Goral Rly Bridge						L	L	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
Kaliganga	137A	Taraghat										L	L	L	–	L	L	L	L	L	–	L	L	L	L	–	L	L	L	L	L	L	L	
Meghna	273	Bhairab Bazar						L	L	L	L	L	L	L	–	L	L	L	L	L	–	–	–	–	–	L	L	L	L	L	L	L	L	
Teesta	294	Kaunia	L	L	L	L	L	–	–	L	L	L	L	L	–	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		

L : Lotus file (from FAP25)
H : Hardcopy
: in MIKE11 database

Observed discharge

River Name	BWDB no.	Station name	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Jamuna	46.9L	Bahadurabad								L	L	L	L	L	–	L	L	L	L	L	L	L	–	L	–	L	L	L	L	L	L	L	L	L

Computed discharge (FAP25)

River Name	BWDB no.	Station name	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Jamuna	46.9L	Bahadurabad Transit																																
Ganges	90	Hardinge Bridge																																
Teesta	294	Kaunia																																

: in MIKE11 database

3.4.4 Geotechnics

In order to obtain a general picture of the geotechnical conditions prevailing in the project area various studies and geotechnical reports prepared in connection with the Jamuna Bridge Project and Brahmaputra Right Embankment Project (FAP 1) have been studied from which the following information could be obtained.

(1) Jamuna Bridge Studies

The subsoil conditions along the banks of Jamuna River are quite uniform consisting mainly of micaceous fine to medium silty sands becoming coarser with increasing depth. The upper 15 to 20 m are loosely deposited, whereas the degree of density of the sublayers will be medium dense or even dense. The top layers are generally composed of silt but in particular areas such as Bhuapur even clayey.

The subsoil is generally classified as poor engineering material, difficult to compact and prone to liquefaction and piping even under static loads and excess pore pressures. The material also tends to shear failures in case of drop of river water levels.

(2) FAP 1 - Priority Sites

The results of 12 exploratory borings (10 to 30 m deep) executed at six priority sites along the Brahmaputra right embankment and of the various field and laboratory tests are summarized as follows:

The vertical stratification is quite variable from borehole to borehole and no tends in stratification could be discerned in North-South direction. Soils are finer near the surface and coarser with increasing depth. Soil layers varying between clays, silts of low plasticity, and of non-plastic silts and below 10 m the soils are of fine sandy silts, silty fine sands and fine to medium sands. The sands are extremely uniform and are slightly micaceous.

(3) FAP 3.1 - Geotechnical Investigations

Under FAP 3.1 a geotechnical investigation programme is being carried out at present which also includes the execution of 10 m deep borings, SPT's (Standard Penetration Tests) and permeability tests along the embankment on the eastern bank of the Jamuna from Bahadurabad downstream at about 2 km spacings. The results of these investigations shall only be available in April or May 1992.

The knowledge of the geotechnical conditions in the project area, the soil characteristics of the prevailing subsoils and the soil mechanics parameters of the various subsoil layers is of utmost importance for the design of any bank protection works. This applies to the in-situ material in the area of the banks as well as to any fill material used in the construction of groynes, bank slopes or embankments. For bank protection measures on Jamuna River, assuming scour depths of 30 m below HWL, information on subsoil conditions down to 30 or 40 m is sufficient.

The slope stability of an earthen structure is contingent on

- the soil properties, e.g. composition, grain distribution, degree of density, shear resistance, permeability
- the external loadings, i.e. live loads, earthquakes
- the vulnerability against erosion caused by seepage (piping), wave and current attack,

and

- the type of revetment inclusive of filter layers.

In order to investigate into the prevailing subsoil conditions in the areas preselected for the pilot works the Consultant will carry out geotechnical investigations as described hereinafter in Section 4.2.3.2.

In accordance with the Final Report by the Committee of Experts, Geological Survey of Bangladesh 1979 a seismic zoning map of Bangladesh was prepared as well as an outline of a code for earthquake resistant design of structures. The 3 zones of high, medium and low seismic risk cross the country obliquely from North-West to South-East. The high risk zone covers the Mymensingh-Sylhet area and parts of Rangpur, whereas most of the area of the Jamuna lies in the zone of medium risk. As per FAP 1 investigations, 100 and 50 years return periods of seismic events call for maximum horizontal acceleration of 0.20 and 0.10 g respectively when designing the banks against earthquake effects. Such data shall be checked during the preliminary design phase.

3.4.5 Executed Bank Protection Works

The Consultant investigated into the history of bank protection works in Bangladesh by collecting and studying existing publications and reports and by discussing the subject matter and the experiences gained with Chief Engineers and competent officers of the Design Circles BWDB in Dhaka and the Executive Engineers of BWDB in the Divisional Offices. The results of such investigations may be summarized as follows.

Actually no long tradition in bank protection works exist in this riverine country where not only severe erosion problems exist on most of the natural rivers but also severe scarcity of suitable materials for bank protection works. Till the early sixties of this century bank protection works on major rivers were mainly restricted to the upstream area of the Hardinge Bridge on River Ganges where stabilization of banks was tried by means of brick revetments.

During the last three decades actual bank protection works have only been carried out for the protection of townships and important infrastructures as the protection of agricultural lands could not be economically justified. To protect the latter areas flood embankments have often been built located at some distance away from the river banks assuming that the river may erode and silt up within the embankment alignments. However, in the case of the Brahmaputra right embankment extending from Kaunia on Teesta River in the North to the confluence of Hurasagar in the South the embankments had often to be retired because of excessive erosion and migration of the river towards West. The embankments had been constructed of prevailing soils (often sandy) from nearby borrow pits since clayey material is generally not readily available. The slopes of these embankments (generally 1V : 3H) were generally unprotected and only exposed locations were covered with brick mattressing.

Contingent an morphology and bed topography of the rivers, the location of townships to be protected, the space available, etc. various types of direct bank protection measures e.g. revetments, retaining walls, porcupines (bamboo crates filled with bricks) or indirect (river training) measures, i.e. groynes, spurs etc. were executed in the past with more or less success. The designs of bank protection works generally followed standard rules adopted in

Bangladesh whereas scale model test were also carried out in the River Research Institute of BWDB for important protection works.

3.4.5.1 Flexible Revetments

The bank revetments commonly practiced in Bangladesh are as follows :

- herring bone bond bricks over a flat brick base course (soling) and graded filter with wire mesh nets over bricks
- revetment with boulder or stone materials over khoa (brick chips) and sand filter with or without wire mesh over it
- revetment with brick blocks, gabions or cement concrete blocks of different sizes over khoa layer.

Normally the revetments are placed on the bank slopes 1:2 or 1:3 upto the low water level. The protection of the bank slope below low water level is arranged by providing a falling apron with hard material at the toe of the revetment as per standard design.

Where sliding of existing banks and revetments have occured, scour holes are often filled with gunny bags filled with sand and subsequently covered by gabions or cement concrete blocks.

In the revetment works executed till recently, BWDB used in general a 10 cm thick coarse sand and/or 15 cm thick brick chips layer as filter below the armour layer, but recently geotextiles are also being used or at least shown an the design drawings below stones or cement concrete (C.C.) blocks as filter material. Since the procurement of geotextile material requires foreign exchange the use of this material may often not be possible. Geotextile bags filled with sand are also being used now-a-days for filling of scour holes and for protection of slopes and river bed against erosion and scouring.

In Chandpur Town Protection Scheme the revetment work with different sizes of cement concrete blocks over sand filled geotextile bags is being practiced since 1990 whereas earlier works at Chandpur were mainly composed of stone riprap over khoa and sand filter. The latter method has not proven successful for the town protection works under severe conditions, paticularly due to uncontrolled placing of the filter and the top layer under water.

In Rajshahi Town Protection Scheme almost all types of bank protection works have been practiced. Earlier works were carried out by brick pitching with wire mesh over khoa filter, and recent work on bank protection also composed of brick revetment over geotextile filter, and C.C. blocks as toe protection.

3.4.5.2 Porcupines

Porcupines placed at the toe of banks and lower parts of the slopes have been found to be effective in smaller silt laden rivers where erosion could be stopped and thus the bank be stabilized with minimum cost. However, its use in flashy rivers like Teesta (e.g. at Belka) or the Jamuna (at Fulbari Ghat) did not prove to be successful for arresting the bank erosion.

3.4.5.3 Groynes and Spurs

During the last 20 years a number of impermeable groynes have been built not only on smaller rivers of Bangladesh but also on Ganges at Rajshahi, on Jamuna at Sailabari,

Sirajganj (Ranigram), Sariakandi and Kazipur (Maizbari), on Lower Meghna at Chandpur and on Teesta at Tambulpur. With the exception of a series of groynes and spurs at Rajshahi all other structures were planned as single groynes aimed at a deflection of flow away from the river bank.

The cores of all groynes were constructed of locally available sandy soils with slopes varying between 1:2 and 1:4 contingent on the designs and model test results. The soil was to be compacted and the slopes to be covered with 6" khoa as filter layer and armoured with brick mattressing along the shanks and cement concrete blocks of various sizes at the groyne heads. To provide for adequate protection against deep scours below the low water levels falling aprons were constructed of C.C. blocks in accordance with the design requirements. As per original design and model tests the groyne heads were often to be of hockey or T-shape but due to construction problems in flowing water and high current velocities most of the groynes were executed with bell shape heads.

For reasons difficult to be assessed the groynes at Chandpur, Kazipur and Tambulpur failed, whereas the groyne at Sailabari has not been subjected to attack because of accretion of that area. The groynes at Sirajganj and Sariakandi were also seriously damaged after their completion but could be repaired and maintained by placing of additional block material.

Bank protection by means of permeable groynes (bamboo/bullah spurs) have also been executed successfully, but mainly on smaller and medium rivers with limited scour depth.

With regard to the causes of failures and damages of revetments and groynes very little or sometimes contradictory information is available. However, based an a general review of design drawings, of the physical site inspections and discussions with BWDB officers one or a combination of the deficiencies as listed below may have caused the failures or damages of the protective structures :

- inadequate design assumptions of current velocities and scour depth resulting in insufficient block weights of armour layer and falling apron dimensions
- inadequate specifications of materials, bank slopes and material compaction and of filter layer supposed to avoid the entrainment of soil particles under extreme hydraulic conditions
- inadequate quality of construction works e.g. soil compaction, placing of filter layer and armour material or even inadequate quantity of materials compared with the design requirements
- inadequate supervision of works
- lack of monitoring, maintenance and repair of structures.

As such, the experience to be gained from recent bank protection works calls for an improved knowledge of the prevailing extreme conditions and for a sound approach in design and construction to avoid unnecessary waste of funds.

3.4.6. Environment

The environmental survey started the 1st of March 1992, for the whole environmental team consisting of

- one expatriate environmental expert

- two local environmental experts

The activities of the environmental team during this first mission were and have been planned to be as follows :
- contacts and cooperation with other FAP projects
- several field trips on both sides of the Jamuna
- first analysis of field and collected data

A preliminary review on the environmental data is as follows :

Data are sets of observations of environmental elements, indicators or properties. Environmental data for Bangladesh are often widely scattered, incomplete, and not reliable. As a result, selection of data sets is a difficult but not impossible task. The most important criteria is the relevance of the data; the second consideration is their reliability in case these data are provided by other or unknown sources. Many individuals and agencies are generating and using data. Individuals tend to be 'discipline oriented', while agencies are 'mission oriented'. In either case, the data are often deficient for use in particular environmental studies.

Turning to River Training and AFPM measures envisaged in FAP 22 Pilot Project, the available database in a number of subject areas for environmental assessment is not only inadequate, but broad-based, often inconsistent and unreliable on closer look. Reviews of the available database in the natural environment (climate, land forms, hydrology, vegetation, etc.) show adequacy, although the length of time series data on dynamic seasonal and spatial context is limited. Data on the species diversity of the natural flora and fauna is less available; and in the field of ecology, water quality and ground water levels of the project area (AFP of the Jamuna) is virtually non-existent. These are primary data required for sound environmental impact assessment for the proposed AFPM measures of the Jamuna river. The status of environmental data so far reviewed is indicated in the following table.

Parameters	Source	Remark
Climate		Adequate
Type	- MPO Report : 1986, UNDP/FAP	
Temperature	- UNDP/FAO (Land Resources	
Rainfall	Report); 1988	
Pressure	- Haroun Er. Rashid; 1991	
Fog/Dew	- Interim Report FAP 2; 1992	
Storms		
Land		
Land forms	- MPO Report : 1986	Tolerably adequate
Soils	- Haroun Er. Rashid : 1991	
Landuse	- JU Masters Thesis : 1991	
	- Interim Report FAP 2; 1992	
		Not adequate
Vegetation (general)	- Interim Report; FAP 2 : 1992	
	- Haroun Er. Rashid : 1991	
	- IUCNNR : 1991	
	- WRI/CIDE, 1990	
		Tolerable
Fauna (general)	- IUCNNR: 1991	
	- Haroun Er. Rashid : 1991	
	- Proc. of the 7th Zoological conf. : 1990	
	- W.G. Harvey	

.... to be continued....

Table 3.4.6-1: Status of Environmental Database for AFPM (FAP 22) Project

Parameters	Source	Remark
Water Quality		
BOD,DO,DIC,DOC, POC	- Safiullah etal: 1982, 1985, 1990	Insufficient
PH	- Safiullah & Huqs : 1990	Insufficient
Suspended matter (Turbidity)	- BWDB/IWTA	Adequate
Temperature	- Nil	No study made
Pollution (Urban Industrial & Agro chemical)	- FAP 2 - Report, 1992	Sketchy
Groundwater Levels		
Water table		
Extraction & Recharge	- MPO Report : 1986	Inadequate
	- MPO Report : 1986	Non-specific
Fishes		
Ecology : Migration/ Reproduction	- FAP 2 - Report : 1992 - R.L. Welcome : 1979 - Chu-Fa Tsai : 1985 - M. Youssouf Ali : 1990 - IUCNNR : 1991	Insufficient
Number/Types/Edibility	- JMBA Report: 1987	
	- Interim Report - FAP 2: 1992 - IUCNNR : 1991	Non-specific
Distribution-catches (Temporal/spatial)	- Haroun Er. Rashid : 1991 - MPO Report : 1986	
Recent Modification	- JMBA Report : 1987	Insufficient
	- MPO Report : 1986 - JMBA Report : 1987 - Nil	Not available

....to be continued....

Table 3.4.6-1: Status of Environmental Database for AFPM (FAP 22) Project

Parameters	Source	Remark
Flora		
Species	- Flora of Bangladesh -	Non-specific
Distribution	BARC: 43 series	
Ecology	- Check-list-plant names	
Rare or Protected species	of Bangladesh	
Interest : ecological,	- Bangladesh - National	
medical, food, fodder, religion	Herbarium	
recent modifications	- IUCNNR: 1991	
Wildlife	- Haroun Er.Rashid : 1991	
Species		
Distribution		Non-specific
Ecology		
Rare or Protected species	- JMBA - Report : 1987	
Ecological or food interest	- Haroun Er Rashid :1991	
Recent modification	- W.G. Harvey : 1990	
predator relationship	- IUCNNR:1991	
Insects		
Ecology		
Species		Not available
Interest		
Fungi	- Nil	
Ecology		
Species		Not available
Interest		
Birds	- Nil	
Ecology		
Food	- W.G. Harvey : 1990	Non-specific
Habitats	- Haroun Er Rashid : 1991	
	- IUCNNR : 1991	
Migration	- FAP 2 - Report : 1992	
Desease		
Microflora &		Non-specific
icrofauna	- Nil	No study made

Table 3.4.6-1: Status of Environmental Database for AFPM (FAP 22) Project

Table 3.4.6-1 presents the primary data required for sound environmental impact analysis. But in most cases data are inadequate or non-existent. The situation demands basic field surveys analysis. Without this the Environmental Assessment of AFPM - measures could be an inadequate process.

3.4.7 Socio-Economics

The data and information collected for the scopes within the Socio-Economic Assessment cover a wide range of different documents. There are few made categories of documentation which is relevant to the Project.

(i) Laws and legal literature viz. comments, sentences, judgements - in the present case on land acquisition and requisition
(ii) Population data, censuses etc.
(iii) Sociological and anthropological data from literature, project documentation etc.
(iv) Administrative rules, regulations, organigrammes

The major sources of information are listed as the end of this chapter.

The Acquisition and Requisition of Immovable Property Ordinance II of 1982 and the Emergency Property Acquisition Act IX of 1989 may be of particular interest for the Project, specially to FAP 21, the latter being passed by the Government of Bangladesh to acquire private property swiftly on emergency basis in order to control flood and tidal waves and bores and river erosion and to take preventive measures against such natural calamities. The Emergency Act will remain in force for a period of five years.

The main features and differences between Land Acquisition Ordinance II and the Emergency Property Acquisition Act IX are charted below:

	Ordinance II of 1982	Act IX of 1989	Remarks
1.	The very Title of Ordinance II of 1982 indicates that it relates to acquisition and requisition of Immovable Property.	It relates to acquisition (not temporary requisition) of both movable and immovable properties (Sec.2)	Acquisition of movable property is rather a harsh law
2.	Preliminary notice of acquisition is only at convenient places on or near the property (not on owners / occupiers/persons interested) vide Sec.3.	Acquisition notice is served on all persons interested in the property (owner or in his absence any male adult member of the family and also at local offices/public places (sec.4/5) etc.	Provisions of 1989 in this regard are more rational than those of Ordinance of 1982
3.	Any interested person may object against acquisition within 15 days (sec.4)	Such objection should be made within 10 days (sec.10).	Preliminary notice u/s 3 of Ordinance 1982 being not served on individuals con-cerned parties may not be in a position to file objection in time.
4.	Power of acqui-sition lies with three tiers of authority :		
	a) upto 10 bighas without objection : DC		
	b) same quality (in case of objection): Commissioner		
	c) if property exceeds 10 bighas: Government (even President)	DC can acquire any quanti- ty of land/property with prior approval of Govt.	Commissioner has no role in this matter

5.	It is a general law of acquisition/ requisition for any public purpose or in the public interest (Sec.3).	This is limited to prevention of flood and upsurge caused by natural calamities and to prevent erosion of river (PREAMBLE)	
6.	Possession of land is taken after ten-dering payment of final compensation based on average value of land during 24 months perceeding acquisi- tion notice	Interim compensation is paid (in full) at the first instance before taking over possession and final compensation is fixed within 3 months thereafter based on similar principle as in Ordinance II of 1982.	One time final compensation is more congenial for the affected persons
7.	LA proceedings stand abated if payment of compen-sation has not been made from the date of acquisition decision (Sec.12)	No abatement procedure exists; but DC is supposed to make payment of final compensation (excluding interim payment) within 14 days after determining final compensation (Sec.14)	The procedure of final payment under Act of 1989 seems to be less realistic, since availability of fund from RB readily may not be ensured in all cases
8.	In case of misuse of property, it is liable to be sur-rendered to DC (Sec.17)	Acquired property cannot be used without prior approval of Govt., for any purpose other than that of acquisition	Provision of 1989 Law seems to be ambiguous in as much as it does not spell out the fate of such misused property
9.	Provisions regar-ding arbitration are more or less the same in both the laws.		
10.	Ordinance II of 1982 is a compre-hensive law without any time-limit for its application	Act of 1989 is supposed to continue for five years only	

References used in Socio-Economic Assessment

A. Books and Legal Texts

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B. Reports and Surveys

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(2) BANGLADESH WATER DEVELOPMENT BOARD (BWDB), Evaluation Study of Brahmaputra Right Embankment Sub-Project under DFC.I, Draft Final Report/University of Dhaka, August 1986, 165 p. + Appendixes.
(3) BANGLADESH BUREAU OF STATISTICS (BBS), Small Areas Atlas of Bangladesh, (Mauzas and Mahallahs); Districts of Rangpur. (Dec. 1989, 123 p); Tangail (Feb. 1986, 52 p); Dhaka (Sept. 1985, 154 p); Pabna (July 1988, 72 p); Jamalpur (May 1986, 51 p); Bogra (Jan. 1988, 65 p).
(4) BANGLADESH BUREAU OF STATISTICS (BBS), Preliminary Report Population Census July 1991, 22 p.
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(6) BANGLADESH BUREAU OF STATISTICS (BBS), Report on The Upazila Development Monitoring Project, Volumes-II, November 1990, 126 p.
(7) BANGLADESH BUREAU OF STATISTICS (BBS), Report on the Household Expenditure Survey, 1988-89, August 1991, 201 p.
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(17) RENDEL PALMER AND TRITTON/NEDECO/BANGLADESH CONSULTANTS LTD., Jamuna Multi Purpose Bridge Authority GOB, Part A : Socio-Economic Report of the Population Affected by JMB Land Acquisition, January 1990,

3.4.8 Land Use and Reclamation

The activities under this sub-chapter do also include the collection and review of data on Agricultural Practices and Physical Planning.

Major data collection has been made from sources outside the Project i.e. FAP 21/22 and in particular from other FAP reports or studies outside of FAP. The collected data for land reclamation and land use are contained in relevant reports and review of data and maps has also been included in the said reports.

The list of the reports, data and maps collected is detailed below :

(i) Reports

- Reconnaissance soil survey - Tangail District-1966 :
  Report: 1966 - Department of Soil Survey
  Maps : Soil associations - scale 1:125,000
  Land use associations - scale 1:250,000
  Land capability associations - scale 1:125,000
  (From SRDI (Soil Research Development Institute)

- Reconnaissance soil survey - Mymensingh District 1966 (Revised in 1972) :
  Report : 1972 - Department of Soil Survey
  Maps : Soil associations - scale 1:125,000
  Land use associations - scale 1:250,000
  Land capability associations - scale 1:125,000
  (From SRDI (Soil Research Development Institute)

- Reconnaissance Soil Survey - Dhaka District 1965 :
  Report: 1965 - Department of Soil Survey
  Maps : Geomorphology and soils - scale 1:250,000
  Soil associations (East & West) - scale 1:125,000
  Land Use associations - scale 1:250,000
  Land capability associations
  (East and West) - scale 1:125,000
  (From SRDI (Soil Research Development Institute)

- Reconnaissance Soil Survey - Pabna District 1965 (Revised in 1976) :
  Report: 1972 - Department of Soil Survey
  Maps : Soil associations 1965 (Revised 1972) - scale 1:125,000
  Land Use associations (Revised 1972) - scale 1:250,000
  Land capability associations
  1965 (Revised 1972) - scale 1:125,000
  (Survey carried out and report prepared under the authority of H. Brammer, FAO Dy.Project Commissioner/East Pakistan)
  (From SRDI (Soil Research Development Institute)

- Reconnaissance Soil Survey - Bogra District 1970 :
  Report 1970: Department of Soil Survey M/o. Agriculture

Maps : Soil associations 1970 - scale 1:125,000
Land Use associations 1970 - scale 1:250,000
Land Capability associations 1970 - scale 1:125,000
(From SRDI (Soil Research Development Institute)

- Working paper on Jamuna chars - FAP 3.1
  Initial findings - January 1992
  Jamalpur Priority Project Study
- FCDI Agricultural Study - FAP 12
  (Draft Final Report - Summary and Conclusions)
- Jamuna Bridge Project- Phase II Study-Feasibility Report Vol.II (Aug/89)
- Jamuna Bridge Project- JICA Report, 1976
- Land Reclamation Project Report on 'Information Systems' - BWDB - 1990
- Land Reclamation Project Report on Proposal for a long term plan on LR & Estuary Control- BWDB-1984
- Land Reclamation on Char Baggar Dona-"Action Plan on Livestock and fish culture" - BWDB
- Land Reclamation on "water management practices of small farmers in Noakhali", BWDB
- Soil Survey Project - Bangladesh, Soil Resources, UNDP,FAO,1971 (SRDI)

(ii) Books

(1) AHMED, N. : Landlessness in Bangladesh
(2) CLEARENCE, M. : Behaviour & poverty in Bangladesh
(3) HOSSAIN, M. : Agriculture in Bangladesh
(4) HUQ, S. : Environmental aspects of agricultural development in Bangladesh
(5) JANSEN, E. : The country boats of Bangladesh
(6) RAHMAN, A. : Peasants & classes
(7) UPL : Rural Poverty in Bangladesh
(8) UPL : Rural Bangladesh, competition for Scarce Resources

(iii) Maps

- (From FAP-19) 4" = 1 mile (1:15,840) BWDB contour maps for Bahadurabad; 4" = 1 mile (1:15,840) BWDB contour map for Madarganj
  These maps were prepared in 1965 (survey done in 1952) by a London based Firm.

- Land suitability maps at 1:50,000 scale have been compiled for the North Central Region Study, FAP 3, by the same specialist who is now working in FAP 21/22.

3.4.9 Miscellaneous

(i) Setting up of a library data base

To make use of the large amount of information collected during the inception phase and still

to be collected in the course of the Project, the Consultant has set up a data base including all documentation such as books, reports, conference papers, maps etc.

A project related key word system facilitates easy search and retrieval of documents. A file card system helps to keep control of the present user of the document.

A print out of that data base is included in this Inception Report in ANNEX III.

(ii) Video documentation

The production of a video documentation has originally been planned for the Test and Implementation Phase only. During the Inception Period however it turned out that such a documentation would also be extremely valuable in the Planning Study Phase. The best example are at present the video films taken during the field trips, mainly those in context with the preselection of test areas. By means of those films also the team members who did not take part at the missions could benefit from them. The same will later apply for the field surveys and the physical modelling.

The raw films produced up to now have also successfully been used to explain important aspects of the study area to non-team members e.g. to representatives of the Client and the funding agencies.

The Consultant intends to put together some about 30 minute films e.g. on the following topics:

- general project description
- physical model tests
- field surveys (sub soil investigations and topographical/hydrometric surveys).

3.4.10 Collection of Literature for FAP 22

According to the tasks 26 and 27 as described in the Consulting Agreement (see also: Annex II) literature has been collected in order to prepare a state of the art with respect to :

(i) river training measures and strategies

(ii) prediction methods for morphological response of different river training strategies related to the Jamuna river conditions.

For reasons of consistency a distinction is made between measures and strategies. Measures are meant to be physical structures, either requiring heavy investment like groynes and eventments or requiring light investments like permeable groynes, bandals, etc. or, as a third possibility, dredging. Strategies are to be interpreted as number of measures aiming at training the river over the full length. Strategies may encompass also combinations of measures, so e.g. a well-balanced mix of permanent structure and dredging or bandalling.

An extensive review of literature (handbooks, periodicals, consultancy reports, etc.) has already been made in the Consultant's home office. After a first selection the literature has been sent to Dhaka and is accessible for the FAP 21/22 project team. The material is in this stage of the project subjected to a critical review in order to condense and summarize the available knowledge on (1) river training measures and strategies, as well as (2) prediction methods for morphological response. After the appearance of the Inception Report a

Technical Report has been planned to be submitted in May 1992, containing the state of the art in both subjects. The state of the art will be based on the critical review of the collected literature, and on consultant's own work, experience, knowledge and international contacts.

In addition the Chinese member of Consultant's Advisory Board prepared an overview of the river training measures and strategies used in the People's Republic of China for harnessing the Hwang Ho and the Jangtse Rivers, including the experience with the morphological impact of these works.

Some preliminary results of the literature review will be presented in Section 4.4.2.

3.5 INSTALLATION OF 1-DIMENSIONAL MODEL

The hydrodynamic flow phenomena in a river and the morphological changes in the bed level of the river are simulated with an 1 dimensional mathematical model. Such a mathematical model is the DOS Mike 11 model, version 2, which has been obtained from the Surface Water Modeling Centre (SWMC) according to the 'Procedures and Conditions for use for SWMC models for FAP activities'. It is mentioned that the rainfall runoff model (NAM model), the transport dispersion and water quality models of this Mike 11 modelling system will not be used within this project.

The installation of the Mike 11 model distinguishes different phases:

(i) First this model was installed on a project 486 type personal computer at the SWMC. Some guidance was provided by SWMC during the development of small models with Mike 11. The use of this model is facilitated since two project staff members have recent experience with the application of Mike 11 in previous projects.
After a preliminary assessment of the usefullnes as well as the capabilities of this model for the project purposes and a reconnaissance of this model package, this computer will be transferred to the FAP 21/22 project office after the inception phase.

(ii) Already during this phase this model was installed on another Project owned 486 personal computer at the project office. The two Mike 11 programmes are used for the hydrology study and partly for the mathematical modelling.

The following existing Mike 11 models are of interest for the project and will be requested:

- The general model (GM) of the main rivers in Bangladesh combined with a database of FAP 25, which covers a period of 25 years.
- A model of the Jamuna river, with less branches and nodes from tributaries and distributors than in the general model and refined by the insertion of more cross sections than in the general model. This model of the Jamuna river has been made by FAP 1 project.

If appropriate adaptations of the programme are required, these adaptations will be requested via the chief resident engineer MPO and the chief resident engineer of FPCO. Regarding the capabilitites special attention will be paid to the accuracy in bed level computations near bifurcations and confluences (e.g. the nodes in the model schematization), large time steps resulting in rather high Courant numbers and a flexible sediment distribution at the bifurcations.
To support the FAP 22 study concerning the possibilities of recurrent and permanent

measures for river training the capabilities of the Mike 11 programme to simulate for example (i) local dredging activities, (ii) dredging of short-cut channels and (iii) the increase of the local hydraulic resistance, will be elaborated by changing the sediment distibution in a bifurcation. One of the limitations of these models is the impossibility to increase a branch length because of bank erosion during a computation.

Note that the conditions at confluences are much simpler then the conditions at bifurcations. Therefore most attention will be focussed on the simulation of the bifurcations. More details are given in Section 4.2.4.2 on physical and mathematical modelling.

3.6 SITE VISITS

In order to get acquainted with the local conditions in the Project area, i.e. the morphology and erosion problems along the Jamuna River, the bank protection measures at various places, the socio-economic and environmental situation, etc., joint and separate field trips were made by groups of professionals of various disciplines during the months of February and March 1992.

(1) A technical team consisting of the Chinese expert of the Consultant's Advisory Board, the team leaders of FAP 21 and 22 and their local counterparts as well as the Consultant's morphologist carried out extensive field visits between the 17th and 25th February 1992 in order to see and study the prevailing conditions of the Jamuna River.

Most of the banks were inspected from the waterside using a country boat, whereas other areas of interest were visited from the landside. Thus, a thorough impression was obtained of the existing situation of bank erosion, formation of chars and river channels, as well as of the embankment works and special protection measures which have been executed in the past by the Bangladesh Water Development Board (BWDB) on the right bank of the river or by the District Councils on the left bank.

In addition to the physical inspection of the river banks, detailed and useful discussions were held with field officers of the BWDB, inter alia with

- the Superintending Engineer, Bogra
- the Executive Engineer, Gaibanda O&M Division
- the Executive Engineer, Bogra O&M Division
- the Executive Engineer and Sub Divisional Engineers I/II, Sirajganj
- the Executive Engineer, Pabna Division, Bera
- the Executive Engineer, Tangail O&M Division
- the Executive Engineer, Morphology Division, Mymensingh.

The subjects of discussions included not only problems of bank erosion and protection measures dealt with by the officers in their respective areas of jurisdiction, but also the experiences they had made with various river training and bank protection measures, (e.g. groynes, cross bars, bank revetments, channel closures etc.), their effectiveness, their designs and their possible causes of failures.

Last but not least the officers' opinions and predictions on suitable test areas which may

face or not progressive erosion also in future were also discussed.

In order to be able to assess the individual stretches of river banks in more detail, maps showing the location of bank lines over a period of years were consulted and collected from the various offices.

(2) The team leader FAP 22 along with the modelling expert and 3 members of the Consultant's Advisory Board paid a visit to the River Research Institute at Faridpur on 5th March, 1992. They inspected the existing facilities and had detailed discussions with the Director of the Institute regarding physical modelling for FAP 21/22 pilot project.

(3) The team of socio-economists, institutional and land acquisition experts made several field trips between the 9th and 18th February and visited areas on both sides of the Jamuna River, i.e.

- Aricha, Narayan, Teota, Jaffarganj (left bank)
- Bera, Nakalia, Nagarbari (right bank)
- Sirajganj, Bogra, Shariakandi, Gaibanda, Fulchari ghat (right bank) and
- Tangail, Bhuapur, Nikrail, Jagannatganj, Madarganj, Bahadurabad (left bank),

During these field visits individual and group interviews were held with farmers and fishermen as well as with landless people living on the embankments.

Discussions were also held at different administration levels, e.g.

- with administrative officers of Bera and Shariakandi Upazila, Deputy Commissioner of Sirajganj
- with officers of WRDB local branches at Bera, Sirajganj, Bogra and Gaibanda, and with
- members of union counsils at Narayan, Teota and Nikrail.

(4) The environmental expert so far inspected the project area around Aricha and Nagarbari as well as between Jagannatganj Ghat and Bhuapur and plans to see other areas along the right bank and further north subsequently.

(5) The reconnaissance survey of major rivers in Bangladesh other than the Jamuna River has been postponed to the time after submission of the Inception Report since all efforts had to be concentrated on the preselection of test areas and early tendering and award of field investigations (topographic/hydrographic surveys and subsoil exploratory works) in order to have the surveys completed before the start of the rainy season. However, places of interest on the rivers Ganges, Kushtia, Teesta, and Lower and Upper Meghna shall be visited sometime in April/May 1992 in order to assess the applicability of the Jamuna pilot project with the conditions on other rivers.

4. UPDATED WORK PROGRAMME AND FIRST STUDY RESULTS

4.1 GENERAL

In his proposal the Consultant has split up the activities to be carried out according to the Terms of Reference into different tasks.

For better reference both the Terms and the Task Descriptions are attached to this Inception Report as Annex II and III, respectively.

Unlike in most other projects, the Consultant had already to undertake a very important study right at the beginning of his project; reference is made to the selection and recommendation of test areas to be done within the inception phase. That gave the Consultant a better than average opportunity to examine and reconsider, where found necessary, his original approach to the project.

To sum up it can be said that no basic modifications seem to be required in the approach so that by and large the work programme can be executed as planned in the scope of works of the Consulting Agreement.

There are only two modifications which are to be mentioned at this place, one of which is actually a proposed amendment. Those are :

- a proposed reallocation of tasks and restaffing in the non-engineering component where a reduction on the economic input in favour of an additional agricultural development input seems to be advisable, mainly in the FAP-22 component, in order to achieve a better participation of the local population. The modification will probably not require additional staff input but another staff mix
- an additionally proposed preliminary assessment of the reciprocal impacts of River Training/AFPM and Inland Water Transport on the Jamuna River. The additional input is tentatively described in Annex V and is estimated to require 3 additional expatriate man-months and 5 additional local professional man-months.

4.2 FAP 21 PLANNING STUDY PHASE

4.2.1 Introduction

The Planning Study phase of the Bank Protection Pilot Project consists of basically two components

- the determination of the hydro-morphological boundary conditions for the design and
- the preliminary design of the test structures

4.2.1.1 Hydro-morphological Boundary Conditions

The design of the test structures requires the knowledge of the basic hydro-morphologic boundary conditions as it were

- the exact location (both in longitudinal and lateral respect to the river)
- the exact alignment of the structures(s)
- the bed levels including maximum scour depths, the structures have to be designed for
- possible modifications of the bank and the river bed close to the bank, upstream and downstream of the structures, which should be taken into account in the design
- velocity and direction of the flow attacking both the bank and the toe of the structure.

To determine the hydro-morphological boundary conditions for the test structures the Consultant will use a hybrid approach, similar to the approach adopted for the Jamuna Bridge Study. In the present approach the following tools will be combined:

- field surveys of the topographical and morphological conditions as well as flow measurements to state the existing situation
- a morphological analysis enabling to predict with a fair accuracy the morphological development at the selected sites
- a two-dimensional mathematical model that will predict the flow pattern near the bank protection structure
- scale models in which the local scour around the bank protection structure is determined (this model will use the bed topography from the morphological analysis and the flow boundary conditions provided by the two-dimensional mathematical flow model).

4.2.1.2 Preliminary Design

Based on the hydro-morphological boundary conditions as described above the test structures will be designed. The preliminary design of the test structures will first require thorough investigations into the safety standards to be applied since, unlike in ordinary design processes, the structures to be eventually built are expected to be damaged. Having found a solution to this crucial question good engineering practice will be applied taking particularly into consideration that the construction of the test structures themselves shall already represent as close as possible a future standard design of bank protection in Bangladesh. That aspect requires special attention to be paid to the application of local construction methods and the use of locally available material, as far as possible.

If material that is not locally available, but (at present) irreplaceable for a safe construction as may be geotextiles, the Consultant will try to develop alternatives.

4.2.1.3 Strategies for the Future

Besides the above described tasks which are required to design the test structures the Consultant will keep in mind the overall objective of the Project, namely to develop new standards for the bank protection. Since the new standards refer to both construction and

design, the procedures required to improve and optimize the design process will also be dealt with, although mainly during the test and monitoring phase. Nevertheless the Consultant will try to include in his preliminary design and in the proposed set up for the Test and Implementation Phase, the conditions required for such an optimization of the design procedures. Two examples from very different spheres shall be mentioned to illustrate that idea :

(1) Although it will eventually be required only at a later stage, the Consultant will already during the Planning Phase start his assessment wether or not probability design methods may be introduced in future standard design procedures.
(2) The use of geotextiles will be a simple must for any future design of bank protection works. However that aspect is for the time being not part of the standard design practice in BWDB and therefore any recommendation to use such material requires a deepgoing individual examination. The Consultant will try to set the scene - in cooperation with the relevant technical and adminis-trative institutions - to have that technique included in the standard procedures. The test rig for the investigation of filter material shall therefore be jointly operated by BUET and the Consultant.

4.2.2 Studies

4.2.2.1 Hydrology

(1) Objectives

The objectives of the hydrology study (Task 9) is to provide hydrological boundary conditions (upstream discharge and downstream water level or rating curves) for the selected sites on the Jamuna.
The methodology described in the proposal for the task 9 has been followed.

(2) Approach Recommended by FHS (Flood Hydrology Study in FAP 25)

A methodology for estimating Design Water Levels at regional level has been developed by FAP 25/CAT team and will be followed also here. (see Ref: 1 in section 3.4.3).

According to the FHS, "Due to the complexity of Bangladeshi Delta and the interaction of the various flood causing factors, the definition of design events of a given return period in terms of standardized boundary condition is simply impossible. Hence, long term simulation with the regional models for the same period (1965-80) as used in the FHS is strongly advocated".

The statistical representativeness of the period 1965-89 for the whole century has been assessed by the FHS and this analysis indicates that the period 1964-1989 can be considered to be typical for this century and so designs can be based on the statistical analysis of output from this period.

It is also indicated that "Combination of various options to reach the final plan may be studied on the basis of simulation for only a few selected flood seasons".

(3) Frequency Analysis

Frequency analysis will be carried out on water level and discharges at several stations along the Jamuna using HYMOS, a hydrological data management and processing package developed by DELFT HYDRAULICS. The recommendations made by FAP 25 for the selection of the probability distributions will be used as guideline for the work in the project.

This analysis will be carried out on peak, seasonal and subseasonal values using, checked observed data or results of the latest run of the FAP 25/GM model depending of their availability.

The determination of uninterrupted periods of low water levels will be determined for several points. Additionally a quick analysis of the short rises and falls in the water level will be done.

(4) Boundary Conditions

The hydrographs of the different years will be sorted for several criteria according to their return period, so a selection of the most suitable data could be done depending on the use of the models.

As a first suggestion for these criteria is the average water level during two months with the flood discharge, August and September.

For some morphological runs, smooth weakly data would be used instead of daily data to increase the time step.

4.2.2.2 Morphology

In the proposal the following objectives for the morphological analysis have been formulated for the planning phase of FAP 21 (see Task 06) :

(1) to contribute to the selection of the test areas
(2) to assist in the determination of the design criteria for the river training works
(3) to estimate the morphological conditions that will be present at the selected sites at the period of construction of the bank protection works.

ad (1) Selection of the Test Areas

For this the following activities were foreseen :

(i) extension of the analysis of the BWDB soundings, as reported upon in Masselink (1989), with the intention to verify on the possibility of a periodicity in the variation of the 50% conveyance (approximately equivalent to a "floodplain that way") of these cross-sections;

(ii) extension of the remote sensing study initiated under the Jamuna Bridge Study, Phase 2. Both studies were taken up again in the Inception Phase. The following remarks are relevant:

- Until now only BWDB cross-sectional data of the year 1987-1988 were identified at BWDB Morphology. The Consultant is still investigating whether more recent data are available at the field offices.
- If no more recent data can be found, then an attempt will be made to extend the analysis on the basis of BWDB cross-sections by using measured widths of channels form satellite images. This will give a fair approximation and may allow for a conclusion on any periodic motion of the Jamuna River. This approach was anyhow already taken in the Inception Phase, because no additional data were available when the preselection of the test areas had to be done.
- The Additional Remote Sensing Study was started with ordering tapes with digital data. It is expected that already some results will be available in June when the selection of the test sites has to be done.
- It was investigated whether the processing of the tapes with digital satellite data could be done in Bangladesh with FAP 19. In that case it would have been a combined activity of FAP 1, FAP 3.1, FAP 16, and FAP 21/22. Ultimately it was decided to do the analysis in the Consultants home office after all, because of the large risks involved as far as the time schedule is concerned when the processing would have been done in Bangladesh. Arrangements were made, however, that the results of the available under certain conditions for the other FAPs as well.

Already some preliminary results of the study of satellite images of the Jamuna River as a continuation of work done within the framework of the Jamuna Bridge Project were available (see Masselink 1989) and Klaassen & Masselink (1992). These results could be used in the selection of the test areas. It was e.g. decided not to select test areas that were located along large outer bends, as from the interpretation of the satellite images it was found that these bends are cutoff within a few years. For more details see the Technical Report No. 1 on the pre-selection of the test areas.

In addition to what was previously anticipated it was decided to do also an extensive analysis of the historical discharge and sediment transport measurements at Bahadurabad. The rationale behind this is that one of the more favoured test areas is located just downstream of this measuring section. It is inferred that a better understanding of the morphological phenomena at this possible test area can be obtained by studying these historical data.

ad (2) Design Criteria

The test structures have to tested during the period of the Project, i.e. in the few years after their construction. It is probable that in these few years extreme conditions (say 1: 100 year conditions) will not occur. Because nevertheless the behaviour of the structures has to be assessed, the structures will be designed and constructed in such a way that they will probably experience some damage also under less exceptional attack. This raises the need for a good morphological predication of the future conditions at the test sites. The morphological analysis has to provide this estimate of the morphological changes and also the accuracy and the upper and lower boundary of these predictions.

This will result in an improved understanding of the morphological processes in the Jamuna River on the basis of the Additional Study which includes a further analysis of LANDSAT and MOS images. The analysis will be similar to the study done within the frame-work of the Jamuna Bridge Project, but more years will be included in the analysis. In the analysis years between 1973 and 1990 will be included.

This morphological analysis will allow to make a prediction of the future bed topography over the period after the implementation of the bank protection structure. The estimate will be used as an input for the computations with a mathematical model for the 2-dimensional flow (see Task 13) that at its turn will provide boundary conditions for the scale model investigation of the local scour.

For the prediction of the local scour an important input parameter is the original water depth for the case that the structure is not yet present. In this particular case the determination of this original conditions is more difficult because the present depth in the outer bends is affected by the input of the erosion products of the bends. Is this input blocked by the fixation of the bank, then the depth in the outer bend will increase. To study this phenomenon, the Consultant will do a supporting study on this aspect. This study is being done in one of the home offices in The Netherlands; for more details see Chapter 4.2.4.2. In addition an analysis will be carried out of the soundings of BIWTA and BWDB, concentrating on the selected test areas. The results of this analysis will be used in combination with results of the mathematical study, the Additional Remote Sensing Study, the local scour models at RRI and the Additional Local Scour Investigation.

ad (3) Conditions Present at the Selected Sites at the Period of Construction of the Bank Protection Works

Based on the improved understanding arrived at in the previous study phase, predictions will be made for the conditions (both hydraulically and morphologically) at the proposed test sites. This will be used in decisions as to how and where the test structures will be constructed. Some of the possible options are in the floodplain or construction on a char.

4.2.2.3 Geotechnics

On completion of the subsoil exploratory works in the field and the testing of representative soil samples in the soil mechanics laboratory all results shall be compiled, assessed and commented leading to a report comprising all geotechnical information, data and parameter as required for the subsequent design works for the bank protection pilot project.

Besides the descriptive report comprising all data of the field works, i.e.

- site situation
- geology
- drilling method
- borehole logs
- SPT and peneteometer results

- ground water levels and results of permeability tests as well as
- the results of all performed laboratory tests.

The report will contain an interpretation of all results as far as the engineering problems are concerned. For the pilot works envisaged this will cover recommendations of bearing capacities and settlements, fill material, temporary and permanent slopes, drainage measures, soil compaction and stabilization, protection against entrainment, etc.

4.2.2.4 Preselection of Test Areas

The objective of the Project is to find optimum design solutions for bank protection and river training works, to build test structures at selected locations along the Jamuna River and to test and observe them over a period of several years.

The preselection of areas where such pilot works could be constructed was one of the early tasks to be performed after the commencement of the Consultant's services to enable the required field investigations (topographic/hydrographic surveys and subsoil exploratory works) to be completed before the start of the rainy season in May 1992, and that the tight work programme of the Planning Phase could be adhered to.

A draft of the Technical Report No.1 - Preselection of Test Areas - was already distributed to the Client, Donors and panel experts on 2nd March 1992 and the report officially submitted on 14 March 1992.

Following is a brief summary of this report comprising the selection criteria, the locations investigated, the valuation and ranking of individual locations and the proposal of the test areas.

(1) Pre-Selection Criteria

The following criteria have been taken into consideration for the assessment of locations

(a) **"Certainty of attack"** criterion
The probability that test structures will be attacked during the next 6 years should be as high as possible

(b) **"Something to defend"** criterion
Test structures should at the same time fulfill some useful purpose by protecting valuable infrastructive or else

(c) **"Accessibility"** criterion
Test areas have to be accessible for construction and monitoring throughout the year

(d) **"Left bank"** criterion
Test areas were to be selected preferably on the left bank of Jamuna River

(e) **"Availability of data"** criterion
Location of discharge and gauging stations close to test areas would be preferable because their existing data base would improve the quality of forecast and design

(f) **"No interference"** criterion
Locations of test areas are not to interfere with other projects of third parties

(g) **"Constructional"** criterion
Test structures in flowing water to be avoided, if possible

(h) **"Helping the river"** criterion
If fears exist that test locations may silt up and will not be attacked in future river training measures may be applied to remedy the situation.

Since locations not fulfilling criteria (f) to (h) have been excluded from investigations, only criteria (a) to (e) have been applied for subsequent ranking of test areas.

(2) Locations Investigated and Assessed

The following locations have been investigated and assessed :

a) North of Manos Regulator (right bank)
b) Fulchari ghat (right bank)
c) Bahadurabad ghat and downstream (left bank)
d) Madarganj (left bank)
e) Sariakandi (right bank)
f) Jagannathganj (fertilizer factory) (left bank)
g) Chandanbaisa (right bank)
h) Kazipur (right bank)
i) Sirajganj (right bank)
j) Betil (right bank)
k) Kathaltali (left bank)
l) Nakalia (right bank)

In the assessment of the individual locations the "certainty of attack" criterion got the highest priority and after evaluating the 1989 SPOT imageries only those locations were preselected and listed for ranking where the morphological conditions of the river offered the highest probability of future attack.

(3) Ranking of Short Listed Test Areas

The ranking of the short listed ares may be obtained from the table here below:

Seclection Criteria	Maximun Marks	Ranking of Preselected Test Areas				
		Bahaduraba d	Chandanbais a	North of Manos Rergulator	Nakalia	Betil
Certainty of attack	9	9	9	7	5	4
Something to defend	6	6	4	4	4	3
Accessibility	3	3	2	2	3	3
Left bank	1	1	-	-	-	-
Availablity of data	1	1	-	-	-	-
TOTAL	20	20	15	13	12	10

The three highest ranked test areas have been proposed to be selected for further field and model investigations and as prospective areas for future pilot works, i.e.

- Bahadurabad (left bank)
- Chandanbaisa (right bank)
- Area north of Manos Regulator (right bank)

The exact locations are shown on the attached map, Figure 4.2.2.4-1

For further details reference is made to the Technical Report No.1 - Preselection of Test Areas dated 1st March, 1992.

