People's Republic of Bangladesh
Ministry of Irrigation, Water Development
and Flood Control

Flood Plan Coordination Organisation

Southwest Area Water Resources Management Project

United Nations Development Programme
(BGD/88/038)

Asian Development Bank
(TA No 1498-BAN)

FAP 4

FINAL REPORT

Volume 8

Engineering

August 1993

Sir William Halcrow & Partners Ltd.

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SOUTHWEST AREA WATER RESOURCES MANAGEMENT PROJECT (FAP-4)

VOLUME 8 - ENGINEERING

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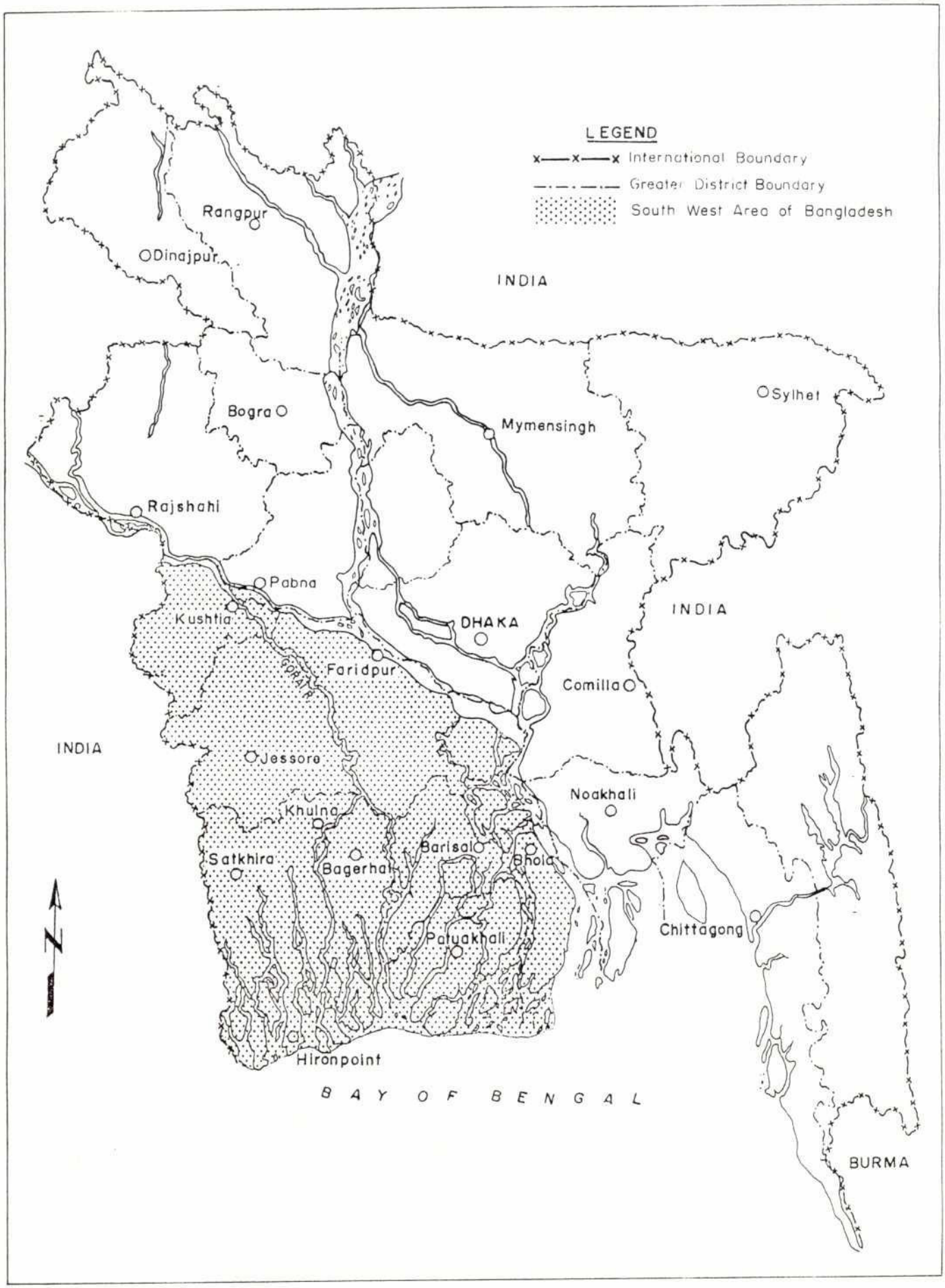
ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AEZ	Agro-Ecological Zones
Aman	Main Monsoon Paddy
AST	Agricultural Sector Team
Aus	Late dry season/early monsoon Paddy
BADC	Bangladesh Agriculture Development Corporation
B.Aman	Broadcast Aman
Baor	Ox-bow lake
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Forest Research Institute
BIWTA	Bangladesh Inland Water Transport Authority
BIWTC	Bangladesh Inland Water Transport Corporation
BIWTMAS	Bangladesh Inland Water Transport Master Plan
BKB	Bangladesh Krishi Bank
BLRI	Bangladesh Livestock Research Institute
BMD	Bangladesh Meteorological Department
Boro	Winter (dry) season Paddy
BRAC	Bangladesh Rural Advancement Committee (NGO)
BRDB	Bangladesh Rural Development Board
BRRI	Bangladesh Rice Research Institute
BSS	Bhumiheen Samabay Samity (Landless Cooperative Society)
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Everywhere (NGO)
CEP	Coastal Embankment Project
CERP II	Second Coastal Embankment Rehabilitation Project
CH	Chainage (1 Chain = 100 feet)
CIDA	Canadian International Development Agency
DAE	Department of Agricultural Extension
DANIDA	Danish International Development Agency
DHI	Danish Hydraulic Institute
DOF	Department of Fisheries
DPHE	Directorate of Public Health Engineering
DSSTW	Deep Set Shallow Tube Well
DTW	Deep Tube Well
EIRR	Economic Internal Rate of Return
FAO	Food and Agriculture Organisation of the United Nations
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCD/I	Flood Control, Drainage and Irrigation
FFYP	Fourth Five Year Plan
FPCO	Flood Plan Coordination Organisation
GB	Grameen Bank
GIS	Geographical Information System
G-K	Ganges - Kobadak
GOB	Government of Bangladesh
HYV	High Yielding Variety
IDA	International Development Agency (World Bank)

IECO	International Engineering Company Inc
IFAD	International Fund for Agricultural Development
Khariff	Summer, monsoon cropping season
KSS	Krishi Samabya Samity (Farmers' Cooperative Society)
LAD	Least Available Depth
LLP	Low Lift Pump
LGEB	Local Government Engineering Bureau
MBR	Madaripur Beel Route
MLGRDC	Ministry of Local Government, Rural Development and Cooperatives
MP	Muriate of Potash
MPO	Master Plan Organisation
MS	Ministry of Shipping
MSY	Maximum Sustainable Yield
NAM	Rainfall Runoff Model
NFC	National Flood Council
NFMP	New Fisheries Management Policy
NGO	Non - Government Organisation
NWC	National Water Council
O & M	Operation and Maintenance
ODA	Overseas Development Administration (U.K)
PDB	Power Development Board
PDEU	Population Development and Evaluation Unit
PEP	Production Employment Programme
PET	Potential Evapotranspiration
PU	Planning Unit
PWD	Public Works Department
Rabi	Winter (dry) season crop
RAOM	Resource Allocation and Optimisation Model
RB	Right Bank
R & H	Roads and Highways
SC	South Central
SCR	South Central Region
SCRM	South Central Regional Model
STW	Shallow Tube Well
SW	South West
SWA	South West Area
SWAM	South West Area Model
SWRM	South West Regional Model
SWMC	Surface Water Modelling Centre
SWR	South West Region
T. Aman	Transplanted Aman
TOR	Terms of Reference
TSP	Triple Super Phosphate
UCCA	Upazila Central Cooperative Association
UNDP	United Nations Development Programme
UNO	Upazila Nirbahi Officer
Upazila (Now Thana)	Administrative Unit above Union and below Zila
WFP	World Food Programme
WARPO	Water Resources Planning Organisation
WSS	Women's Cooperative Society

Figure 1.1



South West Area Location Map

1 INTRODUCTION

1.1 General

This report on Engineering reviews the existing and on-going water resources projects in the Southwest Area (SWA), examines the general drainage features of the Area and identifies possible options for integrated water management including controlled flooding, controlled drainage and for irrigation. The report also assesses the issues of project operation and maintenance. Finally it establishes the unit rates for the main items of work that have been considered in the Regional Plan studies and in the Pre-feasibility studies relating to the Gorai Augmentation Project and other selected schemes.

1.2 Study Area

SWA comprises the Southwest Region and the South Central Region, and covers a total area of about 40,450 km² including charlands, rivers and the Sundarbans (mangrove forests). The area is bounded by the Indian border to the west, the Ganges-Padma and the Lower Meghna to the north and east respectively and the Bay of Bengal to the south (Figure 1.1).

The total net cultivable area in SWA is about 25,000 km² and about 44% of it is covered by existing flood control and drainage (FCD) projects. Irrigated agriculture is practised in areas totalling about 6,400 km² using same form of irrigation : groundwater and surface water systems involving mainly pumping and some traditional manual methods.

2 EXISTING AND ONGOING PROJECTS

2.1 Implementing Agencies

The Government of Bangladesh lays emphasis on vastly increasing the agricultural production through the provision of security against uncontrolled river flooding and drainage inundation, the provision of some necessary infrastructure for promoting the introduction of irrigation and the distribution of some of the agricultural inputs.

The Bangladesh Water Development Board (BWDB), which was established in 1959, is the principal government agency vested with the responsibility for the planning, design, implementation, operation and maintenance of flood control, drainage and major irrigation (FC/D/I) projects in the country. Bangladesh Agricultural Development Corporation (BADC) has been providing until recently some assistance to individual and groups of farmers for establishing minor irrigation facilities (tubewells for groundwater utilisation and low lift pumps for surface water abstraction).

There are also other government agencies which are involved in water related projects or in projects that directly or indirectly impact on the watercourses. The main agencies are :

(a) Local Government Engineering Department (LGED);

(b) Public Health Engineering Department (PHED);

(c) Bangladesh Inland Water Transport Authority (BIWTA)

(d) Fisheries Department

(e) Roads and Highways Department (RHD)

An outline description of the activities of these government agencies in support of the envisaged increased agricultural production is given hereunder :

(a) Local Government Engineering Department

Though LGED is mainly concerned with rural infrastructure development such as roads, culverts and small bridges, they have also constructed a few localised small scale water resources schemes which include embankment, re-excavation of khals, small sluices/regulators, re-excavation of khas and other ponds. In addition, they are also involved in urban development (the housing sector including water supply). LGED have some on-going water related projects in the Southwest Area. There is a need for a greater co-ordination and co-operation between LGED and BWDB as a few of the road projects executed by LGED have blocked some of the natural water courses/drainage routes.

(b) Bangladesh Rural Development Board

BRDB is the prime organisation for rural development in Bangladesh and are carrying out a good number of small scale developments in the Southwest Area. The main components of development under BRDB are agricultural development, homestead production, livestock and fishery development, social forestry, cottage industry, rural infrastructure, etc. Their activities are generally complementary to the BWDB development projects.

(c) Bangladesh Agricultural Development Corporation

BADC is involved in the development relating to agricultural activities. In the Southwest Area there area over 140 FCD/I projects where BADC has been involved in distributing agricultural inputs. The main inputs supplied by BADC to the farmers are agriculture tools and implements, irrigation equipments, seeds, fertilizer, pesticide, etc. and thereby act as a catalyst in agricultural development.

(d) Department of Public Health Engineering

DPHE is the leading government agency involved in the provision of domestic water supply, urban drainage facilities and increasing the public awareness to health and hygienic aspects in the district towns. DPHE has implemented a number of water supply and drainage projects, and some are currently in progress, in the Southwest Area covering the districts of Khulna, Jessore, Kushtia, Faridpur, Barisal, Patuakhali, Chuadanga, Jhenaidah, Bagerhat, Rajbari, Gopalganj, Madaripur, Pirojpur, Magura, Narail, Bhola, Jhalakati, Sariatpur, Meherpur, Satkhira and Perojpur. The water supply developments have been mainly based on deep tubewells (DTW). Surface water systems incorporating basic treatment plants are located in Barisal and Bagerhat.

The water requirements of these and other potential schemes (on district and thana basis) have been considered in the demand assessment relating to the groundwater and surface water resources in the Southwest Area.

2.2 BWDB Projects in SWA

A government agency, the Master Plan Organisation (now WARPO), published a list of existing and on-going BWDB projects based on a data collection survey carried out in 1989. The Consultants have updated this list using information collected during the current study. For this exercise the Consultants in their inception phase sent Project Profile Questionnaires to all the BWDB Circle Offices, but had limited success in getting the required information. This was forth-coming more readily when direct discussions were held with the concerned engineers.

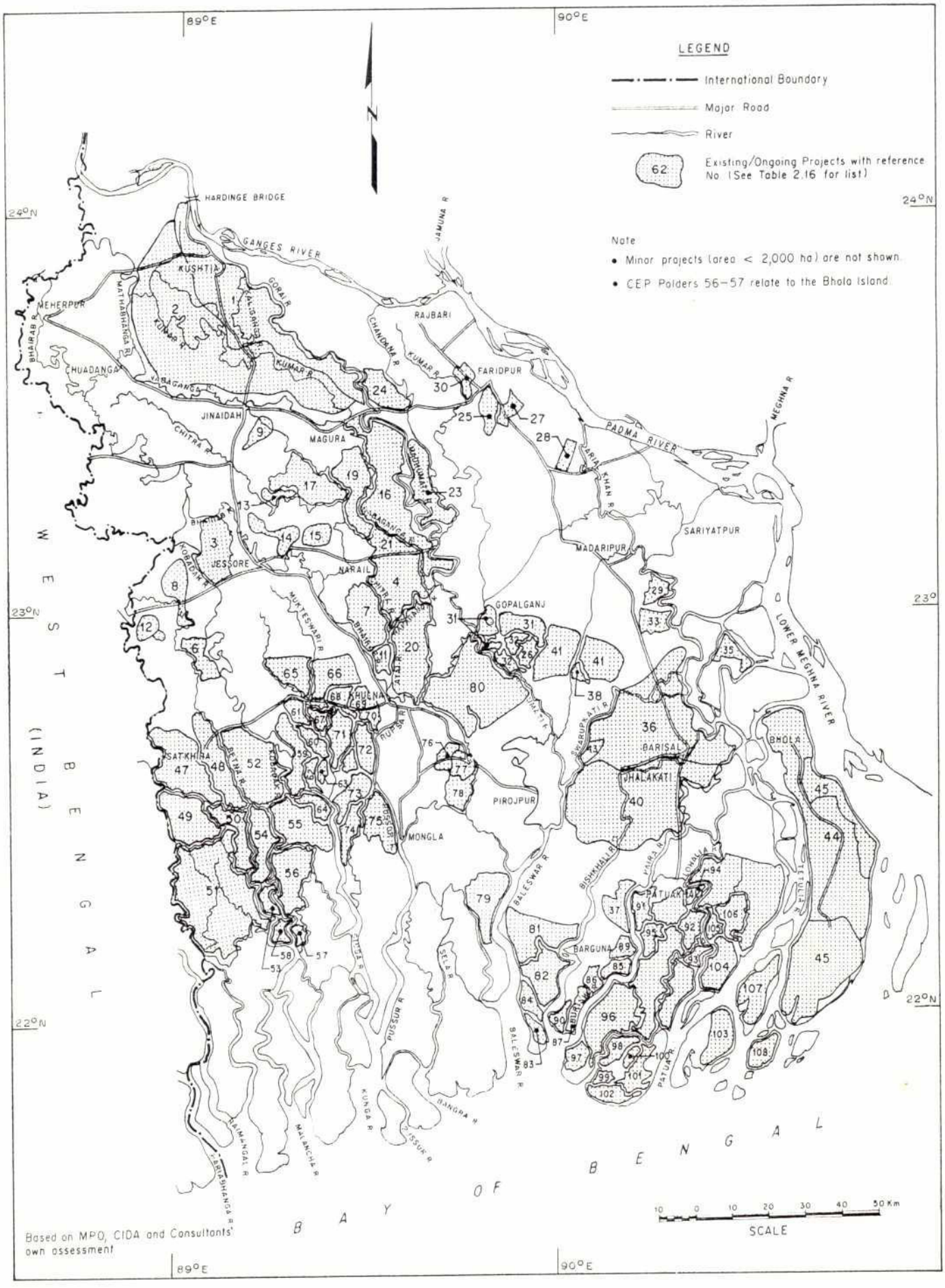
There are more than 140 FCD/I projects in SWA, covering a total gross area of about 14,500 km² (NCA of 11,100 km²) and almost all of them have been implemented by BWDB. A list of the BWDB projects is given in Table 2.1 and their locations are shown in Figure 2.1. The main objectives of these projects (except the Ganges-Kobadak, the Barisal Irrigation, the Bhola Irrigation and the Chenchuri Irrigation Projects) are to provide flood control and drainage to certain selected areas which were prone to severe inundation during the monsoon period. In the four irrigation projects the provision of formalised irrigation facilities is one of the main objectives. In the other FCD/I projects farmers themselves or private entrepreneurs have installed their own minor irrigation facilities (tubewells, LLP, etc).

About 55% of the FCD/I projects are concentrated along the coastal belt, to protect the area from tidal flooding, and are consequently referred to as the Coastal Embankment Project (CEP).

There are also other very small sub-projects in SWA but have not been included in the above list, as each one of them generally relates to a single item of work such as re-excavation of a short length of a khal/drain or replacement of a gate, etc.

FCD/I projects of major significance in view of either their productive potential or their impact on the hydro-morphological processes of the river network are the GK Project, Barisal Irrigation Project, Bhola Irrigation Project Phase-I, Madhumati-Nabaganga FCD/I Project (FCD III Project) and about 76 polders under the Coastal Embankment Project.

Figure 2. 1



Existing and Ongoing Projects

TABLE 2.1

Existing and On-going BWDB Projects in Southwest Area

Map Ref. No.	Name of Projects	Area (Km²) Gross	Area (Km²) Net	Year Completed / Started
	G.K REHABILITATION PROJECT CIRCLE			
1	G.K. Phase - I	7690	4860	69-70
2	G.K. Phase - II	12060	9310	82-83
	KHULNA O & M CIRCLE			
3	Arol Beel D Scheme	158	126	89-90
4	Chenchuri & other Beel D	269	214	75-76
5	Lohagora Flood Protection	179	132	83-84
6	Kalaroa Drainage Scheme	61	56	86-87
7	Singia-Nebugati BDS	85	68	83-84
8	Sonamukhi-Bonmander	74	59	77-78
9	Putia & other BDS	36	29	79-80
10	Drainage of certain Beels in Tala Thana	65	23	79-80
11	Barakpur-Dighulia Scheme	43	31	83-84
12	Kanai Khal Regulator Scheme	41	41	85-86
13	Bara Khurda Reg. Project	20	18	81-82
14	Madia Beel Drainage Scheme	26	26	79-80
15	Dhalgram Bara Khal Regulator	50	40	--
16	Madhumati-Nabaganga *	450	380	88-89
17	Kalidaskhali-Arpara *	162	125	86-87
18	Satkhira-Kolaroa Sub-Project *	69	56	89-90
19	Bamankhali-Barnali *	170	138	88-89
20	Barnal-Salimpur-Kolabashukhali Project	231	220	80-81
21	Chenchuri Beel Irrigation Sub-Project	13	10	92-93
22	Chitra-Bhairab-Afra Project *	350	140	90-91
	FARIDPUR CIRCLE			
23	Alfadanga-Boalmari FPES	142	66	77-78
24	Madhukhali-Baliakandi SP	118	94	91-92
25	Sakunia BD Scheme	57	44	84-85
26	Tarail-Pachuria Project Polder 3	85	57	90-91
27	Baramanikdi Project	38	31	86-87
28	Chatlar-Fakurhati BD	32	16	84-85
29	Kalkini North	38	31	86-87
30	Dhuldi Project	36	28	88-89
31	Tarail Pachuria Project Polder - 1, 2 & 6 *	80	64	90-91
32	Tarail Pachuria Project Polder 4 & 5 *	39	32	88-89
33	Kalkini South *	53	44	86-87
34	Daduria Beel Sub-project *	26	18	89-90
	BARISAL O & M CIRCLE			
35	Hizla Embankment Project	838	567	79-80
36	BIP Phase - I	733	507	78-80
37	Bighai River FSC Project	70	49	86-87
38	Satla-Bagda Project Polder-3	26	25	86-87
39	Bibichini *	27	23	86-87
	BIP CIRCLE			
40	BIP Phase - II	276	201	85-86
41	Satla-Bagda Proj Polder 1&2	73	57	85-86
42	Paisarhat-Ramshil Project *		16	88-89
43	BIP Pilot Scheme Area-I	53	41	78-79
	BHOLA CIRCLE			
44	Bhola IP Phase-I	648	526	90-91
45	Bhola IP Phase-II *	273	223	
46	Sakuchia Island *	73	57	85-86
	Coastal Embankment Project (CEP)			
47	Polder - 1	284	264	64-65
48	Polder - 2	122	100	66-67
49	Polder - 3	184	147	66-67
50	Polder - 4	103	72	64-65
51	Polder - 5	554	420	67-68
52	Polder - (6 - 8)	259	207	66-67
53	Polder - 7/1	39	31	64-65
54	Polder - 7/2	109	76	66-67
55	Polder - (10 - 12)	174	162	74-75
56	Polder - (13 - 14/2)	147	104	66-67
57	Polder - 14/1	26	20	65-66
58	Polder - 15	33	25	67-68
59	Polder - 16	104	101	67-68
60	Polder - 17/1	50	38	69-70
61	Polder - 17/2	34	26	80-81

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TABLE 2.1 (Contd.)

Existing and On-going BWDB Projects in Southwest Area

Map Ref. No.	Name of Projects	Area (Km²)		Year
		Gross	Net	Completed / Started
62	Polder - (18-19)	33	32	68-69
63	Polder - 20	25	16	73-74
64	Polder - 23	43	41	64-65
65	Polder - 24	283	237	64-65
66	Polder - 25	194	136	66-67
67	Polder - 26	27	22	66-67
68	Polder - 27/1	38	29	63-64
69	Polder - 28/1	56	43	63-64
70	Polder - 28/2	26	20	72-73
71	Polder - 29	82	62	67-68
72	Polder - 30	63	57	70-71
73	Polder - 31	101	99	71-72
74	Polder - 32	104	97	66-67
75	Polder - 33	104	79	71-72
76	Polder - 34/1	24	19	63-64
77	Polder - 34/3	32	26	80-81
78	Polder - 35/3	65	49	82-83
79	Polder - 35/1	148	134	66-67
80	Polder - 36/1	400	320	70-71
81	Polder - 39/1	243	205	78-79
82	Polder - 39/1A *	118	94	85-86
83	Polder - 40/1	21	17	65-66
84	Polder - 40/2	37	28	65-66
85	Polder - 41/1	32	26	85-86
86	Polder - 41/2	28	23	86-87
87	Polder - 41/5	24	20	86-87
89	Polder - 41/6A	40	28	86-87
90	Polder - 42	28	23	65-66
91	Polder - 43/2A	49	32	86-87
92	Polder - 43/2B *	98	74	85-86
93	Polder - 43/2C	28	21	89-90
94	Polder - 43/2E *	17	16	88-89
95	Polder - 43/2F *	41	33	88-89
96	Polder - 44	40	28	86-87
97	Polder - 45	41	31	66-67
98	Polder - 46	40	28	85-86
99	Polder - 47/1	21	19	86-87
100	Polder - 47/3	20	21	84-85
101	Polder - 47/4	36	26	86-87
102	Polder - 48	54	49	82-83
103	Polder - 52/53 A & B *	80	64	87-88
104	Polder - 55/1	108	78	86-87
105	Polder - 55/2B	26	24	86-87
106	Polder - 55/2C	63	60	85-86
107	Polder - 55/3 *	98	74	86-87
108	Polder - 55/4 *	51	43	86-87
109	Polder - 56/57	419	399	77-78
	Minor Projects			
	Makla BDS	5	5	81-82
	Sankarpur Regulator Scheme	13	10	81-82
	Jafar Khal Regulator Project	10	10	84-85
	Raghabpur Regulator Project	12	12	85-86
	Lebutala and other BDS	12	12	86-87
	Talbaria-Saikura Project *	8	8	91-92
	Purulia-Charbhatpara Project	20	10	82-83
	Kandor Beel Sub-Project	7	5	91-92
	Sakpaldia	14	12	89-90
	Coastal Embankment Project			
	Polder - 21	17	15	73-74
	Polder - 22	12	11	69-70
	Polder - 27/2	14	4	63-64
	Polder - 41/3	16	7	86-87
	Polder - 41/4	16	10	86-87
	Polder - 43/1/A	10	11	80-81
	Polder - 47/2		9	65-66
	Polder - 47/5		15	86-87
	Polder - 54		15	84-85

Source : MPO and Consultant's collected field information [vp\vol8\tab2-1]

NOTES :

1. On-going (construction) schemes are marked with *. In addition, studies/designs relating to the Second Small Scale FCDI Project are in progress
2. Though the CEP polders come under the jurisdiction of either the Khulna, Barisal or Bhola Circles, they have been grouped together for the purpose of drainage congestion study.
3. 40 Schemes in the above list were designed/implemented under the Early Implementation Project.
4. The Systems Rehabilitation Project is currently examining 16 schemes from the list for possible rehabilitation.
5. The following projects were involved in designs/implementation of some of the CEP Polders rehabilitation
   - The Delta Development Project (CEP 22 and 29)
   - The Khulna Coastal Embankment Rehabilitation Projects (KCERP1 and KCERP2 : CEP 24, 25, 27 &28)
6. Year Completed relates to existing projects and year started relates to the commencement of implementation for on-going projects

2.3 Other Relevant On-Going Projects in SWA

2.3.1 General

The Consultants have had discussions with various other consultants presently involved in planning, design and/or studies for BWDB projects in the Southwest Area. In addition, reports of certain FAP studies/projects that are relevant to the FAP-4 studies have been reviewed. The relevant studies/projects are :

- Third Flood Control and Drainage (FCD-III) Project
- Second Small Scale Flood Control Drainage and Irrigation Project (also referred to as the Small Scale Water Control Structures-3 Project)
- Systems Rehabilitation Project (SRP)
- Khulna Coastal Embankment Rehabilitation Project (KCERP) and Second Coastal Embankment Rehabilitation Project (CERP II)
- Delta Development Project (DDP) and Land Reclamation Project (LRP)
- BWDB Small Schemes Project
- Second Bhola Irrigation Project
- Early Implementation Project (EIP)
- Flood Action Plan (FAP) component 9A : Secondary Towns Protection Project (Khulna in Southwest Area)
- Flood Action Plan (FAP) components 12 and 13 (CEP Polder 17/2, Kolabashukhali Project, Sonamukhi Bonmander BDS, Sakunia BDS).
- Flood Action Plan (FAP) component 7 Cyclone Protection Project
- Flood Action Plan (FAP) component 10 : Flood Warning and Communication
- Flood Action Plan (FAP) component 20 Compartmentalisation Pilot Project
- Flood Action Plan (FAP) component 23 : Flood Proofing

A brief description of these projects is given hereunder.

2.3.2 Third Flood Control & Drainage Project

This BWDB sponsored project consists of three sub-projects: namely Gumti Sub-Project, Naogaon Sub-project and Madhumati-Nabaganga Sub-project. Of these three, only the third one is located within the Southwest Area, and it is listed in Table 2.1.

This project is funded by the Government of Bangladesh (GOB) and the International Development Agency (IDA).

The feasibility study and design for the Madhumati-Nabaganga sub-project was carried out during the period 1984-86 by Engineering and Planning Consultants Ltd in association with Sir William Halcrow & Partners Ltd (U.K.) and Resources Development Consultants Ltd (Sri

Lanka). Construction is in progress and is expected to be completed in the fiscal year 1992/93. The project will provide flood control and drainage for a gross area of 45,000 ha. In addition, gates have been provided to allow river inflow in order to enable limited supplementary irrigation during the pre-monsoon and post-monsoon periods.

2.3.3 Second Small Scale Flood Control, Drainage and Irrigation Project

This is a BWDB sponsored countrywide project and Northwest Hydraulic Consultants Ltd have been providing the necessary consultancy services (studies, design and construction supervision) since 1988. The project is expected to be completed in 1994. This project which is also referred to as the Small Scale Water Control Structures-3, is funded jointly by GOB, IDA and Canadian International Development Agency (CIDA).

There are three types of schemes (listed below) under this project, and their distribution in the Southwest Area on the basis of BWDB O & M divisions is as follows:

a) Appurtenant Structures

Incorporation of new appurtenant structures (based on BWDB design) including construction supervision for 22 existing incomplete schemes: one scheme each in Bagerhat, Gopalganj, Jhenaidah and Rajbari; two each in Faridpur and Barguna; three each in Barisal and Patuakhali, and four each in Jessore and Satkhira O & M divisions.

b) Rehabilitation of Existing BWDB Schemes

Design and construction supervision for the rehabilitation of 11 schemes: one scheme each in Khulna and Patuakhali; two each in Faridpur and Satkhira, and five in Barguna O & M divisions.

c) Fully Planned Schemes

Planning, design and construction supervision for four new schemes: Gopalganj West Polder-4 in Gopalganj, CEP Polder 41/6B in Barguna, CEP Polder 58/1 in Bhola and CEP Polder 55/2A in Patuakhali O & M divisions.

Another 11 Nos sub-projects were studied by the Northwest Hydraulic Consultants Ltd but have been suspended due to the projects being uneconomic.

2.3.4 Systems Rehabilitation Project

This is a BWDB sponsored countrywide programme of rehabilitation works to improve the performance capability of selected existing FCD/I projects. Two separate teams (namely Halcrow-BCEOM-DHV, et al and Haskoning, et al) have been providing the necessary consultancy services for improving the operating capability of these projects (project screening, design and advisory construction supervision for the rehabilitation works), skill development and motivation of BWDB staff in O&M, etc. including cost recovery since 1989. The project is expected to be completed in 1996-97. The project is jointly funded by GOB, IDA, the European Economic Community (EEC) and the Government of Netherlands (GON).

The estimated progress of the feasibility study for rehabilitation of projects in SWA is as follows :

Activity		Name of Projects
Feasibility study completed	:	Hizla Embankment; Barnal-Salimpur-Kolabashukhali; Makla Beel Drainage
Feasibility study in progress	:	CEP Polder 35/1, Polder 40/2 and Polder 48
Identified but yet to be screened	:	CEP Polder 13-14/2, Polder 14/1, Polder 4, Polder 7/1, Polder 7/2, Polder 32, Polder 1, Polder 3, Polder 5 and Polder 15.

2.3.5 Khulna Coastal Embankment Rehabilitation Project

An initial feasibility study of Khulna Coastal Embankment Rehabilitation Project (KCERP) was carried out by Agricultural Development Corporation of Korea in association with Associated Consulting Engineers Ltd (ACE), Bangladesh and was completed in May 1986. A new team of consultants, Chuo Kaihatsu Corporation (CKC),Japan and Development Design Consultants Ltd (DDC), Bangladesh, was engaged in 1988 to carry out detail designs generally conforming to the findings of the above feasibility study. This design exercise was subsequently suspended in November 1989 due to concerns raised by the local people and others on the technical viability of the project. The KCERP implementation commenced in October 1988, but after about 12% of the work had been executed it was also suspended.

A specialist team from ADB and UNDP (comprising J R Clark, N Ahmed, W F T van Ellen, C J Kittel, K Nizammuddin and T Rahman) reviewed the project in November/December 1989 and on the basis of its report (January 1990) it was decided that the KCERP implementation should remain suspended until a further feasibility study has been carried out. Recently, Haskoning and Bangladesh Consultants Ltd. (BCL) have completed a detailed study covering polders 24, 25, 27 and 28 (KCERP II).

2.3.6 Delta Development Project

The Delta Development Project relates to the rehabilitation of certain selected polders of BWDB in the deltaic zones of the Southwest Area under a joint programme of the Governments of Bangladesh and Netherlands. An initial study which was started in 1978 laid emphasis on delta development in the Southwest Region, with three pilot polders in different salinity regimes. However, in 1981 the scope of this study was modified to suit integrated rural development and related to only one polder - Polder 22 in Paikgacha (semi-saline). The programme focussed on appropriate land and water management and on achieving greater participation of the landless and small farmers in the development work.

A second phase of this project was started in 1984 and the development activities were extended to Polder 29. It was intended to further extend this programme to cover other neighbouring polders, but it is learnt that the project has recently been suspended.

2.3.7 BWDB Small Schemes Project

This is a countrywide project of BWDB under the financial assistance from IDA. Engineering and Planning Consultants Ltd in association with Sir William Halcrow & Partners Ltd (UK) and Resources Development Consultants Ltd (Sri Lanka) have been providing consultancy services (feasibility, detail design including construction supervision) from 1985 and it is expected to be completed in 1993.

13 projects were taken up in the Southwest Area for design and implementation, of which eight have been completed. Construction activities are in progress in the remaining five projects. All these 13 projects have been included in the list given in Table 2.1.

2.3.8 Second Bhola Irrigation Project

This BWDB project is an extension of the existing Bhola Irrigation Project Phase-I and would, when implemented, provide irrigation facilities to a further area of about 27,300ha (gross). Code Blizzard Ltd and Bangladesh Engineering and Technological Services Ltd (BETS) were appointed to provide the Consultancy services to examine the technical and economic feasibility for its implementation. A feasibility study, which was started in February 1991, has been completed. It is planned to be taken up for implementation during the period 1992-97.

2.3.9 Early Implementation Project

The Early Implementation Project has been in existence since 1975/76. Under this project, studies, designs and execution of works have been carried out for a number of completely new schemes or for the rehabilitation of certain components of a few existing systems. The activities under this project are carried out by a joint venture between Euroconsult and BWDB under the Technical Assistance from the Government of the Netherlands. In all, this project has been associated with about 40 FCD/I schemes in the Southwest Area of which 12 are relating to the Coastal Embankment Polders. These 40 schemes are included in the list in Table 2.1.

2.3.10 Flood Action Plan Component 9A

This component of the Flood Action Plan relates to the studies carried out for providing protective measures for selected districts or medium sized towns that are prone to erosion and inundation. Six secondary towns (Khulna, Kurigram, Panchagarh, Moulvibazar, Habiganj and Dinajpur) have been selected, of which only Khulna town falls within the Southwest Area. Feasibility studies and designs were carried out by Sir William Halcrow & Partners Ltd in association with Engineering & Planning Consultants Ltd under a financial assistance from the Asian Development Bank (ADB). The studies/designs were executed during the period May 1991 to March 1992.

2.3.11 Flood Action Plan Components 12 and 13

Flood Action Plan components 12 and 13 relate to the agricultural study and the operation and maintenance study respectively that were carried out for selected FCD/I projects by Hunting Technical Services Ltd (UK) in association with Sanyu Consultant Inc., Japan, Technoconsult International Ltd (Bangladesh) and Bangladesh Institute of Development Studies (BIDS) under the financial assistances from the British Overseas Development Administration (ODA) and Japan International Co-operation Agency (JICA) from January 1991 to February 1992. The main objectives of the two studies were to assess the impact of these existing projects on the expected beneficiaries by the Project Impact Evaluation (PIE) and Rapid Rural Appraisal (RRA) methods and the performance of O & M activities. Of the selected 17 projects, only four are located in the Southwest Area (Kolabashukhali Project, CEP Polder 17/2 in Khulna, Sakunia BDS in Faridpur and Sonamukhi Bonmander in Jessore O & M divisions).

2.3.12 Flood Action Plan Component 20

The overall objective of the study under this FAP 20 component is to establish guidelines for compartmentalisation and for setting up appropriate water management systems for the integrated development of the protected areas (sub-compartments). The guidelines would include criteria and principles that relate to the project planning design, implementation, operation and maintenance activities.

Furthermore, these guidelines are expected to cover such aspects as coordination between officials of BWDB and the concerned local government agencies, and between the agencies and the beneficiaries during the above activities. Essentially, the study is intended to test the compartmentalisation and water management concepts in the field under real operating conditions, addressing all relevant issues such as sociological, institutional and environmental aspects.

