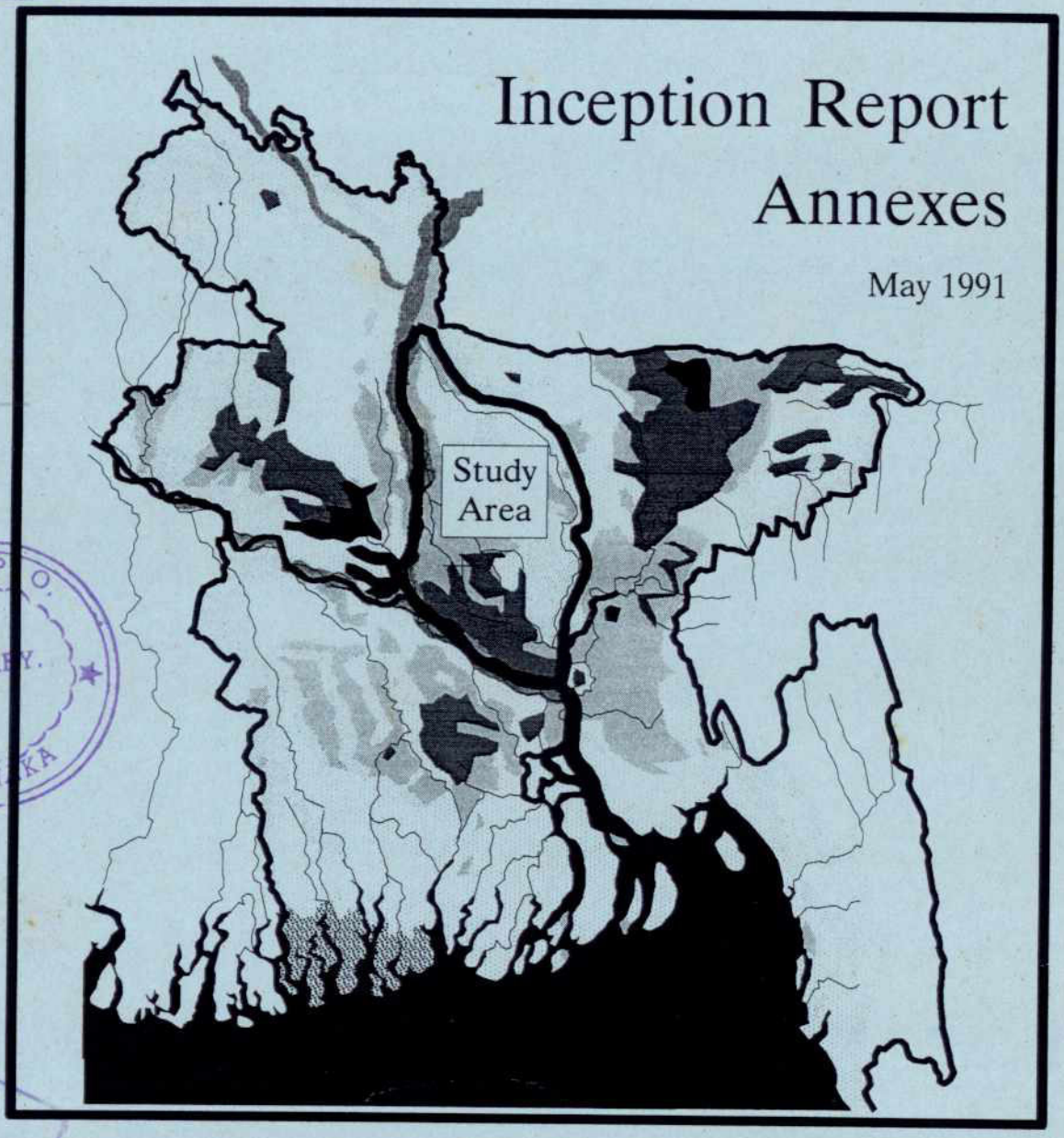
DRAFT

Government of the People's Republic of Bangladesh

Flood Action Plan

FAP 3

North Central Regional Study



Inception Report
Annexes

May 1991

Commission of the European Communities
and
Caisse Centrale de Co-operation Economique
Government of France
Project ALA/90/03

Consortium
BCEOM, Compagnie Nationale du Rhône,
Euroconsult, Mott MacDonald International,
Satec Developpement

in association with:
Desh Upodesh
BETS

BANGLADESH

ACTION PLAN FOR FLOOD CONTROL

NORTH CENTRAL REGIONAL STUDY

(FAP-3)

CONSORTIUM

BCEOM, COMPAGNIE NATIONAL DU RHÔNE,
EUROCONSULT, MOTT MacDONALD INT.,
SATEC DEVELOPPEMENT.

under assignment to

COMMISSION OF THE EUROPEAN COMMUNITIES
and
CAISSE CENTRALE DE CO-OPERATION ECONOMIQUE
GOVERNMENT OF FRANCE
on behalf of
PEOPLE'S REPUBLIC OF BANGLADESH
PROJECT ALA/90/03

in association with

BETS (Bangladesh Engg.and Technological Services)
DESH UPODESH LIMITED

3/8, BLOCK-C LALMATIA, DHAKA

ANNEXES

Location Map

Annex-1 Terms of Reference

Annex-2.1 Extracts from the Bridging Study - Coarse Pilot Model

Annex-2.2 Geotechnical Investigations and Groundwater Level Survey

Annex-2.3 Phase-I : Report on Geotechnical Investigation

Annex-3 Mapping and Topography Programme

ANNEX

North Central Region Study Area
(FAP-3)

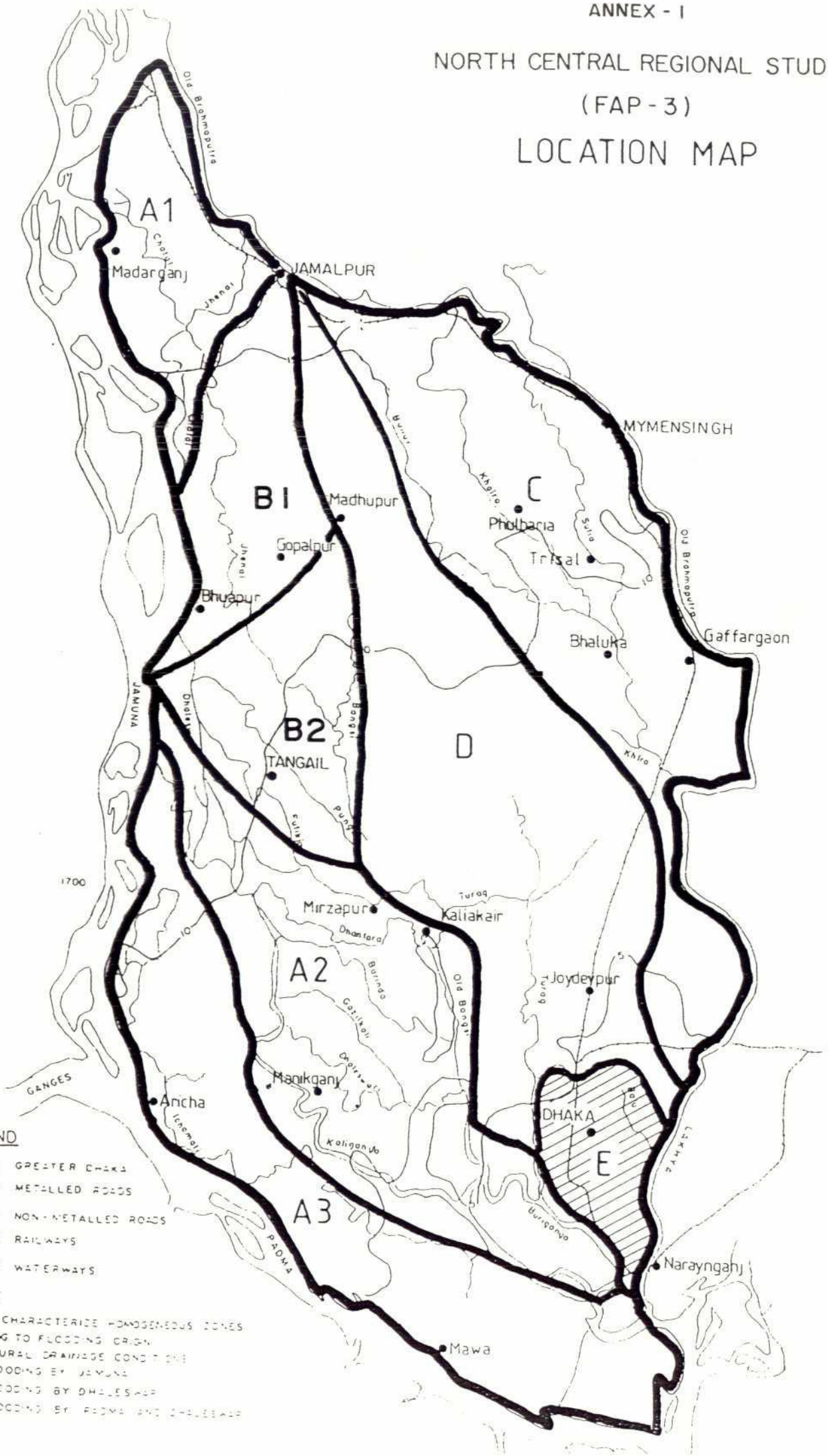
Location Map

ANNEX - I

NORTH CENTRAL REGIONAL STUDY

(FAP - 3)

LOCATION MAP



ANNEX—1

North Central Region Study
(FAP-3)

Terms of Reference

A. TERMS OF REFERENCE

BANGLADESH
ACTION PLAN FOR FLOOD CONTROL

FAP 3

NORTH CENTRAL REGIONAL STUDY

TERMS OF REFERENCE

FLOOD PLAN COORDINATION ORGANIZATION

MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL

Dhaka, 10 June 1990

BANGLADESH
ACTION PLAN FOR FLOOD CONTROL

FAP 3

NORTH CENTRAL REGIONAL STUDY

TERMS OF REFERENCE

FLOOD PLAN COORDINATION ORGANIZATION

MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL

Dhaka, 10 June 1990

TERMS OF REFERENCE FOR THE NORTH CENTRAL REGIONAL STUDY

PREAMBLE

The North Central Regional Study is divided into two phases - Phase 1 : Reconnaissance Study and Phase 2 :the main Regional Study.

The Terms of Reference for Phase 1 were approved at the Technical Committee meeting in March 1990 and the Reconnaissance Study was carried out between March and June 1990. The present Terms of Reference are for Phase 2 : the main Regional Study.

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 The Action Plan attached high priority to flood control and drainage on the left bank of the Brahmaputra under component No 3, "Brahmaputra Left Bank". The Action Plan identified three specific activities under this component:

- North Central Regional Study
- Brahmaputra Left Embankment (North)
- Brahmaputra Left Compartment (North)

1.4 An overall study of flood control and drainage - the North Central Regional Study - will be undertaken as the first step. The existing embankments are not effective against major river floods because of inadequate sections, gaps and bank erosion; drainage is impaired by numerous road embankments and restricted waterway sections. The study will examine various alternatives and establish the most suitable pattern of future water resource development in the region.

1.5 Strengthening of existing embankments, construction of new ones, building appropriate embankment structures for controlled flooding and drainage, remodelling the main drainage systems and compartmentalization would be the main physical features of the regional plan. A priority project was identified in the Action Plan and was confirmed for early implementation in the Reconnaissance Study. This priority project, now called the Jamalpur Priority Project, comprises the northern section of the Brahmaputra Left Embankment (about 80km) and associated water control works and development in the protected area of about 50,000 ha.

1.6 The North Central Regional Study will be financed jointly by the EEC and France, with the EEC acting as leader.The preparation of the priority project, which is not covered by these terms of reference, will also be financed by the EEC and France, but with France taking the lead.

2. THE REGION

2.1 The North Central Region (see Figure 1), is delineated on the west by the Jamuna, on the south by the Padma and the Meghna, and on the north and east by the Old Brahmaputra and the Lakhya. For hydraulic purposes, the study will include left bank tributaries and distributaries of these two rivers; the development of the corresponding catchment areas is included in the North East Regional study (FAP 6). The area of the region is about 12,000 km2 and the total population is around 17.5 million. The population density of about 1460 per km2 is high.

2.2 Most of the region is rural, though the capital city, Dhaka, is located in the south of the region. Most of the commercial and industrial activities of the region are concentrated in the Dhaka area.

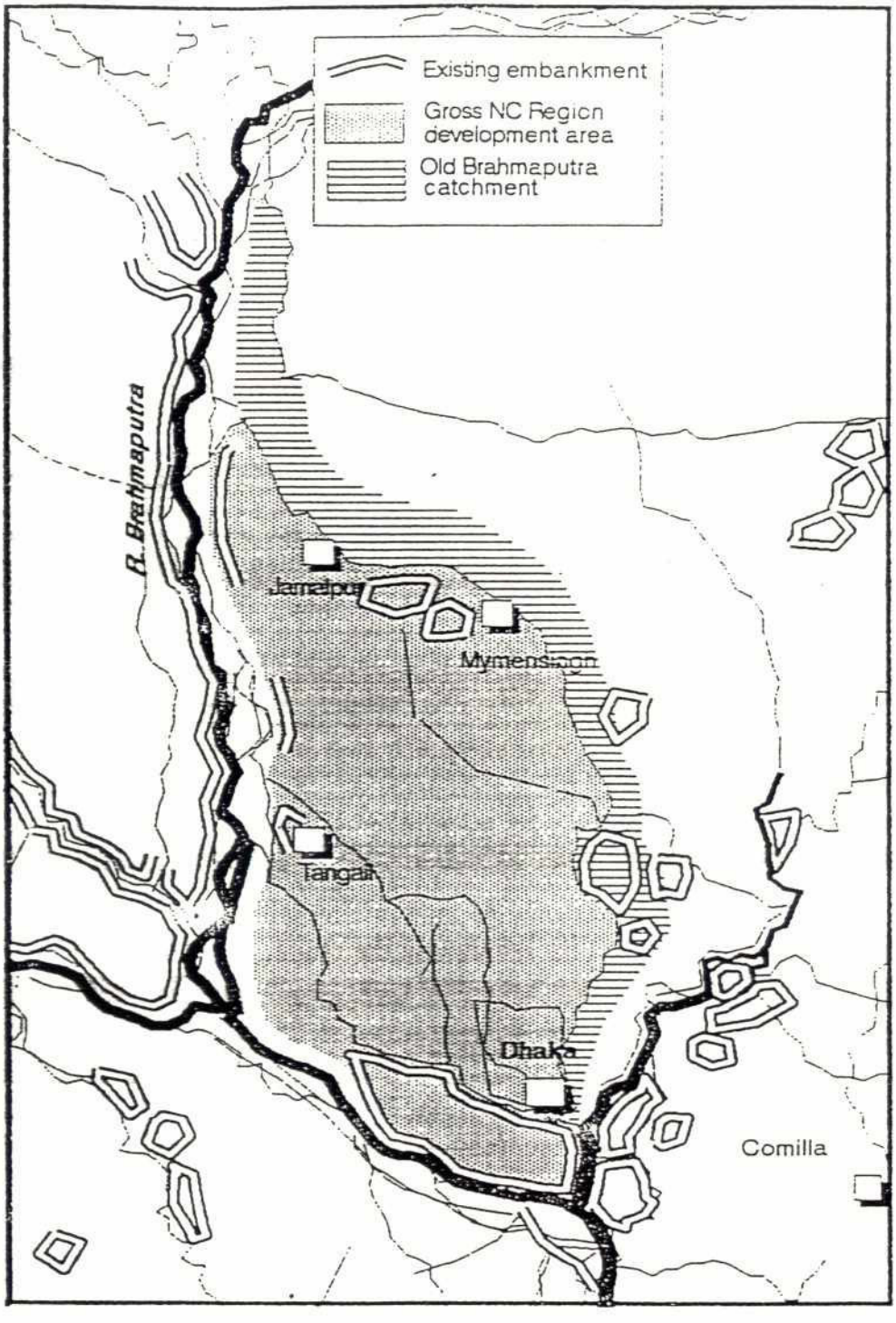


Figure 1 NORTH CENTRAL REGION

2.3 Agriculture dominates the rural economy. Rice is the main crop and is grown on 80% of the cultivated area. Cropping intensities and yields are generally low, which is mainly due to flooding. In a normal year, about 68% of the region is flooded; in severe floods, such as in 1988, over 80% of the area is inundated. The flooding is largely caused by overbank spillage from the Jamuna, the Padma, the Old Brahmaputra and their distributaries. It is further aggravated by high local rainfall and difficult drainage conditions created by backflow of the Meghna at the south east corner of the region.

2.4 Three sub-regions may be defined in terms of physiography and flooding characteristics:

- The West, comprising about half the region and subject to flooding from the Jamuna and Padma rivers. It suffers from very severe flooding. In the Action Plan, this sub-region was identified for priority action.

- The Madhupur Tract, an area of uplifted old alluvium, which is mostly above normal flood levels. Its development is hampered by limited water resources.

- The East, which is flooded mainly from the old Brahmaputra and its distributaries.

2.5 Since a separate flood control study is being undertaken in the Greater Dhaka area, the North Central Regional Study will only consider the Greater Dhaka area when dealing with inter-relationships between it and the rest of the North Central Region.

3. SCOPE OF WORK

3.1 The overall objective of the North Central Regional study is to prepare a regional water development plan with emphasis on the flood control and drainage measures that would be needed to achieve a sustained development of the regional economy, taking into account social and environmental factors. The regional study will focus on areas where flooding and impaired drainage hamper economic activity and will identify a series of measures to alleviate these adverse effects and to develop the land and water resources. The resulting regional water development plan will integrate major components such as the Jamalpur Priority Project (for which technical studies would start

before the completion of the regional study within a comprehensive development framework.

3.2 In undertaking the study, the Consultant will be guided by the following principles :

(1) Flood protection should not be seen as an end in itself, but should be seen as one, albeit important, component of a comprehensive plan for the development of water resources in the region (including drainage and irrigation), the aim of which should be to improve agriculture and to lead to a process of sustained economic and social development in the region.