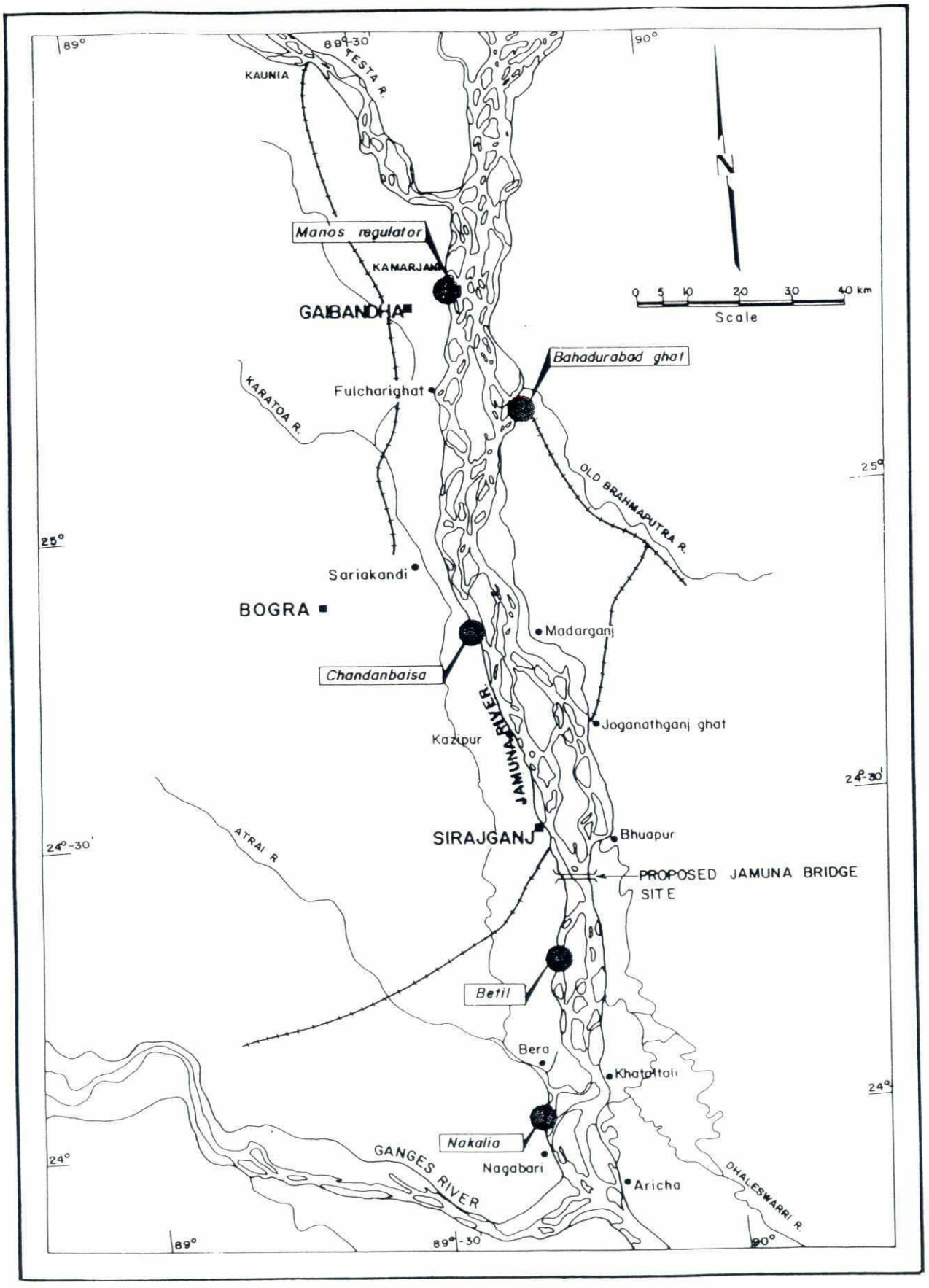

Figure 4.2.2.4-1 : Preselected Test Areas

4.2.3 Surveys

4.2.3.1 Topographic and Hydrographic Surveys

(1) General Remarks

In the FAP 21 planning phase topographic and hydrographic surveys are to be carried out to provide inter alia basic data for physical modelling and the design of test structures.

In the draft Technical Report No.1 - Preselection of Test Areas - of 1st of March 1992, three areas were selected from various locations on the basis of different criteria and ranking. From this assessment the following locations which obtained highest ranking are proposed:

- Bahadurabad
- Chandanbaisa
- Area north of Manos Regulator.

Cross section surveys have to cover areas of about 12 x 3 km at Bahadurabad, 10 x 3 km at Chandanbaisa and 5 x 3 km at Manos Regulator. The cross sections will have a length of about 3 km, 1.5 km on the landside and 1.5 km on the waterside. Within these areas the location of the final test sites/modelling areas will be selected.

The surveys shall be carried out by qualified Bangladeshi Surveying Firms and have to be organized in such a way to finalize the field works before the monsoon rains. Since the surveys will need some time but could not be started before the test areas were identified and agreed upon by FPCO, the Consultant invited already offers from survey companies on a general unit price basis in order to save time in the preparatory phase.

(2) Task Description

The following task description was submitted to the survey companies for the invitation to tender :

TASK DESCRIPTION FOR THE SURVEY COMPANIES

TOPOGRAPHIC AND HYDROMETRIC SURVEY

1 INTRODUCTION

Within the framework of the Bank Protection Pilot Project (FAP 21) for the Jamuna River in Bangladesh a large extent of basic research and testing will be performed on three test sites. For setting up and/or calibrating the physical models and for the preparation of alternative designs, topographic, bathymetric and hydrometric data as well as pertinent information have to be obtained.

These Terms of Reference describe the main topographic and bathymetric surveys which will have to be performed:

- *height connection by levelling*
- *a traverse to the area*

- *cross-section survey on-shore and in the river*

Location of test areas (tentative) :

A: Bahadurabad

B: Chandanbaisa

C: Manos Regulator (Kamarjani)

to be decided upon with FPCO in early March, 1992. On defining the methods to be applied and accuracies to be asked for, it should be kept in mind that the survey results refer to highly variably onshore and offshore topographies and that their main purpose is to build the physical models.

2. SURVEY METHODOLOGY

2.1 CONNECTION TO THE NATIONAL GRID SYSTEM

The test areas shall be connected with the National Grid System in both location and level. It is assumed that the required closed traverse of 2nd order and the levelling distance will not exceed 20 km to reach the next official survey fix points/benchmarks.

2.2 CROSS-SECTIONS

The extension of the test areas is estimated to be up to 10 km along the river and their width is estimated to up to 1.5 km on land and 1.5 km in the river. The cross-sections shall be placed at intervals of 200 m approximately. As a rule, the bathymetric cross-section should be in line with the onshore sections. In the middle between these main cross-sections, short cross-sections covering the river embankment only are required in addition.

The onshore area :

The width of the areas (bank and/or chars) will be generally 1.5 km (but will not exceed 2 km). Heights are to be taken at about 50 m distances, they have to be identified, if necessary, or can be widened if the topography is homogenous. Concrete pillars (about 20 pieces per test area) shall be placed in sheltered and safe (against flow) locations or even beyond the limits of the test area to allow for later follow-up surveys of selected cross-sections.

The offshore area :

Bathymetric survey has to be performed from a boat, the cross-sections generally being in line with those performed onshore. Depths shall be recorded continuously. If the bottom is homogeneously shaped, distances can be widened and vice versa.

The survey boat shall be tracked either by conventional (optical) means and/or electronic positioning, as requirements may be. During the bathymetric surveys the river water level has to be recorded for proper connection of the bathymetric to the topographic levels i.e. river gauges have to be operated temporarily in the survey area and observed in regular intervals during the bathymetric survey. The temporary gauges to be placed at distances of about 2 km, depending on the gradient of the river in the survey area, and to be connected to PWD and/or MSL-level.

2.3 PLANS

For each test site a 1:5,000 layout plan with appropriate contour line distance in the onshore and offshore areas will be produced. Additionally, plans of cross-sections with 1:2,000/1:100 horizontal and vertical scale, respectively shall be drawn.

2.4 PERFORMANCE OF WORKS

The surveys have to be performed during the dry season, as early as to allow the construction of the physical models in time. Surveys shall not start later than end of March, 1992. The deadline for the submission of the documents as specified above is fixed on May 15, 1992. The engaged survey contractor has to realize that up to three test sites must be surveyed simultaneously and thus must be in a position, to provide sufficient professional staff and equipment for several survey teams at the same time.

(3) Offers from Survey Companies

The following six companies were invited on February 18, 1992 to submit their proposals:

1. Progressive Survey Organization, Dhaka-1000
2. The Surveys Ltd., Shyamoli, Dhaka-1207
3. Hydroland Survey Ltd., Kalabagan, Dhaka-1205
4. Denote Survey Ltd., Dhaka-1000
5. The Surveyors and the Realtors, Dhaka-1000
6. The Engineering Survey Ltd., Banglamotor, Dhaka.

All companies offered for both topographic and hydrographic surveys, the quality and the prices showing a remarkably wide spectrum.

(4) Further Approach

The Consultant started negotiations with the survey firms. The main criteria for the award of contract will be focussed on the qualification and capability of the surveyors to carry out the hydrographic part of the survey (the topographic part seems not to be a problem for most of the firms) and secondly on the price. It is obvious that some firms have no experience in the performance of hydrographic surveys, others lack of equipment. All efforts will be made to conclude a contract with the most qualified firm for the whole package under one responsibility before the end of March as to permit the start of the field works at the 1st of April'92.

It is assumed that the final approval on the proposed test areas will be given by FPCO before the conclusion of the contract with the successful survey firm.

4.2.3.2 Subsoil Exploration/Ground Water

Detailed subsoil investigations for the pilot works can only be executed on completion and evaluation of model tests, when the final location and alignment of test structures (embankments, revetments, groynes etc.) have been confirmed. However, in view of the fact that basic information on prevailing subsoil conditions and groundwater fluctuations are already required for preparing alternative designs, the programme of subsoil investigations has been split into two phases. The first phase to be executed before the flood season 1992 as soon as the test areas have been selected and approved, and the second one immediately after the flood season, when also the Planning Study has been approved.

The works of Phase 1 shall be awarded to an experienced boring firm and field works are to commence before end of March 1992. As per schedule the same are to be completed by about mid May 1992, whereas testing of soil samples is to be subsequently performed in the laboratory in Dhaka. All field works and lab tests shall be directed and supervised by the Consultant's soils engineers.

Results generally to be expected from this investigation programme include the

- the type and characteristics of the prevailing subsoil material in the vicinity of the

banks, its degree of density and resistance to erosion, ground water levels, permeability, etc.
- the type of construction material for filling and cladding of banks and embankments, its grain size, consistency, compactibility, etc.

The works to be executed in Phase 1 comprise four exploratory borings at each test area to depths between 20 and 40 m below ground level, taking of soil samples continuously from all non-cohesive and cohesive layers and of performing Standard Penetration Tests at 1.5 m intervals for determining the prevailing degree of density at various depths. More detailed information on the degree of density (cone resistance and local friction) and change of layers shall be obtained from peneteometer tests with a static Dutch Cone penetrometer set. Contingent on the type of subsoil encountered a series of soil mechanics investigations shall subsequently be executed on representative samples for determining the type of soil and soil mechanics parameter as required for the design of the bank protection and river training works.

Quotations for the field and laboratory works have been obtained from the following firms:
1. Soiltech International Ltd., Motijheel, Dhaka.
2. M. Ahmed & Associates Ltd., Mohammadpur, Dhaka.
3. Associated Soil Engineers Ltd., Motijheel, Dhaka.
4. Foundation Consultants Ltd., Motijheel, Dhaka.

All technical works have been offered by the selected firms and with one exception prices do not differ considerably. Therefore, the work approach to the work and the equipment offered will be the decisive factors for awarding the work.

4.2.4 Design

4.2.4.1 Selection of Test Sites

The work on selection of actual test sites and an the layout of test structures within the preselected test areas is scheduled to commence soon after the submission of the Inception Report although the final selection will only be possible when accurate maps, data and results of additional investigations are available.

Important in this connection are the results of the
- topographic, hydrographic and hydrometric surveys, which provide the proper maps of the prevailing situation at the test areas, the bank configuration, levels etc.
- evaluation of remote sensing images in combination with cross section soundings of the Jamuna River performed by BWDB, leading to improved methods to predict the morphological developments of the river channels near the proposed test sites
- one and two-dimensional mathematical models indicating expected high water levels, current velocities and scour depths in the area of the test sites, and

- of the subsoil investigations, confirming in principle the composition and the uniformity or non-uniformity of the subsoils in the test areas.

Initially, alternative solutions of sites and protection measures may be drawn up and compared in order to arrive at technically most appropriate solutions for the different areas.

Type of test structures may inter alia comprise

(1) protruding groynes, guide bunds or protection of existing river banks which are not allowed to retreat from the existing shore line

(2) retired groynes or cross bars which may be constructed on the flood plain with less costs but which will only become effective after the banks have eroded to some extent

(3) protected embankments contingent on the river morphology, degree of current attack, etc.

(4) or a combination of the measures listed above.

In view of the extreme costs involved and the funds available for the test works, measures as per (1) above are hardly envisaged at present. All efforts will, however, be exerted to reduce the attacking forces on the test structures by achieving an optimal alignment of the future shore line by river training, bank alignment etc. and to choose the type of test structures appropriate for such conditions.

In accordance with present technical considerations and rough cost estimates, prepared during the bid period, it appears advisable to restrict the numbers of independent test sites to two and rather to test different design solutions on longer stretches, e.g. geometry, revetment alternatives etc. in series of groynes or in a continuous revetment, where equal flow conditions etc. can be expected.

It has to be noted that the selection of test sites needs to be done by about mid 1992. For early 1993 the detailed design is scheduled and contract(s) to construction companies shall be awarded by mid 1993. Implementation of the test works will start at the end of 1993 and at the end of 1994, respectively that means after at least two flood seasons following the Planning Study. This requires on the one hand that morphological changes over that period will have to be estimated as realistically as possible but on the other hand that the necessity and possibility of layout adjustments will have to be taken into account in order to achieve the task of testing the structures.

4.2.4.2 Mathematical and Physical Modelling

Mathematical and physical modelling are used in an hybrid modelling approach in both FAP 21 and Fap 22, and these applications are treated here separately.

(1) Approach FAP 21

The approach of mathematical and physical modelling for the pilot project with bank protection structures, FAP 21, is elaborated in the following.

In the proposal an approach was outlined (for the phase once the test sites had been selected), essentially consisting of the following elements :

(1) Field surveys on the topography, river bed morphology and flow conditions.

(2) A hydrological analysis using the Mike 11 model and a database covering a period of 25 years.

(3) A morphological analysis, resulting in an estimate of the future conditions (mainly bed topography, but also the general flow field) at the test sites (task 8).

(4) Two dimensional flow computations with a mathematical model using the bed topography predicted under (3) and hydrological information regarding discharges and water levels in design events (task 9).

(5) Physical model testing using the boundary conditions and the flow lines, which are predicted under (4), to determine possible scour depths and flow velocities near the test structures (task 15).

This was also the approach used for Jamuna Bridge Project and the Meghna River Bank Protection Study, FAP 9B. There is however one essential difference between FAP 21 and the other projects: for the other projects the most serious conditions that will occur within the assumed life-time of the structures (say 50 year) had to be taken into account. For FAP 21, however, the testing of the structures takes place only during some years after the construction. The realization of this aspect has led to a change in especially the physical modelling to be carried out at the River Research Institute in Faridpur. The implications are discussed hereafter and hydrological data used are for 2, 5, 10 years return periods instead of 50 and 100 years.

(1.1) Physical Modelling for FAP 21

Four types of physical modelling will be undertaken in the Project :

- determination of the hydraulic design conditions for the test structures
- determination of the local scour near structures
- filter characteristics and interaction of top layers with filters, on a specially constructed filter test rig
- investigation of the effect of a combination of bend scour and local scour near groynes or revetments on the maximum scour depths.

These four aspects will be studied in separate physical models or model facilities, and each of them will be discussed in more detail.

(1.1.1) Hydraulic Design Conditions for Test Structures

For each of three selected test sites, probably the test sites near Bahadurabad, Manos regulator and Chandanbaisa, a physical model will be constructed. These models include a part of the whole channel in front of the test site and some reserve space to allow the possible future channel alignments to be built in.

(3a)

This model investigation should be split into two phases: first a model investigation during the design phase of the test structures and next an optional model investigation during the monitoring phase. This means that the physical model should be maintained during the total project period.

Main purposes of these physical model investigations in the Planning Study is to provide design parameters for the structural design and the verification of the conceptual design :

* The selection of an optimum alignment and layout of the test structures. The alignment of dyke sections and groyne centre lines can be determined definitely.

* The determination of the distribution of the hydraulic load (shear stresses) on the top layer of the test structure as a function of the flow velocities. This includes also an estimation of the shear stresses as a function of the hydrograph or the discharges.

It is planned to build in the model one or two channel alignment(s), which are predicted after a period of 2 to 3 years (from the morphologic study). From the tests with this future channel alignment an impression of the possible variation in the distribution of the hydraulic load on the test structure can be obtained.

* The optimization of the number and the locations of the measuring instruments during monitoring of the test structure. For these purposes the flow velocities should be measured in tests with three different discharges. The main variables are: alternative layout of the test structures, the channel alignment and the discharge.

Additionally some local scour measurements near the head of groynes will be executed also in the same, non distorted model. For an accurate reproduction of the flow field in this type of physical models the roughness condition should be satisfied and therefore the model bed should be very flat and fixed with brickstones and a cemented top-layer, only near the head of the groynes the development of bed forms should be accepted.

Main purpose of an optional investigation with the same one or two model(s) during the Test and Monitoring Phase would be :

- The reproduction of the measured hydrograph, during which some damage has been observed in the prototype test structure. This will result in a more detailed assessment of the critical hydraulic load, of the location of this critical hydraulic load and the type of failure mechanism(s).
- The consequences of the expected near future development of the channel near the test structure can be determined, e.g. new predicted future channel topographies can be built in and the consequences of this channel development for the hydraulic load on the test structure can be estimated.

To simulate the correct flow pattern a length of maximum 4.5 km is required as mentioned in the proposal. Probably a shorter length of the model between 3.5 to 4.5 km will be sufficient.

Some delay is to be expected in obtaining the data of the representative cross sections of the most recent bathymetric surveys, because the issue of these data is not free of charge. The data of the planned site surveys within the frame work of this project will be used to model the bed. For the future channel alignments the results of the morphological study will be used.

The Consultant requested the reservation of space in the first tidal shed of the River Research Institute (RRI) in Faridpur for this model investigation. If this facility is not available or if the final dimensions of the model do not fit in the model area of this shed than an open air model, which is covered by a temporary shed, will be selected.

In the preliminary programme of the measurements, as presented in the proposal, no change has been foreseen yet. The Consultant expects now that the operation of three physical models parallel to each other may be restricted by the capabilities of RRI (new staff officers have been assigned recently, not sufficient discharge capacity). These aspects will be discussed with RRI during the preparation of the model investigations.

(1.1.2) The Local Scour Holes near Structures

The two main types of bank protection structures are groynes and revetments. In recent projects as Meghna River Bank Protection (FAP 9B), Brahmaputra Right Bank Protection Study (FAP 1) and the Jamuna Bridge study more emphasis has been given to the study of the local scour near groynes. Some simple formulae for the maximum scour depth as e.g. the formula of Ahmad, have been validated to these data and the Consultant proposes to use this formula.

For detailed optimization of the shape and layout of the head of the groyne additional tests are required. These tests can be done in a local scour model with a sand bed and without severe scale effects.

However, for the local scour depths near revetments with and without embayment less data is available then for the local scour depths near groynes. Therefore Consultant will consider the possibility of a physical model study to determine the maximum scour depths near revetments. A certain type of revetments with a relatively short length, more or less hard points, have been tested recently within the mentioned FAP 1 study. In addition to these tests a model investigation in which the local scour depth near relatively long revetments is measured, will be elaborated and prepared. During the preparation due attention will be given to possible scale effects. It is planned first to estimate the consequences of possible scale effects before deciding on this model investigation. It is expected that the change of the alignment of the eroding channel with reference to the alignment of the revetment is one of

the main parameters determining the local scour depth.

In the detailed design of this model it will be determined whether it is possible to combine these local scour tests with the study of some structural aspects, as the behaviour of a falling apron, in the same model. Together, these tests will give insight in some of the supposed failure mechanisms.

(1.1.3) The Selection of Model Material for a Scour Model

In a physical model not only the water depth, the model discharge etc. should be scaled according the basic scale laws and scale conditions, but also the bed material in case of local scour models or a movable bed model. The bed material is characterised by ΔD in which Δ is the relative roughness, and D the characteristic grain diameter, in general D_{50}. The relative density is defined as $\Delta = (\rho_s - \rho)/\rho$ when ρ_s is the density of the bed material in kg/m3 and ρ is the density of water in kg/m3. For sand Δ is about 1650 kg/m3.

The sediment transport can be reproduced in the model at scale if the ΔD_{50} is reproduced at the length scale. This follows from the condition that the Shields parameter should have the same value in the model as in the prototype. In a uniform flow the Shields parameter can be determined by:

$$\phi = \frac{h \times i}{\Delta \times D_{50}}$$

in which

ϕ = Shields parameter (-)
h = water depth (m)
i = hydraulic gradient (-)

This means that in practice only the diameter of gravel can be scaled according to this condition to sand in an undistorted model ($i_{model} = i_{proto\ type}$), and keeping the relative density of the model material the same as in prototype. Finer material will become silt or clay in the model and the properties and the transportation characteristics of silt are completely different from the properties and the transportation characteristics of sand and gravel, which are non-cohesive materials and clay is a cohesive material. Therefore the model material should be a non-cohesive material.

If it is not possible to scale the diameter in the product ΔD_{50} than the relative density should be scaled by using a light weight material. From literature it is known that the following light weight materials have been used in physical models :
bakelite, brown coal, coal dust, polystyrene, perspex, crushed and sieved walnuts.

These materials have a relative density between 1.05 to 1.5 and this is considerably less than 1.65 for sand. In some physical models two types of light weight materials have been used, one to simulate the bed load transport and one to simulate the suspension transport. The Consultant believes this will not lead to a reliable reproduction of the sediment transport phenomena in the model.

The Consultant has made a comparison between a movable bed model with sand and the same model with bakelite. The conclusion of this comparison was that the bakelite gives a rather good reproduction of the bed level, which has been measured in the model with a sand bed. However, the size of the bed forms was relatively too high in the model with bakelite as bed material.

The Consultant has also compared the results of physical local scour tests with polystyrene with the results of prototype tests with fine sand. The maximum scour depth was well predicted by the model results, however some differences in the slope of the scour hole were observed.

Some of the disadvantages of these light weight materials in RRI are briefly summarized below:

- All materials are much more expensive than sand
- All materials are sensitive for pollution by dust and algae, therefore not suitable for an open air model with a water temperature of about 30 degrees
- A model with light weight material should have a water circulation circuit, which is not shared with other models, because after some time the light weight material will be found in all supply and discharge canals and also in the other models.

bakelite:

- after some time bakelite will absorb some water resulting in a change of the relative density
- crushing of particles during testing
- shape of the particles is too irregular.

polystyrene:

- very regular shape of the particles
- an advantage is less rounding of the particles during testing

coal dust:

- shape can change and the average diameter can reduce during testing.

To investigate the local scour holes near the head of groynes a deviation from the Shields parameter in the prototype will not result in serious scale effects in the maximum scour depths, if some conditions regarding the model discharge are fulfilled.

The Consultant concludes not to recommend the use light weight materials in the physical models, which are planned within the framework of this project.

(1.1.4) Local Scour in River Bends and Structures as Groynes or Revetments

The Object of the Study

The main purpose of the experimental study is to investigate the effect of bend flow on local scour around constructed groynes along the outer banks of a curved alluvial channel, specially in the case that bank material characteristics have a significant influence on the shape of the cross-sections in the unprotected situation. The study has to result in a formulation to assess the combined scour due to bend flow and groynes.

The Approach of the Study

In order to investigate the afford mentioned problem, it is intended to do several tests in four stages with different slopes and discharges by means of movable bed models in a facility. These four stages are as follows :

A. experiments in straight channel without groynes
B. experiments in straight channel with groynes
C. experiments in curved channel without groynes (with non-erodible and erodible banks)
D. experiments in curved channel with groynes

in the first stage (A), a series of tests with the slopes (0.001, 0.003 and 0.005) and the discharges (20, 30 and 40, 45 l/s) will be done to determine the Chezy coefficient and to select suitable slopes and discharges for other stages.

Finally, the results of the tests will be analyzed and it will be tried to find formulation for local scour in bends.

The Facility of the Study

Since it is necessary to make different slopes of the channel bed, at first, it was intended to use an existing tilting facility with the dimensions 5 x 10 m and the maximum sand layer thickness of 0.25 m. But after designing the experiments, it was needed to apply an 0.50 m thick sand layer to get satisfying results (it was found by different predictors that the depth of scour around a groyne and in a bend will be upto 0.40 m). However, the existing facility does not have enough strength to carry this load.

Consequently, it was decided to construct a new non-tilting facility with the dimensions 6 x 9 m and the height of 0.60 m. This facility will be equipped with a closed system for water and sediment recirculation (Figure 4.2.4.2-1). The maximum discharge will be 40 liters per second and the average diameter of sand to be applied is 0.21 mm.

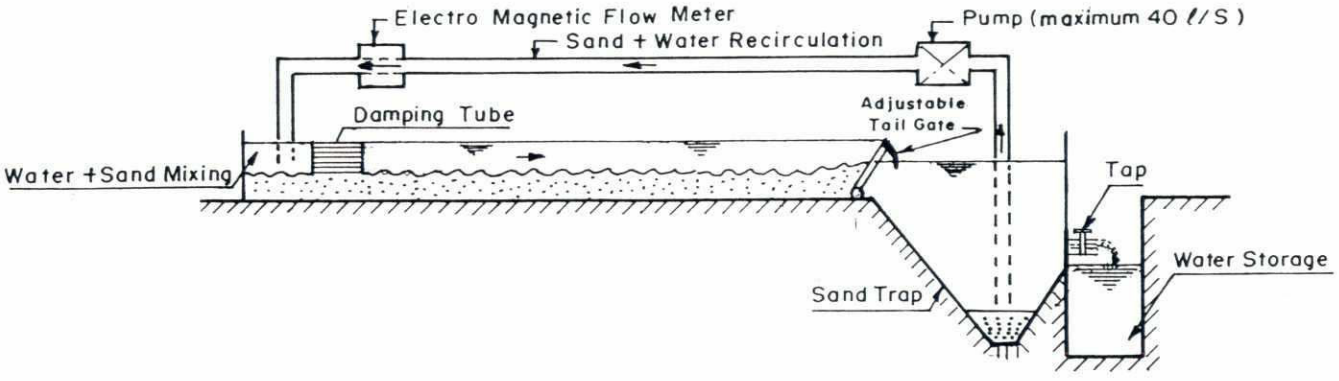

Figure 4.2.4.2-1: Water and Sediment Circuits

(1.1.5) Filter Investigations in a Test Rig

In general a bank protection consists of a top layer on a filter of one or more layers, placed on a subsoil of fine erodible material, like fine sand and clay. For the stability of the toplayer the groundwater flow through the different filter-and top-layers can become important, for example if material of a filter-layer migrates into an adjacent layer or if the uplift pressures on an almost impermeable toplayer results in failure of the bank protection.

These phenomena will be studied in a test rig, which is to be constructed within the framework of this project. In a test rig a small part of the bank revetment can be tested at a scale 1:1. In the proposal phase an area of 1 m^2 was mentioned to be built in the test rig. In the inception phase the preliminary design of the construction of the test rig has been prepared and the area of 1 m^2 has been enlarged up to about 2 m^2 to guarantee that the labourers have enough working space to build in carefully a small part of the bank revetment.

One of the most important aspects of the design is the determination of the most favourable location of the test rig and organization of the supervision of the research programs ensuring a good cooperation with the research institutes and government organizations. The choice of a closed water circuit with an underground or an above the ground-floor located water reservoir has resulted in different alternative layouts of the test rig.

The following type of measurements are foreseen: discharge with V-shaped weir, water pressures by freatic level in small tubes, observation of sediment transport, weight of transported sediment and the measurement of settlements in the top-layer.

All required materials for the construction of the test rig are probably available in Bangladesh. A tentative list of the materials is: bricks and cement mortar, glass window with a thickness of about 15 mm, steel plates and steel frames, steel pipes, a pump with a suction pipe, 2 water level gauges, a V-shaped weir, plastic tubes with diameter 1 to 1.5 cm, a balance to measure transported material and silicone sealing material. Different types of geotextiles will be imported and if possible some modified jute filters may be tested.

To the preliminary programme of research items as the stability and permeability of a so called imperfect filter, the determination of the filter characteristics of new or local materials and the stability of relatively impermeable top-layers the determination of tolerance limits for the construction of filter layers can also be added. This last mentioned item arises from the problem to determine the position accurately where to dump stones or gravel under water during construction of a bank protection structure.

The preliminary test programme has not been changed in the inception phase, although later changes are still possible.

(1.2) Mathematical Modelling for FAP 21

The flow field in the channel in front of the test site will result from a simulation with a 2-dimensional depth-averaged computer programme. The bed topography from the field surveys, selected discharges and water levels from the hydrologic study will be used as input for the model. The simulations with this model will be carried out for two different bed topographies to be expected and for three different discharge levels. It is expected that the conditions for the third test site can be inferred from the results of the other two sites.

It may be required to do some additional computations during the monitoring and evaluation phase, specially to determine the flow field for predicted future bed topographies near the test sites. For that reason, the schematized models will be maintained for later use.

The calculated flow field will be used to determine the boundary conditions (water levels and discharges) in the physical models of the test structures.

A 1-dimensional model for the tests sites

During the inception phase the Consultant realised that a 1-dimensional model of the test site areas may be useful, because this type of computations are much faster than 2-dimensional model runs. A 1-dimensional model will provide additional information to the results of the 2-dimensional model results, for example to estimate whether a future bed topography (bank line and channel depth) will result in major changes in the channel morphology (sediment transport capacity, sedimentation and erosion rate).

Within the actual time schedule it is possible to develop some local one- dimensional models if required and considered useful.

(2) Approach FAP 22

The approach of mathematical modelling in FAP 22, a study of river training with permanent and recurrent measures, consists of the following elements :

- the schematization of river training measures in a 1-d model,
- the schematization of a representative river reach in a 1-d model,
- the selection of a scenario regarding a sequence of wet, average and dry years for the yearly hydrograph, and a time schedule of the selected river training activities,
- the estimation of the effects of the selected river training measures as a result of a 1-dimensional model calculation.

As an option a 2-dimensional model calculation can be considered to determine the effect of river training measures in a specific area (for example the area of the pilot project) or in a representative area with a synthetic bed geometry.

(2.1) 1-dimensional Mathematical Modelling for FAP 22

Different models based on the 1-dimensional model Mike 11 will be used in the River Training and Active Flood Plain Management Study FAP 22 :

(2.1.1) Hydrodynamic Models

The following 1-dimensional hydrodynamic models, which cover the whole reach of the Jamuna river, are of interest for the project: the General Model, and a modified general model of Jamuna river with a reduced number of tributaries and distributaries and with more cross sections inserted. This model has been made by FAP 1.

The purpose of these general hydrodynamic models is:

- to generate boundary conditions for local models and the physical models, as part of the specification of the hydrologic design events providing boundary conditions for the 2-dimensional mathematical model, and input for the morphological analysis, and
- eventually to determine the consequences of the river training measures, which are simulated in the local models, at a larger distance from the location of the measure. These consequences are mainly water level rises or lowerings due to back water effects.

These general models have been developed and calibrated in previous projects.

At this stage it is uncertain whether a morphological model of the whole Jamuna river is required to determine the morphological consequences of the local river training measures (like the propagation of a sand wave along the river bottom in downstream direction). At the Surface Water Modelling Centre (SWMC) the calibration of a strongly schematized morphological model of the whole Jamuna river is under way.

(2.1.2) Local Models

Some examples are given of local, 1-dimensional hydrodynamic and morphological models,

which are to be developed within this project:

- A model to simulate local dredging of bottom sand in the main channel and the supply of the dredged material to a smaller, parallel channel, which is aggressively eroding its bank(s).

It is mentioned that if the effect of bottom vanes or floating vanes can be schematized in an increase of the hydraulic resistance in a branch, this river training measure also can be simulated in a local model, with two or more parallel branches (see Figure 4.2.4.2-2)

- A model to simulate the development of a dredged cut off channel (basically a model, with three parallel branches, of which one branch is a cut off channel). The model results will give an insight view into the sedimentation in the existing channel and the erosion or sedimentation in the cut off channel during a year with an average hydrograph. This measure can be combined with, for example, a partial closure of the aggressive eroding channel, see for example the sketch in Figure 4.2.4.2-3
- In next models the schematization of the bifurcation point will be improved, by adding more nodes and small branches. Also to simulate a river section with three parallel branches, see sketch in Figure 4.2.4.2-4.

These developed local models cover a reach of only 15 to 40 km along the river. They can be a synthetic schematization to obtain a model which is representative for situations which can occur along the whole reach studied in this project. A special problem is the lack of data for the model calibration. The models can be specific for one of the selected test sites, where the results of the field survey will be used for calibration.

A preliminary simulation of dredging in one channel and to supply the spoil to a small side channel to direct the channel development has been done by FAP 1 with two-dimensional depth-averaged model. The first results show that with a moderate amount of dredging (1 million m3) in the low water period a significant change in channel development can be obtained in moderate channels, however, this depends also on the situation upstream of the bifurcation.

All models need boundary conditions (discharges and water levels) for a period of at least some years. From the hydrologic study extreme low flood, average and extreme high flood will be selected. Next step is the determination of several scenarios of sequential wet and/or dry years, combined with a time schedule of one or a combination of the mentioned river training activities.

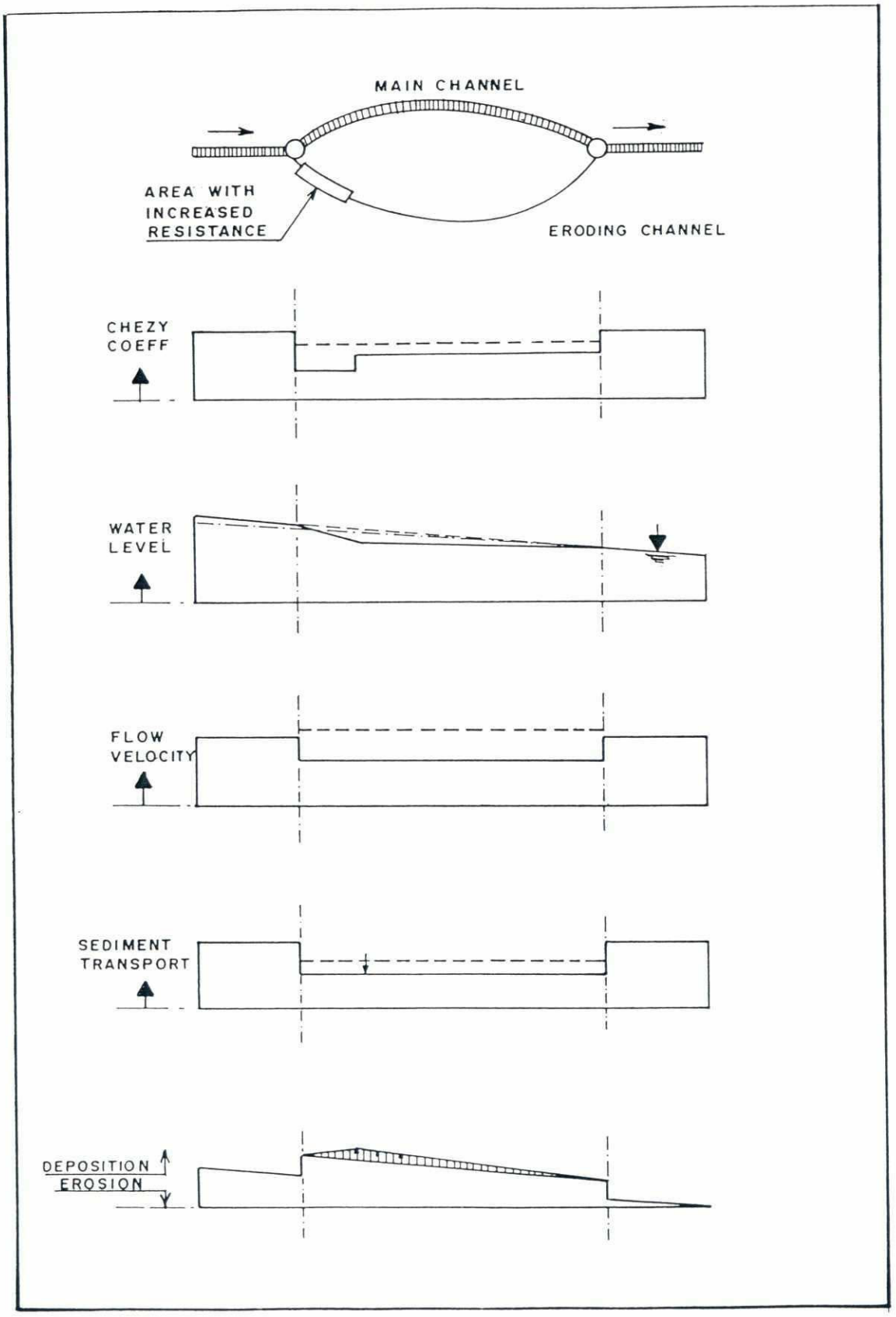

Figure 4.2.4.2-2: Increasing Local Resistance

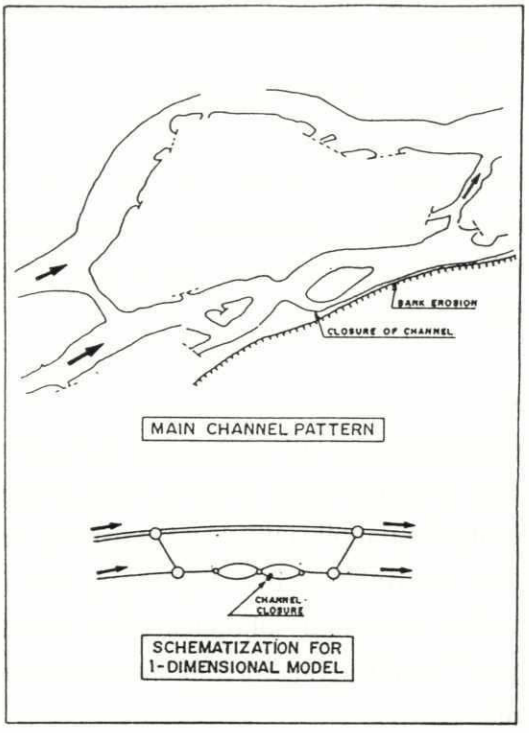

Figure 4.2.4.2-3

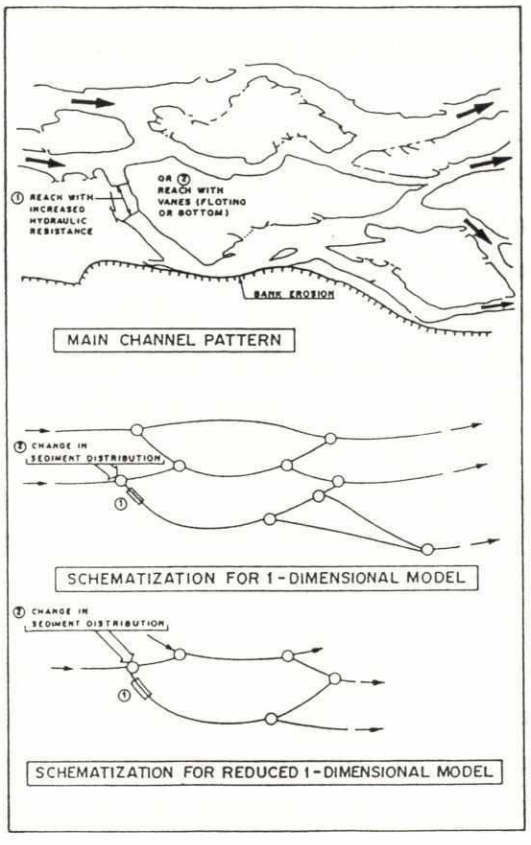

Figure 4.2.4.2-4

4.2.4.3 Construction Measures, Materials and Methods

The investigation into alternative and feasible construction measures with special attention to their effectiveness and sustainibility on the Jamuna River has partly to run parallel with the selection of test sites and layout of test structures. The basic description given in Tasks 16 to 18 is further detailed in the following :

The scope of this work includes however not only the conceptual designs of possible bank protection/river training works but also considerations and investigations regarding materials suitable for the test works and construction methods which may be safely applied under local conditions by local contractors.

(1) Construction Measures

Investigations for the conceptional designs will consider all generally applied bank protection and river training measures, e.g. groynes, spurs, training walls/guide bunds, sills, cross bars, etc. The Consultant will look into their applicability and feasibility under expected conditions of flow direction and velocities as well as scour depths and will critically check possible failure mechanisms of alternative structural solutions. This investigation will result in a selection or at least ranking of feasible construction measures with a first estimation of required geometric dimensions.

(2) Construction Materials

The use of local construction materials, if suitable and available in sufficient quantities, would be of eminent importance to arrive at economic design solutions and construction methods for the planned bank protection and river training works.

Therefore, a critical check and review of all material investigations and tests performed by various local institutions in the recent past (e.g. BUET, RRI, Jute Industry, etc.), and those of the organisations and firms in connection with the Jamuna Bridge Project shall be made and contradictory results detected, if any. The test results and conclusions drawn from such investigations by the various institutions or authors shall then be checked in respect of the quality of materials, their useful applicability for the bank protection works, and especially also with regard to the availability of the corresponding materials in sufficient quantities for large scale bank protection works. Such investigations apply above all to the quality and suitability of concrete aggregate, sand (Jamuna river sand is ostensibly unsuitable because of clay and silt content, and specially mica admixtures), gravel, stones, natural rock, bricks, clay, bituminous materials, fascine materials, etc.

On the basis of these investigation results the Consultant will decide on additional material investigations or test programmes he considers necessary to supplement or recheck the material investigations executed earlier. Such material testing will be done in Bangladesh or in Europe, contingent on the testing facilities available. To the extent special investigations, analyses and comments are required, material specialists shall be assigned to perform such tasks.

Since the design and construction of filters separating the revetment layers from the sandy/silty core of the earthen structure are to be considered as one of the most critical aspect in bank protection in Bangladesh, a special test rig will be installed and operated within this project. Details of that facility are given in Chapter 4.2.4.2 of this report.

Beyond the analyses of construction materials which are mainly to withstand current and wave attacks of the river, also protection measures by means of vegetation shall be investigated. Such investigations shall start with a site survey of existing turfy embankments (type and conditions of grass, degree of protection, maintenance problems etc.) and be followed up by proposals for improvements (e.g. different drought-resistant types of grass, type of top soil, surface protection when planting etc.)

When investigating into the availability of local materials, basic costs, for royalty, quarry and transport shall likewise be obtained as required for subsequent estimates and comparison of design solutions.

In addition to the study on local construction materials, other bank protection materials e.g. various geotextile mats, mattresses etc., although to be imported, shall also be described and assessed with regard to their suitability in Bangladesh and the costs involved.

(3) Construction Methods

It is the task of this investigation to improve on the traditional methods of bank protection works, to propose new methods applying the latest state of the art in bank protection works and to investigate in combinations arriving at most economical solutions, taking into account the prevailing local conditions and checking the applicability of new methods under local conditions. Of particular importance is the protection of the deeper parts of the underwater slopes against scour and erosion to which utmost attention has to be given.

The fine cohesionless river bank and bed material, the partly high current velocities during the flood periods and the resulting large erosion and deep scour depths are factors which not only call for high demands in terms of planning and design but also for reliable construction methods in order that the bank protection and river training works are executed as per design requirements.

As concluded from a number of discussions with responsible BWDB officers and from physical field inspections, the traditional construction methods can - without modifications - hardly fulfill the required prerequisites and if so only with the use of excessive quantities of materials and funds. This does not exclude that certain methods have proved their worth under certain conditions. The partial lack of appropriate materials and equipment, the lack of funds for maintenance works connected with certain deficiencies in design and/or construction (slopes, filter layers, compaction, etc.) and/or supervision were most probably the main causes of early damage and failures in the past.

As such, particular attention shall be paid to the required compaction of the earth fill and the placing of filter and armour layers both in the dry as well as under water. This automatically involves necessary investigations with regard to the application of mechanical equipment to the extent required for a sound execution of work and as per design geometry.

The assessment of possible construction methods shall take into account

- the required quality and accuracy of the construction works
- the degree of difficulty and their suitability and applicability under local conditions
- the experiences of local construction firms
- the protection of works during various construction stages
- the required output of work volume
- the employment of manual labour and mechanical equipment
- comparison of costs in local and foreign currencies.

As far as the experiences of local construction firms in large scale hydraulic works is concerned it must generally be assumed that the same are limited, especially if mechanical equipment is required for special works, e.g. cutting of underwater slopes, placing of mattresses etc.

Even if a large volume of work may be done manually, the application of specific equipment will definitely be required. In order to obtain well in time a comprehensive knowledge of the experiences of local contractors, their organizations, staff, working standards and availability or non-availability of mechanical equipment in Bangladesh, the Consultants intends to carry out a general survey in order to be able to assess the proposed working methods with regard to their suitability and applicability. This survey shall be done by evaluation of contractors' applications comprising details of organization, staff, reference projects, equipment list, financial status etc., by detailed discussions with related firms, visits of construction sites, inspection of equipment items, etc.

To make up any deficits in experience wherever existent the possibilities of engaging foreign specialists for special operations shall also be discussed and taken into consideration.

With regard to mechanical equipment, there are only few contractors in Bangladesh (possessing an industrial status) who own some earthwork/ construction equipment, e.g. dozers, graders, payloaders, compactors, dump trucks, etc. Most of the contractors have to rely on the equipment pools of BWDB, BIWTA, Road & Highways, etc.

In order to be able to decide on the technical and economic necessity of importing specific construction equipment for the pilot works, it is planned to have the equipment situation in Bangladesh investigated by an experienced mechanical engineer. Such investigation shall comprise a general physical check of equipment and a check of the equipment lists not only of equipment owned by the preselected contractors but also of that equipment owned by the mechanical departments of BWDB, BIWTA, and private organizations, if any. It is

understood that not each and every piece of equipment can be checked, but that a fairly good survey can be made. The information to be obtained will generally provide statements on

- type, age, and capacity of equipment items
- the time the equipment has been in operation and its reliability
- present condition and demand of spare parts
- availability for test works
- conditions and rates of hire.

The type of equipment to be investigated depends on the construction methods finally selected, but will generally include :

- earth moving and compacting equipment (dozers, graders, compactors, loaders, trucks)
- dredging equipment (draglines, suction dredgers, etc.)
- pontoons, tugs
- hoisting and other special equipment.

The inspection will also include a general check of existing workshop facilities, the spare parts situation and the qualification of skilled mechanical staff.

The evaluation of all survey and inspection results shall provide comprehensive information on the most suitable construction methods, on equipment items available and required for the execution of test works and on the type of equipment eventually to be imported.

4.2.4.4 Preliminary Design of Test Works

As soon as the design concepts and location of bank protection structures proposed to be constructed have been selected, alternative solutions of preliminary designs shall be prepared based on general design aspects and criteria stipulated before in Task 20, Annex II.

Such aspects and criteria will cover the subjects of

- design water levels, current velocities, scour depths
- wave heights
- loadings, earthquake
- subsoil permeability
- density of subsoil, compaction of fill and settlements
- safety against sliding, liquefaction, erosion, etc.
- geometry of banks, groynes and embankments, i.e. freeboard, crest levels and widths, slopes, berms
- revetment composition, filter layers, size and weight of armour layers
- etc.

Cross sections and slopes will be largely determined by stability requirements but specially in case of groyne heads also by current velocities and scour depths. The alternative design solutions will however predominantly deal with various revetment solutions, the levels of

protection and generally the safety levels of the structural elements.

The philosophy of the pilot project will be to design and construct the test structures at such a (low) level of safety that certain damage of the structure shall be allowed for. In other words, if a test work does not suffer any damage or shows sign of potential failure in the course of the monitoring and adaptation period it may be oversized and therefore not be suitable to serve as a standard design. It shall be striven for to arrive at an optimum design which will have an "optimum" relation of capital and maintenance cost and which just withstands the loads imposed on the structure.

Taking into account the exponential increase of the cost of bank protection on the Jamuna river versus the improvement of the safety standard, as shown in the sketch in (Fig. 4-1), the determination of standard designs is to be considered as kind of trying to square the circle.

Nevertheless, the Consultant shall investigate into the most appropriate application of hydrological design events and return periods and the levels of safety to be adopted.

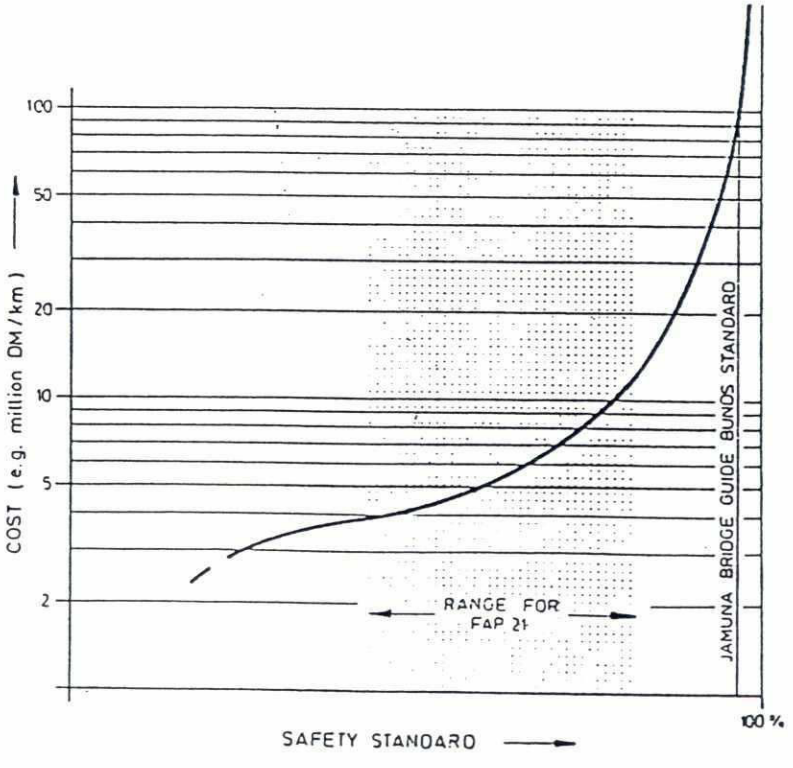

Figure 4.2.4.4-1: Schematic Relation of Cost Versus Standard

In order to decide on the most appropriate design solution(s) to be proposed for execution and to determine the volume of test works financially feasible within the budget amount, cost estimates shall be a decisive criteria in the comparison of alternative solutions and in the decision making process, as already indicated in Task 21.