2.3.13 Flood Action Plan Component 23

The objective of the Flood Proofing Study (FAP-23) is to identify and implement effective measures for improving social welfare in flood prone areas for which flood protection is not technically or economically feasible. These measures are intended to reduce or mitigate the adverse effects of flooding on the social and economic activities of communities, and in particular to avoid loss of human lives, in areas that flood frequently.

The measures may include structural and non-structural (Flood warning) components.

2.4 Overview of the Status of Existing Projects

Though most of these projects were completed during the 1960s and 1970s, the expected increase in agricultural productivity is yet to be realised. The productivity of some of the polders particularly those close to Khulna and Satkhira has started declining after showing some initial increases. In general, there is a lack of any integrated approach for water management within FCD/I projects. The Barisal Irrigation Project (irrigable area, about 72,000 ha out of a total NCA of about 110,000 ha), which started operation in the early 1980s cannot be considered a success yet as only about 23% of the area is currently under irrigated agriculture, mainly due to socio-economic reasons. The G-K Irrigation Project (irrigable area of about 125,000 ha out of a total net NCA of about 142,000 ha), the first phase of which became operational in the early 1970s, could soon be expected to achieve cost effectiveness in its operation after the completion of the ongoing water management rehabilitation programme. However, considering that the managing authority (BWDB) of the G-K Project was able to collect only about 2% of the pump station operating costs from the farmers during the last financial year, the BWDB might have to reassess its policy on collection of water rates in order to ensure that the Project generates its operation fund from within.

According to the Consultants' estimate based on CIDA field survey data (1991) and the Consultants' own data collection (1992), about 16% of the net cultivable area in the Southwest Area is currently irrigated by tubewells and LLPs. These minor irrigation facilities have been established by some rich local farmers or by entrepreneurs as private investments for the sole purpose of generating profits for themselves.

An estimate of minor irrigation utilisation in the southwest Area in the years 1984/85 (MPO data) and 1991 (CIDA data) is as follows :

Year	Area (km^2) Under Minor Irrigation			
	LLP	STW	DTW	Total
1984/85	975	73	468	2175
1991	1127	2087	523	3737

(Note : STW also includes deep seated shallow tubewell)

A comparison of the above data shows that there has been a fairly substantial increase in irrigated areas during the period 1985-91, particularly under the STW mode. However, assessments of the capital and operating costs (Tk/ha) for the three modes show that the LLP mode entails the least capital and operating costs while the STW mode the highest. The following reasons may be attributed to the relatively large increase in the STW mode inspite of its high costs :

(a) Limitation and the lack of dependability of available surface water sources.

(b) Available LLPs are generally of about 57 l/sec (2 cusecs) capacity, while STWs are of about 14 l/sec and command proportionately ¼ the area. Irrigation operators find it more convenient to get together farmers in smaller groups and therefore have preference for the STW mode.

(c) The high capital cost of DTW

The actual losers are the farmers, who in the end pay the exorbitant irrigation charges levied by the irrigation operators.

One of the most striking aspects of the FCD/I projects is the lack of any preventive or routine maintenance programmes. Only the most urgent remedial maintenance works are carried out generally after the advent of disasters. Also, the farmers' participation in the maintenance work has been minimal. Another short-coming of these projects is the under-utilisation of the pumps associated with minor irrigation: on an average, each pump operates only for about 10 hours per day during the peak water demand periods.

2.5 Post Project Evaluation

The Consultants are not aware of the existence of any institutional arrangement within the Ministry of Irrigation, Water Development and Flood Control for a systematic evaluation of the existing FCD/I projects of BWDB. However as stated in Section 2.3 .11 above, limited socio-economic related impact studies have been carried out for some projects on a piece-meal basis by certain local university departments, institutes and consultants at the request of the Ministry/BWDB or the concerned donor agency.

In order to ensure that the Government has reliable and consistent information about the successes of the different types of projects located under varying agro-ecological settings on which to base its policy decisions, the Ministry/BWDB should set up a methodology for the systematic evaluation of the existing FCD/I projects. The evaluation should cover a selected number of projects and possibly address the following:

a) the technical sustainability of the various project components;

b) the economic and financial sustainability (internal rate of return, benefit distribution, etc);

c) employment generation, utilisation of the created facilities by the targeted population, etc. and

d) the trend and impact of privatisation of the facilities (irrigation, etc).

It will be necessary to carry out a regular evaluation, at least at 5 year interval, of the selected projects in order to have a greater understanding of the technological/ sociological interrelationships between the projects and the associated localised hydro-morphological processes/the participating people. A correct understanding of these different impacts would not only lead to making effective improvements to existing projects, but evolve improved design/implementation concepts for the future new projects.

2.6 Conclusions

Some useful lessons could be learnt from a comparative assessment of the potentials and achievements of the existing projects:

- Flood control and drainage by themselves would not have the necessary long term impact on agricultural production; there is an important complementary role for irrigation, especially during the dry season;

- An integrated development approach, including appropriate internal water management, is a pre-requisite for project sustainability;

- An adequate and appropriate institutional framework is a necessity for the operation/maintenance of FCD/I projects on a self-sustaining basis with effective local/beneficiary participation;

- Each project should implement its own cost recovery programme in order to fund its O&M activities.

3 REVIEW OF BWDB DESIGN, CONSTRUCTION AND O&M PRACTICES

3.1 General

The main objectives of the existing BWDB projects, except the Ganges Kobadak (GK), the Bhola Irrigation, the Barisal Irrigation (BIP) and the Chenchuri Irrigation projects are to provide flood control to areas prone to severe flooding resulting from over spilling of the boundary rivers, (and form some of the inland rivers) and drainage to relieve inundation caused by rainfall/runoff. For the four named projects, the provision of formalised irrigation systems was one of the main objectives. In most of the FCD projects, farmers practice some form of minor irrigation (small scale), either individually or in small groups, utilising groundwater/surface water (STW, DTW, LLP, etc).

Designs for most of these projects were prepared by the relevant design cells of BWDB either directly or in association with consultants appointed for the purpose. For the other projects which were designed independently by consultants BWDB held the responsibility for the final vetting and approval.

Implementation of most of these projects were carried out under the supervision of the engineers attached to the concerned BWDB divisional offices, and funding for these projects were directly channelled through the BWDB system. Some of the flood control embankments however were implemented through the Food for Work Programme but based on the designs supplied by BWDB, and the responsibility for construction supervision was left with BWDB. Also certain reaches of these and other embankments have been built by the concerned local government agencies.

The operation and maintenance (O&M) activities of BWDB have been noted to be very minimal, though they hold direct responsibility for activities.

BWDB maintains a network of field offices (zonal, divisional, etc) for the main purpose of project implementation and their O&M. In the Southwest Area it has a substantial network, starting at the top with the zonal Chief Engineer's Office to the lower Sub-Divisional Engineer's Office. There are separate offices for section officers which are mainly located within the project areas. The Southwest Area, which comprises the Southwest Region and the Southcentral Region, has two Chief Engineer's Offices, Six Superintending Engineer's (Circles) Offices, 23 Executive Engineer's (Divisional) Offices and over 50 Sub-Divisional Engineer's Offices (Table 3.1).

3.2 Review of Current Design Procedures

3.2.1 General

BWDB has executed more than 140 FCD and FCD/I projects in the Southwest Area of greatly varying sizes since 1960. The designs for the existing projects have generally been based on a set of basic criteria, but modified for some projects to suit certain local conditions and requirements.

The main criteria which are presently adopted for the design of embankments, drains, canals, and regulators have been reviewed. A summary of the findings is presented here.

TABLE 3.1

BWDB Field Divisions under Southwest Area

ZONE	CIRCLE UNDER	DIVISION
1 Chief Engineer South Western Zone Faridpur	1 Superintending Engineer Faridpur O&M Circle	1 Executive Engineer Faridpur O&M Division 2 Executive Engineer Rajbari O&M Division 3 Executive Engineer Gopalganj O&M Division
	2 Project Director G.K Irrigation Project Kushtia	1 Executive Engineer Kushtia O&M Division 2 Executive Engineer Amla O&M Division 3 Executive Engineer Chuadanga O&M Division 4 Executive Engineer Jhinaidah O&M Division 5 Executive Engineer Sailkupa O&M Division 6 Executive Engineer Pump House Division
	3 Superintending Engineer Khulna O&M Circle	1 Executive Engineer Khulna O&M Division-1 2 Executive Engineer Khulna O&M Division-2 3 Executive Engineer Bagerhat O&M Division 4 Executive Engineer Jessore O&M Division 5 Executive Engineer Satkhira O&M Division-1 6 Executive Engineer Satkhira O&M Division-2
2 Chief Engineer Barisal Project-3	1 Superintending Engineer BIP & Satla-Bagda Circle	1 Executive Engineer Barisal WD Division (Satla-Bagda) 2 Executive Engineer Jalakati WD Division
	2 Superintending Engineer Barisal O&M Circle	1 Executive Engineer Barisal O&M Division 2 Executive Engineer Mech. (BADC/BIP) 3 Executive Engineer Patuakhali O&M Division 4 Executive Engineer Barguna O&M Division
	3 Superintending Engineer Bhola WD Circle	1 Executive Engineer Bhola WD Division-1 2 Executive Engineer Bhola WD Division-2

Source : BWDB

3.2.2 Flood Control Embankment

Three types of flood control embankments have been used in BWDB projects. These are:

(i) Sea dykes or coastal embankments,
(ii) Interior embankments and
(iii) Marginal embankments or dykes.

Sea dykes or coastal embankments have been built since 1961 under the Coastal Embankment Project (CEP), generally along the coastal belt and the banks of the major coastal rivers to protect lands in the southern parts of the country against flooding due to saline tidal surges. Consequently special design considerations such as higher freeboard and flatter side slope on the water side, etc. have been normally adopted. In the early stages of implementation of the coastal embankments, crest elevations were determined on the basis of the recorded maximum normal high tide levels. Known tidal surge levels (due to cyclonic action) were excluded. Presently with the availability of tidal data for longer periods, the crest levels are determined on the basis of high water levels having a 1 in 20 year return period.

Interior embankments have been built mainly along the major rivers such as Padma, Gorai, Madhumati, Nabaganga, etc. in the interior parts of the country to protect lands against river flooding. The marginal embankments or dykes have been built normally along the minor rivers and creeks or for compartmentalisation of any poldered area where velocity of water flow and wave action are mild. The design criteria adopted for the interior and marginal embankments are generally different from that for the coastal embankments.

For the Small Schemes Project a maximum water level of 1 in 10 year return period was considered as the design flood level. Subsequently in 1986 for the Third Flood Control and Drainage Project a maximum water level of 1 in 20 year return period has been taken as the design flood level. The crest levels have been set by adding a suitable free board to the design flood levels.

The design criteria that have been presently followed for the above three types of flood embankments are tabulated in Table 3.2.

The design criteria adopted in the BWDB existing and on-going FCD projects have been found to be generally in conformity with the recommendations of the USBR for Small Earth Dams.

However noting that many of the embankments are currently being constructed without any compaction (only allowing for natural consolidation), during the design a 20% increase in height for the embankment has been generally adopted in order to accommodate the expected natural consolidation and also the foundation settlement.

TABLE 3.2

Flood Embankment - Design Criteria

Design Parameters	Coastal Embankment	Interior Embankment	Marginal Embankment
Design flood level	1:20 year event for Agricultural land protection	1:20 year event for Agricultural land protection 1:100 year event for human life protection	1:20 year event for Agricultural land protection
Free board	1.5 m	0.9 m - 1.20m	0.6 m
Crest width	4.3 m	4.3 m	2.5 m
Side slopes - Country side - River/water side	 1V:2H 1V:7H	 1V:2H 1V:3H	 1V:1.5H 1V:2H
Set back distance	76 m	53 m	38 m
Minimum distance between the edge of the borrowpit on the riverside and tow of the embankment.	6 m	6 m	6 m
Borrowpit depth	1.5m	1.5m	1.5m
Borrowpit side slope	1V:1H	1V:1H	1V:1H
Method of compaction	Manual	Manual	Manual

3.2.3 Drains and Outfall Structures

For the design of drainage channels and outfall regulators the hydrological criteria and parameters given in Tables 3.3 and 3.4 have been generally used.

The bed slopes of drainage channels have been generally set considering the above parameters as well as the natural ground slopes.

It appears from the above design criteria for both drainage channel and outfall regulator that the intention is to quickly direct the rainfall runoff towards the outfall structure. This might result in having relatively large flood depths in the vicinity of the structure, while some areas in the upper reaches are flood free. This situation could cause a reduction in agricultural production in the flooded as well as in the flood-free areas.

It would be advantageous to the farmers if the flooding could be spread over a much larger area, but restricting the flood depth to a maximum of 0.5 m where possible. The design criteria would need to be amended if this concept is to be adopted.

TABLE 3.3

Drainage Channels - Design Criteria

Design Drainage Rate	Channel Section	Other Criteria
Average drainage rate computed from a 10 day pre-monsoon maximum rainfall of 1 in 10 year return period or The drainage rate required to limit the submergence to 3 days for a 10 day rainfall of 1 in 5 year return period and to a maximum of 6 days for a similar rainfall of 1 in 10 year return period.	Trapezoidal X - Section with side slope = 1V:1.5H and bed width (b) to depth (d) ratio of b = 3d for $Q < 5m^3/s$ b = 4d for Q = 5 to 10m3/s b = 5d for Q = 10 to $50m^{3/s}$	Manning "n" = 0.035 Permissible velocity : 0.3 m/s - 0.7 m/s

TABLE 3.4

Outfall Regulators - Design Criteria

Vent size and number	Downstream (R/S) stilling basin, cutoff depth and exit gradient.	Upstream (C/S) stilling basin (flushing), cutoff depth and exit gradient
Computed from a routing of a 10 day pre-monsoon maximum rainfall of 1 in 5 year return period in polder and a maximum water level of 1 in 5 year return period in river. The rate of incremental area of inundation for a depth > 300 mm for 3 days is limited to 5% maximum.	Depends on i) maximum drainage discharge and ii) maximum drainage operating head (gate open) computed from a routing of a 10 day pre-monsoon maximum rainfall of 1 in 20 year return period and 1 in 2 year maximum river water levels. iii) maximum countryside static head (gate closed) = 3 m.	Depends on i) maximum flushing discharge and ii) maximum flushing operating head (gate open) computed from a routing of 1 in 5 year river water level and 80% dependable rainfall (1 in 5 year dry) in polder. ii) maximum riverside static head (gate closed).

3.2.4 Irrigation Canal and Structure

The following parameters have been normally adopted for the design of brick lined and earth canals in some of the projects in the study area:

TABLE 3.5

Irrigation Canals - Design Criteria

Design Parameter	Earth Canal	Brick Lined Canal
Manning's "n' value	0.03	0.017
Trapezoidal section with canal side slope	IV:2H	IV:1H
Bed width (b) to depth (d) ratio for maximum flow of 4.9m^3/s	b = 2d - 3d	b = d
Permissible velocity of canal flow	0.30m/s - 0.60m/s	0.30m/s - 0.70m/s
Canal freeboard	0.4m - 0.6m	0.4m - 0.6m

The size and number of vents of flushing regulator used for irrigation have been determined generally depending on the maximum flushing discharge (QF) computed from 1 in 5 year maximum river level and 80% dependable rainfall (1 in 5 year dry) in polder. The head difference (HL) across the sluice and 1.2 times the design flushing discharge (QF) computed from the above criteria has been generally adopted to determine the countryside cutoff depth for a flushing regulator.

3.2.5 Suggested Improvements to Design Concepts

Drainage Rates

Estimation of the drainage rate as per the first criterion in Table 3.3 relates to the catchment runoff, while according to the second criterion it corresponds to the rate of disposal through a drain network (after allowing for the stipulated inundation of some areas). Consequently the drain capacity required to suit the first criterion will be comparatively high. In addition, the first criterion considers a higher rainfall (1 in 10 year return period). Furthermore, the criterion for sizing of the gate openings (ventage) of the outfall regulator in Table 3.4 does not conform to this higher runoff that results from using the first criterion in Table 3.3.

It is therefore recommended that the first criterion (in Table 3.3) for the estimation of drainage rates be not considered in future designs.

Vent Sizing

Introduction of two variables in a routing analysis, where each is required to correspond to a return period of 1 in 5 years, will in fact relate to a combined event having a return period greater than 5 years. Consequently, the analysis will result in a greater vent capacity estimation.

Routing analysis carried out for the Chenchuri Beel FCD Project (Volume 13 : Prefeasibility Study of Selected Projects) and for the polders of the Coastal Embankment Project (Volume 4 : Coastal Studies) showed that in a number of cases the ventages that

were provided are much greater than the actual requirement if a runoff time series from a rainfall series in a particular year that corresponds to a return period of 2 in 5 years and the river stage time series for the same year were used together. The analyses also showed that in some cases the drainage disposal capacity was predominantly dependent on the relative levels of the protected areas and the river stage and that any further increases in ventage after a certain value (different for each case) did not alter the inundation circumstances.

Compartmentalisation

Presently, the needed ventage capacity is determined as the higher value of two estimates: one based on the disposal of the pre-monsoon runoff, and the other based on the post-monsoon disposal of accumulated pre-monsoon and monsoon runoff. This second estimation basis does accept that drainage retention is unavoidable during the monsoon period in areas where river stages are relatively high.

With the probable introduction of the compartmentalisation concept (Volume 13) for providing improved water management through the adoption of controlled drainage, in the future runoff flowrate and cumulative volume) would be greatly reduced. Consequently, smaller outfall regulators would be needed.

Therefore, a new of design criteria would have to be established that takes into account the compartmentalisation concept and the use of hydrological time series.

3.3 Review of Construction Methodology

3.3.1 General

In the past, most of the flood control and drainage (FCD) Projects of BWDB were constructed by local contractors and supervised by the staff of BWDB. The main thrust of the BWDB project implementation was during the period 1965-1980 when the coastal embankment polders were established. Presently, Madhumati-Nabaganga FCDIII project is the biggest construction work of BWDB in the Southwest Area being carried out by contractors. Since 1974-75 many of the FCD projects have been implemented under the Government's Food for Work Programme which generally uses locally available unskilled labour for executing earthworks.

3.3.2 Embankment Construction

Construction Method and Specification

Embankment Construction carried out by contractors incorporate at least manual compaction which provides some stability to the earthwork. Embankments that have been constructed recently under the Food for Work Programme appear uncompacted; however the adopted embankment cross-section and thickness of soil layers relate to an embankment that would be formed in compacted layers. Consequently most embankments constructed under this programme have had major side slips and breaches within a year or two of construction. The annual maintenance requirements have been noted to be comparatively very high.

Generally, earthwork specification to suit heavy mechanical compaction adopts building of embankments/bunds in layers of 150 mm to 225 mm. Considering that in the Southwest Area compaction of soil layers could be carried out using only light weight equipment (hand operated rollers), it would be advisable to reduce the layer thickness from 225 mm to 150 mm.

Length of Berm and Borrowpit Depth

For the purpose of embankment stability, generally a space (berm) between the river side toe and the edge of borrowpit of 6.0 m is provided to suit a depth of excavation of 1.5 m in the borrowpit. It has been observed at many reaches of existing embankments that adequate space has not been kept during construction, thus endangering the stability of the embankment. Furthermore, in certain reaches where resectioning has been carried out, not only the berm width has been generally reduced, but the borrowpit depth increased. Embankment slips have occurred in many reaches where inadequate berm widths exit.

It is recommended that a minimum of 6.0 m berm width be strictly maintained along the whole length of embankments as per standard BWDB practice.

3.3.3 Construction of Structures

Curing of Concrete

It has been observed at some sites where hydraulic structures were under construction for the on-going FCD projects that concrete curing was not adequately carried out. Inadequate curing produces a concrete of porous material with low strength, and low durability, and have cracks in its surface due to excessive sudden shrinkage. Efforts should be made to ensure that the contractors adopt the correct and adequate curing procedures.

Backfilling of Structure

It has been observed in certain construction sites of on-going projects that adequate compaction of the backfill is not being carried out. In some instances, unspecified material has been used: poor quality excavated material instead of the sand that the BWDB specification requires. Use of poor quality backfill material and its inadequate compaction could be the cause for the damaged structures in some of the existing projects. These damages are generally due to earth subsidence and gully erosion around the structures.

Backfilling is one of the most important items of work in the construction of any structure included in a FCD project, particularly when hydraulic gates are incorporated. Therefore greater emphasis should be placed on the proper and adequate backfilling of structures.

3.3.4 Food For Work Programme

Recently, earthworks associated with construction (or resectioning) of flood control embankments, drains and canals in the Southwest Area have been carried out under the Food for Work Programme. In each designated area a locally nominated body referred to as the Project Implementation Committee (mainly comprising some officials of the Union Councils covering the project location) carries the responsibility for the construction of the earthworks under this programme,with the assistance of BWDB staff for setting out the works on the ground. Compared with the degree of supervisory control BWDB staff has on construction by contractors, the Food for Work Programme have minimal supervision. Also, it should be noted that the officials of the Project Implementation Committees give their services on a voluntary basis and are not responsible to the BWDB. The Project Implementation Committees use the locally available labour force to execute the works.

The Government policy to utilize locally available labour for development activities in an area under the Food for Work Programme is very sound: it has given employment opportunities to many thousands of unemployed/destitute men and women. However, the requirement to achieve high quality work should not be neglected. Most of the earthworks

constructed through the Food for Work Programme, particularly the flood control embankments in the recent past, show lack of appreciation for quality by those in charge of this Programme (Project Implementation Committee).

An inspection of the recently completed works under this programme reveals that very little attention has been given to breaking of clods and compaction of the soil layers in the embankments. Consequently, many of the recently completed embankments are in poor state: side slips and erosion from the crest to the toe are common. These embankments would generally require frequent rehabilitation.

Quality workmanship is a necessity to reduce the excessive annual rehabilitation requirements of flood control embankments. It would be possible to achieve quality workmanship only if the project controlling body has full-time technical staff with relevant qualification and experience to take complete responsibility for effective control and supervision of the works. Each Project Implementation Committee should therefore have at least one paid staff (engineer) with construction experience to take care of quality control of work.

3.3.5 Project Implementation Period

It has been observed that many of the projects in the Southwest Area were not completed within the scheduled period: they have generally taken twice or thrice the allowed time. In most of these cases, the benefits do not start accruing until the construction of the whole project is completed. A preliminary assessment of the economic viability of some of these projects (with extended construction period) on the basis of the year of the start of the initial funding and the delayed commencement of the benefits, shows that these projects would have very low internal rates of return.

It is therefore important that delays in construction should be kept to a bare minimum in order to ensure the economic viability of any project.

3.3.6 Fragmentation of Contracts

The works taken up in the Southwest Area are generally made up of a number of widely scattered sub-projects each of which is sub-divided into a relatively large number of individual (separate) contracts for construction of embankments, drains, canals and hydraulic structures. In view of the fact that a project could have more than a few contracts, a relatively large team would be required to carry out construction supervision for the project.

Most of the sites are in remote places and the construction methods are labour intensive. As there are no engineering testing laboratories available at sites, test samples are seldom collected from the field during execution of works. Consequently, the quality of works is largely dependent on the degree and effectiveness of the site supervision by the field officers. This would require a greater input from the supervision team.

For supervision of construction in the field level the key officers are the Sub-divisional Engineers and the Sectional Officers and if the works are to be properly supervised it is important that they should not be overloaded with work.

Considering the above current practices and procedures of project implementation and the need to have good quality construction, it would be necessary to:

a) provide a bigger team for construction supervision

b) have annual short courses for the training of field staff on construction materials and methodology, testing and quality control of workmanship and contract administration.

c) set up testing laboratories at regional centres (possibly at Faridpur, Barisal, Jhenaidah and Khulna) which could provide the necessary testing facilities for at least earthwork and concrete.

3.4 Review of Operation and Maintenance Practice

3.4.1 General

Preliminary assessment of existing FCD/I schemes in the project area shows inadequacies in the operation and maintenance (O&M) of the flood control and drainage system. The reason generally quoted by the concerned government staff for the poor O&M status is the non-availability of the required funds. Apparently, annual O & M budget allocations to BWDB, the government agency that is responsible for these field activities in addition to project implementation, amounted to only about 30% of what was required for the years 1989-91 and are used mainly for paying staff salaries. Consequently, FCDI systems are deprived of the much needed O&M support and this would eventually lead to not only a severe deterioration of the systems, but also loss of confidence of the beneficiaries on BWDB.

However, an equally important reason for the poor O&M status is that there are no separate offices or staff at divisional level (and lower levels) for project implementation and O&M, and all the available staff at these offices are almost fully committed to project implementation work.

The field assessment has also revealed that the project beneficiaries do not pay any annual charges for the existing facilities; the project in fact does not generate its own funds to meet the cost of any O & M activities.

3.4.2 Related O&M Studies

BWDB have been carrying out the following four major programmes under external aid to study the present status of O&M in various projects and identify suitable measures for improved O&M and cost recovery:

(a) Systems Rehabilitation Project

(b) Second Small Scale Flood Control, Drainage and Irrigation Project

(c) G-K Rehabilitation Project

(d) Early Implementation Project

In addition, LGED has been carrying out similar studies with particular emphasis on participation of thana and other lower level local government institutions (Unions) in promoting these activities. Recently another ADB funded project has been started in the North Central Region to specially address the needed O & M improvement measures.

3.4.3 Constraints to Operation and Maintenance

A preliminary assessment of the existing FCD/I projects in the Southwest Area and a more detailed examination of the Chenchuri Beel FCD Project show that generally the major

constraints for operation and maintenance are the lack of trained O&M staff and necessary funds to meet the requirement. In addition, in some of the existing projects the following constraints have been noted:

- inadequate capacity of some of the drainage structures, particularly due to the prevalence of high river stages outside the embankments;
- social conflicts of different interested groups inside the project, particularly in polder areas, and also influence of the local elites;
- conflicts between farmers on high and low lands and between farmers within the protected area and outside;
- lack of specific and clear demarcation of responsibility among the operational staff;
- lack of adequate coordination between the different government agencies that hold responsibilities for giving specific services/support to the project beneficiaries;
- lack of beneficiary participation;
- theft of fall boards used in water control structures.

3.4.4 Routine and Remedial Maintenance

Routine maintenance is a periodical exercise to keep a system in optimal working condition at all times. The importance of routine maintenance for a system's longevity should not noticeably vary for different systems, whether they are pump stations, water control structures or flood control embankments. considering that routine maintenance needs to be carried out on a regular basis, the related activities should be scheduled in the same manner as that for activities relating to system operation.

Remedial maintenance relates to any repairs to a system after a failure, fault or damage. Its cost could be comparatively very high depending on the extent of the failure/damage. It is generally a one-off failure brought about by a catastrophic event; but failures due to poor design are not uncommon.

Any proposed measures for cost recovery from beneficiaries need to consider the above difference in the two types of maintenance and should not pass the cost of remedial maintenance to the beneficiaries.

4 STATUS OF FC EMBANKMENTS ON THE GANGES-PADMA

4.1 Field Inspection and Survey

The existing flood control embankments on the right bank of the Ganges-Padma traverse a total distance of about 260 km from Ramkrishnapur (near the border with India on the Ganges) to Nandansar at Sariyatpur. The Consultant's team visited and assessed the present status of the embankment. In addition, a longitudinal profile and cross section (at maximum 500 m intervals) survey was carried out through a sub-contract. The results of the survey are tabulated in Table 4.1 and shown in Figures 4.1, 4.2 and 4.3.

A comparison of existing crest levels with those required to meet the design based on a 1 in 100 year flood flow levels is given in Table 4.2. The longitudinal profile in Figure 4.2 also shows the design profile relating to the 1 in 100 year flow.

4.2 Ganges-Padma Embankments

Ganges Embankment

The survey of the existing 144 km of embankment for this project, has shown that it is in a reasonable condition structurally and that its typical cross-sections conform in general to the relevant BWDB design criteria. This is particularly so from km 0 at Ramkrishnapur to km 45, although some sections in this area were only completed in 1991. However, it is damaged and requires repair between km 0 and 3.5 and, near the Bheramara pump house (km 47) where it forms the road, it is low and should be raised if the flooding seen in 1987 is not to be repeated. It is damaged at km 59 and is at a low level east of the Gorai mouth, where it was inundated and damaged in 1987 and the sections will have to be rebuilt and/or raised. There was flooding in the region of km 107 to 117 in 1987, but the embankment appears to be in good condition and the flooding may relate to the operation of the sluices. Many areas of embankment still do not satisfy the design criteria of a 1 in 100 year return period flood and will, therefore, have to be raised.

Padma Embankment West of Arial khan

Flood control measures are present along the whole of the right bank of the Padma from Rajbari to Nandansar (Sariyatpur), a length of about 120 km (Figure 3.1). From km 144 to km 188 (up to Char Bhadrasan), from inspection appears to be in reasonable condition having, like the Ganges embankment, been mainly built or supervised by the BWDB under the Food for Work Programme (FWP), mainly between 1975-80. However, there are a number of areas where it is vulnerable eg at Goalunda Ghat, where the crest level is below the flood design level and between km 169 and 188 where the crest is again low. Also, it was damaged between km 159 and 161 and cut in 1988 at km 177 and 180 in order to allow the passage of flood water and these areas will have to be repaired.

Enquiries show that there was extensive flooding behind km 188 in 1987. The present survey shows that while this section was very vulnerable, it is at present more secure.

Sections of the embankment between km 188 and 211 (the mouth of the Arial Khan) were built in the 1980s, but were piecemeal and sections were damaged by the 1988 flood eg between km 189 to 195. This section of the embankment was therefore largely rebuilt between 1990 and 1992 by the BWDB under the FWP, but still contains a number of gaps to eventually incorporate control structures eg at km 196. Unfortunately, as the cross-sections in this area vary widely and in general the crest elevation is significantly lower than the design level, the embankment is still vulnerable and will have to be upgraded. There was, however, surprisingly little flooding in 1987.

TABLE 4.1
Status of the Existing F.C Embankment along the Ganges-Padma Right Bank

Chainage (Km)	Existing GL m (PWD)	Existing Crest Elevation m (PWD)	Existing (Average) Crest Width (m)	Borrow Pit Location	Adjoining village	Initial Construction Year	Initial Construction by	Comments
0	18.05	21.81	3.50	R/S	C/S	1982	BWDB	1 to 4.5 km 0 to 3.0 km erodd
5	17.69	19.32	3.00	R/S	C/S	1991	FWP (CARE)	
10	18.94	19.09	4.50	--	C/S	1989	"	
15	17.30	18.30	4.80	--	C/S	1975, 1990	"	
20	16.92	18.56	6.00	--	C/S	1965	BWDB	
25	14.27	17.92	6.00	--	--	1965	"	
30	14.54	17.88	4.80	--	--	1915	Railway	32.3 km to 33. 6 km
35	15.80	17.29	3.50	--	R/S	1975	BWDB	
40	14.65	17.30	6.50	--	--	1915	Railway	40.2 km to 45.0 km
45	15.66	19.26	6.30	--	R/S & C/S	?	R & HD	
50	12.81	15.15		--	--			
50	12.81	15.15	4.00	--	C/S	1982	FFW (CARE)	
55	13.62	16.00	4.00	--	C/S	1982	"	58.5 to 59.0 eroded
60	14.29	15.67	3.00			1982	BWDB	
62.5		15.86	4.00	--	--	--	BWDB	
63.5		14.89		--	C/S	?	BWDB	66.0 to 72.5 Eroded
70	11.98	14.04	4.00	--	R/S & C/S	1975	BWDB	
75	11.85	13.93	4.00	--	R/S	1974	BWDB	
80	11.29	12.79	5.00	--	R/S	1974	BWDB	
85	12.07	14.77	5.00	--	--	1974	BWDB	
90	11.68	13.03	4.80	--	R/S	1975	"	
95	10.55	12.95		--	--	--	"	
95	10.55	12.95	5.80	--	R/S	?	LGED	

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TABLE 4.1 (Contd.)

Status of the Existing F.C Embankment along the Ganges-Padma Right Bank

Chainage (Km)	Existing GL m (PWD)	Existing Crest Elevation m (PWD)	Existing (Average) Crest Width (m)	Borrow Pit Location	Adjoining village	Initial Construction Year	Initial Construction by	Comments
100	9.99	12.35	6.00	--	--	1986	LGED	100.5 km to 107.5 km
105	9.88	12.99	4.30	R/S	--	1979	BWDB (FFW)	107.5 km to 110.0 km
110	9.04	12.42	4.60	R/S	--	1980	"	
115	8.04	12.54	4.00	R/S	--	1979	"	
120	1086.00	12.64	4.10	R/S	--	1980	"	
125	9.65	12.06	4.50	R/S	--	1982	"	
130	8.77	12.23	4.80	R/S	--	1981	"	132.2 km to 134.3 km 134.3 km to 135.5 km
135	9.01	11.98	4.30	R/S	--	1981 1980	"	
140	8.84	11.02	4.30	R/S	--	1979 1978	BWDB (FFW)	
145	7.91	10.76	5.80	--	--		"	
145	8.92	10.76	4.00	R/S	--	1978 1989	LGED	145.1 to 147.5 (Road) H.B. B 147.5 to 148.5 (Road) H.B. B
150	8.92	11.49	4.60	R/S	--	1960	R & HD	148.40 to 149.80 (Concrete Toad R & HD)
153.5	8.86	12.57	4.30	R/S	--	1960 1979	BWDB BWDB	149.8 to 159.0 154.0 to 158.5
155	8.31	11.55		R/S	--	1980	BWDB	158.5 to 161.0 (erroed)
160	7.21	10.44	4.40	R/S	--	1980 1990	BWDB BWDB	161.0 to 163.9 163.9 to 164.1
165	6.92	10.77	5.00	R/S	--	1980 1982	BWDB (FFW)	164.1 to 167.9 167.9 to 176.3 (Road) H.B.B
170	6.63	9.88	5.10	R/S	--	1979 1978	LGED BWDB	171.3 TO 173.9 173.9 TO 176.9
175	6.27	9.21	3.90	R/S	--	1978	BWDB	176.9 to 176.9 Public cut during flood in 1988
180	6.65	8.87	4.20	R/S	--	1978	BWDB	180.1 to 180.3 (Public cut 1988 flood
185	7.21	9.63	4.00	R/S	C/S	1978	BWDB	
190	7.19	8.37	4.00	--	--	1979 1992	BWDB BWDB	187.1 to 189.6 (1988 flood)
190	7.19	8.37	4.00	R/S	C/S	1990	BWDB	

[vp\vol8\tab4-1a]

TABLE 4.1 (Continued)
Status of the Existing F.C Embankment along the Ganges-Padma Right Bank

Chainage (Km)	Existing GL m (PWD)	Existing Crest Elevation m (PWD)	Existing (Average) Crest Width (m)	Borrow Pit Location	Adjoining village	Initial Construction		Comments
						Year	by	
195	5.34	8.39	4.00	R/S & CS	--	1990	BWDB	195.4 to 197.9 (No Embankment)
198		8.68	6.00	R/S & CS	--	1984 1990/92	BADB LGED	197.9 to 199.0
200	0.93	7.74	4.20	R/S & CS	--	1990	BADB	202.8 to 211.0 eroded
205	6.07	8.34		R/S & CS	--	1990	BWDB (FFW)	
205	6.07	8.34	6.00					
210	5.58	7.86	7.50	R/S	--			
215	5.79	7.52	7.30	R/S & C/S	--	--	BWDB (FFW)	
220	5.03	6.83	7.10					
220	5.03	6.83	7.60	R/S & C/S	--	1987	LGED	
225	4.43	7.08	6.00	R/S & C/S	--	1984	LGED	
230	5.12	7.22	3.50	R/S & C/S	--	1984	LGED	
235	5.21	6.39	4.40	R/S & C/S	--	1968	LGED	
240	5.19	6.25	4.40	R/S & C/S	--	1984	LGED	
245	5.67	5.72	4.00	R/S & C/S	--	1962	LGED	
250	5.39	6.00	5.10	R/S	--	1986	LGED	
255	3.92	5.00	5.00	R/S	--	1986	LGED	
259	3.11	5.06						

[vp\vol8\tab4-1b]

The remaining 16 km of embankment, down the right bank of the Arial Khan (km 195 to 211), was constructed in the 1970s by the Sibchar Upazila. However, as sections of it have not been completed (km 195 to 197), the areas inland are very vulnerable and the embankment liable to damage, especially as in general, it is low.