(2) The broad environmental effects of all plan components proposed should be examined both in terms of their impacts in the North Central region and in neighboring, especially downstream, areas.

(3) The development scenarios and plans proposed should identify a phased development strategy based on clear assessment of those measures that will be needed in both short and longer terms, and in different parts of the region. In doing so, the past studies on the Dhaka South-West Project and Old Brahmaputra Multipurpose Project should be taken into account.

3.3 The North Central Regional Study comprises two phases:

Phase 1 : A Reconnaissance Study of the region which was carried out from March to June 1990. In the Reconnaissance Study, the physical characteristics and present development of the region was assessed; the main flood zones, development options and broad planning scenarios were identified; priority projects were assessed; and TOR were prepared for the feasibility study of the Jamalpur Priority Project. The TOR for the Reconnaissance Study are given in Annex 1 and the report of the Reconnaissance Study in Annex 9.

Phase 2 : A Regional Study involving the preparation and evaluation of alternative water development strategies and the preparation of a regional water development plan, including identification of priority projects and detailed project planning.

The present terms of reference are for Phase 2 : the main Regional Study. The general structure of the North Central Regional Study is shown in Figure 2.

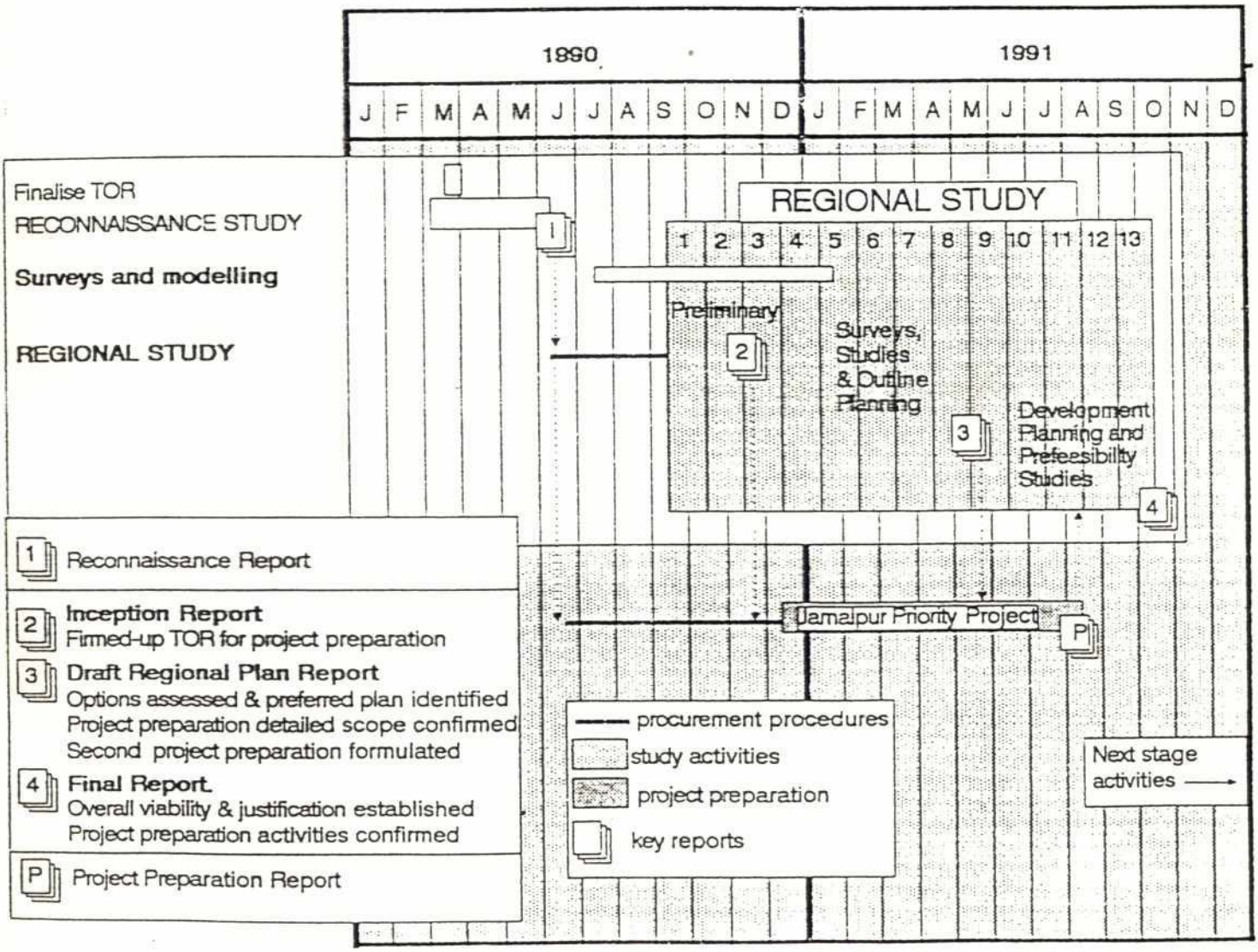


Figure 2 GENERAL STRUCTURE OF NORTH CENTRAL REGIONAL STUDY

In order to ensure continuity between Phases 1 and 2 various 'bridging' activities will be undertaken.

4 BRIDGING PERIOD BETWEEN PHASES 1 AND 2

The following activities will be undertaken in the bridging period :

4.1 River Surveys

Topographic surveys of the main rivers within the region (long and cross-sections) and flow measurements are being carried out by local consultants as a continuation of the Reconnaissance Study contract. Flow measurements during the monsoon season and further topographic surveys will be supervised by the bridging Hydrologist/Modeller (see below).

4.2 Hyraulic Mathematical Modelling

The Hydrologist/Modeller, provided by France under a separate contract, will supervise the topographical and hydrological surveys and will work with the Surface Water Modelling Centre (SWMC) on the development of a coarse pilot model (CPM) of the region.

The models already developed and in the process of being developed at the SWMC under the Surface Water Simulation Project (SWSMP), funded by Danida, will be made available to the Consultant for the purposes of planning and outline design (for procedures and conditions of use see Annex 2A).

While the general model (GM) is currently ready, the coarse pilot model for the North Central Region will be elaborated during this period by the Hydrologist/Modeller who will ensure an effective handover to the Consultant. He will initiate and supervise the collection of additional data required in the fields of hydrology and floodplain morphology, and will work with SWSMP in constructing the CPM, which will be based on MIKE 11 software. He will be guided by the recommendations of the Reconnaissance Study in finalizing his workplan. During the course of his assignment he will work in close co-ordination with FPCO and the team undertaking FAP 25 (Flood Modelling and Management). His assignment will overlap with the start of Phase 2 to ensure an effective transfer of modelling activities to the Consultant. The TOR for the bridging Hydrologist/Modeller are given in Annex 2B.

5. TERMS OF REFERENCE OF PHASE 2

5.1 General Approach

In Phase 2 the Consultant will :

- confirm, develop and compare the alternative regional water development options identified in Phase 1
- prepare a water development plan for the North Central Region, including pre-feasibility studies for priority projects to be implemented during the first five years of the proposed plan.

5.2 Preliminary Activities (Months 1-2)

During the Inception Period the Consultant will:

- Review previous and on-going activities in the region, including:
  - the report of the reconnaissance study together with related data and maps
  - the topographic and hydrological surveys undertaken during the bridging period;
  - the modelling activities undertaken by the bridging Hydrologist;
  - other activities under the Flood Action Plan;
  - other development projects and programmes being undertaken in the region (e.g.,those of the Bangladesh Water Development Board, Food-For-Work and other infrastructural development programmes);
- Decide on the technical and other surveys to be undertaken under the study, continue on-going surveys and initiate new ones;
- Refine details of the coarse pilot hydraulic simulation model (CPM) and applications in close consultation with the bridging Hydrologist and SWMC (see Annex 2a);
- Review and where necessary refine the TOR for the Jamalpur Priority Project feasibility study
- Prepare an Inception Report, including a detailed work plan for the study (Month 2).

5.3 Comparison of Alternative Development Strategies and Preparation of Draft Regional Water Development Plan (Months 3-8)

During this period, the Consultant will undertake the following activities :

a) Review Regional Water Development Planning Options.

The regional water development options (major flood control along main rivers; partial flood control along main rivers; major drainage improvement; local drainage improvement without flood protection) and planning sub-regions identified in the Reconnaissance Study will be reviewed, based on an analysis of water resource development constraints and opportunities in the region.

In doing so, the Consultant will ensure that options proposed for each sub-region are consistent with:

- national and regional planning priorities,
- existing and planned infrastructure in the region and in particular, the Jamuna Bridge,

that the alternative options for different sub-regions are compatible and that potential impacts on downstream areas have been taken into account. The Consultant will also finalize the delineation of the planning sub-regions.

(b) Develop Regional Water Development Strategies

Based on the development options identified, the Consultant will formulate alternative development strategies for the different sub-regions. Each strategy will comprise a phased investment programme of flood control, drainage and water management projects and will take into account necessary complementary agricultural and rural development activities.

In formulating the strategies, the Consultant will undertake technical, agricultural, socio-economic and environmental surveys, associated studies and modelling activities. These will include: topography (see Annex 7) and mapping; morphology; hydrology and hydraulic modelling (main rivers and rainfall); flooding (occurrence/frequency, location/extent); drainage (internal river/drainage system, outfalls, congestion and backwater effects, micro-drainage); general water

resources (surface and groundwater); land use (see Annex 8); agriculture (cropping patterns, yields, irrigation, livestock); fisheries and forestry; communications and markets; agricultural economics; socio-economics; environment; and rural institutions.

In undertaking modelling activities the Consultant will follow the the procedures and conditions given in Annex 2a.

The Consultant will identify potential development projects for each of the sub-regions, make a preliminary assessment of the costs and benefits of each project, assess their likely socio-economic and environmental impacts, and outline alternative water resource development strategies for each sub-region based on a preliminary multi-criteria analysis.

The Consultant will then formulate alternative regional water resource development strategies by combining different of the sub-regional strategies.

The development strategies identified will describe alternative approaches to the development of land and water resources. They will focus on areas where flood protection and drainage improvement is needed and will describe the water resources infrastructure that would be developed, including structural elements such as:

- major river flood protection (embankments and bank protection works)
- major river training (details to be developed by FAP 21/22)
- major inlet/outlet regulators
- minor river and main drainage improvements
- main drainage outlets
- compartmentalisation (water management systems comprising peripheral inlet/outlet structures, internal water control works, channel improvements, related infrastrure etc.)
- development of unprotected areas

Such projects should be planned in conjunction with the complementary development of:

- agriculture (including irrigation, groundwater etc)
- fisheries
- livestock
- communications (roads, navigation)
- markets
- urban infrastructure
- social programmes
- environmental programmes

- institutional programmes.

All planning should take into account national policies and guidelines, including those on decentralisation and privatisation, beneficiary participation and involvement of disadvantaged groups.

Wherever possible, the planning activitities should take into account the findings and results of the Master Plan Organization and of the supporting FAP studies and pilot projects. The special FAP study on methods of economic analysis will be particularly relevant.

(c) Comparison of Regional Water Development Strategies

A comparison of the alternative regional water resource development strategies in terms of their technical, financial, economic and environmental soundness will be made in order to select the strategy which is likely to lead to the maximization water-resource linked development opportunities in the region.The comparison will be based on a multi-criteria analysis, the methodology for which will be suggested by the Consultant. The main criteria will include:

- the direct benefit-cost ratio (including benefits due to improved agriculture and reduced damage) and indirect economic impacts;

- the social impact (e.g., on the rural poor,especially disadvantaged groups such as fishermen and women, on those whose land is aquired and need resettlement and those living in unprotected areas);

- the environmental impacts (e.g., on soil productivity, groundwater recharge, fisheries, forestry, downstream areas)

- organisational, managerial and institutional problems;

- the residual severity of flooding.

A sensitivity analysis will be undertaken to confirm the stability of the ranking of the alternative strategies.

(d) Prepare Draft Regional Water Development Plan

Preparation of a draft Regional Water Development Plan based on the elaboration of the selected strategy and taking full account of other on-going and planned development efforts in the region.The draft plan will include an overview of alternative strategies, details and justification of the preferred strategy and the identification of the priority projects for which pre-feasibility studies will be undertaken.

5.4 The Regional Water Development Plan (months 9 to 13)

The Consultant will finalise the Regional Development Plan, including pre-feasibility studies of main priority compponents. In doing so they will:

- carry out comprehensive pre-feasibility studies of projects included in the draft regional plan, involving engineering studies of proposed works such as embankments, structures and compartments; agricultural, economic, social and environmental studies of likely project impacts; and institutional studies of possible ways of operating and maintaining the projects,

- prepare TOR for the feasibility studies of these projects

- further elaborate and finalize the regional development plan and implementation program, including an overall justification for the various components

- prepare the Final Report of the study, including maps and diagrams needed for a clear comprehension of projects and of activities proposed,

- assist the Flood Plan Coordination Organization (FPCO) in preparation of the TAPP and other reports as may be necessary for implementation of the priority items of the Regional Plan.

Technical guidelines prepared following the Reconnaissance Study are given in Annex 4. These are for information only.

5.5 Coordination with other FAP Activities

In carrying out the regional study the Consultant will co-ordinate their work with teams undertaking relevant FAP components and supporting activities and draw on any findings that are available at the time. In all coordination matters the Consultant will work through FPCO. A list of the Flood Action Plan activities is given in Annex 3.

6 REPORTS

The following reports will be submitted to FPCO, the EEC and the CCCE (France) :

Inception Report (end of Month 2)

The Inception Report will describe the activities undertaken in the first two months and will include the detailed workplan for the study and revised TOR for the Jamalpur Priority Project.

Draft Regional Water Development Plan (end of Month 8)

The draft Regional Water Development Plan will present the water development strategy for the region selected following the multicriteria analysis of alternatives and will outline the priority projects for which pre-feasibility studies are to be undertaken. Draft TOR for the feasibility studies of these projects will also be included.

Final Regional Water Development Plan (end of Month 13)

The draft Final Report will include an assessment of the overall viability of the Regional Plan and detailed pre-feasibility studies and revised TOR for priority projects. It will be presented at the end of Month 12 and will include an Executive Summary not exceeding 20 pages, a Main Report not exceeding 100 pages. Supporting reports, data and maps will be given in annexes.

The FPCO, EEC and CCCE will comment on all reports, including the draft Final Report, within one month, after which they will be finalised. The Final Report of the study will be issued at the end of Month 13.

7. STUDY DURATION AND SCHEDULES

The bar chart shown in Figure 2 gives 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, including modelling, and based on their assessment of the requirements of the study.

The consultant is free to propose a shorter time period for the study so long as this will not affect the quality of the work.

8. STAFFING AND LOGISTICS

8.1 The indicative staffing for the study is given in Table 1. Job descriptions are presented in Annex 5. The Consultant will be expected to prepare a detailed assignment of tasks between the various members of the team they propose, distinguishing, in particular, the components which will be financed out of the EEC grant and out of the French one, both in respect of expatriate and local consultants.

8.2 In their proposals, the Consultant should also include details of survey and other sub-contracts, office facilities and staff, equipment and instruments, transport, mapping and modelling that it is proposed to use in undertaking the study.

8.3 The Consultant will provide necessary supporting staff (e.g., typists, drivers, messengers, draftsmen), office facilities and equipment, and vehicles. They will also provide the microcomputers and peripheral devices needed for the mathematical models.

8.4 All office equipment and cars bought for the purpose of the contract will be handed over to the Bangladeshi authorities by the consultants at the end of the contract. The consultant will also hand over all scientific documents, a users's guide and study data, together with users' manuals.

8.5 It is expected that most of the study will be completed in Bangladesh. However, for a short period at the end of each part of the study, the Consultants will be entitled to propose the completion of a small part of the tasks (e.g., report editing and printing) at their home office.

9 RESPONSIBILITIES OF THE GOVERNMENT

9.1 Freedom from Taxation and Duties.

The Government/Executing Agency shall bear the cost of any taxes, duties, fees, levies and other impositions under the laws and regulations in effect in Bangladesh on the Consultant and expatriate personnel in respect of:

- any payments made to the Consultant or their panel other than Bangladesh nationals, in connection with the carrying out of the services;
- any materials, equipment and supplies brought into Bangladesh for the purpose of carrying out the services and which after having been brought to the country will be subsequently withdrawn therefrom;

Table 1 INDICATIVE STAFFING

EXPATRIATE STAFFING

		Total	EEC	France
1	Project Management	3	2	1
2	Team Leader/Water Resources Engineer	13	13	-
3	Topographer	4	4	-
4	Hydro-Modeller	7	-	7
5	Civil Engineer	12	-	12
6	Mechanical Engineer	2	2	-
7	Irrigation/Drainage Engineer	12	12	-
8	Hydrogeologist	3	3	-
9	Agriculturalist	6	6	-
10	Economist	6	-	6
11	Environmentalist (fisheries)	4	-	4
12	Socio-Economist / Institutionalist	6	6	-
13	Other Specialists	2	1	1
		80	49	31

LOCAL STAFFING

		Total
1	Team Leader/Water Resources Engineer	13
2	Topographer	6
3	Hydro-Modeller	7
4	Civil Engineer (earthworks)	12
5	Civil Engineer (structures)	10
6	Mechanical Engineer	2
7	Irrigation/Drainage Engineers	18
8	Hydrologist	10
9	Agronomist	6
10	Economist	6
11	Environmentalist	6
12	Fisheries Expert	6
13	Socio-Economist	12
14	Institutions Specialist	2
15	Other Specialists	4
		120

- any equipment imported for the purpose of carrying out the services and paid out from the funds provided by the Government and which is treated as property of the Government.

Provided that :

(a) If the Consultant or any of the expatriate personnel shall follow the usual customs procedure of the Government in importing property into Bangladesh;

(b) If the Consultant or any of the expatriate personnel does not withdraw, but disposes of any property in Bangladesh upon which custom duties and taxes have been exempted, the Consultant shall bear such custom duties and taxes in conformity with the regulations of the Government.