Since however, realistic unit rates for various bank protection works are hardly available from other projects, or if available, differ considerably in various rate schedules, contracts and cost estimates the Consultant will have to prepare his own rate analyses for particular work operations in order to arrive at appropriate rates and costs for the planned test works. Such analyses will have to take into account the basic costs for procurement of materials, for staff, labour, equipment hire and transports, as well as ancillary costs, overheads, risk and profit of the contractor.

Comparative costs estimates for the alternative design solutions shall then be prepared in the form of Bills of Quantities taking into account the quantities of individual supplies and work operations, the appropriate rates determined inclusive of estimated costs for mobilization and site installation.

Costs of maintenance will likewise have to be estimated and taken into consideration when comparing design solutions.

In principle, it is the aim to select more than one design solution for bank protection and river training works, and to test them during the implemen-tation phase under largely the same conditions. This however, will only be possible if they are constructed close to each other where equal loadings and conditions can be expected.

The selection of these solutions will be done after careful consideration and weighing of various criteria, e.g.

- degree of protection required
- degree of difficulty in execution of construction methods taking into account the experience and capability of local firms
- volume of local materials and local labour involved
- large or special equipment required
- safe applicability of solutions to varying toe levels of structures
- degree of maintenance and maintenance costs expected
- total construction cost and portion of foreign currency involved
- etc.

The choice of criteria indicates already that not necessarily the lowest cost solutions may be selected but also others, if the same provide the guarantee of higher safety, less risk and less maintenance costs. This may be especially applicable for deeper protection levels, which may inevitably call for higher costs.

Advantages and disadvantages of individual design solutions and construction methods, as well as the reason for selecting particular solutions shall be discussed in detail in the final report of the Planning Phase.

4.2.4.5 Scheduling and Budgeting for the Test Works

In order to provide the Client and the Donors with a comprehensive programme for the Test and Implementation Phase the Consultant will prepare within the Planning Study Report

- a detailed time schedule comprising the periods of
  - . detailed design and preparation of tender documents
  - . additional field investigations
  - . implementation of the test works
  - . monitoring, and
  - . adaptation of designs and modelling in case of damages, and
  - . assumed repair works
- a procurement schedule showing the timing of ordering, delivery and transport of imported materials and equipment to the extent required and
- the Consultant's staff employment schedule showing the composition of the design, construction management and supervisory team inclusive of the functions, and periods of employment of the individual expatriate and local team members.

The basis of the schedules shall be the selected design and construction methods, the location of the sites, the capabilities of the local contractors, the availability of equipment, a reliable supervision of the field works and the requirements of surveys during the monitoring phases.

On the basis of the above mentioned schedules and of the cost estimates of the selected design solutions for the test works a comprehensive budget estimate shall then be prepared which shall remain within the financial ceiling figures of the donors.

The cost items shall include but may not be limited to:

Direct Costs of Consultant

- mm-fees and allowances of foreign and local personnel inclusive of supporting staff in Europe and Bangladesh in accordance with the staff employment schedule of the Test Phase
- transportation costs, i.e. international/local flights, transport vehicles inclusive running costs
- housing and office accommodation in Dhaka and in the field, inclusive of equipment and running costs
- miscellaneous office and communication costs, inclusive of radio equipment for proper communication between Dhaka office and site office.

Cost of Additional Investigations

- topographic and hydrometric surveys, subsoil investigations and laboratory tests

- mathematical/physical modelling
- miscellaneous laboratory tests of materials.

Cost of Construction Materials and Equipment Procured by the Consultant, e.g.

- geotextile filter material/mattresses, flexible cables for falling aprons etc.
- special construction equipment, testing equipment and spares to the extent required
- procurement costs to include all transport costs, as well as costs of clearing/forwarding agent, etc.

Cost of Construction Works to be Subcontracted to Local Contractors

- Test works proposed to be executed to an extent as feasible within the budget limit. The final volume of work shall be determined on the basis of the cost estimates of selected design and construction methods, after having reserved a reasonable amount for repair and adjustment works eventually needed during the monitoring phase.

Cost of Unforeseen Events, Contingencies

- Further about 10 % of the amount available for construction works may be withheld as contingencies, which may be spent at the end of the project if still unused

When preparing the budget it shall be taken into account that all costs and prices of whatever nature shall be determined for the years spent, i.e. price escalations as most probably applicable in Europe and Bangladesh shall be applied for determination of correct cost estimates.

4.3 FAP 21 IMPLEMENTATION PHASE

Even at this stage of the project when more comprehensive information and data and a better knowledge of the project area are available no factors or reasons can be seen which would call for an adjustment of the approach originally envisaged and stipulated for the Test and Implementation Phase. This applies not only to the methodology of the works but also to the time schedule. Hence the descriptions of Tasks 35 to 48 remain basically unchanged.

Therefore, the Consultant's basic approach to the works of the implementation phase is described in a concise form hereinafter.

The Consultant's services of the test and implementation phase, scheduled to start on approval of the Planning Study, comprise all engineering and management tasks relating to the planning and execution of the test works, their monitoring and eventual adaptation/repair measures during subsequent years and their handing over to FPCO/BWDB at the end of the contract period. In detail it is planned

(1) to prepare final designs and tender documents for all test works during the first year

(1993) including the specifications and tender documents for the execution of additional field investigations (mainly survey and subsoil exploratory works) in 1993

(2) to procure and deliver necessary construction materials and equipment well ahead before the start of construction works

(3) to subcontract the planned test works to local contractors, to have the test works physically executed by them over a period of two dry seasons (1993/94 and 1994/95) and to perform detailed site supervision of the works

(4) to observe/monitor the behaviour of the completed test structures during subsequent flood seasons (until 1997) and to plan, tender and subcontract adaptation and repair measures

(5) to hand over the structures on completion of all works by the end of 1997.

It is planned to carry out the test works at 2 or 3 different sites contingent on the volume of work possible to be executed within the financial budget ceiling. The chronological sequence will be as follows :

- implementation of site A during the dry season 1993/94
- implementation of sites B and eventually C inclusive adaptation of site A during the dry season 1994/95
- further adaptation of sites A, B and C each time during the dry seasons 1995/96 and 1996/97.

After completion of the implementation of site A, the Consultant recommends to incorporate the experiences gathered at site A into the new tenders for the sites B and C. The adaptation works should, as they have to be executed rapidly, be contracted within the framework of a basic agreement.

In order to ensure that the construction works may start in late 1993, it is essential that the local office in Dhaka is newly staffed with all required specialists for the preparation of final designs and tender documents as soon as the approval of the Planning Study has been received. This shall by no means be later than about February 1993. Hence even an overlap with the final approval period may have to be envisaged. The additionally required field investigations and possible supplementary physical model tests shall be simultaneously scheduled in such a way that all results are available in time for incorporation in the design works.

The Consultant intends to take over the supply management for the procurement and delivery of imported materials with his own staff in order to save time and costs and to have a permanent control on the procurement situation.

The prequalification of contractors, the preparation and issue of tender documents, the evaluation of bids, the preparation of contract documents and the supervision of construction works are services commonly performed by the Consultant. In the project at hand all services shall likewise be performed with experienced staff in a proper manner whereas, however,

the Consultant is acting as a trustee to the Client and funding agencies in taking over the combined position of the client and consultant towards the contractors engaged to execute the test works.

The monitoring and adaptation/repair phase which will last from 1993 to 1997 requires extensive survey works during the flood seasons and fast assessment, evaluation and redesign services always immediately thereafter. It shall be ensured through early contract awards to competent contractors that adaptation and repair works are always completed ahead of the arrival of the next flood waters under the supervision of the Consultant.

As a result of all services of the test phase, the Consultant shall submit a final report with a description of all works and services performed, and giving comments on optimal design, use of materials, construction methods etc. which together may be considered a manual for future bank protection and river training works in Bangladesh.

Knowing the conditions that prevail in Bangladesh in general and at the banks of the Jamuna in particular, the Consultant is fully aware that the execution of the test works in remote areas, engaging local contractors demands a well organized construction management and a team of experienced, dynamic and motivated engineers, applying special attention to

- contract conditions taking full account of the prevailing local circumstances, structural requirements and time aspects
- the careful and proper selection of local construction firms
- the timely supply of materials and equipment
- all project management tasks
- a proper and detailed site supervision of works.

To guarantee a smooth execution and timely completion of all works, a project management organization is required, where

- all individual tasks and competencies are clearly defined/distributed, and specific job descriptions for office and field staff are issued
- an information system will be established for proper and efficient communication of all decisions, orders, reports etc.
- specific tasks will be taken care of, e.g.
  . prospective planning and general supervision/control of project aims
  . time steering
  . performance and cost control etc.

  so that bottlenecks or delays in project execution may already be recognized in advance, and allow the Consultant to take counteractions on time.

The detailed description of all services of the Consultant required during the test phase may be obtained from the task sheets in ANNEX II of this report hereinafter.

The implementation of the test works will require the acquisition of land both permanently, i.e. for the erection of embankments, groynes etc. and temporarily i.e. for the excavation of fill material, erection of camps etc. As the land acquisition is often a problematic and time consuming procedure the Consultant will provide the Client with maps showing the plots to be acquired as soon as the Planning Study has been approved. It will then be the task of the Client and the Government authorities, to provide the necessary right of way for the pilot works and to ensure that the overall programme of the test phase is not adversely affected.

4.4 FAP 22

4.4.1 Introduction

This section describes the updated work programme of FAP 22 on the basis of the tasks as described in the Consulting Agreement (see Annex II, tasks 26 to 33). The original set up of these tasks can briefly be summarized in the following 3 steps:

(1) Establishing a state of the art of the available tools and experience which enable the Consultant to give an indication of the feasibility of measures to train the Jamuna river in such a way that the channel configuration can be modified and even can lead to a change of the river character as a long term effect. This step will not be revised.

(2) Selection of river training/active flood plain management (AFPM) strategies on the basis of the results of the state of the art. This step will be highlighted in detail.

(3) Definition of a Pilot Project under the condition that river training and active flood plain management appear to be feasible. At present no detailed description of the approach can be given, because this depends fully on the outcome of the previous step. However, some remarks on the results to be expected from this step in the FAP 22 component will be added.

Some preliminary results of the literature review for establishing a state of the art (step 1) will be presented in section 4.4.2, while the updated approach for the steps 2 and 3 will be described in sections 4.4.3 and 4.4.4 with reference to the corresponding tasks as described in the Consulting Agreement (see Annex II).

4.4.2 State-of-the-Art in River Training

The tasks related to the state-of-the-art (see Annex II, tasks 26 and 27) will not be updated. Due to the postponement of the starting date of the project the state-of-the-art cannot be presented in this Inception Report. In this respect a Technical Report has been planned in the first half of May 1992. However, some preliminary results of the collected literature will be presented in sections 4.4.2.1 to 4.4.2.3 hereinafter, which can be considered as the ranking order for the contents of this Technical Report.

4.4.2.1 River Training Measures (Task 26, partly)

As a first result of a preliminary literature review of river training measures the following aspects have been summarized :

*** Definition**

River training measures are all engineering works in a river to regulate the river flow of water and sediments for the sake of erosion control, navigation, etc.

*** Principles**

Two main principles can be distinguished :

- strength of the works (to withstand the attacks of the river flow and scouring);
- effects of the works (the impact on the river must be understood as much as possible).

*** Classification of works**

Some kind of works and methods of river training aim at the regulation of the high water planform, viz. :

- levees
- dredging (capital works changing the alignment e.g. cut-offs, width confinements, etc.)
- bank protection (revetments, groynes, etc.)

while a number of works can be met within the high water banks, such as :

- dredging (closing secondary channels, etc.)
- revetments
- dikes (solid or permeable groynes, jetties, etc.)
- vanes (bottom or surface panels)
- drop structures (stabilizers, sills, weirs, etc.)
- reservoirs (high dams, diversions, etc. for discharge control)
- water quality control works.

Some of these works have either a temporary or a permanent character, often depending on the applied materials and construction method.

*** Objectives**

The objectives and concepts of river training works are for instance :

- planform rationalization (defined high water alignments; changing from braided to branched or to meandering)
- planform stabilization (fixation of high water alignment)
- low water bed regulation (stabilization of channels, flood plain management)
- water level control
- discharge control
- water quality control.

Another way to define the objectives is to distinguish :

- high or flood flow training (works)
- mean flow training (works)
- low flow training (works)

And a third way to classify the objectives :

- training works for flood control
- training works for navigation, etc.

Note, that in general one type of training work serves more than one objective.

*** Limitation**

In the context of the FAP 22 approach it is assessed to be justified that discharge and water quality control works are excluded from being taken up in the state-of-the-art.

*** Permanent versus recurrent and temporary measures**

There are several options for river training works. Permanent structures require a substantial investment and they are effective only when the river is locally attacking (they are permanent not only in time but also in place!). Alternative for permanent structures are recurrent and temporary measures. Recurrent measures are measures that have to be taken again at regular intervals. The advantage of recurrent measures is that when repeating them, this needs not have to be at the same place. This implies that the recurrent measures can be applied at places where they are actually needed in that particular period. Temporary measures are measures that are effective only during a certain time. Examples of these are temporary closure dams to close particularly 'aggressive' channels and permeable groynes made of local materials. There may be some logic in applying recurrent and/or temporary measures in the Brahmaputra/Jamuna river system, because there the attack of the bank is typically locally and temporary, so permanent structures at a particular location may lay idle for quite some time.

In Table 4.4.2-1 a first preliminary review of training measures (permanent, recurrent and temporary) is presented from the literature, which still is subject to more detailed study. Some additional remarks indicating objectives, used materials, etc. are also listed in that table.

*** Effectivity of measures**

The effectivity of a river training measure can be defined as the degree of control to regulate either the sediment and/or water discharge in a channel. In this respect it is obvious that the effectivity of dredging can be up to 100% concerning the regulation of sediment discharge. For other measures (e.g. bandalling) the effectivity is less obvious due to a lack of experience, which mainly is based on trial and error.

Character of Measure	Type of Measure	Remarks
PERMANENT	o Levees	rationalization of High Water Embankment
	o Dredging	capital dredging for High Water (HW)
	- cut-offs	planform corrections
	- confinements	
	- closing channels	braided-meandering
	o Bank Protection	revetments for planform stability
	o Dikes	
	- permeable groynes	
	- impermeable groynes	width limitation, bank protection flood
	- bottom cribs	plain management
	- guide bunds	
	o Vanes	
	- bottom vanes	
	- surface vanes	
RECURRENT	o Dredging	
	- maintenance	- keep channels from HW banks
AND	- Least Available Depth (LAD)	- equipment, strategy
TEMPORARY	o Bank Protection	
	- e.g. bags	- other low cost solutions (?)
	o Dikes	
	- impermeable groynes	- sand bag groynes
		- other types
	- permeable groynes	- tree groynes
		- open wooden pile groynes
		- steel cable groynes
		- timber pile dikes
	o Vanes	
	- bottom vanes	- Potapov screens
		- Chao Phraya screens
		- Iowa screens (Odgaard)
	- surface screens	- floating
		- bandalling

Table 4.4.2-1 Preliminary Review of River Training Measures

Notes :

1. permanency may address the works or the effects
2. permeable groynes and vanes are mostly recurrent measures
3. stone bottom vanes are considered to be permanent works

Some preliminary remarks on the various river training measures are listed below:

Dredging

For maintenance type of work surface dredging is preferable. A trailer suction boom dredge seems attractive but shallow draft river versions do not exist.

Bags

Limited experience is gained in the Bhagirathi (Calcutta Port Trust) to apply bags both for bank protection and groynes. For groynes the trial and error concept is strived at.

Permeable groynes

Basically the groynes give additional resistance over a part of the river width, affecting the distribution of the flow. The results are that behind the screens low flow fields exist and sedimentation occurs. In the remaining part of the river section additional stream flow causes erosion.

The method may be repeated a number of years (Irrawaddy) to built up a flood plain gradually and narrow the river.

Vanes

There are different statements about the principles of the vanes :

(1) diversion of water flow from sediment flow

(2) generation of spiral flow.

ad1

diversion of the flows means that the upper parts of the flow with relative small sediment concentrations are directed towards the main channel and the low parts of the flow with relative high sediment concentrations are directed towards the banks.

Both surface vanes and bottom panels may be used in this way (see Fig.4.4.2-1)

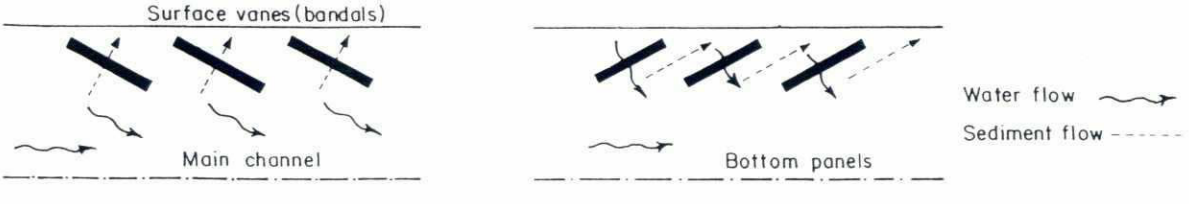

Figure 4.4.2-1: Surface Vanes and Bottom Panels

Both measures aim at deepening of the main channel and sedimentation along the banks, thus reshaping the cross-section.

ad2

The statements about the spiral flows are rather inconsistent :

- o The surface eddy with horizontal axis generated behind the bandals is the main cause of the deepening of the channel (?)
- o The spiral flow generated by the floating (towed) vanes is acting directly in the fairway
- o The concept of the Iowa vanes is different. One vane consists in fact out of a series of foils. The vanes and the nearby bank create a spiral flow (also in straight stretches)
- o Applications of Iowa vanes in river bends have the objective to create a spiral flow contrary to the spiral bend flow. The total effect is then a reduced spiral flow and reduced outer bend scouring.
- o problems about the effectivity of vanes are for instance
  - assessment of effects just after installation
  - the changing configuration affects the effectivity
  - assessment of the final configuration (is a stable equilibrium configuration possible ?)
  - the downstream effects (damping of spiral flow by viscosity effects).
- o Jan./Feb. 92 an Iowa-vane module will be made and added to the RIVCOM package (2D water/sediments : Delft Hydraulics)

4.4.2.2 River Training Strategies (Task 26 partly)

River Training Strategies are to be interpreted as a number of measures aiming at training the river over the full length. Strategies may encompass also combinations of measures, so e.g. a well balanced mix of permanent structures and dredging or bandalling.

As far as possible the Consultant will collect and review literature on worldwide experience regarding river strategies. From the Consultant's library files and technical reports the following notes are made :

(1) Europe

Review will be based on available literature dealing with : (i) History of river management in Europe and (ii) Fluvial hydraulics and river training in Europe.

In addition a study tour to Europe will be made in order to attend the 5th International Symposium on River Sedimentation from 6 to 10 April in Karlsruhe/Germany as well as to visit the Rhine and Rhone rivers and the head offices of the joint venture partners. The study tour will be joined by 2 members of the Project (H. Brühl and S.M. Mansur) and 4 members to be nominated by the Client.

The Study Tour is scheduled to be as follows :

- 6 to 10 April Symposium on River Sedimentation in Karlsruhe
- 11 to 13 April Visit to the River Rhine, Rhein - Ruhr head office and installations for flood protection and inland navigation
- 14 to 15 April Visit to Delft Hydraulics to have discussions on 2 dimensional models and satellite imagery evaluation
- 15 to 17 April Visit to Rhone river/valley and head office of Compagnie Nationale du Rhone.

Note, that the meeting on Braided Rivers (Form, Process and Economic Applications) from 6 to 7 May 1992 will be attended by a member (working in the home office) of the Project.

(2) Asia

Collected information concerns:

*	Indus (Pakistan)	:	- Control by weirs (barrages) - Main objective irrigation
*	Chao Phraya (Thailand)	:	- Concrete/steel vanes (vides available)
*	Ganges (India)	:	- Navigability of the Ganga - Master plan for navigation on national waterway (Ganga-Bhagirathi-Hooghly), August 1989 - Permanent versus non-permanent measures.
*	Brahmaputra (India)	:	- Low water bed-bandalling
*	Irrawaddy (Myanmar)	:	- Pile screens
*	Mekong		

(3) China

*	Yellow River	:	- Ref. "Taming the Yellow River by Brush L.M. et al. - Contributions of Dr. Wan Zhaohui (Member Advisory Board)
*	Yangtze River	:	- Contributions of Dr. Wan Zhaohui - Various literature sources.

* Field visit to Yellow River and Yangtze River :
  - first arrangements for a visit in the last week of May 1992, have been made
  - field visit focusses on a visit to Zengzhou (a famous vulnerable node in the Yellow River) and to the Yangtze River upstream and downstream Nanjing (mid-islands including "head" protection works).

(4) USA

*	Tenessee, Mississippi	:	- Stone vanes in lower Mississippi

* Field visit to Tenessee and Mississippi river basin has still to be prepared, but is scheduled to take place directly after the field visit to China.

(5) References

A list of references from the Consultant's library has been made on the basis of the following rivers : Brahmaputra, Ganges, Indus, Irrawaddy, Mekong, Mississippi (Tenessee), Hwong Ho (Yellow River).

4.4.2.3 Hydraulic and Morphological response to AFPM (Task 27)

Within the frame-work of FAP 22 (Active Flood Plain Management) it is being investigated whether it is feasible to "train" a river with dimensions like the Brahmaputra/Jamuna River type of dimensions and characteristics, in another way than with major river training structures like groynes and revetments on a large scale. The latter type of river training works has a number of disadvantages : they are very expensive and, in a braided river system, the individual elements are only active during the periods they are "attacked" by the river. For the larger time of their engineering life time they are laying idle, as the attack of the river is somewhere else. Hence there is some logic in trying to train such a river on a recurrent basis, concentrating the investments on location where in that particular period the major attack of the river is taking place.

The types of measures typically to be considered are recurrent measures. These measures do not necessarily have to be at a small scale, as they are an alternative to very expensive river training structures. Measures typically to be considered are amongst others :

- (large scale) dredging,
- bottom vanes, floating panels or bandals,
- closures of "aggressive channels", where a number of different techniques can be employed.

All these methods have in common that they will result in changes of the river's "regime" and hence its dimensions. Although these methods are recurrent measures, when applied on a systematic basis to these braided river systems, they will result in changes in the braiding pattern and in the dimensions of the individual channels. It is of utmost importance to predict the response of the river system on these recurrent measures to estimate the benefits to obtain on the one hand and to determine the environmental impacts on the other hand.

This Section of the Technical Report (appearance : first half of May 1992) provides a state-of-the-art in the prediction of the hydraulic and morphological response of braided rivers to human interventions as indicated above. Broadly speaking, these interventions can either be a reduction in the total width available for the river system (via the narrowing of the river by bank protection works) or remedial measures aiming at consistently eliminating the most outward channels, thus reducing the average number of channels per cross-section of a braided river system.

With respect to the latter it is appropriate to realize that a river usually tends to strive towards some equilibrium, in the case of a braided river towards a certain number of channels with definite dimensions. Recurrent measures will introduce time-dependent

behaviour as the river will continue to strive towards the 'equilibrium' state it was in before the intervention. In general however, a braided sand bed river is anyhow a very dynamic system in which many changes are taking place in a short time. This means that it may be possible to determine and describe the changes of the rive system on a statistical basis.

The structure of this section of the Technical Report on the State of the Art of River Training will be as follows:
In Chapter 2 a review is given of the imposed and dependent variables in a river system. Due attention is given to the various time scales at which this division between imposed and dependent variables have to be considered. For the present project the emphasis is on responses of the river system on an engineering time scale in the order of say 50 years. Chapter 3 gives an overview of the various types of prediction methods. It is shown that none of these methods are based on genuine physical laws as simply these laws have not been formulated until now.
Hence the relationships that are available are either fully empirical or they are based on certain assumptions ("beliefs") that cannot be verified.

In the subsequent chapters 4 through 7 the different approaches are described. Each chapter ends with a tentative application of the proposed prediction methods to the conditions in the Jamuna River. This allows, in a first attempt, to get some idea about the applicability of the various methods to Jamuna type conditions. In Chapter 8 the different approaches are discussed in some detail and mutual comparisons are made. In the final Chapter 9 a tentative selection is made of methods that can be applied to estimate the hydraulic and morphological response of the Jamuna River to human intervention. In the subsequent stages of FAP 22 these methods will actually be applied to evaluate the benefits and the effects of recurrent measures compared to major river training works using groynes and/or revetments on a major scale.

4.4.3 Selection of River Training/AFPM

4.4.3.1 General

With reference to section 2.3, the scope and purpose of the River Training AFPM Pilot Project (FAP 22) have been focussed on an "active" approach trying to divert the river away from the threatened reaches and in due time, to change the characteristics of the river. Due to the relatively unpredictable behaviour of the braiding Jamuna river (only 1 to 2 year predictions seem to be possible) the classical approach to narrow the river bed by applying "hard" river training works (e.g. groynes, bank protection) on a large scale has been excluded at present. The risk that such permanent structures may lay idle for quite some time (e.g. due to channel shifting) is too high. Therefore it is decided to consider the possible technical feasibility of a more flexible approach by applying "soft" recurrent measures on a large scale. These measures should aim at the reduction of the braiding index (given by the number of channels in a cross section) which finally may result in a rather stable river with

a multi-channel planform. The morphological behaviour of such a multi-channel river might be more predictable than the present braiding behaviour. At that moment the application of "hard" river training measures can be considered again. However, the present FAP 22 project aim at the flexible approach to tame the Jamuna river. This does not mean that the application of individual "hard" (permanent) structures are excluded from being considered in this flexible approach.

In the following sections a "straight forward" procedure will be described in order to meet the objectives as presented in the tasks 28 through 30 (see Annex II).

4.4.3.2 Formulation

This section is mainly related to the tasks 28 and 29 on the basis of the following aspects :

(1) A basic schematization of the threatened reaches of the Jamuna river

(2) A schematic presentation of the various river training measures to divert the river away from these threatened reaches.

(3) A first set up of a methodology for comparing the various measures on their effect (including reliability and sustainability) and cost effectiveness.

(4) A first set up of a methodology for the determination of alternative strategies in order to divert the river away from problem spots. This methodology should give insight in the number of measures for a well balanced mix and in the time to be active after implementation.

ad(1) Basic Schematization of Threatened Reaches

The main problem of the Jamuna flood plain concerns bank erosion along areas of importance (outer flanks attacking the embankments, char erosion, etc.). This bank erosion problem is schematically presented in Figure 4.4.3-1.

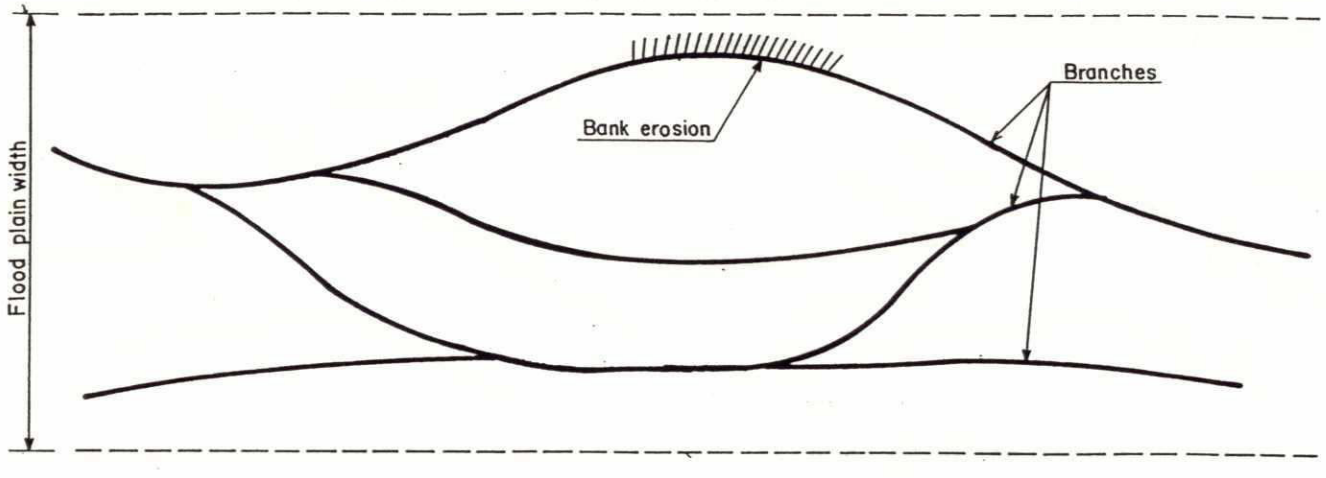

Figure 4.4.3-1: Typical Bank Erosion Along Jamuna

ad(2) Schematization of River Training Measures

A number of measures can be considered in order to solve the problem of bank erosion along the various threatened reaches. On the basis of Figure 4.4.3-1 a following figure has been sketched indicating some possible training measures (see Figure 4.4.3-2) :

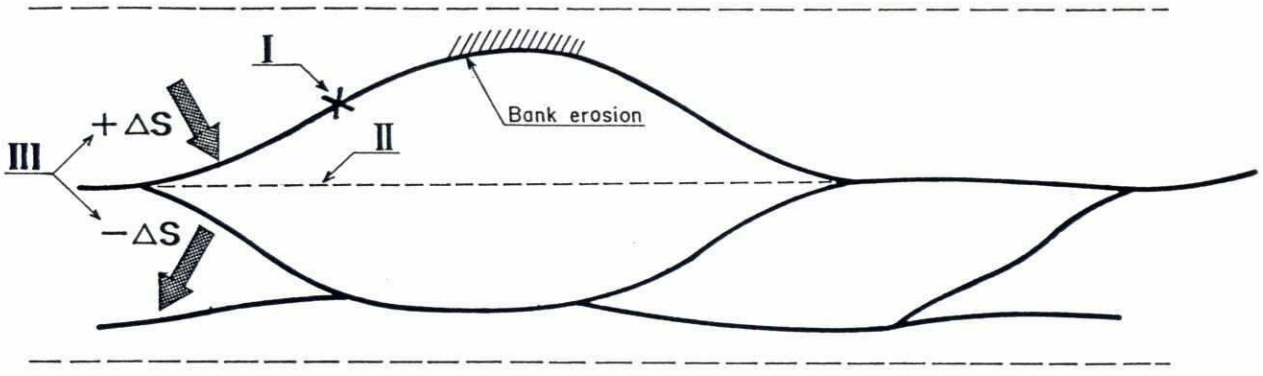

Figure 4.4.3-2: Some Training Measures

(I) Closure of problem channel; note, that as a short term effect the water levels, bottom levels and widths of the adjacent reaches will be affected.

(II) Dredging of a lead channel; note, that the dimensions of the lead channel will affect the sediment and water discharge distribution at he bifurcation point. Consequently optimum dimensions have to be determined to divert the flow from the problem branch.

(III) Dredging to induce the sediment discharges in the branches in such a way that the problem branch will be silted up (during one flood season).

In Figure 4.4.3-3 some training measures based on the use of groynes, bottom and/or floating vanes and bandals have been presented schematically with locations near to a bifurcation point. All these measures have in common to induce the sediment discharge distribution and to increase the flow resistance.

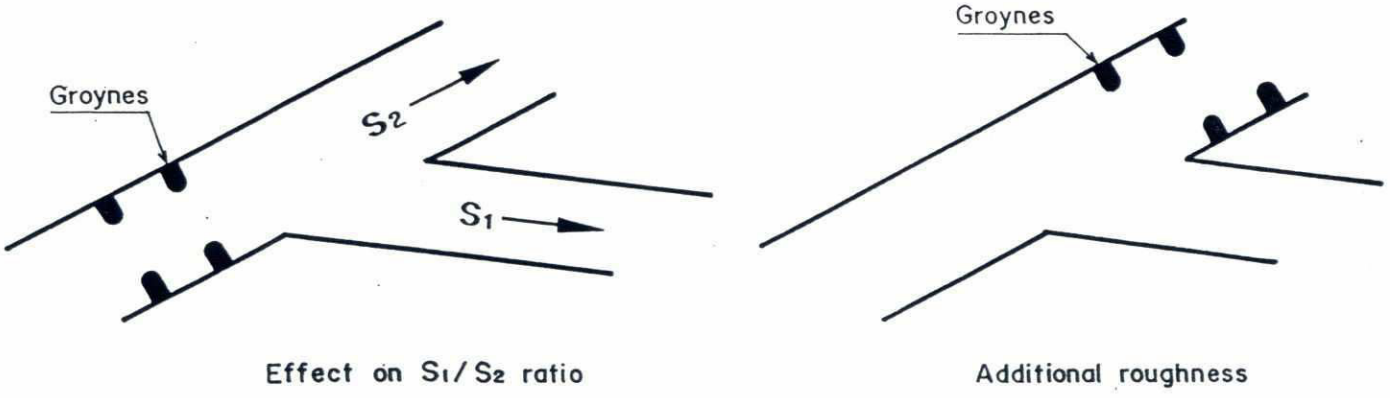

Figure 4.4.3-3: Additional Training Measures

Note, that all these river training measures might be beneficial for the long term approach to achieve a more stable Jamuna river with lesser braiding index. On the other hand the short term effects on water levels, bottom levels and widths of the adjacent reaches may not lead to unacceptable situations (see Section 4.3.3.3).

ad(3) Effectivity and Cost Effectiveness of Measures

As shown in the preceding schematization of river training measures (ad 2) one of the main results of the measures should be the ability to divert the sediment discharge at a bifurcation point. On the other hand the ability of measures to divert the flow (caused by additional roughness, spiral flows, etc.) is also of importance. However, for the time being, the ability of measures to divert the sediment discharge is supposed to be the leading phenomenon on which the methodology will be based for comparing the various measures on their effectivity and cost effectiveness.

According to the first results of the state-of-the-art (see Section 4.4.2) the effectivity of a river training measure can be defined as the degree of control to regulate the sediment discharge in a channel. From this point of view it is obvious that the effectivity of a measure directly is related to reliability (mechanical fall outs due to age of equipment, fuel shortages, logistics, etc.) and sustainability (accuracy in positioning vanes and/or bandals, reduction by propagation of sand dunes, etc.). Based on these considerations as well as the results of the state-of-the-art and the results of the field visits to China and USA the following output, as presented in Figure 4.4.3-4, will be striven for :

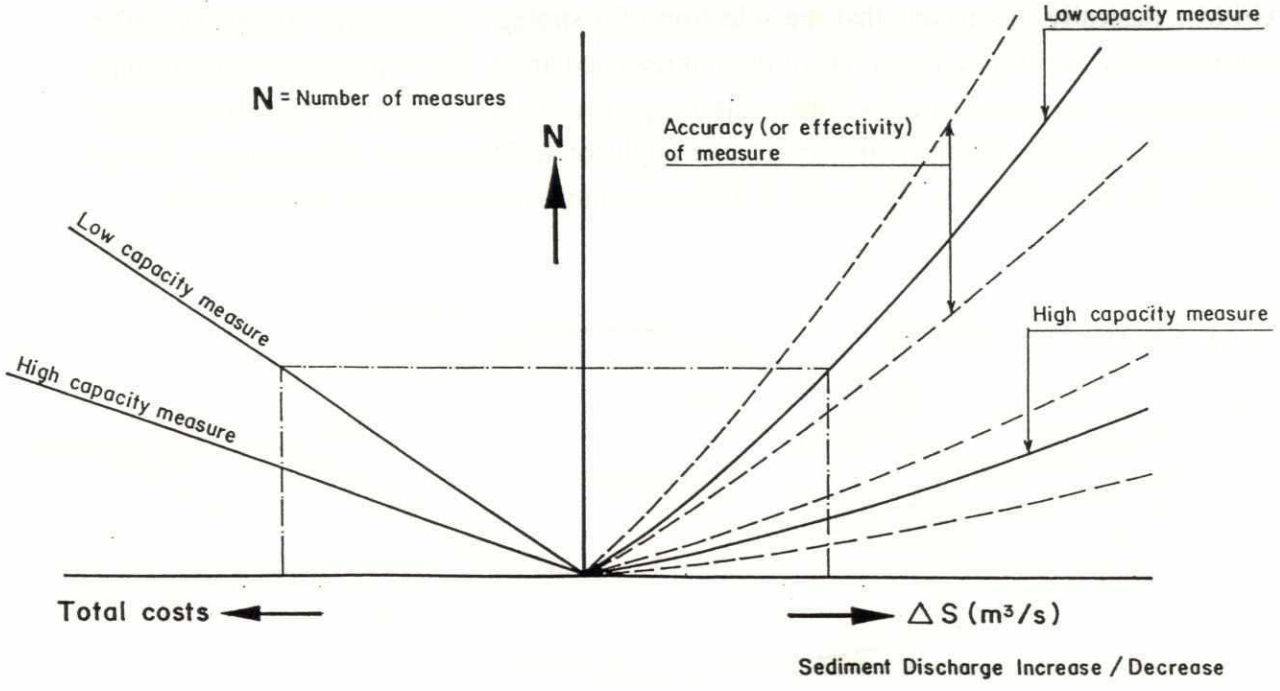

Figure 4.4.3-4: Effectivity and Costs

Figure 4.4.3-4 is related to the effectivity and costs of measures (e.g. dredgers, vanes, bandals, etc.). From experience in Bangladesh and the state-of-the-art it should be possible to make an empiric relation between ΔS (rate of sediment to be dredged) and the number N of measures. Normally data will be found for ΔS quantities smaller than those needed for Jamuna conditions. This means, that extrapolation (or scaling) of the results will be necessary. It is obvious, that the accuracy of such figures depends on the amount of data and on the measure itself. The accuracy of a dredger might be supposed to be higher than the accuracy of other measures (such as : bandalling, vanes, etc.). On the other hand the effectivity of a measure is directly related to the accuracy as shown in Figure 4.4.3-4. Once such a relationship between the number N (or a mix) of measures and ΔS has been established, it should be possible to determine finally the costs of a certain strategy (which is defined as the number of one or more measures) as this is indicated in the left graph of Figure 4.4.3-4.

The methodology as presented is supposed to be a methodology to achieve the objectives as described in tasks 28 and 29 (partly).

ad(4) Alternative Strategies

As described in task 29 (see Annex II) the strategies can consist of :

- permanent structures
- recurrent measures
- a combination of both

They all aim in principle to divert the river away from threatened reaches (e.g. bank erosion) as this might be the general set up for the approach of the Active Flood Plain Management (AFPM). Basically this means that the selection of a strategy is subjected to the particular features nearby the bifurcation points of these threatened areas. These particular features may be for example : (i) the actual sediment discharge distribution (S_1 and S_2) in the branches downstream the bifurcation point, or (ii) the angle of incidence (ϕ) of the major branch upstream the bifurcation. In figure 4.4.3-5 these examples are indicated schematically.

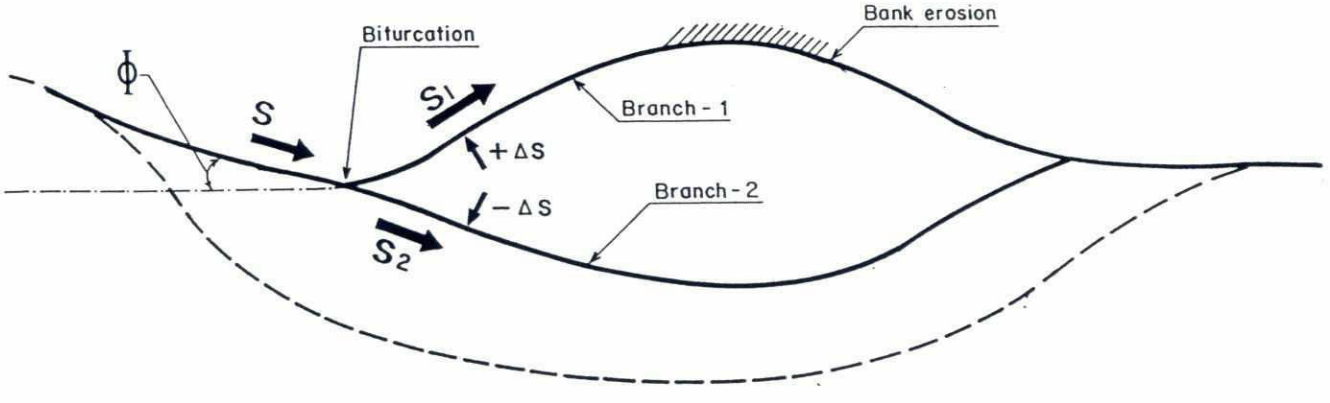

Figure 4.4.3-5: Typical Problem Area in the Jamuna Flood Plain

In essence, each strategy should be able to increase the sediment discharge in branch 1 and to decrease this respectively in branch 2. The increase and/or decrease of sediment discharge is indicated by ΔS in Figure 4.4.3-5.

Corresponding to the methodology as described for effectivity and cost effectiveness (ad 3) a following methodology will be indicated here after on the basis of using basic Mike 11 calculations in order to get insight in:

- the total amount of Δ S to divert the sediment discharge aiming at the closure of branch 1 (see Figure 4.4.3-5) within a period of 1 to 2 years
- the time needed for closure of branch 1 on the basis of various alternative strategies; these calculations depend on the results of the preceding step (see ad 3 : costs and effectivity).

As a first step a number of calculations with Mike 11 will be made on the basis of one single bifurcation (local model) and using hydraulic boundary conditions as to be collected from the field and/or the existing General Mike 11 Model for the Jamuna river. Depending on a selected scenario (time schedule) for the river training strategy to be applied, the bed level raise in branch 2 (see Figure 4.4.3-5) can be computed as a function of the time. Note, that such a local model can cover a reach of 15 to 40 km along the river and that the calibration of such a local model is limited to one or two years due to the fast shifting character of the Jamuna river. A first schematization of the output to be expected from these calculations is indicated in Figure 4.4.3-6.

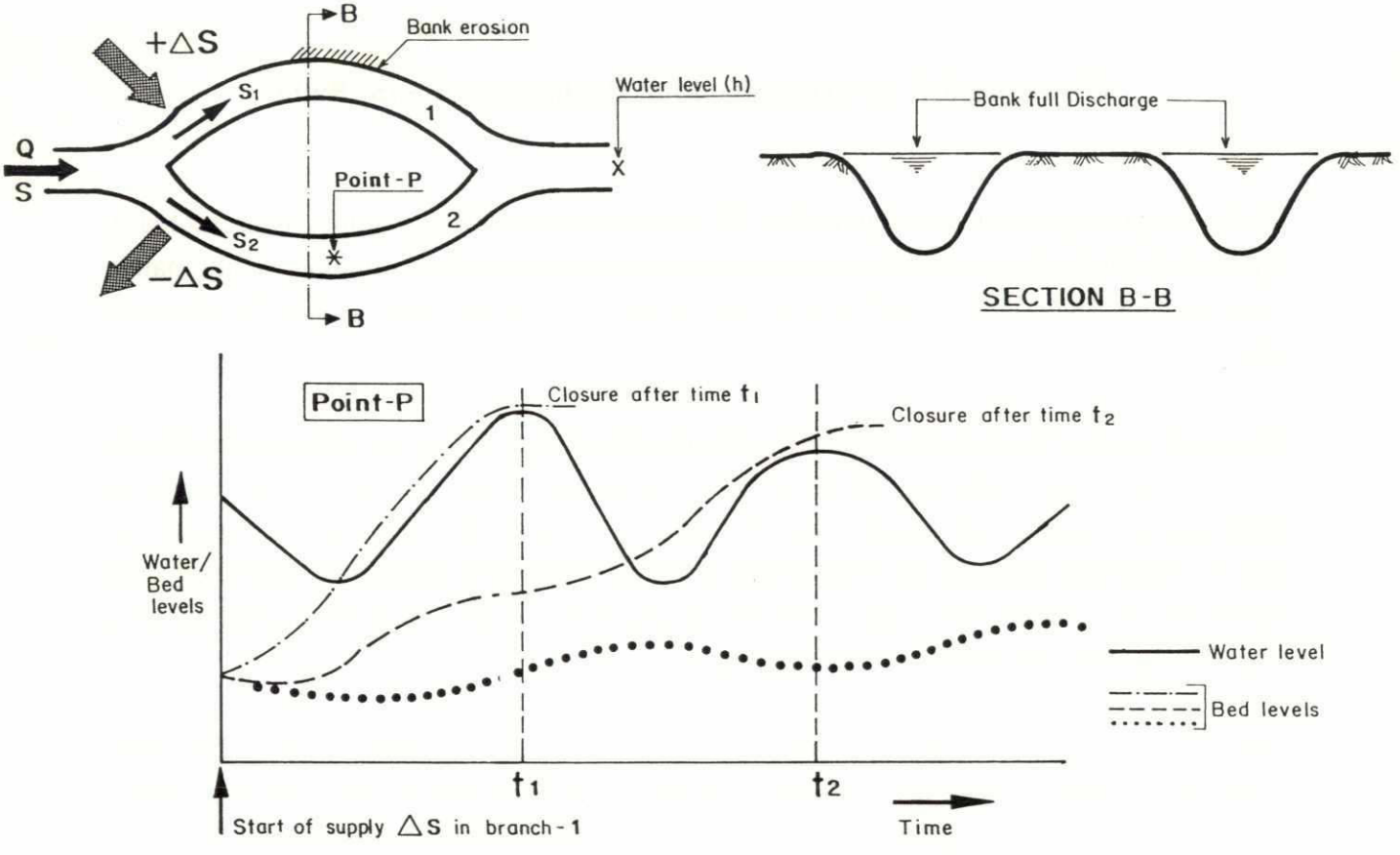

Figure 4.4.3-6 Local Model Output By Varying ΔS

Depending on the time required to complete the closure of branch 1 an optimum value of ΔS can be derived from Figure 4.4.3-6. On the other hand it may be obvious, that ΔS strongly depends on the original sediment discharge distribution over the branches (to be expressed by the ratio S_1/S_2) as well as the bankfull discharge in branch 2. By varying this input in Mike 11 the result may be as presented in Figure 4.4.3-7

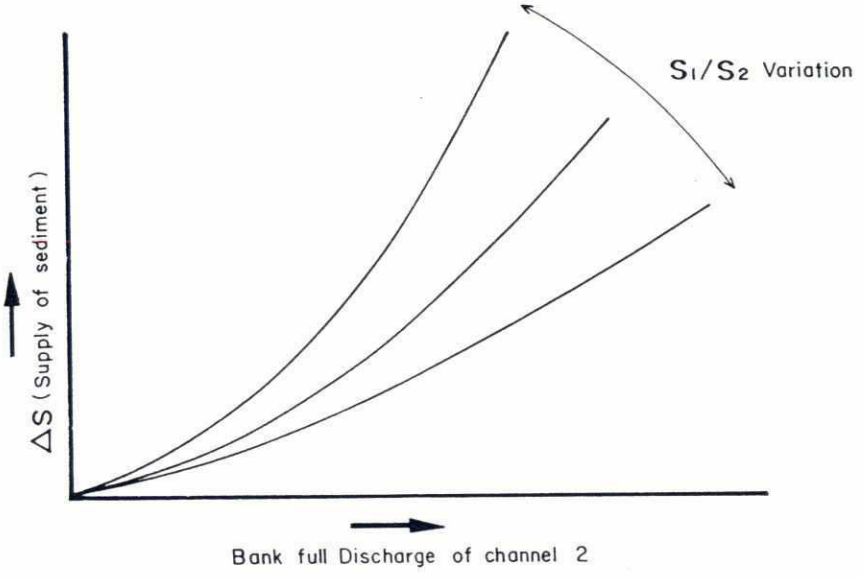

Figure 4.4.3-7: ΔS versus Bankfull Discharge and S_1/S_2 Ratio

Using output as presented in Figure 4.4.3-7 in combination with the output as presented in figure 4.4.3-4 (costs and effectivity) one should be able to formulate a number of alternative strategies for River Training and Active Flood Plain Management (Ref. to Task 29 of Annex II).

However, it may be realised that the described methodology serves as a first set up for the analysis. At a later stage of the project the schematization of the local model might be improved by adding more nodes and small branches. On the other hand the consequences of the river training measures (short term/long term) have also to be considered. The short term effects (such as: water level rises or lowerings) have been foreseen to be considered by using the General Mike 11 Model for the Jamuna River.

According to the presented methodology using local Mike 11 models, FAP 1 has made dredging simulations with a 2 D-depth averaged model. The first results show that with a moderate amount of dredging (1 million m^3) in the low water period a significant change in channel development can be obtained. Therefore, it might be useful to make use of these 2

D-calculations, which strongly will depend on the developments with the 1 D-Mike 11 model. Possible decisions regarding the use of 2 D-Models can only be made at a later stage of the project.

As described under task 29 (see Annex II) the formulation of alternative strategies should be also subjected to "non-engineering" aspects. In this respect reference is made to the Sections 4.6 to 4.8.

4.4.3.3. Evaluation and Selection

As a following step in the analysis the FAP 22 approach it is envisaged to evaluate the various river training strategies, formulated on the bases of the methodology as presented under 4.4.3.2, on their short term and long term consequences.