Padma Embankment East of Arial Khan

Inspection of the existing embankment sections between km 67 and 119 indicates they are in a reasonable condition although it has been deliberately cut in a number of areas and at km 70, for example, was damaged by the 1988 floods. The various sections of it were constructed between 1984 and 1991 by a variety of Government Agencies, including the BWDB, Roads and Highways and Local Government. It is different from the embankment sections described earlier in that it is also a road and is concreted in a number of areas. Also, it has had to be protected from erosion by gabions and concrete in a number of areas.

TABLE 4.2

Comparison of Existing and Proposed Crest Levels

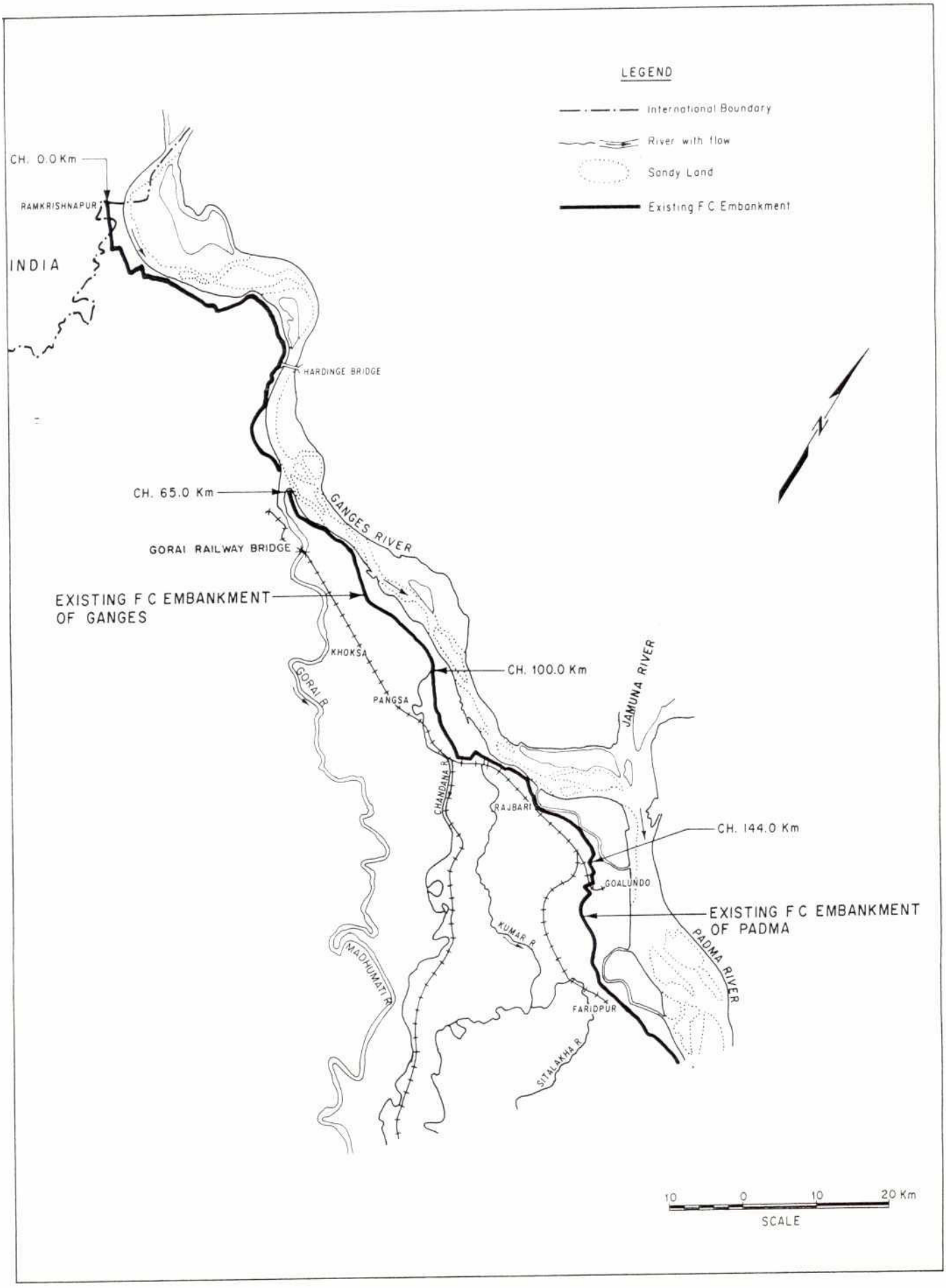
Chainage	Existing GL	Existing Crest Elevation	Proposed Crest Elevation
Km	m (PWD)	m (PWD)	m (PWD)
0	18.05	21.81	19.13
5	17.69	19.32	18.84
10	18.94	19.09	18.56
15	17.30	18.30	18.07
20	16.92	18.56	17.99
25	14.27	17.92	17.70
30	14.54	17.88	17.42
35	15.80	17.29	17.13
40	14.65	17.30	16.84
45	15.66	19.26	16.56
50	12.81	15.15	16.27
50	12.81	15.15	16.27
55	13.62	16.00	15.99
60	14.29	15.67	15.70
62	N/A	15.86	15.56
63	N/A	14.89	15.36
70	11.98	14.04	15.13
75	11.85	13.93	14.84
80	11.29	12.79	14.56
85	12.07	14.77	14.27
90	11.68	13.03	13.99
95	10.55	12.95	13.70
95	10.55	12.95	13.70
100	9.99	12.35	13.42
105	9.88	12.99	13.13
110	9.04	12.42	12.84
115	8.04	12.54	12.56
120	10.86	12.64	12.27
125	9.65	12.06	11.98
130	8.77	12.23	11.70
135	9.01	11.98	11.41
140	8.84	11.02	11.13
145	7.91	10.76	11.00
145	8.92	10.76	11.00
150	8.92	11.49	10.86
153	8.86	12.57	10.77
155	8.31	11.55	10.73
160	7.21	10.44	10.60
165	6.92	10.77	10.46
170	6.63	9.88	10.33
175	6.27	9.21	10.20
180	6.65	8.87	10.06
185	7.21	9.63	9.93
190	7.19	8.37	9.80
190	7.19	8.37	9.80
195	5.34	8.39	9.66
198	N/A	8.68	9.58
200	0.93	7.74	9.53
205	6.07	8.34	9.40
205	6.07	8.34	9.40
210	5.58	7.86	9.13
215	5.79	7.52	8.85
220	5.03	6.83	8.58
220	5.03	6.83	8.58
225	4.43	7.08	8.35
230	5.12	7.22	8.12
235	5.21	6.39	7.89
240	5.19	6.25	7.66
245	5.67	5.72	7.43
250	5.39	6.00	7.20
255	3.92	5.00	6.97
259	3.11	5.06	6.86

Source : Data on existing features based on field survey, while proposed crest elevations are based on flood levels of 1 in 100 year return period.

N/A: Not Available

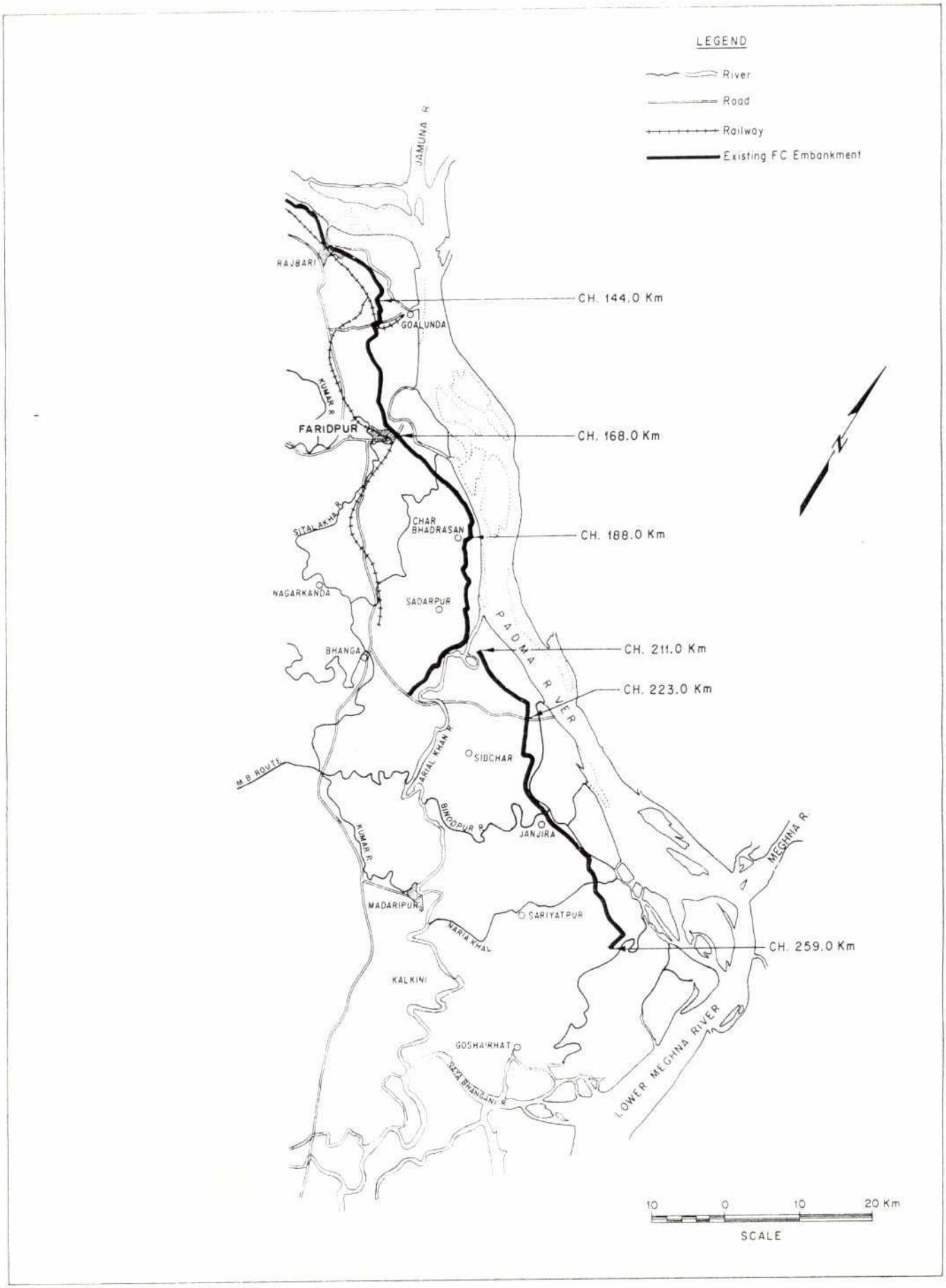
[vp\vol8\tab4-2]

Figure 4.1a



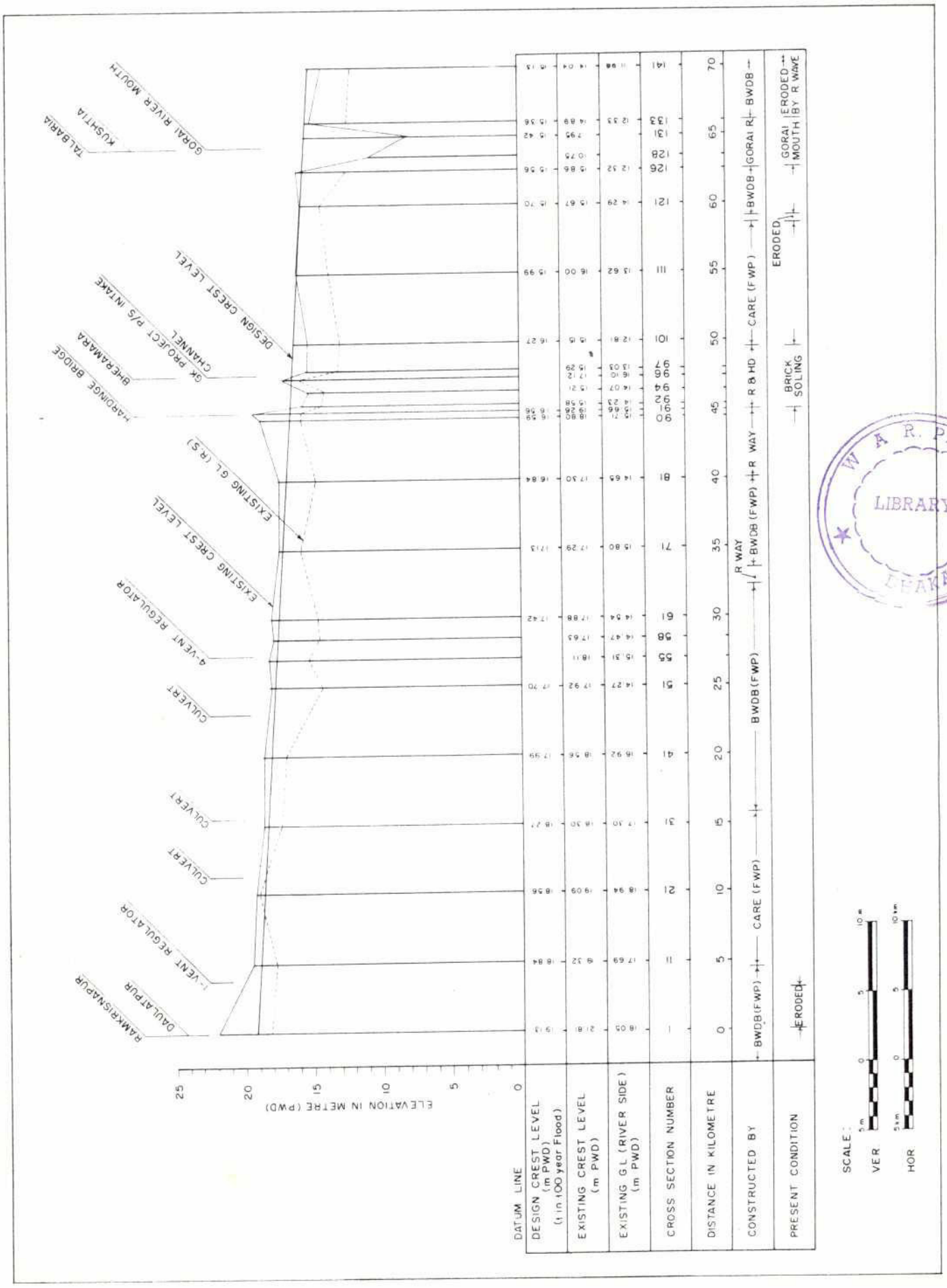
Ganges—Padma : Existing Flood Embankment

Figure 4.1b



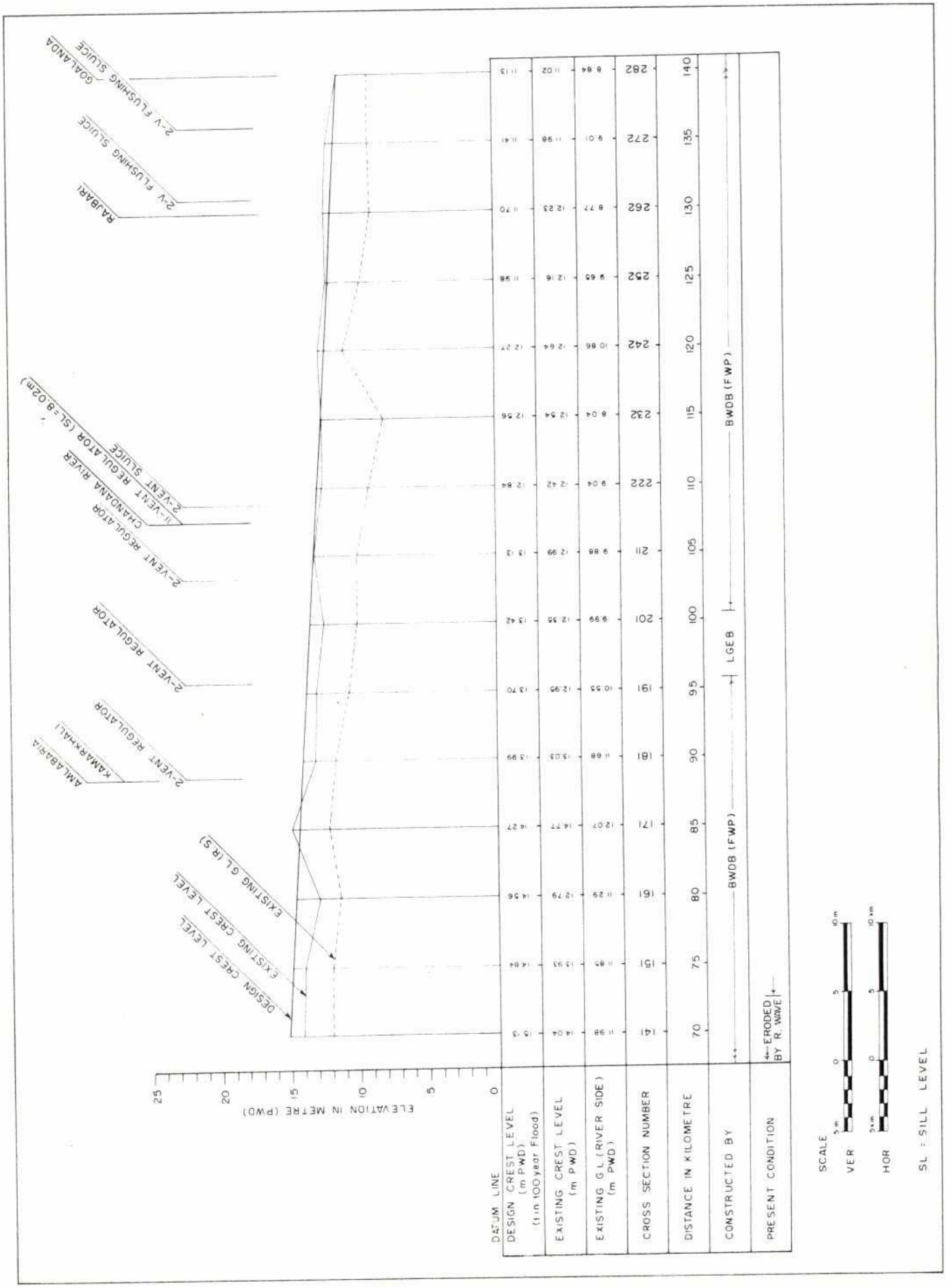
Ganges–Padma : Existing Flood Embankment

Figure 4.2a



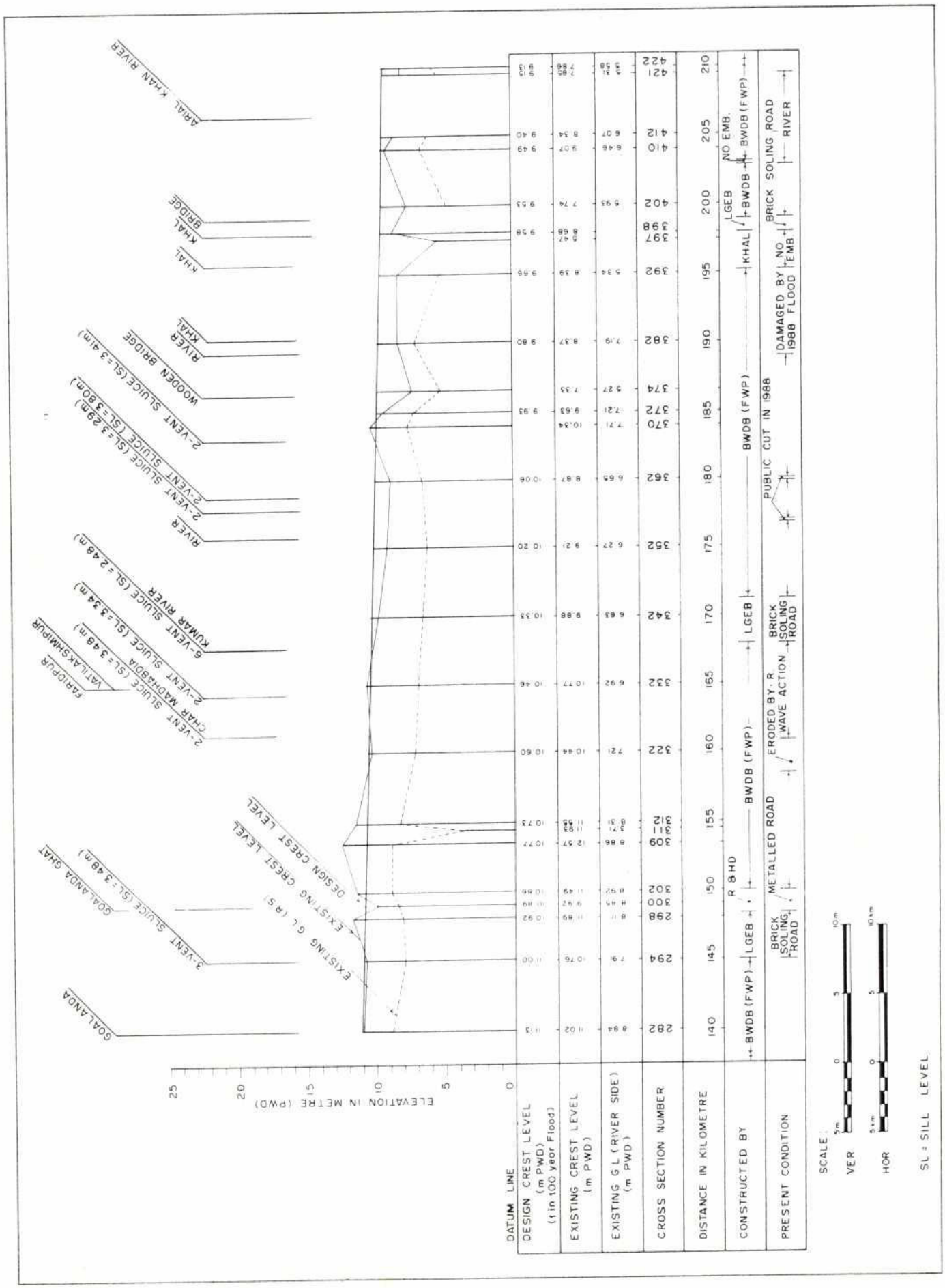
Longitudinal Section of Flood Embankment Along Ganges-Padma

Figure 4.2b



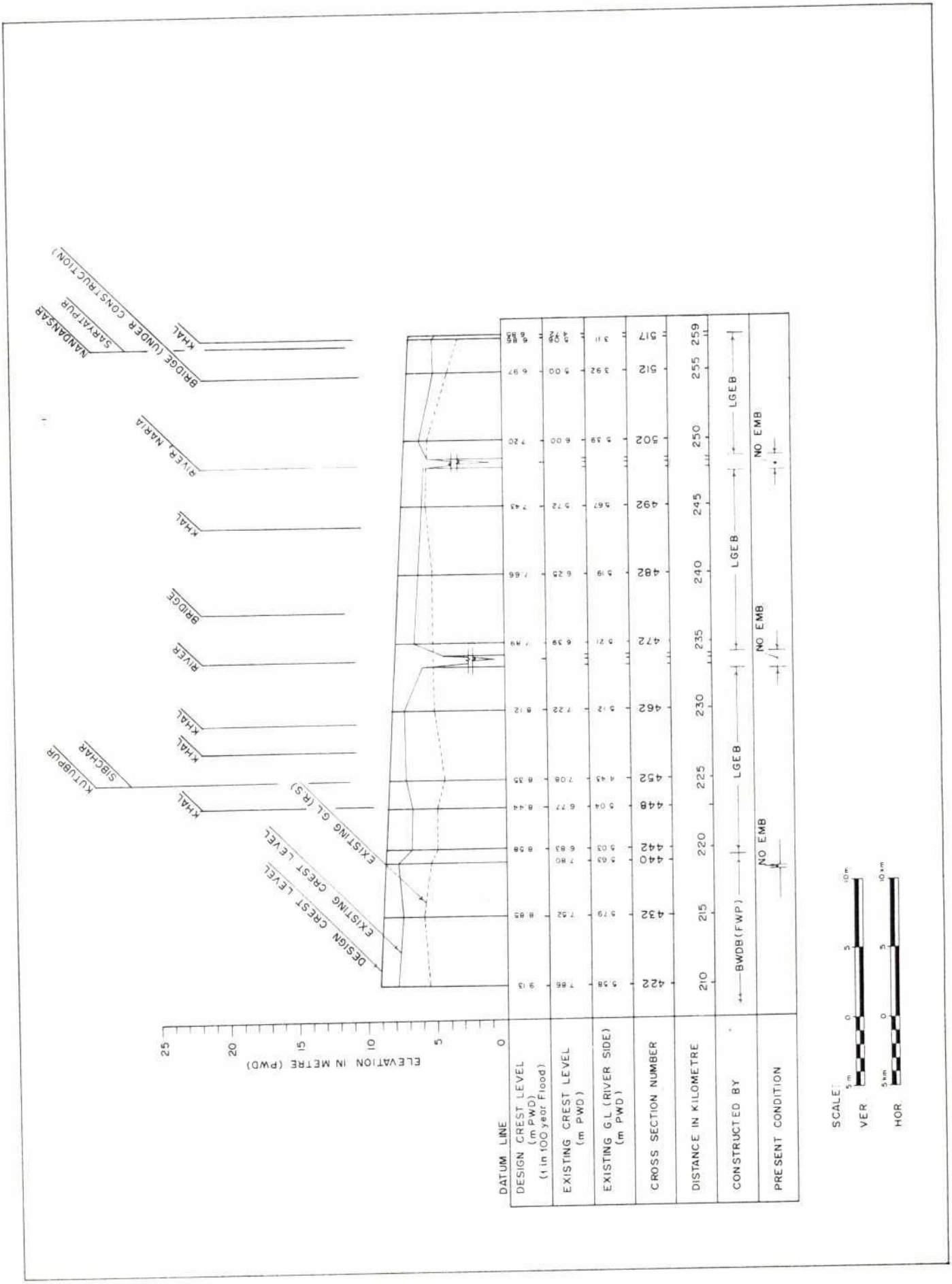
Longitudinal Section of Flood Embankment Along Ganges-Padma

Figure 4.2c



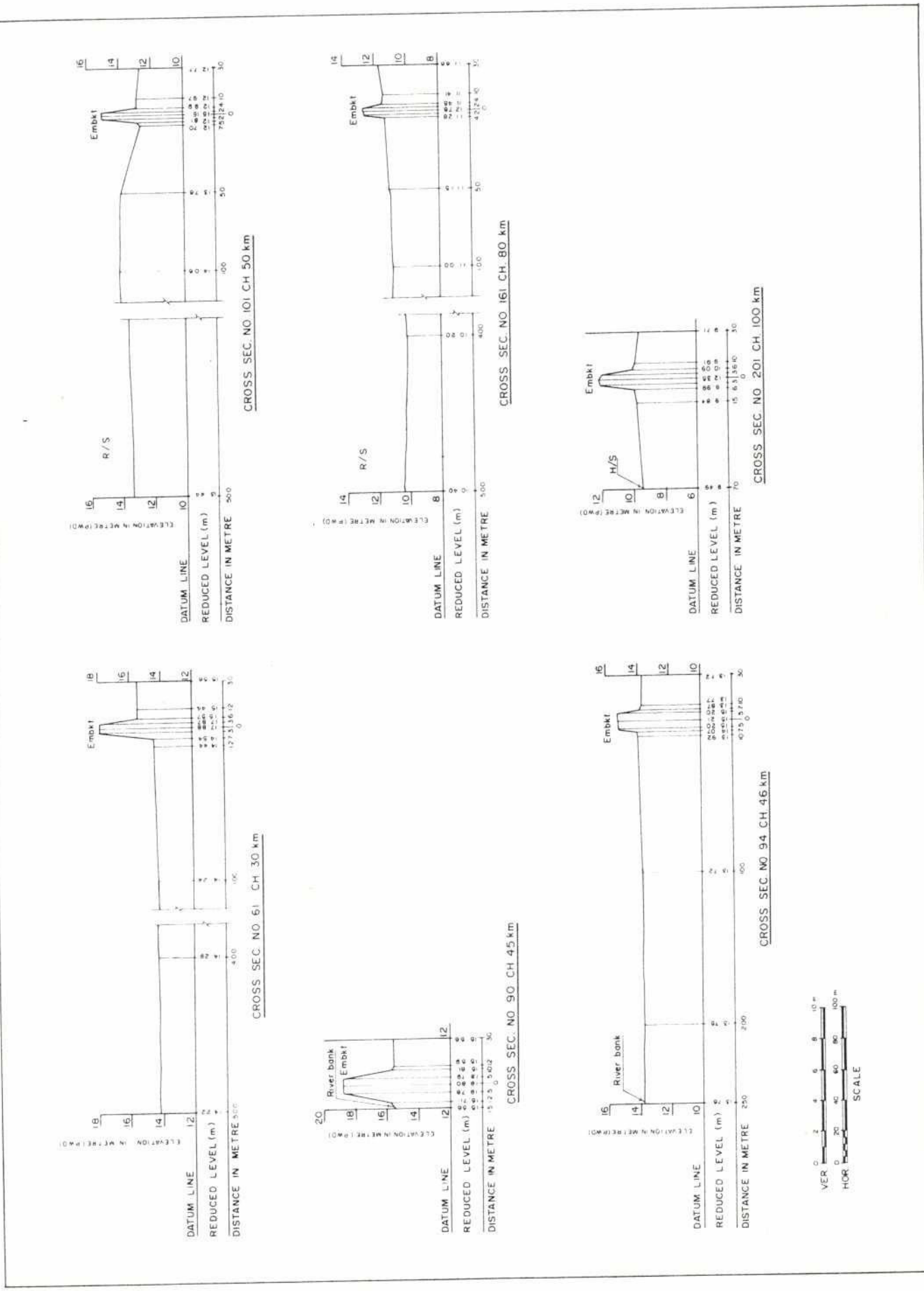
Longitudinal Section of Flood Embankment Along Ganges-Padma

Figure 4.2d



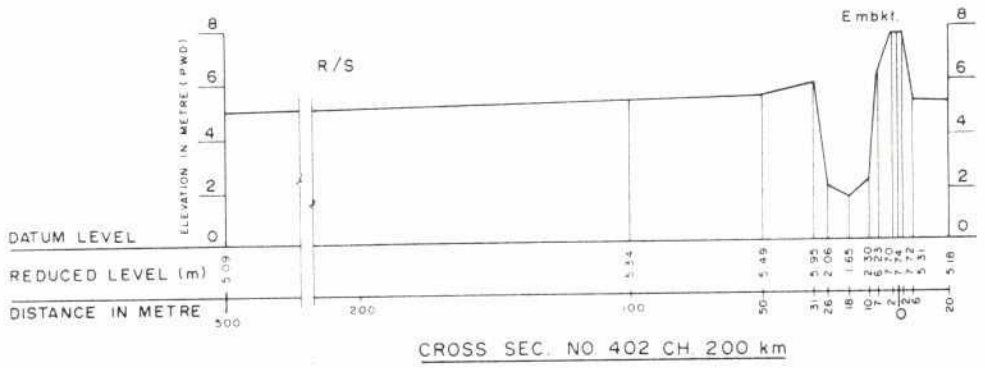
Longitudinal Section of Flood Embankment Along Ganges-Padma

Figure 4.3a

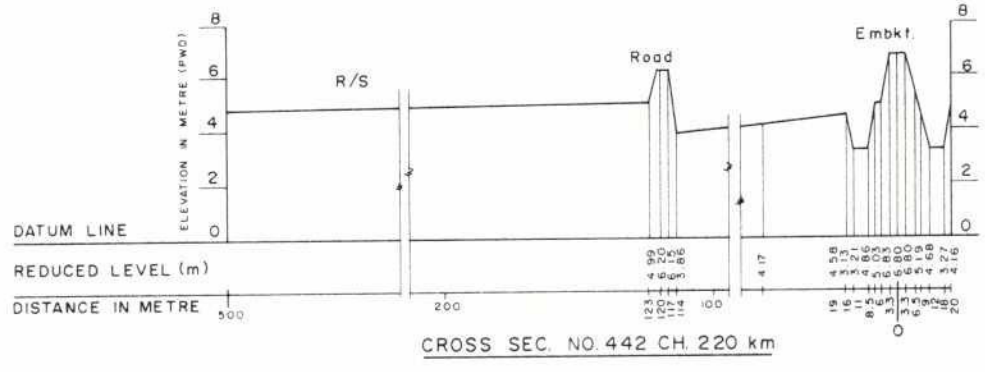


Cross Section of Flood Embankment, Ganges-Padma

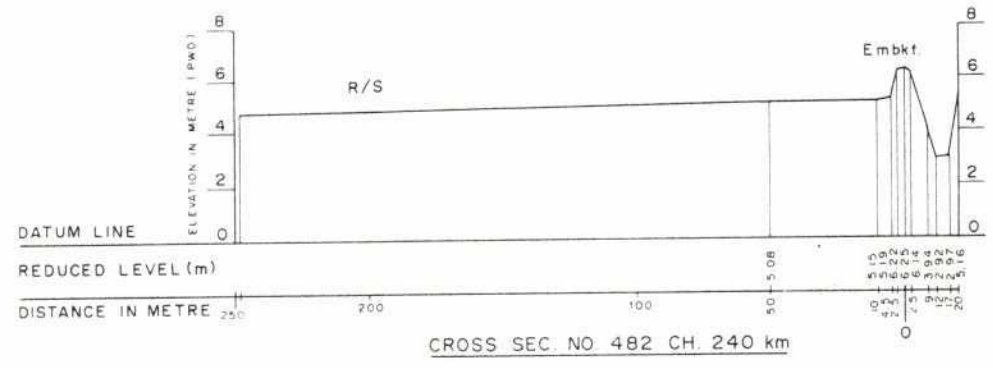
Figure 4.3b



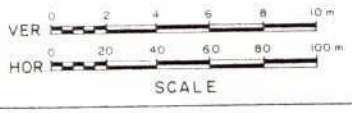
CROSS SEC. NO. 402 CH. 200 km



CROSS SEC. NO. 442 CH. 220 km



CROSS SEC. NO. 482 CH. 240 km



Cross Section of Flood Embankment, Ganges-Padma

5 REVIEW OF SELECTED PROJECTS

5.1 General

Existing FCD/I projects of major significance in view of either their agricultural productive potential or their impact on the hydro-morphological processes of the river network in the Southwest Area are the Ganges-Kobadak Irrigation Project, the Barisal Irrigation Project, Bhola Irrigation Project, Madhumati-Nabaganga (FCD III) Project and about 76 polders of the Coastal Embankment Project (CEP).

The present status and the possible future scenario of the CEP polders are discussed in detail in Volume 4 : Coastal Studies. Similarly, the prevailing situation in the Barisal Irrigation Project is discussed in Volume 13 : Pre-feasibility studies of selected Projects.

In this chapter the status of the Ganges-Kobadak, Bhola Irrigation and the Madhumati-Nabaganga projects are discussed.

5.2 Ganges-Kobadak Irrigation Project

5.2.1 Project Location

The Ganges-Kobadak (G.K) Irrigation Project covers thirteen Thanas namely: Kushtia Sadar, Bheramara, Daulatpur, Mirpur, Kumarkhali, Khoksa, Chuadanga and Alamdanga of Kushtia district; Jhenaidah Sadar, Harinakunda and Sailkupa of Jhenaidah district, and Magura Sadar and Sreepur of Magura district. The gross project area is about 198,000 ha of which about 142,000 ha is cultivable. The net irrigable area is 125,000 ha on the basis of providing only supplementary irrigation for an Aman crop. The project is bounded by the river Padma and the Gorai to the North-East, the Mathabhanga river to the West and the Nabaganga to the South (Figure 5.1). The G.K. Project lies in a flood free zone.