9.2 Other Privileges and Exemptions

The Government shall :

- provide the expatriate personnel with work permits and such other documents as shall be necessary to enable them to perform the services including privileges specified in the Government of the People's Republic of Bangladesh notification no/RO 88-L/85/906/CUS dated the 13th February,1985 and no/RO 89-/85/907/CUS dated 13th February 1985 (circular of 1988 is to be incorporated);

- arrange for the personnel and their authorised dependants to be provided promptly with all necessary exchange permit and travel documents required for their stay in Bangladesh;

- facilitate clearance through customs of any property required for the services and of the personal effects of the expatriate personnel and the prompt issue to the Consultant's expatriate personnel of Custom Pass Books.

- issue to officials, agents and representatives of the Government all such instructions as may be necessary or implementation of the services:

- exempt the Consultant and their personnel for the services from any requirement to register or obtain any permit to practice the profession of Engineer or Architect or to establish himself either individually or as a corporate entity according to the laws of Bangladesh;

- arrange for duties and taxes on the imported equipment, vehicles and other materials relating to the project which will be retained in Bangladesh, to be paid by the implementing agency in Bangladesh.

9.3 Services, Facilities and Equipment

- The Government shall provide assistance to collect pertinent data, maps and information available for the performance of the Services under this Contract.

- The Government shall, if available, provide accommodation in government rest houses at standard rates.

- Indemnify, save and hold harmless the Consultant and its personnel form and against all claims, demands or suits, that may be made or brought against the Consultant and the personnel arising directly form the performance of the services provided that, such claims, demands or suits are not the result of negligence or wilful acts of the Consultant and its personnel.

9.4 Data Collection

- FPCO will coordinate the collection of all relevant information available with Government of Bangladesh agencies requested by the Consultant.

10 RESPONSIBILITIES OF THE CONSULTANT

10.1 Responsibility of Consultant

The Consultant shall carry out the services as detailed in " Terms of Reference" in the best interest of the Government for the successful realization of the program with all reasonable care, skill and diligence with sound engineering, administrative and financial practices and shall be responsible to Executive Agency for the discharge of responsibilities.

The Consultant shall, during the execution of the services, appoint and designate a Team Leader to represent the Consultant in Bangladesh in all matters relating to the services.

The Consultant shall be responsible for the professional and technical competence of its employees and the personnel's behaviour and shall use its best efforts to select and employ for work in Bangladesh only those persons who in its

judgement will be the best and most likely to perform satisfactorily the terms of their employment.

The Consultant shall keep accurate and systematic records and accounts in respect of the services in such form and detail as is customary in the profession and shall be sufficient to accurately establish the costs and expenditures incurred for the services.

Except with the prior approval of the Government/Executive Agency, the Consultant shall not any time communicate to any persons or entity not connected with the services any confidential information, disclosed to them for the purpose of the services or disclosed by them in the course of their services, nor shall the Consultant or the Consultant's personnel make public any information relating to the services.

The Consultant shall be responsible in respect of life, health, accident, travel and other insurance with may be necessary for the Consultant's personnel for the purpose of the services.

All existing rules and regulations of the Govt. of Bangladesh related to the classifiction, custody and issue of restricted maps, aerial photographs and other related data shall be maintained.

10.2 Information

The Consultant shall furnish the Executing Agency with such information relating to the services and the Project as the Executing Agency may from time to time reasonably request.

10.3 Assignment, Sub-Contractors

Except with prior written approval of the Government, the Consultant shall not assign or transfer the contract or any part thereof nor engage any independent Consultant or sub-contractors to perform any part of the services other than nominated personnel listed in the contract.

The approval of the Executing Agency to the assignment of any part of the Contract or to the engagement by the Consultant of independent consultants or sub-contractors to perform any part of the services shall not relieve the Consultant of any of his obligations under this contract.

10.4 Prohibition on Conflicting Activity

No member of the personnel assigned to this Project shall engage, directly or indirectly, either in his name or through the Consultant, undertake any other business or

professional activities in Bangladesh during the performance of his duties or assignment under this contract.

10.5 Laws and Regulations of Bangladesh

This Contract shall be and is deemed to be a Bangladesh contract and shall accordingly be governed by and construed according to the laws for the time being in force in Bangladesh.

The Consultant shall respect and abide by all applicable laws and regulations in Bangladesh and shall use his best efforts to ensure that the Consultant's personnel and their dependents while in Bangladesh and local employees of the consultant shall respect and abide by all laws and regulations of Bangladesh.

10.6 Ownership of Drawings, Data and Reports

All reports and relevant data, such as maps, drawing, plans, statistics and supporting records or materials, compiled or prepared in the course of Services shall be the absolute property of the Government. The Consultant agrees to deliver all these materials to the Executive Agency upon completion or termination of this Agreement.

10.7 Reports and Communication

All reports, communications, recommendations and general correspondence from the Consultant to the executing Agency under the Agreement shall be in English language. The distribution list for reports is given in Annex 8.

10.8 Notice of Delay

In the event when the Consultant delay in obtaining the required services or facilities set forth in this contract for the conduct of the services, or the occurrence of any event or condition that might delay or prevent completion of the services in accordance with the time schedule, the Consultant shall promptly notify the Government of such delay indicating what steps are being taken or suggested by the consultant to meet the situation and may request an appropriate extension of time for completion of the services.

ANNEXES

Annex 1	:	TOR of Reconnaisance Study
Annex 2	:	(a) Definition of SWSMP II and conditions of use
	:	(b) Detailed TOR for 'bridging' Hydrologist / Modeller
Annex 3	:	List of Flood Action Plan Activities
Annex 4	:	Technical Guidelines
Annex 5	:	Job Descriptions
Annex 6	:	Proposed Specifications for Land Use Study
Annex 7	:	Proposed Specifications for Topography and Mapping
Annex 8	:	Distribution List for Reports
Annex 9	:	Report of the Reconnaissance Mission (Available end June 1990).

GD

ANNEX—2.1

North Central Region Study
(FAP-3)

Extracts from the Bridging Study
- Coarse Pilot Model

(5)

GOVERNMENT OF FRANCE

PEOPLE'S REPUBLIC OF BANGLADESH

BANGLADESH ACTION PLAN FOR FLOOD CONTROL

FAP3

NORTH CENTRAL REGIONAL STUDY

BRIDGING STUDY

COARSE PILOT MODEL

BCEOM

APRIL 1991

02

LIST OF CONTENTS

3.1.5 Aerial Photos

The aerial photos from 1983 were collected recently and handed over to the main study team. It was too late to use them for the base map.

The aerial photos from Finnmap are not yet available. They would be very useful for the Main Study and for improving the Base Map and the Coarse Pilot Model.

3.1.6 Base Map

There were no good maps available on the whole area at a convenient scale (1:50,000 with synthesis at 1:250,000)

Based on SPOT Images ("Black and White" and "Multispectral") we have prepared a elementary "Base Map" to locate the river system and the main roads at scale 1:250,000. We have used this "Base Map" to produce maps showing the location of the hydrometric stations , cross sections, catchments and schematization. Reduced copies of these maps are available in this report. (see "Location Map", "Cross-section", "NAM catchments".)

3.2 TOPOGRAPHICAL DATA

3.2.1 BWDB Cross-sectional data

We collected (see list 3.2.1) the "most recent" cross-sections from Morphology Section of BWDB and from some other offices. We never achieved collection of information on Banar cross-sections and the only cross-sections available in SWMC seem suspicious. For Bangshi, 1985 data were using instead of 1987 collected only in bad plots. SWMC is going to collect the raw data for 1987 available in Jamalpur Sub-division (This Field Book is not yet available in Morphology Section in Dhaka).

A big problem was faced to locate these cross-sections. The several index maps existing were not consistent. In general, the name of the village indicated in the raw data was used to locate approximately these

cross-sections. Big differences with the previous index map were found (see Map 3.2.1 and CROSS-SECTION MAP).

We didn't find the location of the first 3 cross-sections of Turag which must be in Buriganga River. Attempts will be made to find the name of the place during field visits.

Checks on the consistency and quality of the cross-sections were made by plotting the cross-sections and the longitudinal profiles (see example in annexe 5.2).

Also when cross-section surveys are undertaken the water level at the cross-section location is also recorded in the level books, unless the river is dry. At water level recording stations this information was used as a cross check against the recorded water levels to detect possible errors in either the cross-section datum or the water level datum. In a number of locations errors between the two independent measurements of the water level were found, in some cases up to 1 meter difference being recorded (see Table 3.2.1). Field checks would be required to verify whether the errors were in the cross-sectional surveys or the bench mark connections to the water level staff gauges. The Finnmap levelling connecting all secondary bench marks used by the BWDB could be beneficial in resolving these anomalies.

It is clear that gross errors are being introduced into either the water level records or the cross-sectional surveys at some locations.

Collection of cross-section data at discharge gauging sites would be made from Hydrology Section to compare with the cross-section surveyed near the place.

Table 3.2.1

Comparison of Water Levels recorded from two independent sources

CROSS SECTION			BWDB STATION			
C/S N°	DATE OF SURVEY	WL m PWD	NAME	LOCATION	WL m PWD	Difference ± m
D-5	7/ 6/89	5.62	TILLI 68	2.5 km U	6.43	- 0.81 ≤
D-8	16/ 6/89	6.16	JAGIR 68.5	2.5 km U	≤ 5.80	+ 0.36 ≥
D-13	22/ 6/88	4.36	SAVAR 69T	2.5 km D	5.42	- 1.06 ≥
D-14	19/ 6/89	4.12	-DO-	2.5 km U	5.02-5.08	- 0.90 ≤
D-16	13/ 6/89	3.8	KALATIA 70T	2.5 km U	3.99-4.02	- 0.19 ≤
D-21	29/ 5/89	2.73	REKABI BAZAR 71A	-	2.73-3.07	0
D-23	23/ 5/89	2.23	KALAGACHIA 71T	-	2.24-2.17	0
K-3	17/ 5/87	4.5	TARAGHAT 137A	1.5 km U	3.37	+ 1.13 ≥
BGA-4	25/11/89	1.83	DHAKA 42T	-	1.73-2.10	0
L-4	13/12/89	1.59	TRIMOHINI 9.5T	2.5 km D	1.87±.2?	- 0.28 ?
L-5	15/12/89	1.55	DO	2.5 km U	1.90±.2?	- 0.35 ?
L-9	24/12/89	1.42	LAKHPUR 177T	-	1.86-1.58	- 0.16
L-16	8/ 1/90	1.21	DEMRA 179T	1.5 km U	1.06-1.28	0
OB-9	4/12/88	11.61	JAMALPUR 225	-	12.18	- 0.57
OB-19	12/11/88	7.21	MYMENSINGH 228.5	-	7.6	- 0.39
OB-28	5/12/88	2.3	TOKE 229	-	2.79	- 0.49
BHI-6	4/10/87	12.67	MADHUPUR 12	4 km D	11.55	+ 1.12 ≤
BHI-7	4/10/87	12.52	MADHUPUR 12	4 km U	11.55	+ 0.97 ≥
BHI-18	28/ 9/87	8.62	MIRZAPUR 14	-	9.03	- 0.41
TUR-5	2/ 3/90	1.7	MIRPUR 302	1 km D	1.19-1.96	0
TN-2	19/ 2/90	1.0	TONGI 299T	1 km D	0.88-1.02	0

Location : U means Upstream , D means Downstream.
? : Tidal effect not known
Difference :≤ means that the difference may be smaller due to the slope of the water level. (≥ means the contrary)

3.2.2 Cross-Section Survey :

A program was prepared in March 1990 to survey 676 km of secondary rivers with cross-section taken for every 5 km. Due to various constraint such as

- time needed to get basic documents for BWDB
- insufficient capacity of local contractors

only 179 km have been levelled before the monsoon by Desh Upodesh (River Jhenai, Chatal, Atai, Old Louhajong, Sapai). The program started again after the monsoon in October and ended in February 1991.

A Report on Cross-Section Survey will be submitted in April 1991.

All the available cross-sections are indicated on "Cross-section Maps".

In addition, survey under the SWMC programme would provide some cross-sections for the remaining gap due to the mistakes in BWDB index maps. This cross-section survey will be carried out by the SWMC's own survey team in the month of June 91.

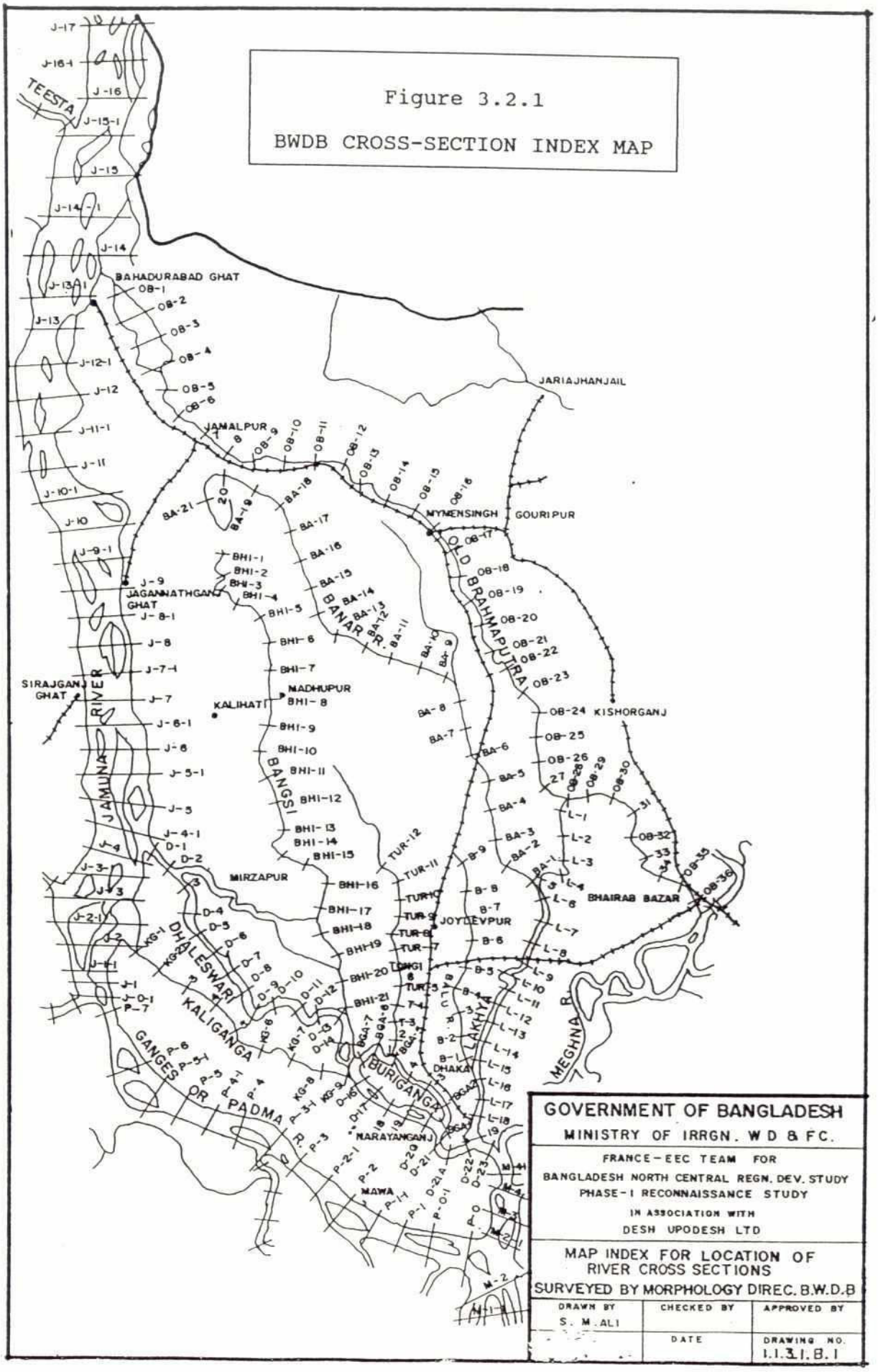
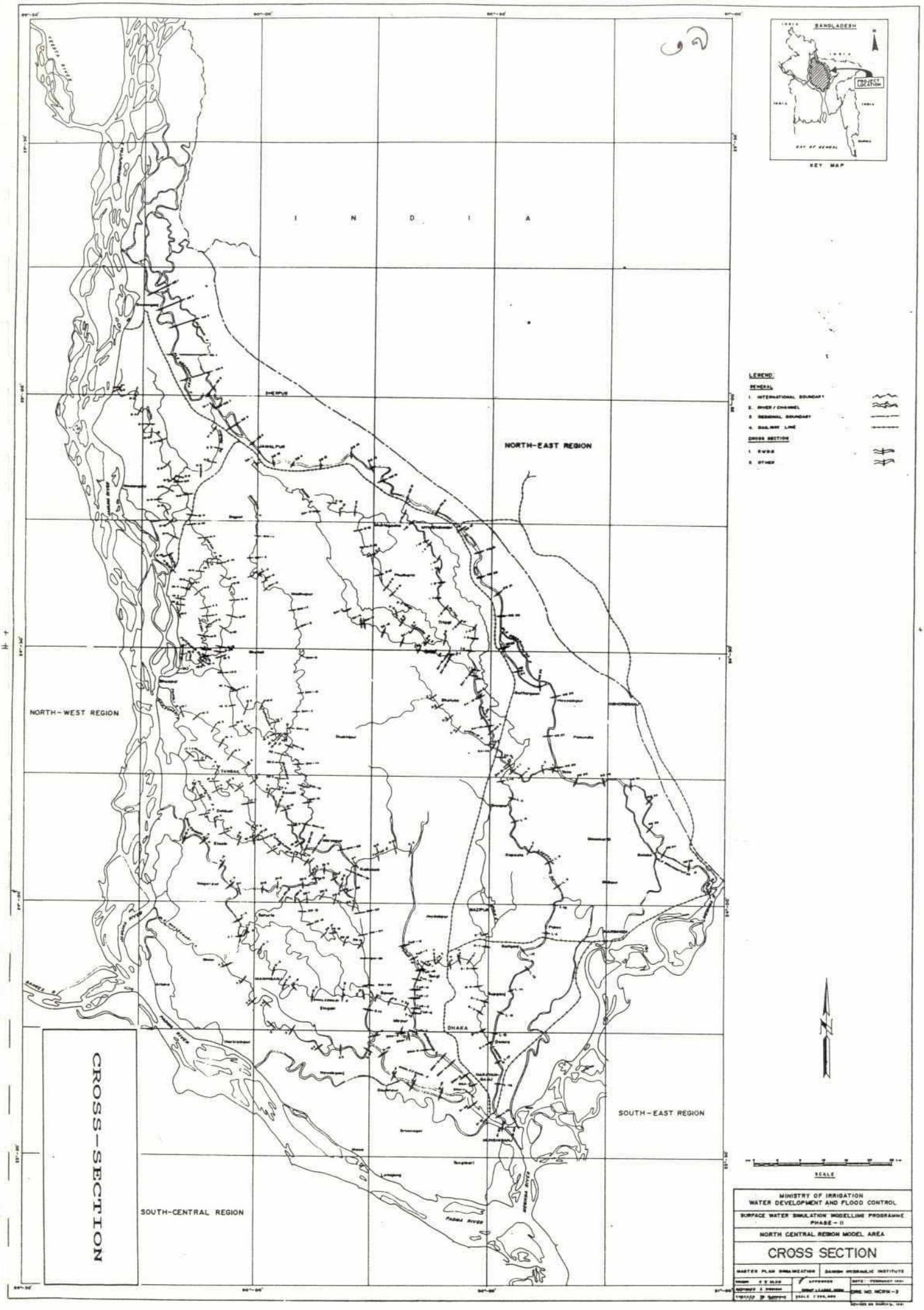