The short term consequences are mainly related to the specific sites, where separate training measures will be performed. These consequences are mainly the water level rises or lowerings and the induced widening of channels (bank erosion) after closures of problem- and/or outflanking channels. They will have their impact on non-engineering aspects, such as : socio-economic aspects, environmental, legal and institutional aspects, for which reference is made to the sections 4.6 to 4.8.

As far as the technical feasibility of river training strategies is conserved, the short term consequences will be determined using the General Mike 11 Model for water level rises and/or lowerings. On the basis of some empirical knowledge on bank erosion the short term effect on channel widening will be indicated as accurately as possible.

As it might be observed, the short term effects can have some local negative effects, while at the other hand the long term effects might be beneficial with respect to the overall flood plain width reduction.

On the basis of preliminary predication methods (see Section 4.4.2) the morphological response of the Jamuna river subjected to river training measures on a wider scale will be evaluated. Note, that these predictions will be made to assess the long term (a few generations or even centuries) effects for the Jamuna rive planform. Therefore, it is of utmost importance to find a satisfactory equilibrium between the (possible) negative short term effects and the (in) accuracy of long term predications, which might be supposed to be beneficial for the Jamuna flood plain.

For the selection of most promising strategies a multi-criteria ranking system will be used in accordance with the task description of Task 30(see Annex II).

4.4.4. Pilot Project

4.4.4.1 Medium-term plan

Referring to the methodology as presented in the preceding Section 4.4.3 the results of this methodology have to be considered as a rough estimate for the technical (un)-feasibility of river training strategies for the Jamuna river. This first order rough estimate has to be based on the extrapolation (or scaling) of the existing experience from all over the world to the actual Jamuna conditions. When these estimates indicate the technical feasibility of a selected river training strategy (or strategies), a next step has to be made to develop a medium term plan (see Annex II, Task 31). Although, at present no details on the medium term investigations and extended trials can be given, some preliminary remarks are made.

Subject of this task should be the refinement of the preceding analysis with respect to costs (investments, etc.) including a reliable planning basis for the long and medium term. Whenever these tasks have to be performed, only a refinement at a prefeasibility level can be envisaged due to the restricted time and budget limits of the Planning Study Phase.

It is obvious, that the non-engineering aspects have also to be considered, whenever a refinement of the preceding analysis has to be made. However, from this point of view the prefeasibility level as an utmost result of this task has been underlined once again (see also sections 4.6 to 4.8).

4.4.4.2 Pilot Project

Considering the objectives as defined for tasks 32 and 33 (see Annex II) the same preliminary remarks as for the Medium-term plan have to be made.

If river training with relatively light measures appears to be technically feasible on the basis of the rough estimate methodology for the selection of river training also a refinement with respect to costs, material, equipment time schedules, etc. should be made. In this respect the refinement can only be of a prefeasibility level due to the restricted time and budget limits of the Planning Study Phase.

4.5 APPLICABILITY OF JAMUNA EXPERIENCE TO OTHER RIVERS IN BANGLADESH

According to the Terms of Reference the Consultant has to investigate the applicability of the experience to be obtained to other rivers in Bangladesh. The Consultant intends to do this by proceeding in the following way : First the river characteristics of the main rivers in Bangladesh will be inventoried, based on existing information and concentrating on hydraulic and morphological data like discharges, planform, water level slopes, widths, water depths, bed material size, etcetera, but also considering socio economic and environmental aspects. Next a comparison will be made between the characteristics of the other rivers and the

Jamuna River, and based on this conclusions will be drawn as to the applicability of the Jamuna experience.

Already in this stage some conclusions can be drawn, partly based on the experience of the Consultants' staff in other projects in Bangladesh :

(1) The hydraulic and morphological conditions in the Jamuna River are comparable to the conditions in the Padma and the Lower Meghna Rivers, although it seems that the width of the Padma River is relatively constricted near Padma.

(2) The Jamuna experience is not applicable for the Upper Meghna River, because this river (other than its braiding planform does suggest) is essentially a meandering river in a river bed that is too spacious for its present discharge variation.

(3) Nevertheless much of the lessons to be learned from FAP 21 are applicable to any other river (in Bangladesh) as they concern the possible ways of failure of a river "defence" works.

4.6 ENVIRONMENTAL (ECOLOGICAL) ASSESSMENT

4.6.1 Introduction

The training project of the Jamuna river should not only prevent the damaging effects of floods (uncontrolled river channel displacements), but also conserve as far as possible their beneficial effects. The aim of this evaluation is therefore to take environmental aspects into consideration, in order to foresee the consequences of the project, before these become irreversible.

The environment assessment includes both of the ecological and human aspects in order to:

- analyze the natural resources and wealth within the project area
- examine the environmental linkages
- define the interactions with people
- look to the effects of possible past actions
- predict how far the project could disturb the environment "functioning" and the most obvious consequences, positive or negative, which could be generated
- see the way that the negative effects could be avoided, reduced or compensated; see if, considering environmental problems, we should find several alternatives and the best way to achieve the objectives of this project.

4.6.2 Methodology

Programme

The environmental assessment of the FAP 21/22 must give some guidelines for the technical project in the aim of preserving as much as possible the natural and human environment.

Therefore, to get an as complete as possible idea of the environment "functioning", the environment survey will have to go through the following stages:

(1) Ecological state of the art
(2) Underlining of the sensible points
(3) Initial state of environment including socio-economic, agricultural and human points of view
(4) Environmental constraints caused by River Training/AFPM measures
(5) Recommendations.

The first mission of the environmentalist will be concentrated on the two first stages. Almost all the social, economical and agricultural aspects are reviewed by the socio-economical and land reclamation specialist, the environmental part therefore has rather to be understood as an ecological survey as a first approach.

Actually, most of the subjects that will be reviewed refer to ecology subjects: flora, fauna, fishes, water quality, ground water levels, etc. They will be completed as much as possible with some other aspects like health problems, microflora and microfauna, uses of plants. At the end of this part, as far as the system "functioning" is understood the most sensitive points of this area and the degree of interdependence of the ecosystem components should be explained.

The three last stages will be realized during the second mission of the environmentalist, in cooperation with the socio-economic and the land reclamation teams, in order to achieve a synthetic view of environmental problems. This will include for example pedology, agricultural practices, fodder problems, fishing activities, social characteristics as well as the biological point of view. Considering all these aspects together, the interactions of human and natural environment will be identified.

After that the environmental results have to be adjusted to the results of the technical project, issued from the interim report. A synthetic description of the possible impacts on the environment, negative or positive, will be done. Finally, identifying all sorts of impacts on the natural environment and consequently on the human population, some recommendations will be given in the final report : means to avoid or mitigate some effects, advices to compensate the inevitable impacts, defining some recommendations to improve environment.

Data Collection

As environment is a new science in Bangladesh, there are very limited data base: for either

no study has been done, or data are not published, or they are not accessible. Hence the whole basic work has to be done in order to realize realistic and efficient environmental impact assessments.

No local data on the Jamuna natural environment are presently found. Since the present subject is not to realize an impact assessment, but rather to develop environmental guidelines for the pilot project, no field measures are envisaged (they should however be considered in case the project continues).

At present, the Environmental Assessment depends fully on some existing data:

- First looking to general and statistical data about Bangladesh (which are really scattered) and try to get some adapted informations from them which are available with NGO's, universities, FAP, Public Organizations.
- Secondly, using other project's field investigations. Some other FAP projects are now starting with long term field measures and some data should be provided by them around the end of the year, especially from those including the Jamuna as a part of their study area.

A review on the actual state of the data to be obtained from FAP projects is as follows :

FAP 16 :
- fisheries : a report should be done in April '92.
- charlands : a field investigation (questionnaires) based on the GIS results is going to begin. A preliminary literature review has been done.
- some maps issued from the GIS may be useful.

FAP 2 :
- a detailed field investigation is starting on two selected site of which one is in Gaibandha. The EIA report is expected by December '92. Some data about water quality, aquatic and terrestrial flora and fauna should be available at the end of the monsoon.

FAP 3.1 :
- three or four spots of water sampling are situated on the Jamuna river, of which one in the fertilizer industry's effluent (SHARIAKANDI : left bank). Consequently, water quality data should be available in one or two months. Statistically, they are of course not valid, but as no measures are yet known, they could give a general and relative idea of the water quality of the Jamuna river.

To complete this data review some information will be added as a result of different field trips on the Jamuna river. Several sites, dispersed along the right and the left banks of the Jamuna will be visited. Field investigations will provide a sampling inventory of aquatical and terrestrial flora and fauna in broad sense. This will be completed with informations from meetings with the local people.

4.6.3 Preliminary results of the Environmental Assessment

4.6.3.1 Actual Status of Active Jamuna Flood Plain (AJFP)

Operationally, the project area of the active flood plain of the Jamuna river is confined within the embankments on either banks, which includes in-channel flood plain, charlands, and strips of land between bankline and embankments. (see Figure 4.6.3.1-1)

Land: The AJFP is mostly composed of unstable chars and multiple channels of the Jamuna river. Chars frequently change their shape, size and location each year during seasonal floods: new chars are formed and previous ones eroded. The elevation between low and high points of these accretions may be as much as 5 meters and with the higher levels on either bank can be upto 6 meters. The deposits are mainly sands with silts or clayey-silts. Although the Jamuna channel is extremely braided, there are several stretches with no chars.

The AJFP area may be classified as a single wetland, in the rainy season, which includes the Jamuna channel and seasonally flooded levee-land on either banks of the river. The areal extent of this wetland is confined only to the multiple braiding channels and a few low lying areas with stagnant water within the main Jamuna channel during the low water period.

Climate: The climatic and hydrological regime of the AJFP is dominated by the influence of the Himalayan Ranges to the north and the monsoon system operating in the Bay of Bengal. The climate is sub-tropical with hot summer and cool winter.

The summer covers the period from March to June with average temperature around 34°c. The monsoon spreads over the months of June to October. More than 80% of the total annual rainfall occurs during the monsoon months.

November to March experiences winter season with mean temperature is about 18°c. The average winter rainfall is less than 10 cm.

Soils: The soil type of the region is noncalcareous alluvium (enturic fluvisols) comprising recent deposits of the Jamuna river. This is mainly grey or grayish brown, sandy or silty and neutral to moderately alkaline. Thick silty deposits of this alluvium suffers from low permeability and poor aeration. This soil type is found mainly in the chars and diaras of the Jamuna river. The status of macro-nutrients (primarily nitrogen), micro-nutrients (particularly zinc and sulphur) and organic matter of the soil is not known. Soils classification will be covered by the Land Reclamation Study.

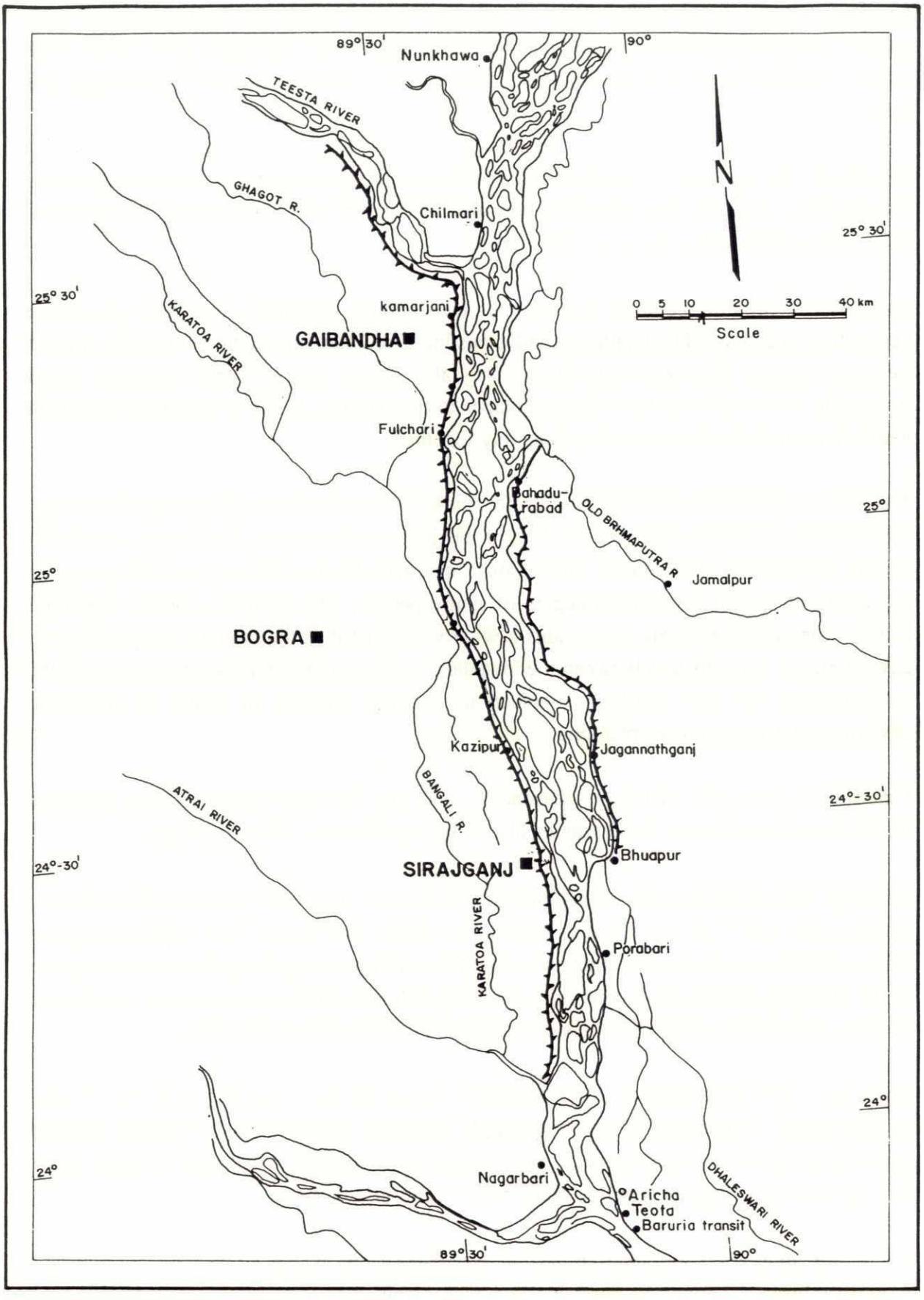

Figure. 4.6.3.1-1 : The Project Area (Jamuna River)

Habitats: The ecology of the AJFP involves the interaction between a large number of faunal and floral species and a range of different habitat types. The habitats include both aquatic and terrestrial environments ranging across land levels and landscape qualities. The major habitats of the AJFP are charlands, homesteads, wetland-lowlands-waterbodies, and fields.

Charlands have distinct successions of natural and managed vegetation, settlement patterns and landuses. Besides, they are also important habitat for birds and livestock. No surveys have been carried out in these charland areas.

Homesteads provide the home and the main environment for people, livestock, greenleave vegetables, and trees. The habitat provides nesting, breeding and feeding sites for a host of important insects, birds and other fauna. They also shelter a lot of weeds which are useful for people. Some of these have direct linkages to the ecology, health and productivity chain which surrounds the homesteads and society together.

Wetland, Lowlands and Water Bodies form vital link in the chain of landscape formation, maintenance of species diversity, cycling of nutrients, sustenance of food chain, and in the control of pollution. The aquatic and seasonal terrestrial flora and fauna which they support are the basis of the survival strategies of many people. The wetlands contain important habitats for migratory birds. It contains a wide variety of differing aquatic or semi-aquatic environments. The linkages between the lowlands, wetland and water bodies are vital for the understanding of their working together to provide services in order to appreciate environmental management planning.

Grasslands over the charlands seasonally, and are the main cattle grazing resource. Extensive colonization of these grasses also helps stabilization of the charland.

Ecology: Bio-geographically areas alongside the Jamuna river have already suffered for the Brahmaputra right bank embankment built during 1960s. The natural flora and fauna habitats have been taken over for cultivation and settlement, or have changed significantly in response to the changing hydrological conditions; hunting also affected many species of which birds of prey, water fowl, certain reptiles and amphibians are worth mentioning.

There are 5,000 floral species in Bangladesh of which the exact number in the AJFP areas is not known. Vegetation of the homesteads and field habitats can be roughly mapped anytime through rapid field surveys. But various flora growing in wetland including chars having seasonal life-cycle requires much work and time to enlist.

There are about 660 avifauna (birds) in Bangladesh, of which some 110 resident and migratory birds are found in north-western region; but there appears no record as to their types, number and distribution in the AJFP areas.

About 200 species of mammals were known to line in this part of the world during the beginning of 20th century, and currently it is less than 100 species. The primary impacts were seen in the floodplain. The present status of mammals in terms of their species, number and distribution along the Jamuna floodplain is not known.

There are 19 species of amphibians, 150 reptile species (including 31 turtles and tortoises), 18 species of lizards and 78 species of snakes are currently known in Bangladesh (some are predatory or act as biological pest control). But there is no counts or record of their types and distribution along the AJFP.

There are 260 freshwater species of fish, of which some 200 species are found in the Jamuna floodplain and other areas of the North-Western regions. Of the total 110 species are marketed and another 40 species are through to be of local economic or social importance. Fish in ecological terms sit at the top of aquatic food chain. Through their feeding habits fish controls aquatic weeds, secondary disease vectors and crops pest. They are the vital link in the food chain between rivers and floodplain, and the main source of protein for the rural millions. There have been some works on fish types, migration, spawning etc. but area-specific information particularly of the AJFP has not been published.

Fungi plays a vital role in decomposition and production of plant nutrients; it helps building healthy soil environment. Information of fungi and insects is critically lacking for floodplain and wetland.

The primary basis of the food chain and nutrient cycle is controlled by micro-organisms of terrestrial and aquatic habitats. Works on micro-fauna (zooplankton) and micro-flora (phytoplankton) in aquatic ecology of wetland, rivers and flood deposits are completely lacking and information related to micro-organisms of the AJFP is almost nil.

The preceding discussion is attempted to surface few parameters for its sound assessment in relation to physical attributes, habitat and ecology; but data on their account are very sketchy, inadequate or totally absent. The situation demands undertaking of field trips and data collection from different organizations in order to make a reasonable assessment of the environment. The recommendations about environmental risks will be given subject to : first, the degree of advancement of the technical project, secondly the availability of environmental regional data.

4.6.3.2 Sensitive Points

The project takes place in an area where species and people are adapted to the wide variations of hydrologic conditions. The interactions between the ecosystem components are so close that if one of them is modified, the repercussions will be felt at different levels. Looking to Figure 4.6.3.2-1, we can see for example that an increasing or a decreasing of the algae population (microflora) could influence water quality, microfauna, fishes,

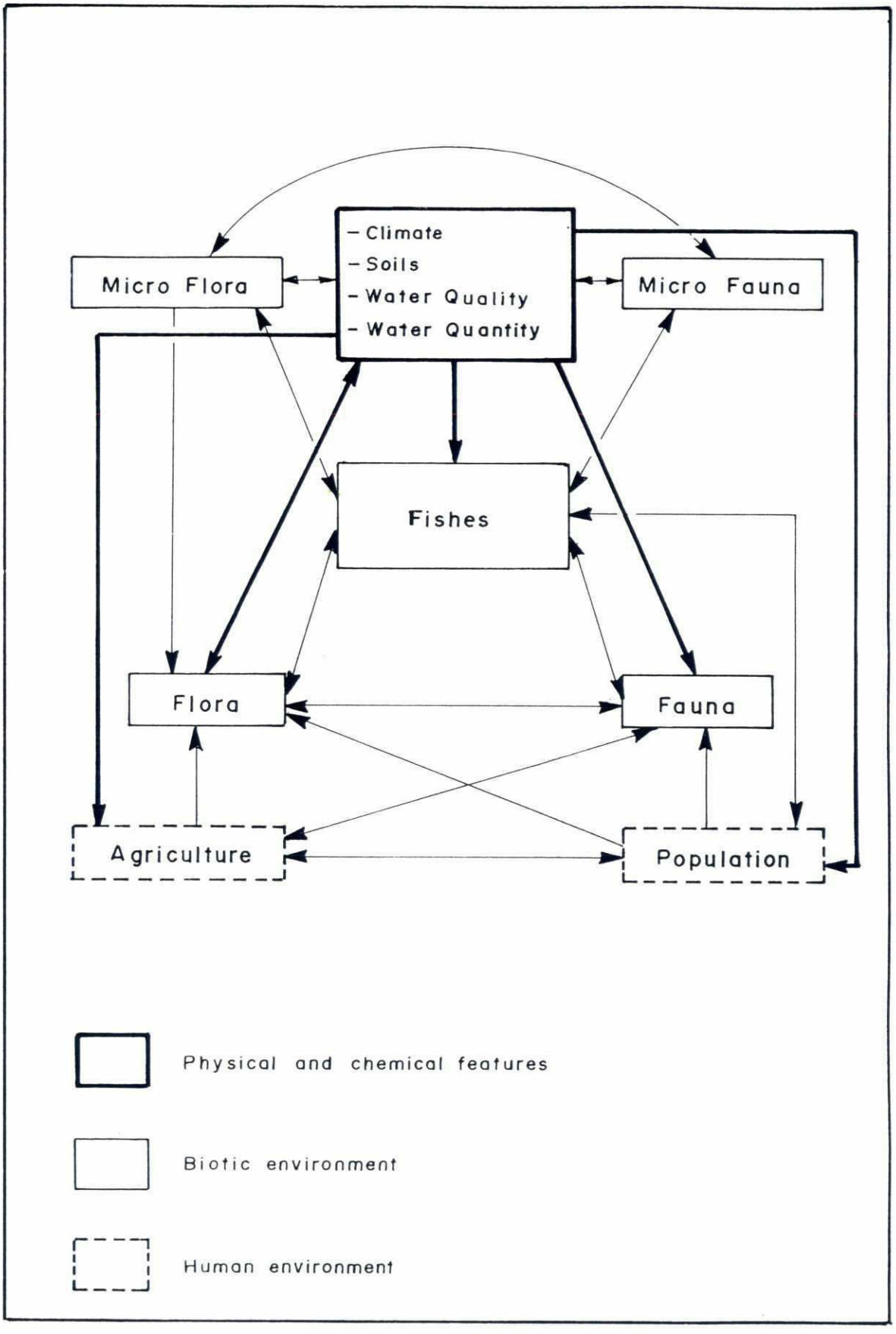

Figure 4.6.3.2-1: Environmental Interactions

birds, fishermen, etc. In some particular cases, simultaneous modifications of different environmental factors being combined, can have a synergetic influence, which is difficult to foresee.

It is particularly important that in countries like Bangladesh where the rural population is so dependent on the natural environment, much care has to be taken for these interrelations and the indirect perturbations of a project on the human population in connection with economic, social, or health effects. Considering this complicated system, we can easily guess that the input of an exogenous element (construction works) will probably have consequences, positive or negative, more or less important, on one or several components of the ecosystem (including people). Due to this complexity and the weak state of knowledge on natural environment in Bangladesh, it appears to be hazardous to foresee the possible chain of reactions that could follow an artificial intervention (direct or indirect impacts, long and short terms effects).

Consequently, the Environmental Assessment will at present be restricted to point out the sensitive points of the environment, particularly those which interfere with the human population. The Environmental Assessment will also include as far as possible the identification of the works that could disturb these sensitive points and the interrelations, entering exogenous factors.

Considering the complexity of the ecosystem interrelations, every small component may be very important, such as a chain link. However, the most important ones are those which are directly related to people's life :

Flora: As the riverbanks of the Jamuna are either intensively cultivated, or greatly eroded, only a few of natural floral species are surviving in this area. However, weeds and natural flora should be preserved as much as possible due to: (i) conservation of the floral biodiversity and the genetic potential; (ii) their more or less important role in the ecosystem; (iii) the use that they may have for people (fodder, medicinal, nutritional, fuel, etc.). For example, we must have interest to medicine plants to support health care in rural regions.

As one of the embankments and river training aims is to gain stable surfaces to extend cultivation, the direct consequences on flora will be a reduction of natural areas and an increasing of weeds control.

The natural flora, as well as the agricultural species, will also be sensitive to water-level variations in the channels, impacts of works like dredging, pollution, rhythm and importance of floods, ground water levels, modifications in fauna communities, etc. These factors alteration could affect photosynthesis, water demand, dispersal, range of vegetal communities.

Fishes: We actually do not know much about the ecological requirements of fishes in

Bangladesh like their food habits, reproduction periods and areas, rhythm and length of migration, number and space repartition of each species. Some general statistical data are available at a national scale, but until now no local long term survey has been carried out.

However, since it is known that fish life depends on many factors: water quality, hydrology, microflora and fauna, vegetation, therefore, a modifi-cation of the hydrologic regime and mostly the flood control would have direct and indirect consequences on the fishes population composition. Any alteration of the water flow, rhythm and length of floods, banks management, could affect or modify the composition of fish population: number of species, age classes, total quantity, relative proportion of each species, space distribution of species.

As an important part of the human population depends directly on the fisheries, for example for : proteins, oil, vitamins and of course money, a main concern is the maintenance of the fishery resources.

Water Quality and Quantity: Water quality will be observed as a decisive factor regarding to pollution, health and fertilization. No data are available on water quality at the present time. Therefore, it is through other FAP fields investigations (restricted samplings) and probably through interviews with local organizations (NGO's, health centers, departments of environment of BOGRA) that the interpretation will be made.

Pollution can be of three sorts : chemical, organic or physical :

- chemical pollution may come from industrial origin (fertilizer industry of SHARIKANDI) or from agro-chemicals use (pesticides, herbicides and fertilizers). Which should increase with largest dispossibility of cultivable lands.
- organic pollution comes essentially from the input of organic matter and from the result of chemical pollution (fertilizers). Which increases the microorganisms production.
- physical pollution can be induced by the raise of the suspended matters concentration due to dredging works, or to water velocity variations.

The potential influence of the River Training/AFPM Pilot Project on each type of pollution needs to be evaluated. Then the consequences of pollution on natural environment and health should be identified.

As a result of River Training and AFPM, more land area is expected to be reclaimed for human use. This will give rise to uses of more agro-chemical as well as the amount of sewage and waste affluent within the AJFP areas. In turn, this will increase river water pollution resulting in the low availability of oxygen and thus affect fish growth.

The sanitary role of water appears under two aspects : drinking water and water diseases. A quantified study of these problems seems to be difficult, but the consequences on health of water quality variations should be determined.

The fertilization role of flooded water has not been proved by the moment. Nutrients contents of water has to be estimated in order to evaluate the role of floods and the consequences of river training on fields fertilization.

It is observed that areal cultivations were situated in small depressions where alluviums should have been deposited. As a result of the River Training and AFPM, the river might attain higher stage during floods due to the reduced width of the active floodplain area. On the other hand, river stage may decrease during the low water period. In general it might be expected, that due to the river training works, there will be a substantial increase in the hydraulic depth of the channel thus forcing the stage to go down. As a result, the local water table will also fall affecting not only the existing extraction of water for domestic use through tubewells but the withdrawal of water for irrigation through shallow tubewells of the adjacent areas. Magnitude of those affects are predictable once the results of the technical study on River Training and AFPM will be specified.

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4.7 SOCIO-ECONOMIC AND INSTITUTIONAL ASSESSMENT

4.7.1 General

Since no explicit socio-economic input was expected from the project according to the Terms of Reference the Socio-Economic Assessment has been introduced by the Consultant. A first approach to it is described in the Task 12 of the Consulting Agreement, c.f. Annex II.

The Consultant's socio-economic team consists of

- an expatriate Socio-Economist and Institutional Specialist
- an expatriate Economist
- a local Socio-Economist
- a local Land Acquisition Specialist
- a local Economist
- a local Legal Advisor.

That team is closely related to the land reclamation group consisting of

- the expatriate Land Reclamation Expert and
- the local Land Reclamation Expert.

In the Inception Phase, the socio-economic team undertook a thorough revision of the task descriptions as well as the main interlinkages between different tasks on socio-economic matters.

The different tasks the socio-economic experts are in charge of or will be involved in are listed below in ranking order :

(1) Main tasks specifically under the responsibility of the socio-economic experts :
- Task 12 : Socio-Economic Assessment
- Task 34 : Proposal of Institutional Arrangements

(2) Important tasks in which the socio-economic experts to be involved and/or give substantial inputs to :
- Task 02 : Review of Existing Data
- Task 29 : Formulation of Alternative strategies of River Training/AFPM
- Task 30 : Selection of Recommended River Training/AFPM Strategies
- Task 31 : Approach for Development of a Medium-Term Plan
- Task 32 : Design of River Training/AFPM Pilot Project
- Task 33 : Preparation of Implementation of Pilot Project

(3) Particular task difficult to participate substantially in :
- Task 04 : Reconnaissance of Major Rivers in Bangladesh

Thus the socio-economic experts will be involved in many different tasks and at different levels and occasions of the overall FAP 21/22 study schedule (specific comments are given below). In addition to that the socio-economic experts will have to maintain close collaboration and coordination with other tasks and subject matter experts for reasons of interconnected tasks/disciplines, complementary approach, overlapping or gap risks etc. These correspond first of all to non-engineering tasks and experts but an equally close relation to the engineering tasks and experts will be required, in order to come to well balanced and fully acceptable recommendations of the Planning Study.

Based on the results of the preliminary activities undertaken (field visits, collection and review of data and documents) and an in-depth analysis of the Task descriptions the following comments shall be given to the original approach (reference is made to Annex II with the Task descriptions as per the Consulting Agreement) :

Task 12 : Socio-Economic Assessment

Analysis of the present socio-economic situation : additional quantitative inquiry or survey with some cross-checkings with the overall 1981 census will be of no relevance for FAP 21/22 and themselves due to several reasons :

- time budget of the socio-economic study
- a priori study area for the analysis of the current situation cannot be selected at this stage
- more interest to focus on a qualitative approach for assessing River Training/AFPM issues and/or integrated rural development at local level
- availability of sufficient existing statistical data, especially from BBS (Bangladesh Bureau of Statistics, see list of documents consulted in chapter 3.4.7).

The second and third sub task of the present situation analysis described in Task 12 will be undertaken as described.

In addition, a general anthropological and sociological qualitative assessment will be also undertaken by the Consultant to get a better understanding of the current socio-economic conditions.

Task 34 : Proposal of Institutional Arrangements

Study works will be undertaken following Task 34 description, especially for the implementation of the FAP 21 test works. In addition to that :

(1) an overall analysis of the institutional framework and legal aspects for the current situation will be carried out in line with an analysis of the existing socio-economic situation (see 4.7.3 hereafter).

(2) an institutional analysis will be needed for FAP 22; institutional constraints will intervene both as structural factors when dealing with River Training/AFPM

strategies and as complementary organizational measures, including institutional strengthening and/or reforms for implementing medium-term plan, pilot studies, actions and projects, if any. Detailed methodology and contents of this second part will be given during the second socio-economic mission.

Task 02 : Review of Existing Data and
Task 04 : Reconnaissance of Major Rivers in Bangladesh

The approach will be slightly different from the one indicated in the original task description. It is actually not required to achieve heavy investigations on other river reaches in Bangladesh than the Jamuna, since FAP 21/22 is focussing on that very specific river :

- FAP 21 aims at implementing test structures and FAP 22 may define a pilot project only if technical feasibility seems promising. The socio-economic data related to other rivers are of no relevance for FAP 21/22.
- Considering the limited time available in the present Project, the evaluation of existing data can only be done using data from Government Offices and from existing consultancy reports.
- It can be stated that the Brahmaputra/Jamuna river bed pattern clearly differs from most of the other rivers in Bangladesh : the former is a braided river and the latters and meandering ones.

It will therefore be useless for the purpose of the Project to investigate over almost all the Bangladeshi flood plain areas and the study will focus on the Jamuna river in its entirety. It must be pointed out that carrying out an in-depth review on each bank of this river would be time consuming in view of the large number of projects and institutions involved and the difficulty to get information from each institutional source.

4.7.2 Up-dated Approach

4.7.2.1 Scope of Works

In terms of social and cultural structures the rural population is not homogeneous in Bangladesh. Therefore, for a better understanding and preparation of flood control and/or environment management plans socio-economic studies must not be limited to the quantitative and objective aspects only. The Consultant believes that, in parallel and in line with the objective of the study, a qualitative and more subjective approach relying on human sciences (historic background, anthropology, sociology) is also needed. Its purpose will be among others to :

(1) better understand the major constraints and bottlenecks for economic and social development, through identification of socio-cultural diversity within the rural area, and assessment of population behaviour and attitude against present and future river bed shifting and bank erosion,

(2) better evaluate both possible positive and negative impacts of river training works and

AFPM : economically (micro and macro levels), socially and culturally, for the environment and the existing institutions,

(3) enlighten the choices and strategies proposed on the basis of the engineering studies; propose possible alternatives and evaluate impacts of technical pilot projects, especially for FAP 21,

(4) take up a bottom-up approach, starting from the poor rural population (small farmers and landless) and village/union council levels and raise from these all the systemic components and constraints of AFPM with the development at every level (local, regional and national),

(5) in case the technical feasibility of river training/AFPM was proven or at least likely, participate substantially in the :
- Formulation of alternative strategies of River Training/AFPM (Task 29)
- Selection of recommended River Training/AFPM strategies (help to decision makers) (Task 30)
- Approach for development of medium-term plan (Task 31)

(6) participate in identification and preparation of implementation of a possible pilot study/project (Task 33). This will include a limited number of villages and union councils directly concerned.

On the basis of that enhanced approach the Socio-Economic and Institutional Assessment Study will comprise the following three main phases or missions:

First mission

This mission is the present one, mainly dedicated to undertake the reconnaissance study, the methodological upgrading and the analysis of the present situation.

Second mission

Completion of the socio-economic and institutional assessment of the present situation. Synthesis in terms of constraints and potentialities for river training/AFPM measures towards economics and social development :
- Participation in the selection of strategies and in an approach to a medium term plan by highlighting possible constraints or benefits
- Participation in the selection for areas for a river training/AFPM pilot project (in case of a technical feasibility).

Third mission
- Socio economic and institutional impact study and correcting measures recommended for FAP 21 test works

- Terms of reference of the detailed investigations to undertake in the next stage if a pilot study/project looks feasible for FAP 22. Conversely, if there is no sufficient technical feasibility, there will be no pilot project.

Consequences on the work plan and staff assignment are indicated in the following paragraph.

4.7.2.2 Staffing

From the approach proposed hereabove, it appears clear that there is a need for the socio-economic/institutional study to include also qualitative aspects and not to rely only on a quantitative socio-economic approach. For reaching that objective the Consultant intends :

(1) to introduce a new position for an agricultural development specialist (at grass-roots level). He will evaluate the agro-economic impacts and recommend the correcting measures for the FAP 21 pilot project on the one hand and will carry out the agricultural/rural bottom-up approach proposed for an eventual pilot study/project for FAP 22.

It is anticipated that two missions of about 1 month each for an expatriate agricultural development specialist and his counterpart will be required.

(2) to reduce accordingly the input of the economic experts from 4 to 1.5 to 2 man months each. The rationale is that no cost/benefit analysis will be needed for FAP 21/22 and that the economist's input will mainly be to assist in setting up series of unit rates for the construction works and to tentatively quantify possible macro economic benefits - and cost - of river training/AFPM.

(3) to reduce from 2 to 1 month the intervention time previously scheduled for the legal advisor, and reduce from 3 to 2.5 months, the time previously scheduled for the local land reclamation expert for the first mission and from 4.5 to 4 months time of the land acquisition specialist.

The above staffing considerations are included in the updated work and staff schedules in Chapter 6 and 7.

4.7.3 Socio-Economic Assessment of the Present Situation

4.7.3.1 Definition of an Envelope Study Area on Both Sides of the Jamuna River

For the purpose of the socio-economic and institutional study, it is proposed to consider at first the general envelope of the study area covering both sides of the Jamuna River from the northern boundary with India till the confluence with the River Ganges. This envelope study area consists of the Jamuna River itself with its chars and major bed and two strips of

administrative units (Union Councils), one on each side of the river. The areas of the Union Councils considered at this stage are supposed to be flooded during normal years and thus to be liable of AFPM problems and/or potentialities. The total envelope study covers 3,583 square kilometers, water and river bed included. For further details see the Table 4.7.3-1 at the end of the chapter.

A practical definition of this envelope study area has been delineated from the following information :

- results of field trips
- Small Areas Atlas of Bangladesh (6 present Zilas concerned)
- 1:50,000 topographical maps

For the envelope study area altogether 8 Zilas, 25 Upazilas, 87 entire Union Parishads and 1340 Mauzas (Revenue Villages) have been counted but it is obvious that at this stage a detailed breakdown as to the parts of the Unions and Mouzas cannot be given.

This more detailed approach will be done at the stage of the pilot project for FAP 21 after selection of individual locations and for FAP 22 if alternative technical strategies and concepts were found feasible and may lead to a pilot project.

The total population of the envelope study area was 1.575 millions (1981 census data), comprising around 302,000 households (demographical definition). On the basis of an average annual growth rate of 2% to 2.5%, the population should represent now about 2 millions and the overall average population density should have increased in parallel from 440 to 550 inhabitants per square kilometer.

4.7.3.2 Further Socio-Economic Analyses

Further analyses of the socio-economic situation of the project are in progress, the results of which shall be presented in a separate Technical Report or in the Interim Report.

Contents of such a report will comprise but not be limited to the following subjects and relate them to the objectives and scope of the Project :

(1) General socio-demographic characteristics of the study area, e.g.

- Total number of population and household and population density
- Population structure (average size of household, sex and age, literacy, occupation)
- Main demographic parameters: CBR, CDR, average annual growth rate
- Active population and Demographic Dependency Ratio

(2) General anthropological and sociological references, e.g.

- The historical heritage of technology and culture
- Household, family and relationship system
- Large family and lineage

- Other criteria of social differentiation
- Traditional grass-roots organizations and political institutions
- Psycho-sociological aspects: behaviour and attitude of population against present and future problems and hopes for changes (including flood)
- Three particular key questions: solidarity and collective responsi-bility at village/union council level, family planning, and creation of non-agricultural employments.

(3) Socio-economic characteristics of agricultural and rural activities

- Size of farm, holdings and land-less people
- Off-farm permanent and part-time activities
- Land tenancy systems and other production factors, social relations through production activities
- Overview of the farming systems
- Level of agricultural revenues
- First simple typology of rural households.

(4) Review of existing surveys and reports

achieved or in progress in relation with socio-economic, sociological and institutional approach of flood control and rural development in Bangladesh.

4.7.4 Institutional Framework and Legal Aspects

The information of the population of the project area and the acceptance of the envisaged pilot works by them are important factors for a smooth implementation of the Project. Thus the political and administrative institutions have to play an active part in this task.

In preparing the Project also legal aspects are involved which will require fast and proper attention by the authorities concerned in order that the time schedule can be adhered to. For example, the implementation of the test works of FAP 21 will require the provision of right of way and the acquisition of land both permanently, i.e. for the construction of embankments, groynes etc., and temporarily, i.e. for the excavation of fill material, erection of camps etc. As the acquisition is often a problematic and time consuming procedure the Consultant will provide the maps with marked plots to be acquired as soon as the Planning Study has been approved and will do everything possible to maintain a close contact to all institutions involved.

As it is important that the responsibilities of all local bodies, institutions and authorities as well as the legal aspects in preparing and implementing the project are well known, the following subjects shall be dealt with in the Socio-Economic and Institutional Study :

(1) Land laws of Bangladesh and customs related to land
(2) Land acquisition and resettlement
    - The reglementation and legal aspects

- Programmes and projects achieved or in progress

(3) Institutional framework

- Brief history of the evolution of the administrative set-up since independence
- Political, administrative and technical institutions
  - o Main lines of the present constitution of Bangladesh
  - o Central level: main ministries concerned and specialized semi-autonomous bodies
  - o Regional level: Zilas (new Districts) and Upazilas

- o Local level: Union Parishads.
- Agricultural and rural development specialized institutions
  - o Agricultural development services: applied research, extension
  - o Input supply, marketing, cooperative organization, credit
  - o Educational institutions
  - o Health Institutions
  - o International aid programme: relief operations and programmes, UNICEF, Food for Work programmes, development programmes and projects
  - o NGO's activities.

4.7.5 Conclusions of Socio-Economic and Institutional Assessment

The result of the assessment of all socio-economic and institutional aspects will therefore contain

(1) A summary of the major problems and constraints from socio-economic and sociological points of view of and proposals for strategic lines of possible improvements in the long run.

(2) A description of the institutional set-up, activities and responsibilities

(3) Legal aspects in connection with land acquisition and project implementation

(4) Scope of a future socio-economic and institution study related to FAP 21.

4.7.6 Land Acquisition Procedure for FAP 21

The procedures and problems in connection with land acquisition for pilot works may already be raised at this stage.

As soon as the sites for the test structures of FAP 21 have been selected and approved the details of land acquisition will have to be worked out area by area. Each strip of land that will have to be acquired will have to be shown on the relevant mauza maps. The proposal for acquisition will then be placed before the concerned Deputy Commissioner. Problems which may crop up are listed below :

1. The District Land Allocation Committee may not agree to allocate the quantum of land proposed to be acquired, therefore proper justification will be required.

2. As soon as the proposal is accepted at the district level the matters will be referred to the Government, i.e. the Ministry of Land. The approval of the proposal will require follow up in the Ministry in Dhaka. Finally the approval will come from the Prime Minister.

3. The people affected by land acquisition as well as the representatives of local administration etc. will have to be contacted. They all have to be made to understand the need for acquisition of such land.

4. The people affected and the local leaders may not have objection to the proposal provided the compensations assessed for the acquired land are adequate.

5. To give the entire operation of land acquisition a human touch it has to be seen that the people affected are assisted in re-settlement in the adjoining areas. They may also be assisted in starting new occupation if they happen to lose their old trade or job.

6. The relevant land laws regarding ownership, assessment of compensation and disbursement of the same will be taken care of by the Land Acquisition Branch of the Deputy Commissioner's office.

7. With the co-operation elicited from the people of the concerned locality, the issues may not pose to be a great problem. It is always seen that if the cause is understood to be genuine, and if the compensation assessed as adequate, people as a whole do not object much. But it has to be seen that quick disbursement of compensation is ensured.

8. The Land Acquisition Ordinance of 1982 and the Emergency Land Acquisition Law of 1989 guide the process of acquisition. The matter will need constant contact with the district administration and the ministry. However, most of all the local administration and local people will have to be involved in all the issues connected with land acquisition.

The problem of re-settlement of displaced people because of land acquisition is not altogether new in Bangladesh. But since there are no specific laws or rules in this regard, the question of mitigating the hardship and disruption of the displaced people has to find some positive consideration of the Government. That is why in addition to liberalising the compensation assessment rules, instructions have to be issued to all concerned to the effect that 'provisions should invariably be made by the acquiring bodies for rehabilitation of the affected people'. It is stressed that the provisions be suitably applied for re-settlement of the people affected by the pilot project FAP 21, so that problems in work implementation will be avoided.

Table 4.7.3-1 SOCIO-ECONOMIC AND INSTITUTIONAL RECONNAISSANCE OF PRESENT SITUATION DEFINITION OF THE ENVELOPE STUDY AREA ON BOTH SIDES OF JAMUNA RIVER

ZILA	UPAZILA		UNION COUNCIL		Area	House	Population	No of	Density of	Average
(New Districts)	Geo-code	Name	Geo-code	Name	(acres)	hold 1982	1981	Mauzas/ Union	Population per km.	Size of household
KURIGRAM	61	NAGESNLARI (RB)	63	Narayanpur	13,575	2073	11392	11	207	5.5
			75	Nookhawa	8,807	1714	9157	6	257	5.3
	52	KURIGRAME (RB)	47	Jatrapur	17,008	2105	12465	9	181	5.9
			28	Ghogadaha	6,705	3051	16000	7	590	5.2
			85	Panchgachhi	5,963	2663	16689	5	693	6.2
	94	ULIPUR (RB)	05	Begumganj	36,301	3997	24850	20	169	6.2
			22	Buraburi	9,833	3680	20067	14	504	5.5
			61	Hatia	7,571	3930	19808	10	646	5.0
	74	RAUMARI (LB)	23	Dautbanga	10,615	4101	23331	6	451	5.7
			11	Bandaber	14,680	4997	31777	10	535	6.4
			71	Rowmari	8,992	4331	25602	4	703	5.9
			35	Jadmchar	8,671	3246	19131	5	545	5.9
	09	CHILMARI (RB/LB)	47	Nayarhat	12,845	1212	6900	10	132	5.7
			23	Chilmari	6,554	731	4128	10	153	5.2
			11	Ashtamer Char	17,528	2433	14752	22	197	6.1
	08	CHAR RAJIBPUR (RB/LB)	57	Kodail Kati	6,199	2035	12576	4	591	6.2
			19	Char Rajibpur	7,739	3690	22584	5	721	6.1
			76	Mohauganj	13,499	3117	19002	17	348	6.1
			38	Kamarjani	7,734	1435	9237	8	295	6.4
				Sub-total :	221859	55601	319448	183	356	5.7
GHAIBANDA	21	FULCHARI (RB/LB)	11	Erendabari	21,352	3697	22646	16	255	6.1
			23	Fazlupur	17,021	2364	15565	17	226	6.6
			83	Uria	5,835	2334	13086	4	554	5.6
			35	Pulchari	12,244	1966	11803	15	338	8.6
	88	SUGHATTA (RB)	38	Haldia	11,566	2725	17159	13	367	6.3
	24	GAIBANDA (RB)	51	Kamarjani	7,935	2140	10307	12	321	4.8
				Sub-total :	76,193	15226	90566	77	294	5.9
BOGRA	81	SARIAKANDI (RB)	19	Chaluabari	14,454	1563	8424	30	144	5.4
			37	Hatsherpur	6,813	2750	14601	12	530	5.3
			55	Kazla	16,509	2048	10963	11	164	5.4
			88	Sariakandi	6,328	3722	19809	18	773	5.3
			56	Kanirbari	12,920	3349	16802	11	321	5.0
			12	Bohali	17,155	2910	15034	14	217	5.2
				Sub-total :	74,179	16342	85633	96	285	5.2
SIRAJGANJ	50	KAZIPUR (RB/LB)	43	Khas Rajbari	9,042	1428	7999	15	219	5.6
			08	Char Girish	16,872	2753	16763	20	246	6.1
			60	Natuarpara	6,740	2532	15433	8	566	6.1
			51	Maizbari	4,873	4207	22324	8	1132	5.3
			69	Nishintapur	8,983	1435	8580	8	236	6.0
			94	Tekani	8,162	2215	12986	7	393	5.9
	78	SIRAJGANJ (RB)	51	Mechhra	11,109	4096	20508	22	456	5.0
			34	Kaoakola	8,409	1789	11583	30	340	6.5
			25	Kaliaharipur	6,736	4603	26406	15	969	5.7
			69	Saidabad	6,902	4089	25243	20	904	6.2
				Sirajganj town	(4,835)	(17313)	(101587)	(32)	(5192)	(2.1)
	11	BELKUCHI (RB)	81	Rajapur	6,947	5507	32837	5	1168	6.0
			27	Belkuchi	6,554	6412	37105	10	1399	5.8
			13	Baradhul	7,730	1985	10086	22	322	5.1

to be continued

Table 4.7.3-1 continued

ZILA (New Districts)	UPAZILA Geo-code	UPAZILA Name	UNION COUNCIL Geo-code	UNION COUNCIL Name	Area (acres)	House hold 1982	Population 1981	No of Mauzas/ Union	Dentisity of Population per km.	Average Size of household
	27	CHAUHALI (RB)	47	Sadiachaupur	12,790	4162	25570	32	494	6.1
			71	Sthal	10,341	8047	12230	33	292	6.0
			23	Ghorjan	7,398	1798	10038	19	335	5.6
			30	Mizkutia	12,033	5725	33711	29	247	5.9
			37	Limarpur	14,763	4263	24317	38	407	5.7
				Sub-total :	171,219	78359	287481	373	415	3.7
PABNA	16	BERA (RB)	31	Haturia Nakalia	7,543	4123	25003	17	819	6.1
			63	Nutan Bharenga	10,371	4804	29663	20	707	6.2
			73	Puran Bharenga	6,531	1843	11641	23	440	6.3
			84	Ruppur	7,355	2755	15647	19	526	5.7
			52	Masundia	6,965	2274	12196	23	431	5.4
			21	Dhalar Char	9,575	1674	9987	26	258	6.0
				Sub-total :	48340	17473	104137	128	532	6.0
JAMALPUR	15	DEWANGANJ (LB)	51	Danghdara	10,447	3073	18927	7	448	6.2
			29	Char Amahaoa	9,170	3518	22793	7	614	6.5
			65	Hatibhanga	4,619	2042	11395	3	610	5.6
			07	Bahadurabad	10,713	3817	20432	3	471	5.4
			36	Chikajani	8,576	3043	14604	8	421	4.8
			43	Chukaibari	6,867	2788	13962	7	502	5.0
	29	ISLAMPUR	63	Kulhandi	7,024	2133	11674	6	411	5.5
BOGRA		(LB)	07	Belgachha	8,746	2801	15037	9	425	5.4
		(RB)	94	Sapdhari	7,580	2633	15375	8	501	5.8
			71	Noapara	9,564	3804	21058	10	544	5.5
	58	MADARGANJ	35	Char Pakerdaha	8,316	3882	20875	12	620	5.4
		(LB)	23	Balijuri	9,826	5871	31555	12	794	5.4
			59	Joiekhali	10,519	3613	21311	17	501	5.9
	85	SARISHABARI	84	Satpoa	11,561	59282	34719	23	742	5.6
SIRAJGANJ		(LB)	73	Pogaldigha	9,883	6027	34047	8	851	5.6
			10	Aona	7,553	4245	23214	15	759	5.5
			63	Pingna	7,203	3706	20371	13	247	5.5
				Sub-total :	148167	62924	351349	168	586	5.6
TANGAIL	19	BHUAPUR (LB)	13	Arjuna	9,822	3837	23547	18	592	6.1
			54	Gabsara	17,056	3650	20703	15	299	5.7
			81	Nikiail	10,968	2885	18070	21	407	6.3
	47	KALIHATI (LB)	29	Durgapur	12,781	4684	29570	30	572	6.3
			87	Salla	6,787	4152	25238	21	919	6.1
	95	TANGAIL	71	Kakna	9,380	4072	25257	19	665	6.2
			53	Hugra	8,529	3247	19826	22	573	6.1
			65	Katuli	12,214	4843	29648	44	600	6.1
	76	NAGARPUR	14	Bhara	7,604	3467	21510	16	699	6.2
			43	Gayhata	6,346	3758	23669	23	922	6.3
			94	Salimabad	5,948	3527	20226	10	840	5.7
				Sub-total :	107435	42122	257264	239	592	6.1
	10	DAULATPUR	38	Char Katari	4,697	2530	15020	2	790	5.9
			09	Bachamura	9,733	3197	17564	24	446	5.5
			19	Baghutia	11,124	4125	22368	25	497	5.4
	78	SHIVALAYA	59	Teota	12,470	4358	24646	35	488	5.7
				Sub-total :	38,024	14210	79598	86	517	5.6
TOTAL CONCERNED (8 ZILAS)		25 UPAZILAS		87 Union Councils + Town (Sirajganj)	885416	302257	1575476	1340	440	5.2

4.8 LAND RECLAMATION AND LAND USE

4.8.1 General

4.8.1.1 Meaning

Land reclamation to be included in the Active Flood Plain Management (AFPM) on either bank of the Jamuna River as contained in FAP 22 may have different definition-meaning-explanation. Therefore the following restrictions and/or definitions have been made :

- Land reclamation within the project will mainly concern the increase of the productivity by drainage improvements as part of the overall measures for active flood plain management.
- Land reclamation could cover the accretion of new land by siltation or by dredge deposits. It could also cover the increase of the productivity of the new lands by means of flood protection, drainage & irrigation accompanied with soil improvement, one should however keep in mind that flood protection is not an objective by its own in the Project, because the Project (FAP 22- River Training - AFPM) only considers the active flood plain within the embankments.
- Accretion of new land may be considered not as a direct objective of the Project, but to take it into account whenever possibilities arise.