5.2.2 Project objective

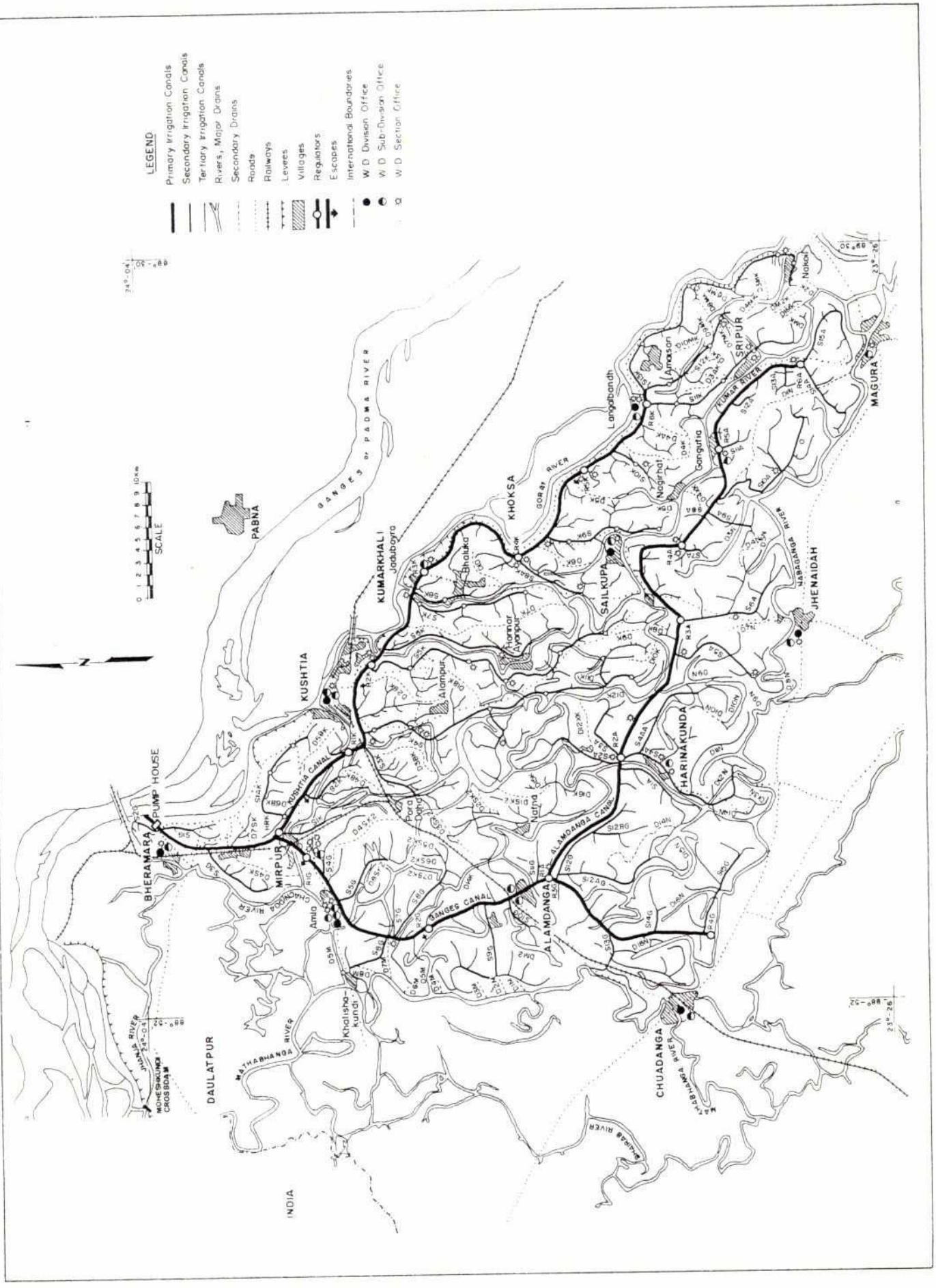
The initial objective of the project was to provide supplementary irrigation facilities to the traditional varieties of crops in the project area, and thereby increase the cropping intensity from 122% to about 200% within the net cultivable area of 142,000 ha. However, it is now intended to raise the cropping intensity to 241%.

5.2.3 Project Implementation

The project was implemented during the period 1955-70 and 1970-83 for the Phase-I and Phase-II respectively based on a comprehensive FAO report in the early stage and feasibility study carried out by Yachie Engineering Company, Japan with the financial assistance from ADB. The Engineering works comprised 39 km of flood embankments, 1251 km of drainage channels/khals, 3551 No. outlet structures, 2188 No. hydraulic structures, 3 main (axial flow) pumps (36.8 m^3/s each), 12 No. subsidiary (mixed flow) pumps (3.54 m^3/s each) and 1655 km of irrigation canals (a summary of the works is given in Table 5.1). The total cost of the project implementation was 738.90 M TK.

The Bangladesh Water Development Board, which initially executed the project, is responsible for its operation and maintenance. Besides, the Bangladesh Agricultural Development Corporation (BADC) arranges the supply of improved seeds and fertilizers and the Bangladesh Rural Development Board (BRDB) helps in the formation of farmers organisation.

Figure 5.1



Ganges-Kobadak Irrigation Project, Phase-I & II

In the meantime, the farmers switched over from low yielding varieties to high yielding ones due to the country's greater demand for food grain.

5.2.4 Subsequent Studies and Project Rehabilitation

Rehabilitation work to increase the capacity of the water delivery system was initiated in 1984 (Phase I) on the basis of a NEDECO studies under the UNDP Technical Assistance. This work funded by ADB is nearing completion at an estimated cost of 1888 M Tk (based on 1983 prices)

In 1988/89 a team of consultants comprising DHV and ACE carried out reconnaissance surveys to identify existing operational practices and made recommendations (incorporating new operational strategies) for adoption after the above rehabilitation work was completed.

A joint study by the Bangladesh Rice Research Institute and the International Irrigation Management Institute involving long term field research was carried out in 1991/92 in selected areas to increase irrigation effectiveness and crop production through improved secondary canals operation.

The current studies relating to the second phase of the Technical Assistance programme, which started in 1991, are conducted by Hydraulic Research Wallingford (UK). The objective of this consultancy services is to establish a sustainable O&M capability through the development of appropriate methods to improve the management of irrigation water (higher efficiencies and better equitable distribution of water). The studies lay emphasis on the formation of water user associations (of farmers) and on cost recovery.

5.2.5 Present Project Status

This project was planned and designed on the basis of a supplementary irrigation concept (to provide irrigation only for an Aman crop covering the main monsoon period), but it is currently utilised to irrigate an additional Aus crop which has a higher water demand. Furthermore, the water requirements of the high yielding varieties presently cropped by the farmers are relatively greater. Consequently, at present only about 80,000 ha is being irrigated during kharif-II season (Mid July to Mid November), while about 38,000 ha. is irrigated during kharif-I season (March to June).

In addition, according to the rehabilitation feasibility study of 1984 the G.K. Project had experienced many problems and set backs such as : delayed completion of the main pumping station; much higher water use per unit area than envisaged; lack of funds to allocate sufficient manpower, equipment and materials for the proper operation and maintenance of the project; and lack of appropriate land and water ordinances vested with BWDB/GK Project to properly enforce the water distribution throughout the area. According to this study, due to the lower productivity and inadequate O & M the average annual net benefit published in Bangladesh Agriculture Sector Review, sponsored by UNDP, 1989 was 26.8 M Tk (1984) and a B/C ratio of 0.6 compared with the pre-project estimate of 1.6.

Though the combined capacity of the existing three main pumps and 12 subsidiary pumps (after carrying out the necessary rehabilitation) might be adequate to increase the irrigated area to 125,000 ha, the electricity supply through the present sub-station is insufficient to operate all the 15 pumps simultaneously.

From the discussion with the G.K. Project officials and also from the Project Director's Report (1992) it is evident that the total demand for power supply is about 14 MW, but only about 9 MW is supplied at present. Construction of a new sub-station was started in

1992 to meet the additional power requirement and is scheduled to be commissioned in late 1993.

5.2.5 Operation and Maintenance Status

The pump houses were designed and constructed at Bheramara in the early 1960's as the first stage of full development of the Ganges including a barrage. At that time the levels in the river were significantly higher as there was less abstraction upstream and in particular the Farakka barrage had not been built. With the low levels in the Ganges that are now being experienced, there are already problems with the operation of the system. Any further significant decrease in level would therefore have serious consequences.

The level at the pump house entrance is determined by the level in the Ganges and the headloss in the approach channel. The headloss could be kept low by keeping the channel to the design cross section. It is also important to ensure that silt settles in the approach channel where it is easily removed rather than in the canal system where disposal is more problematic. The Ganges level at Bheramara is controlled by the hydraulics of the downstream reach. At low flows the Ganges becomes a series of pools and narrows that shift each year. Some years there may be a constriction in the low flow channel near to Bheramara which could result in higher levels for the same flow and other years there is not. This natural variability must be taken into account in the analysis.

Available records show that siltation of the intake channel is very high which causes the project to incure a significant amount of cost each year as there is no scope for flushing. Low water levels of the Ganges has aggravated the overall project condition in recent years.

TABLE 5.1

Project Inventory and Brief Details

Name of the Project (including the name of Thana District)	Ganges-Kobadak irrigation Rehabilitation Project in Thanas Kushtia Sadar, Bheramara, Daulatpur, Mirpur, Kumarkhali, Khoksa, Chuadanga and Jhenaidah Sadar, Harinakunda, and Sailkupa of Jhenaidah district and Magura Sadar and Sripur of Magura district.	
Executing Agency	Bangladesh Water Development Board (BWDB).	
Funding Agency	Asian Development Bank Credit Agreement No. 671 BD(S.F.)	
Year of Commencement	a) Phase-I b) Phase-II c) Rehab.	: 1955 : 1970 : 1984/85
Year of Completion	a) Phase-I b) Phase-II c) Rehab. Original Revised	: 1970 : 1983 : 1989/90 : 1992/93
Project Cost	a) Phase-I&II 738.90 M Tk b) Rehab. phase 1887.97 M Tk	
Background & objectives	The objective of the project was to overcome the acute food problem in the country in 1953 as per a comprehensive FAO report submitted to the then Government of Pakistan.	
Achievement of the targeted objectives	The project could not achieve the targeted benefit due to operational, maintenance and management problems associated with the pump stations and water distributary system.	
Flood Embankments along Rivers Padma and Gorai	Length (km)	= 39
Primary Irrigation Canals	Length (km)	= 193
Secondary Irrigation canals	Length (km)	= 467
Tertiary Irrigation canals	Length (km)	= 995
Drainage Channels/Khals	Length (km)	= 1251
Intake Channel	Length (km)	= 0.921
Main Pump	No of Pumps Avg. capacity (m^3/sec)	= 3 = 36.8
Subsidiary Pump	No of Pumps Avg. capacity (m^3/sec)	= 12 = 3.54
Outlet Structure	No of Structure	= 3551
Inspection Road	Length (km)	= 196
Barrack, & Buildings	No of Barracks & Buildings	= 699
Regulator Gate	No of Gates	= 931

Source : BWDB Project Office

5.3 Bhola Irrigation Project

5.3.1 Project Location and Area

The existing Bhola Irrigation Project (BHIP) is located in Bhola Island which is situated in the Meghna Estuary. The main Shahbazpur channel of the Meghna lies to the east and the Tetulia channel to the west of the Island. Since about the 1970s the island has been protected from the ravages of cyclone damage and saline water by a coastal embankment and drainage sluices under CEP. The Bhola District comprises seven thanas of which six are in the Bhola Island. The existing Bhola Irrigation Project covers three of the six thanas Bhola, Borhanuddin and Lalmohan within the Island. The remaining areas of the Island have recently been considered under a 2nd Bhola Irrigation Project, however its implementation is yet to start. The location of the project area is shown in Figure 5.2.

5.3.2 Project Objective

In the pre-project, the area was subjected to heavy saline water intrusion from the Meghna, which caused damage to crops (53,000 ha). Due to this salinity problem, regular cultivation in this land area was not possible. Moreover, in the winter and dry seasons, cultivation was restricted by undue drought in the project area. Even after the construction of the flood control embankments under CEP, the agricultural production was low as the area was poorly drained by the network of creeks and was subjected to shallow flooding in small parts. These problems were initially mitigated by excavating/re-excavating khals, and reconstructing sluices at convenient outfalls.

The objective of the Irrigation Project was to increase the cropping intensity to 182.39% within the net cultivable area of about 53,000 ha by improving the flood control and drainage measures and by providing irrigation facilities. A Feasibility Study for the second phase of Bhola Irrigation Project was completed by Coode Blizard in association with BETS in 1991.

5.3.3 Project Implementation

The Bhola Irrigation project is designed to improve the project area creeks so that irrigation water supplies may get propagated under the influence of tidal energy which will enable the use of single-stage low lift pumping by groups (co-operatives) of private pump owners.

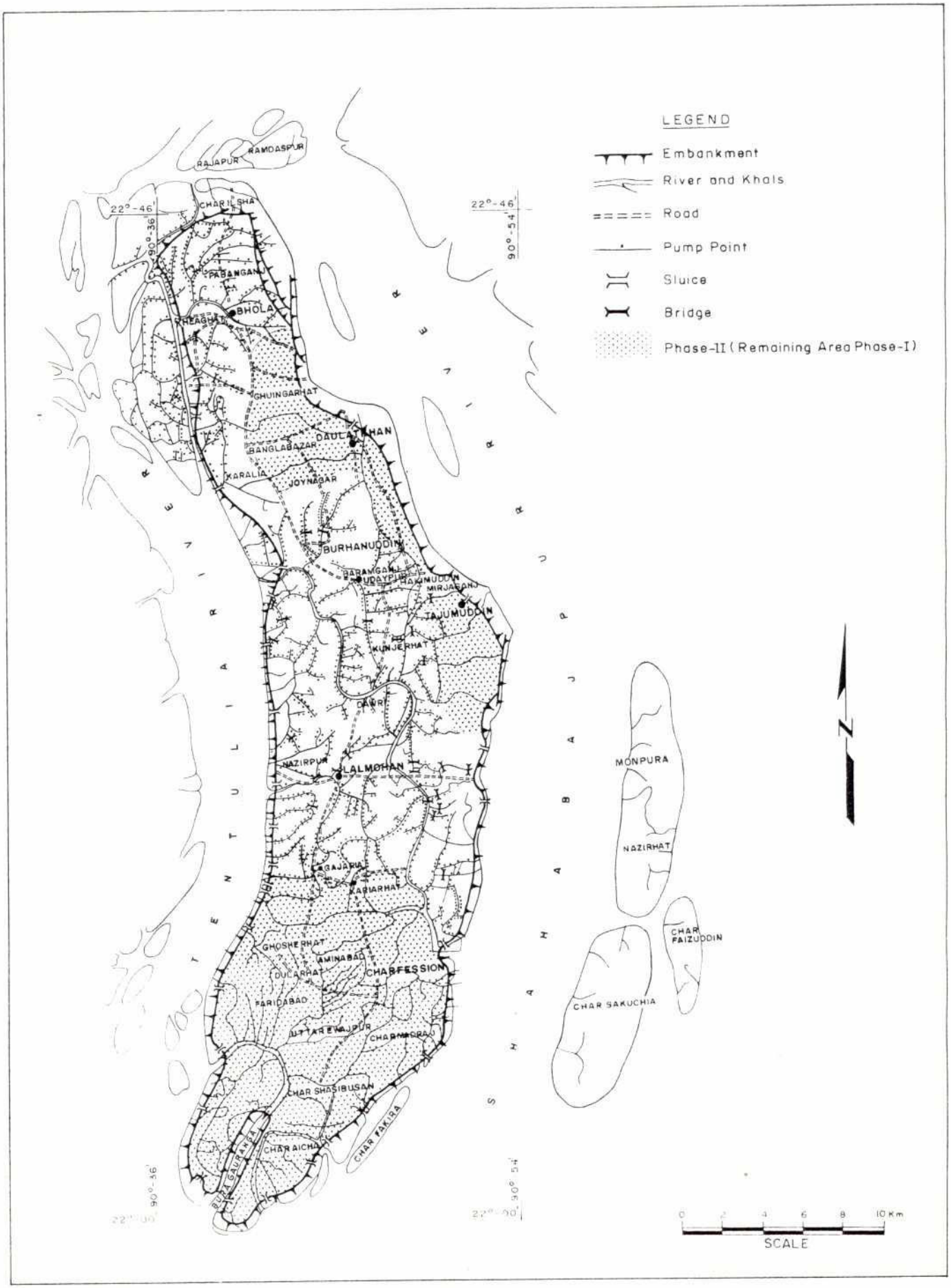
The project was implemented during the period 1983-1991 based on a report of the Mission of the Asian Development Bank (ADB) and FAO Investment Centre and the FAO/IC for feasibility studies and outline designs. The implementation was carried out under a financial assistance from ADB and the European Economic Community (EEC). The engineering works comprised 600 km of drainage channels/khalls excavation/re-excavation, 36.50 km of flood embankments reconstruction, 22 km of flood embankments repairing and 2 No sluices/regulators reconstruction (a summary of the works is given in Table 5.2). The total cost of the project implementation was 630.79 M TK.

5.3.4 Present Project Status and Impact

The following observations could be made on some of the salient features relating to the organizational aspects of BHIP on the basis of available information:

The LLPs are generally owned and operated by individuals who are not farmers. They tend to dictate the pumping schedule and quantities which are, more often than not, generally

Figure 5.2



Bhola Irrigation Project

lower than the farmers' requirements. In addition, the existing irrigation charge rates are considered too high by the farmers. Consequently, the rate of the expansion of command area has been relatively slow. The LLPs are also being used for purposes other than irrigation: notably rice milling, fishing/trawler, etc.

However, according to collected field data about 36% of NCA is under irrigated agriculture incorporating HYV crops and the average annual income of the participating farmers after the project implementation has increased by about 128%. Labour employment has also increased : by 137% for family labour use and 193% for hired labour use.

A preliminary assessment of the social impacts showed that the higher income has positively influenced the farmers to send their children to school which is substantiated by the fact that 60% of the school age children are currently enrolled. Women's role and participation in the project is however minimal. The expansion of irrigation and cultivation of HYV Boro have together increased the demand for fertilizer and pesticide and the small and marginal farmers have to depend on loans/credits for the purchase of these. But the rural credit market in the project area is still excessively dependent on non-institutional sources which charge exorbitant interest rates.

5.3.5 Rehabilitation Requirements

Along the western side at Borhanuddin (Gongapur) and mostly on the eastern side of Bhola, erosion is at its worst form due to Meghna (Shahabazpur channel) flow. As a result, some parts of the project area are prone to deep flooding. This has led to a good number of people becoming landless. These people have taken shelter on slopes of the embankment. In order to prevent this erosion hazard, rehabilitation work for protecting the banks needs to be executed. Already, BWDB have started the implementation of some protective measures.

TABLE 5.2

Project Inventory and Brief Details

Name of the Project (including the name of upazila and district)	Bhola Irrigation Project in the Thana Bhola, Borhanuddin and Lalmohan under Bhola District.
Executing Agency	Bangladesh Water Development Board (BWDB)
Funding Agency	International Development Agency (IDA) and European Economic Community (EEC)
Year of Commencement	1983
Year of Completion	1991
Project Cost	630.79 M TK
Background & objectives	The project area was affected by saline water intrusion and consequently agricultural activity was low. The project was implemented to overcome these problems and increase cropping intensity this project was implemented.
Achievements of the targeted objectives	According to an assessment the implementation stage, the project appears to be moving quickly towards the targeted objective.
Flood embankment along rivers/channels Shahbagpur & Tentulia	Reconstruction Length (km) = 36.50 Repair Length (km) = 22.00 (repair)
Drainage channels/khals	Length (km) = 600 (excavation/ re-excavation)
Drainage regulator/sluice	No of sluices reconstructed = 2
Bridge over creek crossing	No of bridge/culvert = 28
Road	Length (km) = 43

Source : BWDB Project Office

5.4 Madhumati-Nabaganga Sub-project

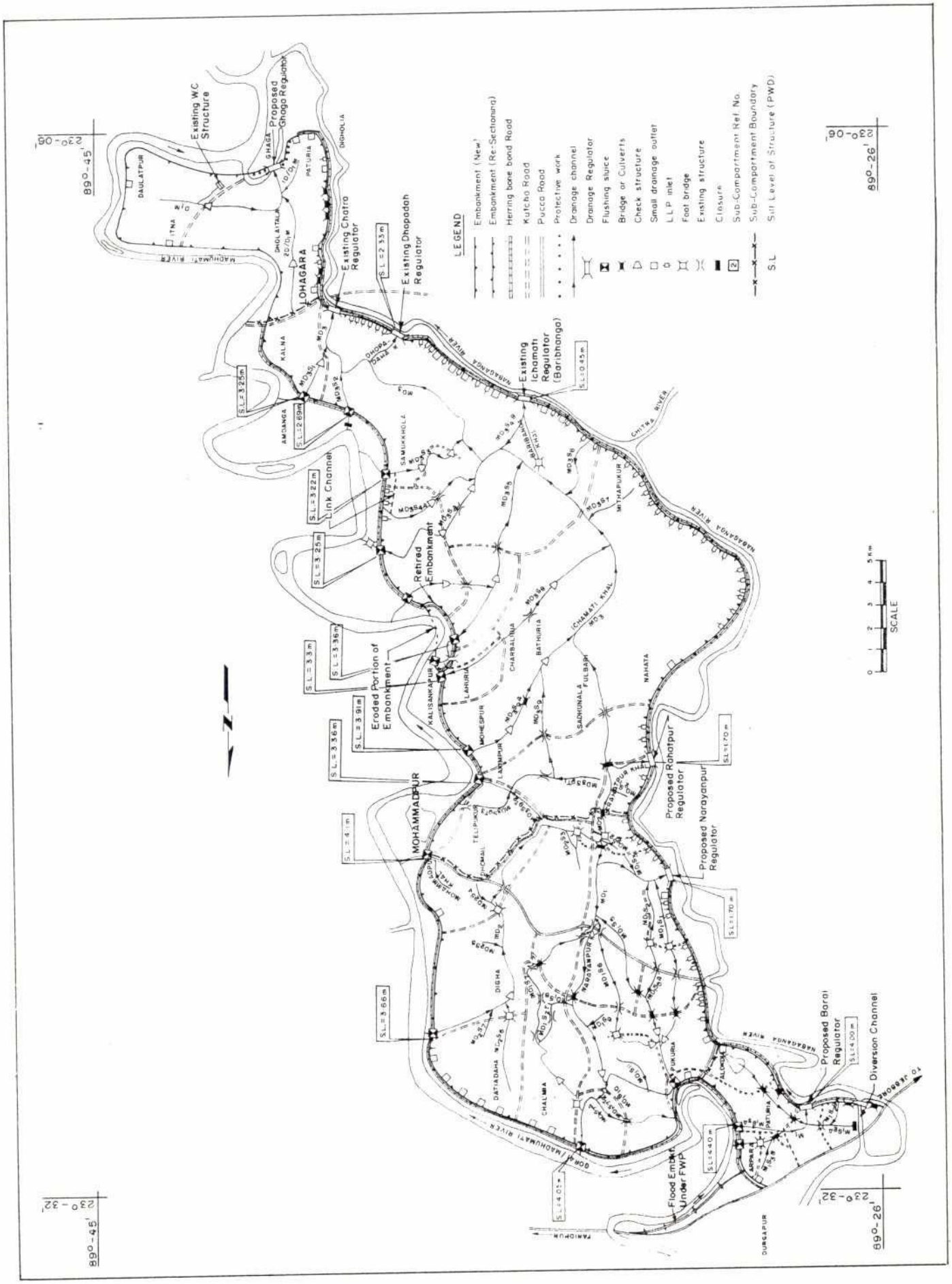
5.4.1 Location and Description

The Madhumati-Nabaganga sub-project, which is a component of the Flood Control and Drainage III Project, is located in Lohagara Upazila in Narail district and Mohammadpur and Magura Upazilas in Magura district. It is bounded by the Gorai-Madhumati river to the east, the Nabaganga river to the west, the Magura-Kamarkhali highway to the north and the Halifax cut to the south. The sub-project covers a gross area of 45000 ha of which 38000 ha is cultivable. It is a flood control and drainage project incorporating irrigation facilities to limited areas, and its implementation has been jointly funded by the government and IDA. The project layout is given in Figure 5.1 which shows the alignments/locations of the major development works.

5.4.2 Objective

The primary objective of the project is to increase food production through the introduction of structural measures which would cause : reduction of crop losses due to flooding; shift from broadcast deep water to transplanted shallow water rice cultivation in the Aman

Figure 5.3



Madhumati-Nabaganga Sub-Project

season with supplementary irrigation when feasible and increase in the area under Boro cultivation as a result of a shorter Aman season and improved irrigation facilities.

After the implementation of the project works the area would be fully controlled from flood, and would have improved surface drainage facilities and supplementary irrigation. The cropped area would be increased (a considerable area could be brought under HYV crop). It is envisaged that the cropping intensity would increase from 142% to 150%.

5.4.3 Project Implementation

A feasibility study of the Madhumati-Nabaganga sub-project was carried out by NEDECO, Netherlands in 1984. Subsequently, Engineering and Planning Consultants Limited of Bangladesh (in association with Sir William Halcrow & Partners Ltd. of the United Kingdom and Resources Development Consultants Limited of Sri Lanka) prepared the detailed designs starting in 1986, and then continued with the construction supervision.

The original Project proforma was approved in 1985 for a total cost of 483 M Tk. But during detailed engineering of the sub-project, the quantities of works provided in the original Project Proforma were changed to suit actual field requirements. Consequently the Project Proforma was revised in 1991, and the revised total cost is 557 M Tk. A list of the project components is shown in Table 5.3.

The project was originally scheduled to be completed in 1990-91. In the revised Project Proforma the construction period was extended to 1992-93. The flood control embankments and the outfall/flushing regulators and irrigation incorporated intakes have been constructed. To date between 35-40% of the drainage networks have been completed.

5.4.4 Present Agriculture

According to data collected from the project area in March 1993, areas totalling about 6,000 ha has been brought under irrigated agriculture. About 85% of this area is covered by the STW mode of irrigation and another 10% is under LLP mode. The LLP mode is used generally by the large farmers.

5.4.5 Project Completion

The supervising consultant's input has come to end without the completion of construction of the entire drain networks. Since these networks were intended to act as channels for the distribution of irrigation water from the Madhumati (through the flushing sluices), the farmers who expected to adopt LLP irrigation would have to go without it for at least another year.

These delays in completing FCD/I projects not only lowers the eventual EIRR of the projects, but also enforces negative impact on some of the farmers who had earlier benefitted from agriculture in receding flood areas.

TABLE 5.3

Project Inventory and Brief Details

Embankment :	
a) New Construction	22.10 km
b) Resectioning Work	135.32 km
c) Km Post installation	174 Nos.
Protective Work	1.38 km
Paving access Ramp	80 Nos.
Excavation/ Re-Excavation of drainage channel	204 km
Regulator:	
a) New construction	4 Nos.
b) Remodelling work	3 Nos.
Flushing Sluice	15 Nos.
Bridge/Culvert	29 Nos.
Cross Regulator	49 Nos.
Road Works :	
a) Embankment (Pavement) HBB	135.32 km
b) Road (Pavement) HBB	7.00 km
c) Carpeting work	13.10 km
LLP outlet structure	60 Nos.
Building	1337 m^2
Land Acquisition	736 ha

6 DRAINAGE IN THE SOUTH WEST AREA

6.1 Introduction.

The study area could be divided into the southern Coastal Embankment Project (CEP) area which is criss-crossed by a network of rivers and creeks that are predominantly influenced by tides, and the remaining areas further north on which there is marginal or no impact of tides. Drainage issues relating to the CEP area and possible interventions to resolve them are discussed in Volume 4 : Coastal Studies while those for the non CEP areas are discussed here. The gross area north of the CEP area is about 23,000 km² and the main inland rivers which impact on this area are the Mathabhanga, Kobadak, Bhairab, Chitra, Begabati, Nabaganga, Gorai/Madhumati, Chanda/Barasia, Kumar, Old Kumar, Swarupkati and Arial Khan. The boundary rivers are the Ganges in the north and the Padma/Lower Meghna in the east. The Gorai/Madhumati is the main distributary of the Ganges into SWA, while the Arial khan is the main one for the Padma/Lower Meghna.

6.2 NAM Catchments and Runoff Coefficients

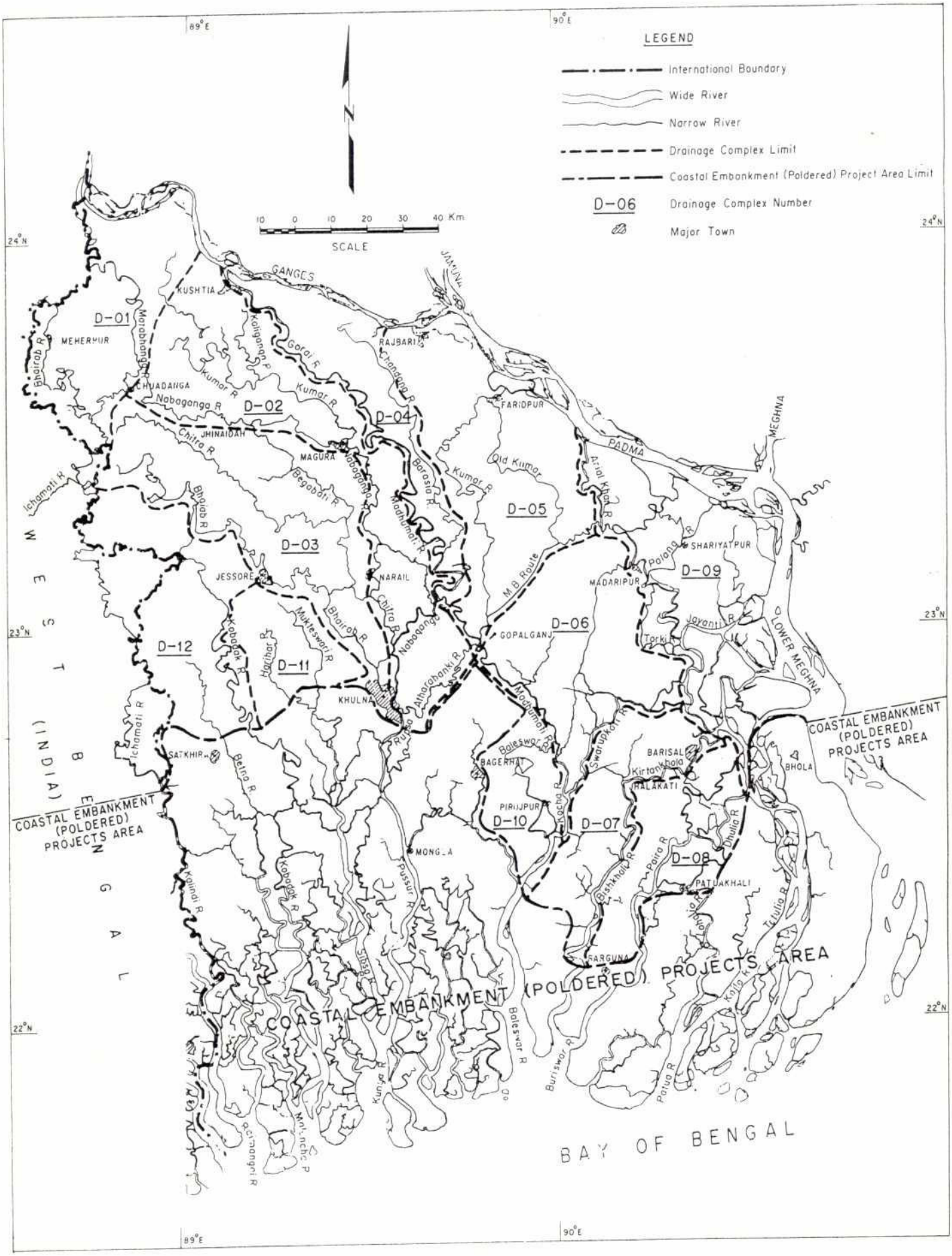
SWMC has sub-divided the drainage basins of the entire country into a number of catchments (NAM) to facilitate its hydraulic modelling exercise. In SWA, the area north of the CEP is covered by 37 NAM catchments. Previous studies (including that carried out by FAO in 1988) have considered some relevant agroecological criteria and divided the study area into four, the High Ganges Floodplain (HGF), the Low Ganges Floodplain (LGF), the Ganges Tidal Floodplain (GTF) and the Old Meghna Estuarine Floodplain (MEF). For the purpose of this study, this area has been divided into 12 drainage complexes by taking into consideration the topography and relief, soil characteristics, agroecological criteria and the catchment boundaries stated in Section 6.1.

The HGF, which is predominantly high and medium high land, has a smooth landscape of nearly level to very gently sloping broad ridges, inter-ridge depressions and nearly level to very gently undulating broad basins. Ground level varies from El. 15.0 m PWD at he high land to El. 1.0 m PWD at the lower end. Drainage Complexes D-01, D-02, D-03 and D-12 fall within HGF. 60-70% of these complexes are covered by broad ridges and inter-ridge depressions; their soils are moderately permeable. Broad basins cover the remaining areas of the complexes, particularly in the south, and their soils are generally low permeability clay.

The LGF is predominantly high and medium high land and has typical meander landscape: relief along the sides of the rivers crossing the area is somewhat irregular, comprising narrow ridges, inter-ridge depressions, broad low lying basins (particularly in the south) and cut-off channels. The difference in elevation between the ridge top and the corresponding basin bottom generally varies between 3.0 and 5.0 m. Accordingly, the northern half of the study area has a comparatively rolling topography, while the central and southern areas have fairly flat terrain. Furthermore, the central and southern areas have a large number of extensive beels. Drainage Complexes D-04, D-05, D-06 (part), and D-09 (part) belong to LGF. Except for about 30-40% of these complexes in the north which have generally narrow ridges with wide inter-ridge depressions, the remaining areas are usually covered by wide, low lying basins that have soils of low permeability.

The GTF has a number of inter-connecting tidal channels and creeks which carry freshwater in the rainy season. The area is slightly basin shaped, and where unprotected, it could be shallowly flooded by high tides. Most soils are moderately permeable. Drainage Complexes D-06 (part), D-07, D-08, D-10 and D-11 belong to GTF.

Figure 6.1



Drainage Complexes

The MEF is smooth, almost level with floodplain ridges and shallow basins. Soils are relatively uniform and the permeability is moderate in the higher lands and low in the depressions. A part of Drainage Complex D-09 falls within MEF.

In view of the variations in the reliefs and soil texture, the different drainage complexes and the integral NAM catchments show differences in their runoff and groundwater recharge capabilities. Results of catchment model simulation based on mean annual rainfall are given in Table 6.1 and they illustrate the variation in area weighted runoff coefficients (0.38 to 0.67) of the drainage complexes.

These coefficient of runoff values relating to annual rainfall though appear high but are considered realistic on the basis of comparison of simulated runoff with measured flow in rivers at selected locations made by FAP-25.

6.3 River Systems and Drainage Disposal

Plot of the river stage contours for the study area for the months July, August (Figure 6.2) and September based on the results of the simulation of measured daily flows corresponding approximately to a 1 in 5 return period year shows that about half the total area that lies south of Magura-Faridpur (Figure 6.3) would be subjected to drainage congestion in view of the relatively lower land levels there. The simulation results further showed that the drainage congestion in these southern areas on an average lasts for periods ranging from 5 to 8 weeks (during July to September). This broadly agrees with information collected during field visits.

Except the Gorai-Madhumati-Lower Nabaganga conveyance system and the Arial Khan system that function as the main distributary of the Ganges, and the Padma/Lower Meghna respectively, the other rivers are almost entirely dependent on internal runoff. The Gorai/Madhumati system, which runs almost along the median line of the study area, also operates as one of the main drainage disposal rivers in the Southwest Area.

It is seen from the available river cross section data pertaining to the inland rivers and river stage levels obtained through simulation of flows by the hydrodynamic model for different years that presently the Kobadak-Betna and the Begabati-Bhairab systems function as the main drainage lines for the areas West of the Gorai/Madhumati. In the east the Kumar and the Old Kumar-Arial Khan systems carry out a similar function (Figure 6.4).