Figure 3.2.1
BWDB CROSS-SECTION INDEX MAP
TEESTA
BAHADURABAD GHAT
JAMALPUR
JARIAJHANJAIL
MYMENSINGH
GOURIPUR
OLD BRAHMAPUTRA
BANAR BR.
JAGANNATHGANJ GHAT
SIRAJGANJ GHAT
JAMUNA RIVER
KALIHATI
MADHUPUR
BANGSI
MIRZAPUR
DHALESWARI
KALIGANGA
GANGES OR PADMA R.
BURIGANGA
NARAYANGANJ
DHAKA
LAKHYA
MEGHNA R.
JOYDEVPUR
BHAIRAB BAZAR
KISHORGANJ
MAWA
GOVERNMENT OF BANGLADESH
MINISTRY OF IRRGN. W D & FC.
FRANCE-EEC TEAM FOR
BANGLADESH NORTH CENTRAL REGN. DEV. STUDY
PHASE-I RECONNAISSANCE STUDY
IN ASSOCIATION WITH
DESH UPODESH LTD
MAP INDEX FOR LOCATION OF RIVER CROSS SECTIONS
SURVEYED BY MORPHOLOGY DIREC. B.W.D.B
DRAWN BY S. M. ALI
CHECKED BY
APPROVED BY
DATE
DRAWING NO. 1.1.3.1.B.1


BANGLADESH
PROJECT LOCATION
KEY MAP
I N D I A
NORTH-EAST REGION
NORTH-WEST REGION
SOUTH-EAST REGION
SOUTH-CENTRAL REGION
DHAKA
LEGEND
GENERAL
1. INTERNATIONAL BOUNDARY
2. RIVER / CHANNEL
3. REGIONAL BOUNDARY
4. RAILWAY LINE
CROSS SECTION
1. RWDS
2. OTHER
SCALE
CROSS-SECTION
MINISTRY OF IRRIGATION
WATER DEVELOPMENT AND FLOOD CONTROL
SURFACE WATER SIMULATION MODELLING PROGRAMME
PHASE - II
NORTH CENTRAL REGION MODEL AREA
CROSS SECTION
MASTER PLAN ORGANIZATION
DANISH HYDRAULIC INSTITUTE

3.3 HYDROLOGICAL DATA

3.3.1 BWDB Hydrological Network

Under the existing BWDB Hydrological Network, there are about 45 water level stations and 17 discharge stations in the region (including the boundaries).(see Figure 3.3.1 Hydrological Stations from BWDB)

A majority of the existing gauging sites have records extending from the 1980's although a number of old stations on the main rivers were established in the 1960's.

The existing network of gauging stations broadly covers the main rivers around the region but only 9 discharge stations were available on the internal rivers.

We collected the daily data from several sources for the years 1987-1990 and we are going to receive the 1990-1991 data.

Due to a computer failure in BWDB Hydrology Section, a lot of data had to be collected on hard-form and to be entered manually instead of collecting them in diskette format.

A full list of the water level and discharge data collected is given in Table 3.3.1.a & 3.3.1.b and their location shown in "Location Map".

3.3.2 Additional Data Collection Programme:

The additional data collection programme initiated during the Bridging Studies was carried out by the Bridging Hydrologist with DUL during the 1990's monsoon. Fifteen water level and discharge stations were surveyed with data collection beginning in June 1990 until November 1990 (see figure 3.3.2). Discharges were measured during the month of August and September. The results of these survey were presented in two reports submitted to FPCO and CCC. These data were entered into Mike 11 Database.

3.3.3 Data Quality:

Some gross errors can be easily identified. However, other data errors can be more difficult to detect, particularly if they are connected with incorrect bench mark datums. The classical problems noted during the fields visits concerning BWDB stations are:

- staff gauges are often only supported by bamboo staves and are susceptible to movement: they are not always in a vertical position.
- their location is not always good (local effects) and in some rivers with high condition of water level, they must often be shifted by local staff.
- after shifting, they are not immediately tied into the bench mark: the new zero is based on the difference in reading of the 2 gauges.

Consistency of water level data was undertaken by comparing the water level curves at adjacent sites and observing their relative levels and phasing. We also use information from the cross-sectional survey (See table 3.2.1). Some discrepancies were found and are still pending. The FINNMAP "2nd Order Levelling Programme" including BWDB bench marks will be very useful to improve the consistency of the data.

4. RAINOFF-RUNOFF MODEL

4.1 INTRODUCTION

4.1.1 NAM Model

The estimation of rainfall runoff in rural catchments is done by the rainfall-runoff model NAM. It is a lumped, conceptual model accounting continuously for the moisture content in four different but interrelated storage zones; surface storage, lowerzone storage, upper and lower groundwater storage. (see fig 4.1.1)

NAM treats each subcatchment as one unit. The parameters and variables are thus representing average values for the entire subcatchment.

The runoff thus generated can be distributed and added to each discharge grid point of the hydrodynamic (HD) module as lateral inflows.

Full details of the NAM model is given in the MIKE11 User's' Guide.

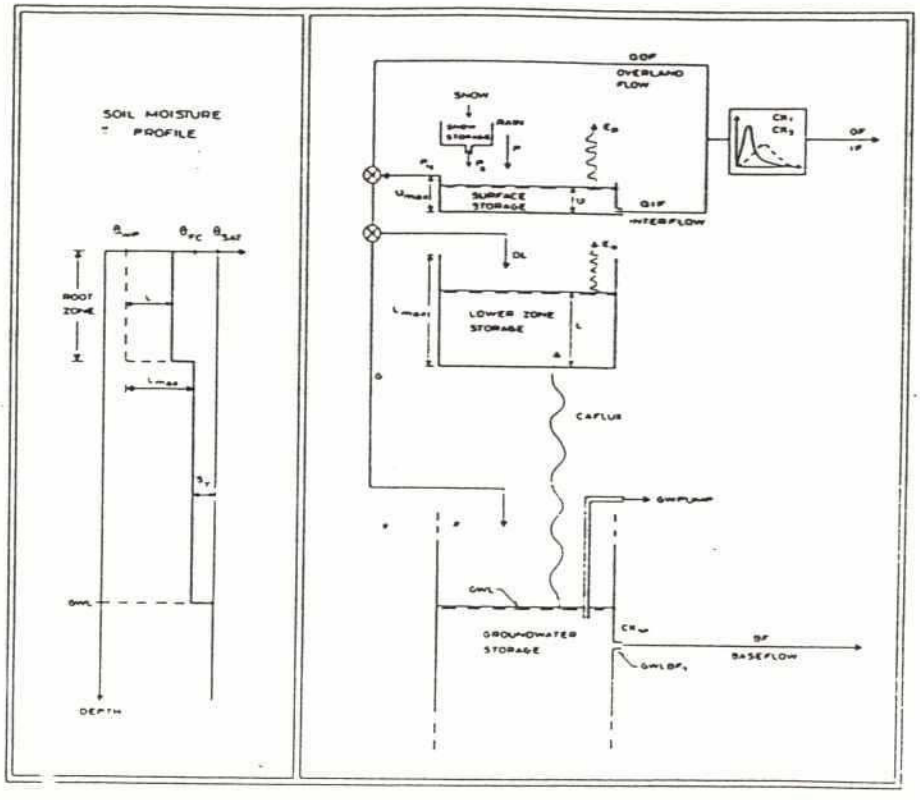


Figure 4.1.1: structure of the NAM model

80

5. HYDRODYNAMIC MODEL

5.1 INTRODUCTION

The channel flow model used for the Bridging Study was the hydrodynamic (HD) module of MIKE11. It is a software package for modelling flows and water levels in river systems and has been developed specifically for application on microcomputers. It is based on DHI's SYSTEM 11 modelling package.

The model is based on the numerical solution of the St. Venant equations describing one dimensional flow. Branched and looped river systems can be handled by the modelling system as well as features such as floodplain flow and off-line storage. Provision is made for the inclusion of flows over weirs, embankments, culverts and other similar hydraulic structures. Output from the channel flow model consists of time series of water levels and discharges.

Full details of the modelling package is given in the MIKE11 User's Guide and Scientific documentation.

5.2 METHODOLOGY

The HD model is run for a historic event and the simulated results compared with the observed results. In a looped or branched network it is important that comparisons with water level and discharges are made to ensure that the correct flow splits are simulated at interval junctions.

For the conditions which prevail in Bangladesh, calibration of the HD models ideally should be for a continuous 12 month period as there may be significant differences in the channel flow characteristics between the dry and monsoon seasons. Additional calibration runs should be carried out for further periods, refining the model calibration, to ensure that the model represents the prototype situation over a wide range of conditions. Following a satisfactory calibration, the model

Figure 5.5

SCHEMATIZATION

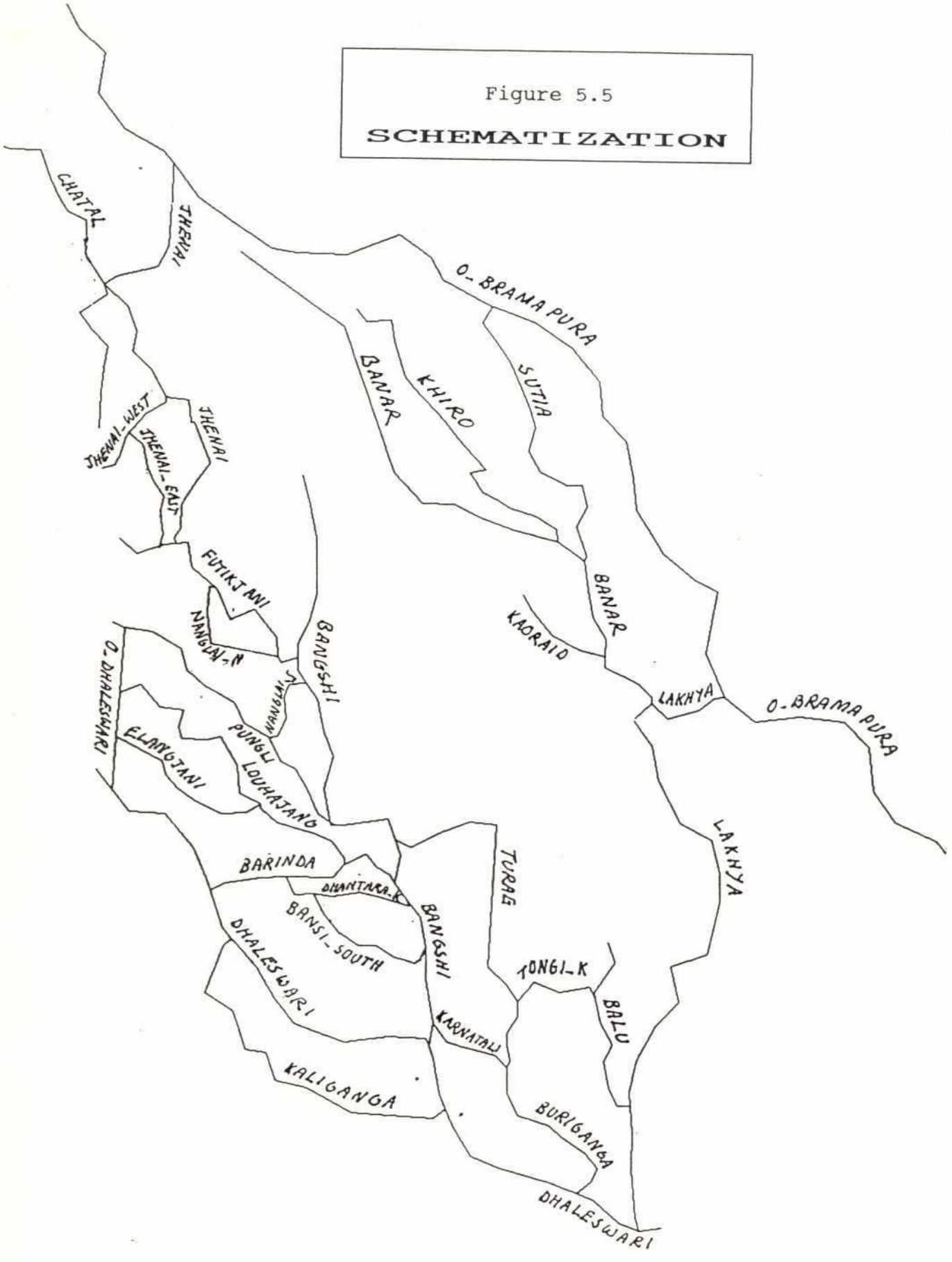
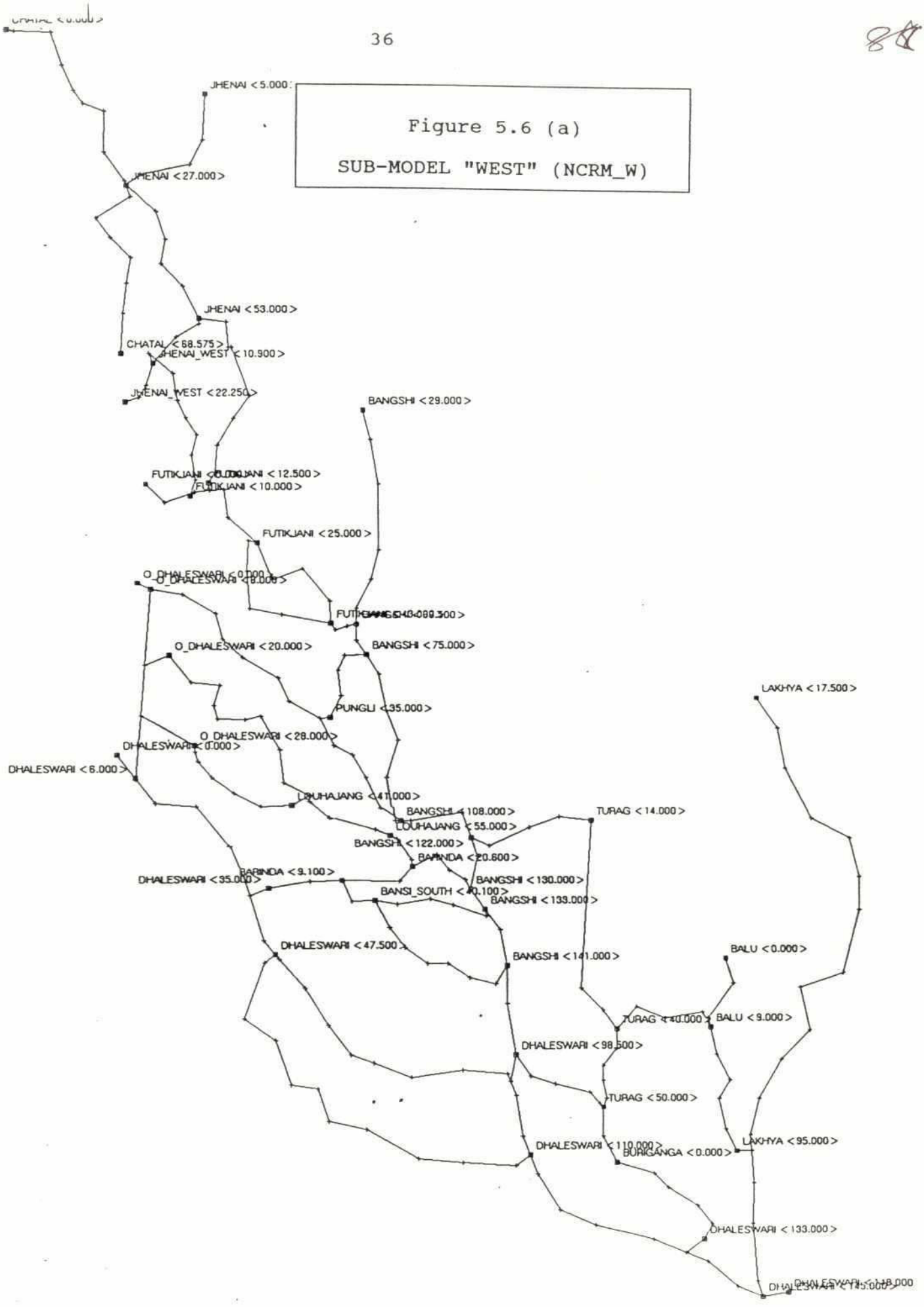


Figure 5.6 (a)