Land use depends strongly on the soil types of the active Jamuna flood plain. The higher quality of soil type the higher the crop yields are. In this respect land may be used for grasses or for more qualified crops (e.g. tobacco, lentil, potatoes, etc.) depending on the soil quality.

4.8.1.2 Purpose

- to assess the value of the reclaimed land due to AFPM
- to propose a zoning of the activities according to the nature & character of the soils together with their land use, land suitability, land capability & land associations
- to describe the measures to be taken in order to reclaim/ rehabilitate the land
- to estimate corresponding cost & benefits for agriculture, housing etc.
- to propose an organization for the implementation of these measures in close cooperation & liaison with Socio-economist, Environmentalist and Land Acquisition Specialist.

4.8.2 Preliminary Results

In the following sections some preliminary results of the analyses which shall be amended in the next phase of the project. At the end some conclusions and remarks on the work planning are given.

4.8.2.1 Soil Classifications

The active young Jamuna flood plains in the adjoining right and left banks of the river are nearly every year subject to rapidly water moves over the land as a result of which many properties, livestock etc. are damaged or lost. Slightly irregular landscape of recent ridges and inter-ridges depressions together with new spill deposits alongside the active channels are the characteristic land-forms of these areas.

In different parent materials the soils of the active Jamuna flood plains show different degrees of development, mainly due to drainage conditions and kind of sediments. In the active Jamuna flood plains stratified alluvium and shallow soils over a stratified substratum predominate with large areas of sandy alluvium. In other places, the deposits are generally fine sandy loam to silty clay loam.

In slightly sheltered parts where no erosion or thick deposition has taken place during the last years, prismatic structure has developed on the silty land. The reaction varies from near neutral to moderately alkaline - locally some clayed soils occupy the deeply flooded basins. The soils have been classified in terms of the USDA 7th approximation.

Most of the Jamuna active flood plains have been classified as Entisols or Inceptisols when biotic mixing has destroyed alluvial stratification. Soil development is generally very rapid in these sedimentary materials.

For the scope of this Inception Report only soils series shall be described to give a general view of the soils of the active Jamuna flood plain.

Correlation of soils series in the USDA classification

Order	Sub group	Soil series
Entisols	Typic Haplaquents	{ Sandy alluvium { Silty alluvium
Inceptisols	Typic Haplaquents	Dhamrai
	Aeric Haplaquents	Sonatala

Entisols, typic haplaquents sandy alluvium

Seasonally flooded, poorly drained, raw sandy alluvium occurs irregularly on ridges and in depressions or chars and on the active flood plains along the distributaries of the Jamuna River. It is associated with large areas of silty alluvium and in a few cases with Dhamrai

soils. It is grey, generally non-mottled, loose sand to loamy sand, stratified throughout and neutral to moderately alkaline in reaction.

It is coarser than associated silty alluvium and therefore more appropriate for internal drainage.

Entisol, Typic Haplaquents silty alluvium

The silty spill deposits are a miscellaneous land type consisting of seasonally flooded, poorly drained, grey, very friable, stratified almost raw alluvium. Generally they occur irregularly over ridges and depressions of the braided Jamuna river channels and the active flood plain areas of some of its distributaries. They are associated with relatively small areas of sandy alluvium and occasionally with Sonatala and Dhamrai soils. Textural variations occur within short distances, laterally as well as within the profile. They are sandy loam to silty clay loam. They are exposed to severe river erosion as well as new deposition.

They differ from associated sandy alluvium in their fine texture and consequently have higher moisture retentivity.

Enceptisols, Typic Haplaquents, Dhamrai series

Dhamrai series consist of poorly drained, seasonally flooded, moderately textured soils developed in gently to very gently undulating recent to subrecent Jamuna alluvium. These soils are generally associated with Sonatala series and spill on the active flood plain.

These soils have a silty clay loam texture, with weak to moderate prismatic or angular blocky structure having medium clay coatings.

Enceptisols, Aeric Haplaquents, Sonatala series

The Sonatala series consist of seasonally flooded, somewhat poorly to poorly drained, medium textured soils developed in Jamuna flood plain alluvium occurring on the summit or upper slopes of rearly level to gently undulating ridges. These soils have a finely mottled, friable moderately alkaline silt loam subsoil with weak, coarse prismatic structure.

4.8.2.2 Land Fragmentation & Parcelling

Land fragmentation is a process whereby individual ownership of a piece of land is retained by the owner. This is the system of tradition in Bangladesh. Sometimes this process poses a big problem for the development of the land in the mechanised form for growing optimum crop-yields. Land tenure and ownership are very important considerations. The pressure of a rapidly expanding population has led to considerable land fragmentation over the past centuries. The average farm size is between 1 and 2 ha.

For ensuring mechanised cultivation land fragmentation has to be parcelled/ consolidated, though it appears to be difficult for changing the existing land tenure system of the country.

4.8.2.3 Land Capability

Land capability classification is a method of grouping the soils of an area to show their relative suitability for sustained production of common agricultural crops. The classification is designed to suit the agricultural conditions by which crops can be grown throughout the year. Much of the land is continuously flooded for about half the year and both wet land crops and dry land crops are often grown on the same soil at different seasons of the year.

Outline of Classification

Two levels of generalization are recognized: Land capability class is identified by Roman numerals I to V :

- Class I land (very good agricultural land) has least limitations for crop production throughout the year and a wide range of agricultural use
- Class II, III, IV & V have increasingly severe limitations for crop production. Class V (very poor and non-agricultural land) is considered unfit for economic agricultural use.

Sandy alluvium

This land is very droughty in the dry season, and subject to seasonal flooding. This landscape is exposed to severe erosion and new deposition due to the activity of the shifting channels. Under present conditions this land is unsuitable for development.

Silty alluvium

Most of the crops presently grown give good to moderate yields, but there is a grave risk of loss of crops by sudden flooding, catastrophic river erosion or burial by fresh deposition. This would make, under present conditions, any investment in water control very hazardous and also limits development possibilities to introduction of fertilizer and high yielding crop varieties.

4.8.2.4 Conclusion and Final Remarks

Prediction methods for morphological response of the major braided Jamuna river via permanent structure or recurrent measures or by combination of both may have advantages and disadvantages.

Advantageous effects of permanent structures or recurrent measures may allow zoning of the active flood plains of the Jamuna river and increased socio-economic use of the flood plains. This can be an important aspect of the management and development of the flood plains with respect to land use by developing ways and means to achieve optimum results. This aspect will be incorporated in the development of the different strategies to be tested in river training.

If there are sufficient indications that river training and active flood plain management is technically feasible, then the results of the Land Reclamation and Land Use study will be

included in the formulation of a Terms of Reference for a Pilot Project with respect to AFPM.

A more detailed description of the analysis of land reclamation and land use is under preparation. This activity will continue during the next phase of the project. The final description including considerations on Agricultural Practices and Physical Planning will be part of either the Interim Report or a separate Technical Report.

References:

(1) DOLBERG, F. (1985), LRP Technical Report No.24 on "Action Plan on Livestock & Fish Culture"

(2) EYSINK, W.D. (1984), LRP Technical Report No.20 on "Proposal for a Long Term plan on Land Reclamation and Estuary Control"

(3) FAP-1 (1st & 2nd Interim Report) Brahmaputra Right Bank Study (BRTS)

(4) GOPROB (1970), Reconnaissance Soil Survey (Bogra Dist. & Part Dinajpur Sadar Sub-division) by Department of Soil Survey, M/O. Agriculture

(5) GOPROB (1966), Reconnaissance Soil Survey (Mymensingh Dist.) by Department of Soil Survey, M/O. Agriculture

(6) GOPROB (1965), Reconnaissance Soil Survey (Pabna Dist.) by Department of Soil Survey, M/O. Agriculture

(7) GOPROB (1966), Reconnaissance Soil Survey (Tangail Dist.) by Department of Soil Survey, M/O. Agriculture

(8) MOSHARAFF HOSSAIN, Agriculture in Bangladesh (Performance Problems and Prospects)

(9) NEEFJES, K. (1985), Land Reclamation Project (LRP) Technical Report No.28 on "Water Management Practices of Small Farmers in Noakhali", Bangladesh

(10) SALEEMUL HAQ, Environmental Aspects of Agricultural Development in Bangladesh

4.9 NAVIGATIONAL ASPECTS

In Bangladesh, the largest deltaic country in the World, with its numerous rivers and canals, it is obvious that water transport is one of the main means to move persons and cargo. The Jamuna River, though not the most plied one, is nevertheless an important shipping route particularly for river crossing but also for longitudinal shipment, mainly between Chilmari, Nagarbari and Baghabari. At present the port of Baghabari is threatened in his accessibility since the channel where the port is situated, is drying up.

With respect to the impact of River Training/Active Flood Plain Management on various other aspects (such as : environment, socio-economics, etc.) last but not least the navigation on the Jamuna river has also to be considered. On the one hand AFPM may be beneficial to navigation. On the other hand conflicts of interests may occur. In this respect the following aspects have been listed indicatively :

- A channel used for navigation may be closed. On the other hand channels may also be dredged providing improved navigation (draught) conditions.
- Dredged cross channels may silt up due to increased flow velocities in the main channel.
- Creation of larger and more permanent chars may increase the sailing routes of cross river ferries.
- A basic objective of AFPM is the reduction of the cross sectional width of the Jamuna river resulting in greater water depth due to increased flow velocities, which in general is helpful to navigation.
- Ship induced waves may affect river training measures, especially the light recurrent measures.

Due to the indicated interaction between navigation and River Training/AFPM a more detailed study on these aspects is strongly recommended to add to the FAP 22 project. This study should cover all the important navigational aspects with respect to AFPM, of which the technical feasibility might be improved due to mutual benefits. Therefore this study can be considered to be an essential part of the analysis for the selection of river training strategies (Annex II, Task 30). Reference is made to Annex V for the task description including an assessment of the man months.

5 UPDATED WORK PLAN

As reported in the preceding sections the project activities have developed by and large according to the work flow chart updated on 1st January 1992 and submitted to the Client and the Funding Agencies.

For easy reference, that work plan is attached as Fig.5-1. The updated work flow chart Fig.5-2 includes both the activities as they were actually undertaken before the Inception Report as well as the forecast of the future activities.

Comparing both charts one can notice that no shift of any milestone - represented by the various reports - had to be envisaged.

Since the field surveys will physically start on first April- the mobilization being undertaken in the last week of March- the Consultant is at present looking forward to get these crucial works finalized before the beginning of the rainy period, unless any unforeseen events happen.

The updated work plan also reflects the modification envisaged in the socio-economic and institutional assessment- represented by Task 12- and which is in more detail explained in section 4.7. The three missions mentioned there are clearly shown, the last one being planned to prepare the mitigating measures for land acquisition, resettlement etc. in the context with the bank protection test sites.

Task 34 A is the assessment of the possible influences of river training and active flood plain management on inland navigation. Whereas the main task will be undertaken in August, some ancilliary works, especially with regards to recording large river bottom formations will be made before and after that period.

FIG. 5-1

1 January '92

WORK FLOW CHART – PLANNING STUDY

Milestones : Commencement of Services; Inception Report; Interim Report; Progress Rep.; Draft Final Reports (FAP 22); Approval (FAP 21); Final Report (FAP 21+22)

No.	Task	FAP	Corresponding Tasks	Reference to ToR
1	Mobilization and Project Preparation	21,22		
2	Review of Existing Data	21,22	3,4,5,9,10,11,12,26	5.2.2.1
3	Installation of 1–D Mathematical Model (Mike 11)	21,22	2,6,8,9,13,29,30	5.2.2.1
4	Reconnaissance of Major Rivers in Bangladesh	21,22	2,5,11,26	5.2.2.1
5	Field Inspection of Jamuna River	21,22	2,4,7,8,11,26	5.2.2.1
6	Morphological Analysis	21,22	3,7,27,29,30	5.2.2.1
7	Preselection of Test Areas	21	5,6,8,10,13,14	5.2.2.1
8	Topographic and Hydrometric Surveys	21(22)	3,5,7,13,20	5.2.2.1
9	Specification of the Hydrological Design Events	21	2,3,13,20	5.2.2.3
10	Subsoil Investigation in Test Areas	21	2,7,16,20	5.2.2.2
11	Environmental Assessment	22	2,4,5,30	
12	Socio–Economic Assessment	22(21)	2,16,26,30	
13	2–D Mathematical Flow Modelling	21(22)	3,7,8,9,14,20,29,30	
14	Selection of Test Sites	21	7,13,15,16	5.2.2.2
15	Physical Modelling	21,22	13,14,16,20,29,30	5.2.2.2, 5.2.2.4
16	Selection of Alternative Test Measures	21	10,11,12,14,15,26,28,29,30	
17	Analysis of Construction Materials	21	20,21,22	5.2.2.3
18	Analysis of Construction Methods	21	20,21,22	5.2.2.3
19	Assessment of Local Contractors' Capabilities	21	20	5.2.2.3
20	Preparation of Alternative Designs	21	8,9,10,15,16,17,18,19,21,23,28,29,30,34	5.2.2.3
21	Rate Analysis and Cost Estimation	21(22)	17,18,20,22,28	5.2.2.3, 5.2.2.4
22	Selection of Design and Construction Methods	21	18,19,21,23,24,28,29,30,34	5.2.2.3
23	Inspection of Locally Available Construction Equipment	21	20,22	5.2.2.3, 5.2.4
24	Staffing and Scheduling of the Test and Impl. Phase	21	22,25	5.2.2.4
25	Budgeting of the Test and Implementation Phase	21	24	5.2.2.4
26	Review of Possible River Training Methods and Concepts	22(21)	2,4,5,12,16,27,28	5.3.2
27	Prediction Methods for Morphological Behaviour	22(21)	6,26,28	5.3.2
28	Formulation of River Training/AFPM Concept	22(21)	16,20,21,22,26,27,29	5.3.2
29	Formulation of Altern. Strategies of River Training/AFPM	22(21)	3,6,13,15,16,20,22,28,30	5.3.2
30	Sel. of Recommended River Training / AFPM Strategies	22(21)	3,6,11,12,13,15,16,29,31	5.3.2
31	Approach for Development of Medium–Term Plan	22	30,32,34	5.3.2
32	Design of River Training / AFPM Pilot Project	22	31,33,34	5.3.2
33	Preparation of Implementation of Pilot Project	22	32	5.3.2
34	Proposal of Institutional Arrangements	21,22	34,22,30,31,32	5.4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	1991	1992												1993		
	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M

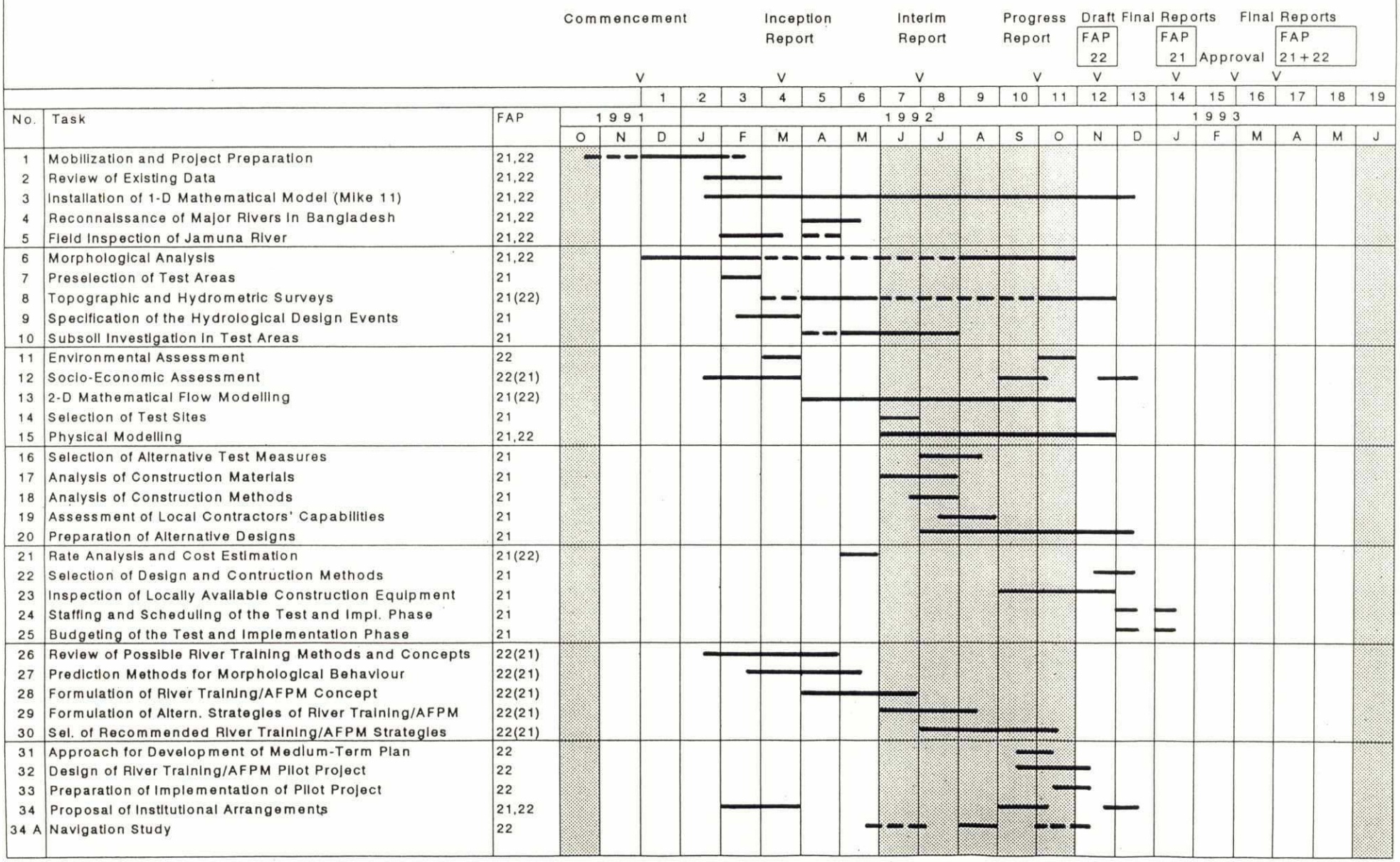
//// Monsoon

5-2

FIG. 5-2

FAP 21 / 22 WORK FLOW CHART - PLANNING STUDY

20 March 1992



No.	Task	FAP
1	Mobilization and Project Preparation	21,22
2	Review of Existing Data	21,22
3	Installation of 1-D Mathematical Model (Mike 11)	21,22
4	Reconnaissance of Major Rivers in Bangladesh	21,22
5	Field Inspection of Jamuna River	21,22
6	Morphological Analysis	21,22
7	Preselection of Test Areas	21
8	Topographic and Hydrometric Surveys	21(22)
9	Specification of the Hydrological Design Events	21
10	Subsoil Investigation in Test Areas	21
11	Environmental Assessment	22
12	Socio-Economic Assessment	22(21)
13	2-D Mathematical Flow Modelling	21(22)
14	Selection of Test Sites	21
15	Physical Modelling	21,22
16	Selection of Alternative Test Measures	21
17	Analysis of Construction Materials	21
18	Analysis of Construction Methods	21
19	Assessment of Local Contractors' Capabilities	21
20	Preparation of Alternative Designs	21
21	Rate Analysis and Cost Estimation	21(22)
22	Selection of Design and Contruction Methods	21
23	Inspection of Locally Available Construction Equipment	21
24	Staffing and Scheduling of the Test and Impl. Phase	21
25	Budgeting of the Test and Implementation Phase	21
26	Review of Possible River Training Methods and Concepts	22(21)
27	Prediction Methods for Morphological Behaviour	22(21)
28	Formulation of River Training/AFPM Concept	22(21)
29	Formulation of Altern. Strategies of River Training/AFPM	22(21)
30	Sel. of Recommended River Training/AFPM Strategies	22(21)
31	Approach for Development of Medium-Term Plan	22
32	Design of River Training/AFPM Pilot Project	22
33	Preparation of Implementation of Pilot Project	22
34	Proposal of Institutional Arrangements	21,22
34 A	Navigation Study	22

Monsoon

6 UPDATED STAFFING SCHEDULE

For easy reference also the two staffing schedules of 1st January (Fig.6-1) and 20 March (Fig.6-2) are shown on opposite pages. The staffing has been adjusted in three respects :

(i) by including the proposed additional navigation study (Task 34A)

(ii) by considering the modified socio-economic and institutional assessment and

(iii) by some internal rearrangement in the assignments of the Advisory Board members.

In the following tables the new staff is printed in italic letters.

(ad i) Navigation Study, Task 34A

To perform that study some additional staff input is required. The Consultant proposes, in order to assure a maximum of continuity and a minimum of "friction losses" due to briefing of newcomers to make use of Project personnel as far as possible. Another advantage of that approach is the minimizing of international flights. Hence the following staff changes would be proposed :

		Changes in MM Exp.	Changes in MM Loc.	Changes in Flights
17.1	Chief River Training Engineer-1	+ 0.5		0
17.2	Low Cost River Training Expert *	+ 1.0		+ 1.0
10.1	Surveyor/Hydrographer-1	+ 1.5		0
10.2	Surveyor-2		+ 1.5	
21.2	*Inland Navigation Transport Economist-1*	*+ 1.0*		*+ 1.0*
21.2	*Inland Navigation Transport Economist-2*		*+ 2.0*	
	Subtotal	+ 4.0	+ 3.5	+ 2

* The proposed person has been the project manager of the Ganga River Navigation Pilot Project in India, in 1986 to 1989

(ad ii) Socio-Economic and Institutional Assessment

The basic idea behind the intended modification is to include qualitative (anthropologic and grass-root level) approaches and to reduce the economic and pure quantitative aspects: for further details see section 4.7.2

FIG. 6-1 STAFFING SCHEDULE – PLANNING STUDY

Milestones : Commencement of Services (Premobilization | Mobilization) ⇩ Inception Report ⇩ Interim Report ⇩ FAP 22 Draft Final Report ⇩ FAP 21 ⇩ Approval ⇩ FAP 21+22 Final Report

No.	Function	Person	Man-Months Expatriates BD	Man-Months Expatriates EUR	Man-Months Local	Flights
	PROJECT DIRECTORATE					
1	Project Director	Dr H Brahl	5,0	1,0	2,0	12
2	Advisory Board Project Activities	5 Experts		1,5		
		Dr D Neuhaus		2,0		
3	Technical Home Office Support	C Cottereau		1,0		
		M Borchert		2,5		
		F Koch		–	6,0	
		A B Bhuiyan				
		Sum P.D.	5,0	8,0	8,0	12
	PROJECT MANAGEMENT					
1/4.1	Chief Res. Eng. (Proj.Manager)	Dr H Brahl	11,0	3,5	15,5	11
4.2	Deputy Project Manager	S M Mansur				
		Sum P.M.	11,0	3,5	15,5	11
	FAP 21					
5.1	Chief Hydr. Des. Eng. + Team Leader	H Schwenk	10,5	–	14,5	4
5.2	Hydraulic Design Eng. 2	A Q M Ali				
6.1	Modelling Expert 1	M v d Wal	4,5	–	4,5	1
6.2	Modelling Expert 2	J Islam				
7.1	Phys. Modelling Exp. 1	E Doutriaux	5,0	–	6,5	1
7.2	Phys. Modelling Exp. 2	Q Saifuddin				
8.1	Hydrologist 1	G Fleury	1,0	–	3,0	1
8.2	Hydrologist 2	Z H Khan				
9.1	Morphologist 1	G J Klaassen	1,0	–	3,0	1
9.2	Morphologist 2	M Bodiuzzaman				
10.1	Surveyor 1	J Heise	7,5	1,0	8,0	2
10.2	Surveyor 2	H Kamal				
11.1	Subsoil Expert 1	W Schönung	4,0	–	7,0	2
11.2	Subsoil Expert 2	Z Hasan				
12.1	Construction Managem. Expert 1	C Netzeband	6,0	–	3,0	1
12.2	Construction Managem. Expert 2	A N Chowdhury				
13.1	Socio Economist 1/Institutional Spec.	C Potin	2,0	–	2,0	1
13.2	Socio Economist 2	K Nizamuddin			2,0	
13.3	Land Acquisition Specialist	M A Jabbar				
15.1	Mechanical Engineer 1	J L Ormieres	3,0	–	4,0	1
15.2	Mechanical Engineer 2	M Rahman				
16.1	Economist 1	F de Cock	2,0	–	2,0	1
16.2	Economist 2	K Hussain				
		Sum FAP 21	46,5	1,0	59,5	16
	FAP 22					
17.1	Chief River Training Eng.+ Team Leader	F v d Knaap	9,5	1,0		3
17.2	Low Cost-River Training Specialist	P v Groen	1,0	–		1
17.3	River Training Engineer 2	S I Chowdhury			11,0	
8.1	Hydrologist 1	G Fleury	0,5	–		–
8.2	Hydrologist 2	Z H Khan			1,5	
9.1	Morphologist 1	G J Klaassen	2,0	–		2
9.2	Morphologist 2	M Bodiuzzaman			2,5	
6.1	Modelling Expert 1	M v d Wal	5,5	–		2
6.2	Modelling Expert 2	J Islam			6,5	
18.1	Land Reclamation Expert 1	E Elizechea	2,0	–		2
18.2	Land Reclamation Expert 2	A Mia			5,0	
13.1	Socio Economist 1/Institutional Spec.	C Potin	1,0	–		1
13.2	Socio Economist 2	K Nizamuddin			2,5	
13.3	Land Acquisition Specialist	M A Jabbar			2,5	
14.1	Environmental Expert 1	C Bertrand	2,0	–		2
14.2	Environmental Expert 2	A H Huq Bhuiya			3,0	
16.1	Economist 1	F de Cock	2,0	–		1
16.2	Economist 2	K Hussain			2,0	
19	Legal Advisor	H I Bhuiyan				
		Sum FAP 22	25,5	1,0	38,5	14
		Total	88,0	13,5	121,5	53

cf line 1/4.1 Chief Resident Engineer

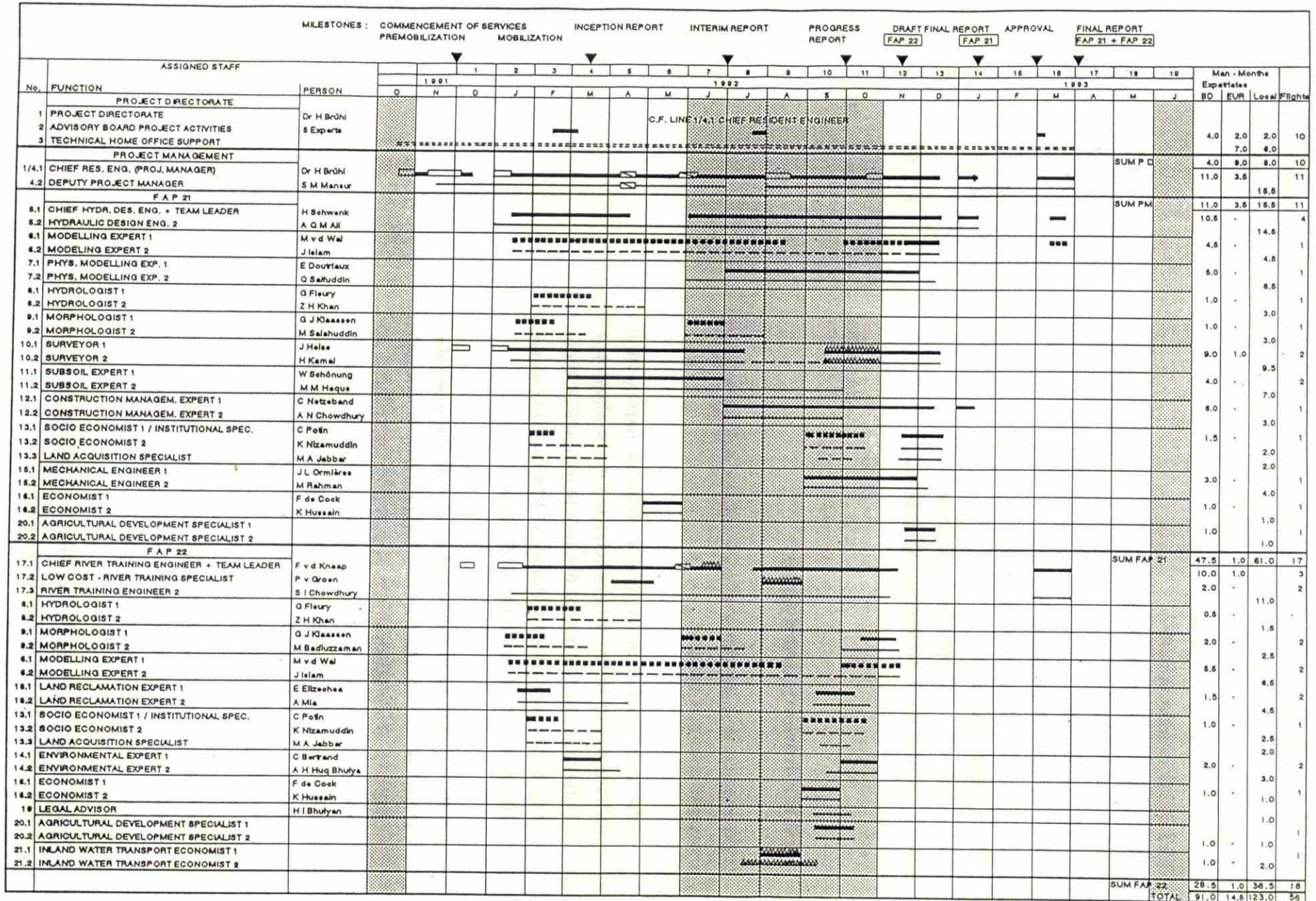
1991: O N D — 1992: J F M A M J J A S O N D — 1993: J F M A — 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

//// Monsoon ▭ in Europe ▬ — in Bangladesh

FIG. 6-2

FAP 21/22 STAFFING SCHEDULE - PLANNING STUDY

20 MARCH 1992



No.	FUNCTION	PERSON	Man - Months Expatriates BD	EUR	Local	Flights
	PROJECT DIRECTORATE					
1	PROJECT DIRECTORATE	Dr H Brühl				
2	ADVISORY BOARD PROJECT ACTIVITIES	6 Experts				
3	TECHNICAL HOME OFFICE SUPPORT		4.0	2.0	2.0	10
	PROJECT MANAGEMENT			7.0	6.0	
1/4.1	CHIEF RES. ENG. (PROJ. MANAGER)	Dr H Brühl	4.0	8.0	8.0	10
4.2	DEPUTY PROJECT MANAGER	S M Mansur	11.0	3.5		11
	F A P 21				16.5	
5.1	CHIEF HYDR. DES. ENG. + TEAM LEADER	H Schwenk	11.0	3.5	16.5	11
5.2	HYDRAULIC DESIGN ENG. 2	A Q M Ali	10.5	-		4
6.1	MODELLING EXPERT 1	M v d Wal			14.5	
6.2	MODELING EXPERT 2	J Islam	4.5	-		1
7.1	PHYS. MODELLING EXP. 1	E Doutrlaux			4.5	
7.2	PHYS. MODELLING EXP. 2	Q Saifuddin	5.0	-		1
8.1	HYDROLOGIST 1	G Fleury			6.5	
8.2	HYDROLOGIST 2	Z H Khan	1.0	-		1
9.1	MORPHOLOGIST 1	G J Klaassen			3.0	
9.2	MORPHOLOGIST 2	M Salahuddin	1.0	-		1
10.1	SURVEYOR 1	J Helse			3.0	
10.2	SURVEYOR 2	H Kamal	9.0	1.0		2
11.1	SUBSOIL EXPERT 1	W Schönung			9.5	
11.2	SUBSOIL EXPERT 2	M M Haque	4.0	-		2
12.1	CONSTRUCTION MANAGEM. EXPERT 1	C Netzeband			7.0	
12.2	CONSTRUCTION MANAGEM. EXPERT 2	A N Chowdhury	6.0	-		1
13.1	SOCIO ECONOMIST 1 / INSTITUTIONAL SPEC.	C Polin			3.0	
13.2	SOCIO ECONOMIST 2	K Nizamuddin	1.5	-		1
13.3	LAND ACQUISITION SPECIALIST	M A Jabbar			2.0	
15.1	MECHANICAL ENGINEER 1	J L Ormikres			2.0	
15.2	MECHANICAL ENGINEER 2	M Rahman	3.0	-		1
16.1	ECONOMIST 1	F de Cock			4.0	
16.2	ECONOMIST 2	K Hussain	1.0	-		1
20.1	AGRICULTURAL DEVELOPMENT SPECIALIST 1				1.0	
20.2	AGRICULTURAL DEVELOPMENT SPECIALIST 2		1.0			1
	F A P 22				1.0	
17.1	CHIEF RIVER TRAINING ENGINEER + TEAM LEADER	F v d Knaap	47.5	1.0	61.0	17
17.2	LOW COST - RIVER TRAINING SPECIALIST	P v Groen	10.0	1.0		3
17.3	RIVER TRAINING ENGINEER 2	S I Chowdhury	2.0	-		2
8.1	HYDROLOGIST 1	G Fleury			11.0	
8.2	HYDROLOGIST 2	Z H Khan	0.5	-		-
9.1	MORPHOLOGIST 1	G J Klaassen			1.5	
9.2	MORPHOLOGIST 2	M Badluzzaman	2.0	-		2
6.1	MODELLING EXPERT 1	M v d Wal			2.5	
6.2	MODELLING EXPERT 2	J Islam	5.5	-		2
18.1	LAND RECLAMATION EXPERT 1	E Elizeches			6.5	
18.2	LAND RECLAMATION EXPERT 2	A Mia	1.5	-		2
13.1	SOCIO ECONOMIST 1 / INSTITUTIONAL SPEC.	C Polin			4.5	
13.2	SOCIO ECONOMIST 2	K Nizamuddin	1.0	-		1
13.3	LAND ACQUISITION SPECIALIST	M A Jabbar			2.5	
14.1	ENVIRONMENTAL EXPERT 1	C Bertrand			2.0	
14.2	ENVIRONMENTAL EXPERT 2	A H Huq Bhuiya	2.0	-		2
16.1	ECONOMIST 1	F de Cock			3.0	
16.2	ECONOMIST 2	K Hussain	1.0	-	1.0	1
19	LEGAL ADVISOR	H I Bhuiyan			1.0	
20.1	AGRICULTURAL DEVELOPMENT SPECIALIST 1					
20.2	AGRICULTURAL DEVELOPMENT SPECIALIST 2					1
21.1	INLAND WATER TRANSPORT ECONOMIST 1		1.0	-	1.0	
21.2	INLAND WATER TRANSPORT ECONOMIST 2		1.0	-	2.0	1
			28.5	1.0	38.5	18
			91.0	14.5	123.0	56

		Changes in MM Exp.	Changes in MM Loc.	Changes in Flights
13.1	Socio-Economist-1 Institutional Specialist	0		+ 1.0
13.2	Socio-Economist-2		0	
13.3	Land Acquisition Specialist		- 0.5	
16.1	Economist-1	- 2.0		0
16.2	Economist-2		- 2.0	
18.1	Land Reclamation Expert-1	0		0
18.2	Land Reclamation Expert-2		- 0.5	
19	Legal Advisor		- 1.0	
20.1	*Agricultural Development Specialist-1*	*+ 2.0*		*+ 2.0*
20.2	*Agricultural Development Specialist-2*		*+ 2.0*	
	Subtotal	0	- 2.0	+ 3.0

(ad iii) Advisory Board Experts

During the first missions of some of the Advisory Board experts it turned out that

- some additional input by the Chinese expert in his institute would be very beneficial for the Project. He will make accessible special Chinese literature and other documentation on river training/AFPM, provide some translations and arrange the study tour.

- On the other hand it become clear that due to a certain overlap of experiences the assignments of the other experts to Bangladesh could possible be reduced and modified. So it seems very useful to have the expert on geotextiles paying a visit to Bangladesh, particularly in respect of advising on the investigations to be carried out on the filter testing.

There will be no change in the total assignment months of the Advisory Board experts. However a decrease of the number of flights is expected. 0 - 2.0

Total difference of 20 March Staffing Schedule compared to the 1 January Schedule	**+ 4.0**	**+ 1.5**	**+ 3.0**

ANNEX I

TERMS OF REFERENCE

B A N G L A D E S H

A C T I O N P L A N F O R F L O O D C O N T R O L

F A P 2 1 / F A P 2 2

B A N K P R O T E C T I O N A N D

R I V E R T R A I N I N G / A F P M

P I L O T P R O J E C T

T E R M S O F R E F E R E N C E

FLOOD PLAN COORDINATION ORGANIZATION

MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL

Dhaka, Oktober 1990

PREAMBLE

The Action Plan for Flood Control is to be seen as the first of several stages in the development of a comprehensive system of flood control and drainage works. It would be carried out in parallel with agricultural development and a program of non-structural measures such as flood preparedness and disaster management. The plan will set the foundations of a long-term program to meet the objective of achieving a permanent and comprehensive solution to flood control.

Provision of stable embankments on both banks and improvement of water control in the areas protected along both sides of the Brahmaputra (Jamuna) as well as the Active Flood Plain Management (AFPM) are high priority objectives.

The strategy of the Flood Action Plan is to make a start with the provision of stable embankments along the main rivers of Bangladesh, starting at the upstream end. Priority is therefore attached to a program for embankments along the Jamuna initially. For that reason efforts to control erosion of the banks of the Jamuna, by means of bank protection, river training and/ or appropriate measures in the riverbed have got high priority as well.

The Action Plan contains 11 main components and 15 supporting activities. These have the objective to procure data and information needed for the preparation of the future projects. The activities FAP 21 and FAP 22 are planned to be located on the Jamuna River and comprise:

- Activity FAP 21 : Bank Protection Pilot Project
- Activity FAP 22 : River Training and Active Flood Plain Management (AFPM) Pilot Project.

The Bank Protection Pilot Project aims at evolving appropriate bank protection techniques, considering river characteristics, availability of material, construction method and cost involved. In Bangladesh the rivers can be categorised depending upon the severity of erosion. Useful experience and bank protection methods exist in the country for the various river categories. However, there is a need for improvement, especially for the large rivers, by adopting modern materials and techniques, to make the works durable and cost-effective. Output from this component of the FAP will be useful in all the regional development activities that will be recommended through FAP 1,2,3,4,5,6 and 9. For field trials of the recommended methods that will emerge from literature review and performance evaluation of completed projects suitable sites have to be located on the banks of the Jamuna.

The River Training and AFPM Pilot Project aims at evolving appropriate and cost-effective methods for works in the Active Flood Plain to control currents to prevent bank erosion and to reclaim and preserve new land in the river bed for settlements and agricultural use. Suitable sites for trials have to be located in the northern reach of the Jamuna.

It is necessary to establish the most economic, appropriate and effective combination of Bank Protection and River Training and AFPM activities. Even though the Pilot Projects for activities FAP 21 and FAP 22 may be carried out in separate locations, they shall allow to conclude on the combined effects.

1. Background

1.1 The disastrous 1987 and 1988 floods in Bangladesh raised considerable international interest in helping the country to find a long-term solution to its flood problem. A number of studies were undertaken and, in June 1989, the Government of Bangladesh requested the World Bank to coordinate the preparation of a five-year Action Plan for Flood Control in Bangladesh. The role of the Bank in co-ordinating international efforts to assist Bangladesh in flood control was endorsed in the Communique of the G7 Economic Summit Meeting held in Paris in July 1989. The Action Plan was discussed and endorsed by a meeting of donors held in London in December, 1989.

1.2 The Action Plan consists of project-oriented studies in all the country's main regions, supporting activities to promote improved project design and execution, and non-structural measures. For each plan component, one or more donors have expressed an interest in financing first phase activities, comprising surveys, studies or pilot projects. The various actions are to be implemented by these donors in close cooperation with the Government of Bangladesh and under the co-ordination of the World Bank, as described in the Action Plan.

1.3 FAP 21 and FAP 22 are restricted in size, configuration and time. However, the monitoring methodologies adopted shall allow to verify or predict the long-term behaviour of construction materials and selected designs, to appraise the safety and durability of River Training measures and to gather information on Active Flood Plan management procedures in order to gain design criteria for application in the regional and other planning studies.

1.4 Because of the close relationship of both projects, they have been merged into one package, the Bank Protection and River Training AFPM Pilot Project and will be handled by one consultant group. This project is related to other FAP activities, such as:

- FAP 1 : BRE strengthening
- FAP 2 : North West Regional Study
- FAP 3 : North Central Regional Study
- FAP 9 : Other Town Protection
- FAP13 : Operation and Maintenance Study
- FAP14 : Flood Response Study
- FAP15 : Land Acquisition and Resettlement Study
- FAP16 : Environmental Study
- FAP19 : Geographic Information System
- FAP24 : River Survey Program
- FAP25 : Flood Modelling and Management
- FAP26 : Institutional Development Program

The Consultant for the Bank Protection and River Training/AFPM Pilot Projects has to keep in mind possible interactions with those activities. However, his proposal should be self-sufficient so that missing information from other projects does by no means delay his performance.

1.5 The Consultant shall acquaint himself especially with the studies to be performed under FAP 3 North Central Regional Study and FAP 3.1 Jamalpur Priority Study, both of which are concerned with the design of the embankment along the left bank of the Jamuna and which may indicate the necessity of bank protection works in critical places.

1.6 The Consultant shall inform himself about the activities concerning river training performed under the Jamuna Bridge Project, and about the modelling activities done by the MPO/SWMC. He should acquaint himself with the completed and on-going programmes of bank protection and river training works carried out by BWDB and other agencies. He shall moreover take into account the data collection programs of BWDB and BIWTA.

1.7 The Bank Protection and River Training AFPM Pilot Project (Activities FAP 21 and FAP 22) will be financed jointly by the Federal Republic of Germany (via Kreditanstalt für Wiederaufbau, KfW) and France (via Caisse Centrale de Cooperation Economique, CCCE), with the KfW acting as the leading agency.

1.8 The implementing agency will be the Flood Plan Co-ordination Organization (FPCO). After the contract with the Consultant has been concluded, the further handling and supervision of the contract shall lie with FPCO.

2. THE LOCATION

2.1 The Bank Protection and River Training/AFPM Pilot Project initially concerns this downstream reach of the Brahmaputra (Jamuna) within Bangladesh from the Indian Border to the confluence with the Ganges. On both sides of the river embankments exist, although not continuously. Especially on the right bank the erosion can be serious, threatening also the embankments. In some places bank protection works, e.g. revetments and groynes have been constructed. For the construction of improved Bank Protection test works the Consultant may propose locations on both sides of the river. However, preference is to be given to the left bank because of priority development - the right bank protection being covered by FAP 1. Measures to be tested within the AFPM-component of the project concern the Active Flood Plan within the mentioned river reach between the right bank and the left bank of the Jamuna. Wherever reasonably possible the test works are to be located at such sites where they can have direct benefits.

3. OBJECTIVES AND EXPECTED OUTPUTS

3.1 The objectives of the project are:

- For the Bank Protection Pilot Project (FAP 21):

  to find improved solutions for the structural design, use of construction materials and methods of realization by designing and constructing different types of full scale test protection works at some selected locations on the Jamuna River and by monitoring the behaviour of these test works;

- For the River Training and Active Flood Plain Management Pilot Project (FAP 22):

  to find methods of appropriate interventions in the active flood plains of the main rivers, which aim to control bank erosion and achieve river stabilization, and which at the same time could have application to the development and management of the active flood plain. The assessment of river training methods, designs and construction materials is expected to lead to pilot trials at selected locations on the Jamuna River.

3.2 The output of the project is expected to include:

- an understanding of the behaviour of the Jamuna with and without the effect of the applied works;
- a critical evaluation of all the tests that have been carried out, covering technical, financial and economic aspects, social and environmental implications, as well as institutional requirements;
- recommendations for the applicability of the tested works for the Jamuna and other rivers in Bangladesh
- design criteria for bank protection, river training and AFPM works for rivers in Bangladesh and guide-lines and manuals for the design, construction and maintenance of such works;
- a core of Bangladeshi engineers who are thoroughly trained in planning, designing, constructing and maintaining such works, including the necessary surveys and preparatory studies;
- as far as reasonably possible residual physical works that are suitable for continued maintenance and which are preferably situated at such locations where they have a direct benefit.

4. SCOPE OF WORK

4.1 The program will be executed in two phases; a planning phase followed by a test phase. Within the planning phase (1 year) the Consultant will carry out a study for the full scale trials (Bank Protection and River Training/AFPM measures), based on the evaluation of the experience in the past, on examination of new techniques and construction materials and, if necessary, additional investigations. In the planning study also the problems and possibilities of

river training activities will be treated and medium term applied research and planning strategy will be developed with the objective to identify a short term meaningful and cost effective first package of investigations, which may lead in the long run to a reliable planning basis for Jamuna river stabilization, taking into account measures for Active Flood Plain Management including land reclamation.

4.2 After presentation of the draft final report on the results of the Planning Phase the findings will be scrutinized by a small group of internationally reputed experts, to be selected by the funding agencies in close consultation with the FPCO. The proposals of the Consultant will be discussed in detail and a decision will be taken by the FPCO and the funding agencies on the definition and the extent of the test phase. It will be decided among other on the locations of the test works, on their nature, size and design including construction materials and construction methods to be used. In addition, decisions will be taken on the procedures and the organizational matters connected to the implementation of the test works and test measures as well as on the time schedule and the methodology of the Monitoring and Test Program after the implementation of the test works.

4.3 Only after these basic decisions the consultant will continue the Test Phase and prepare the final design for the test works and test measures. He will handle procurement of those goods and services required for the implementation of the tests wich cannot be provided by his own means. These goods and services will be subcontracted by him. He will manage the implementation of the test works in the framework of his overall responsibility and liability for the project.

4.4 During the monitoring and adaptation stages the Consultant will observe the performance and effects of the test works and test measures for at least three years after their completion. If necessary, he will arrange for repair and/or modification of test works and test measures during this period, acting again in full responsibility.

4.5 In his final evaluation the Consultant will give recommendations on the most cost effective and appropriate methods for design, appropriate materials, construction and maintenance of the bank protection works as well as River Training works and measures for Active Flood Plain Management.

5. TERMS OF REFERENCE

5.1 Introduction

Based on the objectives and scope of work the Consultant will in his proposal elaborate a work program - in detail for the Planning Phase and in outline for the subsequent Test Phase. In his proposal he will describe extent, size and organization of the program indicating required staff,

logistical arrangements and goods and services either to be provided by the Consultant's own means or to be subcontracted by him. The proposal will also include a detailed time schedule for the Planning Phase and a cost estimation (in the form of a firm financial offer for the Planning Phase and in the form of an option for the Test Phase).