TABLE 6.1

Rainfall-Runoff-Recharge Rates in the Drainage Complexes (Area North of the Coastal Embankment Polders)

Drainage Complex Name		NAM catchments partly/fully in the Drainage complex	Area Km²	Annual Mean (weighted)			
				Rainfall mm	Runoff mm	Ground water Recharge mm	Runoff co-efficient
D-01	Upper Bhairab-Mathabhanga Drainage Complex	SUW-1, 6	1510	1513	699	504	0.46
D-02	Kaliganga-Kumar-Nabaganga-Chitra-Atharbanki Drainage Complex	SUW-2, 3, 7, 10, 14B & 15	2813	1709	732	419	0.43
D-03	Begabati-Chitra-Bhairab Drainage Complex	SUW-8, 9, 13, 14A & 14B	2142	1692	642	503	0.38
D-04	Gorai-Madhumati-Chandana-Barasia Drainage Complex.	SUW-4, 11	2068	1699	792	428	0.46
D-05	Kumar-MBR canal Drainage Complex.	SUW-5, 12, 16, 17 & SUC-1	2455	1821	749	435	0.41
D-06	Madhumati-Swarupkati-Kocha-Drainage Complex.	SUW-16, 17 & SUC-2, 4, 5, 7, 17	1840	1936	975	442	0.50
D-07	Kirtonkhola-Bishkhali Drainage Complex.	SUC-7, 8, 11, 17	1116	2265	1471	623	0.65
D-08	Rangamatia-Paira-Buriswar Drainage Complex.	SUC-9, 10, 11, 12, 13	1450	2431	1625	698	0.67
D-09	Arial khan-Palang-Jayanti-Torki-Ilisha Drainage Complex.	SUC-1, 2, 3, 5, 6, 9, 10	2308	2135	922	583	0.43
D-10	Baleswar Drainage Complex.	SUW-16, 25	988	2167	1123	645	0.52
D-11	Mukteswari-Harihar-Bhadra Drainage Complex.	SUW-20, 21	698	1845	849	430	0.46
D-12	Betna-Kobadak Drainage Complex.	SUW-13, 14A, 18,19	1462	1656	658	561	0.40
For all the Drainage Complexes		37 Nos.	*20850	1875	890	508	0.47

* Excluding the areas of the major rivers such as the Ganges, Padma, L.Meghna etc.

Source : Consultant's model analysis

The major rivers systems that help with the drainage disposal are :

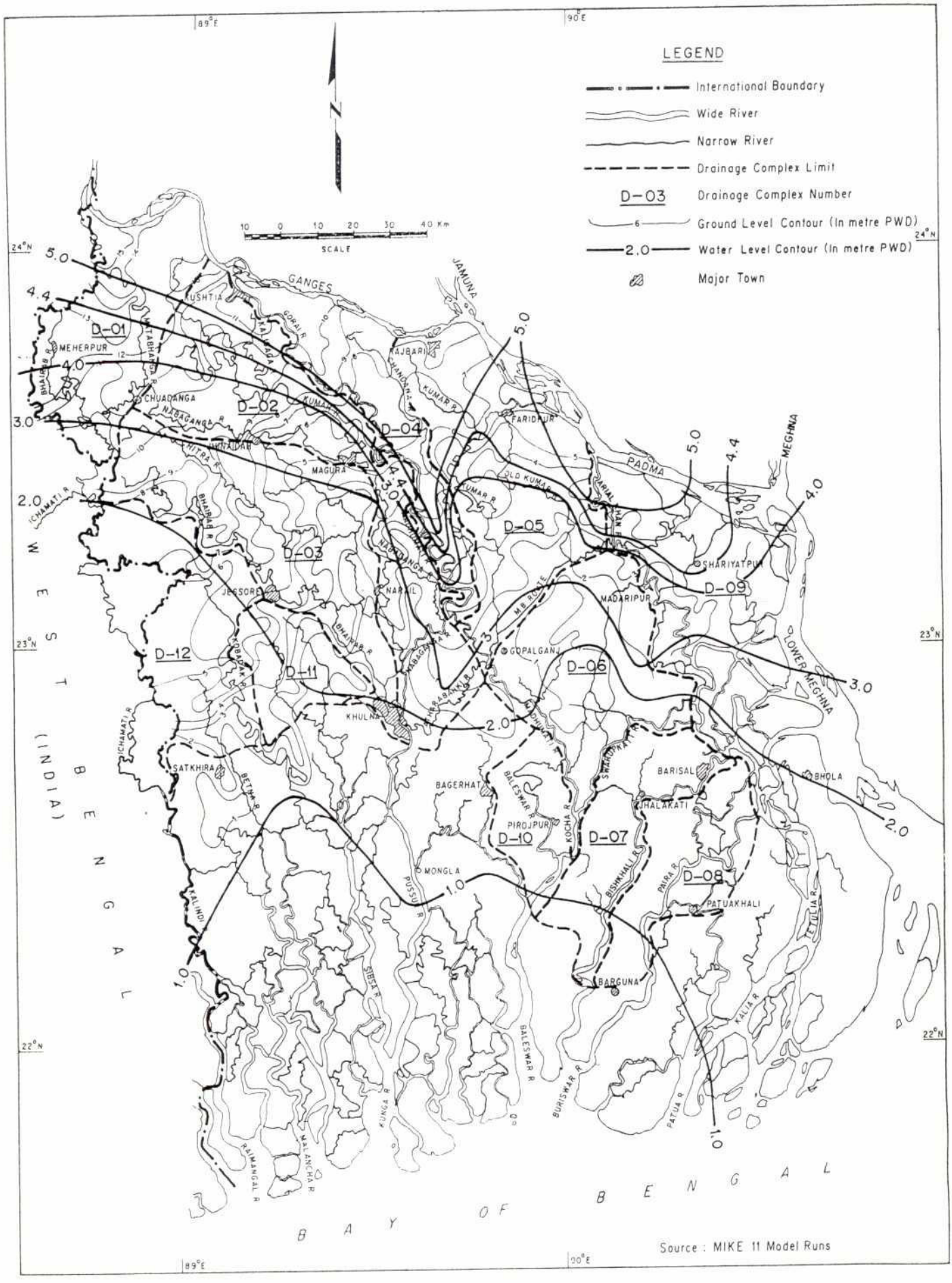
Drainage Complex :D-01 Mathabhanga-upper Bhairab River System.

Drainage Complex : D-02 Kaliganga-Kumar-Nabaganga-Chitra-Atharbanki River System.

Drainage Complex : D-03 Begabati-Chitra-Bhairab River System.

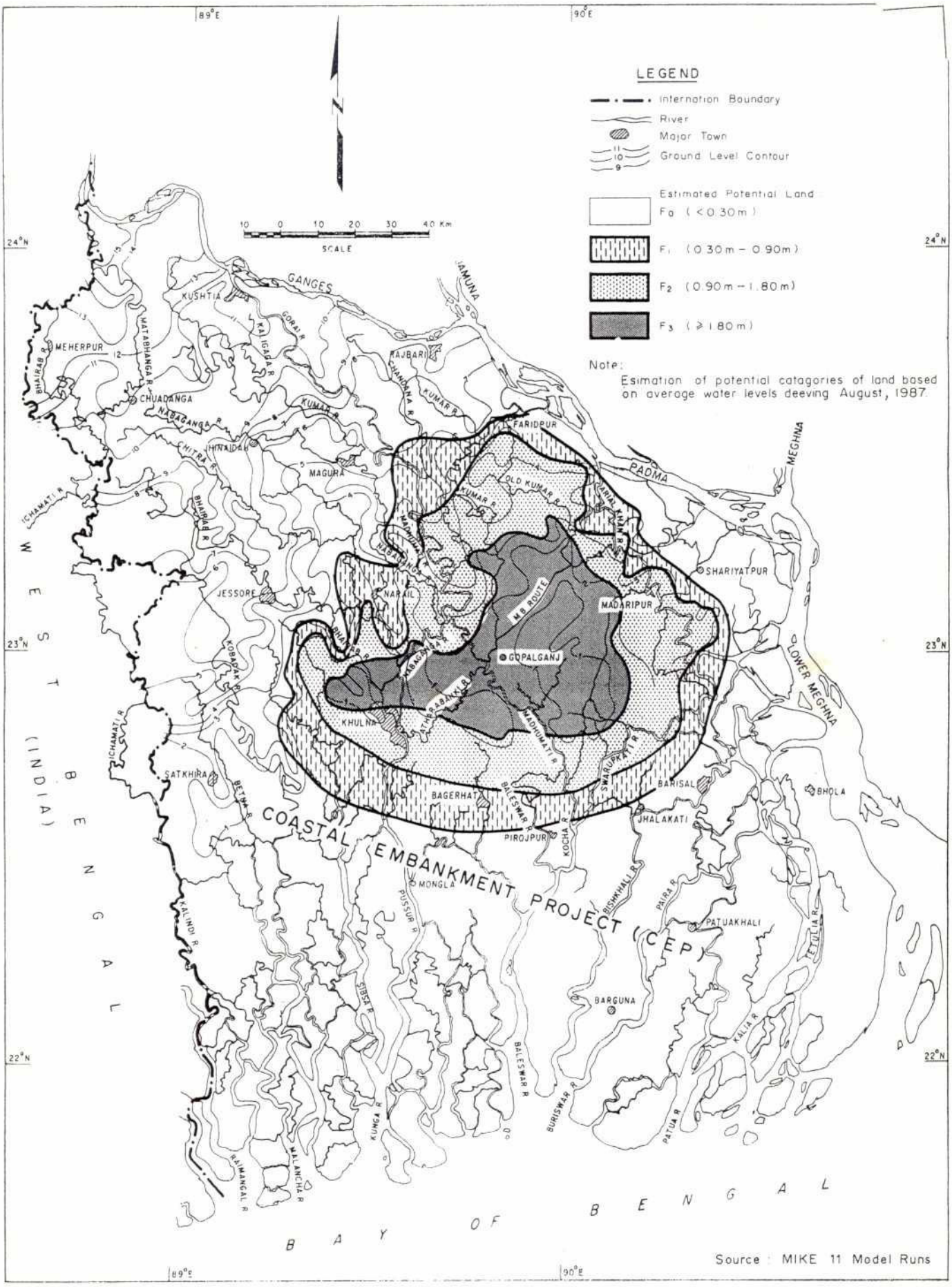
Drainage Complex : D-04 Gorai-Madhumati-Chandana-Barasia River System.

Figure 6.2



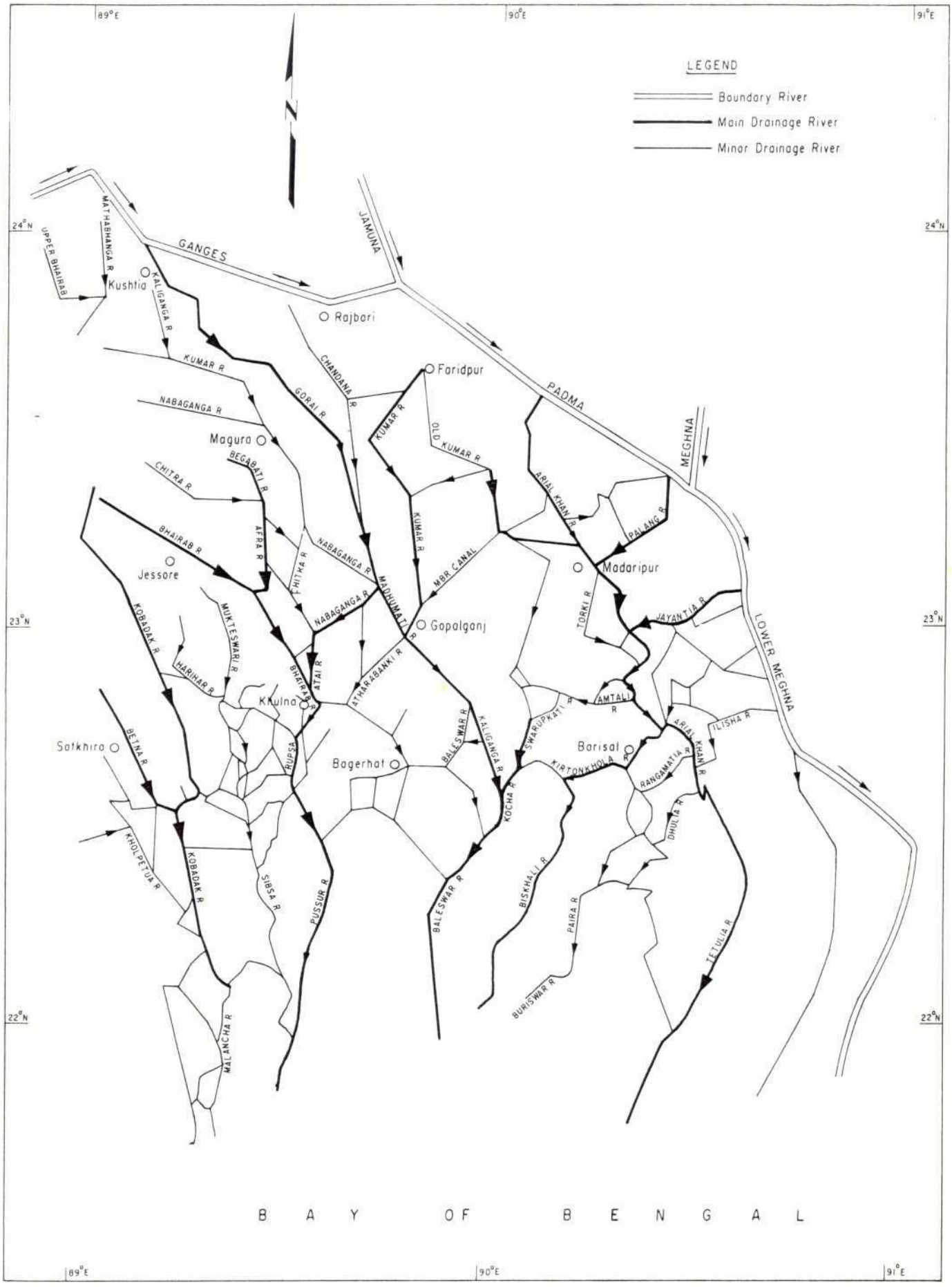
1982, August River Stage Level

Figure 6.3



Indicative Inundation due to Drainage Congestion for 1 in 5 year Flood Through Gorai (Areas North of CEP)

Figure 6.4



Drainage Disposal by River Systems
Schematic Network

Drainage Complex : D-05 Kumar-MBR canal River System.

Drainage Complex : D-06 Madhumati-Swarupkati-Kocha River System.

Drainage Complex : D-07 Kirtonkhola-Bishkhali River System.

Drainage Complex : D-08 Rangamatia-Paira-Buriswar River System.

Drainage Complex : D-09 Arial Khan-Palang-Jayanti-Torki-Ilisha River Systme.

Drainage Complex : D-10 Baleswar River System.

Drainage Complex : D-11 Mukteswari-Harihar-Bhadra River System.

Drainage Complex : D-12 Betna-Kobadak River System.

6.4 Characteristics of Drainage Complexes

6.4.1 D-01 Upper Bhairab-Mathabhanga Drainage Complex

This drainage complex is at the north-western extremity of the High Ganges Floodplain (HGF). In this complex the Upper Bhairab and Mathabhanga rivers which were the former main distributaries of the Ganges River still receives Ganges flows at high stages of the Ganges. These two rivers which form the internal drainage channel systems for the complex join together near the International Boundary and flow across the boundary into India as Ichamati River. During the period of higher Ganges stages in the monsoon; water levels in both the Mathabhanga and the Upper Bhairab are dominantly controlled by the Ganges levels. River water levels of this complex are not affected by the water levels in the Gorai Madhumati River although the overbank spilling of the Ganges sometimes occurs. The relief of the complex area which is a part of the High Ganges Floodplain (HGF) is particularly complex as a result of the violent past behaviour of the former two main distributaries. The High Ganges Floodplain within this Drainage Complex which is predominantly high and medium high land, has a smooth landscape of nearly level to very gently slopping broad ridges, inter-ridge depressions and nearly level to very gently undulating broad basins. Ground level in the complex varies from E1.15.0 m PWD to E1.10.0 m PWD.

The high land soils are usually loamy to well textured clay which are moderately permeable while the basin soils are usually clayey and slowly permeable.

The total drainage area of the complex is about 1510 km^2 and consists of the NAM catchments SUW-01 and SUW-06. The annual mean rainfall and estimated runoff (weighted) within the complex are 1513 mm and 699 mm respectively (Table 6.1). The estimated corresponding ground water recharge is 504 mm. The entire complex area is estimated initially drained by the Mathabhanga, Bhairab and ultimately by the Ichamati rivers. To the south-east of this complex area lies the GK Project to the Mathabhanga River. The internal drainage pattern in the area under the Upper Bhairab River is complex due to the large numbers of disconnected beels and baors and silted up main drainage channels or old rivers. As a result, large expanses of the area are shallowly flooded after heavy rains.

Due to gradual channel sedimentation and intensive growth of vegetation in the old dying channels flow capacity is restricted and sluggish and much less than would be required for proper drainage. However the mean water levels in the existing upper Bhairab-Mathabhanga river system in both the pre-monsoon (Jun 3rd decade WL. = 2.9m to 2.4m PWD) and monsoon (August 2nd decade WL. = 5.0m to 2.5 m PWD) as shown in Figure 6.2 are

much below the existing ground levels which indicates the area is well drained by the existing river system.

6.4.2 D-02 Kaliganga-Kumar-Nabaganga-Chitra-Atharbanki Drainage Complex

This drainage complex is on the right bank of the Gorai-Madhumati River and extends from the north to the south following the existing river systems of Kaliganga, Kumar, Nabaganga, Chitra and Atharbanki. Most of the area of this complex, particularly the upper area, is in the High Ganges Floodplain (HGF); the remainder is in the Low Ganges Floodplain (LGF). Almost the entire area of the complex is covered by the existing GK and Madhumati-Nabaganga Projects. The complex area consists of NAM catchments SUW-02, SUW-03, SUW-07, SUW-10 SUW-14B (Partly) and SUW-15 (Table 6.1). The ground level varies from El. 12.0 m PWD at the north to El. 1.0 m PWD at the south.

The total drainage area of the complex is about 2813 km². The annual mean rainfall (weighted) within the complex is 1709 mm and the corresponding runoff and ground water recharge estimates (weighted) are 732 mm and 419 mm respectively.

The water levels in the river systems which serve as the internal drainage channels for the complex are affected by the water levels in the Gorai-Madhumati River especially by the back water effects due to high water levels in the Madhumati upto the Halifax cut and in the Lower Nabaganga which receive high flood flows from the Ganges during the monsoon. The mean water levels in the existing river system in both the pre-monsoon and the monsoon (Figure 6.2) show that the drainage water in the rivers within the complex is flowing towards the south and south west directions with milder slope. The upper area is well drained where as the lower area between the rivers Nabaganga and Atharabanki would be subject to drainage congestion in view of the relatively lower land levels (El. +_ 1.0 m PWD) there. The depth of inundation during average monsoon period would be upto 2.0 m.

6.4.3 D-03 Begabati-Chitra-Bhairab Drainage Complex

This drainage complex is in the High Ganges Floodplain (HGF) having about 60-70% of the area covered by broad ridges and inter-ridge depressions and the remaining by undulating broad basins particularly in the south. The complex is extends from the north-west to the south following the Begabati, Chitra and Bhairab Rivers as its internal drainage channel system. High lands predominantly occur in the north-western part where as medium low and low lands occur in the southern part of the complex. The ground slopes down gradually from the El. 10.0 m PWD at the upper end to the El. 1.0m PWD at the lower end.

The high land soils are usually loamy to we textured clay and moderately permeable. The low land and basin soils are usually clayey and slowly permeable.

This drainage complex consists of NAM catchments SUW-08, SUW-09 and part of SUW-13, SUW-14A & 14B. The total drainage area of the complex is about 2144 km². The annual mean rainfall (weighted) is 1692 mm and the corresponding runoff and ground water recharge estimates are 642 mm and 503 mm respectively.

In this drainage complex the area lying between the Nabaganga and Chitra Rivers (which were the former distributaries of the Mathabhanga River) forms a trough like drainage basin with the Fatki-Begabati River as the main drainage channel. The Fatki River is a distributary of the Nabaganga River which is commonly called Begabati at the downstream reach. The Begabati River is small and sluggish having no such distinguishable drainage channel networks in its tributary areas. As a result the poor drainage and widespread flooding occur

during the monsoon. This drainage problem is further compounded by flood flows from the Nabaganga River. Further downstream, where the Begabati and Chitra Rivers join, the extent of flooding in the drainage area is extensive because of the backwater effects due to high water levels in the Madhumati at the Halifax Cut. If the flows from the Begabati-Chitra are diverted to the Bhairab through an existing link river (after widening), the drainage congestion could be reduced in the above area.

The area lying between the Chitra and Bhairab Rivers upto the Afra khal is the drainage area of the Bhairab River. The drainage flows through the Chitra-Begabati and enters into the Bhairab through the Afra khal. Along the downstream reach of the Bhairab River the lower area of the complex is susceptible to drainage congestion because of the high water levels in the Madhumati at the Halifax Cut in the monsoon.

The mean river water levels during an average flood year within the complex vary from El. 2.7 m PWD to El. 1.4 m PWD in the pre-monsoon and from El. 3.0 m PWD to EL. 2.0 m PWD (Figure 6.2) in the monsoon which show that the lower area of the complex is susceptible to water logging upto a depth of about 1.0 m in the monsoon.

6.4.4 D-04 Gorai-Madhumati-Chandana-Barasia Drainage Complex

This complex is in the Low Ganges Floodplain (LGF). About 30-40% of the areas in the north are covered generally by narrow ridges and the remaining areas comprise wide and low lying basins. The complex is a narrow strip bounded on the west by the Gorai-Madhumati River, on the east by the railway line and the Chandana-Barasia Rivers and on the north by the right bank of the Ganges River (Figure 6.1). High lands predominantly occur in the north where as medium high and low lands occur in the south of the complex. The ground level on average varies gradually from El. 10.0 m PWD at the upper end to El. 3.0 m PWD at the lower end.

The high and medium high land soils are silt loams to silty clay loams and are relatively more permeable, where as the low land soils are silty clay loams to heavy clays and are relatively low permeable. Some basins have peat soils.

This drainage complex consists of NAM catchments SUW-04 and SUW-11. The total drainage area of the complex is about 2067 km^2. The annual mean rainfall (weighted) in the complex is 1699 mm and the corresponding runoff and ground water recharge estimates (weighted) are 792 mm and 428 mm respectively.

The entire complex drain into the Gorai-Madhumati river, north of the MB Route Canal. The Chandana and Barasia Rivers serve as the main internal drainage channels for the complex. The mean river water levels in the monsoon corresponding to on average flood year within the complex are lower than the ground levels in the upper reaches of the river systme. In the lower reaches, the river stage tends to rise higher the adjoining lands due to the backwater effects of the high flood flows in the Madhumati.

As the complex is following closely along and draining directly into the Gorai-Madhumati River, flooding within the complex is particularly sensitive to the river stages.

6.4.5 D-05 Kumar-MBR Canal Drainage Complex

This drainage complex is in the Low Ganges Floodplain (LGF) having almost a similar landscape, soil and relief as that of the D-04 drainage complex. The drainage area extends from the right bank of the Ganges-Padma River towards the south and is bounded on the west by the rivers Chandana-Barasia-Madhumati and on the east by the Arial Khan - MB

Route Canal. The Kumar and Sitalakha (Old kumar) along with the inter-connecting channels form the internal drainage channel system for the complex. The ground level on average varies from El. 8.0 m PWD to El. 2.0 m PWD, from the north to the south.

The drainage complex consists of NAM Catchments SUW-05, SUW-12 and partly SUW-16, SUW-17, and SUC-01. The total drainage area of the complex is about 2455 km². The annual mean rainfall (weighted) within the complex is 1821 mm and the corresponding runoff and groundwater recharge (weighted) are 749 mm and 435 mm respectively.

Besides the rainfall runoff the complex area was previously flooded over by the overbank spilling of the Ganges-Padma River as well as the spilling through the Arial khan river. Presently the construction of Ganges-Padma right bank embankment has to eliminate the high flood flows from the Ganges-Padma over the Area.

The Kumar and the Sitalakha divide the complex into two drainage areas. However the drainage flows from both areas lead to the Madhumati River with MB Route Canal forming the main outfall channel. During the monsoon the Gorai-Madhumati has high water levels and consequently the lower part of the complex is subject to drainage congestion and inundation. The depth of inundation in the lower part could rise upto about 2.0m.

6.4.6 D-06 Madhumati-Swarupkati-Kocha Drainage Complex

This complex consists of the Low Ganges Floodplain, Ganges Tidal Floodplain with Peat Basins and the Old Meghna Estuarine Floodplain. The land characteristics, relief and soil condition of the Low Ganges Floodplain part of the complex are similar to that of the complexes D-04 and D-05. The Ganges Tidal Floodplain (GTF) part of the complex has a number of inter connecting tidal channel and creeks which carry freshwater in the rainy season upto the coast and the area is slightly basin shaped which is shallowly flooded by the high tide in the rainy season and some part of the area remains wet even in the dry season. The high land soils are silt loams and silty clay loams and the basin soils are silty clays. Most soils are moderately permeable and some are rapidly permeable. The peat basin part of the complex is a low-lying landscape of nearly level broad basins having clay soils at the basin margins and peat soils at the basin bottoms, they are slowly permeable. The Old Meghna Estuarine Floodplain (MEF) part of the complex which is very small is smooth, almost level with floodplain ridges and shallow basins. Soils are relatively uniform with predominantly silty soils, but basin soil are silty clay and clay. The permeability is moderate in the higher areas and slow in the depressions.

The average ground level of the complex varies between El.2.0 m PWD and 1.0 m PWD. The complex consists of NAM catchments SUC-04 and part of SUC-02, SUC-05, SUC-07, SUC-17, SUW-16 and SUW-17. The total drainage area of the complex is 1840 km². The annual mean rainfall (weighted) is 1936 mm and the corresponding runoff and ground water recharge estimates (weighted) are 975 mm and 442 mm respectively. The Swarupkati, Madhumati and Kocha rivers along with the other interconnecting river channels serve the area for the internal drainage. But the external flood flows in the monsoon through the Madhumati (from the Ganges) and the Swarupkati (from the Padma through Arial Khan and other distributaries) cause drainage congestion in the complex due to their high flood flow levels. From the plotted average mean river water level contours it is found that the complex, particularly in the central part, is susceptible to inundation in the both pre-monsoon and monsoon periods and the depth of inundation could be upto 1.0m.

6.4.7 D-07 Kirtonkhola-Bishkhali Drainage Complex

This drainage complex is in the Ganges Tidal Floodplain (GTF). The general landscape, relief and soil conditions of this complex are similar to that of the Ganges Tidal Floodplain area of the complex D-06. The complex area is bounded on the west by the Swarupkhati-Kocha Rivers and on the east by the Kirtonkhola-Bishkhali Rivers. The former act as the internal drainage channels for the complex. The ground level of the complex is about 1.0 m PWD.

The complex consists of NAM catchments SUC -08 and part of SUC-07, SUC-11 and SUC-17. The total drainage area of the complex is about 1116 km². The annual mean rainfall (weighted) is 2265 mm and the corresponding runoff and ground water recharge estimates (weighted) are 1471 mm and 623 mm respectively.

This complex is susceptible to inundation in both the premonsoon and monsoon periods due to drainage congestion in the downstream river channels and the depth of inundation could be upto 1.

6.4.8 D-08 Rangamatia-Paira-Buriswar Drainage Complex

This drainage complex is in the Ganges Tidal Floodplain and to the south of the drainage complex-07. The general landscape, relief and soil conditions of this complex are almost similar to that of the drainage complex D-07. It consists of parts of NAM catchments SUC-09, SUC-10, SUC-11, SUC-12 and SUC-13. The rivers Rangamatia, Paira and Buriswar sere as the internal drainage channel system for the complex. The average ground level within the complex area is 1.0 m PWD.

The total drainage area of the complex is about 1450 km². the annual mean rainfall (weighted) is 2431 mm and the corresponding runoff and ground water recharge estimates are 1625 mm and 698 mm respectively. The average river water levels are 1.5 m PWD in the pre-monsoon and 2.0 m PWD in the monsoon periods, which indicate that some parts of the complex could be inundated upto of about 1.0 m due to drainage congestion (tidal effects).

6.4.9 D-09 Arial Khan-Palang-Jayanti-Torki-Ilisha Drainage Complex

This drainage complex is mostly in the Low Ganges Floodplain (LGF) with a very small part of it in the old Meghna Estuarine Floodplain. It consists of NAM catchments SUC-03, SUC-06, and part SUC-01, SUC-02, SUC-05, SUC-09 and SUC-10. The ground level slopes down from El. 5.0 m PWD at the north to El. 1.0 m PWD at the south. The general landscape, relief and soil conditions of the complex area are almost similar to that of LGF and partly to that of MEF.

The complex lies between the rivers Padma-Lower Meghna and Arial Khan. The Arial Khan, Palang, Jayanti, Torki and Ilisha act as the drainage channel system for the complex. The total area of the complex is 2308 km². The annual mean rainfall (weighted) is 2135 mm and the corresponding runoff and ground water recharge estimates (weighted) are 922 mm and 583 mm respectively.

6.4.10 D-10 Baleswar Drainage Complex

This Drainage Complex is in the Ganges Tidal Floodplain (GTF) of the study area and it consists parts of NAM catchments SUW-16 and SUW-25. The ground level is about 1.0 m PWD. The Baleswar river acts as the main drainage channel in this complex. The

total drainage area of the complex is 988 km² and the annual mean rainfall and runoff (estimate) within the complex area are 2167 mm and 1123 mm respectively. The corresponding ground water recharge (estimate) is 645 mm. The drainage flows in this complex are affected by the tidal flows in the river during the monsoon period.

6.4.11 D-11 Mukteswari-Harihar-Bhadra Drainage Complex

This complex is mostly in the Ganges Tidal Floodplain (GTF) and adjacent to the poldered areas under the Coastal Embankment Project (CEP). It consists of NAM catchments SUW-20 and SUW-21. The drainage complex is bounded on the west by the Kobadak and on the east by the Bhairab and the rivers Mukteswari, Harihar and Bhadra act as its internal drainage channel systems. The Harihar River has no distinguishable channel at its upstream portion but joining with the Bhadra River it becomes a distinct channel for internal drainage. The Mukteswari River joins with the Bhadra and flows towards the south as Bhadra. The area to the south and west of the Lower Bhairab River including the low lying peat area to the west of Khulna is in this drainage complex. The ground level of the area varies from El. 6.0 m PWD at the north end to El. 1.0 m PWD at the south end. The general landscape, relief and soil conditions of the complex area are similar to that of the GTF area.

The total drainage area of the complex is 698 km². The annual mean rainfall (weighted) is 1845 mm and the corresponding runoff and ground water recharge estimates are 849 mm and 430 mm respectively. The ground level of the lower part of the area are about 1.0 m PWD (adjacent to the drainage complexes D-02 and D-03) and generally gets inundated in both the pre-monsoon and monsoon periods. The inundation is caused by the drainage congestion at the downstream where there is tidal influence in the rivers during the monsoon.

6.4.12 D-12 Betna-Kobadak Drainage Complex

This complex is in the High Ganges Floodplain (HGF) and also adjacent to the CEP area. It consists of NAM catchments SUW-19 and part of SUW-13, SUW-14A and SUW-18. The drainage area is mainly to the west of the Kobadak River upto the International Boundary. The river systems of Kobadak and Betna act as the internal drainage channels for the complex,. The general landscape, relief and soil conditions of the complex area are similar to that of the LGF area. The average ground level varies from El.8.0 m PWD at the northern end to El. 2.0 m PWD at the southern end.

The Kobadak River which was formerly a main distributary of the Mathabhanga River has a small drainage area largely because of the fact that much of the lands lying along its banks drain away from the river. The flooding in the tributary drainage area of the Kabadak is relatively mild.

The drainage area to the west of the upper Betna River, a former distributary of the Kobadak River drains generally towards India.

The total drainage area of the complex is 1462 km². The annual mean rainfall (weighted) in the complex is 1656 mm where as the corresponding runoff and groundwater recharge are 658 mm and 561 mm respectively. The main of river water levels (tidal) in both the pre-monsoon and monsoon periods are slightly than the average ground level which indicate that the complex area would have mild drainage congestion problems.

7 IRRIGATION AND DRAINAGE DEVELOPMENT

7.1 General

For the Southwest Area three different options could be considered for the provision of irrigation facilities: a surface water full gravity system, a surface water low lift pumping system (LLP) and a groundwater tubewell system. In addition, for certain areas the irrigation facilities could be based on a combined use of surface water and groundwater facilities.

Furthermore, an environmentally friendly and more appropriate development concept as presently advocated, relates to integrated water management within the protected areas incorporating controlled flooding, controlled drainage (with provisions for future fisheries development) and irrigation.

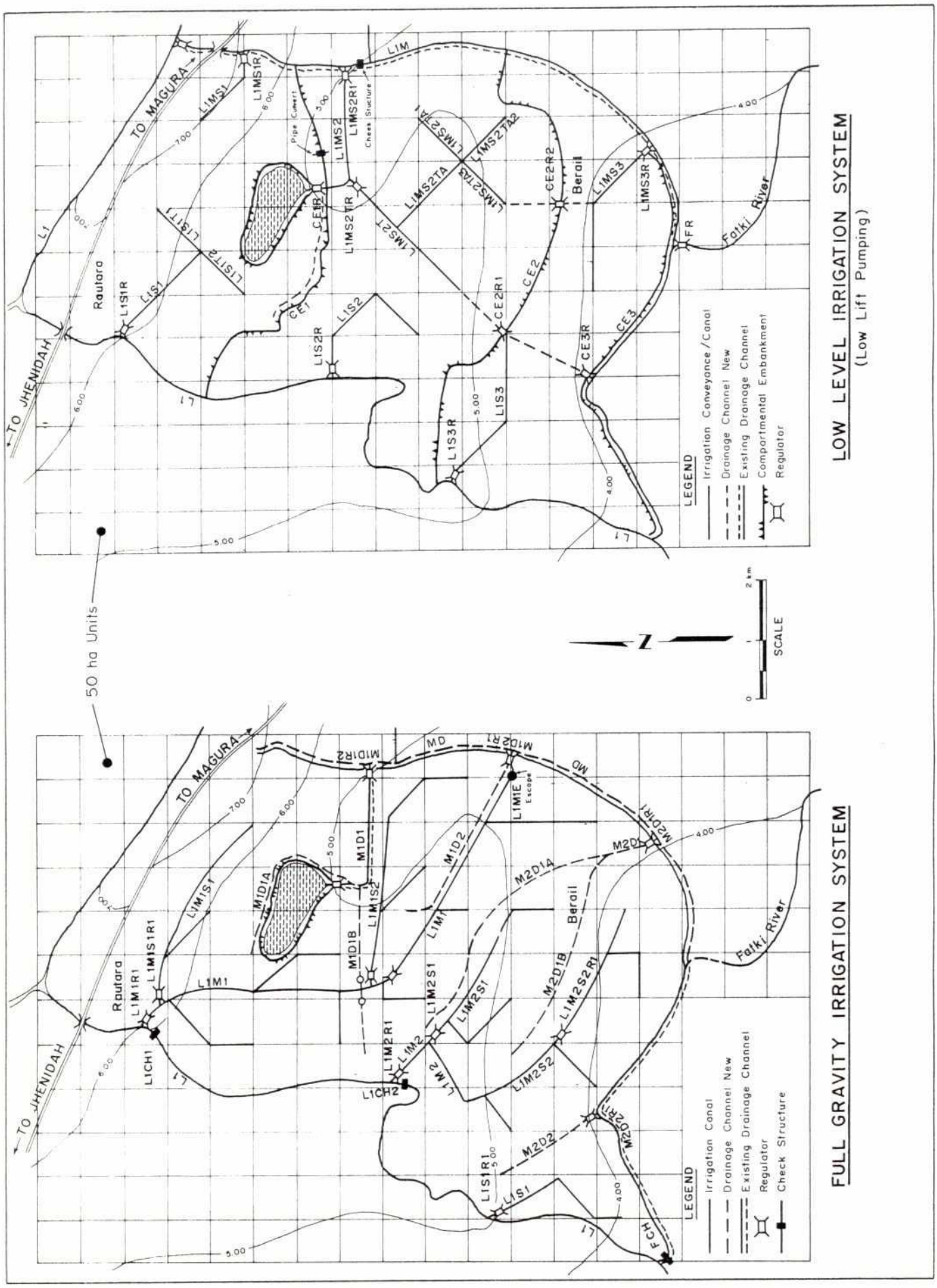
Therefore, any future rehabilitation programmes should take note of the need to introduce the integrated water management concept.