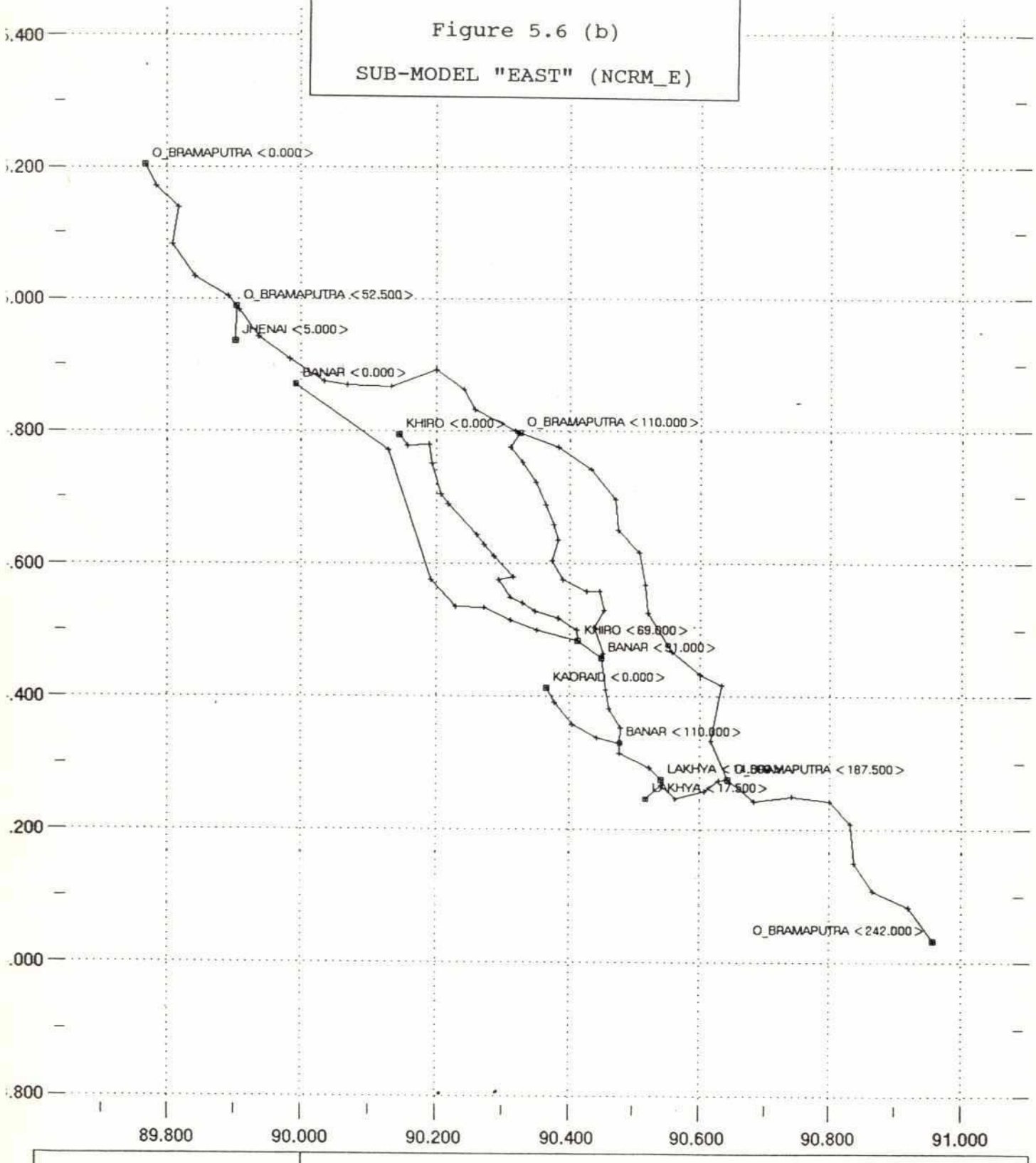
SUB-MODEL "WEST" (NCRM_W)



87

Figure 5.6 (b)

SUB-MODEL "EAST" (NCRM_E)



S W M C	North Central Regional Model " Coarse Pilot Model " Sub – model "East"
SCALE : 1 : 8000 DATA FILE : NCRM_E.RDF EDITED : 23 – MAR – 1991, 11:25	**MIKE 11** Dwg no.:

89

6. Future work programme

6.1 LOGISTICS

The "Bridging Period" ends on April 15th 1991. The "Coarse Pilot Model" in its stage of development had been handed over to the modeller of the North Central Regional Study working for the inception report, but will not be used before several months.

Further development of the model by SWMC, towards pilot model will lead to a model which is more suitable for use in feasibility studies.

Particular aspects of the modelling work which needs to be undertaken in the near future are described in the next paragraph.

In order to strengthen the North Central Regional Modelling Group, a microcomputer has been left as a grant to the NCRMG (see annexe 2.3) and the local consultant engineer working with the bridging modeller will work three months more as a bridging input in the NCRMG under the supervision of the Group Leader.

6.2 ASPECTS OF MODELLING WORK

6.2.1 Preamble

The future work will be done under the normal supervision of the SWMC and all these aspects listed below were defined in cooperation with the "supervision staff" of SWMC.

6.2.2 Data collection

The hydrological data collection programme has already been instigated by the SWMC for the 1991-1992 hydrological year. The stations are shown in the Location Map.

The hydrological data for 1990-91 are about to be collected. The cross-sectionnal data during the discharge

measurement would be useful to do more checks and must be collected.

Some cross-sections will be surveyed in June 1991. The programme has not yet been finalized.

Some data which are going to be collected by the "FAP 3 " team could be useful for the NCRMG, specially the FINNMAP 1:50000 aerial photos taken in December 1990, the new "SPOT" images taken in October 1990, the FINNMAP second order levelling results and the new FAP 3 survey.

2.3 NAM Model

Further development of the NAM model should include :

- run for the 1990 monsoon as soon as the data will be available.
- refinement of the calibration against the some gauged streamflow data, hydrograph shapes, water balance, and hydrodynamic model results.

6.2.4 Hydrodynamic Model

The work undertaken to-date is presented as trial runs and refinement/modification of the NCRM will continue within the SWMC.

Further development of the HD model should include:

- inclusion of new topographical data available.
- further checking of topographical and hydrometrical data, specially with the results of FINNMAP second order levelling witch will be collected by the NCR Main Study consultant.
- use of discharge boundaries instead as water level boundaries for the main upstream boundaries.
- introducing floodplains using the best information. (new SPOT images for the width ?)
- refinement of the calibration, specially against discharges.
- Run for the 1987, 1988 and 1990 hydrological year

ANNEX–2.2

North Central Region Study
(FAP-3

Geotechnical Investigations
and
Groundwater Level Survey

NORTH CENTRAL REGION STUDY
PHASE-1 - RECONNAISSANCE
SUPPORTING ACTIVITIES

GEOTECHNICAL INVESTIGATIONS AND GROUND WATER LEVEL SURVEY

A. GEOTECHNICAL INVESTIGATIONS

1. BACKGROUND

Within the North Central Regional Study (Phase-1) a special attention must be paid to the construction of embankments. Since the geotechnical data are still scarce, it was found necessary to launch a campaign of soil investigation to assess both the quality of existing structures and the characteristics of soil where new embankments may be proposed.

2. OBJECTIVES

The investigations will be aimed at determinating the general characteristics of the building materials which will be used for the embankments. Moreover, the foundations of the structures will be selected and designed according to the outcomes of the soil investigations.

As the geotechnical data available mainly concern the right bank of the JAMUNA river and the south of the project area, the soil investigation under the present addendum will be conducted in the northern part of the project area.

3. SUPPORTING MAPS

Maps to scale 1:50000, sheets 78G12, 78G16, 78H9, 78H13 and 78H14, as well as available BWDB local maps will be used to locate the borings.

4. SCOPE OF WORKS

a. Preparation Works

The area to be surveyed will be located on the basis of the location map attached to the present addendum and which forms an integral part of the addendum. On the spot, borings will be positionned according to natural constraints (vegetation, water) and under the instructions of the engineer responsible for the soil investigations. Location of each boring will be plotted and numbered on a 1:50 000 scale map.

b. Investigation works

The works to be performed consist in :

- drilling 36 boreholes, 11 borings upto 15 m depth and 25 up to 25 m depth,
- opening of 10 two-metre depth pits,
- conducting SPT tests in each boring at 1.50 m depth interval,
- taking soil samples from each boring at 1.50 m depth interval.

Investigation results and sample location will be recorded on a set of sheets, one for each boring, clearly indicating the boring serial number and showing the subsoil profile with the various soil layers, the location of SPT and the test results.

c. Laboratory tests

The laboratory tests, type and quantity, to be performed on the soil samples will be decided upon in close collaboration with the expatriate engineer responsible for the soil investigations and will include :

- Soil identification parameters :
  - Grain size distribution
  - Maximum grain size
  - Fines content
  - Clay content
  - Natural water content
  - In situ dry density
- Atterberg limits
- Consolidated undrained direct shear test
- Compaction test (for clayey samples only)
- Standard consolidation test

5. SUBMISSION OF DOCUMENTS

All the documents to be issued as the result of the field and laboratory investigation, shall be conveyed to the BCEOM/CNR Team Leader not later than June 30th, 1990.

Two copies of maps and field investigation sheets will be submitted, for agreement,on transparent plastic paper. In addition, all the documents shall be delivered in five copies/prints.

6. SCHEDULE OF WORKS

The commencement of works being fixed on May 2nd, 1990, and the submission of all documents on June 30th, 1990, it is mutually agreed upon the following schedule :

All borings are to be completed not later than june 11th, 1990.

Soil samples are to be delivered to the laboratory as borings go along, the last samples being to conveyed to the laboratory not later than June 21st, 1990.

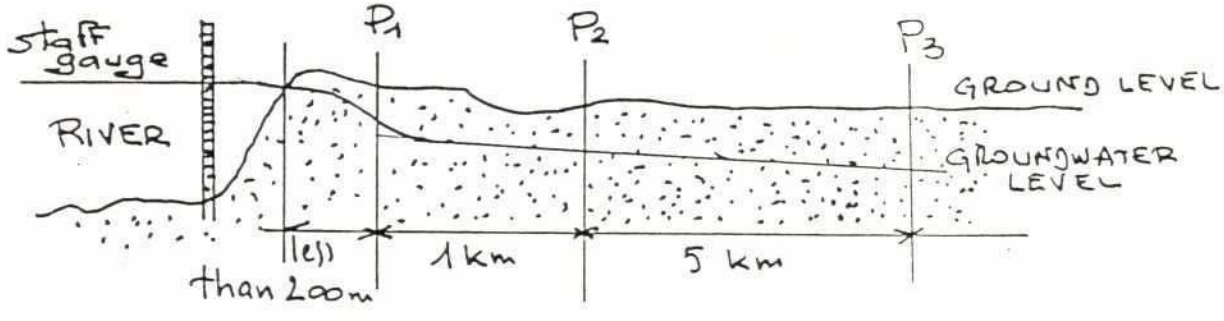
Payments due for these two categories of works will be linked to the strict observance of this time schedule.

The Engineer in charge of the geotechnical investigation is requested to prepare a detailed programme of works on the basis of the abovementioned schedule. This programme, to be drawn up in a bar chart form, shall be submitted to BCEOM/CNR Team Leader prior to the commencement of works. In addition, the soil investigation engineer shall prepare weekly programmes of works to be submitted in due time to the BCEOM/CNR Team Leader. These programmes will be continuously updated according to the actual progress of works.

B. GROUNDWATER LEVEL SURVEY

1. BACKGROUND

The point is well known that the available volumes of groundwater are important. What is significantly less known is the potential direct recharge from the rivers. At present, piezometric surveys are conducted along the PADMA river. In order to assess the hydraulic diffusivity (Transmissivity/Storage) of the aquifer close to the JAMUNA river, two additional piezometric transects are to be set up as shown on the sketch below.



During the transient flood period, the recording of piezometric readings at short time intervals will allow to evaluate hydro-dynamical coefficients, and thus to precise the amount of direct recharge from the river.

2. SCOPE OF WORKS

The works consist in setting up 6 piezometers to record variations throughout the early monsoon period. Measuring points will be located along two separate transects close to the JAMUNA river in the area where soil investigation are to be conducted. The setting out of the piezometric borings will be done according to instructions to be provided by the BCEOM/CNR Team Leader. Location of the piezometer stations, to be identified by a serial number, will be plotted on a 1:50 000 scale map.

The piezometric borings will be 15 m depth borings to be drilled by means of the watering method. Casing will be 37 mm dia PVC duct. Borings will be fitted with concrete capping and bentonite sealing over the two first metres. The strainer to be placed at the bottom of the boring will be 1 m long strainer.

3. WATER LEVEL MEASUREMENTS

Groundwater level measurements will start as soon as the piezometer installation is completed and will carry on till June 30th 1990. Water levels shall be daily recorded at 5 hour intervals between 8 am and 6 pm.

Field observers provided with basic stationery and recording sheets will be posted at each piezometer station. The field engineer in charge of the soil investigation will maintain contact with BWDB hydrological department staff who will provide river water levels.

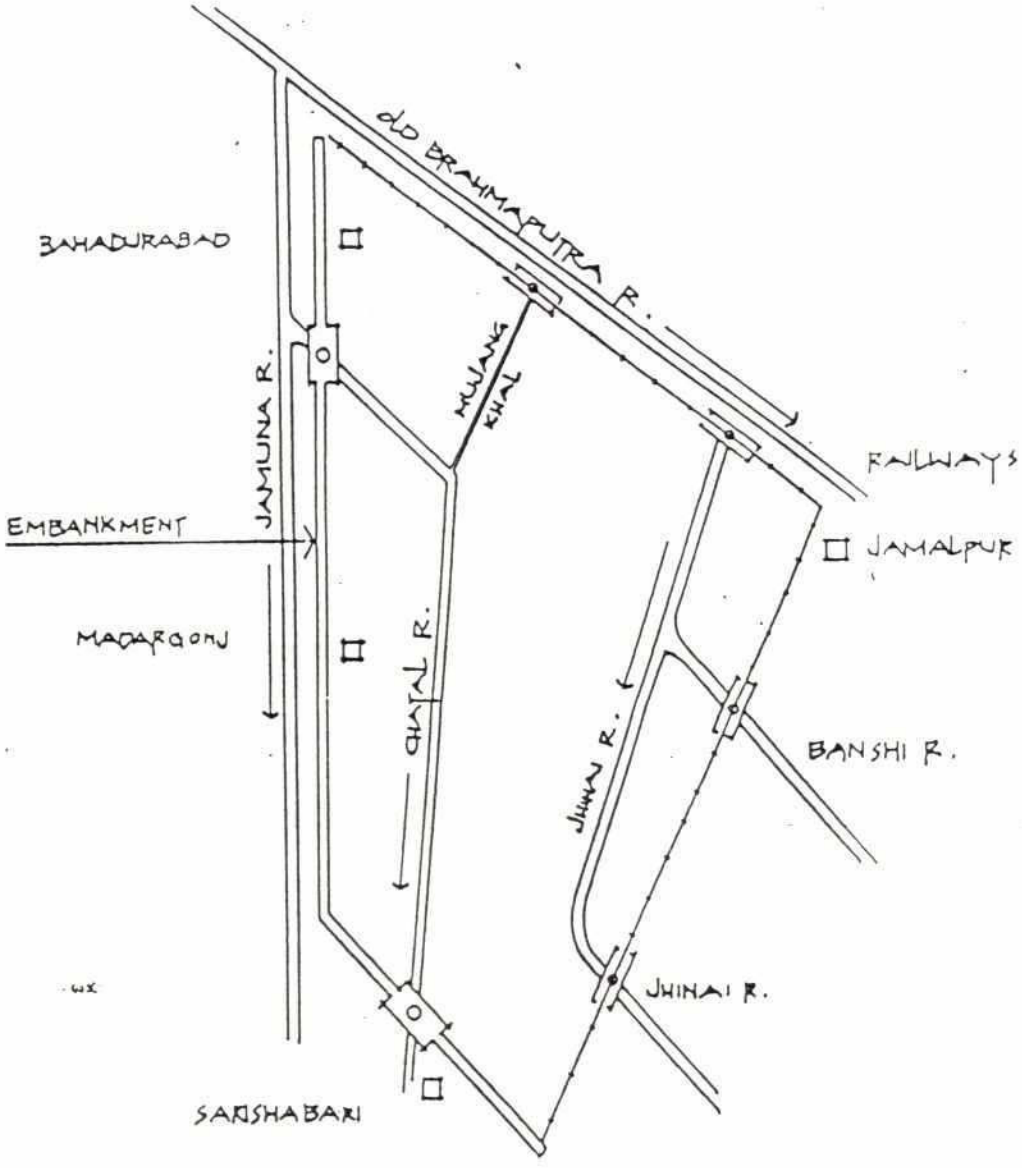
4. REPORTING

Documents to be submitted will consist of a location map and 6 sets of recording sheets, one for each piezometer station. A recording sheet shall clearly indicate the piezometer serial number, the date, time and piezometer reading, the water level in the JAMUNA river close to the measuring station, at different time intervals if possible.

All the records shall be conveyed to the BCEOM/CNR Team Leader not later than July 9th, 1990.

LOCATION

OFFTAKE OR OUTLET



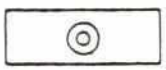
BASIC SCHEME OF GEOTECHNICAL INVESTIGATION

END.

PT 15m

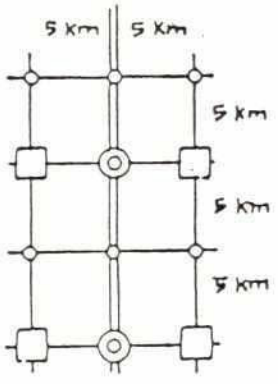
PT 25m

OMPACTION.
m DEPTH.

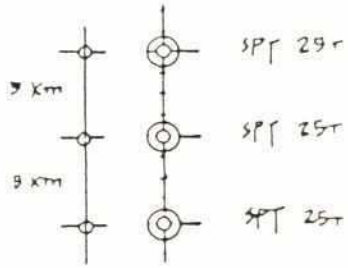


SPT 25m

G STRUCTURES



EMBANKMENT



MINISTRY OF
IRRIGATION, WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN CO-ORDINATION ORGANIZATION

FRANCE - EEC TEAM
IN ASSOCIATION WITH
DESH UPODESH LT

MONTHLY GAUGE READING STATEMENT

in metre above PWD Datum.