5.2 Bank Protection Pilot Project (FAP 21)

5.2.1 General

As shown in the past, protection against erosion of the banks and embankments of the Jamuna River by construction of groynes and revetments by local methods is difficult, expensive and in some cases not successful. But inspite of these problems, it is often the only type of works which can ensure an efficient protection of some priority sites, e.g. towns and ghats.

The objective of the Bank Protection Pilot Project is to find improved solutions for the design, use of construction materials and methods of realization by designing and constructing different types of test protection works at some selected locations on the Jamuna River and by monitoring the behaviour of these test works in scale 1:1.

The project will be carried out in the following steps:

5.2.2 Planning Study

5.2.2.1 Review of all existing data

The Consultant will review the relevant available and ongoing studies and data especially for the Jamuna River, but also for other rivers in Bangladesh with similar problems.

5.2.2.2 Selection of the test sites

The Consultant will carry out preparatory activities for the selection of the test sites, for example:

- reconnaissance of other major rivers in Bangladesh to assess the applicability of the Pilot Project
- thorough field inspection on site on both banks of the Jamuna River
- topographic and hydrometric survey
- measures of the local flow conditions and the morphology in the areas proposed for the test works, investigations of the soil conditions, assessment of the wave conditions.
- investigations based on mathematical models, if deemed necessary. The use of Mike 11, through the surface water modelling centre of MPO is required.

- use of satellite imageries

The Consultant will study various sites, for a final proposal, including:

- about 3 to 6 groynes, (however at least 3) of possibly different shapes, on one or two sites. Improvement of existing groynes may be considered as well

- about 3 sites for bank revetment tests

Final number of sites, structures and their size will depend on the justified need of the test program and available funds. The Consultant will propose the locations for the test works at priority sites, particularly on the left bank, where they may have a long-term benefit. He will develop the criteria for the selection of the sites, and give justification for his proposals including cost effectiveness of alternative technical solutions and application at sites on other major rivers. He will pay due attention to other activities of the FAP as well as projects of BWDB to take account of their findings and to avoid duplication.

5.2.2.3 Selection of design and construction methods

The Consultant will analyse the locally available materials, e.g. jute, bricks, concrete blocks with local aggregates and execute the testing of their properties. He will do an inspection, examination and evaluation of existing protection works and make an assessment on their respective success or failure.

He will appraise the feasibility of modern methods and new materials under the conditions prevailing in Bangladesh.

The Consultant will prepare alternative designs of the test protection works and will specify the hydrological design event(s) to be established in conjunction with FAP 25. In proposing alternative solutions the Consultant may take into his consideration the partial renewal or extension of existing protection works. He should review and may improve on traditional local design, using materials locally available, as well as design based on modern methods and new materials, e.g. geotextiles. Also the use of locally available materials in different combination with new material should be considered.

He also has to take into account the lack of coarse material such as gravel and stone (e.g. boulders would have to be imported from long distances i.e. Sylhet, Chittagong Hill Tracts, India or Bhutan), the fineness of the sediment and the huge scour depths to be expected. He has to analyze the different methods, which may be used and propose the most cost effective and economic solutions.

5.2.2.4 Preparation of the Test Phase

The Consultant will have to take preparatory steps for the following test phases, e.g. preliminary negotiations with contractors (preferably local) and preparing procedures for the eventual import of construction materials for implementation of the test works. He will evaluate, if new construction equipment should be imported or if it should be hired abroad or locally. He will decide on the usefulness of scale models tests. These models will be performed preferably in the RRI and/or in the Consultants own facilities.

The Consultant will submit a revised and detailed implementation plan, including time schedule, number and qualification of his personnel and a detailed cost estimate of his cost and fees as hiring and purchase of equipment and other subcontracts for the following phases.

Any revision of his financial proposal should be in the framework of his original proposal and contract.

After submission of the Planning Study the FPCO and the Funding Agencies will decide on the continuation of the programme as pointed out above (see 4.2).

5.2.3 Preparation of Implementation

After the approval of the planning study the Consultant will prepare the final design and necessary documents for the supply of materials and the execution of test works.

The Consultant will carry out the test works with preferably local subcontractors under his full responsiblity and liability in order to have a maximum of flexibility under difficult conditions, to carry out time critical unforeseen adaptation works and repairs. He will be responsible for the preparation and organization of the implementation of the works.

After having received prior approval of the FPCO he will withdraw funds directly from KfW/CCCE project accounts to cover the expense for the supplies and works. The Consultant will maintain books and records on utilization of project funds. He will enable also representatives of FPCO and the Funding Agencies to inspect such books and relevant documentation to the utilization of project funds.

5.2.4 Implementation of Test Works

For the planning, preparation and execution of test works the Consultant will provide his own construction management (if he deems necessary through engagement of experienced personnel from contractors). Hence the costs for the construction management have to be included in the offer submitted by the Consultant. Through his construction management he will in due

time provide for necessary construction equipment, in addition to the manpower, taking into account local availability of reliable equipment in accordance with the envisaged construction methods.

5.2.5 Monitoring and Adaptation of Test Works

The Consultant will elaborate an overall implementation schedule, in the context of the Planning Study, which allows the monitoring of the test works during at least three seasons within the Bank Protection Pilot Project.

He will propose a monitoring programme, which comprises sufficient measurements of the flow conditions and the morphology, especially through measurements of the development of scours at the toe of the test works and the behaviour of the bank protection under the scour effect. He has to monitor the morphological effectiveness of the structure in terms of quality, quantity and time.

He will scrutinize damages or failures and make a critical assessment, to provide for necessary repairs or modifications of the test works concerning construction and eventually geometrical shape. After prior approval from FPCO, he will carry out the required repairs and modifications under the same procedures as stated above. Appropriate procedures, for which the Consultant may put forward his proposals, will be established for emergency or timely repairs.

5.2.6 Intermediate and Final Evaluation, Outcome

The Consultant will in detail assess and describe the advantages and disadvantages of the works tested. The designs, construction aspects, performance and local effects will be evaluated carefully. He will also determine the financial and economic feasibility of the works.

The Consultant will establish recommendations for cost effective and appropriate improved concepts of structural design, construction methods and construction materials for the protection works taking into account the technical and physical aspects as well as the cost of construction and expected maintenance costs.

The Consultant will assess the reliability of the results, and will elaborate the criteria for generalized extension of the results not restricted to the local site conditions to enable possible wide spread application of the results.

Finally, he will give recommendations for further investigations after the monitoring period of three years.

Preliminary results of these evaluations have to be presented in an intermediate evaluation report end of 1995, in order to provide first recommendations to FAP, besides of the regular reports to be submitted.

The final evaluation report will be submitted at the end of the project.

5.3 River Training and AFPM Pilot Project (FAP 22)

5.3.1 General

Bank protection works such as groynes, spurs etc. are the traditional solutions for local bank erosion prevention; in this solution the river courses of the channels composing the braided bed, upstream and downstream of the works remain free to change in position and geometry.

River training is a solution which aims through light and/or heavy structures, not necessarily located nearby the threatened zone to close secondary channels and stabilize the main channel course away from the zone to be protected. Light river training means are e.g. bandals, bottom panels, dredging etc.

Therefore, theoretically both bank protections and flood plain land reclamation benefit from this technique. Reference is made to the ideas of the Active Flood Plain Management (AFPM), as laid down in the Flood Action Plan.

Although river training by means of light structures, could appear cheaper at first sight than the traditional groynes for local bank protection, its efficiency and possible implementation in a powerful river such as the Jamuna remain questionable. However, because of the prospect of substantial savings and because of its possible application to future long term river control, this limited objective option should be investigated and if practicable, pilot trials carried out.

A preliminary assessment of the "State of the Art" for implementation of river training with heavy light or mixed structures is an important first step.

5.3.2 Planning Study

The Planning Study should be carried out in stages.

(a) Investigation of appropriate technical means for effective river training works on the Jamuna, including a rough assessment of possible size, cost and effectiveness of such means. A distinction should be made between temporary/seasonal works and permanent or semi-permanent works where sustainability is

important.

(b) Investigation of appropriate methods to predict the effect of such training works on the morphological behaviour of the Jamuna river, including an assessment of the reliability of such methods; their costs and time requirements.

(c) Preparation of an interim report in month 8, which would describe the findings of the preliminary studies and outline the options for a river training pilot project.

(d) Depending on the findings, preparation of design of the initial pilot project works with cost estimated, schedules, manpower and material/equipment requirements.

(e) Assessment of AFPM requirements, in the light of possible river training measures and its appropriate incorporation in the Pilot Project.

(f) Preparation of an outline strategy for the medium term investigations and extended trials necessary to lead to a reliable planning basis for major investment in river training works in the Jamuna.

(g) Preparation of a draft planning report in month 14 which will include fully detailed proposals for carrying the Pilot Project.

The Consultant shall develop his own methodology for the planning study and will present it in his proposal. The scope of work includes but is not limited to the tasks mentioned hereafter:

- collect and scrutinze all appropriate practical experience in river training of relevant rivers of the world, which are comparable in size and/or morphology with the Jamuna River. Summarized lessons learned by this experience in relation to the proposed Jamuna River training options, especially in relation to effectiveness of the works and the reliability of the prediction of the morphological behaviour of the river.

- assess the specific size and cost of technically feasible means for river training which are known nowadays to interfere in a major stream of comparable size and morphology of Jamuna (e.g. groynes, cross bars, diversions or closures of channels, dredging etc.)

- assess the reliability, effectiveness and, if appropriate, sustainability of such training measures.

- examine scenarios for possible overall investment, operation and maintenance costs for various levels of river training measures on the Jamuna and their likely benefits in the context of the objectives of the FAP.

- prepare an outline risk assessment of morphological interference by river training, expecially to possible secondary effects.

- identify state of the art of tools and techniques to analyse and predict the morphological behaviour of major braided rivers of a size comparable to the Jamuna (e.g. physical scale model, mathematical model, theoretical and probalistic approach etc.)

- assess the applicability and reliability of those tools available. For major training works only such tools and techniques should be investigated, which have proven their reliability to such a degree, that reliable results can be expected in a reasonable period.

- identify the data base needed for the application of those tools, their cost, including data collection, time needed for meaningful results, their degree of reliability compared with the risks involved for the investment in major river training in the Jamuna.

- develop an outline strategy to approach the planning of river training in the Jamuna with more or less available and proven investigation tools. Consider a medium term planning period of 10-20 years and a short term period of 4 years being consistent with the medium term strategy.

- identify and assess the applicability and appropriateness of short term "light" training methods for achieving limited objectives and as a first stage of developing an understanding of river behaviour. Methodology should be based on traditional and proven techniques.

- evaluate the likely planning and investigation costs including necessary data collection for both strategies.

- assess the likely reliability of the proposed approach compared to the relevant investment involved.

The approach of the study should be done in a pragmatic way only based on readily available information, especially the results of FAP 1. Specialised research works are not expected. All statements should reflect state of the art in river training including traditional methods. All aspects should consider size and morphological conditions of

the Jamuna. The study should be submitted not later than month 14. Presentation should summarize the major findings, however, give comments and resource data to be able to verify the basic assumptions.

5.3.3 Further Steps

The further steps (Definition of the extent and size of the Implementation Phase, Preparation of Implementation, Implementation of Test Works and Test Measures, Monitoring and Adaptation, Evaluation) will be undertaken following the same procedures as described above under 4 and 5.2.

5.4 Complementary Activities

The Consultant will include in the Planning Study proposals for appropriate institutional arrangements and procedures necessary to execute the Bank Protection and River Training/AFPM Pilot Projects and further steps for implementation of Bank Protection Works. If necessary these include proposals for land acquisition and suitable arrangements for resettlement. Coordination with the relevant on-going FAP activities (e.g. FAP 15, 26 etc.) should be established.

5.4.1 The Consultant will make outline proposals for effective training programmes to achieve a maximum transfer of knowledge and to make sure a competent continuation of the activities after the end of the Project and withdrawal of the Consultant. Details of such programmes and of the institutions involved will be determined with FPCO during the Planning Phase.

6. **REPORTS**

The following reports will be submitted by the Consultant:

- In his offer the Consultant will submit a comprehensive technical proposal elaborating his intentions on the extent, size and organization of the program as described above. To allow for thorough preparation, the proposal period will be four months.

- During the Planning Phase (1st year) he will submit 4 quarterly Progress Reports, containing also the most important intermediate results, the personnel and financial situation as well as deviations from the original program and problems faced. The first of these four quarterly reports will form the Inception Report, the fourth at the end of the Planning Phase will be the Draft Final Report.

- After examination of the Draft Final Report and decision on the continuation of the program (see above 4.2) the Consultant will submit the Final Planning Study three months after the end of the Planning Phase.

- During preparation, implementation, monitoring and adaptation he will give quarterly Progress Reports.

- During monitoring the Consultant will after each flood season submit a yearly report summarising observations and experience gained during the monitoring campaign and give conclusions to be drawn and the justification for the proposed adaptations of the test works.

- A Preliminary Evaluation Report will be submitted by the end of 1995 and the Final Evaluation Report at the end of the project.

7. PROJECT DURATION AND SCHEDULES

The bar charts shown in Figure 1 and 2 give the indicative timing for the main activities. The Consultant will produce a detailed schedule taking into consideration the likely availability of results from supporting activities and based on their assessment of the requirements of the projects. The signing of the contract is taken as month 0 of the program. A mobilization period of 2 months is allowed for.

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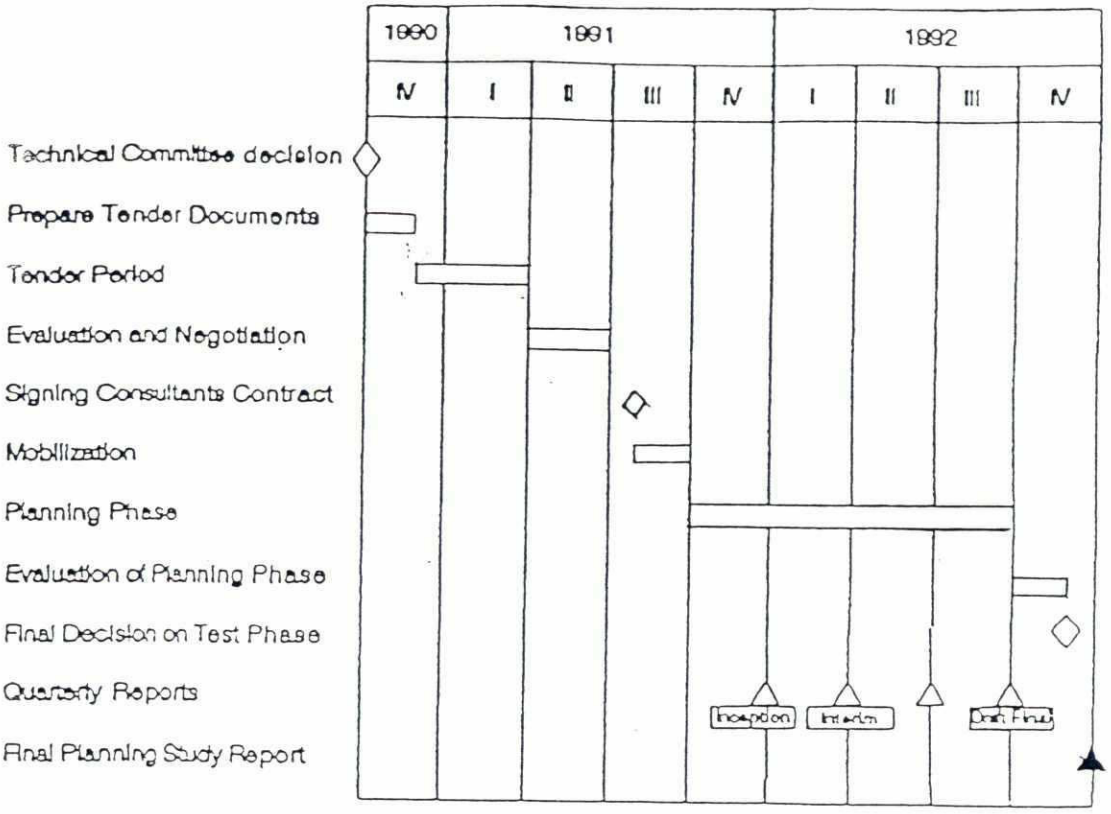

Figure 1 PLANNING PHASE

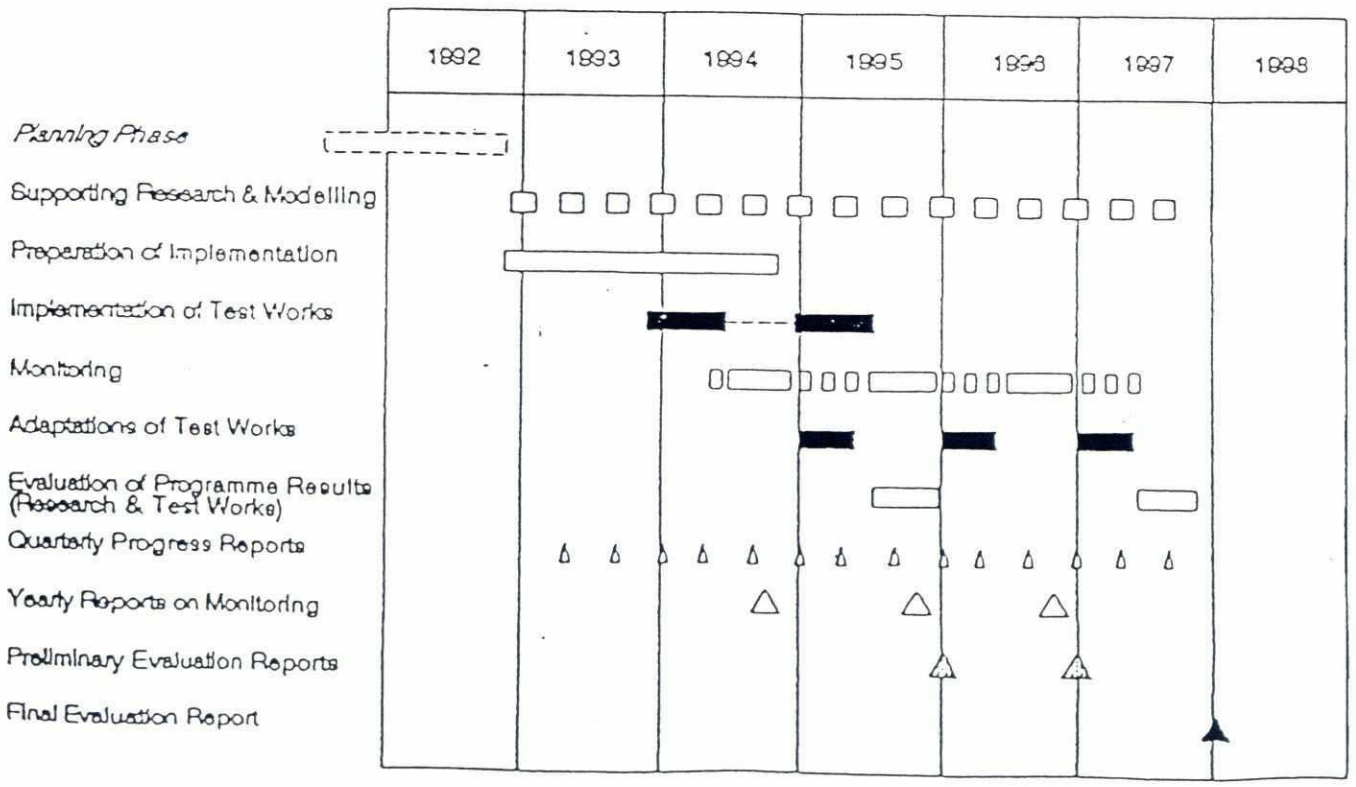

Figure 2 TEST PHASE

ANNEX II

PLANNING STUDY TASK DESCRIPTIONS
(AS PER CONSULTING AGREEMENT)

TASK: **MOBILIZATION AND PROJECT PREPARATION**

FAP: 21/22 T.o.R.:--

OBJECTIVES: To organize the assignment of the team members and to provide for all facilities and equipment necessary for a smooth performance of the project.

INPUT:
- organizational set-up (Chapter E)
- staffing (Chapter J)
- facilities, equipment and logistics (Chapter L)

DETAILS: This offer is based on the assumption that most of the work - even during the Planning Study - will be carried out in Bangladesh. Project preparation in Europe will be limited mainly to discussions relating to the assigments of the experts and the general aspects of project organization.

The main activities of project preparation will be carried out in Bangladesh by the chief resident engineer in cooperation with the local partner. These are:

- liaise with the authorities and institutions concerned
- procure all relevant project data available in Bangladesh
- procure the logistics required
- rent and equip office rooms
- procure vehicles and other equipment
- procure accomodation
- hire local supporting staff etc.

OUTPUT: Project preparation will be done to such a degree that the experts are able to immediately start the project work entrusted to them.

STAFF:
- Responsible:
  chief resident engineer
- Further activities:
  competent staff of the local partner

TASK: **REVIEW OF EXISTING DATA**

FAP: 21/22 T.o.R.:5.2.2.1

OBJECTIVES: To review existing data and available and ongoing studies on the hydrological, hydraulic, sedimentological, morphological, geotechnical, socio-economic and environmental conditions of the Jamuna River and its floodplains, and other rivers in Bangladesh with similar problems.

INPUT: No inputs required from other tasks. Major inputs from ources outside the project (GoB offices, local consultants, other projects, etc.)

DETAILS: Although many data on rivers and river banks in Bangladesh have been collected, these data can not be used easily, firstly because they are scattered over different governmental offices, secondly because no attempts have been made until now to bring the data together to obtain a more complete picture, and thirdly because a thorough check on the accuracy of the data has never been carried out. Considering the limited time available in the present project, the review of existing data can only be done using data readily available from Government offices (BWDB Hydrology, BWDB Morphology, River Research Institute, SPARRSO, etc.) and from consultancy reports.

The Consultant has a good insight into which type of data can be obtained where. This is based on the experience the partners and the individual experts have obtained in working in Bangladesh in the recent past. Furthermore, some data bases are available at the Consultant's offices which merely have to be updated to get a fairly complete set of data on some aspects. Whenever appropriate, checks on the consistency of the data will be made and if felt necessary, data may be excluded from the analysis. Considering the above, the Consultant will introduce the data as much as possible in simple data bases to allow an easy access to the data (now and in future) and to allow for a screening on completeness, accuracy and consistency.

Not only data from the Jamuna River will be reviewed. The present project should also provide useful information on ther major rivers, consequently also data on the Ganges, Padma and Upper and Lower Meghna and possibly some other rivers will be reviewed. This holds especially for the socio-economic data, because these are less restricted to a particular river.

Although at present it is estimated that the available data will suffice for the present project, it is possible that some vital data are missing which should be known. It is proposed to make an allowance for the collection of such additional data. If and when required, he Consultant will propose in the Inception Report this to be covered by the contingencies. This proposal will also indicate the consequences of such additional data collection in terms of time and money. Considering the above, the present activity can be summarized as follows:

(1) collection of data from Government offices and other sources, as far as these data are not yet in the possession of the Consultant.

(2) identification of relevent Consultancy reports and review of data included in these reports.

(3) extending of existing data bases and developing of some new ones

(4) screening the data on completeness, accuracy and consistency

(5) preparation of review report of data considering the relevance for FAP 21 and FAP 22

(6) if appropriate, drawing up of proposals for additional data collection

OUTPUT: The review of the existing data will be given in the Inception Report, to be published 5 months after the start of the project. This review will include

(1) a list of all data found

(2) a critical evaluation considering the use of the data in FAP 21 and FAP 22

(3) if appropriate, an indication of additionally needed data and

(4) if appropriate, recommendations as to how these additional data have to be collected, including a proposal for covering this from the contingencies.

STAFF:

- Responsible:
  chief resident engineer
- Further activities:
  hydraulic design engineers
  hydrologists
  morphologists
  subsoil experts
  land reclamation experts
  socio-economists
  environmental experts and economist

TASK:

INSTALLATION OF 1-DIMENSIONAL MATHEMATICAL MODEL (MIKE 11)

FAP: 21/22 T.o.R.:5.2.2.2

OBJECTIVES: To obtain a 1-dimensional mathematical model within the project that (for design and research purposes) can be used for the simulation of

(1) the water motion and

(2) the morphological changes in channel networks

INPUT: Copy of the MIKE 11 mathematical model with data basefrom SWMC (Surface ater Modelling Centre). Training of project staff members in the use of the MIKE 11 model.

DETAILS: Both for FAP 21 and FAP 22 the use of a 1-dimensional mathematical model is appropriate. These 1-dimensional models usually consist of two parts, one for the computation of the water motion and the other (the morphological part) for the computation of sediment transport and bed level changes. For the application in FAP 21 and 22 it is also important that the model can handle branched networks. Thist implies that the water and sediment distribution at bifurcations can be determined inside the program (water motion, being determined by the hydraulic conductivity of the downstream channels), or that it can be imposed (sediment transport, also being affected by the geometry of the bifurcation or by artificial measures like vanes, bandals, dams, etc.). The conditions at confluences are much more simple.

For FAP 21 e.g. such a model can be used for the determination of the so-called Jones-effect, the deviation of the actual velocity from the velocity corresponding to steady flow due to the passage of a flood wave and the related changes in water level slope. For FAP 22 such a model will be extremely useful to evaluate the effect of possible measures to influence the water and sediment distribution at bifurcations. The model can then determine how the significance of an eroding channel will be reduced as a result of such measures.

According to the Terms of Reference the use of MIKE 11 is required. In this particular case models will be developed for specific purposes by the project itself. This will be done by the Consultant's (expatriate) modelling expert, who has ample experience in the use of models similar to MIKE 11. In an early stage of the project the Consultant will review the capabilities of the MIKE 11 program for the use in both FAP 21 and FAP 22. If appropriate, adaptations of the program will be discussed with SWMC. Requests for adaptations will be channelled through the chief resident engineer, MPO via the chief resident engineer, FPCO , in conformity with the "Procedures and Conditions for Use for SWMC models for FAP activities".

As the project will work on DOS machines, the DOS MIKE 11 version will be requested, which according to the same regulations will be supplied without charge. This holds especially for the Brahmaputra/Jamuna branch that is already incorporated in the general Model of SWMC (only water motion). The Consultant's modelling expert will develop and / or extend this model in close cooperation with

SWMC staff in the centre. Once the model(s) have been developed they will be transferred to the project office of the Consultant's for further use. It should be mentioned here that within the framework of the Jamuna Bridge Study the Consultant has set up similar models of the Brahmaputra/Jamuna River, both for the water motion and the morphology, and the experience obtained in developing these models can be extremely useful in developing models on the basis of MIKE 11.

OUTPUT: No specific output, but the model will be used within different tasks, amongst others, the tasks 09 and 30.

STAFF:

- Responsible:
  modelling experts
- Further activities:
  chief resident engineer
  hydrologists

TASK: **RECONNAISSANCE OF MAJOR RIVERS IN BANGLADESH**

FAP: 21/22 T.o.R.:5.2.2.2/5.2.2.3

OBJECTIVES: The objectives of this task are two-fold:

(i) To make a reconnaissance of the Brahmaputra/Jamuna river and other major rivers in Bangladesh to assess the applicability of the Pilot Project

(ii) To collect and review experience in Bangladesh with bank erosion problems and bank protection measures along major rivers

INPUT: Review of data and existing reports on the various major rivers in Bangladesh (task 02).

DETAILS: An important aspect is to what extent the experience to be gained within FAP 21 and 22 can be used for rivers in Bangladesh other than the Brahmaputra/Jamuna river. This will be investigated during the inception phase, via a number of site visits. At the same time the experience with bank erosion problems and with bank protection measures in Bangladesh will be collected and reviewed.

Important in this assessment are the river characteristics, the socio-economic interests to be considered and the type of bank protection measures used. Therefore, a review will be made of these items at an early stage. Based on their experience (derived from recent or ongoing projects along the Ganges and Kustia rivers, the Kushiara and the Surma river and the Upper and Lower Meghna river, and from an analysis of existing data and reports on other major rivers like the Teesta) an overview of the river characteristics will be prepared. Socio-economic aspects will be added to this review. Also a list of bank protection works in Bangladesh will be made. Based on this review a selection will be made of the rivers and sites to be included in the reconnaissance survey.

The actual reconnaissance survey will not be carried out in one run. The Consultant will make about four trips of a few days to recognize the rivers and to discuss with BWDB officials and others relevant aspects like the history of bank protection works of the river concerned, including the experience gained over the years.

The results of the review and of the site visits will be used for the assessment of the applicability of the experience to be gained in FAP 21 and FAP 22 and for the preparation of a record of experience with bank protection works along major rivers in Bangladesh. Already now it can be stated that the characteristics of the Brahmaputra/Jamuna river (being a braided river) clearly differs from most of the other (meandering) rivers in Bangladesh. This implies that the experiences gained through FAP 22 will be largely applicable to the Jamuna river.

OUTPUT: In the Inception Report discussions will be included on:

(i) the applicability of the experience to be obtained during the project to rivers in Bangladesh other than the Brahmaputra/Jamuna river

(2) experience in Bangladesh with bank erosion problems and bank protection measures along major rivers

The latter results will be used in the generation of alternative concepts for bank protection works.

STAFF:

- Responsible:
  chief resident engineer
- Further activities:
  chief hydraulic design engineer/teamleader FAP 21
  river training expert/teamleader FAP 22
  hydrologists
  morphologists
  socio-economists

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TASK: **DETAILED FIELD INSPECTION OF THE JAMUNA**

FAP: 21 and 22 T.o.R.: 5.2.2.2

OBJECTIVES: To get a better and more detailed knowledge of the Jamuna river in order to determine the salient patterns of the banks and to help select the test areas

INPUT: Visits made during the proposal phase, other FAP's

DETAILS: The systematic inspection of the Jamuna will start with flights over the Jamuna banks so as to give a general survey of the main morphological changes since the last visits were carried out in March 1991, and in order to detect or confirm erosion prone areas and to assess their access possibilities (as reliable maps are not available).

The field visits will cover both banks, from the Teesta confluence, for the right bank, and from the Old Brahmaputra offtake, for the left bank, down to the Ganges confluence. The river will be divided into stretches according to the access possibilities by car, as the site visits made during the proposal phase have stressed the access problems. From the access points, boats will be used to inspect the bank conditions in the corresponding stretch. Special attention will be given to Sirajganj, Phulchari, Beara,Bahadurabad Ghat, Madarganj, and Jagganathganj Ghat, where serious erosion problems were noticed during the field visit or have been recorded in the past few years.

The typical characteristics of the banks (slopes, visual reconnaissance of the materials) will be noted, the existing protection (revetment, groynes, cross-bars, porcupines, jacks) will be systematically inspected and their main features (type, dimensions, design, materials, damage), will be recorded.

Meetings with the local authorities (site offices of BWDB, local governments) will permit in-depth discussions and data collection of relevant information on the erosion problems in a sector along with additionnal data linked with the protection works (year of completion, damages and repair works). This will help the consultant define the possible causes of failures, the evolution of the banks during the past years, the costs of repair or maintenance works and will provide valuable data on the capacity of local firms. Data (drawings, bill of quantities, updated schedules of rates, available equipment and materials) will be collected during the visits.

Reconnaissance of existing infrastructure (staff gauges, monuments and bench marks) and of the access roads will form part of the trips.

OUTPUT:

- improved knowledge of the present river conditions
- comprehensive list of existing protection works, including main features and damage
- tentative list of erosion prone areas, possible locations for the test areas.

STAFF:

- Responsible
  chief resident engineer
- Further activities:
  team leaders of FAP 21 and FAP 22
  morphologist
  mathematical and physical modelling experts
  subsoil engineer
  surveyor

TASK: **MORPHOLOGICAL ANALYSIS**

FAP: 21/22 T.o.R.:5.2.2.2/5.3.2

OBJECTIVES: The objectives of the morphological analysis are the following:

(1) to contribute to the site selection
(2) to assist in the determination of the design criteria for the river training works
(3) to estimate the morphological conditions that will be present at the selected sites in the period of construction of the bank protection works
(4) to provide possible future morphological changes as a basis for decisions regarding maintenance of implemented structures
(5) to assist in the intermediate evaluation and at the end of the testing phase in the evaluation of the methodology (used in the planning and detailed design phase and in the maintenance period) for the establishment of the design criteria for the river training works

INPUTS:

. field data like BWDB cross-sections (digitized, for the period up to 1987 available with the Consultant) over the years, (tapes with data of) satellite images

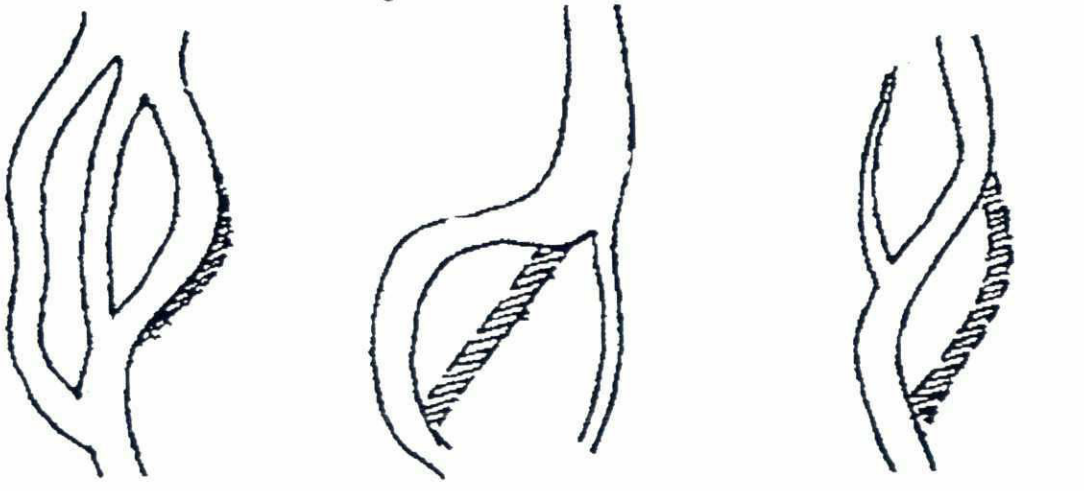
. special task study on remote sensing, the T.O.R given in annex Section N-1, former D-2 of Volume 2

DETAILS: In a morphological sense, the Brahmaputra/Jamuna river is a rapidly changing river due to:

. bank erosion
. cutoffs and
. new channels initiated by outerbend overflow channels

These different types of changes are schematically shown below.

Fig. 06-1



a) Erosion along outer bend

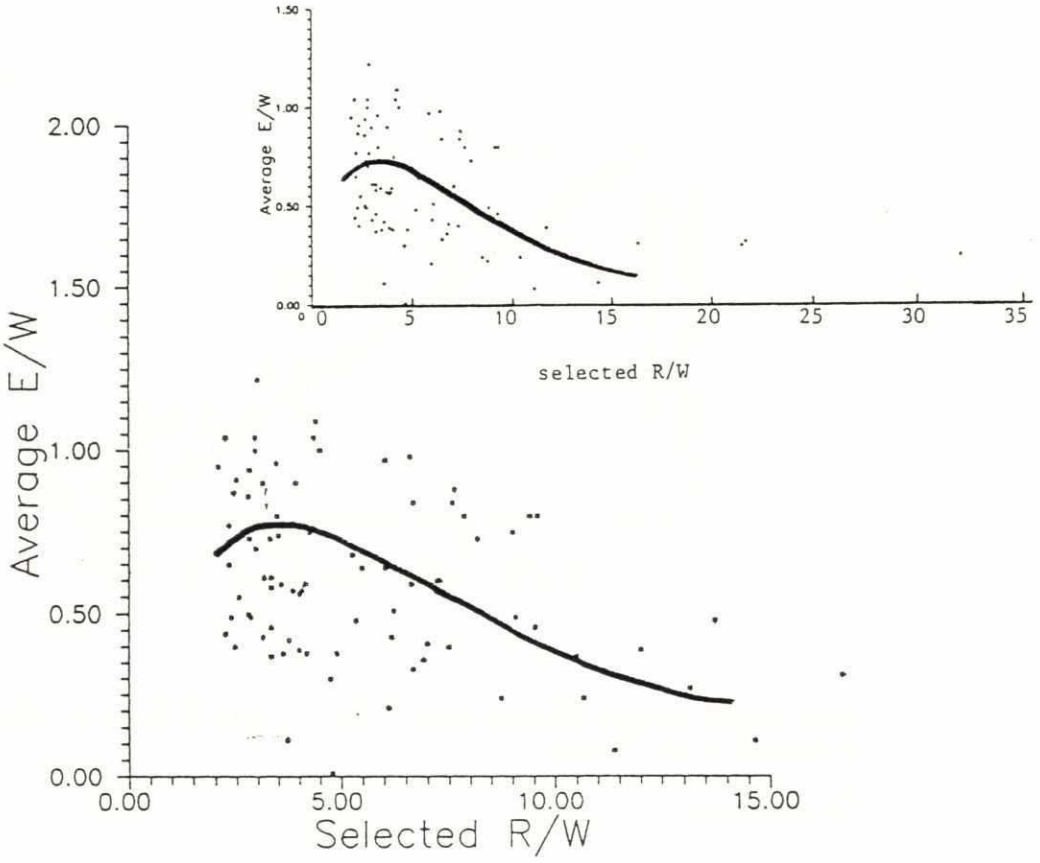
b) Cutoff

c) Formation of new channel

Recently the Consultant has done an exploring analysis of these changes and their occurrence in the Jamuna within the framework of the Jamuna Bridge project. The results of this analysis, combined with a more extended analysis of satellite images within the context of the present project, will be the backbone of the morphological predictions to be made within the present project. Some results of the exploring analysis are presented hereafter for a better understanding.

According to the recent analysis, the bank erosion rates of the river showed that the erosion could be up to 1 km/year and that the yearly relative erosion (bank erosion rate E / river width B) may vary between about 0.1 to 1.25, depending on the ratio between the radius of curvature R divided by W. See the figure below:

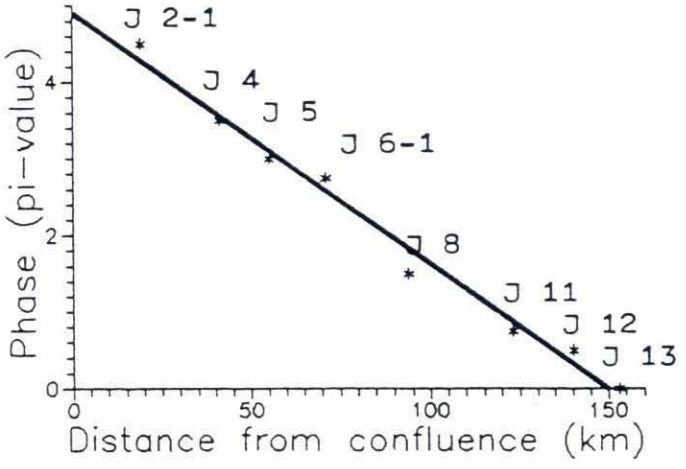
Fig. 06-2



Also cutoffs were studied and it was found that in braided sand-bed rivers like the Jamuna river these cutoffs take place already at low cutoff ratio's (between 1 .0 and 1.5!). Finally the development of a new channel from an outer bend overflow was also identified, although the actual analysis of this phenomenon was not attempted owing to the limited data available. The overall conclusion of the analysis of the changes in channel pattern is that they are only reliable for some 2 years. After that the chaotic components (like the length of the hydrograph and the related shifting of the second-order bars) become more and more dominant. For more details see Volume 2, annex D.

Another aspect that the Consultant studied is the changes in the cross-sections measured by BWDB since 1967 for those cross-sections in the Jamuna River where a continuous record is available. It was observed that most probably some periodicity is present in these cross-sections. The observed phase lag is plotted in the below figure:

Fig. 06-3



and it clearly suggests some periodicity. The time scale of the observed phenomenon seems to be some 20 years.

Site selection

The implication is that although from the analysis of the LANDSAT images it became clear that predictions for future channel patterns for two years and more ahead become less and less accurate, it is nevertheless possible (using the results of the analysis of the BWDB Soundings) to predict with some accuracy whether a certain location will continue to be attacked over the coming 5 years. This knowledge can be used advantageously for the selection of the test sites. In fact this selection has to be carried out on the basis of existing knowledge only, because the time is too limited to do an extensive study in the planning phase. The Consultant's plans, however, to incorporate in the analysis reported above (in particular of the BWDB soundings) the recent soundings to verify the approach suggested here.

Design criteria

Design criteria have to be established for the river training works considering the morphological conditions in the future. An optimal solution has to be found between initial costs and maintenance costs. This has to be based on an assessment of the morphological conditions over the say 5 years after the structures have been implemented. The morphological analysis has to provide this estimate of the morphological changes and also the accuracy and the upper and lower boundary of these predictions.

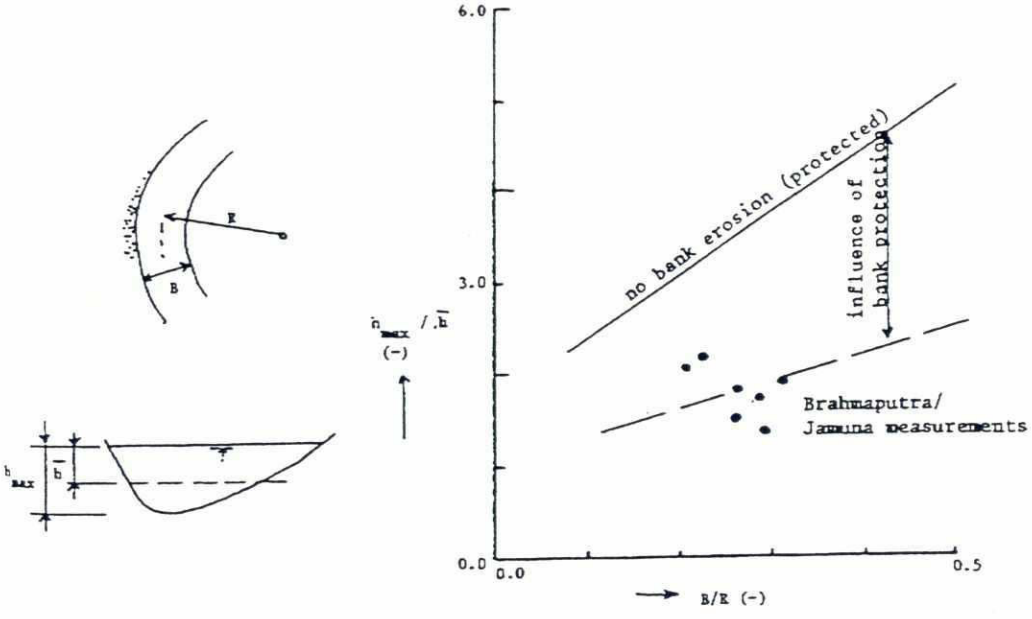
This calls for an improved understanding of the morphological processes in the Jamuna River. It is therefore proposed to carry out a supporting study based on a further analysis of LANDSAT images, including the analysis of the occurrence of cutoffs. The analysis will be similar as the study done within the frame-work of the Jamuna Bridge project, but more years will be included in the analysis. In the Jamuna analysis the following years were included: 1976, 1977, 1978, 1984, 1986 and 1987. For the present project the images of the years 1973, 1974, 1975, 1979 through 1983, 1985, 1988, 1989 and 1990 will be analyzed. When available, also an image of 1991 will be included. This analysis will not only allow for an improvement of the understanding of the morphological processes, but it will also facilitate the extrapolation of the channel pattern changes over the past few years to the conditions in the period of the coming years. The analysis should be done on geometrically corrected images and has to be done in combination with BWDB soundings. Apart from bank erosion rates per year, also the probability of erosion at a particular site over a number of years will be studied.

The described morphological analysis will allow to make a prediction of the future bed topography over the period after the implementation of the bank protection structure. This estimate will be used as an input for the computations with a 2-dimensional mathematical model for the 2-dimensional flow (see task 13) that at its turn will provide boundary conditions for the physical model investigation of the local scour.

For the prediction of the local scour an important input parameter is the original water depth for the case that the structure is not yet present. In this particular case the determination of these original conditions is more difficult because the present depth in the outer bends is affected by the input of the erosion products of the bends.

Is this input blocked by the fixation of the bank, then the depth in the outer bend will increase. This is schematically indicated in the below figure:

Fig. 06-4



This phenomenon is important and the Consultant will do a special study on this aspect. This study has to be done in a truly movable bed and bank model. The Terms of Reference for that scour investigation are given in Section N-3.

Conditions during construction

The bank protection works will only be constructed 2 to 3 years after their designs have been made. In the meantime conditions at the construction site will have changed owing to the changing morphological conditions. It is quite essential that in the period of preparation of the tender documents a good estimate is provided of the conditions during the construction. Therefore an estimate has to be made quite beforehand of the morphological changes at the construction sites. The accuracy of these predictions will be better than presently possible thanks to the results of the supporting study in which an additionalmorphological changes at the construction sites. The accuracy of these predictions will be better than presently possible thanks to the results of the supporting study in which an additional analysis of LANDSAT images is carried out. Because even then the predictions can be made with a limited accuracy only, the predictions have to be updated every year.

Adaptation

The morphological analysis will also assist in the decisions as to adaptation of the bank protection structures in the period after the implementation. Each year the conditions at the different sites will be assessed, the future developments will be estimated (to be done especially by morphological analysis) and based on this it will be decided whether or not and if so, what kind of maintenance should be carried out.

Intermediate and final evaluation

Intermediate and final evaluation has to be carried out. In this evaluation the advantages of the use of morphological prediction methods have to be assessed. The effect of the improved understanding will be evaluated and, if appropriate, additional investigations will be proposed. The results of the supporting studies and the experience obtained in the field will be summarized in a document that can be used for the design of bank protection works along the Jamuna river and similar major rivers in Bangladesh.

To sum up, this leads to the following activities to support the morphological analysis:

- analysis of recent and 'historical' satellite images (from 1973 onward)
- analysis of recent BWDB cross-sections
- scour investigations, to improve methods for the combined local scour and outer bend scour.

OUTPUT: The following output is foreseen:

(1) morphological contribution to the site selection

(2) report of the supporting study providing better prediction techniques for channel changes and bank erosion

(3) design criteria

(4) estimates of the conditions during the construction of the bank protection works

(5) morphological contribution to decisions regarding maintenance of the implemented structures

(6) contribution to the evaluations of the design methods, the maintenance and the role that models and prediction methods have played

STAFF:

- Responsible:
  morphologist/river training engineers
- Further activities:
  chief hydraulic design engineer
  chief river training engineer

TASK: **PRESELECTION OF TEST AREAS**

FAP: 21 T.o.R.: 5.2.2.2

OBJECTIVES To delineate some, say 5 or 6, areas where test sites could be located after further investigations

INPUT: Site visits, morphological analysis, existing data

DETAILS: The field visits, the review of existing data and the morphological analysis will enable the preselection of areas (10 to 15 km long) where additional investigations (topography, subsoil investigation, hydrometric surveys, mathematical and physical modelling) will be carried out. Precise site location for the test works in the test areas will be defined at the end of the investigation phase.

In order to select these areas, different criteria will be considered:

- existence of sites where the morphological analysis and the existing data have shown regular erosion, so as to ensure that the test works will be exposed to the river attacks during the monitoring phase
- existence of valuable infrastructures to be protected (towns, ferry ghats, factories)
- proximity of priority development areas (Jamalpur priority project)
- possibility of access
- areas where interference with other projects (river training works for the Jamuna bridge, test sites already selected by FAP 1 on the right bank) will be lessened

After the field visits of the proposal phase, a first group of 5 possible test areas has been tentatively selected :

- Bahadurabad Ghat (left bank) is an important crossing point for the railway, erratic movements of the Jamuna leads to frequent changes in the location of the ferry terminal, this point is easily accessible by train, but local roads in very poor conditions render car use very difficult
- Madarganj (left bank) is a small town regularly attacked by the river, is included in the Jamalpur Priority area
- Jagganathganj Ghat (left bank) is another railway crossing point prone to erosion, access by road is difficult
- Shariakandi (right bank)
- Beara (right bank), south of Sirajganj

Other sites have also been considered during the proposal phase, but they were finally not retained for various reasons:

- Sirajganj (studied by FAP 1)
- Phulchari Ghat (a char is being formed)
- Bhuapur (included in the Jamuna bridge river training programme)

For practical reasons, other areas located between Bahadurabad and Jagganathganj may be selected according to their morphological characteristics only, so as to test lighter designs, without the idea of protecting a particular zone in the long term.

OUTPUT: A list of sites where additional investigations (topographic and hydrometric surveys, 2-D mathematical modelling, local scour physical modelling) will be carried out. The final test sites will be located within these areas.

STAFF:

- Responsible:
  chief resident engineer
- Further activities:
  chief hydraulic engineer
  morphologist

TASK:

TOPOGRAPHIC AND HYDROMETRIC SURVEYS

FAP: 21 T.o.R.: 5.2.2.2

OBJECTIVES: To obtain the topographic, hydrographic and hydrometric data and pertinent information

- for setting up and/or calibrating the mathematical and physical models (tasks 13+15) and
- for the preparation of alternative designs (task 07)

INPUT: Necessary prerequisites of this task are:

- to be in possession of the required basic maps, information of bench marks, location and levels
- to have the right of way for the survey works
- the test areas to be finally decided upon (task 07)

DETAILS: Following the preselection of the test areas the topographic and hydrometric surveys are to be carried out in these areas as soon as possible, in order to make best use of the dry season. It should be borne in mind that the bank configuration and the local flow pattern are subject to significant changes from one dry season to the other. Thus the measurements can only be valid for the situation at the time of their execution and large scale systematic investigations are not justified during this phase of the project.