7.2 Full Gravity System

When the water level in a supply canal/river is relatively high and could command an adjoining, large irrigable area which has a mild slope (about 1% slope), then a full gravity system could be provided for irrigating the area. Water could be diverted from the supply canal/river into a network of distribution canals and led directly on to the farmers' plots, all based on gravity flow. The distribution canals would have to be routed along relatively higher elevation in order to be able to command the adjoining plots. In addition, the system should have a network of drains to take away from the area, the return flows from the irrigation application, and also to drain the area during the rainy season. The cost of provision of the two networks of channels and associated water control structures to equitably and efficiently distribute the water is high compared to a low lift pumping or a tubewell system. A full gravity system is estimated to cost about 3.8 million taka per km² (NCA), of which almost 3.7 million taka per km² would have to be borne by the government to ensure that the required flow reaches the top most corner of every 50 ha unit of collective farms unit (Figure 7.1), while the beneficiaries within each 50 ha unit could be expected to provide a simple network of farm ditches at their own cost (approximately 0.1 million taka per km²) to distribute the water, on the basis of any agreed rotation, to their individual plots. Once the system is implemented, the annual operating and maintenance cost (to be recovered from the farmers) will be relatively low about 60,000 taka per km² (about 2% of the initial capital investment).

7.3 Low Lift Pumping System (LLP)

A relatively low cost water distribution system could be provided to the same area (Figure 7.1) if a low level conveyance network, that could incorporate any existing water courses/khals within the area, is adopted. The main system would convey the water to a convenient corner of every 50 ha collective farm unit and the beneficiaries would then be expected to lift the required water on to their network of farm ditches and distribute to their individual plots, all at their own cost. This type of water distribution would not only suit mildly sloping land, but also flat areas or a mix of the two as generally found in the Southwest Area. The main system which would be implemented by the Government is estimated to cost about 2.8 million taka per km², while the beneficiaries would have to bear the additional cost of 0.3 million taka per km² for providing their own collective pumps and farm ditches. Thus, the total development cost for this system would be 3.1 million taka per km², about 0.7 million taka per km² lower than the full gravity system. However, the



Irrigation Systems Comparison

operating and maintenance cost of this low lift pumping system which has to be borne by the farmers could be relatively high : about 270,000 taka per km² per annum (about 8.7% of the initial capital investment).

7.4 Comparison of the Full Gravity and LLP Systems

Though the initial capital cost of development of a LLP system is relatively low, its annual operating and maintenance cost that the farmers have to bear will be about 210,000 taka/km² higher than that for the gravity system. This will put an extra burden on the farmers, increasing his production cost per ha for the rabi/boro crop season by about 13% (about 1500 Taka per ha). Furthermore, it would not be possible to achieve the same level of equitable and efficient distribution of water as is possible with a full gravity system.

However, a LLP system would involve a greater degree of participation in the development by the farmers and the private sector (particularly the provision of the pumps) which is one of the main requirements for sustaining the development. But this need for greater financial contribution to the development by the farmers and the private sector could cause some delay in achieving the envisaged full development compared to the gravity system development.

Another important consideration that should be given when selecting the type of irrigation system is the need of the government to spread its investment to cover as large areas as possible such that more people would benefit from a limited investment potential of the government. A low investment LLP systems development would not only satisfy this requirement, but would conform to the main concept of the National Minor Irrigation Development Project of the government, the implementation of which is due to commence in mid 1993.

Taking into cognisance the above pros and cons of the two surface water systems, the LLP system has been selected for planning purposes as the means of provision of irrigation in most of the proposed agricultural development areas in the Southwest Area.

7.5 Irrigation System Design

Preliminary designs of the irrigation systems for the different projects proposed under the present study have been based on the LLP system incorporating low level networks of canals. The irrigation intake structures (or flushing sluices) along selected rivers have been designed based on the mean monthly water levels and flows given in Tables A1 - A17 included in the Appendix.

7.6 Groundwater Development

The Southwest Area groundwater resources evaluation in the Hydrogeology Section of the Final Report (Volume 5) has identified 5 of the 21 districts (Faridpur, Gopalganj, Madaripur, Sariatpur and Kushtia) as having potential for further DTW irrigation development : more than 50% of their groundwater resources are yet to be developed. Another three districts (Magura, Narail and Rajbari) have between 35% and 50% of their resources undeveloped. Four of the remaining 13 districts (Jhenaidah, Jessore, Chuadanga and Meherpur) have almost fully developed their available resources, while the other eight districts cover the coastal areas and their groundwater potential has been always very low or nil.

The above evaluation is based on MPO estimates of available recharge, which according to field information appear rather conservative. It is likely, in practice, that more groundwater is available for irrigation than has been assumed.

As shown in the Hydrogeology Section of the Final Report, DTW is the recommended main source of groundwater, the method which is most likely to have a detrimental effect on other users, particularly on the HTWs (rural water supply). In addition, in areas around Khulna and further south the issue of saline intrusion is a special complication. In the past, BADC have had a major role in controlling groundwater abstraction by DTW, but under the current deregulated development some consideration therefore needs to be given to the matter of groundwater management, to avoid problems.

DTW installation will be an important vehicle for minor irrigation development and it will basically be in the form of joint ventures between the farmers and the private sector: it will be self financing and driven by market forces. It is therefore considered that some action is required to particularly protect HTW supplies. As stated in Section 9.5.2, this could be achieved by instigating programmes to install force-mode Tara HTW in those areas where irrigation by DTW is to be extended. The project cost of the irrigation development should include the cost of this mitigation programme for the rural water supply. The programme should be funded by the government and implemented through DPHE.

Under a regulated groundwater development programme it could have been possible to maximise the use of the groundwater and surface water resources for irrigation by adopting a conjunctive use of the two resources. This would particularly be advantageous where the surface water supply is not arriving from a regulating reservoir. A basic form of conjunctive use is presently being practiced in some areas of the GK Project, where groundwater is utilised when the canal supply is either shut off during the fixed maintenance period each year or insufficient to meet the crop water demand. But this small scale groundwater abstraction (a maximum of 56 l/s) will cause the conjunctive use to be a non cost-effective programme in the GK Project.

However, under the present emphasis on minor irrigation development based on the deregulated groundwater utilisation, a large conjunctive use scheme is out of context.

7.7 Rehabilitation of Existing Schemes

In the Southwest Area, only three formalised irrigation schemes have been in operation for some years: the G-K Project, the Barisal Irrigation Project and the Bhola Irrigation Project (Phase I). Already, the rehabilitation of the G-K Project is underway with emphasis on incorporating an appropriate water management programme. The Barisal Irrigation Project is presently operating at much below its envisaged capacity, and any future rehabilitation study should consider not only the structural aspects, but also the social and institutional aspects that would promote cost recovery.

All the other existing BWDB projects are basically flood control schemes with some provision for drainage disposal. They generally do not have comprehensive drain networks. Introduction of irrigation facility to these existing projects should therefore be in conjunction with the rehabilition of its drainage system (including compartmentalisation), which together could allow an integrated water management to be practiced.

Furthermore, future development programmes should place emphasis on maximising the returns from the existing projects through appropriate rehabilitation, introduction of workable O&M measures and cost recovery.

7.8 Issues Relating to Drainage

In the Southwest Area, the South Central Region and eastern part of the Southwest Region are mostly subjected to overbank flooding from the rivers. Model study indicates that in an

average year the water levels in the inland rivers would be 2.5m higher than the surrounding land levels for 2-3 months in the monsoon period and would generally cause the drainage to be impeded.

The study further shows that drainage disposal during the pre-monsoon period particularly in areas outside the CEP polders would not experience any impedance. Drainage congestion in the CEP polders are discussed in Volume 4 : Coastal Studies.

However, with the incorporation of compartmentalisation and controlled drainage in existing FCD areas and in any new projects being taken up for implementation, the prevailing excessive inundation at outfall locations could be greatly reduced.

Preliminary designs that have been produced for the projects proposed under the present study are based on the runoff coefficients estimated for the different drainage complexes in Table 6.1, and on the river stage levels given in Tables A1 - A16 in the Appendix.

8 COST RECOVERY

8.1 General

It would not be possible for any government to continue financing the annual operation and maintenance (O & M) costs of its development projects. So cost recovery from the beneficiaries should be made to cover the O & M costs in order to ensure the sustainability of the projects. The lack of adequate funding for the O & M of projects have been seen by many studies as the prime factor for the poor performance of those projects.

Cost recovery from the beneficiaries of water resources cum irrigated agricultural development projects is a complex issue. FCD/I projects do not have the same and/or equal impact on all beneficiaries: benefits could vary from one project to another, also vary from one plot to another within the same project. Moreover, in Bangladesh the provision of flood control and drainage (implementation, maintenance, etc) has been traditionally considered the responsibility of the government.

Though there have been statutory provisions since 1976 for collection of water rates from farmers benefitting from any BWDB sponsored FCD/I developments, the actual collection has been next to nothing in the whole of Bangladesh, possibly in keeping with the above traditional view. However, recent field surveys, including the one the Consultant conducted in some of the existing projects (the Chenchuri Beel, Bamankhali-Barnali and Alfadanga-Boalmari), indicate that the farmers appear to appreciate the linkage between poor O&M and low agricultural production (reduced area, yields, etc) and show willingness to at least participate (providing free labour) in maintenance work. However, the present statutory provision by which the BWDB is responsible for both the assessment of water rates and their collection does not appear to be the correct procedure to achieve cost recovery in view of the slow confidence build-up between government agencies and beneficiaries. It would be prudent to involve the beneficiaries, as well as others who would be expected to subsequently provide support facilities to the beneficiaries, when determining the water rate for each project.

The Government of Bangladesh having appreciated the need for cost recovery has recently initiated a number of studies, including pilot programmes, to identify suitable measures to improve beneficiary participation and achieve high cost recovery.

8.2 Water Rate Ordinance

Collection of water rate from beneficiaries is a form of recovering the cost of the operation and maintenance of a project in partial or full.

The first Water Rate Ordinance which was enacted was the "East Pakistan Irrigation Ordinance of 1963" which stipulated that the water rate should be 10% of the gross incremental benefits of crop production accruing to the owner or occupier of the land as a result of the supply of water.

In 1976, the water rate to be collected was reduced from 10% of the incremental benefits to 3% and this rate remained unchanged until 1983 when the ordinance was repealed and replaced by the "Bangladesh Irrigation Water Rate Ordinance of 1983", and Rate Rules were published in January, 1984. Specific water charges for completed gravity irrigation projects were published in June 1984. The new ordinance and rules differed significantly from the old version in that the water rates were no longer related to the gross incremental benefits due to supply of water for irrigation but were determined on the O&M cost per unit area basis separately for each of the three cultivation seasons and they amounted to Tk. 125 - 375 per ha each crop season depending upon the crops grown.

However, in view of the negligible level of collection performance in the implementation of the 1983 Water Rate Ordinance, an amendment was made on the ordinance in 1990 and draft rules were formulated in 1992 to supersede the 1984 Water Rate Rules. Again this version differed from the previous one in that the water rate is based on an annual O&M cost divided by the irrigable land in the project area.

8.3 Present Status of Cost Recovery

Although different water rate ordinances have been promulgated at different times and amendments made thereto to ensure cost recovery, unfortunately the level of collection performance is very negligible at present. For example in the GK project, which is the largest irrigation development in the Southwest Area (it is also the largest in the whole of Bangladesh), it is estimated that it was able to recover only about 2% of the pump station operating cost from the beneficiaries during the last financial year. Now BWDB may have to reassess its policy on collection of water rates in order to ensure that the project generates its own operation and maintenance fund from within.

8.4 Issues of Cost Recovery

Various issues relating to cost recovery have been raised by farmers and some field staff of BWDB during interviews held in some existing FCD/I project areas (Alfadanga - Boalmari, Madhumati - Nabaganga, Chenchuri Beel, etc) and in the G-K Irrigation Project area. Some of the main issues raised by the farmers are:

(a) Delayed Irrigation Water Supply

This issue which was particularly raised by the farmers in the G-K Project results in lowered yields (due to usage of older seedlings, vulnerability to pest attacks, etc) and reduced cropping intensities.

Also in the FCD/I projects those farmers who generally depend on private irrigators (who use tubewells or low lift pumps) experience the same problem.

(b) Frequent Disruption of Pump Operation

This issue also results in lowered yields. It is caused by either power failures (or fluctuating power supply) or breakdowns of the equipment due to poor maintenance.

(c) Drainage Problem

The problem is generally caused by poor maintenance of the khals, drains and outfall regulators, and in some cases it is also due to a poor design of the system.

The drainage problem has arisen at times due to conflict in needs of the farmers in different parts of the same project, such as timing, duration and depth of flooding.

(d) Reluctance of Share-Croppers to Participate

The farmers generally appreciate that the cost of O & M could be reduced if they participate in the O & M activities. While land-owner farmers have indicated their willingness to participate in O & M activities, the landless share-croppers appear to have some reservation due to the temporary nature of their tenancy.

Considering that in the Southwest Area, according to the Consultant's preliminary field survey, about 75% of the net cultivated area is owned by about 30% of the farmers who could be referred to as large/medium farmers (each household owning more than 1.0 ha) and a fair extent of the large farmers are share-cropped by some of the remaining 70% of the farmers (small, marginal and landless farmers), the impact of the share-croppers reservation on cost recovery could be appreciable.

(e) Previous Failures of Farmers' Cooperatives

Some farmers who had previously participated in shallow tubewell cooperatives that had failed showed a certain apprehension about the success of any future groupings of the farmers. They believed that some of the powerful farmers with large landholding would again scuttle the new programmes if their priorities are not adequately established. Also the unsupportive attitude of absentee landlords was mentioned by many landless farmers.

8.5. Present O&M Studies

As stated in Section 3.4, BWDB have been carrying out O & M and cost recovery studies for the following projects through separate consultants:

(a) Systems Rehabilitation Project

(b) Second Small Scale Flood Control, Drainage and Irrigation Project

(c) Ganges-Kobadak Rehabilitation Project

(d) Early Implementation Project.

Under the Systems Rehabilitation Project there is an on-going pilot programme in the existing Karnafuli Irrigation Project (near Chittagong) to form water user groups (of beneficiaries) with the help of the relevant staff of the local government institutions and NGOs and then transfer to them the responsibilities for collection of water rates. The programme will also promote the participation of the water user groups in O & M activities.

A similar field programme is being carried out under the Ganges-Kobadak Rehabilitation Project.

In addition to the above studies, under the on-going compartmentalisation Pilot Project (FAP-20) an extensive field programme has been incorporated to involve the beneficiaries in O & M activities and in cost recovery.

The Local Government Engineering Department has also initiated similar studies/programmes under some of their recent projects.

It is therefore important to ensure that there is some form of co-ordination between these various studies and extensive field programmes.

9 UNITS RATES AND COST ESTIMATION

9.1 Major Items of Works

The major items of works for hydraulic structures, flood embankments, drainage channels, etc. that would associated with the proposed developments are:

Earthwork,
Land acquisition,
Mechanical compaction,
Backfill for structures
Reinforcement concrete,
M.S Reinforcement,
Form work,
Brick work,
Slope protection with blocks
Mass concrete,
Stop log,
Steel slide gate,
Steel flap gate.

9.2 Unit Rates

Cost estimates for hydraulic structures, flood embankments, drainage channels, etc. have been prepared based on average unit rates for the above items of work that were evolved from the following schedules of rates (BWDB):

Faridpur O & M circle for 1988-1989,
Khulna O & M circle for 1992-1993,
Barisal O & M circle for 1988-1989 and
Bhola W.D circle for 1988-1989.

Where necessary the above schedules were adjusted to represent the mid 1991 BWDB rates.

Comparison of the schedules of rates of the above BWDB circles for the same year has shown that the unit rates of materials and items of works are fairly uniform for the whole SWA.

As per the FPCO guidelines, the cost estimates have been prepared on the basis of BWDB's schedules of rates of mid 1991.

For preparing the cost estimates of works relating to roads the latest available Schedule of Rates (1989-90) of the Roads and Highways Department for Khulna Zone which comprises Jessore and Barisal Road Circles, has been taken and updated to mid 1991.

The unit rates of 600mm dia and 900mm dia R.C.C pipes have been obtained from suppliers.

The unit rates of materials and item of works for mid 1991 are tabulated in Tables 9.1 and 9.2.

TABLE 9.1

Unit Rates of Some Major Construction Materials Updated to Mid 1991

Item No.	Materials	Unit	Unit Rate(Tk)
1	Cement & Aggregates :		
	Portland cement	kg	5.00
	Sand (Local)	m^3	285.00
	Stone/gravel	m^3	1,000.00
	Brick	1000 Nos.	2,200.00
	Brick khoa (including breaking)	m^3	620.00
2	Steel materials :		
	Reinforcement bar	ton	23,000.00
	Structural steel	ton	30,600.00
	Steel sheet pile	ton	24,600.00
3	Concrete Products :		
	R.C Pipe (d = 600 mm)	m	900.00
	R.C Pipe (d = 900 mm)	m	1,980.00
4	Others :		
	Timber (Class-a)	m^3	22,400.00
	Timber (Class-b)	m^3	18,300.00
	Bitumen	ton	25,500.00

TABLE 9.2

Unit Rates of Some Items of Works Updated to Mid 1991

Item No.	Items of Works	Unit	Unit Rate (Tk)
1	Jungle cutting/Scrub Clearing & stripping	m^3	0.50
2	Earthwork in embankment construction including borrowing and transporting from borrowpit, spreading clod breaking and rough dressing to required profile for initial 30 m lead and 1.5 m lift.	m^3	16.50
3	Extra over item 2 for manual compaction.	m^3	4.00
4	Extra over item 2 for mechanical compaction.	m^3	6.00
5	Extra over item 2 for additional lead of every 15 m beyond the initial lead of 30m.	m^3	2.50
6	Extra over item 2 for additional lift of every 1 m beyond the initial lift of 1.5 m.	m^3	1.50
7	Fine dressing and close turfing.	sqm	2.00
8	Earth work for drainage channels/canals including excavation to required profile and formation of embankment/dyke as item 2.	m^3	20.00
9	Earthwork in foundation excavation for hydraulic structures including levelling, dressing and placing within 30 m lead and 1.5 m lift.	m^3	23.50
10	Backfilling of hydraulic structures by earth.	m^3	21.50
11	Backfilling of hydraulic structures by sand	m^3	183.00
12	Land acquisition	ha	250,000.00
13	Form Work	m^2	209.00
14	Mass Concrete or C.C (1:3:6)	m^3	1,820.00
15	R.C Concrete (1:2:4)	m^3	2,480.00
16	M.S Reinforcement	kg	26.50
17	PVC Water stop	m	960.00
18	Khoa (Brick chip) filter bed	m^3	735.00
19	Supplying and placing brick block (38 cm x 38 cm x 30 cm)	m^2	500.00
20	Supplying and placing brick block (38 cm x 38 x 23 cm)	m^2	400.00
21	Steel Slide gate (1.63 m x 1.93 m)	Nos.	60,000.00
22	Steel flap gate (1.63 m x 1.93 m)	Nos.	26,000.00
23	Steel channel for slide gate (1.63 m x 1.93 m)	Nos.	41000.00
24	Fall board/stop log (wooden)	m^3	31,500.00
25	0.6 m dia R.C.C Pipe	m	900.00
26	0.9 m dia R.C.C Pipe	m	1980.00
27	Sand cushioning for sub-base with sand (F.M. 0.50)	m^3	203.00
28	Bricks on end edging (70mm across the road)	m	18.00
29	Bricks on edge pavement in herring bone bond on sand cushioning (F.M. 0.50)	m^2	116.00
30	Single brick flat soling .	m^2	68.00
31	Picked jhama 1st class brick chips [size 25 mm to 38 mm.	m^3	672.00
32	Labour for compaction of brick chips by power driven road roller.	m^3	57.00

9.3 Cost Estimation

On the basis of the above unit rates of materials and items of works the cost estimates for different types of works and structures in a water related project in the study area such as new flood embankments, repairing and resectioning of existing khals and embankments, slop protection of embankment, water bond macadam road and herring bone bond road, sluice gates, etc. have been computed and tabulated in the following Tables.

TABLE 9.3

Volumes of Earthwork for Embankments Adapting Manual Compaction (Per Meter Length)

Height H (m)	Bottom width B (m)	Design Volume VD (m^3/m)	Construction Volume VC (m^3/m)	Bottom Width of borrow pit X (m)	Lead LD (m)	Lift HL (m)	Turfing TF (m^2/m)	Land acquisition width LA (m)	Earth work for fisheries development VF (m^3/m)
1.5	11.8	12.1	13.3	7.4	17.8	1.5	9.1	32.7	1.3
2.5	16.8	26.4	29.0	17.8	26.1	2.0	14.5	48.1	2.9
3.0	19.3	35.4	38.9	24.5	30.9	2.3	17.2	57.3	3.9
3.5	21.8	45.7	50.2	32.0	36.1	2.5	19.9	67.3	5.0
4.5	26.8	70.0	77.0	52.8	49.6	3.0	25.3	93.1	7.7
5.0	29.3	84.0	92.4	60.1	54.7	3.3	28.1	102.9	9.2
5.5	31.8	99.8	109.2	71.3	61.8	3.5	30.7	116.6	10.1

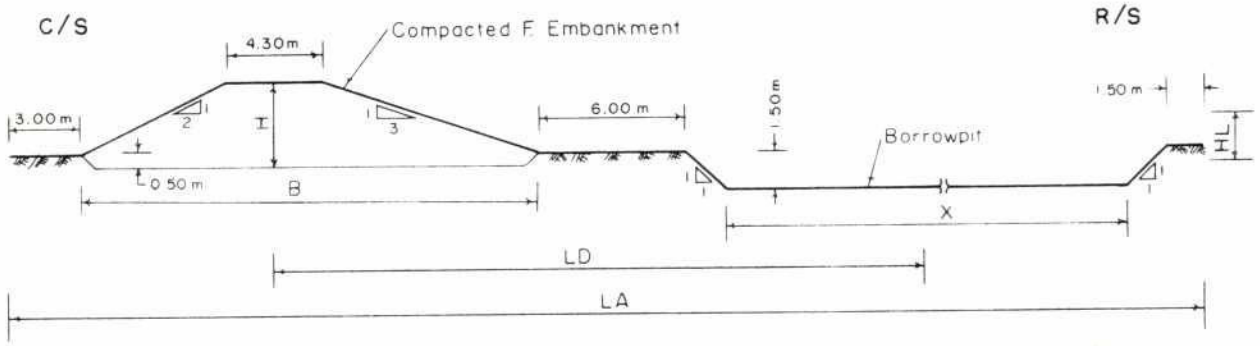


Figure - 9.1

Reference to Figure - 9.1
Bottom width, B = 4.3 + 5H
Design Volume, VD = H(4.3 + 2.5H)
Construction Volume, VC = 1.10VD (To allow for volume reduction due to foundation settlement and future embankment consolidation).

Bottom width of borrow pit, X = (VC/1.5) - 1.5 (Considering percentage of manual compaction is equal to percentage of bulking of borrowed soil).

Lead, LD = 3H + X/2 + 9.65
Lift, HL = (H + 1.5)/2
Turfing, TF = 5.4H + 1 (Considering 0.5m extra turfing on either side of crest width).

Land acquisition width, LA = B + X + 13.5
Earth work for Fisheries Development, VF = 0.1 VC.

TABLE 9.4

Volumes of Earthwork for Embankments Adapting Machine Compaction (Per Meter Length)

Height H (m)	Bottom width B (m)	Design Volume VD (m3/m)	Construction Volume VC (m3/m)	Bottom Width of borrow pit X (m)	Lead LD (m)	Lift HL (m)	Turfing TF (m^2/m)	Land acquisition width LA (m)	Earth work for fisheries development VF (m^3/m)
1.5	11.8	12.1	12.1	7.5	17.9	1.5	9.1	32.8	1.2
2.5	16.8	26.4	26.4	18.1	26.2	2.0	14.5	48.4	2.6
3.0	19.3	35.4	35.4	24.7	31.0	2.3	17.2	57.5	3.5
3.5	21.8	45.7	45.7	32.4	36.4	2.5	19.9	67.7	4.6
4.5	26.8	70.0	70.0	50.3	48.3	3.0	25.3	90.6	7.0
5.0	29.3	84.0	84.0	60.7	55.0	3.3	28.0	103.5	8.4
5.5	31.8	99.3	99.3	72.0	62.2	3.5	30.7	117.3	9.9

Reference to Figure - 9.1
Bottom width, $B = 4.3 + 5H$
Design Volume, $VD = H(4.3 + 2.5H)$
Construction Volume, $VC = VD$
Bottom width of borrow pit, $X = VC/1.35) - 1.5$ (Considering machine compaction achieves 10% extra consolidation than natural soil).

Lead, $LD = 3H + X/2 + 9.65$
Lift, $HL = (H + 1.5)/2$
Turfing, $TF = 5.4H + 1$ (Considering 0.5m extra turfing on either side of crest width)
Land acquisition width, $LA = B + X + 13.5$
Earthwork for Fisheries Development, $VF = 0.1VC$

TABLE 9.5

Cost of Earthwork (per meter run and per meter cube) for Different Heights of Embankment.

Height of Embankment (m)	Manual compaction		Mechanical Compaction	
	Cost per Meter Run (Tk)	Cost per m^3 (Tk)	Cost per Meter Run (Tk)	Cost per m^3 (Tk)
1.5	1147.00	24.80	1147.00	27.10
2.5	1942.00	25.50	1941.00	27.70
3.0	2513.00	27.80	2497.00	29.95
3.5	3069.00	27.60	3053.00	29.80
4.5	4746.00	31.40	4612.00	33.60
5.0	5465.00	31.30	5187.00	33.45
5.5	6600.00	33.75	6494.00	35.90

TABLE 9.6

Volumes of Earthwork for Repairing Embankments Adapting Manual Compaction (Per Meter Length)

Design Height H2 (m)	Existing Height H1 (m)	Height of Fill above Crest h (m)	Bottom Width of Design Section B2 (m)	Bottom Width of Existing Section B1 (m)	Bottom with of Existing Borrow pit X (m)	Volume of Stepping V1 (m^3/m)	Construction Volume Excluding Stepping V2 (m^3/m)	Construction Volume VC (m^3/m)	Lead LD (m)	Lift HL (m)	Turfing TF (m^3/m)
5.0	4.7	0.3	29.3	21.8	54.0	1.6	25.7	27.3	51.6	4	28
5.0	4.4	0.6	29.3	20.6	54.0	1.5	32.1	33.5	51.6	4	28
5.0	4.1	0.9	29.3	19.4	54.0	1.4	38.1	39.4	51.6	4	28
5.0	3.8	1.2	29.3	18.2	54.0	1.3	43.7	45.0	51.6	4	28
5.0	3.5	1.5	29.3	17.0	54.0	1.2	49.0	50.2	51.6	4	28
5.0	3.2	1.8	29.3	15.8	54.0	1.1	53.9	55.0	51.6	4	28
5.0	2.9	2.1	29.3	14.6	54.0	1.0	58.5	59.4	51.6	4	28
5.0	2.6	2.4	29.3	13.4	54.0	0.9	62.7	63.5	51.6	4	28

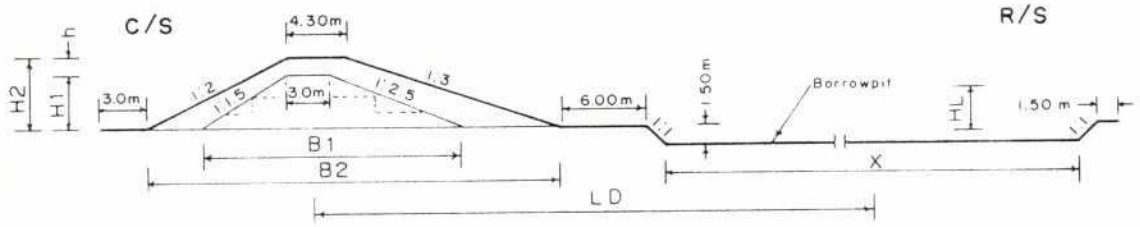


Figure - 9.2

Reference to Figure - 9.2
Height of fill above crest, h = H2 - H1
Bottom width of Design Section, L2 = 4.3 + 5H2
Bottom width of Existing Section, L1 = 3 + 4H1
Bottom width of Existing Borrow pit, X = (1.43 + 0.33L2) H2-1.5
Volume of Stepping, V1 = 0.33 H1 [Considering height of each step is 0.6m]
Construction Volume Excluding Stepping, V2 = (2.15 + 0.5L2) H2-(1.5 + 0.5L1)H1
Construction Volume, VC = V1 + V2
Lead, LD = X/2 + 3H2 + 9.65
Lift, HL = H2/2 + 1.5
Turfing, TF = 5.4 H2 + 1 [Considering 0.5m extra on either side of crest width]

TABLE 9.7

Cost for Resectioning of External Embankment.

Design Height (m)	Existing Height (m)	Height of fill (m)	Cost for Resectioning per km Length (M.TK)
5.0	2.6	2.4	3.13
5.0	3.8	1.2	2.45
3.5	1.5	2.0	1.79
3.5	2.5	1.0	1.38

Protection of Embankment by Brick Mattressing.

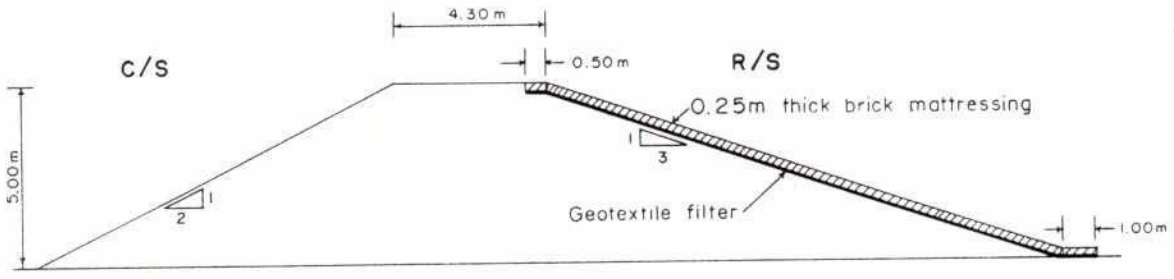


Figure – 9.3

TABLE 9.8

Cost for Protection of Embankment (by brick mattressing)

Items of Works	Quantity Per Km	Unit	Rate (Tk)	Cost for Protection per Km Length (M.Tk.)
Geotextile filter	17300	m^2	95.65	1.56
Wire netting	22000	No.	470.00	10.34
crates (0.9m X 0.9m X0.45m) Brick Bates in crates	4330	m^3	590.00	2.56
Total				14.46

Protection of Embankment by Geotextile.

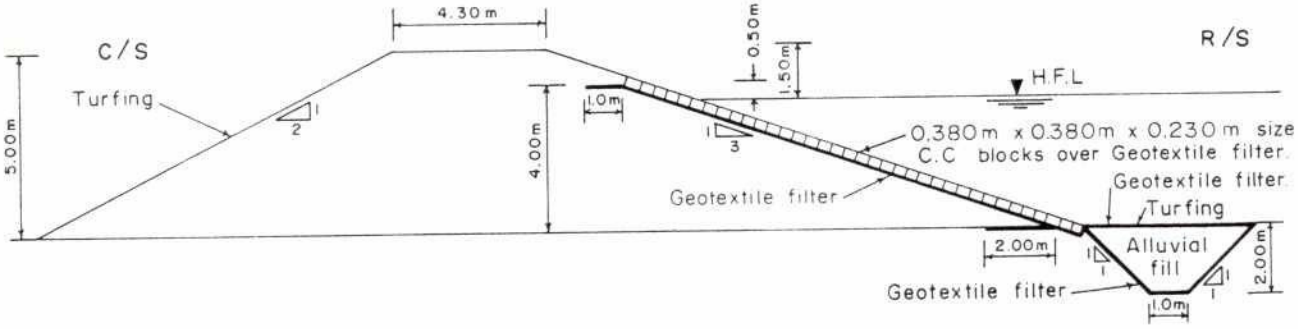


Figure – 9.4

TABLE 9.9

Cost of Geotextile for Protection of Embankment

Items of works	Quantity Per Km	Unit	Rate (Tk.)	Cost Per Km (M.Tk)
Brick block (0.38 X 0.38 X 0.23m)	90,000	No.	52.75	4.75
Labour for placing blocks	90,000	No.	2.88	0.26
Supplying and placing Geotextile	27,000	m^2	95.65	2.58
Excavation of Key Trench	6,000	m^3	16.15	0.10
Filling of Key Trench	6,000	m^3	16.45	0.10
Total				7.79

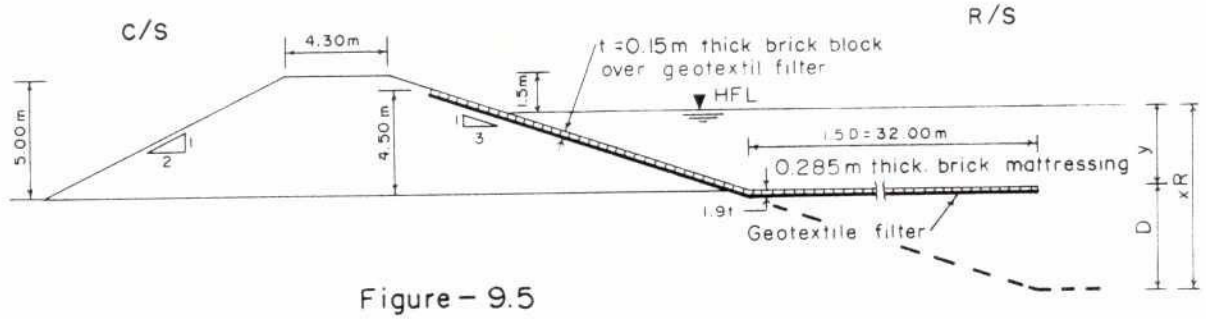


Figure – 9.5

TABLE 9.10

Cost for Protection of Embankment (Block at slope and brick mattressing in berm) Per Km Length

Item of work	Quantity Per Km	Unit	Rate (Tk.)	Cost Per Km Length (M.Tk)
Brick block including laying in position (0.51mX0.51mX0.15m)	55,000	No.	66.00	3.63
Wire netting Crate (0.9mX0.9mX0.45m)	40,000	No.	470.00	18.80
Brick bats in Crates	9,100	m^3	590.00	5.37
Geotextile filter	46,000	m^2	95.62	4.40
Land acquisition	3.5	ha	250,000.00	0.88
Total				33.08

TABLE 9.11

Cost for Protection of Embankment (Block both at slope & berm)

Items of works	Quantity Per Km	Unit	Rate (Tk.)	Amount (Lac Tk.)
Brick block including laying in position on slope (0.51mX0.51mX0.15m)	55,000	No.	66.00	3.63
Concrete block including laying in position on berm (0.38mX0.38mX0.30m)	228,000	No.	99.75	22.75
Geotextile filter	46,000	m^2	95.62	4.40
Land acquisition	3.5	ha	250,000	0.88
Total				31.66

Water Bound Mechadam Road.