SG 17
Shukhnagar
Madarganj
Jamalpur

... ... – JAMUNA ...River... ... ...
NTH JULY ... ...1990... ... ...Nontidal/Tidal ... ...
GR = Gauge Reading. WL = Water Level.

Zero value = 14.25 m PWD.

ur	0800		0900		1200		1500		1800		Highest			Lowe		
te	GR	WL	GR	WL	GR	WL	GR	WL	GR	WL	Hour	GR	WL	Hour	GR	
1	1·41	16·33	1·39	16·31	1·30	16·22	1·23	16·15	1·25	16·17						
2	1·17	16·09	1·16	16·08	1·16	16·08	1·16	16·08	1·16	16·08						
3	1·16	16·08	1·16	16·08	1·15	16·07	1·15	16·07	1·14	16·06						
4	1·12	16·04	1·12	16·04	1·12	16·04	1·12	16·04	1·12	16·04						
5	1·12	16·04	1·12	16·04	1·12	16·04	1·12	16·04	1·12	16·04						
6	1·16	16·08	1·17	16·09	1·18	16·10	1·19	16·11	1·20	16·12						
7	1·19	16·11	1·18	16·10	1·17	16·09	1·16	16·08	1·15	16·07						
8	1·16	16·08	1·18	16·10	1·20	16·12	1·21	16·13	1·22	16·14						
9	1·28	16·20	1·29	16·21	1·30	16·22	1·31	16·23	1·32	16·24						
10	1·35	16·27	1·36	16·28	1·37	16·29	1·38	16·30	1·39	16·31						
11	1·40	16·32	1·41	16·33	1·42	16·34	1·43	16·35	1·44	16·36						
12	1·46	16·38	1·47	16·39	1·48	16·40	1·49	16·41	1·50	16·42						
13	1·50	16·42	1·51	16·43	1·52	16·44	1·53	16·45	1·54	16·46						
14	1·54	16·46	1·55	16·47	1·56	16·48	1·57	16·49	1·58	16·50						
15	1·59	16·51	1·61	16·53	1·62	16·54	1·63	16·55	1·64	16·56						
16	1·65	16·57	1·65	16·57	1·65	16·57	1·65	16·57	1·65	16·57						
17	1·65	16·57	1·65	16·57	1·65	16·57	1·65	16·57	1·65	16·57						
18	1·65	16·57	1·66	16·58	1·67	16·59	1·68	16·60	1·69	16·61						
19	1·72	16·64	1·74	16·66	1·75	16·67	1·76	16·68	1·77	16·69						
20	1·84	16·76	1·86	16·78	1·87	16·79	1·88	16·80	1·89	16·81						
21	1·95	16·87	1·97	16·89	1·98	16·90	1·99	16·91	2·00	16·92						
22	1·94	16·86	1·94	16·86	1·94	16·86	1·94	16·86	1·94	16·86						
23	1·94	16·86	1·95	16·87	1·96	16·88	1·97	16·89	1·98	16·90						
24	1·98	16·90	1·98	16·90	1·98	16·90	1·99	16·91	2·00	16·92						
25	*0·63	17·04	0·65	17·06	0·66	17·07	0·67	17·08	0·67	17·08		WL = 16·41 + GR				
26	0·65	17·06	0·65	17·06	0·65	17·06	0·65	17·06	0·65	17·06						
27	0·64	17·05	0·64	17·05	0·64	17·05	0·64	17·05	0·64	17·05						
28	0·63	17·04	0·63	17·04	0·63	17·04	0·63	17·04	0·63	17·04						
29	0·68	17·09	0·63	17·04	0·63	17·04	0·63	17·04	0·64	17·05						
30	0·66	17·07	0·66	17·07	0·65	17·06	0·64	17·05	0·63	17·04						
31	0·63	17·04	0·63	17·04	0·62	17·03	0·62	17·03	0·61	17·02						

ero Values confirmed. Monthly HWL & LWL underlined

* Gauge change on 24th day (600 HRS)
Old reading 2.00 m = New reading 0.61 m

Signature
Date .....

Signature of the Gauge Reader
Date .....

MONTHLY PIEZOMETRE READING STATEMENT
in metre above PWD Datum

July '1990

Piezometre No : PP4 Place : Sukhnagori, Madargonj
Piezometre top: R.L. : 17.50 m Height from ground : 0.32 m
Piezometre Readers Name : Mr. Hasen Ali

Date	Ground Water Level						Remarks
	0800 Hr.		1300 Hr.		1800 Hr.		
	From Piz. Top	G.W.L.	From Piz. Top	G.W.L.	From Piz. Top	G.W.L.	
1	0.74	16.76	0.82	16.68	0.89	16.61	
2	1.02	16.48	1.05	16.45	1.09	16.41	
3	1.05	16.45	1.04	16.46	1.03	16.47	
4	0.88	16.62	0.78	16.72	0.69	16.81	
5	0.67	16.83	0.69	16.81	0.70	16.80	
6	0.79	16.71	0.79	16.71	0.79	16.71	
7	0.94	16.56	1.00	16.50	1.04	16.46	
8	~~1.00~~ ~~0.79~~	16.50	~~0.97~~ ~~0.78~~	16.53	~~0.95~~	16.55	
9	0.79	16.71	0.78	16.72	0.77	16.73	
10	0.86	16.64	0.92	16.58	0.94	16.56	
11	0.96	16.54	0.96	16.54	0.97	16.53	
12	0.97	16.53	0.98	16.52	0.99	16.51	
13	0.95	16.55	0.97	16.53	0.99	16.51	
14	0.98	16.52	1.00	16.50	1.02	16.48	
15	0.98	16.52	0.90	16.60	.86	16.64	
16	0.79	16.71	0.82	16.68	0.85	16.65	
17	0.84	16.66	0.86	16.64	0.88	16.62	
18	0.87	16.63	0.88	16.62	0.89	16.61	
19	0.85	16.65	0.84	16.66	0.83	16.67	
20	0.75	16.75	0.74	16.76	0.73	16.77	
21	0.45	17.05	0.43	17.07	0.42	17.08	
22	0.39	17.11	0.43	17.07	0.47	17.03	
23	0.43	17.07	0.46	17.04	0.48	17.02	
24	0.46	17.04	0.46	17.04	0.46	17.04	
25	0.36	17.14	0.35	17.15	0.34	17.16	
26	0.32	17.18	0.32	17.18	0.32	17.18	
27	0.35	17.15	0.32	17.18	0.30	17.20	
28	0.30	17.20	0.31	17.19	0.32	17.18	
29	0.32	17.18	0.32	17.18	0.34	17.16	
30	0.36	17.14	0.33	17.17	0.30	17.20	
31	0.34	17.16	0.34	17.16	0.33	17.17	

ANNEX-2.3

North Central Region Study
(FAP-3)

Phase-I
Report on Geo-Technical Investigation

BANGLADESH ACTION PLAN FOR FLOOD CONTROL

NORTH CENTRAL REGIONAL STUDY

PHASE-1

REPORT ON GEO-TECHNICAL INVESTIGATION

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JUNE, 1990/SEPTEMBER, 1990

CONTENTS

REPORT ON GEOTECHNICAL INVESTIGATION INCONNECTION WITH NORTH CENTRAL REGIONAL STUDY (PHASE-I).

1. INTRODUCTION:

As part of North Central Regional Study (Phase-I), this report have been prepared for Bangladesh Water Development Board to Provide informations on Sub-soil stratification for evaluation of foundation condition along the existing railway embankment from Jamalpur to Jagannathgonj ghat and Bahadurabad ghat and possible alignment of the proposed flood protection embankment along the bank of Bhrahamputra river from Jagannathgonj ghat to Bhahadurabad ghat. This report include logs showing soil stratification at respective borehole locations and results of all field & laboratory tests carried out in this connection.

2. SCOPE OF WORKS :

According to scope of works, prepared by M/s. BECOM & CNR Consortium, the investigation was to :

i) Drill exploratory borcholes-covering execution of Standard Penetration Test (S.P.T.) including collection disturbed soil samples at 1.5 m intervals, recording, of soil stratification and G.W.T. in the bore holes, etc: upto 15-25 m depth, at selected locations.

ii) Collect soil samples - for necessary laboratory tests.

iii) Perform laboratory tests-on selected representative soil samples for their classification and to determine shear, settlement and compaction charecteristics of significant strata encountered in different boreholes.

iv) Prepare Report-containing location of bore holes, result of all field and laboratory tests, method of investigation/tests, discussions on geotechnical condition, etc.

3. DESCRIPTION OF WORKS :

To collect required informations-covering execution of Standard Penetration Tests (S.P.T.) includisng collection of disturbed samples at 1.5 m interval, collection of undisturbed soil samples from cohesive zones, recording of soil stratification and G.W.T. in the bore holes, etc. i) in addition to one auger boring upto 6 m depth from top, one exploratory boring upto 15 m depth by the side of existing Railway embankment at 13-selected location, ii) at selected locations for 6-hydraulic structures, one exploratory boring upto 25 m depth and iii) one exploratory boring upto 15 m depth at 8-locations and upto 25 m depth at 5-locations along the possible alignment of the proposed flood protection embankment afrom Jagannathgonj ghat to Bhahadurabad ghat were carried out by wash method. In addition to Grainsize analysis, Atterberg limits tests, Specific gravity tests, on representative selected samples collected from different strata for their classification, etc. necessary laboratory tests to

determine Undrained shear characteristics, Unconfined compressive strength, Consolidation characteristics, etc. were carried out on representative undisturbed samples collected from cohesive strata encountered in different bore holes. To establish scompaction characteristics, modified compaction tests were performed on soil samples collected from 2 m depth as 10-selected locations. To monitor ground water level and movement 2 sets of 37 mm diam. open Stand pipe piezometers were installed at two selected alignments.

4. METHCD OF INVESTIGATION :

This investigation consists of field and laboratory tests, which were carried out as following :

A. FIELD WCRKS:

i) Boring : at locations selected by the representative of M/s. BECOM & CNR, using M.S. casing in upper 2 m only and Bentonite/clay slurry as drilling fluid, bore holes upto required depth were drilled by wash method. Soil stratification and Ground Water level, as in the bore holes was recorded during drilling. Soil stratification, sampling, Standard Penetration resistance (N-Values), G.W.T. etc. are presented in the bore log.

ii) Standard penetration Tests : from existing ground level(E.G.L.) to final depth of drilling, in all bore holes Standard penetration tests were performed at 1.5 m intervals. Summation of bolows of 63.5 Kg. hammer falling freely through 76.2 cm height required for 2nd and 3rd 150 mm Penetration were recorded as N-values and presented in the bore logs.

iii) Disturbed soil sampling : during execution of Standard Penetration test, soil retained within split spoon were preserved within polythene bags and transported to laboratory in airtight condition with proper identification mark.

iv) Undisturbed soil sampling : were collected within 75 mm diam thin walled shelby tubes by pushing into the very soft to firm strata or by driving into firm to stiff strata. After removing disturbed soil from ends and cleaning, soil samples were preserved within the shelby tubes in wax sealed condition and transported to laboratory within wooden boxes with proper identification marks.

v) Bulk disturbed sampling - about 10 Kg disturbed samples collected from about 2 m depth at selected locations were transported to laboratory within proper identification marks.

vi) Stand Pipe piexometers-2 sets of 37 mm diam open stand pipe piezometers (three in each set) as shown in Drawing No.52 were installed by water boring.

B. LABORATORY TESTS :

i) Natural moisture content test - on selected samples were performed according to ASTM-D420-69.

ii) Wet and dry densities test - on selected undisturbed samples were performed according to ASTM-D420-69.

iii) Atterberg limits tests - on selected samples collected from cohesive zones only, were performed according to ASTM-D423-66 & D424-59.

iv) Grainsize analysis tests - (Wet sieve & Combined hydrometer analysis) on selected representatived samples were performed according to ASTM D-421-38 and D422-63.

v) Unconfined compression tests - on 35.6 mm diam specimens prepared form selected undisturbed samples were performed according to ASTM D2166-85.

vi) Consolidated undrained Direct Shear tests - after consolidation under 3-different vertical loads, Undrained Direct Shear(Q_c) tests on 50.8 mm X 50.8 mm undisturbed specimens were performed according to ASTM-D3080-72.

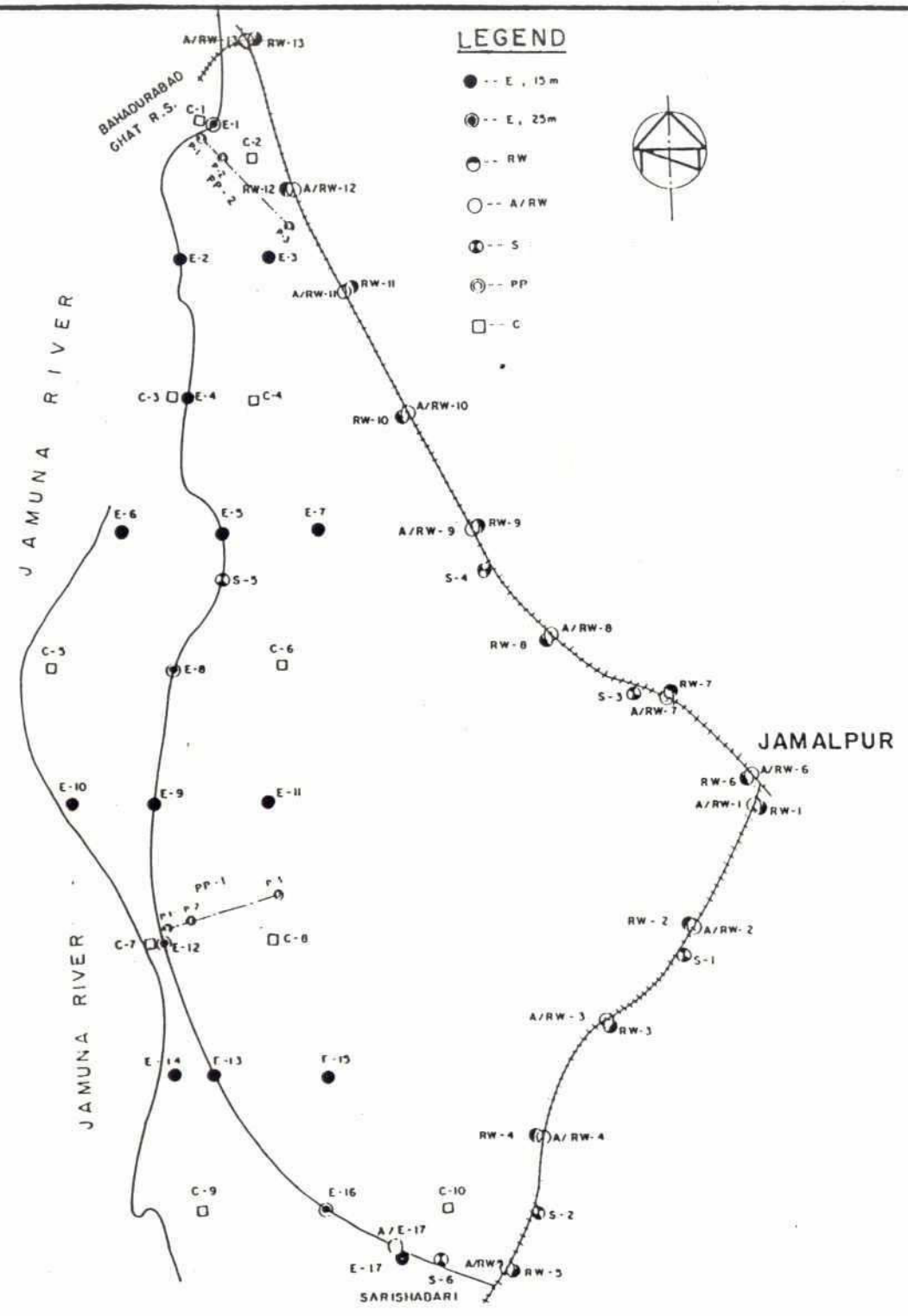
vii) Consolidation tests - with 1:1 load increment ratio and 24 hours duration for each load change, standard consolidation tests on 50.8 mm diam. X20 mm thick specimens prepared from undisturbed samples collected from cohesive zones were performed according to ASTM-D2435-70.

vii) Modified Compaction test - on soil asamples collected from about 2 m depth at selected location were performed according to ASTM D698-78. Results of such tests are presented in Table-I.

MODIFIED COMPACTION CHARACTERISTICS

Sample No.	Maximum dry density (t/m^3)	Optimum moisture content (%)
C-1	1.72	19.0
C-2	1.82	14.6
C-3	1.86	15.0
C-4	1.87	15.5
C-5	1.79	14.0
C-6	1.72	14.0
C-7	1.86	12.5
C-8	1.72	16.0
C-9	1.69	11.5
C-10	1.72	13.5

TABLE - I



SKETCH SHOWING BORE HOLES LOCATION

CLIENT :- BGEOM / CNR

PROJECT :- N-C REGIONAL STUDY PHASE-I

LOCATION :- JAMALPUR

DRN. :- E_usufzai CHKD.- DATE :- DRG.NO.- 01

CLIENT :- BCEOM /CNR
PROJECT :- N-C REGIONAL STUDY PHASE -I.
LOCATION :- JAMALPUR .