The Consultant will subcontract the execution of the topographic and hydrographic surveys to an experienced Bangladeshi company, the scope of works being attached in Section O-3. The surveys will be continuously directed, supervised, analysed and supplemented by a chief surveyor/hydrographer of the Consultant.

The final scope of services can only be defined in the course of the studies, after the approval of the test areas by the Client and after evaluation of the existing data. However, a preliminary scope is presented. It is based on the assumption that 6 test areas will be investigated.

The activities of this task include:

1. Topographic Surveys

1.1 A traverse 2nd order connected to the National Grid System

1.2 Cross sections survey with 2rd order levelling at intervals of about 200 m to 500 m, depending on the horizontal scale of the physical models to be erected. The total length along the shore is assumed to be not more than 10 km per test area. The width of the bank strip and/or chars to be surveyed depends on the levels of the flood plain and the relevance of scour flow currents, and it will not exceed 1.0 km.

1.3 Some permanent concrete bench marks will be installed at safe distances to the bank to allow later follow up survey of selected cross sections.

1.4 Survey of the locations of the subsoil investigations (task 13).

2. Hydrographic Surveys

2.1 Cross section surveys at the same interval as the topographic sections in the respective test area will be performed with a standard echo sounder. They are expected to be not longer than 2 km each.

2.2 The water depths will be related to the National Grid System.

2.3 The hydrographic surveys will be done during the low flow period.

3. Hydrometric Surveys

3.1 The purpose of the hydrometric surveys under this task is to provide data on the flow velocity and direction at selected points of some or all test areas to assist - if and when required - calibration of the physical model or in case of special local current effects.

3.2 In exceptional cases some float tracks may be measured.

3.3 Some supplementary flow measurements are scheduled for higher water levels, as and when required, for running special effects in the physical models and for the dimensioning of test works (tasks 20 and 22).

3.4 Bed load samples will be taken from the bottom surface at some locations of all tests areas, say 50 in total, for the morphological studies and to relate bank and bottom material characteristics. The scope of the work may further be obtained from Section O-3.

4. Assessment of Wave Conditions

Generally, the erosive forces of the flow on the banks will be superior to the impacts caused by wave action. However, in certain areas, the load on the banks caused by wave actions may play a role which cannot be neglected. The Consultant will, therefore, assess the wave height and periods at all test areas using standard calculations and forecasting methods and deduce the resulting erodibility, compared to the flow effects. The calculations will be based on existing wind statistics, regarding speed, direction and duration frequencies.

OUTPUT:

- cross-sections and maps of the test areas to be used for tasks 15 and 20
- locations of subsoil investigations for task 10
- data on flow velocities and directions listed and, if and when required, on maps, for tasks 15 and 20
- data on and samples of bottom material for tasks 10
- assessment on wave impact for tasks 16, 20 and 22

STAFF:

- Responsible:
  surveyor
- Further activities:
  chief hydraulic design engineer
  modelling experts
  physical modelling experts
  hydrologists
  subsoil expert

TASK 09

TASK: **SPECIFICATION OF THE HYDROLOGICAL DESIGN EVENTS**

FAP: 21 and 22 T.o.R.: 5.2.2.3

OBJECTIVES: To provide hydrological boundary conditions (upstream discharge and downstream water stages) for selected sites on the Jamuna. These boundary conditions will be provided for various return periods ranging from 2 to 100 years.

INPUT:
- selection of test areas (task 07).
- discharges and water levels resulting from the general model, run with standard boundary conditions defined by FAP 25 for a series of reference floods. These parameters will be provided at each relevant computation points of the GM between Nookhawa and Aricha.

DETAILS: Interpolate and analyse previous parameters resulting from 1 D Mike 11 model to give boundary conditions for the mathematical 2-D model and/or physical model defined in tasks 13 and 15. This will be done using available detailed local topographical data and the results of additional surveys (tasks 5, 6 and 8).

OUTPUT: Reference boundary conditions for local detailed models of selected sites (tasks 13 and 15). Expectations as to floods as input for the morphological analysis.

STAFF:
- Responsible:
  hydrologist

TASK: **SUBSOIL INVESTIGATIONS IN TEST AREAS**

FAP: 21 T.o.R.: 5.2.2.2

OBJECTIVES: To obtain detailed geotechnical and hydrological information for the preparation of alternative designs (task 20).

INPUT: Prerequisites for planning the subsoil investigations are the preselection of test areas and at least a preliminary layout of the planned test work (task 07).

DETAILS: Detailed subsoil investigations can only be executed on completion and evaluation of model tests (task 13, 15), when the final location and alignment of test structures (embankments, groynes) have been confirmed. However, in view of the fact that basic information on prevailing subsoil and groundwater fluctuations are already required for preparing alternative designs, the programme of subsoil investigations has been split into two phases. The first phase to be executed before the flood season 1992 as soon as the results of Task 07 are available and the second one immediately after the flood season, when also the Planning Study has been approved (see task 35).

Phase 1 investigations being the subject of this task shall be subcontracted to a Bangladeshi company experienced in the field of subsoil exploratory works. The scope of works may be obtained from Section O-2. The field and laboratory works shall be continuously directed, supervised and analysed by an experienced expatriate soils engineer, who shall be supported by local engineers.

Results generally to be expected from this investigation programme include the knowledge of

- the characteristics of the prevailing subsoil and foundation material of the flood embankments, degree of density and resistance to erosion etc.
- the type of construction material for filling and cladding of embankments, its grain size, consistency, compactibility, etc.

The final scope of investigations specified in the tender documents may be slightly adjusted after the number and location of sites have been determined. But in principle the following investigations shall be executed.

1. Exploratory Borings

Exploratory borings shall be sunk down to varying depth, maximum 40 m below ground level by percussion or rotary drilling method and disturbed/undisturbed samples be continuously taken from all non-cohesive and cohesive layers respectively. The degree of density shall simultaneously be determined by executing Standard Penetration Tests (SPT) within the borehole. The subcontractor is to properly preserve all soil samples and to furnish complete field records, e.g. borelogs with indication of groundwater level, sample and SPT results, etc.

2. **Penetrometer Tests**

In order to obtain more detailed information on the degree of density (cone resistance and local friction) and change of layers, cone penetration tests by a Dutch penetrometer (10 or 20 t capacity) shall be executed at selected

locations. It has been presumed that adequate penetration depths can be achieved and thus less borings be executed after the boring and penetrometer results have been calibrated at locations close to each other.

3. **Soil Mechanics Investigations**

Contingent on the type of subsoil to be encountered and the design parameter required, soil mechanics investigations shall be executed on representative samples selected by the Consultant. Such investigations will predominantly be those listed in the tender documents, but are not necessarily limited to the same. In case of cohesive samples it is intended to have the results of the local laboratory counterchecked by some analyses in the Consultant's own laboratory in Germany.

4. **Groundwater Oberservations**

In order to determine the permeability of the prevailing subsoil and the groundwater gradients at fluctuating river water levels it is intended to instal some piezometers perpendicular to the river bank and to observe the groundwater levels therein simultaneously with the river water levels at regular intervals for a period of about 8 months.

It may be observed that water borings have been excluded from this phase of soil exploratory works, the reason being that at this stage when the final location of groynes is still uncertain such borings can only serve as a general exploratory survey, since necessarily not located at the final alignment of the test structures. Moreover, the mobilization of a floating platform is comparatively costly if used for very few borings only. Contingent on the final selection and layout of test structures water borings may need to be executed during the second phase of subsoil exploratory works, but during this phase deep borings close to the shore line shall provide sufficient results.

OUTPUT: Geotechnical data and parameters as required for the preliminary design works (task 20) e.g.

- borelogs with indication of soil layers, SPT results
- penetrometer records indicating cone and local friction values and levels of change of layers
- soil mechanics data and parameter
- river water and groundwater levels, permeability figures

STAFF:

- Responsible:
  subsoil expert
- Further activities:
  hydraulic design engineer

TASK

ENVIRONMENTAL ASSESSMENT

FAP: 22 T.o.R.: additional to TOR

OBJECTIVES: Within the project, environmental factors are taken into consideration in order to be aware of the initial condition of the floodplain, to forecast its modified state due to possible AFPM measures and to suggest compensatory measures for impact limitation and environmental improvement.

The following elements will be examined:

- water quality
- groundwater levels
- fish
- vegetation
- wildlife

INPUT:

- bibliographic research on the environment (climate, ground, vegetation, fauna)
- application of recommendations and directives from the situation in earlier conditions, particularly components 16 and 17 of the Flood Action Plan
- information from the E.P.C.P., I.U.C.N., W.W.F., and the United Nations
- missions in the field, data recorded in relation to fauna and flora on preselected sites

DETAILS: The study of environmental factors is composed of two parts:

1) The initial state will include the analysis of environmental constraints of the area (climate, soil, vegetation, fauna and the human factor). The aim is to give a general definition of the area from a natural perspective (understanding and general presentation of the site environments). Particular points where the project could have an impact will be examined in greater detail (water quality, fish, vegetation, wildlife).

2) Condition after works and recommendations:

   - Water quality: information will be given on the risks involved in modifying water quality, in terms of possible developments in AFPM and river training.

   - fish: from a more general perspective, all major problems connected with the hydrobiology area will be analysed; morphological change in flowing sections and sediment, access, fish development in the waters supplied during high river levels, ground extractions undertaken, prolification and development of feeding, reproduction and shelter for fish; the role of aquatic vegetation for fish.

- vegetation on land: the dynamism of natural vegetation and the colonising mechanism will be determined, to outline a possible scenario for vegetal evolution in the areas affected or created (new alluvial deposits, embankments). An evaluation of the structurally-modified sections will be put forward from a vegetal viewpoint (protective role in terms of structural changes, as well as use of vegetation for food or economic motives).

- wildlife: possible repercussions of the project on wildlife will be analysed and protective measures will be suggested.

Furthermore, an assessment of possible effects on the groundwater levels in the wake of a drastic reduction in the width of the flood plain will be made. A side effect of such a measure may be falling groundwater levels as a result of deeper river channels and, mainly in the dry season, lower water levels in the river.

Finally, the present and future fertilizing role of the sediments deposited on the flood plain and close to the river banks will be assessed on the basis of the existing information.

OUTPUT: A general synthesis of the project and its environmental impact will be worked out together in the form of a general table giving the positive and negative aspects in relation to the environment (multi-criteria analysis by measure).

STAFF:

- Responsible:
  environmental expert
- Further activities:
  morphologists
  river training engineer
  socio-economist
  and acquisition specialist

TASK: SOCIO-ECONOMIC ASSESSMENT

FAP: 21 and 22 T.o.R: additional to TOR

OBJECTIVES: To acquire a good knowledge of the population, its activities, organisation and relations with public/ private entities, to assess the socio-conomic consequences of proposed works and the possible participation of the population in these works

INPUT:
- existing data
- field survey

DETAILS: The first task concerns the population: an inventory will be prepared based on the administrative yearly censuses, with some cross-checkings with the overall 1979 population census and field enquiries. This enquiry will concern a few selected villages, and group interviews to check the accuracy of the list given by family (composition, age). The data collected will be grouped together under the following headings: population by village. structure by age group; significant features (birth and mortality rates, out or in - migration, growth rate); level of education. Based on this, a population projection will be prepared.

The second task is the inventory of activities and infrastructures. This will mainly concern people engaged in agriculture, and also other activities, unemployment, and comparison of those figures with estimates of active population.

Revenues per household will be tentatively estimated. The third activity will be through interviews with officials and group interviews to describe the social and administrative organisation of the population and interrelations between the various groups and public/private entities. It will be devoted to the understanding of the organisation of works, and mainly of the agricultural production, of separation of activities between sexes, of their repartition throughout the year. It will define qualified/non qualified manpower which could be available for activities concerned by FAP 21/22. It will give also some details on existing organisations (at village/upazila levels) and on the involvement of population for activities of common interest (such as construction of tracks or maintenance activities).

The conclusion of these three tasks will be an analysis of the present socio-economic situation.

In the second part it is necessary to assess what will be the impact of the projected works on this socio-economic situation, mainly what could be its positive impact, and the conditions to be fulfilled to attain these benefits - aspects involved will be amongst others:

- definition of the incidence of works on employment and revenue; structures, contacts, information needed to obtain the full participation of the population, including for the maintenance of works

- various socio-economic aspects:

  . extension of the agricultural land, corresponding benefits
  . flood damage avoided
  . effect of the prevention of bank erosion on village location and other infrastructures, corresponding benefits

- specific consideration of land acquisition problems and of needs of resettling some households.

OUTPUT: An analysis of socio-economic impacts of the project.

STAFF:
- Responsible
  socio-economist
- Further activities:
  land acquisition expert

TASK: **2-DIMENSIONAL MATHEMATICAL FLOW MODELLING**

FAP: 21/22 T.o.R.:

OBJECTIVES: To carry out a number of mathematical model investigations to determine the future flow field near the river training structures at the selected sites, with the aim of providing boundary conditions for the local scour models and to provide information on flow velocities required for the design and the implementation of the protection works.

INPUT:

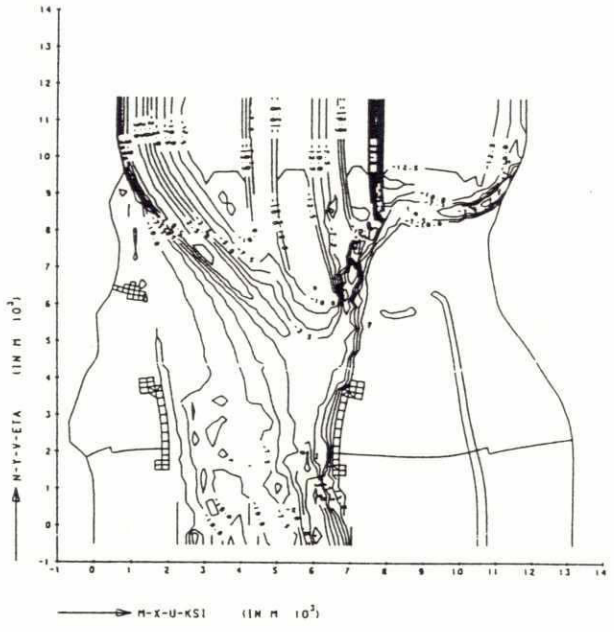
- Hydrological boundary conditions. Assessment of the morphological conditions at the selected sites.
- Special task study on 2-D mathematical flow modelling, the T.o.R. given in annex D-3 in Volume 2

DETAILS: For the local scour models, which will be operated to determine the design scour depths and/or the required maintenance in future, boundary conditions like the flow velocities near the proposed structures are needed. This information can be provided by mathematical models or by physical models. The Consultant has considered to do studies in a physical model, but that would only be cost-effective if it was done in Bangladesh. The possibilities for doing this type of studies in Bangladesh with the River Research Institute are very limited, also because the measuring of velocities in the models can be done with limited accuracy only. Therefore, it is decided to do the study of the flow field with a mathematical model, in Europe. In this respect it should be realized that according to the Consultant's estimates in some years from now these models will be available in Bangladesh,too.

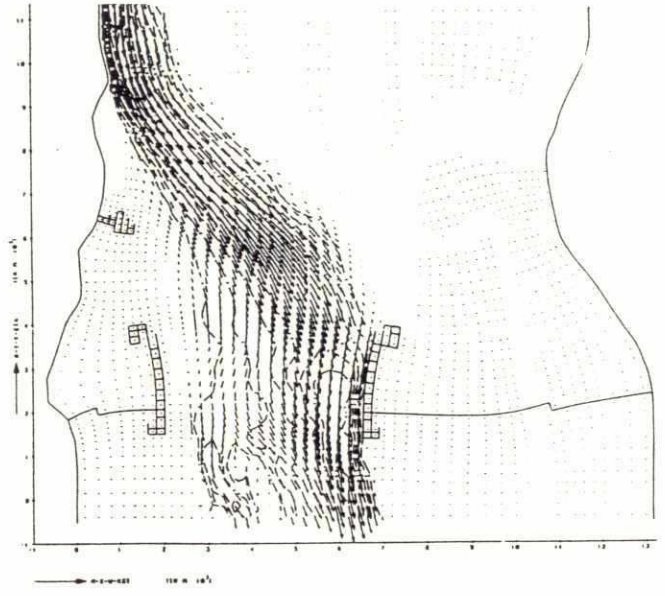
The type of model to be used is a 2-dimensional depth-averaged flow field model. The Consultant has such a model available in the home office of Delft Hydraulics. This model has also been used during the Jamuna Bridge project, where different bed topographies were studied with the mathematical model. There these bed topographies were "invented" on the basis of the overall movable bed and movable bank model (see the enclosed video for some details of this model). For the present project the results of the morphological analysis will be used. Because the computations have to simulate the conditions over the coming years no extreme discharges will be applied, but estimates will be made of maximum discharges reasonably to be expected in the coming years.

Different maximum discharge levels will be used, and in the local scour models for these levels the scour depths and the damage will be determined. Downstream boundary conditions are the water levels for the applied discharges and these will also be provided by the hydrological analysis.

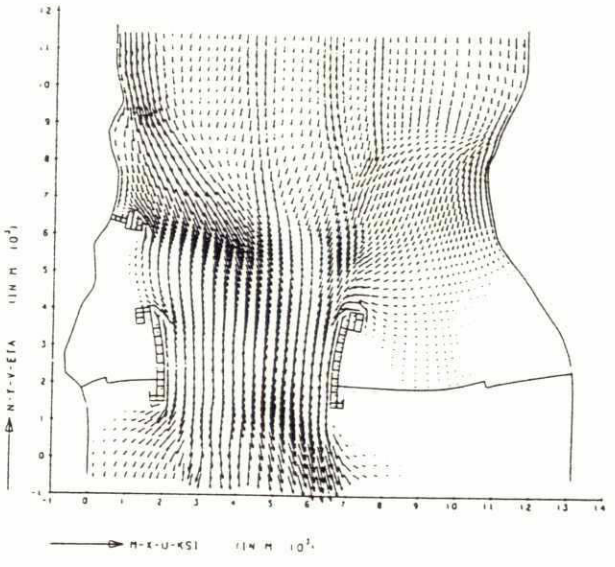
Two-dimensional depth-averaged models for flow field computations are nowadays standard within the leading hydraulic institutes in the world. Delft Hydraulics' models are in addition using a curvilinear grid which provides better results than rectangular grids. Moreover, Delft Hydraulics has recently developed an automatic grid generator which can be used quite advantageously in the present situation.



a) Adopted bed topography



b) Discharge 50,000 m^3/s



c) Discharge 80,000 m^3/s

An example of the use of a 2-dimensional model for the Jamuna Bridge project is given on the preceding page. The flow field has been computed for two different discharge levels. The bed topography is a combination of the bed topography of the Jamuna river in 1987 and the results of the model with movable bed and banks.

The simulations with the mathematical model will be carried out for two different bed topographies to be expected and for three different discharge levels. It is expected that the conditions for the third test site can be inferred from the results of the other two sites, if deemed advantageously combined with the simulations carried out for the Jamuna Bridge Study.

It may be required to do some additional computations during the monitoring and evaluation phase. For that reason, the schematized models will be maintained for later use.

OUTPUT: Predicted flow fields for the selected sites for the period of construction and the monitoring phase. Then the predicted flow fields will be used to provide early estimates of the flow velocity near the structures, and more important, they will be used to generate the boundary conditions for the physical models to be used under task 15. This will eventually lead to better designs for the test structures via optimization procedure (see task 15). Probably also some flow fields to be predicted during the monitoring and evaluation phase, to evaluate the observed behaviour of the test structures.

STAFFING:

- Responsible
  specialists on 2-D modelling in home office
- Further activities
  project director
  modelling expert
  chief river training engineer

TASK: SELECTION OF TEST SITES

FAP: 21 T.o.R: 5.2.2.2

OBJECTIVES: To determine the actual location of the test sites and the type of protective structures.

INPUT: After preselection of the test areas (task 07) the results of

- topographic and hydrometric surveys (task 08)
- socio-economic assessments and (task 12)
- two-dimensional mathematical flow modelling will provide the input data for final selection, of test sites (task 13)

DETAILS: As soon as the input data for each of the test areas - preselected as per criteria described in task 07 - are available, alternative solutions of sites and protection measures shall be drawn up and compared in order to arrive at the technically most appropriate solution for the protection of a priority site. Protection measures may inter alia comprise

(1) protuding groynes, longitudinal training walls or protection of existing river banks which application should not allow a retreat of the existing shore line (like Sirajganj or Chandpur)

(2) retired groynes or cross bars which may be constructed with less costs but which will only become effective after the banks have eroded to some extent

(3) retired and protected embankments whose depth of retirement will be contingent on the river morphology, degree of current attack, etc. or which may be planned in several rows of defence for high waters with different durations of return

(4) or a combination of the measures listed above

In view of the extreme costs involved and the funds available for the test works, measures as per (1) above are hardly envisaged at present. All efforts will, however, be exerted to reduce the attacking forces on the test structures by achieving an optimal alignment of the future shore line by river training, embankment alignment etc. and to choose the type of test structures appropriate for such conditions.

The type, location and alignment of the test structures shall be determined after thorough evaluation of the morphological changes during the past years, of the results of topographical, hydrographical and hydrometric surveys, of the expected high water levels, current velocities and scour depths and of the results of the mathematical model tests (task 13) and subsoil investigations (task 10).

In accordance with present technical considerations and rough cost estimates, as described in Section M, it appears advisable to restrict the numbers of independent test sites to three and to test different design solutions, e.g. geometry,

revetment alternatives etc. in series of groynes or in a continuous embankment, where equal flow conditions etc. can be expected.

It has to be noted that the selection of test sites needs to be done before the monsoon season 1992 but that the implementation of the test works will only start after the passage of two flood seasons at the end of 1993 and at the end of 1994 respectively. This requires on the one hand that morphological changes over that period will have to be estimated as realistic as possible but on the other hand that the necessity and possibility of layout adjustments will have to be taken into account in order to achieve the task of testing the structures.

OUTPUT: Location of test sites and layout of test structures.

STAFF:

- Responsible:
  chief hydraulic design engineer
- Further activities:
  chief resident engineer
  modelling expert
  morphologist

TASK: **PHYSICAL MODELLING**

FAP: 21/22 T.o.R.:5.2.2.2, 5.2.2.4

OBJECTIVES: To carry out a number of physical model investigations to determine the local scour around the test works to be designed, and thus in combination with the hydraulic design engineers to determine the optimum design (including layout) of these test works. To provide the hydrauli design conditions for the test structures.

INPUT: Results of the morphological analysis regarding depths of the channels that will attack the test structures during the test phase (task 08). Results of the mathematical modelling of the 2-D dimensional flow fields (task 13). Tentative designs of the test works (task 20).

DETAILS: The main hydraulic design parameters for the test structures are

(1) the total scour depths that may occur near the test structures and

(2) the current velocities near the structures

The total scour depth is the combination of the local scour around the structure, the local water depth (in the outer bend of the channel) possibly the additional increase in depth due to the blockage of the sediment supply from the bank erosion (see task 08 and the scour investigation, see Section N-3). The local scour is determined with physical model studies. In these models also measurements will be done to get more detailed information on the current velocities than can be provided by the mathematical flow period models (from task 13).

The physical modelling of the local scour will be done at the River Research Institute at Faripur. Tentative Terms of Reference for these model investigations are included in Section O-1. Here a summary is given.

For the physical modelling undistorted models (horizontal and vertical scales are the same) will be used. The approximate scale is 1:150, but this scale will be determined in more detail during the Inception Phase. The bed levels in the model will be derived from the morphological analysis including a rough estimate (or an improved prediction based on the optional scour investigation) of the lowering of the bed levels due to the blockade of bank erosion products (see task 08). Other boundary conditions are the side boundary of the model (to be provided by the simulated flow fields under task 13), via a dividing stream line, the upstream discharge and the downstream water levels. The bed material in the model will be fine sand. The flow velocity in the model will be scaled according to the Froude condition (so the velocity scale will be approximately 1:12), although some deviation may be accepted to have some movement of the bed material. Scour holes formed under these conditions will provide good estimates of local scour to be expected around the future test structures.

Additionally to the physical model tests carried out in the planning study phase, further tests may become necessary to improve the detailed design in the first year of the test and implementation phase. The scope of work for such additional model investigation would be defined in the Planning Study Report.

OUTPUT: Contribution to the design of the test structures via prediction of the scour depths near the structures and the velocities over the bank protection structures (important for the design of the top layer).

STAFF:

- Responsible:
  modelling experts
- Further activities:
  chief hydraulic design engineer
  chief river training engineer

TASK:

SELECTION OF ALTERNATIVE TEST MEASURES

FAP: 21 T.o.R.:--

OBJECTIVES: The selection of technically feasible constructions for training of the Jamuna river, with special attention to effectiveness and sustainability of these river training works.

INPUT: For the selection of alternative test measures input is required from the following tasks:

- the morpological analysis (tasks 02, 04 and 06)
- subsoil investigation in test areas (task 10)
- selection of test sites (task 14) and
- topographic and hydrometric surveys (task 08)

DETAILS: The selection of alternative test measures can be divided into different parts:

- selection of feasible conceptual designs of the training works
- selection of the construction materials and the construction method.

For a conceptual design all generally applied measures will be examined, for example: different types of groynes, guide bunds, sills, hard points, cross bars, vanes, diversions or closures of channels, different types of dredging, and measures to influence the rate of sedimentation locally.

From the feasible measures the failure mechanisms and the values of different characteristic geometric parameters will be determined, (as for example the shape of the head of a groyne, or the depth of the toe of a structure). Also the parameters for the strength and the decisive hydraulic and geotechnical load will be assessed. From this preliminary analysis already a reduced number of feasible measures will result. The Consultant is experienced with a systematic conceptual design procedure for hydraulic structures which can also be applied to river training works.

The Consultant has a wide range of experience in applied research for new bank protection materials, as different types of mattresses, geotextiles, sand bags, stone asphalt, grass on clay and concrete blocks.

In recent years the Consultant has developed a probabilistic design method for the protection structures (top layer and filter layers) which will be checked for its applicability in the case of the FAP 21/22 project.

OUTPUT: The selection of few feasible test measures, with a first estimation of the geometric dimensions of these measures and a preliminary determination of the location of these measures in the selected test sites.

STAFF:

- Responsible:
  chief hydraulic design engineer
- Further activities:
  chief resident engineer
  morphologist
  subsoil expert

TASK:

ANALYSIS OF CONSTRUCTION MATERIALS

FAP: 21 T.o.R. R.2.2.3

OBJECTIVES: To investigate into the quality, suitability, availability and economic use of local construction materials.

INPUT: Existing studies and test reports on local materials used in bank protection works.

DETAILS: The use of local construction materials, if suitable and available in sufficient quantities, would be of eminent importance to arrive at economic design solutions and construction methods for the planned bank protection and river works.

Initially, the Consultant intends to critically check and review all material investigations and tests performed by various local institutions in the recent past (e.g. BUET, RRI, Jute Industry, etc.), and those of the Dutch organisations and firms in connection with the Jamuna Bridge Project and to investigate into contradictory results, if any. The test results and conclusions drawn from such investigations by the various institutions or authors shall then be checked in respect of their useful applicability for the bank protection works, and especially also with regard to the availability of the corresponding materials in sufficient quantities for large scale bank protection works. Such investigations apply above all to the quality and suitability of concrete sand (Jamuna river sand is ostensibly unsuitable because of clay and silt content, and specially mica admixtures), gravel, stones, natural rock, clay, bituminous materials, fascine materials, etc.

On the basis of these investigation results the Consultant will decide on additional material investigations or test programmes he considers necessary to supplement or recheck the material investigations executed earlier. Such material testing will be done in Bangladesh or in Europe, contingent on the testing facilities available. To the extent special investigations, analyses and comments are required, the Consultant shall assign material specialists to perform such tasks.

Since the design and construction of filters separating the protection layers from the sandy/silty core of revetments are to be considered as one of the most critical aspects in bank protection, especially in Bangladesh, a special test rig will be installed and operated within this project. Details of that facility are given in Section O-4.

Beyond the analyses of construction materials which are mainly to withstand current and wave attacks of the river, also protection measures by means of vegetation shall be investigated. Such investigations shall start with a site survey of existing turfy embankments (type and conditions of grass, degree of protection, maintenance problems etc.) and be followed up by proposals for improvements (e.g. different drought-resistant types of grass, type of top soil, surface protection when planting etc.)

When investigating into the availability of local materials basic costs, i.e. for royalty, quarry and transport shall likewise be obtained as required for a subsequent cost comparison of rates and design solutions (tasks 20/21/22).

OUTPUT: Report on local construction materials with information on quality, suitability, availability and costs.

STAFF:

- Responsible:
  chief hydraulic design engineer
- Further activities:
  chief resident engineer
  construction management expert

TASK: **ANALYSIS OF CONSTRUCTION METHODS**

FAP: 21 T.o.R. 5.2.2.3

OBJECTIVES: To assess traditional and new construction methods and to compare them according to technical and economic criteria.

INPUT: All information on traditional methods as obtained from project design drawings, physical inspections of the river sites and enquiries from BWDB officers.

DETAILS: The fine cohesionless river bank and bed material, the partly high current velocities during the flood periods and the resulting large erosion and deep scour depths are factors which call for high demands in terms of planning, design and execution of bank protection works.

As concluded from a number of discussions with responsible Water Board officers and from physical field inspections, the traditional construction methods can - without modifications - hardly fulfill the required prerequisites and if so only with the use of huge quantities of materials and funds. This does not exclude that certain methods have proved their worth under certain conditions. The partial lack of appropriate materials and equipment, the lack of funds for maintenance works connected with certain deficiencies in designs (slopes, filter layers, compaction, etc.) were in many cases the causes of early damage and failures in the past.

It is the task to improve on the traditional methods, to propose new methods applying the latest state of the art in bank protection works and to investigate in combinations arriving at most economical solutions, taking into account the prevailing local conditions and checking the applicability of new methods under local conditions. Of particular importance is the protection of the deeper parts of the underwater slopes against scour and erosion to which utmost attention shall be given.

The assessment of chosen construction methods with regard to expected bank stability shall be based on the following criteria:

- stability against sliding, liquefaction caused by earthquakes, piping, etc.
- stability of slope revetment layers and materials against current, waves, scour, and liquefaction and the consequences in case of damage, i.e. degree of vulnerability in case of minor damage
- slope resistance against human activities
- degree of difficulty and required accuracy in work execution
- required use of large equipment
- scope of maintenance works required
- costs of execution and maintenance with components in foreign currency
- etc.

OUTPUT: Analysis of various design solutions and construction methods as a basis for the preparation of alternative designs (task 20)

STAFF:
- Responsible:
  Chief Hydraulic Design Engineer
- Further activities:
  construction management expert

202

TASK: **ASSESSMENT OF LOCAL CONTRACTORS' CAPABILITIES**

FAP: 21 T.o.R. 5.2.2.4

OBJECTIVES: To obtain a comprehensive knowledge of preselected local contractors, their organization, staff, experience and working standard in works similar to the test works.

INPUT: List of Class A contractors working for and approved by Bangladesh Water Development Board (BWDB).

DETAILS: During the inspection trip to Bangladesh discussions were held with two local contractors in Dhaka who were awarded large scale embankment works for the embankments of Jamuna Bridge and Teesta Barrage Projects respectively. Moreover, a number of Class A contractors of Bogra and Gaibanda region were questioned regarding details of their firms, experience and references in bank protection works, use of mechanical equipment items etc. The status of Class A contractors allows the participation in construction works of larger volumes but does not necessarily give any specific indication on experience and capability of the firms.

In order to obtain a comprehensive idea of the most competent and qualified construction firms in the field of earthworks, bank protection and river training works the Consultant intends to advertise in local newspapers a prequalification notice and to evaluate the applications according to appropriate criteria, e.g. organization and staffing of firm, specific experience in required construction works (references), previous collaboration with foreign firms, construction equipment owned, financial status/extent of trustworthiness etc.

After preparation of a long list detailed discussions with selected firms' representatives, inspections of the firms' offices, yards and sites shall follow in order to check the standard of the firms and of their works, and to support or adjust the impression gained from the prequalification documents.

It must generally be assumed that the practical experience of local contractors in large-scale hydraulic works is limited. This may e.g. apply to proper grading of underwater slopes accurate placing of large size matresses under water, etc. To make up such deficits wherever existent, it shall be recommended by the Consultant that the contractors finally prequalified may engage foreign specialists, well experienced in the tendered works and obtain advice from foreign firms to the extent required. The Consultant may assist the local firms, if necessary, by issuing a list of foreign firms, well experienced in the respective types of works. It appeared from the discussions with the local contractors that such a solution will in principle be accepted and that contacts to foreign firms exist already partially.

Even if a large volume of work may be done manually, the use of specific equipment items is most important. In order to obtain well in time a clear idea of the availability or non-availability in Bangladesh of all required equipment items, a mechanical engineer will investigate into the actual situation. Details see task 23.

OUTPUT:

- list of local contractors, capable of executing the test works (possibly with foreign assistance)

- Specific points, conditions and criteria to be taken into account when preparing tender documents and contracts.

STAFF:

- Responsible:
  construction management expert/chief resident engineer
- Further activities:
  mechanical engineer

TASK 20

TASK: **PREPARATION OF ALTERNATIVE DESIGNS**

FAP: 21 T.o.R.: 5.2.2.3

OBJECTIVES: To prepare alternative preliminary design solutions for groynes, bank revetments, etc.

INPUT: Further to the conclusions of the preliminary design study performed for preparing the proposal, and attached in Section M, the results of the following tasks will have to be taken into account when preparing preliminary design proposals

- hydrological design events (task 09)
- subsoil investigation (task 10)
- mathematical and physical modelling (task 13/15)
- selected alternative measures (task 16)
- analyses of construction materials and methods (task 17/18)

DETAILS: As soon as the type and location of protective structures proposed to be constructed have been finally selected (task 16) alternative solution of preliminary designs shall be prepared based on design criteria stipulated before. Such design criteria will include

- design water levels, freeboard and crest levels,
- loadings and hydraulic strains, caused by earthquakes, currents, waves, etc.,
- cross sectional requirements, i.e. slopes, width of berms, roads etc.,
- surface and internal sealings, drainage, etc.,
- revetment composition and requirements (filter layer, weight of armour etc.),
- structural and hydraulic stability requirements, e.g.
  - . density of subsoil and fill, settlements
  - . safety against sliding etc.
  - . seepage, excess water pressure
  - . erosion, protection against deep scours, etc.
- Requirements when strengthening existing embankments
- etc.

In view of the fact that cross sections and slopes will be largely determined by planning and stability requirements, the alternatives will predominantly deal with various revetment solutions, the levels of protection, etc. In this connection the results of the material analyses (task 17), the necessary use of equipment and the resulting construction methods will be most important.

OUTPUT: Alternative preliminary design solutions for selected test structures.

STAFF:

- Responsible:
  chief hydraulic design engineer
- Further activities
  subsoil activities
  morphologist

TASK: **RATE ANALYSIS AND COST ESTIMATES**

FAP: 21 T.o.R. 5.2.2.3

OBJECTIVES: To investigate into appropriate, realistic item rates for bank protection works and to prepare cost estimates for alternative design solutions.

INPUT: The bases for the rate analysis and cost estimates shall be the

- location of the construction sites (task 14)
- material costs (task 17)
- costs for labour and consumables
- costs of equipment, hire rates (task 23)
- alternative designs/construction methods (task 20)

DETAILS: It has already become obvious when preparing this proposal that realistic unit rates for various construction methods in bank protection works are hardly available from other projects, or if available, differ considerably in various rate schedules, contracts and cost estimates (cf the Preliminary Design, Section M, where detailed information on and a large compilation of contradictory unit prices are given). With the exception of rates for standard operations the Consultant shall therefore be obliged to prepare his own rate analyses for particular work operations in order to arrive at appropriate rates and costs for the planned test works. Such analyses will have to take into account the basic costs for procurement of materials, for staff, labour, equipment hire and transports, as well as ancillary costs, overheads, risk and profit of the contractor.

Comparative cost estimates for the alternative design solutions shall then be prepared in the form of Bills of Quantities taking into account the quantities of individual supplies and work operations, the appropriate rates determined and the estimated costs for mobilization and site installation.

OUTPUT:

- comprehensive rate analysis
- cost estimates as criteria for the decision-making process in selecting the most suitable/economic design (task 22), for determining the volume of test work financially feasible, and as input of the budget estimate of the implementation phase (task 25).

STAFF:

- Responsible:
  chief hydraulic design engineer
- Further activities:
  chief resident engineer
  construction management expert

TASK: **SELECTION OF DESIGN AND CONSTRUCTION METHODS**

FAP: 21 T.o.R. 5.2.2.3

OBJECTIVES: To determine the design solution(s) and related construction methods for the execution of test works.

INPUT: Bases for the decision on design solutions and construction methods shall be

- the alternative design proposals (task 20), supplemented by
- the cost estimates of those proposals (task 21).

DETAILS: In principle, the aim is to select more than one design solution for bank protection and river training works, and to test them during the implementation phase under largely the same conditions. This however, will only be possible if they are constructed close to each other where equal loadings and conditions can be expected.

The selection of these solutions will be done after careful consideration and weighing of various criteria, e.g.

- degree of protection required
- degree of difficultiy in execution of construction methods taking into account the experience and capability of local firms
- volume of local materials and local labour involved
- large or special equipment required
- safe applicability of solutions to varying toe levels of embankments
- degree of maintenance and maintenance costs expected
- total construction cost and portion of foreign currency involved
- etc.

The choice of criteria indicates already that not necessarily the cheapest solutions may be selected but also others, if the same provide the guarantee of higher safety, less risk and less maintenance costs. This may be especially applicable for deeper protection levels, which may inevitably call for higher costs.

Advantages and disadvantages of individual design solutions and construction methods, as well as the reason for selecting particular solutions shall be discussed in detail in the final report of the Planning Phase.

OUTPUT: Design solutions and construction methods to be proposed for execution of test works.

STAFF:

- Responsible:
  chief hydraulic design engineer
- Further activities:
  chief resident engineer
  modelling expert
  construction management expert
  subsoil expert
  mechanical engineer

TASK: **INSPECTION OF LOCALLY AVAILABLE CONSTRUCTION EQUIPMENT**

FAP: 21 T.o.R. 5.2.2.4

OBJECTIVES: To determine the number and type of equipment items which need to be imported.

INPUT: Equipment lists of preselected construction firms and those of BWDB, BIWTA, etc.

DETAILS: As is known at present, there are only few Ccontractors in Bangladesh (possessing an industrial status) who own some earthwork construction equipment, e.g. dozers, graders, payloaders, compactors, dump trucks, etc. Most of the contractors have to a large extent to rely on the equipment pools of BWDB, BIWTA, Road & Highways, etc. There aret, however, different opinions as far as the condition of such pool equipment is concerned.

In order to be able to decide on the technical and economic necessity of importing specific construction equipment, the Consultant considers it necessary to have the equipment situation in Bangladesh investigated by an experienced mechanical engineer. Such investigation shall comprise a general physical check of equipment and a check of the equipment lists not only of equipment owned by the preselected contractors but also of that equipment owned by the mechanical departments of BWDB, BIWTA, and private organizations, if any. It is understood that not each and every piece of equipment can be checked, but that a fairly good survey can be made. The information to be obtained will generally provide statements on

- type, age, and capacity of equipment items
- the time the equipment has been in operation and its reliability
- present condition and demand of spare parts
- availability for test works, and
- conditions and rates of hire

The type of equipment to be investigated depends on the construction methods finally selected, but will generally include:

- earth moving and compaction equipment (dozers, graders, compactors, loaders, trucks)
- dredging equipment (draglines, suction dredgers, etc.), and
- pontoons, tugs, and
- lifting and special equipment

The inspection will also include a general check of existing workshop facilities, the spare part situation and the qualification of skilled mechanical staff.

After evaluation of all inspection results it shall be decided which construction equipment required for the execution of test works is reliably available in Bangladesh and which pieces and type of equipment will have to be imported to ensure a largely uninterupted continuation of work.

OUTPUT:
- list of equipment items to be imported
- hire rates of equipment for cost estimates

STAFF:

- Responsible:
  mechanical engineer
- Further activities:
  chief resident engineer

TASK 24,

TASK: **STAFFING AND SCHEDULING OF TEST AND IMPLEMENTATION PHASE**

FAP: 21 T.o.R: 5.2.2.4

OBJECTIVES: To prepare a proposal for:

- a time schedule for the construction works
- a staffing schedule of the Consultant's team in accordance with the schedules for the construction works

INPUT:

- tentative staffing schedule - test and implementation phase
- preparation of alternative designs (task 20)
- number of test sites
- assessment of local contractors' capabilities (task 19)
- selection of design and construction methods (task 22)
- effect of training on the job

DETAILS: On the basis of the preliminary staffing schedule given in the technical proposal a revised version will be prepared which considers especially the results of the planning and design, the capability of the Contractors as well as the selected construction sites and method. Particular attention should be paid to the integration of the local experts into the team in order to achieve a high training effect. Furthermore, great emphasis will be laid on the staff's engagement during the monitoring and evaluation phase.

OUTPUT: Detailed schedules showing, among others, the following details:

- a time schedule for the construction works including
  - . final design phase
  - . procurement of material and equipment
  - . additional site investigations
  - . tendering phase
  - . implementation and adaptation of the test works
- a staffing schedule, including
  - . the composition of the Consultant's team
  - . functions of the team members
  - . exact time and duration of employment in relation to the time of execution of the different construction work
  - . names of the team members

STAFF:

- Responsible:
  chief resident engineer
- Further activities:
  chief hydraulic design engineer
  construction management expert

TASK: **BUDGETTING OF THE TEST PHASE**

FAP: 21 T.o.R. 5.2.2.4

OBJECTIVES: To propose a comprehensive budget estimate for the test phase within the prescribed financial frame of the project.

INPUT: Basic data of Consultant's fees as well as costs of construction works shall be obtained from

- Task 21 - Rate analysis and cost estimates
- Task 22 - Selection of design and construction methods
- Task 23 - Staffing and scheduling of test phase, and

DETAILS: In order to ensure that the budget limit of the funding agencies is not exceeded, the Consultant shall prepare a detailed estimate of all costs which may be incurred by him during the test phase including those to be paid to subcontractors.

The cost items shall include but may not be limited to:

1. Direct Costs of Consultant

- mm-fees and allowances of foreign and local personnel inclusive of supporting staff in Germany and Bangladesh in accordance with the staff employment schedule of the Test Phase
- transportation costs, i.e international/local flights, transport vehicles inclusive running costs
- housing and office accommodation in Dhaka and in the field, inclusive of equipment and running costs
- miscellaneous office and communication costs, inclusive of radio equipment for proper communication between Dhaka office and site office

2. Cost of Additional Investigations

- topographic and hydrometric surveys, subsoil investigations and laboratory tests (Phase II)
- mathematical/physical modelling
- miscellaneous laboratory tests of materials

3. Cost of Construction Materials and Equipment Procured by Consultant, e.g.

- geotextile filter material/matresses, flexible cables for falling aprons etc.
- special construction equipment, testing equipment and spares to the extent required
- procurement costs to include all transport costs, as well as costs of clearing/forwarding agent, etc.

4. Cost of Construction Works to be Subcontracted to Local Contractors

Test works proposed to be executed as per task 22 to an extent as feasible within the budget limit. The final volume of work shall be determined on the basis of the cost estimates of selected design and construction methods, after having reserved a reasonable amount for repair and adjustment works eventually needed after the flood seasons.

Tentatively, in the Preliminary Design Study (Section M) the construction costs based on prices extrapolated to 1993/1994 are estimated at:

site A:16.32 million DM
site B: 4.15 million DM
site C:14.75 million DM

the total estimated cost being 35.22 million DM. Cost for adaptation and contingencies are estimated to be in the tune of about 8 million DM.

5. Cost for Unforeseen Events, Contingencies

Initially 5 to 10 % of the amount available for construction works may be withheld as contingencies, which may be spent at the end of the project if still unused.

When preparing the budget it shall be taken into account that all costs and prices of whatever nature shall be determined for the years spent, i.e. price escalations as most probably applicable in Europe and Bangladesh shall be applied for determination of correct cost estimates.

OUTPUT: Comprehensive budget estimate for the Test Phase with indication of test work volumes (length of embankment, number of groynes) which may be executed with the funds provided.

STAFF:

- responsible:
  chief resident engineer
- Further activities
  chief hydraulic design engineer
  construction management expert
  mechanical engineer

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TASK: **REVIEW OF POSSIBLE RIVER TRAINING METHODS AND CONCEPTS**

FAP: 22 T.o.R.:5.3.2

OBJECTIVES: To prepare a state-of-the-art and critically review possible river training concepts and methods for major braided rivers, giving due attention to both permanent structures and measures of a temporary nature.

INPUTS: Literature, specific reports prepared by authorities,institutes, consultants and others, including the Consultant's own files and experience. Results of tasks 16 of FAP 21. (Optional) Visits to some rivers of similar character and size as the Jamuna River to obtain first-hand information on experiences obtained during river training.

DETAILS: The ultimate aim of this activity is to prepare a critical state-of-the-art of river training of major braided sand-bed rivers. In the Consultant's opinion a distinction should be made, at least initially, between river training methods and river training concepts.

River training methods comprise the whole range of measures that can be taken to train a river. A major difference exist between permanent structures and so-called recurrent measures, measures that have to be repeated regularly.

River training works by means of permanent structures is often done in the form of groynes, revetments, etc. Within the framework of FAP 21 a review will be made of permanent river training works and the results of this study can be used in the present task also. Recurrent measures comprises bandals, bottom and floating vanes, closing of "secondary" channels by constructing (submerged?) dams, and dredging. In the highly changeable Jamuna river environment there is some logic in applying recurrent measures because they allow to direct all activities to problem spots. The disadvantage of permanent structures is that they may lay idle for quite some time, because the river has turned away from what initially was a trouble spot.

Concepts for river training works encompass conceptual designs of how a river will be trained. This may be a reduction of the river width or the number of channels by narrowing the width available for the river by constructing groyns and/or revetments at both sides of the river. Such a concept is then based on permanent structures. Important aspects are then the applied constriction, the mutual distance of the groynes, whether the river training should be built by means of pairs of groynes or whether they should be built intermittently at both sides, etc. The opposite is river training by means of recurrent measures, e.g. the continuous and repeated closing of "outflanking " channels to limit the width occupied by the river.The state-of-the-art in river training works and river training concepts will be prepared on the basis of:

(1) an extensive review of literature (handbooks, periodicals, Consultanty reports, etc.);

(2) collecting Consultant's own work and experience with river training works and concepts;

(3) review of modern concepts on river training and new techniques for the construction of river training works, based on Consultant'ss knowledge and international contacts.

The collected material will be reviewed critically. The above activity will start with an extensive literature survey to be carried out by the river training specialist. Because of the availability of literature and the easy access to data bases on literature, this preliminary stage will be carried out in Consultants' home office. In a later stage the material obtained will be condensed and critically reviewed in Bangladesh.

According to the Terms of Reference also the experience of rivers with comparable size and/or planform characteristics has to be collected and reviewed. This will be done mainly on the basis of the above literature. In addition, a visit will be paid to two major river basins in the world, notably the Hwang Ho (Yellow river) in P.R. of China and the Tennessee and Misissippi river basin, to obtain first-hand information on the experience obtained there when training these two large rivers. Also this experience will be included in the state-of-the-art, to be presented in the Inception Report, to be published 5 months after the start of the project.

OUTPUT: State-of-the-art in river training works and river training concepts, to be included in the Inception Report.

STAFF:

- Responsible:
  chief river training engineer
- Further activities
  morphologist
  low-cost river training specialist

TASK: **PREDICTION METHODS FOR MORPHOLOGICAL RESPONSE**

FAP: 22 T.o.R.:5.3.2

OBJECTIVES: To prepare a state-of-the-art and critically review prediction methods for the morphological response of the major braided rivers subjected to river training either via permanent structures or recurrent measures or via a combination of both. Selection of prediction method(s) to be used for the assessment of the response of different strategies for river training of the Jamuna river.

INPUT: Literature, specific reports prepared by authorities, institutes, consultants and others, including the Consultant's own files and experience.

Visits to some rivers of similar character and size as the Jamuna river to obtain first-hand information on experiences obtained during river training.

DETAILS: The ultimate aim of this activity is to prepare a critical review prediction methods for the morphological response of the major braided rivers subjected to river training. A distinction can be made between river training via permanent structures and river training via so-called recurrent measures, measures that have to be repeated regularly. But both methods intend to change the characteristics of the river in such a way that it becomes less harmful to the socio-economic values which at present are regularly threatened.

With permanent structures it is intended to reduce the active width of the river and in doing so reduce the number of channels. This reduced number of channels however will have to have larger discharge capacity and therefore result on a larger attack on the river banks. Limiting the width allowed to the river may ultimately lead to a complete change of the Jamuna river from a braided river system to a meandering river. Such a change may have advantages, but it also has disadvantages. The advantage is that locations where bank erosion will take place can better be predicted (bank erosion along meandering rivers occurs at the outer bend), a.o. by using recently developed mathematical models like MIANDRAS model of Delft Hydraulics. It may also be that the flooding frequency decreases. These effects may allow zoning of the floodplain of the Jamuna river, and increased socio-economic use of the floodplain. A disadvantage of a change to a meandering river lies in the increased depth of this river because it has to carry the total bankful discharge in one channel. In Mawa located along the Padma river, which carries the combined discharge of the Jamuna and the Ganges rivers water depths of up to 60 m have been measured. Keeping in mind that the river depth corresponds approximately to the bankful discharge to the power 1/3 this would mean that a meandering Jamuna river could have depths up to 45 m, which is far in excess of the present erosion depths of up to 30 m. Recurrent measures when carried out on a large scale may also result in a change of the river characteristics. If for instance systematically the "outflanking" channels are being cut off or closed this will in due time lead to a smaller number of parallel channels, but these channels will have larger dimensions.