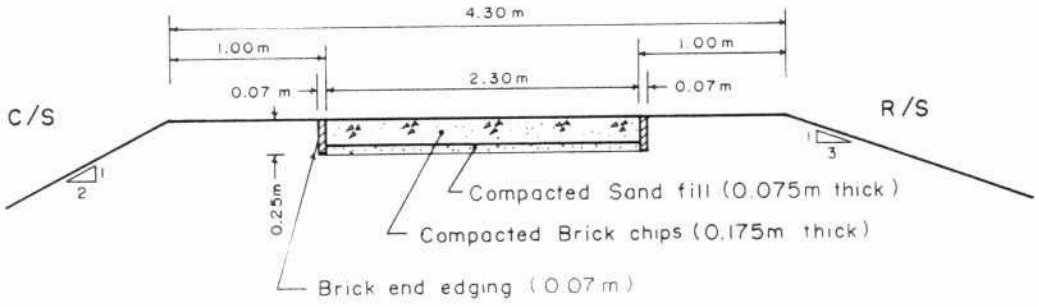


Figure – 9.6

TABLE 9.12

Cost of Water Bound Mechadam Road

Items of works	Quantity Per Km	Unit	Rate (Tk.)	Cost Per Km Length (M.Tk)
Sand Cushing for sub-base (F.M.0.50)	170	m^3	203.00	0.035
Brick on end edging (70 mm across the road)	2000	m	18.00	0.036
Brick Chips (25mm-38mm)	575	m^3	672.0	0.387
Compaction of brick Chips by power driven road roller	400	m^3	57.00	0.023
Total				0.481

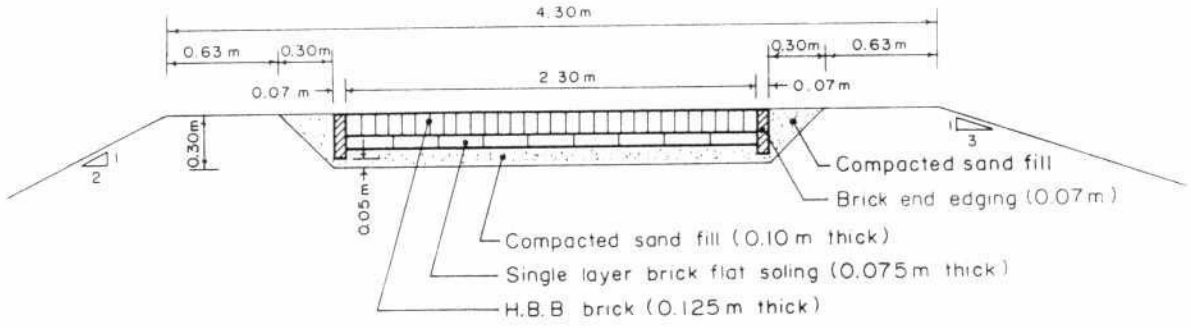


Figure – 9.7

TABLE 9.13

Cost of H.B.B Road

Items of works	Quantity Per Km	Unit	Rate (Tk.)	Cost per km Length (M.Tk)
Sand cushioning for Sub-base (F.M.0.50)	330	m^3	203.00	0.067
Brick on end edging (70 mm across the road)	2,000	m	18.00	0.036
Brick in herring bone bond	2,300	m^2	116.00	0.267
Single brick flat soling	2,300	m^2	68.00	0.157
Total				0.527

TABLE 9.14

Cost Estimate of Sluice Gate (1.52m X 1.83m)

Major Items of works	Quantity			Unit	Rate Tk.	Amount (Tk.)		
	1-Vent	3-Vent	5-Vent			1-Vent	3-Vent	5-Vent
Foundation Excavation	15.0	19.2	24.3	%m^3	2,350.00	35,250.00	45,120.00	57,105.00
Lean Concrete (1:3:6)	20.0	28.0	40.0	m^3	1,820.00	36,400.00	50,960.00	72,800.00
R C Concrete (1:2:4)	250.0	316.0	403.0	m^3	2,480.00	620,000.00	783,680.00	999,440.00
M.S. Reinforcement	190.0	250.6	320.0	%Kg	2,650.00	503,500.00	664,090.00	848,000.00
Form Work	1150.0	1182.0	1286.0	m^2	209.00	240,350.00	247,038.00	268,774.00
Back Filling by local sand	812.0	834.0	815.0	m^3	183.00	148,596.00	152,622.00	149,145.00
Sand Filter	30.0	36.0	41.0	m^3	183.00	5,490.00	6,588.00	19,803.00
Khoa-Filter Bed	22.0	24.0	27.0	m^3	735.00	16,170.00	17,640.00	19,845.00
Pitching Block (C.C)	160.0	170.0	190.0	m^2	500.00	80,000.00	85,000.00	95,000.00
PVC Water stop	28.0	31.0	49.0	m	960.00	26,880.00	29,760.00	47,040.00
Steel Sheet Piles	105.0	114.0	129.0	m^2	3,000.00	315,000.00	342,000.00	387000.00
Foundation Treatment	L.S	L.S	L.S	--	L.S	100,000.00	300,000.00	500,000.00
Steel Flap Gate (1.62mX1.93m)	1	3	5	Nos.	20,000.00	20,000.00	60,000.00	100,000.00
Steel slide Gate (1.62mX1.93m)	1	3	5	Nos.	60,000.00	60,000.00	180,000.00	300,000.00
Steel Channel for slide gate (1.62mX1.93m)	1	3	5	Nos.	41,000.00	41,000.00	123,000.00	205,000.00
Flood Embankment Construction	3.5	4.0	4.5	%m^3	2,450.00	8,575.00	9,800.00	11,025.00
Turfing	2.0	2.5	2.5	%m^2	200.00	400.00	500.00	500.00
Ring Bund construction	84.5	84.5	84.5	%m^3	1,650.00	139,425.00	139,425.00	139,425.00
Diversion Channel	45.0	55.3	64.7	%m^3	2,000.00	90,000.00	110,600.00	129,400.00
Dewatering	L.S	L.S	L.S	--	L.S	100,000.00	150,000.00	200,000.00
Others	L.S	L.S	L.S	--	L.S	100,000.00	150,000.00	200,000.00
Total						2687,000.00	3647,800.00	4749,300.00

Appendices

APPENDIX A

River Stage and Flow Data

APPENDICES

Table A1	Water Level (m.PWD) for January 1982
Table A2	Water Level (m.PWD) for February 1982
Table A3	Water Level (m.PWD) for March 1982
Table A4	Water Level (m.PWD) for April 1982
Table A5	Water Level (m.PWD) for May 1982
Table A6	Water Level (m.PWD) for June 1982
Table A7	Water Level (m.PWD) for July 1982
Table A8	Water Level (m.PWD) for August 1982
Table A9	Water Level (m.PWD) for September 1982
Table A10	Water Level (m.PWD) for October 1982
Table A11	Water Level (m.PWD) for November 1982
Table A12	Water Level (m.PWD) for December 1982
Table A13	Water Level (m.PWD) for January 1983
Table A14	Water Level (m.PWD) for February 1983
Table A15	Water Level (m.PWD) for March 1983
Table A16	Annual Maximum Water Level (m.PWD)
Table A17	1982-83 Monthly Flow (m^3/s)
Table A18	1982-83 Monthly Flow (m^3/s)

Figure A1	Location of Water Level Assessment
Figure A2	Location of River Flow Assessment

TABLE A1

Water Level (m.PWD) for January 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.76	0.56	0.66	66	PALANG	20.010	0.92	0.69	0.81
2	KOBADAK	109.500	1.06	0.22	0.60	67	NARIA-KH	0.000	1.55	0.43	0.92
3	BETNA	47.000	1.79	0.55	1.03	68	KUMAR-1	0.000	1.10	0.92	1.02
4	LABANGABATI	8.750	1.59	0.04	0.70	69	KUMAR-1	12.300	0.93	0.81	0.87
5	KHOLPETUA	21.000	1.92	-1.33	0.26	70	KUMAR-1	20.500	0.60	0.48	0.53
6	MALANCHA	0.000	1.59	-1.06	0.25	71	KUMAR-2	0.000	0.60	0.48	0.53
7	L_SOLMARI	8.500	1.81	-0.81	0.39	72	KUMAR-2	10.333	1.00	0.51	0.68
8	SALTA	0.000	2.08	-1.36	0.33	73	TORKI-1	20.430	0.76	0.45	0.60
9	RUPSA	4.194	1.77	-0.73	0.41	74	TORKI-2	0.000	1.08	0.16	0.59
10	KAZIBACHA	15.000	1.78	-0.99	0.33	75	BISHKANDIA	31.500	1.21	-0.70	0.25
11	SIBSA	21.915	1.80	-1.31	0.25	76	UZIRPUR	0.000	1.03	-0.35	0.35
12	SIBSA	45.265	1.67	-1.19	0.25	77	UZIRPUR	10.500	1.08	-0.45	0.32
13	PUSSUR	16.835	1.71	-1.06	0.30	78	SHANDHA	5.500	1.10	-0.49	0.30
14	PUSSUR	65.995	1.50	-1.02	0.24	79	SHIKARPUR	0.000	1.00	-0.20	0.43
15	PUSSUR	98.210	1.40	-0.89	0.24	80	AMTALI	3.500	0.99	-0.22	0.41
16	NABAGANGA_L	29.000	1.33	-0.30	0.46	81	AMTALI	10.500	1.00	-0.28	0.37
17	NABAGANGA_M	17.250	1.33	-0.28	0.47	82	LOWERMEGHNA	19.000	1.47	0.16	0.77
18	KATAKHALI-SW	13.500	1.41	-0.19	0.53	83	LOWERMEGHNA	41.250	1.52	0.02	0.70
19	CHUNKURI	6.000	1.76	-0.99	0.35	84	JOYANTI-1	6.500	1.46	0.07	0.71
20	HARIA	18.500	1.93	-1.36	0.29	85	JOYANTI-1	13.010	1.46	0.06	0.71
21	MADHUMATI	82.000	1.11	1.08	1.09	86	JOYANTI-2	5.667	1.46	0.06	0.71
22	MADHUMATI	108.000	0.88	0.82	0.85	87	S-MEGHNA	3.500	1.40	0.04	0.65
23	MADHUMATI	149.500	0.74	0.42	0.57	88	S-MEGHNA1	10.000	1.59	-0.09	0.65
24	MADHUMATI	181.500	1.25	-0.18	0.49	89	NAYABHANGANI	0.000	1.40	0.05	0.66
25	MADHUMATI	205.000	0.57	0.46	0.52	90	NAYABHANGANI	14.500	1.34	-0.01	0.58
26	MADHUMATI	207.000	0.60	0.19	0.40	91	DHARMAGANJ	4.000	1.35	-0.17	0.54
27	MADHUMATI	248.375	0.59	0.17	0.37	92	DHARMAGANJ	8.000	1.33	-0.17	0.53
28	POYLAHARA	10.000	1.31	-0.49	0.35	93	DHARMAGANJ	15.000	1.31	-0.18	0.52
29	GASHIAKHALI	10.500	1.42	-0.70	0.31	94	KALABADAR-1	9.000	1.26	-0.16	0.51
30	BHAIRAB	8.500	1.09	0.08	0.48	95	KALABADAR-2	10.000	1.42	-0.25	0.53
31	ATHAROBANKI	32.000	1.43	-0.15	0.55	96	ILSHA	25.500	1.22	-0.20	0.48
32	BALESWAR	64.000	1.28	-0.66	0.30	97	SHAHABAZ-1	4.167	1.79	-0.38	0.56
33	BALESWAR	93.000	1.38	-0.67	0.29	98	SHAHABAZ-1	12.500	1.73	-0.46	0.53
34	KALIGANGA	21.800	0.89	-0.18	0.32	99	TENTULIA	8.000	1.06	-0.15	0.43
35	BHAIRAB U	39.853	0.60	0.53	0.57	100	RANGAMATIA	3.360	1.09	-0.16	0.45
36	BHAIRAB U	123.000	1.36	-0.26	0.49	101	KIRTONKHOLA	14.000	1.07	-0.28	0.41
37	KALIGANGA U	17.333	4.62	4.61	4.61	102	KIRTONKHOLA	24.000	1.07	-0.33	0.39
38	CHITRA	131.500	1.06	-0.01	0.50	103	BISHKHALI	3.250	1.23	-0.52	0.34
39	CHITRA	151.505	1.19	-0.17	0.48	104	BISHKHALI	21.500	1.28	-0.62	0.31
40	NABAGANGA_U	98.000	1.83	1.82	1.82	105	BISHKHALI	44.500	1.45	-0.79	0.28
41	NABAGANGA_U	123.000	1.17	0.80	0.94	106	BISHKHALI	70.000	1.45	-0.86	0.26
42	NABAGANGA_U	164.000	0.94	0.24	0.56	107	BISHKHALI	86.500	1.44	-0.92	0.23
43	CHANDANA	39.100	2.47	2.46	2.46	108	KHAIRABAD	31.000	1.22	-0.48	0.33
44	KUMAR	42.900	0.75	0.74	0.74	109	PANDAB-1	4.250	1.15	-0.43	0.35
45	KUMAR	99.300	0.57	0.47	0.52	110	DHULIA	9.750	0.95	-0.17	0.40
46	SITALAKHYA	0.000	0.81	0.80	0.80	111	DHULIA	23.000	1.05	-0.27	0.37
47	SITALAKHYA	24.800	0.78	0.77	0.77	112	PAIRA	19.175	1.31	-0.55	0.32
48	SITALAKHYA	46.000	0.73	0.72	0.73	113	PAIRA	24.000	1.36	-0.64	0.30
49	MBR	0.000	0.60	0.48	0.53	114	BURISWAR	5.000	1.37	-0.66	0.29
50	BARASIA_ARBT	25.500	0.68	0.44	0.57	115	BURISWAR	30.000	1.40	-0.82	0.25
51	GORAI	13.000	5.31	5.28	5.29	116	BURISWAR	37.500	1.41	-0.85	0.25
52	GORAI	82.000	1.11	1.08	1.09	117	BURISWAR	47.000	1.44	-0.92	0.23
53	ARIALKHAN	9.000	1.56	1.28	1.43	118	PATUAKHALI	0.000	1.15	-0.41	0.32
54	ARIALKHAN	30.500	1.15	0.95	1.06	119	LOHALIA	19.625	1.14	-0.39	0.32
55	ARIALKHAN	53.000	1.02	0.45	0.72	120	LOHALIA	23.000	1.15	-0.41	0.32
56	ARIALKHAN	64.000	1.03	0.30	0.64	121	LOHALIA	32.500	1.14	-0.38	0.32
57	ARIALKHAN	101.000	1.08	0.16	0.59	122	LOHALIA	63.000	1.07	-0.30	0.32
58	ARIALKHAN	125.500	1.00	-0.21	0.43	123	PADMA	48.000	1.74	1.34	1.52
59	ARIALKHAN	143.000	1.09	-0.24	0.43	124	PADMA	54.000	1.70	1.22	1.43
60	ARIALKHAN	149.500	1.15	-0.18	0.46	125	PADMA	90.000	1.55	0.43	0.92
61	ARIALKHAN	161.000	1.11	-0.17	0.46	126	TENTULIA	68.333	0.78	-0.09	0.33
62	ARIALKHAN-L	0.000	1.66	1.09	1.33	127	SWARUPKATI	0.000	1.15	-0.66	0.25
63	ARIALKHAN-L	6.000	0.99	0.94	0.96	128	SWARUPKATI	8.500	1.17	-0.71	0.24
64	ARIALKHAN-L	16.000	0.99	0.93	0.96	129	SWARUPKATI	14.500	1.16	-0.72	0.24
65	ARIALKHAN-L	26.000	1.05	0.81	0.93	130	SWARUPKATI	16.500	1.17	-0.72	0.24

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a1]

TABLE A2

Water Level (m.PWD) for February 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.67	0.48	0.58	66	PALANG	20.010	0.71	0.42	0.57
2	KOBADAK	109.500	0.94	0.16	0.53	67	NARIA-KH	0.000	1.28	0.22	0.71
3	BETNA	47.000	1.66	0.51	0.97	68	KUMAR-1	0.000	0.86	0.70	0.79
4	LABANGABATI	8.750	1.43	0.01	0.63	69	KUMAR-1	12.300	0.70	0.61	0.66
5	KHOLPETUA	21.000	1.79	-1.34	0.18	70	KUMAR-1	20.500	0.49	0.38	0.43
6	MALANCHA	0.000	1.44	-1.08	0.17	71	KUMAR-2	0.000	0.49	0.38	0.43
7	L_SOLMARI	8.500	1.64	-0.85	0.30	72	KUMAR-2	10.333	0.90	0.41	0.59
8	SALTA	0.000	1.93	-1.37	0.24	73	TORKI-1	20.430	0.57	0.33	0.46
9	RUPSA	4.194	1.61	-0.78	0.32	74	TORKI-2	0.000	0.88	0.04	0.44
10	KAZIBACHA	15.000	1.61	-1.02	0.25	75	BISHKANDIA	31.500	1.11	-0.71	0.19
11	SIBSA	21.915	1.66	-1.32	0.17	76	UZIRPUR	0.000	0.92	-0.40	0.27
12	SIBSA	45.265	1.51	-1.21	0.17	77	UZIRPUR	10.500	0.98	-0.48	0.24
13	PUSSUR	16.835	1.54	-1.08	0.21	78	SHANDHA	5.500	1.00	-0.52	0.23
14	PUSSUR	65.995	1.35	-1.04	0.16	79	SHIKARPUR	0.000	0.86	-0.27	0.33
15	PUSSUR	98.210	1.25	-0.91	0.16	80	AMTALI	3.500	0.86	-0.29	0.31
16	NABAGANGA_L	29.000	1.19	-0.37	0.37	81	AMTALI	10.500	0.88	-0.34	0.29
17	NABAGANGA_M	17.250	1.19	-0.35	0.37	82	LOWERMEGHNA	19.000	1.21	-0.01	0.57
18	KATAKHALI-SW	13.500	1.25	-0.25	0.42	83	LOWERMEGHNA	41.250	1.27	-0.12	0.52
19	CHUNKURI	6.000	1.60	-1.02	0.26	84	JOYANTI-1	6.500	1.22	-0.08	0.54
20	HARIA	18.500	1.77	-1.37	0.20	85	JOYANTI-1	13.010	1.22	-0.09	0.54
21	MADHUMATI	82.000	0.74	0.72	0.73	86	JOYANTI-2	5.667	1.22	-0.09	0.54
22	MADHUMATI	108.000	0.64	0.56	0.60	87	S-MEGHNA	3.500	1.19	-0.10	0.49
23	MADHUMATI	149.500	0.61	0.30	0.44	88	S-MEGHNA1	10.000	1.35	-0.22	0.48
24	MADHUMATI	181.500	1.11	-0.27	0.38	89	NAYABHANGANI	0.000	1.18	-0.10	0.50
25	MADHUMATI	205.000	0.46	0.37	0.42	90	NAYABHANGANI	14.500	1.13	-0.12	0.44
26	MADHUMATI	207.000	0.50	0.12	0.32	91	DHARMAGANJ	4.000	1.16	-0.26	0.41
27	MADHUMATI	248.375	0.50	0.11	0.30	92	DHARMAGANJ	8.000	1.14	-0.26	0.40
28	POYLAHARA	10.000	1.19	-0.51	0.29	93	DHARMAGANJ	15.000	1.11	-0.26	0.39
29	GASHIAKHALI	10.500	1.31	-0.71	0.25	94	KALABADAR-1	9.000	1.08	-0.25	0.38
30	BHAIRAB	8.500	0.96	0.05	0.42	95	KALABADAR-2	10.000	1.21	-0.33	0.39
31	ATHAROBANKI	32.000	1.27	-0.20	0.45	96	ILSHA	25.500	1.03	-0.28	0.36
32	BALESWAR	64.000	1.18	-0.67	0.26	97	SHAHABAZ-1	4.167	1.54	-0.49	0.41
33	BALESWAR	93.000	1.28	-0.68	0.25	98	SHAHABAZ-1	12.500	1.47	-0.57	0.38
34	KALIGANGA	21.800	0.80	-0.22	0.26	99	TENTULIA	8.000	0.88	-0.23	0.32
35	BHAIRAB U	39.853	0.51	0.45	0.49	100	RANGAMATIA	3.360	0.92	-0.24	0.33
36	BHAIRAB U	123.000	1.22	-0.32	0.40	101	KIRTONKHOLA	14.000	0.93	-0.34	0.32
37	KALIGANGA U	17.333	4.61	4.60	4.60	102	KIRTONKHOLA	24.000	0.97	-0.39	0.30
38	CHITRA	131.500	0.92	-0.08	0.41	103	BISHKHALI	3.250	1.15	-0.55	0.27
39	CHITRA	151.505	1.06	-0.25	0.39	104	BISHKHALI	21.500	1.20	-0.64	0.25
40	NABAGANGA_U	98.000	1.65	1.65	1.65	105	BISHKHALI	44.500	1.35	-0.80	0.23
41	NABAGANGA_U	123.000	1.04	0.62	0.79	106	BISHKHALI	70.000	1.34	-0.85	0.22
42	NABAGANGA_U	164.000	0.79	0.18	0.47	107	BISHKHALI	86.500	1.33	-0.89	0.20
43	CHANDANA	39.100	2.46	2.45	2.46	108	KHAIRABAD	31.000	1.11	-0.52	0.26
44	KUMAR	42.900	0.57	0.57	0.57	109	PANDAB-1	4.250	1.05	-0.47	0.27
45	KUMAR	99.300	0.46	0.37	0.42	110	DHULIA	9.750	0.82	-0.24	0.31
46	SITALAKHYA	0.000	0.62	0.61	0.61	111	DHULIA	23.000	0.93	-0.33	0.28
47	SITALAKHYA	24.800	0.60	0.59	0.59	112	PAIRA	19.175	1.20	-0.58	0.25
48	SITALAKHYA	46.000	0.56	0.56	0.56	113	PAIRA	24.000	1.25	-0.66	0.24
49	MBR	0.000	0.49	0.38	0.43	114	BURISWAR	5.000	1.26	-0.68	0.23
50	BARASIA_ARBT	25.500	0.55	0.32	0.45	115	BURISWAR	30.000	1.30	-0.81	0.21
51	GORAI	13.000	5.00	4.97	4.99	116	BURISWAR	37.500	1.32	-0.85	0.21
52	GORAI	82.000	0.74	0.72	0.73	117	BURISWAR	47.000	1.33	-0.89	0.20
53	ARIALKHAN	9.000	1.25	0.97	1.12	118	PATUAKHALI	0.000	1.04	-0.47	0.23
54	ARIALKHAN	30.500	0.90	0.73	0.82	119	LOHALIA	19.625	1.02	-0.46	0.24
55	ARIALKHAN	53.000	0.82	0.28	0.55	120	LOHALIA	23.000	1.04	-0.47	0.23
56	ARIALKHAN	64.000	0.83	0.15	0.49	121	LOHALIA	32.500	1.02	-0.46	0.23
57	ARIALKHAN	101.000	0.88	0.04	0.44	122	LOHALIA	63.000	0.92	-0.39	0.22
58	ARIALKHAN	125.500	0.86	-0.28	0.33	123	PADMA	48.000	1.42	1.01	1.19
59	ARIALKHAN	143.000	0.93	-0.31	0.33	124	PADMA	54.000	1.39	0.90	1.12
60	ARIALKHAN	149.500	0.98	-0.26	0.34	125	PADMA	90.000	1.28	0.22	0.71
61	ARIALKHAN	161.000	0.94	-0.25	0.33	126	TENTULIA	68.333	0.62	-0.17	0.22
62	ARIALKHAN-L	0.000	1.37	0.79	1.05	127	SWARUPKATI	0.000	1.06	-0.68	0.20
63	ARIALKHAN-L	6.000	0.81	0.77	0.79	128	SWARUPKATI	8.500	1.08	-0.72	0.19
64	ARIALKHAN-L	16.000	0.81	0.77	0.79	129	SWARUPKATI	14.500	1.08	-0.73	0.18
65	ARIALKHAN-L	26.000	0.83	0.61	0.72	130	SWARUPKATI	16.500	1.08	-0.72	0.19

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a2]

TABLE A3

Water Level (m.PWD) for March 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.61	0.43	0.52	66	PALANG	20.010	0.81	0.56	0.69
2	KOBADAK	109.500	0.85	0.13	0.46	67	NARIA-KH	0.000	1.38	0.37	0.84
3	BETNA	47.000	1.55	0.48	0.92	68	KUMAR-1	0.000	0.98	0.82	0.91
4	LABANGABATI	8.750	1.31	-0.03	0.56	69	KUMAR-1	12.300	0.80	0.71	0.76
5	KHOLPETUA	21.000	1.66	-1.35	0.12	70	KUMAR-1	20.500	0.51	0.40	0.45
6	MALANCHA	0.000	1.32	-1.09	0.11	71	KUMAR-2	0.000	0.51	0.40	0.45
7	L_SOLMARI	8.500	1.51	-0.88	0.23	72	KUMAR-2	10.333	0.92	0.45	0.62
8	SALTA	0.000	1.80	-1.38	0.18	73	TORKI-1	20.430	0.66	0.42	0.55
9	RUPSA	4.194	1.48	-0.81	0.25	74	TORKI-2	0.000	0.93	0.17	0.53
10	KAZIBACHA	15.000	1.48	-1.04	0.18	75	BISHKANDIA	31.500	1.13	-0.65	0.23
11	SIBSA	21.915	1.53	-1.33	0.11	76	UZIRPUR	0.000	0.94	-0.32	0.32
12	SIBSA	45.265	1.39	-1.21	0.11	77	UZIRPUR	10.500	0.99	-0.41	0.28
13	PUSSUR	16.835	1.40	-1.09	0.15	78	SHANDHA	5.500	1.01	-0.44	0.28
14	PUSSUR	65.995	1.22	-1.04	0.09	79	SHIKARPUR	0.000	0.88	-0.18	0.39
15	PUSSUR	98.210	1.12	-0.91	0.10	80	AMTALI	3.500	0.88	-0.20	0.37
16	NABAGANGA_L	29.000	1.07	-0.42	0.29	81	AMTALI	10.500	0.90	-0.26	0.34
17	NABAGANGA_M	17.250	1.08	-0.41	0.30	82	LOWERMEGHNA	19.000	1.29	0.13	0.69
18	KATAKHALI-SW	13.500	1.14	-0.29	0.36	83	LOWERMEGHNA	41.250	1.33	0.02	0.63
19	CHUNKURI	6.000	1.47	-1.03	0.19	84	JOYANTI-1	6.500	1.28	0.06	0.65
20	HARIA	18.500	1.66	-1.38	0.14	85	JOYANTI-1	13.010	1.28	0.05	0.64
21	MADHUMATI	82.000	0.56	0.53	0.55	86	JOYANTI-2	5.667	1.28	0.05	0.64
22	MADHUMATI	108.000	0.51	0.43	0.47	87	S-MEGHNA	3.500	1.24	0.03	0.59
23	MADHUMATI	149.500	0.51	0.23	0.36	88	S-MEGHNA1	10.000	1.41	-0.09	0.58
24	MADHUMATI	181.500	1.01	-0.33	0.31	89	NAYABHANGANI	0.000	1.23	0.04	0.60
25	MADHUMATI	205.000	0.48	0.39	0.44	90	NAYABHANGANI	14.500	1.17	-0.01	0.53
26	MADHUMATI	207.000	0.52	0.16	0.35	91	DHARMAGANJ	4.000	1.19	-0.16	0.49
27	MADHUMATI	248.375	0.52	0.14	0.33	92	DHARMAGANJ	8.000	1.18	-0.16	0.47
28	POYLAHARA	10.000	1.13	-0.49	0.27	93	DHARMAGANJ	15.000	1.16	-0.16	0.46
29	GASHIAKHALI	10.500	1.26	-0.65	0.27	94	KALABADAR-1	9.000	1.11	-0.15	0.45
30	BHAIRAB	8.500	0.92	0.04	0.40	95	KALABADAR-2	10.000	1.24	-0.23	0.47
31	ATHAROBANKI	32.000	1.15	-0.24	0.38	96	ILSHA	25.500	1.06	-0.19	0.42
32	BALESWAR	64.000	1.17	-0.62	0.28	97	SHAHABAZ-1	4.167	1.57	-0.36	0.50
33	BALESWAR	93.000	1.25	-0.62	0.27	98	SHAHABAZ-1	12.500	1.50	-0.44	0.47
34	KALIGANGA	21.800	0.81	-0.18	0.29	99	TENTULIA	8.000	0.91	-0.14	0.38
35	BHAIRAB U	39.853	0.44	0.38	0.41	100	RANGAMATIA	3.360	0.94	-0.15	0.40
36	BHAIRAB U	123.000	1.11	-0.37	0.32	101	KIRTONKHOLA	14.000	0.94	-0.25	0.37
37	KALIGANGA U	17.333	4.62	4.61	4.61	102	KIRTONKHOLA	24.000	0.97	-0.30	0.35
38	CHITRA	131.500	0.82	-0.13	0.34	103	BISHKHALI	3.250	1.15	-0.48	0.31
39	CHITRA	151.505	0.95	-0.30	0.31	104	BISHKHALI	21.500	1.20	-0.57	0.29
40	NABAGANGA_U	98.000	1.71	1.70	1.70	105	BISHKHALI	44.500	1.33	-0.73	0.26
41	NABAGANGA_U	123.000	0.93	0.64	0.76	106	BISHKHALI	70.000	1.30	-0.78	0.25
42	NABAGANGA_U	164.000	0.69	0.14	0.40	107	BISHKHALI	86.500	1.27	-0.81	0.23
43	CHANDANA	39.100	2.46	2.45	2.46	108	KHAIRABAD	31.000	1.10	-0.44	0.31
44	KUMAR	42.900	0.55	0.54	0.54	109	PANDAB-1	4.250	1.05	-0.39	0.31
45	KUMAR	99.300	0.48	0.39	0.44	110	DHULIA	9.750	0.83	-0.16	0.36
46	SITALAKHYA	0.000	0.62	0.62	0.62	111	DHULIA	23.000	0.93	-0.25	0.33
47	SITALAKHYA	24.800	0.59	0.59	0.59	112	PAIRA	19.175	1.18	-0.50	0.29
48	SITALAKHYA	46.000	0.55	0.54	0.55	113	PAIRA	24.000	1.24	-0.59	0.28
49	MBR	0.000	0.51	0.40	0.45	114	BURISWAR	5.000	1.25	-0.61	0.27
50	BARASIA_ARBT	25.500	0.46	0.25	0.36	115	BURISWAR	30.000	1.27	-0.74	0.24
51	GORAI	13.000	4.75	4.74	4.74	116	BURISWAR	37.500	1.28	-0.77	0.24
52	GORAI	82.000	0.56	0.53	0.55	117	BURISWAR	47.000	1.27	-0.81	0.23
53	ARIALKHAN	9.000	1.40	1.15	1.28	118	PATUAKHALI	0.000	1.05	-0.40	0.28
54	ARIALKHAN	30.500	1.01	0.85	0.94	119	LOHALIA	19.625	1.03	-0.38	0.28
55	ARIALKHAN	53.000	0.90	0.39	0.65	120	LOHALIA	23.000	1.05	-0.40	0.28
56	ARIALKHAN	64.000	0.90	0.27	0.58	121	LOHALIA	32.500	1.04	-0.38	0.28
57	ARIALKHAN	101.000	0.93	0.17	0.53	122	LOHALIA	63.000	0.93	-0.31	0.26
58	ARIALKHAN	125.500	0.88	-0.18	0.38	123	PADMA	48.000	1.57	1.20	1.38
59	ARIALKHAN	143.000	0.96	-0.23	0.39	124	PADMA	54.000	1.54	1.08	1.29
60	ARIALKHAN	149.500	1.00	-0.16	0.41	125	PADMA	90.000	1.38	0.37	0.84
61	ARIALKHAN	161.000	0.97	-0.16	0.40	126	TENTULIA	68.333	0.65	-0.10	0.27
62	ARIALKHAN-L	0.000	1.51	0.97	1.20	127	SWARUPKATI	0.000	1.05	-0.61	0.23
63	ARIALKHAN-L	6.000	0.90	0.85	0.88	128	SWARUPKATI	8.500	1.08	-0.65	0.22
64	ARIALKHAN-L	16.000	0.90	0.85	0.87	129	SWARUPKATI	14.500	1.07	-0.66	0.22
65	ARIALKHAN-L	26.000	0.93	0.72	0.83	130	SWARUPKATI	16.500	1.08	-0.65	0.22

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a3]

TABLE A4

Water Level (m.PWD) for April 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.88	0.67	0.77	66	PALANG	20.010	1.38	1.25	1.32
2	KOBADAK	109.500	1.16	0.33	0.72	67	NARIA-KH	0.000	2.03	1.00	1.44
3	BETNA	47.000	1.86	0.64	1.13	68	KUMAR-1	0.000	1.58	1.43	1.51
4	LABANGABATI	8.750	1.66	0.15	0.82	69	KUMAR-1	12.300	1.39	1.29	1.35
5	KHOLPETUA	21.000	1.95	-1.07	0.39	70	KUMAR-1	20.500	0.97	0.80	0.87
6	MALANCHA	0.000	1.61	-0.81	0.38	71	KUMAR-2	0.000	0.97	0.80	0.87
7	L_SOLMARI	8.500	1.86	-0.63	0.52	72	KUMAR-2	10.333	1.28	0.84	1.00
8	SALTA	0.000	2.10	-1.17	0.45	73	TORKI-1	20.430	1.25	0.84	1.02
9	RUPSA	4.194	1.83	-0.55	0.54	74	TORKI-2	0.000	1.48	0.63	1.01
10	KAZIBACHA	15.000	1.83	-0.78	0.47	75	BISHKANDIA	31.500	1.40	-0.23	0.62
11	SIBSA	21.915	1.82	-1.04	0.38	76	UZIRPUR	0.000	1.29	0.10	0.72
12	SIBSA	45.265	1.68	-0.92	0.38	77	UZIRPUR	10.500	1.31	0.00	0.68
13	PUSSUR	16.835	1.75	-0.82	0.44	78	SHANDHA	5.500	1.31	-0.04	0.66
14	PUSSUR	65.995	1.51	-0.77	0.37	79	SHIKARPUR	0.000	1.33	0.26	0.82
15	PUSSUR	98.210	1.42	-0.62	0.37	80	AMTALI	3.500	1.30	0.23	0.79
16	NABAGANGA_L	29.000	1.40	-0.15	0.58	81	AMTALI	10.500	1.28	0.16	0.75
17	NABAGANGA_M	17.250	1.40	-0.13	0.59	82	LOWERMEGHNA	19.000	1.90	0.69	1.24
18	KATAKHALI-SW	13.500	1.48	-0.05	0.64	83	LOWERMEGHNA	41.250	1.92	0.51	1.13
19	CHUNKURI	6.000	1.80	-0.77	0.48	84	JOYANTI-1	6.500	1.87	0.58	1.17
20	HARIA	18.500	1.96	-1.11	0.42	85	JOYANTI-1	13.010	1.86	0.56	1.16
21	MADHUMATI	82.000	0.83	0.78	0.80	86	JOYANTI-2	5.667	1.86	0.57	1.16
22	MADHUMATI	108.000	0.80	0.68	0.73	87	S-MEGHNA	3.500	1.76	0.51	1.07
23	MADHUMATI	149.500	0.82	0.50	0.65	88	S-MEGHNA1	10.000	1.98	0.37	1.07
24	MADHUMATI	181.500	1.32	-0.03	0.60	89	NAYABHANGANI	0.000	1.76	0.52	1.07
25	MADHUMATI	205.000	0.92	0.75	0.83	90	NAYABHANGANI	14.500	1.67	0.44	0.98
26	MADHUMATI	207.000	0.93	0.57	0.75	91	DHARMAGANJ	4.000	1.69	0.27	0.94
27	MADHUMATI	248.375	0.92	0.51	0.72	92	DHARMAGANJ	8.000	1.66	0.25	0.91
28	POYLAHARA	10.000	1.48	-0.19	0.59	93	DHARMAGANJ	15.000	1.65	0.24	0.90
29	GASHIAKHALI	10.500	1.65	-0.30	0.63	94	KALABADAR-1	9.000	1.59	0.25	0.88
30	BHAIRAB	8.500	1.29	0.16	0.64	95	KALABADAR-2	10.000	1.73	0.16	0.89
31	ATHAROBANKI	32.000	1.50	-0.03	0.66	96	ILSHA	25.500	1.52	0.20	0.84
32	BALESWAR	64.000	1.51	-0.30	0.62	97	SHAHABAZ-1	4.167	2.13	0.07	0.94
33	BALESWAR	93.000	1.62	-0.25	0.65	98	SHAHABAZ-1	12.500	2.05	-0.02	0.91
34	KALIGANGA	21.800	1.14	0.18	0.66	99	TENTULIA	8.000	1.35	0.23	0.77
35	BHAIRAB U	39.853	0.72	0.64	0.68	100	RANGAMATIA	3.360	1.39	0.24	0.80
36	BHAIRAB U	123.000	1.43	-0.11	0.61	101	KIRTONKHOLA	14.000	1.34	0.16	0.79
37	KALIGANGA U	17.333	4.64	4.63	4.63	102	KIRTONKHOLA	24.000	1.30	0.11	0.76
38	CHITRA	131.500	1.15	0.13	0.63	103	BISHKHALI	3.250	1.39	-0.10	0.70
39	CHITRA	151.505	1.27	-0.03	0.60	104	BISHKHALI	21.500	1.42	-0.20	0.66
40	NABAGANGA_U	98.000	1.76	1.74	1.75	105	BISHKHALI	44.500	1.65	-0.33	0.63
41	NABAGANGA_U	123.000	1.27	0.82	1.00	106	BISHKHALI	70.000	1.68	-0.40	0.62
42	NABAGANGA_U	164.000	1.04	0.38	0.68	107	BISHKHALI	86.500	1.67	-0.41	0.60
43	CHANDANA	39.100	2.54	2.52	2.52	108	KHAIRABAD	31.000	1.45	-0.03	0.69
44	KUMAR	42.900	0.89	0.87	0.88	109	PANDAB-1	4.250	1.38	0.01	0.70
45	KUMAR	99.300	0.92	0.76	0.84	110	DHULIA	9.750	1.25	0.23	0.74
46	SITALAKHYA	0.000	1.00	0.97	0.99	111	DHULIA	23.000	1.29	0.14	0.71
47	SITALAKHYA	24.800	0.96	0.93	0.94	112	PAIRA	19.175	1.54	-0.11	0.67
48	SITALAKHYA	46.000	0.92	0.90	0.91	113	PAIRA	24.000	1.58	-0.19	0.65
49	MBR	0.000	0.97	0.80	0.87	114	BURISWAR	5.000	1.58	-0.21	0.64
50	BARASIA_ARBT	25.500	0.77	0.53	0.65	115	BURISWAR	30.000	1.62	-0.34	0.61
51	GORAI	13.000	4.98	4.95	4.96	116	BURISWAR	37.500	1.64	-0.37	0.61
52	GORAI	82.000	0.83	0.78	0.80	117	BURISWAR	47.000	1.67	-0.41	0.60
53	ARIALKHAN	9.000	2.15	1.92	2.03	118	PATUAKHALI	0.000	1.34	-0.03	0.64
54	ARIALKHAN	30.500	1.64	1.48	1.57	119	LOHALIA	19.625	1.33	-0.01	0.65
55	ARIALKHAN	53.000	1.48	0.95	1.17	120	LOHALIA	23.000	1.34	-0.03	0.64
56	ARIALKHAN	64.000	1.48	0.80	1.10	121	LOHALIA	32.500	1.32	-0.06	0.64
57	ARIALKHAN	101.000	1.48	0.63	1.01	122	LOHALIA	63.000	1.26	0.02	0.61
58	ARIALKHAN	125.500	1.34	0.25	0.81	123	PADMA	48.000	2.35	2.02	2.16
59	ARIALKHAN	143.000	1.42	0.19	0.80	124	PADMA	54.000	2.28	1.88	2.05
60	ARIALKHAN	149.500	1.47	0.23	0.82	125	PADMA	90.000	2.03	1.00	1.44
61	ARIALKHAN	161.000	1.41	0.22	0.80	126	TENTULIA	68.333	1.03	0.22	0.61
62	ARIALKHAN-L	0.000	2.14	1.71	1.89	127	SWARUPKATI	0.000	1.34	-0.22	0.61
63	ARIALKHAN-L	6.000	1.42	1.33	1.38	128	SWARUPKATI	8.500	1.35	-0.26	0.59
64	ARIALKHAN-L	16.000	1.42	1.33	1.38	129	SWARUPKATI	14.500	1.33	-0.28	0.58
65	ARIALKHAN-L	26.000	1.51	1.28	1.39	130	SWARUPKATI	16.500	1.33	-0.28	0.58