BORE HOLE NO :-RW-I

METHOD OF BORING :- WASH
DIAM. OF BORING :- 12 cm
DATE OF EXECUTION :- 8.5.90

DEPTH (m)	VISUAL CLASSIFICATION OF SOIL	LOG	R.L (m)	STANDARD PENETRATION TEST RESULTS (N - VALUES)	G.W.T	SAMPLING	SUMMARY OF LAB. TEST RESULTS																
							SP. GRAVITY G_s	MOISTURE CONTENT W (%)	ATT. LIMITS L_w	ATT. LIMITS P_w	DENSITIES γ_w (t/m³)	DENSITIES γ_d (t/m³)	G.S. DISTRIBUTION SAND (%)	G.S. DISTRIBUTION SILT (%)	G.S. DISTRIBUTION CLAY (%)	SHEAR STRENGTH TYPE OF TEST	SHEAR STRENGTH C (t/m²)	SHEAR STRENGTH φ (°)	CONSOLIDATION C_v	CONSOLIDATION C_c	σ_n (t/m²)
			17.1	0 10 20 30 40	9.3 m (b ON 9-5																		
	Light brown Soft Clayey SILT with some sand .			2		A3-1	2.68		43	26			14	55	31								
				10		B0-2																	
						A3-3	2.69		53	21			11	41	48								
				14		A3-4																	
5	Brown Stiff to very stiff CLAY & SILT with some sand .			20		B0-5		24.4			2.01	1.62				UC	6.0	N.A	0.66	0.14	8		
						A3-6	2.69		71	28			11	42	47								
				17		A3-7																	
				10		A3-8																	
						A3-9																	
10	Brown Compact to dense SAND with some silt			12		A3-10	2.66						83	15	2								
				12		A3-11																	
				23		A3-12																	
15				32																			
						A3-																	
						A2-																	
						A3-																	
20						A3-																	
						A3-																	
						A3-																	
25						A3-																	
						A3-																	
						A3-																	
30						A3-																	

DRAWN BY :- E_usufzai | CHECKED BY :- M. Ahmed | DATE :- | DRAWING NO :- 02

CLIENT :- BCEOM / CNR
PROJECT :- N-C REGIONAL STUDY PHASE - I.
LOCATION :- JAMALPUR.

BH. NO.- A/RW-1

METHOD OF BORING :- AUGER
DIAM. OF BORING :- 12 cm
DATE OF EXECUTION :- 13.6.90

DEPTH (m)	VISUAL CLASSIFICATION OF SOIL	LOG	R.L. (17.9 m)	STANDARD PENETRATION TEST RESULTS (N - VALUES)	G.W.T 1.3m(b ON 14.6	SAMPLING	SUMMARY OF LAB. TEST RESULTS: SP. GRAVITY G_s	MOISTURE CONTENTS W (%)	ATT. LIMITS L_w	ATT. LIMITS P_w	DENSITIES γ_w (t/m³)	DENSITIES γ_d (t/m³)	G.S. DISTRIBUTION SAND (%)	G.S. DISTRIBUTION SILT (%)	G.S. DISTRIBUTION CLAY (%)	SHEAR CHARACTERISTICS TYPE OF TEST	SHEAR CHARACTERISTICS C (t/m²)	SHEAR CHARACTERISTICS ϕ (°)	CONSOLIDATION CHARACTERISTICS θ_v	CONSOLIDATION CHARACTERISTICS C_v	CONSOLIDATION CHARACTERISTICS P_c (t/m²)
				0 10 20 30 40																	
	Light brown Loose Silty SAND with trace clay			4		A3-1	2.66						60	32	8						
	Brown Soft Clayey SILT with some sand			2		A3-2	2.68		47	20			13	55	32						
	Redish brown Stiff CLAY and SILT with some sand			12		B0-3 A3-4		22.0			2.0	1.7				UC	5.8	N.A			
5				15		A3-5	2.69						10	46	44						
						A3-															
						A3-															
10						A3-															
						A3-															
						A3-															
15						A3-															
						A3-															
						A3-															
						A3-															
20						A3-															
						A3-															
						A3-															
						A3-															
25						A3-															
						A3-															
						A3-															
						A3-															
30						A3-															

DRAWN BY :- E. usufzai | CHECKED BY :- M. Ahmed | DATE :- | DRAWING NO - 03

CLIENT :- BCEOM /CNR
PROJECT :- N-C REGIONAL STUDY PHASE - I.
LOCATION :- JAMALPUR .

BORE HOLE NO :- RW-2

METHOD OF BORING :- WASH
DIAM. OF BORING :- 12 cm
DATE OF EXECUTION :- 10.5.90

DEPTH (m)	VISUAL CLASSIFICATION OF SOIL	LOG	R.L. 16.5 (m)	STANDARD PENETRATION TEST RESULTS (N - VALUES) 0 10 20 30 40	G.W.T 2.4m (8 ft) ON 11.8	SAMPLING	SUMMARY OF LAB. TEST RESULTS: SP. GRAVITY G_s	MOISTURE CONTENTS W (%)	ATT. LIMITS L_w	ATT. LIMITS P_w	DENSITIES γ_w (t/m³)	DENSITIES γ_d (t/m³)	G.S. DISTRIBUTION SAND (%)	G.S. DISTRIBUTION SILT (%)	G.S. DISTRIBUTION CLAY (%)	SHEAR CHARACTERISTICS TYPE OF TEST	SHEAR CHARACTERISTICS C (t/m²)	SHEAR CHARACTERISTICS ϕ (°)	CONSOLIDATION CHARACTERISTICS θ_o	CONSOLIDATION CHARACTERISTICS C_v	OR ICR P_o (t/m²)
	Light brown Soft Sandy SILT with some clay.			4		A3-1	2.67		33	18			28	56	16						
	Light brown Very loose Silty SAND with trace clay .			5	▽	A3-2	2.66						59	35	6						
5				8		A3-3															
	Grey Firm to stiff Clayey SILT			9		BO-4 / A3-5	2.64	50.4	46	22	1.71	1.13	3	70	27	Qc	3.6	6	1.32	0.36	9
				7		A3-6															
	Grey Loose to compact SILT & SAND with trace clay .			6		BO-7 / A3-8	2.67						47	47	6						
10				15		A3-9															
				25		A3-10															
	Grey Compact to dense Silty SAND .			40		A3-11	2.66						76	21	3						
15				42		A3-12															
						A3-															
						A3-															
20						A3-															
						A3-															
						A3-															
						A3-															
25						A3-															
						A3-															
						A3-															
30						A3-															

DRAW.N BY :- E_usufzai | CHECKED BY :- M. Ahmed | DATE :- | DRAWING NO :- 04

ANNEX—3

North Central Region Study
(FAP-3)

Mapping and Topography Programme

Mapping and Topography Report.

According to the, Flood Action Plan/3 (FAP/3) Terms of Reference (TOR), proposed methodology it is an urgent matter to clarify the mapping and topographical situation.

This report is required ahead of the inception report (end of the first month).

CONTENTS

1. TOPOGRAPHIC SURVEYS.

1.1 **FINNMAP.**

The FINNMAP survey and mapping programme differs from the original programme assumed in the FAP/3 TOR as follows:

- Topographic maps 1:50,000 are not in the latest FINNMAP programme while FAP/3 TOR assumed these maps were in their programme.
- First order levelling is not in their latest programme. In FINNMAP's programme there is only Second- and Third Order levelling.

The FINNMAP survey and mapping programme for FAP/3 related areas is given below:

1 Aerial photo coverage 1:50,000 scale of the left and right bank of the JAMUNA river (22,000 Km^2.,see fig.:NCRS/2/03).

2 Aerial photo coverage 1:20,000 scale of the Jamalpur Priority Project (JPP, see fig.:NCRS/2/03) and the Compartalization Pilot Projects in Tangail and Sirajganj.

3 G.P.S. survey (50 stations).

4 G.P.S. computations and adjustment.

5 Second-Order levelling (ca. 1100 Km.).

6 Third-Order levelling JPP area (186 Km.).

7 Spot height levelling JPP area (2800 Km.).

8 Aerial triangulation, rectification, production of mosaïcs and contourline mapping.

Progress of FINNMAP as per 15 March '91:

1 Aerial photos taken and printed, full coverage ready. Classification and preparation of flight index by Survey of Bangladesh (SOB) in progress (estimated ready by the end of March) after screening by Security (time required not known) the photo's will then be made available to the Projects through FPCO.

2 As sub 1.

3 G.P.S. measurements field work completed.

4 Final computations and adjustment still to be done. As FINNMAP intends supply only final data (i.e. no raw data) to FPCO it will perhaps take an other two to three months but does not affect the NCRS work.

5 About 40% of the Survey station pillars have been installed.*)
The Second-Order levelling is about 30% complete and it is uncertain if all fieldwork will be ready before the onset of the monsoon. Final calculations and adjustment also await connection to and checking of the existing First-Order SOB Bench Marks (where these are still intact).
In order to check the homogenity of the Second-Order levelling measured at both sides of the Jamuna river this two networks are connected at Phulchari - Bahadurabad and Sirajganj - Bhuapur using trigonometric levelling crossing the open water river channels and precision levelling across the islands (chars).

6 All pillars have been installed.*)
The Third-Order levelling network field work and computations are ready but await connection to existing SOB Bench Marks. We have no information when the connections will be made and the latest SOB BM reduced levels will become available (possibly completed in June '91).

7 Spot height levelling observations ready now for 43% of the network. No further information is available (possibly available June '91).

8 Not feasible before G.P.S. adjustment. According to the FINNMAP tentative schedule it will take another three months after G.P.S. adjustment to complete this programme (i.e. 5 to 6 months time).

NOTES:

The survey and mapping activities for the Compartalization Pilot Projects in Tangail and Sirajganj are in the 1991/1992 FINNMAP programme.

Spot height levelling observations (see point 1.1 sub 7) in JPP area are ready for approx. 70% at the end of April '91.

*) Descriptions and locations of part of the installed pillars (BM's) are made available by FINNMAP through FPCO in advance of the final level computations, so that any new survey work carried out in the near future can be tied in to the new BM's and the reduced levels adjusted later if neccessary.

1.2 **The NCRS Bridging Period Survey.**

A Longitudinal- and Cross-section survey along secondary Rivers within the North Central Region was carried out as an addendum to the Phase 1 Reconnaisssance Study. The field work for this survey was carried out during the Bridging period between Phase 1 and Phase 2 Studies. This survey supporting activity was neccessary for the set up and execution of a hydraulic "Coarse Pilot Model" of the North Central Region. In Nov-Dec. 1990 a supervisory mission was carried out to check field work, computations and drawings. A brief cross check on computations and drawings was carried out during the first weeks of the Phase 2 of the FAP/3 programme.

2. AERIAL PHOTOGRAPHS AND SATELLITE IMAGERY.

2.1 **SPOT images.**

SPOT multispectral imagemaps,from satellite imagery taken in the period Febr.- March 1989, were received by the Government of Bangladesh/Flood Plan Co-ordination Organization (GOB/FPCO) as a contribution by the French Govt. to the Bangladesh Flood Action Plan (FAP) in November 1990. The SPOT multispectral imagemaps covering the whole North Central Region, 44 sheets, were made available to the FAP/3 Study on 30 March '91.
For listing of available imagemaps see annex A.

2.2 **SOJUZKARTA photospace products.**

SOJUZKARTA satelite imagery products, pictures taken at the end of 1985, cover about 95% of the North Central Regional Study area. Products are available in black/white-, colour- and colour synthesized- prints, transparant film positives and negatives. Different resolutions (ie 5m., 6-8m., or 15-30m.) and scales (1:1,350,000 - 1:50,000) depending on type of camera and orbit are liable for sale. It is possible to obtain 1:25,000 5m. resolution, KFA-1000 camera, products. Products shown at a demonstration at the World Bank office in Dhaka were of a very good quality.

2.3 **Aerial Photographs.**

Aerial photography covering the whole of Bangladesh at a scale of 1:50,000 was taken in 1983-1984.
A set of aerial photographs, covering the North Central Region, was received at the start of the Phase 2 Study. However the set is incomplete (perhaps due to security screening). For available Aerial photographs listing see Annex B.

For Aerial photo coverage in December 1990 see point 1.1 sub para 1 and 2 (FINNMAP programme). It would be most helpful for the progress of the Study if these photographs are made available to NCRS as soon as possible.

3. OTHER AGENCIES DATA.

3.1 **Survey of Bangladesh (SOB) maps and survey data.**

The most commonly available map in Bangladesh is probably the 1:50,000 series Topographic Maps. These cover the whole Country. The print editions of these maps vary from the late Fifties to updated maps, using 1983 Aerial photography, for post 1984 editions (see fig.:NCRS/2/01).

SOB has carried out First-Order levelling in the North Central Region along various tracks as shown in fig.:NCRS/2/02. Altimetric checking of the still existing SOB BM's is in the FINNMAP programme. Results are likely not to be available before the start of the 1991 monsoon (see point 1.1 sub para 5).
A list with descriptions and Heights above MSL (Mean Sea Level in feet) of the SOB First-Order levelling and other Governmental Organisations (accuracy order not indicated) is with the FAP/3 Study project.

3.2 **BWDB maps and PWD data.**

In almost all districts BWDB prepared for special areas 4" to 1 mile maps. The survey for these maps took mostly place in 1958-59 and probably extended into the early Sixties. The same can be said of the 8" to 1 mile maps with the only difference that in the North Central Region these maps are surveyed only in Tangail District. The availability of the BWDB maps is not yet known but the necessary steps have been taken to acquire these maps for the FAP/3 project.

The contour interval for both types of maps is 1 (one) foot. As these maps are old the actual elevations and planimetry may have changed considerably.

Altimetric datum for BWDB maps is PWD Datum. This Datum differs from the SOB Mean Sea Level. The general difference given by Survey Organisations is + 460 mm. The general differences can only be adjusted accurately, when the SOB and BWDB Bench Marks are tied in to the new Second-Order network, after completion of the FINNMAP survey work.

NOTE: All survey work done for the NCRS Bridging Period Survey was tied in to PWD datum BM's or when using SOB BM's related to the PWD altimetric datum as the hydrographic network model for North Central Region is based on PWD datum.

4. FUTURE PROGRAMME

4.1 **Revised topographical survey programme.**

As time available before the start of the monsoon is a major constraint (very limited fieldwork can be done during the wet season) the field survey work should be split into 2 (two) parts. Furthermore part of the topographic work can only be defined after the priority programme.
Part 1 (one) of the programme will be implemented prior to the start of the monsoon and Part 2 (two) after the wet season.

Part 1:

This will require a concentrated crash programme using Electronic Tacheometric instruments or Theodolites mounted with EDM's (Electronic Distance Measurment) and Engineers Levels to achieve the rapid, accurate, reliable output required in the limited time available. It is not possible to undertake efficient intensive survey field work in the Ramadan and the subsequent National Holidays. A realistic starting date would therefore be 20th. April 1991.
Depending on weather conditions and equipment available, between 125 and 175 km. of embankment longitudinal profile with a combination of embankment cross-sections (50 to 100 m. length) at approximatly 500 m. intervals and at 10 km. intervals a transect of 1 km., can be surveyed.

This survey will follow the embankment,if existing and at a secure location, along the left bank of the Jamuna river from Bahadurabad Ghat to the Dhaleswari off take, then along the left bank of the Dhaleswari river to the conjunction with the Burhi Ganga river (total length approx. 220 km.).

Due to time and equipment available constraints the part 1 survey is divided into priorities.

Priority 1:
From Sarishabari to the district boundary between Tangail and Manikganj (approx. 80 km.).

Priority 2(a):
From Bahadurabad Ghat to Sarishabari. Only portions will be surveyed (approx. 60 km.).

Priority 2(b):
From the district boundary between Tangail and Manikganj up to the Burhi Ganga river. Only portions will be surveyed (approx. 80 km.).

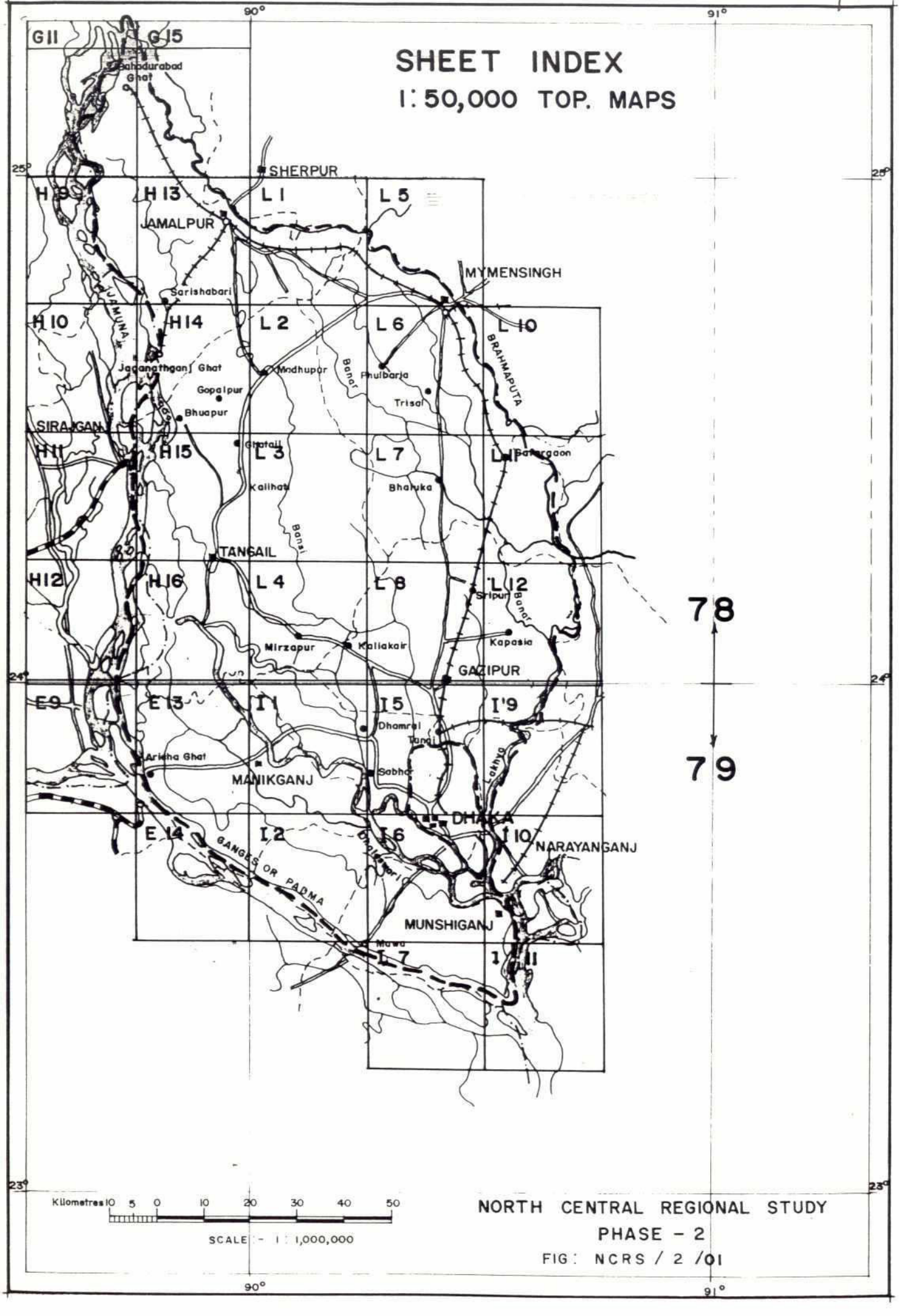
For priority 2(a) and 2(b) the portions to be surveyed will be determined by the Civil Engineers Earthworks after their field visits.