A thorough assessment of the effects of any large-scale river training measures as to their effects is therefore required. The Consultant will prepare a state-of-the-art on prediction methods for the morphological response of the major braided rivers subjected to river training on the basis of:

(1) an extensive review of literature (handbooks, periodicals, Consultancy reports, etc.)

(2) collecting the Consultant's own work and experience with river training works and concepts

(3) review of modern concepts on river training and new techniques for the construction of river training works, based on the Consultant's knowledge and international contacts. The collected material will be reviewed critically. The above activity will start with an extensive literature survey to be carried out by the river training specialist. Because of the availibility of literature and the easy access to data bases on literature, this preliminary stage will be carried out in the Consultant's home office. In a later stage the material obtained will be condensed and critically reviewed in Bangladesh. Methods to be included in the review are minimum streampower approach by e.g. Chang, the method by Bettess and White, the regime approach by Ramette and an extension of the Consultant's own work on meandering and braiding of rivers. It is not intended to develop new methods, as FAP 22 intends to use existing and proven methods only.

According to the Terms of Reference also the experience of rivers with comparable size and/or planform characteristics has to be collected and reviewed. This will be done mainly on the basis of the above literature. In addition, a visit will be paid to two major river basins in the world, notably the Hwang Ho (Yellow River) in P.R. of China and the Tennessee and Misissippi River basin, to obtain first-hand information on the experience obtained there when training these two large rivers. Also this experience will be included in the state-of-the-art, to be presented in the Inception Report, to be published 5 months after the start of the project. The experience on these rivers and any other experience known to the Consultant or published in the literature will be compared with existing prediction methods for the morphological response of major rivers to river training on a large scale.

In a final step the prediction methods and their applicability will be checked against the conditions in the Jamuna river and one or more methods will be selected for use in the analysis of the river training strategies to the Jamuna river, to be done under task 30. In this selection due attention will be given to proven abilities of a method to provide fair predictions.

OUTPUT: State-of-the-art on prediction methods for the morphological respons of the major braided rivers subjected to river training either via permanent structures or recurrent measures or via a combination of both, to be included in the Inception Report. Selection of one or more methods for use in the analysis of the river training strategies to the Jamuna river, to be done under task 30.

STAFFING:

- Responsible:
  morphologist
- Further activities:
  chief river training engineer
  low-cost river training engineer
  chief resident engineer

TASK: **FORMULATION OF RIVER TRAINING/AFPM CONCEPTS**

FAP: 22 T.o.R.:5.3.2

OBJECTIVES: To formulate possible river training concepts and works tested on reliability, cost-effectiveness, effect, and sustainability. To give some preliminary findings and to indicate options for a river training pilot project.

INPUT: Results of the state-of-the-art for river trainingconcepts and measures as prepared under task 26. Characteristics of the Jamuna river and other major rivers in Bangladesh, as obtained during the tasks 2, 4 and 6.

DETAILS: In task 26 a state-of-the-art is prepared of possible river training concepts and works in general. The next step is to check these concepts and works against the specific conditions in the Jamuna river. Although the dimensions and characteristics of the Jamuna rivers will also have been in the back of the mind when preparing the review under task 26, it is only in this task that the possibilities and limitations of certain concepts and work under the specific Jamuna conditions will be tested. The major point in this stage is to test the applicability of these concepts and works for the specific Jamuna conditions characterised by very large channels, high and extended floods and extreme variability in planform characteristics.

A major constraint therefore will be the costs of the river training measures. In this stage not a full fledge feasibility study will be carried out, but based on unit prices to be prepared under task 21 of FAP 21 to get a first estimate of the costs-effectiveness of the different concepts and river works.

Other aspects that have to be considered for the specific Jamuna and Bangladesh conditions are the reliability, and the sustainability of the possible concepts and works. Also the effects of the different river training concepts and works will be assessed briefly. This will lead to a number of possible river training concepts and works that are tested on their reliability, cost-effectiveness, effect and sustainability.

Finally the preliminary findings will be summarized in an interim report to be published after 8 months. In this report also options for a pilot river training project will be indicated.

OUTPUT: Possible river training concepts and works tested on reliability, cost-effectiveness, effect, and sustainability, which can be used as the basis for the preparation of different strategies for river training. Interim report with findings of the preliminary study and an indication of possible options for a river training pilot project.

STAFF:

- Responsible:
  chief river training engineer
- Further activities:
  economist
  chief resident engineer

TASK: **FORMULATION OF ALTERNATIVE STRATEGIES OF RIVER TRAINING/AFPM**

FAP: 22 T.o.R.: 5.3.2

OBJECTIVES: To formulate a number of alternate strategies for river training and active floodplain management

INPUT: Possible river training concepts and works tested on reliability, cost-effectiveness, effect and sustainability.

DETAILS: Under task 28 possible river training concepts and works have been identified, that have been screened as far as reliability, cost-effectiveness, effect and sustainability is concerned. In a next step these possible concepts have to be developed into different strategies for river training. These strategies can consist of:

- permanent structures
- recurrent measures
- a combination of permanent structures and recurrent measures

The strategies to be developed will consist only of measures that are considered technically feasible.

Apart from the components of the river training strategy an important decision is related to the investment levels that are assumed to be needed, both initially and for maintenance. These investment level is closely linked to the safety levels that are accepted. A further aspect is the time over which the investments are spread, and the risk that is run in the mean time.

Another important aspect is the management and development of the floodplains with respect to land use and discharge capacity. This has to be ensured via institutional and legal measures, and assumptions as to the possibilities of developing ways and means to arrive at an optimum management and development of the floodplains have to be made. The latter will be based on an inventory of socio-economic, institutional and legal aspects of present floodplain use in Bangladesh.

All these aspects will be incorporated in the development of the different strategies to be tested. This implies that the strategies may differ in:

- components (permanent structures, recurrent measures, or both)
- investment and safety levels
- period over which the investments are being made

OUTPUT: A number of alternative strategies for river training and active flood plain management to be analysed under task 30.

STAFF:

- Responsible:
  chief river training engineer
- Further activities:
  socio-economist
  land reclamation expert
  land acquisition specialist
  legal advisor
  chief resident engineer

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TASK: **SELECTION OF RECOMMENDED RIVER TRAINING/AFPM STRATEGIES**

FAP: 22 To.R.:5.3.2

OBJECTIVES: To analyse the strategies for river training and active floodplain management on costs, effects (including the environmental effects), benefits, socio-economic aspects, legal and institutional aspects. To select the most promising strategy (strategies) and to estimate the economical feasibility of this strategy (these strategies).

INPUT: Different strategies for river training and active floodplain management as developed under task 29. Modelling technique(s) selected during task 27 to predict the morphological effects of the different strategies. Socio-economic, legal and institutional aspects of floodplain use as determined under Task 29.

DETAILS: Under task 29 different strategies have been formulated for further assessment. All these strategies are considered to be technically feasible. In the present task these strategies will be analyzed as far as their costs, effects (including the environmental effects), benefits, socio-economic aspects, legal and institutional aspects. Costs will be determined on the basis of preliminary designs of the permanent structures, their initial costs and maintenance costs, and on the running costs of the recurrent measures. For all strategies investment schedules will be prepared.

The effects of the different strategies will be assessed. As a basis will be used the prediction of the morphological response of the Jamuna river to the imposed river training and active floodplain management measures. This will yield the improved possibilities for improved land use and options for reclamation. Also the environmental effects will be evaluated, considering both the natural values and the socio-economic aspects. It is obvious that strategies leaning heavily on permanent structures will have a much larger effect than strategies that are based on recurrent measures only.

Benefits of the different strategies will be evaluated considering not only the direct socio-economic benefits (via increased production, and the reduced impovering of the population due to reduced erosion of the banks and the connected reduced loss of land), but including also the generated benefits from the FAP as a whole, requiring labour over a longer period and being a stimulance to the economic development of Bangladesh.

The strategies have also to be analyzed as to the feasibility of the institutional and legal requirements. These will be considered for all the strategies formulated and it will be assessed to what extent these requirements can be fulfilled within the Bangladesh context.

To select the most promising strategy (strategies) the costs, effects (including the environmental effects), benefits, socio-economic aspects, and legal and institutional aspects of the different strategies will compared and the most promising one(s) will be selected. For this purpose a multi-criteria ranking system will be used.

To estimate the economical feasibility of the selected strategy (strategies) no detailed feasibility study will be carried out in this planning study. The considerations as to the feasibility will concentrate on the cost-effectiveness of the selected strategy (strategies).

The above analysis can result in different conclusions as to the feasibility of FAP 22. If there are sufficient indications that river training and active floodplain management is feasible then the project will continue with the Tasks 31, 32 and 33. If it is clearly not feasible, then the project will be stopped. Anyhow, a summary report will be prepared providing the major findings and a reference to resource data.

OUTPUT: Conclusions as to the technical and economical feasibility of river training and/or active floodplain management for the Jamuna River. If feasible, recommendations regarding an implementation phase.

STAFF:

- Responsible:
  chief river training expert
- Further activities:
  chief resident engineer
  low-cost river training specialist
  hydrologist
  morphologist
  socio-economist
  land reclamation expert
  environmental specialist
  economist

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TASK:

APPROACH FOR DEVELOPMENT OF MEDIUM-TERM PLAN

FAP: 22 T.o.R.:5.3.2

OBJECTIVES: To prepare a strategy for medium term investigations and extended trials of river training and active flood plain management (only to be carried out when river training and active floodplain management appears to be feasible).

INPUT: Results of the analysis of the different strategies for river training and active flood plain management. State-of-the-art of river training works and concepts.

DETAILS: The planning study of FAP 22 is based on the use of existing knowledge and rough estimates to assess whether river training in combination with active floodplain management may provide interesting prospects. This is done both for "heavy" structures and for "light" measures. Also combinations have been considered. Assuming that the application of these techniques may lead to a solution which appears to be technically and economically feasible, the next step to take is the refinement of the analysis. This can only be done when a reliable planning basis for investments becomes available, especially when this concerns major investments for river training on an extensive scale.

For the preparation of such a planning basis much more information will be needed. Therefore, an approach has to be developed for medium term investigations and extended trials which in due time should provide in sufficient information.

To prepare such an approach it is required to have an idea where, when and how in due time river training works will be implemented. This calls for at least a tentative plan for the long term development of the river. The Consultant intends to prepare such an outline plan for the long term and at the same time to develop a plan for the medium term. In a next step a strategy for medium term investigations and extended trials will be developed. Necessarily these additional investigations and trials will consist of technical and socio-economic information, while furthermore it may be required to develop improved prediction methods for predicition of the effects of the developments at different time scales.

At present no details on the medium term investigations and extended trials can be given, because they depend fully on the outcome of the previous studies within the frame-work of FAP 22.

OUTPUT: Strategy for medium term investigations and extended trials, and as a basis a tentative long-term plan an medium term plan.

STAFF:

- Responsible:
  chief river training expert
- Further activities:
  chief resident engineer
  morphologists
  land reclamation experts
  socio-economists
  environmental experts

TASK: **DESIGN OF INITIAL PILOT PROJECT**

FAP: 22 T.o.R.: 5.3.2

OBJECTIVES: To design an initial pilot project (only to be carried out if river training with relatively light measures appears to be feasible).

INPUT: Results of the study on the feasibility of strategies with light structures and/or recurrent measures.

DETAILS: If river training with light measures appears to be feasible, then an initial pilot project is appropriate. In this task such a pilot project will be designed. What type(s) of light river training measure will be tested in this pilot scheme depends on the outcome of the previous studies within the frame-work of FAP 22.

For the pilot project cost estimates, time schedules, manpower, and material and equipment required will be prepared.

OUTPUT: Design of an initial pilot project for the testing of light river training measures, including cost estimates, time schedules, manpower, and material and equipment required.

STAFF:

- Responsible:
  chief river training engineer
- Further activities:
  chief resident engineer
  chief hydraulic design engineer
  low-cost river training specialist

TASK:

PREPARATION OF IMPLEMENTATION OF PILOT PROJECT

FAP: 22 T.o.R.:5.3.2

OBJECTIVES:

To prepare the implementation of the pilot project, including the incorporation of active floodplain management (only if river training by means of light structures appears to be feasible).

INPUTS: Design of initial pilot project as prepared under Task 32.

DETAILS: Once the design of the pilot project for the testing of light river training measures has been finalized, a plan for implementation has to be prepared. In this plan due attention will be given to socio-economic, legal and institutional aspects.

OUTPUT: Plan for implementation of pilot project.

STAFF:

- Responsible:
  chief river training engineer
- Further activities:
  socio-economist
  legal advisor
  chief hydraulic design engineer
  chief resident engineer

TASK: **PROPOSAL OF INSTITUTIONAL ARRANGEMENTS**

FAP: 21 and 22 T.o.R.: 5 - 4

OBJECTIVES: To obtain the full participation of central and local administrations for land acquisition, for the construction of the Test Works, and for their operation and maintenance, to organize this participation, and to train them to full capability in managing the project after the departure of expatriates.

INPUT: Previous assessments of similar projects.

DETAILS: Institutional arrangements will have basically two components:

. arrangements which are needed for the management of the technical aspects (at central and local levels).

. arrangements needed to get the full participation of local authorities and of people concerned, including for land acquisition problems, to which due consideration is given in par 3 below.

1) Management of Technical Aspects

The Consultant will take the necessary contacts so as to involve a national agency from the very beginning of the project. This agency should normally be the BWDB, which has the responsibility of developing all flood related development projects, with FPCO supervision as it is a FAP Activity. This Agency, in relation with the Consultant will be concerned with the following aspects:

. coordination with other ministries and agencies including local administration
. agreement on the procedure for the selection of local contractors, and for awarding of contracts, as soon as construction is involved. The preparation of specification relating to legal aspects of contracts will have to be the responsibility of this agency
. solution of any difficulty which may arise in the application of these contracts
. participation in the preparation of programmes for operation and maintenance of structures
. management and supervision of operation and maintenance immediately after the end of the expatriate technical assistance

2) Local participation

The Consultant will liaise with local autorithies concerned to involve them from the beginning of the studies, to inform them of the project objectives and of the location of project components which may have an impact on population and activites. He will organize a committee representing local authorities and groups involved, and regular meetings with this committee to reach solutions concerning the following aspects:

- preparation of project designs minimizing the detrimental consequences on local conditions, including for land acquisition
- definition of local participation in the construction of structures; subsequently for their operation and maintenance, and organization of corresponding groups and activities
- rganization of liaison between local and central levels, including coordination with BWDB.

3) **Land acquisition problems**

Once the engineers have determined the location of proposed structures, and the affected land either permanently (to build structures) or temporarily ground extraction, access and place needed for operation on the bank i.l. warehouses, storage, camp, etc.), the land acquisition specialist will have to perform the following tasks:

- to inform the villagers through their representatives of the main project features, and of corresponding land needs
- to make an inventors of plots of land which will be affected:
  .use
  .registration or not
  .de facto user (owner or not, according customary rights)
  .value of the piece of land, or of its annual net revenue
- to organize contacts with people affected to confirm the value of the lands and specific problems which may arise for land acquisition
- to confirm, to the local authorities and administrations involved, the acquisitions required, and to prepare a Programme for these acquisitions
- to establish the legal procedure which has to be implemented, and to prepare a detailed work plan showing all agencies involved, their responsibilities, the timing of their interventions and the financial involvements

OUTPUT: Smooth implementation of structures, including land acquisition.

- efficient operation and maintenance
- minimization of detrimental consequences of the project
- full benefits to local population

STAFF:

- Responsible:
  socio-economist/institutional expert
- Further activities:
  land acquisition specialist
  legal advisor
  chief resident engineer

ANNEX III

AVAILABLE DOCUMENTATION OF THE PROJECT LIBRARY

AUTHOR	TITLE	PERIOD
	Procedures and Conditions of use for SWMC Models for FAP Activities	
	Acquisition and Requisition of Immovable Property Ordinance	1982
	Identification Mission for FAP 21/22	June 1990
	Compartmentalization Pilot Project,ToR,(FAP 20)	September 1990
	Jamuna Bridge Bank Protection Research Project,CUR Report(incl. Annexes I to III)	
	Jamuna Bridge Bank Protection Research Project, CUR Report (inc. annex IV)	
	Agriculture in Bangladesh Performance Problems & Prospects	
	Inorganic Grain Size Analysis	September 1989
AFPM	Bank Protection and AFPM Pilot Project, FAP 21/22	
Ahmed, N.	Landlessness in Bangladesh	
Ahmed, S.G.	Public Personnel Administration in Bangladesh	1986
Atiur, R.	Peasants and Classes - A Study in Differention in Bangladesh	
BCEOM, CNR, Euroconsult, etc.	North Central Regional Study, Interim Report	November 1991
BETS	Review of the Present Monitoring System of BWDB Projects,BETS R&D Publication No.3	October 1989
BETS	An Investigation into the Drainage Problem of Metropolitan Dhaka and its Solution,BETS R&D Publication No.4	December 1990
BWDB	Schedules of Rates:a)Dhaka O & M Circle,b)Sylhet O & M Circle	1988

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AUTHOR	TITLE	PERIOD
BWDB	Brahmaputra Right Flood Embankment Project, Feasibility Report	November 1977
BWDB	Comprehensive Plan for Protection of Chandpur Town and Chandpur Irrigation Project	January 1975
Bangladesh Bureau of Statistices	Preliminary Report Population Census	July 1991
Bangladesh Bureau of Statistices	The Bangladesh Census of Agriculture and Livestock: 1983-84, Zila Series Tangail	August 1980
Bangladesh Bureau of Statistices	The Bangladesh Census of Agriculture and Livestock: 1983-84, Zila Series, Manikganj	September 1988
Bangladesh Bureau of Statistices	The Bangladesh Cesneus of Agriculture and Livestock: 1983-84, Zila Series, Gaibandha	December 1987
Bangladesh Bureau of Statistices	The Bangladesh Census of Agriculture and Livestock: 1983-84, Zila Series, Bogra	June 1987
Bangladesh Bureau of Statistices	The Bangladesh Census of Agriculture and Livestock: 1983-84, Zila Series, Pabna	August 1987
Bangladesh Bureau of Statistices	The Bangladesh Census of Agriculture and Livestock: 1983-84, Zila Series, Jamalpur	November 1988
Bangladesh Bureau of Statistices	The Bangladesh Census of Agriculture and Livestock: 1983-84, Zila Series, Serajgonj	September 1987
Bangladesh Bureau of Statistices	The Bangladesh Census of Agriculture and Livestock: 1983-84, Zila Series, Kurigram	December 1987
Bangladesh Bureau of Statistices	Report on the Household Expenditure Survey	August 1991
Bangladesh Bureau of Statistices	Small Area Atlas of Bangladesh, Mauzas and Mahallahs of Dhaka District	September 1985

AUTHOR	TITLE	PERIOD
Bangladesh Bureau of Statistices	Small Area Atlas of Bangladesh, Mauzas and Mahallahs of Tangail Distict	February 1986
Bangladesh Bureau of Statistices	Small Area Atlas of Bangladesh, Mauzas and Mahallahs of Jamalpur District	May 1986
Bangladesh Bureau of Statistices	Small Area Atlas of Bangladesh, Mauzas and Mahallahs of Bogra District	June 1988
Bangladesh Bureau of Statistices	Small Area Atlas of Bangladesh, Mauzas and Mahallahs of Pabna District	July 1988
Bangladesh Bureau of Statistices	Small Area Atlas of Bangladesh, Muazas and Mahallahs of Rangpur District	December 1989
Bangladesh Bureau of Statistices	Bangladesh Education in Statistices, 1991	January 1992
Bangladesh Bureau of Statistics	Report on the Upazila Development Monitoring Project 1990, Vol. II	June 1991
Bangladesh Bureau of Statistics	Report on the Upazila Development Monitoring Project, Vol. I	Nov. 1990
Bangladesh Bureau of Statistics	Current Levels & Trends of Mortility, Fertility, Nuptiality Patterns & Internal Migration of Bangladesh	January 1966
Bangladesh Bureau of Statistics	Statistical Yearbook of Bangladesh	1991
CNR,BCEOM and Euroconsult	Jamalpur Priority Project Study(FAP 3.1),Technical Proposal	November 1990
CNR,BCEOM and Euroconsult	North Central Regional Study,Phase-I Report on Geotechnical Investigation	1988
China-Bangladesh Joint Expert Team	Study Report on Flood Control and River Training Project on the Brahmaputra, Vol.3	1991
China-Bangladesh Joint Expert Team	Study Report on Flood Control and River Training Project on the Brahmaputra, Vol.2	1991

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AUTHOR	TITLE	PERIOD
China-Bangladesh Joint Expert Team	Study Report on Flood Control and River Training Project on the Brahmaputra River in Bangladesh, Vol.1	March 1991
China-Bangladesh Joint Expert Team	Study Report Flood Control and River Training Project on the Brahmaputra River in Bangladesh, Vol.4	
China-Bangladesh Joint Expert Team	Study Report Flood Control and River Training Project on the Brahmaputra River in Bangladesh, Vol.5	
China-Bangladesh Joint Expert Team	Study Report on Flood Control and River Training Project on the Brahmaputra River in Bangladesh	March 1991
Chowdhury, M. Abedin, S.	Case Study on River Erosion,Chandpur Regional Workshop on Erosion and Sediment Transport Processes,Dhaka	September 1986
Coleman	Brahmaputra River: Channel Processes and Sedimentation,Sedimentary Geology, No.8,P.129-239	1969
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ANNEX IV

MINUTES OF THE PROJECT MEETINGS

PROJECT MEETING NO. 1

DAY : 29.01.92 10.00 AM to 12.30 PM
VENUE: PROJECT OFFICE

Participants: List attached as ANNEX 1

1. GENERAL ASPECTS

Information was given by the Project Director on the present status of office installation and schedule of finalization. The main outstanding items are

- **Project Office working hours:** The Project will follow a 5 days week from Sunday to Thursday 08.30 AM to 05.00 PM (with an ½ hrs break from 1.00 to 1.30 PM). A skeleton support staff will be available on Saturday from 9.30 AM to 02.30 PM.

- **Vehicles:** The 3 Honda cars waiting in Chittagong are aspected to be at the Project's disposal within 3-4 days. Since 1 of the cars got damaged it will be replaced by a new one arriving by February, 15.

- **ISD Line:** Application is under way since two weeks, the number is expected to be allocated early next week; 2 to 3 days later the telephone may be connected. As soon as the international phone number is known, Letter heads an project name cards will be finally printed. Spelling of names to be checked by each professional.

- **Arrival of expatriates:** The hydrologist Mr Fleury is expected to arrive on February 1, 1992 (subject to reconfirmation by CNR) and the socio economist Mr Potin will arrive on February 3, 1992.

- **Visit to the Project by M.D. of Rhein-Ruhr:** Mr W Matuschka, Managing Director of Rhein-Ruhr, will visit the Project from January 30 to February 1, 1992. During his stay a meeting with the Chairman FPCO and a site visit to the Jamuna is scheduled.

- **Project Office Inauguration:** After completion of the Project Office a inauguration reception will be arranged, inviting project related staff of FPCO, BWDB, etc. and those FAP components which are in close connection with FAP 21/22.

- **All Donors Meeting:** To be held either 24-27 February or first week of March. The Consultant's experts of the Advisory Board have been invited to the Project as from about February 18 to 20 to give their input for the pre-selection of sites and to discuss with FPCO's panel experts and the donors' (kfw/CCCE) experts to be present at that venue. It was noted that the very late decision of the meeting's date may impede the one or the others presence.

2. ORGANIZATION OF PROJECT ACTIVITIES

General: Since FAP 21/22 Project is a very special and extremely complex project which cannot be carried out with standard routines only, much stress has to be put on an optimum integration of the different disciplines and flow of information. This objective shall be achieved by the following measures:

- **Regular Project Meetings:** Until submitting the Inception Report the regular Project Meetings (as per Section F-8 of the Consulting Agreement) shall take place weekly. FPCO Project Administrator Mr Salam shall, if possible, participate regularly to guarantee the flow of information between FPCO and the Consultant and vice versa and to easy desicion taking and approvals. Subject to agreement of FPCO Project Administrator, the regular Project Meetings will take place every Sunday at 10.00 AM sharp. Their duration shall be limited to 1-1½ hours. The Project Meetings shall be given serial numbers starting with #1 as the present one. They shall be minuted, the minutes being distributed to FPCO and KfW and within the Project.

- **Coordination FAP 21/FAP 22:** Since the two project components are partly integrated and partly working on their own (c.f. Section G of the Consulting Agreement) the Team Leaders will coordinate the work of the experts assigned to their components and have a close and continuous working contact.

  They will meet daily at about 9.00 AM with the Project Director for mutual information (for about 10-15 minutes).

  Independent of this institutionalized coordination it will be indispensable that all experts are looking at the project as a whole and inform their colleagues of findings and considerations that may be important for them.

- **Presentations 1):** At the end of the Project Meetings a member of the staff will give a short presentation of his activities, findings, problems etc. The first presentation, in Project Meeting #2, will be given by Mr G Klassen, Morphologist.

- **Presentations 2):** The Project thinks it necessary to have video documentation of activities and presentation of important technical aspects already in the Planning Study and not only during Test and Implementation, as anticipated in the Consulting Agreement. This holds particularly for processes and events not accessible to all staff involved, for example certain results of the physical models or phenomena on the river which can be presented to and discussed by all the staff interested.

- **Presentations 3:** It will be checked and discussed with FPCO wether the Project should additionally purchase an overhead projector.

- **Symposium on River Sedimentation:** 6 to 10 April in Karlsruhe/ Germany. The symposium will be attended by 4 Project related Officers of GOB (FPCO and others). After the symposium a visit to the Consultant's head offices at Dortmund, Lyon and de Voorst shall be paid to discuss issues presented in the Inception Report.

- **Documentation, Collection of Data:** Due to the complexity and the time constraint of the Project a large amount of data, documentation etc. has to be collected and evaluated in short time.

  In order to avoid the same data/documentation acquired twice by different staff, and to have a control of the data either available in the project or asked for, the acquisition of data shall be centrally handled, although no central library will be kept. Mr Mia is at present handling that issue, he will be assisted be Mr v d Wal who will arrange for a computerized data base from which lateron the list of documentation utilized in the Project may be retrieved in the form as required for the Inception Report.

  All professional staff is requested to inform Mr Mia/v d Wal of all documentation acquired and officially requested for by letter.

3. INCEPTION REPORT

Main objective of the Inception Report is the proposal of pre-selected site areas by the Consultant. Therefore he will do his almost to present the Inception Report by mid March, 3½ months after the date of Commencement of Services, that means 1½ earlier than proposed and included in the Consulting Agreement. That reduction in time available requires a very well organized work and may require a revision of the scope to be performed within that period. Priority shall be given to all those items which are required for pre-selecting the test areas. Other, less urgent items may be left to be done after the Inception Report and included in the Interim Report.

- **Technical Papers** may be produced and distributed between the official reports; they would be attached as an annex to the next following official report. Most probably the **Review of the State of the Art of River Training** could be one of these technical papers. It would be submitted 2nd half of April 1992. Other possible modifications of the scope for the Inception Report shall be discussed and decided upon at Project Meeting # 2.

  A proposal for the **contents and structure of the Inception Report** was circulated to the participants asking for their comments and suggestions until Saturday, February 1, 1992. A new proposal will be circulated at Project Meeting # 2.

4. TECHNICAL PROJECT MATTERS

4.1 Pre-selection of Test Areas

The criteria for pre-selection of test areas as per Task No.07 of the Consulting agreement where comprehensively discussed.

It was noted that the by far most important criterion has to be the guarantee (= highest possible probability) that the selected area will be exposed to the flow and hence be able to be tested throughout the planned monitoring period of 2 to 3 years. **All other criteria have to**

be of secondary or less importance. Furthermore, care should be taken not to have the project used for building a particular embankment. (c.f. also para 4.2)

In discussions with FAP 1 and FAP 3 it turned out that

- possibly not more than one test area may be located on the left bank, namely Bahadurabad since in no other area regular erosion seems to take place.

- the one or other of the FAP 1 priority sites could be investigated to be test areas.

Both matters will be treated with more detail within the project and discussed with related FAP. (e.g. also FAP 3.1)

4.2 Design of Test Structures

It was discussed that the design and hence the construction cost of the test structure will considerably depend on the criteria involved in selecting the test area. This point of view is particularly evident in case one of the criteria being the protection of some important infrastructure. In such a case may be a second defence line will have to be provided for which would safely prevent a collapse of the total structure should the test structure fail. Such a double structure will probably be far more costly than a structure which would not necessarily have to be collapse-proof. Therefore it may well be possible to include one or two test areas which will not protect any particular installation, c.f. also last para of "DETAILS" in Task 07, page G-23 of the Consulting Agreement.

4.3 Site Visits

The visits of possible test areas shall be programmed within short. It was felt that the use of BWDB speed boat may be very valuable and a meeting with high BWDB officials shall be arranged within short.

For far away destinations, (e.g. Teesta or north of it), to save time the professional staff would travel by plane and be picked up by a Project car which had been sent there in advance.

A possible schedule for site visit shall be discussed in Project Meeting # 2.

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PROJECT MEETING NO.2

DAY : 04.02.92 10.00 AM to 11.45 PM
VENUE: PROJECT OFFICE

Participants: List attached as ANNEX 1

Distribution: Project, FPCO, KfW

1. GENERAL ASPECTS

- **New professional staff:** took up their activities in the project since the last meeting.

01.02.1992	Mr J Islam, Modelling Expert
01.02.1992	Mr Q Saifuddin, Morphologist
01.02.1992	Mr Salauddin Khan, Morphologist
01.02.1992	Mr H Nizzamuddin, Socio-economist
01.02.1992	Mr M A Jabbar, Land Acquisition Specialist
04.02.1992	Mr C Potin, Socio-economist

- **Acquisition of Data:** This turns out to be a very difficult matter since the acquisition through official channels takes much time and requires often several reports in writing sent to different authorities. In some cases reluctance was even found to hand over information which was regarded to be sensitive, this applies particularly to reports on damages to embankment which are, on the other hand, very important for project component FAP 21. The only possible way is to retrieve the data unofficially, parallely to the official request which will be made in all cases.

- **Copy of data, documentation:** A bottle neck appeared in the copying capacity of the Project when large reports are to be copied in a few days and when the material is only (unofficially) borrowed for a short time. In these cases a contract will be made with a copy shop.

- **Meeting reports:** Short informal reports of important meetings with other FAPs etc. will be distributed to colleagues involved.

- **Next Project Meeting:** Sunday 09.02.1992 10.00 AM, with a presentation by M vd Wal.

2. INCEPTION REPORT

A new version of the contents (cum list of matters) was discussed and several suggestions came up. Deadline for presentation of further suggestions is Saturday 8.2.92.

3. SITE VISITS

Site visits should concentrate in the present stage of the Project to those sites on the Jamuna which could be considered to be pre-selected Test Areas.

Visits to other sites and visits to other rivers of Bangladesh will be done before the Inception Report only if time permits, otherwise they will be carried out at a later stage. The time schedule for the site visits shall be fixed after more in depth discussions with FAP 3 and FAP 3.1. Further investigation will be done wether BWDB speed boats may be available at that time in case that the customs clearance of the Project's speed boat will not be finalized on time.

4. REMOTE SENSING STUDIES

Discussions held with FAP 19 (Geographic Information System) revealed that some comparative evaluation of satellite imaging is being done in a similar way and extend as planned for the Project. Further discussions will be hold to avoid double work and to coordinate evaluation criteria. A cooperation will be investigated to make best use of the funds available for both projects. In case of necessity a modification of the scope of works may be discussed with FPCO/KfW and officially proposed in the Inception Report.

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PROJECT MEETING NO.3

DAY : 09.02.92 10.00 AM to 12.00 PM
VENUE: PROJECT OFFICE

Participants: List attached as ANNEX 1

Distribution: Project, FPCO, KfW

1. GENERAL ASPECTS

- **Professional staff** movement since last Project Meeting:

05.02.92	Mr G Fleury	Hydrologist
05.02.92	Mr Zahirul H Khan	Hydrologist

  took up their activities

- **Advisory Board Experts:** in the context with the Donors' Conference, Prof. Vollmers is scheduled to arrive 24.02.92.

- **KfW Delegation:** the travel schedule of the KfW Delation in the context with the Donors' Conference is not yet known. The Project Director will inquire directly.

- **ISD telephone:** the connection is said to be made today, the number will be known 2 days later.

- **Honda cars:** two Honda cars are said to be released from Customs on 11.02.92.

- **Air freight:** the equipment is said to be released from Customs this week, i.e. until 13.02.92.

2. SEMINARS STUDY TOURS

- **Symposium on Sedimentation:** It was pointed out that the Project needs the nomination of the GOB participants as soon as possible in order not to run into problems with the registration and booking of accommodation. In case they were not known within the next few days FPCO will instruct the Project Director in writing to start the registration and accommodation for 4 persons.

- **Study Tour Yellow River/Mississippi:** This tour should start the earliest possible to provide the expected input to the "Review of the State of the Art of River Training". Due to the other Project activities, the earliest date will be mid May 1992. Since visa and other arrangements in China and USA are more time consuming than in Europe FPCO was asked to prepare nomination of the 4 GOB participants well in advance. FPCO asked the Project Director to send an official request.

  Contacts for the preparation of the study tour may be made with World Bank and ESCAP, Bangkok who had a recent mission to China.

3. INCEPTION REPORT

The final version including the staff responsible for the different chapters was presented and basically adopted.

4. PRE-SELECTION OF SITES

As expected, the discussions with the different Authorities and FAPs did not yet result into a clear picture. Further clarification is expected by examining in depth the study of priority sites of FAP 1 (Brahmaputra right bank embankment), by the satellite imagery evaluation and by the site visits.

It was felt to be important that the Project Director should make it clear that the **Project's objective is to test structures, not to construct embankments.** That means that the primary criterion for the selection of test areas will have to be the guarantee of a continuous flow attack through the total monitoring period, not necessarily the economic or socio-economic needs for a bank protection.

5. SITE VISITS

The site visits are indispensable for the selection of the test areas. This will include the pre-selected areas which up to now seem to be

- o Bahadurabad and may be Madarganj on the left bank
- o Gaibandha, Fulchari, Kazipur, Betil on the right bank.

Areas for which funds are or will be available, i.e. Sirajganj, Sariakandi and Mathurapara on the right bank, shall not be included in that list.

The programme for the site visit in connection with the selection of test areas will be fixed until 12.02.92. The trip shall start on 16.02.92 latest and it is hoped that the Project's speed boat will be released from Customs by that time because it turned out that BWDB speed boats will not be readily available. The use of a country boat would extend the trip or reduce the efficiency. The Shab-e-Barat holiday on 19.02.92 (instead of 20.2.92 as originally scheduled) results in an additional constraint.

6. AQUISITION OF DOCUMENTATS AND DATA

With exception of some books and reports borrowed from libraries all documentation and data have up to now been collected on unofficial ways. There is however information which needs official release; other information, though produced for the FAP, seems not to be available at all, like e.g. part of the aerial photographs of 1990 of FINMAP, although these photos are nearly indispensable for the proposal of the test areas and for the site visit.

The FPCO Project Administrator will attempt to have these aerial photographs released. He will also arrange to release the 3 sets of 1989 processed SPOT images which are reserved for the Project according to information received by the French Embassy.

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PROJECT MEETING NO.4

DAY : 16.02.92 10.00 AM to 11.30 PM
VENUE: PROJECT OFFICE

Participants: List attached as ANNEX 1
Distribution: Project HB, SM, HS, FvdK,
FPCO
KfW

1. GENERAL ASPECTS

- **Professional staff** movement since last Project Meeting:

14.02.92	Mr E Elizechea	Land Reclamation Specialist finished his assignment.
14.02.92	Dr Wan Zhaohui	Expert of the Advisory Board arrived at Dhaka.

- **KfW Delegation:** The schedule for the KfW experts is as follows:

23.02.92	-	Arrival Dr v Raumer (12.50)
24.02.92	-	Arrival Mr Selzer
24.02.-27.02	-	FAP 20
29.02.92	-	Arrival Dr Heidt
	-	Meetings FAP 21/22
01.03.-04.03	-	FAP- Conference
05.03.92	-	Wrap-up meeting
	-	departure Mr Selzer
06.03.92	-	departure Mr Heidt.

- **ISD No. FAX:** The fax with the Number 883990 is operable.

- **Air freight:** There is a good chance that the air freight will be cleared today. Mr J Heise is following up this matter.

- **Honda cars:** The first two cars were delivered yesterday.

2. DONORS' CONFERENCE

The time schedule is as follows:

01.03.92	-	Inauguration
02.03.-04.03	-	Technical Sessions
05.03.92	-	Closing Session.

The 02.03.92 will be dedicated to engineering aspects, the other two days to non-engineering aspects, mainly socio-economical, environmental, institutional ones.

FAP 21/22 will be presented in Session H2: MANAGING OUR RIVERS, together with FAP 1 and FAP 9B. The presentation is being co-ordinated through some meetings of the respective Project Team Leaders, the following one immediately after the present Project Meeting.

3. SITE TRIPS

Last weak the following site trips were made:

09.02.92 to 10.02.92	The land reclamation specialists Mr Elizechea and Mr Miah to Aricha and Nagarbari areas.
09.02.92 to 15.02.92	The socio-economists Mr Potin, Dr Nizzamuddin and Mr Jabbar to Bogra, Fulchari, Sariakandi, Sirajganj and Tangail.

The results are at present being summarized and a certain modification of the assignment schedule for the socio-economists, land reclamation specialists and economists will be proposed.

The following site trips are envisaged for the days to come:

17.02.92 to 20.02.92	Mr Schwenk, Mr Fvd Knaap, Mr Klaassen, Mr Md Ali, Mr Kamal to the preselected test areas Gaibanda, Fulchari, Sariakandi, Bahadurabad, Sirajganj, Bera. The morphology adviser Dr Wan Zhaohui will also participate in that site trip which is expected to supply important criteria for the final selection and proposition of test areas. Since the air freight has not yet been released from the customs the trip had to be substantially rescheduled, since instead of the Project's own speed boat, country boats will have to be used for river side inspections. Also the overnight stays at BWDB rest houses had to be rescheduled on short term.
18.02.92 to 19.02.92	The socio-economists Mr Potin, Dr Nizzamuddin and Mr Jabbar to Bahadurabad and Jamalpur areas.

4. TIME SCHEDULE FOR SELECTION OF TEST AREAS

The tight schedule for the field surveys which have to be finalized before starting of the monsoon was discussed. To be on the safe side, the bulk of these surveys should be scheduled to be finalized by mid May. Two months will be needed to carry out these surveys provided that no unexpected events disturb the programme, an additional handicap being the Ramadan month starting by March 6 and the subsequent Eid.

Hence the test areas need to be (provisionally) approved by mid March, to allow to start the field surveys by that time. Therefore, the Project will do its utmost to present the proposal for the test areas by March 1, in form of a concise Technical Report. Interim information on the preselection process will be given to all parties concerned as usual.

5. ACQUISITION OF DOCUMENTS AND DATA

This activity continues to be quite cumbersome. FPCO promised that the 1989 SPOT maps will be available latest tomorrow. More problems have to be expected for the acquisition of cross sections from the Morphology section of BWDB which are needed for both the Jamuna and the Padma for comparison of morphological features.

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PROJECT MEETING NO.5

DAY : 23.02.92 10.00 AM to 12.00 PM
VENUE : PROJECT OFFICE

Participants: List attached as ANNEX 1

Distribution: Project HB, SM, HS, FvdK,
FPCO
KfW

1. GENERAL ASPECTS

Nil

2. PRE-SELECTION OF TEST AREAS

The field trip of Mr Schwenk, Mr vd Knaap, Mr Klaassen, Mr Md Ali, Mr Kamal and Dr Wan Zhaokui along the Jamuna to possible test areas proved to be very useful. Together with the SPOT maps of 1989 and a 1991 Landsat image a sound selection can now be made.

Approach

The selection itself will consist of two consecutive steps :

Step 1 : Establishment of a "long list of areas" based on morphological criteria.

Step 2 : Establishment of a "short list of areas" and a ranking, using the other criteria mainly :

- o certainly of attack
- o protection of infrastructure etc.
- o accessibility
- o availability of data and others

Approval procedure

Due to the short time available to start the field surveys fast approval, at least an unofficial one, of the test areas by the bodies concerned (FPCO, BWDB, KfW/CCCE, Panel of Experts) is indispensable.

Therefore, is possible unofficial contacts shall be made to as many persons involved in the approval process, preferably before the commencement of the Donors' Conference, discussing the criteria, the ranking procedure and the selected areas.

The official draft of the Technical Report on the Selection of the Test Areas shall be presented in the first week of March.

Discussion of some possible test areas

The present state of evaluation of the morphological information seems to lead to the following long list :

- o Bahadurabad downstream of the ghat
- o Chandanpaisa
- o North of Manos river regulator
- o Betil
- o Site close to Nagarbari.

Areas to be excluded

There are some areas which are felt that they should be excluded :

i) areas which are in close connection to the Jamuna Bridge (e.g. Bhuapur as a future "hard point".

ii) areas which include sites that are being constructed or for which funding process is on the way, e.g. Sirajganj town protection and Shariakandi Jamuna break through prevention.

iii) areas which are too important to be protected (top priority areas) since it would not be possible to build low safety test works at these places.

PROJECT MEETING NO. 6

DAY : 08.03.92 10.00 AM to 11.00 AM
VENUE : PROJECT OFFICE

Participants: List attached as ANNEX 1

Distribution: Project HB, SM, HS, FvdK,
FPCO
KfW

1. GENERAL ASPECTS

Professional staff movement since the last Meeting

24.02.92	Prof Bouvard Prof H J Vollmers	Experts of the Advisory Board arrived at Dhaka
25.02.92	Mr G Klaassen Mr C Potin	Morphologist and Socio-Economist finished their assignment
01.03.92	Ms C Bertrand	Environmentalist
02.03.92	Dr A H Bhuiya	Environmentalist 2 and
04.03.92	Mr W Schönung	Sub Soil Expert took up their assignment
08.03.92	Dr Wan Zhaohui	Expert of the Advisory Board finished his assignment

Library: The data base and the file card box are now operable. Mr Khorshed is responsible under the guidance of Mr M vd Wal. Search and retrieval of documents, reports, books, maps etc. is possible according to different categories: author, key words and others. The staff is required to have also personal professional literature registered - marked personal property-of local....., in order to be available.

Documents should only be borrowed using the file cards.

2. DONORS' CONFERENCE

A short look back on the Donors' Conference as well as an the official and unofficial meetings with persons from GOB, the donors, and other FAPs showed that the conference proved to be useful. The Project took note that some effort has to be done to avoid misunderstanding in FPCO and the public on a duplication of activities in FAP. Particularly with respect to FAP 1 and 9B it is important to be aware of the quite different objectives: FAP 1 and 9B are to design adhoc protection for specific objects/areas (like Sirajganj, Chandpur). FAP 21 however is to consolidate existing knowledge, including the designs that are elaborated in FAP 1 and 9B, and to generalize them, with the objective to create new standard design and construction criteria which shall be applied, in the future, in Bangladesh by local professionals and using local contractors, material and methods.

3. PRE-SELECTION OF TEST AREAS

The Technical Report No.1 on Pre-selection of Test Areas has been circulated as a preliminary draft from March 1 on, among FPCO, the donors (KfW and CCCE) and the Panel of Experts. Their reaction was in every way positive. The discussions that followed with many of the experts resulted in some useful amendments of the draft. The Technical Report will be issued this week officially following some consultancy with FPCO.

4. INCEPTION REPORT

The dead line of March 15, 1992 set by the Consultant for submitting the Inception Report cannot be held due to the additional work load involved with the unexpected Donors' Conference. Now the Project set the new dead line to March 19 in order to allow for the discussion of the Inception Report with KfW during the 5th International Symposium on River Sedimentation in Karlsruhe.

A detailed discussion on the details of the Inception Report followed and it was agreed that the basic contributions shall be ready for revision, consolidation and editing on Thursday March 12.

5. STUDY TOUR

Since the departure date is less than a month from now, names of GOB participants are now urgently required to apply for visa for Germany, The Netherlands and France in time.

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PROJECT MEETING NO. 7

DAY : 15.03.92 10.00 AM to 10.45 AM
VENUE : PROJECT OFFICE

Participants: List attached as ANNEX 1

Distribution: Project HB, SM, HS, FvdK,
FPCO
KfW

1. GENERAL ASPECTS

This Project Meeting takes place at a time where everyone is very busy with his part in the preparation of the Inception Report.

SPOT maps: the two missing maps can be picked up at FPCO.

FAP reports: suggestion was made that FPCO may ask the FAP projects that they may release project information to other FAP projects without a specific request to/from FPCO. This would significantly speed up the process of data gathering.

2. INCEPTION REPORT

The administrative and financial issues will not be included in the Inception Report which will have a very wide circulation. The Administrative and Financial Report No.1 will include the Project period until March 31, 1992.

3. SUBCONTRACT FOR SUBSOIL INVESTIGATIONS

The Consultant informed that he had preliminarily selected a subcontractor for the subsoil investigations but that contract has not yet been awarded. In selecting the subcontractor main emphasis was laid on the quality of the work and the guarantee of the field works being done in time.

Therefore the subcontractor has to be from Dhaka, to have a better control on him through his home office. To be flexible, a private enterprise was agreed to be more suitable for the purpose. For state owned large companies the size and type of the job (12 borings and abut 9 penetrometer tests, on 3 different sites) is not convenient. A fast mobilization, such as to start real exploratory works latest on 1st April, 1992 was regarded to be indispensable. The price will be well below the budget ceiling sum.

Under the above conditions no objection was made with regards to the procedure.

4. STUDY TOURS

Europe: Now that the names of the participants are known, it must be made sure that their passport be submitted to the Embassies for visa application as soon as possible.

China/USA: It was once more stressed that nomination of GOB participants must take place earlier than in the case of the Europe study tour, due to the longer visa procedures for China and USA. Due to the importance of that study tour for the decision making on River Training/AFPM it was felt important to have the Project Administration participating in it.

ANNEX V

PRELIMINARY T.O.R. FOR ADDITIONAL STUDIES

STUDY ON NAVIGATIONAL ASPECTS

TASK : **ANALYSIS OF THE INTERACTION BETWEEN NAVIGATION AND RIVER TRAINING/AFPM**

FAP : **22** **T.O.R. : Additional.**

OBJECTIVES: To analyze the influence of navigational aspects on the strategies for river training and active floodplain management. To indicate possible mutual interests in the performance of an initial pilot project.

INPUT : Different strategies for river training and active floodplain management as developed under task 29 (see Annex II). Results of the study on the technical feasibility of strategies with light structures and/or recurrent measures.

DETAILS : The FAP 22 project aims at the flexible approach to divert the river away from the threatened reaches and, in due time, to change the characteristics of the river. The long term effects of such an approach should be the reduction of the cross sectional width of the Jamuna river and consequently an increase of the water depth. In this respect there are no conflicting interests with navigation as far as the long term effects are considered. On the other hand, considering the present situation of the Jamuna river floodplains, the short term effects of the AFPM approach might be either beneficial to navigation or they may cause conflicts of interests as for example :

- A channel used for navigation may be closed, while other channels may be dredged leading to improved navigation (draught) conditions.
- Dredged cross channels may silt up due to increased flow velocities in the main channel.
- Creation of larger and more permanent chars may increase the sailing routes of cross river ferries.
- Ship induced waves affect river training measures especially the light recurrent measures.

The study has to focus on the optimization of the benefits of the river training strategies to be selected for AFPM regarding the mutual

interests with navigation. Due to the wide experience of the Bangladesh Inland Water Transport Authority with light structures and/or recurrent measures (e.g. dredging, bandalling), BIWTA's involvement in the FAP 22 Planning Study with respect to this particular study on navigational aspects is highly recommended.

As part of the study on navigational aspects some river survey is envisaged to be carried out in co-operation with BIWTA. This survey aims at a better understanding of the effectivity of light structures (such as : bottom vanes and/or bandals) affected by sand dunes propagating along the river bottom. The river survey should therefore provide a well balanced set of longitudinal soundings on typical problem river stretches (and/or bifurcation points) to be selected in the light of an initial pilot project.

Last but not least the input of an inland water transport economist would be needed to assess the importance of certain transport routes as well as possible costs arising from or benefits generated by certain River Training/AFPM measures.

OUTPUT : Conclusions on the interaction between River Training/AFPM and navigation on the Jamuna river. Conclusions on the relationship between the effectivity of river training measures and sand dunes propagating along the river bottom. Activities should be started as early as possible in order to include the output of the study on navigational aspects in the Draft Final Report.

STAFF :

- Responsible
  chief river training engineer
- Further activities
  low-cost river training specialist
  inland water transport economist
  surveyor

MANMONTHS:

	Expatriate	Local
chief river training engineer	0.5 mm	
low-cost river training specialist	1.0 mm	
surveyor-1	1.5 mm	
inland water transport economist-1	1.0 mm	
inland water transport economist-2		2.0 mm
surveyor-2		1.5 mm
	---	---
	Total : 4.0 mm	3.5 mm