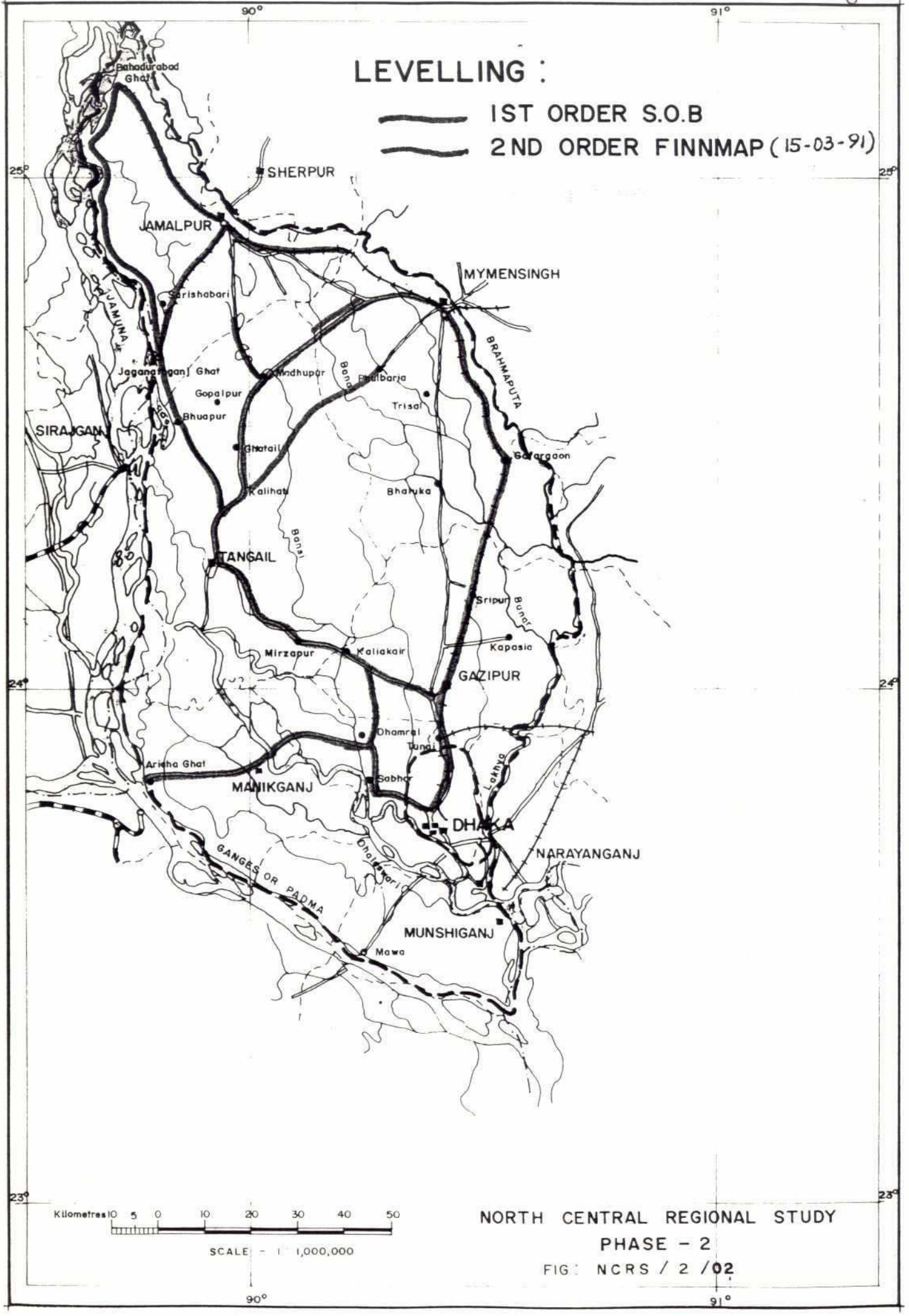
Priority 3:
This is the remainder part of priority 2(a) and 2(b) lengths.

Part 2:

After the monsoon survey work will continue with the remainder of the Part 1 topographical survey programme as and if required.

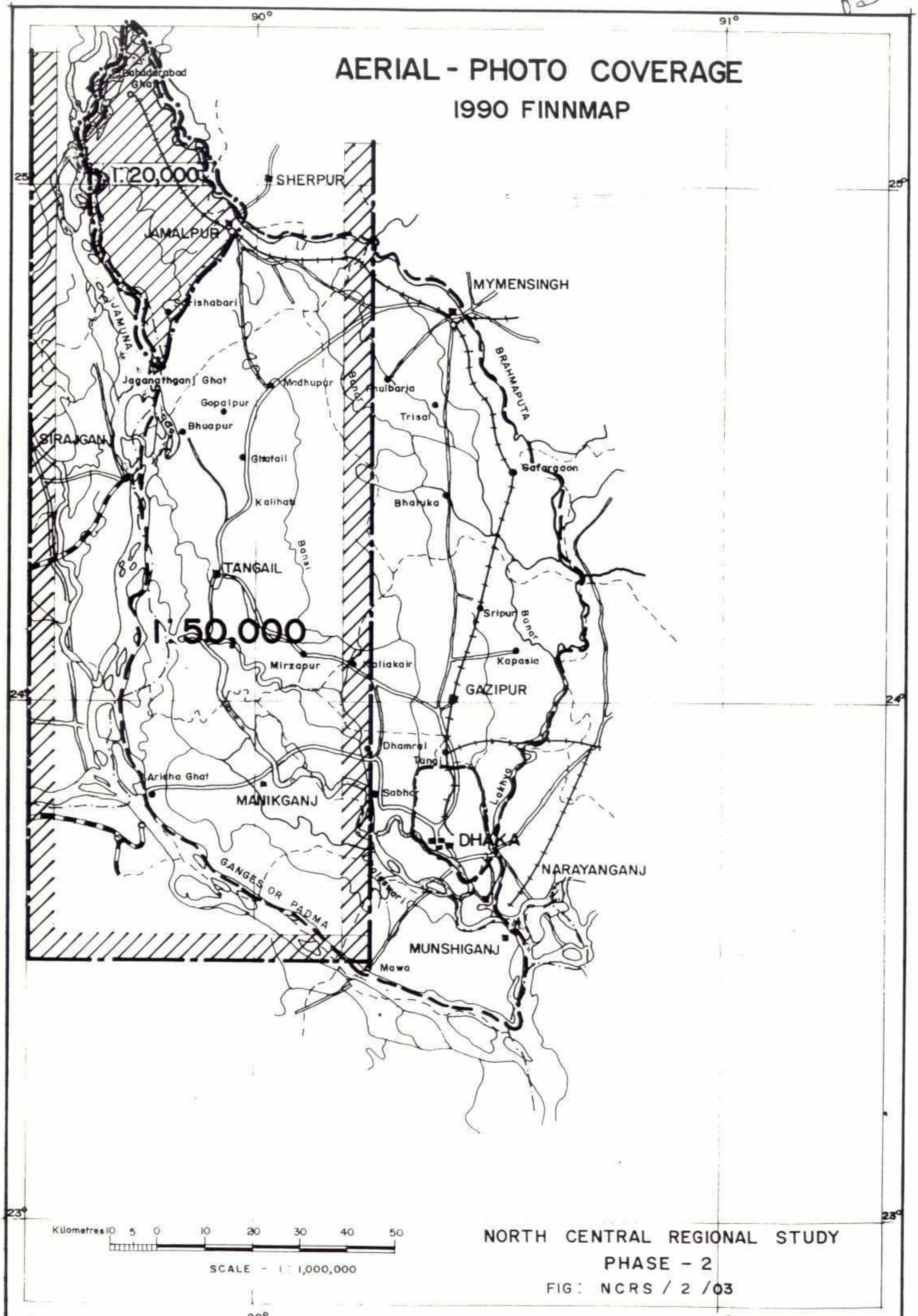
Also the remainder of the survey work as stipulated in the TOR (ie 100 km. of Khal survey, plus the remainder (approx. 80 km. out of 300 km.) of embankment survey, 325 km. transects and about 20 site surveys, will be carried out.


SHEET INDEX
1:50,000 TOP. MAPS
90°
91°
25°
24°
23°
G11
G15
H9
H13
L1
L5
H10
H14
L2
L6
L10
H11
H15
L3
L7
L11
H12
H16
L4
L8
L12
E9
E13
I1
I5
I9
E14
I2
I6
I10
I11
Saheburabad Ghat
SHERPUR
JAMALPUR
MYMENSINGH
Sarishabari
JAMUNA
Jagannathganj Ghat
Madhupur
Banar
Phulbarja
Trisal
BRAHMAPUTA
Gopalpur
Bhuapur
SIRAJGANJ
Ghatail
Kalihati
Bhaluka
Bansi
TANGAIL
Sripur
Kapasia
Mirzapur
Kaliakair
GAZIPUR
Dhamrai
Aricha Ghat
MANIKGANJ
Sabhar
Lohjang
DHAKA
NARAYANGANJ
GANGES OR PADMA
Dhaleswari
MUNSHIGANJ
Mawa
78
79
Kilometres 10 5 0 10 20 30 40 50
SCALE - 1 : 1,000,000
NORTH CENTRAL REGIONAL STUDY
PHASE - 2
FIG: NCRS / 2 /01


LEVELLING :
1ST ORDER S.O.B
2ND ORDER FINNMAP (15-03-91)
90°
91°
25°
24°
23°
Bahadurabad Ghat
SHERPUR
JAMALPUR
MYMENSINGH
Sarishabari
JAMUNA
Jagannathganj Ghat
Gopalpur
Bhuapur
SIRAJGANJ
Ghatail
Kalihati
Bhaluka
Trisal
Bara
Baulbaria
BRAHMAPUTA
Gafargaon
TANGAIL
Bansi
Sripur
Kapasia
Mirzapur
Kaliakair
GAZIPUR
Dhamrai
Turag
Lakhya
Aricha Ghat
MANIKGANJ
Sabhar
DHAKA
NARAYANGANJ
GANGES OR PADMA
Dhaleswari
MUNSHIGANJ
Mawa
Kilometres 10 5 0 10 20 30 40 50
SCALE - 1 : 1,000,000
NORTH CENTRAL REGIONAL STUDY
PHASE - 2
FIG: NCRS / 2 /02

AERIAL - PHOTO COVERAGE

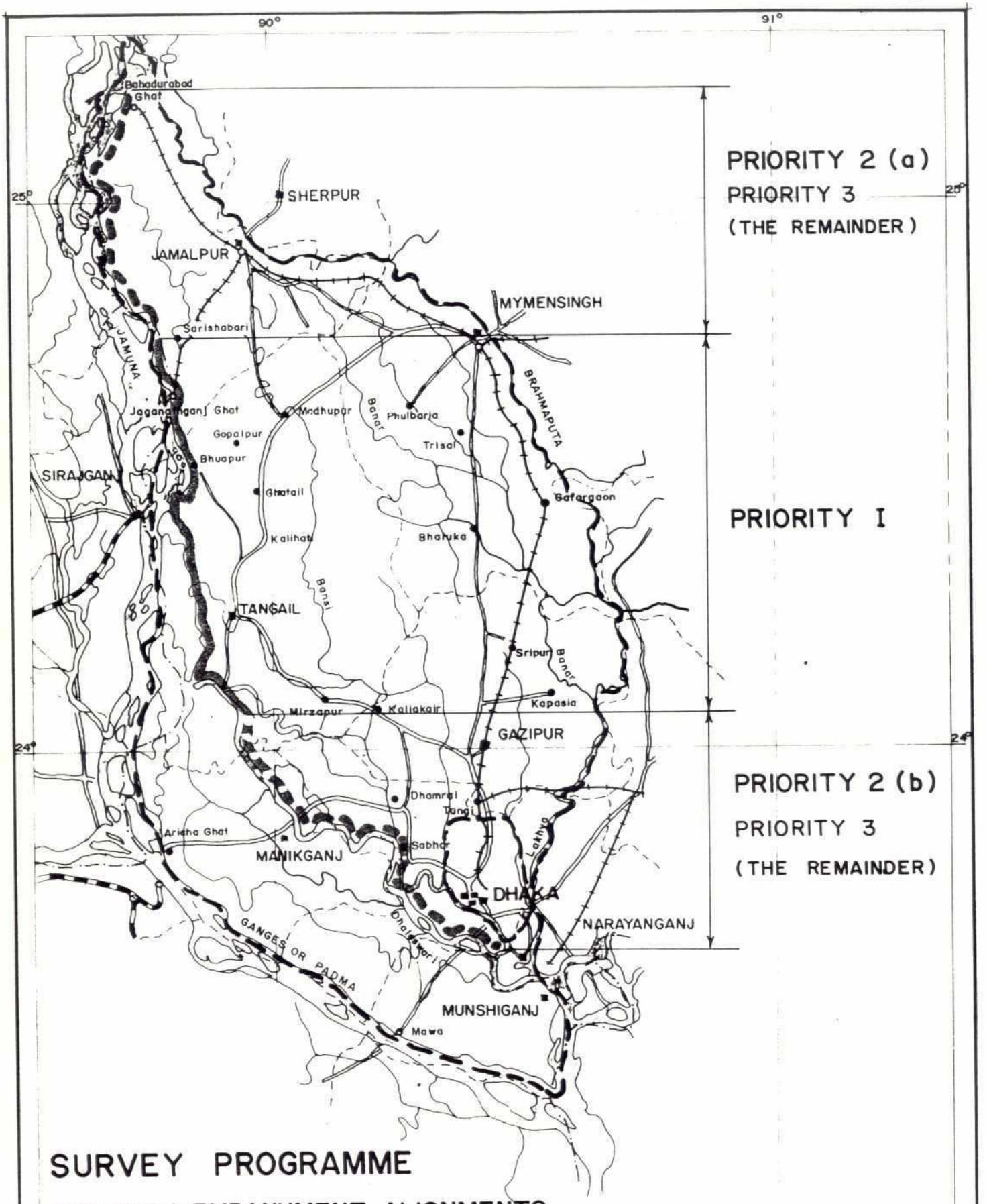
1990 FINNMAP


90°
91°
25°
24°
23°
Bahadurabad Ghat
1:20,000
SHERPUR
JAMALPUR
MYMENSINGH
Sarishabari
JAMUNA
BRAHMAPUTA
Jaganathganj Ghat
Madhupur
Banar
Phulbaria
Gopalpur
Trisal
Bhuapur
SIRAJGANJ
Ghatail
Gafargaon
Kalihati
Bhaluka
Bansi
TANGAIL
Sripur
Banar
1:50,000
Kapasia
Mirzapur
Kaliakair
GAZIPUR
Dhamrai
Tongi
Aricha Ghat
Sabhar
MANIKGANJ
Lakhya
DHAKA
NARAYANGANJ
GANGES OR PADMA
Dhaleswari
MUNSHIGANJ
Mawa
Kilometres 10 5 0 10 20 30 40 50
SCALE - 1: 1,000,000

NORTH CENTRAL REGIONAL STUDY

PHASE - 2

FIG: NCRS / 2 /03



SURVEY PROGRAMME

PRIORITY EMBANKMENT ALIGNMENTS

Kilometres 10 5 0 10 20 30 40 50

SCALE - 1 1,000,000

NORTH CENTRAL REGIONAL STUDY

PHASE - 2

FIG: NCRS / 2 /04

Annex A

SPOT image '89 maps 1/50.000 covering North Central Region.

Serial	Number										
78 F	12	16									
78 G	9	10	11	12	13	14	15	16			
78 H	9	10	11	12	13	14	15	16			
78 K	4										
78 L	1	2	3	4	5	6	7	8	10	11	12
79 E	9	13	14								
79 I	1	2	3	5	6	7	8	9	10	11	12
								Total number of sheets :			44

20/03/91	AERIAL Photos scale 1/50.000 jear : 1983										NCRS
	From - to		From - to		From - to		From - to		From - to		
Run	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	Total
15	16	24									9
16	1	9									9
17	1	5									5
18	1	11									11
19	15	15	22	27							7
20	41	57	60	62	65	65					21
21	21	43									23
22	31	57	63	71							36
23	5	20	70	78	83	89					32
24	33	44	49	74							38
25	3	11	16	28	86	92	96	98			32
26	27	59	63	68							39
27	1	25	80	80	87	89					29
28	40	42	47	75							32
29	32	35	39	61	67	69					30
30	28	60									33
31	24	30	34	34	52	85					42
32	1	25	64	74							36
33	22	51									30
34	17	24	31	48							26
35	12	14	18	27	44	45					15
36	4	7	16	16	20	20	31	32	39	42	12
37	17	18	25	25	29	30	33	36	44	55	21
38	1	2	6	11	18	28	35	36			21
39	15	21	26	34	43	45					19
40	3	5	17	29	34	39					22
41	12	42	48	50							34
42	13	24	30	36							19
43	25	42									18
44	15	15	19	31							14
45	17	17	21	25							6
46	36	43									8
47	22	30									9
											738