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a4]

TABLE A5

Water Level (m.PWD) for May 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Map Ref. No.	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.95	0.72	0.83	66	PALANG	20.010	2.04	1.93	2.00
2	KOBADAK	109.500	1.24	0.37	0.77	67	NARIA-KH	0.000	2.72	1.74	2.14
3	BETNA	47.000	1.92	0.66	1.16	68	KUMAR-1	0.000	2.29	2.18	2.24
4	LABANGABATI	8.750	1.76	0.17	0.86	69	KUMAR-1	12.300	2.05	1.97	2.01
5	KHOLPETUA	21.000	2.02	-1.09	0.44	70	KUMAR-1	20.500	1.22	1.11	1.17
6	MALANCHA	0.000	1.68	-0.83	0.43	71	KUMAR-2	0.000	1.22	1.11	1.17
7	L_SOLMARI	8.500	1.96	-0.60	0.58	72	KUMAR-2	10.333	1.45	1.12	1.25
8	SALTA	0.000	2.17	-1.18	0.50	73	TORKI-1	20.430	1.65	1.16	1.38
9	RUPSA	4.194	1.93	-0.53	0.61	74	TORKI-2	0.000	1.80	0.97	1.35
10	KAZIBACHA	15.000	1.93	-0.77	0.53	75	BISHKANDIA	31.500	1.46	-0.24	0.67
11	SIBSA	21.915	1.90	-1.07	0.43	76	UZIRPUR	0.000	1.42	0.19	0.84
12	SIBSA	45.265	1.76	-0.96	0.43	77	UZIRPUR	10.500	1.40	0.06	0.77
13	PUSSUR	16.835	1.85	-0.82	0.50	78	SHANDHA	5.500	1.39	0.00	0.74
14	PUSSUR	65.995	1.60	-0.79	0.42	79	SHIKARPUR	0.000	1.55	0.42	1.00
15	PUSSUR	98.210	1.50	-0.64	0.42	80	AMTALI	3.500	1.49	0.37	0.95
16	NABAGANGA_L	29.000	1.51	-0.08	0.67	81	AMTALI	10.500	1.43	0.28	0.88
17	NABAGANGA_M	17.250	1.51	-0.05	0.68	82	LOWERMEGHNA	19.000	2.48	1.26	1.80
18	KATAKHALI-SW	13.500	1.60	0.01	0.73	83	LOWERMEGHNA	41.250	2.43	0.93	1.58
19	CHUNKURI	6.000	1.89	-0.77	0.54	84	JOYANTI-1	6.500	2.40	1.04	1.65
20	HARIA	18.500	2.04	-1.12	0.47	85	JOYANTI-1	13.010	2.40	1.01	1.63
21	MADHUMATI	82.000	1.47	1.43	1.45	86	JOYANTI-2	5.667	2.39	1.02	1.63
22	MADHUMATI	108.000	1.16	1.10	1.13	87	S-MEGHNA	3.500	2.13	0.87	1.44
23	MADHUMATI	149.500	1.00	0.65	0.80	88	S-MEGHNA1	10.000	2.44	0.71	1.46
24	MADHUMATI	181.500	1.44	0.06	0.70	89	NAYABHANGANI	0.000	2.14	0.89	1.45
25	MADHUMATI	205.000	1.10	0.93	1.01	90	NAYABHANGANI	14.500	1.93	0.72	1.28
26	MADHUMATI	207.000	1.08	0.69	0.88	91	DHARMAGANJ	4.000	2.00	0.51	1.22
27	MADHUMATI	248.375	1.02	0.60	0.81	92	DHARMAGANJ	8.000	1.94	0.47	1.18
28	POYLAHARA	10.000	1.53	-0.21	0.62	93	DHARMAGANJ	15.000	1.92	0.44	1.15
29	GASHIAKHALI	10.500	1.69	-0.32	0.64	94	KALABADAR-1	9.000	1.81	0.45	1.12
30	BHAIRAB	8.500	1.36	0.22	0.69	95	KALABADAR-2	10.000	2.00	0.36	1.15
31	ATHAROBANKI	32.000	1.62	0.03	0.75	96	ILSHA	25.500	1.75	0.37	1.06
32	BALESWAR	64.000	1.55	-0.34	0.62	97	SHAHABAZ-1	4.167	2.49	0.33	1.25
33	BALESWAR	93.000	1.65	-0.26	0.65	98	SHAHABAZ-1	12.500	2.41	0.24	1.21
34	KALIGANGA	21.800	1.19	0.22	0.72	99	TENTULIA	8.000	1.51	0.38	0.96
35	BHAIRAB U	39.853	0.82	0.73	0.77	100	RANGAMATIA	3.360	1.56	0.40	0.99
36	BHAIRAB U	123.000	1.55	-0.05	0.69	101	KIRTONKHOLA	14.000	1.49	0.29	0.93
37	KALIGANGA U	17.333	4.72	4.71	4.72	102	KIRTONKHOLA	24.000	1.42	0.19	0.88
38	CHITRA	131.500	1.28	0.20	0.72	103	BISHKHALI	3.250	1.43	-0.05	0.76
39	CHITRA	151.505	1.38	0.05	0.69	104	BISHKHALI	21.500	1.45	-0.18	0.70
40	NABAGANGA_U	98.000	2.23	2.20	2.22	105	BISHKHALI	44.500	1.67	-0.35	0.64
41	NABAGANGA_U	123.000	1.45	1.15	1.25	106	BISHKHALI	70.000	1.71	-0.45	0.60
42	NABAGANGA_U	164.000	1.19	0.44	0.78	107	BISHKHALI	86.500	1.68	-0.52	0.57
43	CHANDANA	39.100	2.60	2.56	2.58	108	KHAIRABAD	31.000	1.50	0.01	0.75
44	KUMAR	42.900	1.50	1.46	1.48	109	PANDAB-1	4.250	1.43	0.06	0.78
45	KUMAR	99.300	1.12	0.97	1.04	110	DHULIA	9.750	1.39	0.34	0.87
46	SITALAKHYA	0.000	1.65	1.61	1.63	111	DHULIA	23.000	1.36	0.21	0.81
47	SITALAKHYA	24.800	1.58	1.54	1.56	112	PAIRA	19.175	1.57	-0.10	0.70
48	SITALAKHYA	46.000	1.47	1.44	1.46	113	PAIRA	24.000	1.61	-0.21	0.67
49	MBR	0.000	1.22	1.11	1.17	114	BURISWAR	5.000	1.61	-0.23	0.66
50	BARASIA_ARBT	25.500	0.94	0.67	0.80	115	BURISWAR	30.000	1.63	-0.40	0.60
51	GORAI	13.000	5.83	5.77	5.80	116	BURISWAR	37.500	1.65	-0.45	0.59
52	GORAI	82.000	1.47	1.43	1.45	117	BURISWAR	47.000	1.68	-0.52	0.57
53	ARIALKHAN	9.000	3.19	3.01	3.09	118	PATUAKHALI	0.000	1.41	0.02	0.73
54	ARIALKHAN	30.500	2.41	2.30	2.36	119	LOHALIA	19.625	1.42	0.04	0.74
55	ARIALKHAN	53.000	1.95	1.47	1.67	120	LOHALIA	23.000	1.41	0.02	0.73
56	ARIALKHAN	64.000	1.91	1.25	1.52	121	LOHALIA	32.500	1.39	-0.03	0.73
57	ARIALKHAN	101.000	1.80	0.97	1.35	122	LOHALIA	63.000	1.37	0.12	0.72
58	ARIALKHAN	125.500	1.54	0.41	0.99	123	PADMA	48.000	3.41	3.18	3.29
59	ARIALKHAN	143.000	1.58	0.35	0.97	124	PADMA	54.000	3.27	2.99	3.12
60	ARIALKHAN	149.500	1.63	0.40	1.02	125	PADMA	90.000	2.72	1.74	2.14
61	ARIALKHAN	161.000	1.58	0.38	1.00	126	TENTULIA	68.333	1.19	0.33	0.75
62	ARIALKHAN-L	0.000	2.87	2.63	2.74	127	SWARUPKATI	0.000	1.39	-0.22	0.65
63	ARIALKHAN-L	6.000	2.09	1.98	2.04	128	SWARUPKATI	8.500	1.39	-0.29	0.62
64	ARIALKHAN-L	16.000	2.08	1.97	2.03	129	SWARUPKATI	14.500	1.36	-0.32	0.61
65	ARIALKHAN-L	26.000	2.09	1.95	2.02	130	SWARUPKATI	16.500	1.36	-0.31	0.61

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a5]

TABLE A6

Water Level (m.PWD) for June 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	1.30	1.04	1.17	66	PALANG	20.010	2.80	2.69	2.75
2	KOBADAK	109.500	1.65	0.63	1.09	67	NARIA-KH	0.000	3.45	2.63	2.96
3	BETNA	47.000	2.29	0.90	1.46	68	KUMAR-1	0.000	3.05	2.94	3.00
4	LABANGABATI	8.750	2.19	0.35	1.14	69	KUMAR-1	12.300	2.77	2.67	2.73
5	KHOLPETUA	21.000	2.39	-0.85	0.75	70	KUMAR-1	20.500	1.84	1.72	1.77
6	MALANCHA	0.000	2.04	-0.57	0.73	71	KUMAR-2	0.000	1.84	1.72	1.77
7	L_SOLMARI	8.500	2.40	-0.27	0.98	72	KUMAR-2	10.333	2.06	1.81	1.92
8	SALTA	0.000	2.53	-0.96	0.82	73	TORKI-1	20.430	2.27	1.80	2.02
9	RUPSA	4.194	2.38	-0.16	1.02	74	TORKI-2	0.000	2.33	1.51	1.91
10	KAZIBACHA	15.000	2.36	-0.48	0.89	75	BISHKANDIA	31.500	1.62	0.10	1.07
11	SIBSA	21.915	2.27	-0.83	0.75	76	UZIRPUR	0.000	1.73	0.69	1.27
12	SIBSA	45.265	2.10	-0.71	0.74	77	UZIRPUR	10.500	1.64	0.49	1.19
13	PUSSUR	16.835	2.30	-0.56	0.84	78	SHANDHA	5.500	1.59	0.38	1.14
14	PUSSUR	65.995	1.96	-0.56	0.73	79	SHIKARPUR	0.000	1.92	0.95	1.46
15	PUSSUR	98.210	1.86	-0.39	0.72	80	AMTALI	3.500	1.86	0.88	1.40
16	NABAGANGA_L	29.000	2.04	0.43	1.18	81	AMTALI	10.500	1.77	0.79	1.32
17	NABAGANGA_M	17.250	2.05	0.47	1.20	82	LOWERMEGHNA	19.000	3.11	2.01	2.49
18	KATAKHALI-SW	13.500	2.14	0.52	1.25	83	LOWERMEGHNA	41.250	3.06	1.53	2.20
19	CHUNKURI	6.000	2.31	-0.49	0.90	84	JOYANTI-1	6.500	2.94	1.69	2.29
20	HARIA	18.500	2.40	-0.88	0.79	85	JOYANTI-1	13.010	2.93	1.64	2.25
21	MADHUMATI	82.000	3.57	3.43	3.50	86	JOYANTI-2	5.667	2.91	1.65	2.26
22	MADHUMATI	108.000	2.77	2.65	2.71	87	S-MEGHNA	3.500	2.59	1.40	2.00
23	MADHUMATI	149.500	1.81	1.45	1.61	88	S-MEGHNA1	10.000	3.04	1.25	2.05
24	MADHUMATI	181.500	2.02	0.68	1.29	89	NAYABHANGANI	0.000	2.62	1.44	2.03
25	MADHUMATI	205.000	1.57	1.33	1.45	90	NAYABHANGANI	14.500	2.26	1.24	1.80
26	MADHUMATI	207.000	1.49	1.14	1.32	91	DHARMAGANJ	4.000	2.43	1.01	1.74
27	MADHUMATI	248.375	1.38	0.98	1.19	92	DHARMAGANJ	8.000	2.33	0.94	1.67
28	POYLAHARA	10.000	1.83	0.09	0.99	93	DHARMAGANJ	15.000	2.30	0.89	1.63
29	GASHIAKHALI	10.500	2.01	0.02	0.98	94	KALABADAR-1	9.000	2.16	0.90	1.59
30	BHAIRAB	8.500	1.84	0.49	1.11	95	KALABADAR-2	10.000	2.40	0.79	1.62
31	ATHAROBANKI	32.000	2.15	0.51	1.26	96	ILSHA	25.500	2.10	0.78	1.50
32	BALESWAR	64.000	1.81	-0.08	0.90	97	SHAHABAZ-1	4.167	3.06	0.72	1.75
33	BALESWAR	93.000	1.95	0.09	0.98	98	SHAHABAZ-1	12.500	3.04	0.62	1.69
34	KALIGANGA	21.800	1.43	0.55	1.05	99	TENTULIA	8.000	1.81	0.80	1.36
35	BHAIRAB U	39.853	1.39	1.31	1.35	100	RANGAMATIA	3.360	1.88	0.82	1.41
36	BHAIRAB U	123.000	2.08	0.43	1.19	101	KIRTONKHOLA	14.000	1.78	0.74	1.37
37	KALIGANGA U	17.333	4.73	4.72	4.72	102	KIRTONKHOLA	24.000	1.72	0.63	1.31
38	CHITRA	131.500	1.84	0.67	1.23	103	BISHKHALI	3.250	1.59	0.40	1.14
39	CHITRA	151.505	1.92	0.54	1.20	104	BISHKHALI	21.500	1.61	0.20	1.06
40	NABAGANGA_U	98.000	2.37	2.34	2.36	105	BISHKHALI	44.500	1.89	-0.03	0.97
41	NABAGANGA_U	123.000	1.96	1.49	1.66	106	BISHKHALI	70.000	2.04	-0.13	0.91
42	NABAGANGA_U	164.000	1.82	0.88	1.30	107	BISHKHALI	86.500	2.03	-0.28	0.88
43	CHANDANA	39.100	2.66	2.59	2.62	108	KHAIRABAD	31.000	1.73	0.39	1.14
44	KUMAR	42.900	1.81	1.75	1.78	109	PANDAB-1	4.250	1.68	0.40	1.19
45	KUMAR	99.300	1.60	1.41	1.50	110	DHULIA	9.750	1.77	0.74	1.28
46	SITALAKHYA	0.000	2.03	1.97	2.00	111	DHULIA	23.000	1.68	0.59	1.20
47	SITALAKHYA	24.800	1.96	1.91	1.94	112	PAIRA	19.175	1.81	0.24	1.06
48	SITALAKHYA	46.000	1.89	1.83	1.86	113	PAIRA	24.000	1.82	0.12	1.02
49	MBR	0.000	1.84	1.72	1.77	114	BURISWAR	5.000	1.82	0.09	1.01
50	BARASIA_ARBT	25.500	1.77	1.46	1.60	115	BURISWAR	30.000	1.87	-0.18	0.93
51	GORAI	13.000	7.67	7.55	7.61	116	BURISWAR	37.500	1.94	-0.22	0.91
52	GORAI	82.000	3.57	3.43	3.50	117	BURISWAR	47.000	2.03	-0.28	0.88
53	ARIALKHAN	9.000	4.11	3.95	4.03	118	PATUAKHALI	0.000	1.61	0.32	1.11
54	ARIALKHAN	30.500	3.19	3.07	3.14	119	LOHALIA	19.625	1.64	0.36	1.12
55	ARIALKHAN	53.000	2.58	2.21	2.37	120	LOHALIA	23.000	1.61	0.32	1.11
56	ARIALKHAN	64.000	2.50	1.97	2.21	121	LOHALIA	32.500	1.56	0.14	1.12
57	ARIALKHAN	101.000	2.33	1.51	1.91	122	LOHALIA	63.000	1.66	0.42	1.09
58	ARIALKHAN	125.500	1.92	0.93	1.45	123	PADMA	48.000	4.45	4.25	4.34
59	ARIALKHAN	143.000	1.86	0.82	1.42	124	PADMA	54.000	4.29	4.05	4.15
60	ARIALKHAN	149.500	1.94	0.83	1.46	125	PADMA	90.000	3.45	2.63	2.96
61	ARIALKHAN	161.000	1.89	0.80	1.42	126	TENTULIA	68.333	1.61	0.63	1.11
62	ARIALKHAN-L	0.000	3.48	3.31	3.39	127	SWARUPKATI	0.000	1.53	0.01	1.04
63	ARIALKHAN-L	6.000	2.82	2.71	2.78	128	SWARUPKATI	8.500	1.53	-0.01	0.97
64	ARIALKHAN-L	16.000	2.82	2.71	2.77	129	SWARUPKATI	14.500	1.50	-0.01	0.93
65	ARIALKHAN-L	26.000	2.82	2.69	2.76	130	SWARUPKATI	16.500	1.50	0.01	0.93

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a6]

TABLE A7

Water Level (m.PWD) for July 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	1.36	1.11	1.23	66	PALANG	20.010	4.04	4.00	4.02
2	KOBADAK	109.500	1.69	0.67	1.13	67	NARIA-KH	0.000	4.43	4.07	4.18
3	BETNA	47.000	2.33	1.02	1.53	68	KUMAR-1	0.000	4.32	4.27	4.29
4	LABANGABATI	8.750	2.22	0.39	1.17	69	KUMAR-1	12.300	3.97	3.92	3.94
5	KHOLPETUA	21.000	2.40	-0.80	0.77	70	KUMAR-1	20.500	2.78	2.72	2.75
6	MALANCHA	0.000	2.05	-0.53	0.75	71	KUMAR-2	0.000	2.78	2.72	2.75
7	L_SOLMARI	8.500	2.48	-0.04	1.14	72	KUMAR-2	10.333	2.91	2.82	2.86
8	SALTA	0.000	2.56	-0.89	0.87	73	TORKI-1	20.430	2.91	2.73	2.82
9	RUPSA	4.194	2.50	0.13	1.22	74	TORKI-2	0.000	2.87	2.32	2.58
10	KAZIBACHA	15.000	2.44	-0.34	1.00	75	BISHKANDIA	31.500	1.67	0.27	1.15
11	SIBSA	21.915	2.30	-0.77	0.79	76	UZIRPUR	0.000	1.82	1.01	1.48
12	SIBSA	45.265	2.12	-0.66	0.77	77	UZIRPUR	10.500	1.69	0.74	1.32
13	PUSSUR	16.835	2.36	-0.47	0.91	78	SHANDHA	5.500	1.64	0.57	1.26
14	PUSSUR	65.995	1.97	-0.50	0.77	79	SHIKARPUR	0.000	2.13	1.45	1.80
15	PUSSUR	98.210	1.87	-0.35	0.75	80	AMTALI	3.500	2.02	1.31	1.69
16	NABAGANGA_L	29.000	2.42	0.98	1.61	81	AMTALI	10.500	1.89	1.16	1.55
17	NABAGANGA_M	17.250	2.44	1.07	1.67	82	LOWERMEGHNA	19.000	3.77	3.12	3.35
18	KATAKHALI-SW	13.500	2.48	1.16	1.73	83	LOWERMEGHNA	41.250	3.70	2.51	2.97
19	CHUNKURI	6.000	2.38	-0.35	1.00	84	JOYANTI-1	6.500	3.52	2.78	3.13
20	HARIA	18.500	2.42	-0.81	0.83	85	JOYANTI-1	13.010	3.49	2.73	3.08
21	MADHUMATI	82.000	6.02	5.95	5.99	86	JOYANTI-2	5.667	3.47	2.74	3.10
22	MADHUMATI	108.000	4.85	4.78	4.82	87	S-MEGHNA	3.500	3.00	2.25	2.65
23	MADHUMATI	149.500	2.92	2.73	2.82	88	S-MEGHNA1	10.000	3.64	2.10	2.77
24	MADHUMATI	181.500	2.55	1.49	1.93	89	NAYABHANGANI	0.000	3.05	2.31	2.70
25	MADHUMATI	205.000	2.06	1.87	1.96	90	NAYABHANGANI	14.500	2.54	2.01	2.33
26	MADHUMATI	207.000	1.86	1.61	1.74	91	DHARMAGANJ	4.000	2.77	1.69	2.29
27	MADHUMATI	248.375	1.57	1.23	1.41	92	DHARMAGANJ	8.000	2.62	1.53	2.14
28	POYLAHARA	10.000	1.85	0.12	1.01	93	DHARMAGANJ	15.000	2.59	1.42	2.07
29	GASHIAKHALI	10.500	1.97	0.01	0.95	94	KALABADAR-1	9.000	2.39	1.42	1.99
30	BHAIRAB	8.500	1.93	0.67	1.27	95	KALABADAR-2	10.000	2.71	1.27	2.03
31	ATHAROBANKI	32.000	2.47	1.12	1.71	96	ILSHA	25.500	2.32	1.21	1.84
32	BALESWAR	64.000	1.83	-0.11	0.87	97	SHAHABAZ-1	4.167	3.53	1.22	2.24
33	BALESWAR	93.000	1.90	0.07	0.96	98	SHAHABAZ-1	12.500	3.57	1.05	2.13
34	KALIGANGA	21.800	1.51	0.67	1.13	99	TENTULIA	8.000	1.98	1.15	1.63
35	BHAIRAB U	39.853	1.78	1.72	1.75	100	RANGAMATIA	3.360	2.02	1.20	1.69
36	BHAIRAB U	123.000	2.43	0.96	1.59	101	KIRTONKHOLA	14.000	1.90	1.15	1.61
37	KALIGANGA U	17.333	4.82	4.81	4.81	102	KIRTONKHOLA	24.000	1.79	1.01	1.50
38	CHITRA	131.500	2.24	1.14	1.66	103	BISHKHALI	3.250	1.65	0.56	1.22
39	CHITRA	151.505	2.31	1.06	1.64	104	BISHKHALI	21.500	1.63	0.29	1.10
40	NABAGANGA_U	98.000	2.50	2.46	2.48	105	BISHKHALI	44.500	1.84	0.01	0.94
41	NABAGANGA_U	123.000	2.36	1.81	2.03	106	BISHKHALI	70.000	1.96	-0.17	0.86
42	NABAGANGA_U	164.000	2.33	1.46	1.82	107	BISHKHALI	86.500	1.94	-0.34	0.80
43	CHANDANA	39.100	2.98	2.82	2.89	108	KHAIRABAD	31.000	1.77	0.53	1.23
44	KUMAR	42.900	2.90	2.85	2.88	109	PANDAB-1	4.250	1.72	0.55	1.30
45	KUMAR	99.300	2.15	2.05	2.10	110	DHULIA	9.750	1.89	1.02	1.49
46	SITALAKHYA	0.000	3.38	3.31	3.34	111	DHULIA	23.000	1.76	0.81	1.34
47	SITALAKHYA	24.800	3.22	3.16	3.19	112	PAIRA	19.175	1.82	0.31	1.09
48	SITALAKHYA	46.000	3.03	2.98	3.01	113	PAIRA	24.000	1.82	0.16	1.03
49	MBR	0.000	2.78	2.72	2.75	114	BURISWAR	5.000	1.82	0.12	1.01
50	BARASIA_ARBT	25.500	2.94	2.72	2.82	115	BURISWAR	30.000	1.84	-0.21	0.88
51	GORAI	13.000	9.74	9.67	9.70	116	BURISWAR	37.500	1.88	-0.26	0.85
52	GORAI	82.000	6.02	5.95	5.99	117	BURISWAR	47.000	1.94	-0.34	0.80
53	ARIALKHAN	9.000	5.52	5.47	5.49	118	PATUAKHALI	0.000	1.64	0.51	1.23
54	ARIALKHAN	30.500	4.47	4.42	4.45	119	LOHALIA	19.625	1.69	0.55	1.25
55	ARIALKHAN	53.000	3.53	3.41	3.47	120	LOHALIA	23.000	1.64	0.51	1.23
56	ARIALKHAN	64.000	3.34	3.15	3.25	121	LOHALIA	32.500	1.63	0.33	1.26
57	ARIALKHAN	101.000	2.87	2.32	2.58	122	LOHALIA	63.000	1.81	0.69	1.27
58	ARIALKHAN	125.500	2.11	1.42	1.78	123	PADMA	48.000	6.15	6.08	6.11
59	ARIALKHAN	143.000	2.04	1.26	1.72	124	PADMA	54.000	5.93	5.85	5.88
60	ARIALKHAN	149.500	2.10	1.27	1.77	125	PADMA	90.000	4.43	4.07	4.18
61	ARIALKHAN	161.000	2.04	1.20	1.72	126	TENTULIA	68.333	1.85	0.84	1.34
62	ARIALKHAN-L	0.000	4.59	4.51	4.55	127	SWARUPKATI	0.000	1.56	0.20	1.10
63	ARIALKHAN-L	6.000	4.06	4.02	4.04	128	SWARUPKATI	8.500	1.55	0.09	0.99
64	ARIALKHAN-L	16.000	4.04	4.00	4.02	129	SWARUPKATI	14.500	1.51	0.04	0.94
65	ARIALKHAN-L	26.000	4.01	3.96	3.99	130	SWARUPKATI	16.500	1.51	0.05	0.94

Source : Consultant's Model Analaysis based on BWDB Data

TABLE A8

Water Level (m.PWD) for August 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	1.53	1.30	1.40	66	PALANG	20.010	4.47	4.41	4.43
2	KOBADAK	109.500	1.76	0.77	1.22	67	NARIA-KH	0.000	4.61	4.37	4.45
3	BETNA	47.000	2.54	1.68	1.95	68	KUMAR-1	0.000	4.71	4.65	4.68
4	LABANGABATI	8.750	2.26	0.49	1.24	69	KUMAR-1	12.300	4.42	4.37	4.40
5	KHOLPETUA	21.000	2.37	-0.71	0.80	70	KUMAR-1	20.500	3.55	3.52	3.54
6	MALANCHA	0.000	2.02	-0.44	0.77	71	KUMAR-2	0.000	3.55	3.52	3.54
7	L_SOLMARI	8.500	2.66	0.55	1.52	72	KUMAR-2	10.333	3.47	3.43	3.45
8	SALTA	0.000	2.58	-0.76	0.94	73	TORKI-1	20.430	3.22	3.12	3.17
9	RUPSA	4.194	2.75	0.87	1.71	74	TORKI-2	0.000	2.93	2.58	2.76
10	KAZIBACHA	15.000	2.55	-0.00	1.22	75	BISHKANDIA	31.500	1.68	0.43	1.22
11	SIBSA	21.915	2.30	-0.64	0.84	76	UZIRPUR	0.000	1.85	1.15	1.55
12	SIBSA	45.265	2.11	-0.55	0.80	77	UZIRPUR	10.500	1.72	0.86	1.39
13	PUSSUR	16.835	2.47	-0.28	1.04	78	SHANDHA	5.500	1.66	0.64	1.32
14	PUSSUR	65.995	1.95	-0.40	0.80	79	SHIKARPUR	0.000	2.15	1.62	1.89
15	PUSSUR	98.210	1.83	-0.25	0.77	80	AMTALI	3.500	2.04	1.48	1.77
16	NABAGANGA_L	29.000	3.04	2.43	2.69	81	AMTALI	10.500	1.92	1.31	1.63
17	NABAGANGA_M	17.250	3.16	2.63	2.85	82	LOWERMEGHNA	19.000	3.80	3.28	3.48
18	KATAKHALI-SW	13.500	3.21	2.79	2.97	83	LOWERMEGHNA	41.250	3.71	2.73	3.10
19	CHUNKURI	6.000	2.47	-0.04	1.19	84	JOYANTI-1	6.500	3.58	3.02	3.27
20	HARIA	18.500	2.44	-0.68	0.89	85	JOYANTI-1	13.010	3.54	2.98	3.22
21	MADHUMATI	82.000	8.19	8.13	8.16	86	JOYANTI-2	5.667	3.53	2.99	3.24
22	MADHUMATI	108.000	6.86	6.82	6.84	87	S-MEGHNA	3.500	3.03	2.49	2.77
23	MADHUMATI	149.500	4.68	4.62	4.65	88	S-MEGHNA1	10.000	3.68	2.35	2.90
24	MADHUMATI	181.500	3.54	3.26	3.38	89	NAYABHANGANI	0.000	3.08	2.55	2.82
25	MADHUMATI	205.000	2.91	2.86	2.89	90	NAYABHANGANI	14.500	2.58	2.24	2.43
26	MADHUMATI	207.000	2.72	2.66	2.68	91	DHARMAGANJ	4.000	2.80	1.91	2.40
27	MADHUMATI	248.375	2.04	1.89	1.97	92	DHARMAGANJ	8.000	2.63	1.73	2.24
28	POYLAHARA	10.000	1.89	0.27	1.12	93	DHARMAGANJ	15.000	2.61	1.60	2.15
29	GASHIAKHALI	10.500	1.96	0.10	0.99	94	KALABADAR-1	9.000	2.40	1.60	2.06
30	BHAIRAB	8.500	1.91	0.97	1.42	95	KALABADAR-2	10.000	2.73	1.44	2.11
31	ATHAROBANKI	32.000	3.10	2.67	2.86	96	ILSHA	25.500	2.33	1.36	1.90
32	BALESWAR	64.000	1.85	-0.04	0.90	97	SHAHABAZ-1	4.167	3.60	1.37	2.31
33	BALESWAR	93.000	1.88	0.17	0.99	98	SHAHABAZ-1	12.500	3.64	1.16	2.18
34	KALIGANGA	21.800	1.64	1.00	1.35	99	TENTULIA	8.000	1.98	1.26	1.66
35	BHAIRAB U	39.853	2.61	2.54	2.57	100	RANGAMATIA	3.360	2.02	1.34	1.74
36	BHAIRAB U	123.000	2.84	2.23	2.47	101	KIRTONKHOLA	14.000	1.91	1.33	1.67
37	KALIGANGA U	17.333	4.88	4.85	4.87	102	KIRTONKHOLA	24.000	1.79	1.21	1.55
38	CHITRA	131.500	3.06	2.48	2.74	103	BISHKHALI	3.250	1.66	0.66	1.26
39	CHITRA	151.505	3.03	2.48	2.72	104	BISHKHALI	21.500	1.65	0.36	1.15
40	NABAGANGA_U	98.000	3.16	3.10	3.12	105	BISHKHALI	44.500	1.83	0.08	0.96
41	NABAGANGA_U	123.000	3.14	2.78	2.91	106	BISHKHALI	70.000	1.94	-0.09	0.87
42	NABAGANGA_U	164.000	3.32	3.03	3.15	107	BISHKHALI	86.500	1.90	-0.26	0.81
43	CHANDANA	39.100	4.75	4.68	4.71	108	KHAIRABAD	31.000	1.78	0.60	1.25
44	KUMAR	42.900	4.23	4.19	4.21	109	PANDAB-1	4.250	1.73	0.66	1.33
45	KUMAR	99.300	3.01	2.97	2.99	110	DHULIA	9.750	1.89	1.11	1.51
46	SITALAKHYA	0.000	4.61	4.55	4.57	111	DHULIA	23.000	1.76	0.87	1.36
47	SITALAKHYA	24.800	4.30	4.25	4.28	112	PAIRA	19.175	1.81	0.37	1.11
48	SITALAKHYA	46.000	3.86	3.85	3.85	113	PAIRA	24.000	1.82	0.21	1.04
49	MBR	0.000	3.55	3.52	3.54	114	BURISWAR	5.000	1.81	0.17	1.02
50	BARASIA_ARBT	25.500	4.71	4.65	4.68	115	BURISWAR	30.000	1.83	-0.15	0.89
51	GORAI	13.000	12.23	12.15	12.19	116	BURISWAR	37.500	1.86	-0.17	0.86
52	GORAI	82.000	8.19	8.13	8.16	117	BURISWAR	47.000	1.90	-0.26	0.81
53	ARIALKHAN	9.000	5.79	5.73	5.76	118	PATUAKHALI	0.000	1.63	0.52	1.24
54	ARIALKHAN	30.500	4.84	4.78	4.81	119	LOHALIA	19.625	1.70	0.56	1.26
55	ARIALKHAN	53.000	3.94	3.85	3.89	120	LOHALIA	23.000	1.63	0.52	1.24
56	ARIALKHAN	64.000	3.74	3.61	3.67	121	LOHALIA	32.500	1.62	0.35	1.25
57	ARIALKHAN	101.000	2.93	2.58	2.76	122	LOHALIA	63.000	1.77	0.72	1.26
58	ARIALKHAN	125.500	2.13	1.59	1.87	123	PADMA	48.000	6.47	6.42	6.45
59	ARIALKHAN	143.000	2.06	1.44	1.79	124	PADMA	54.000	6.24	6.18	6.21
60	ARIALKHAN	149.500	2.10	1.42	1.83	125	PADMA	90.000	4.61	4.37	4.45
61	ARIALKHAN	161.000	2.04	1.33	1.77	126	TENTULIA	68.333	1.82	0.85	1.32
62	ARIALKHAN-L	0.000	5.05	4.98	5.02	127	SWARUPKATI	0.000	1.58	0.31	1.15
63	ARIALKHAN-L	6.000	4.50	4.44	4.47	128	SWARUPKATI	8.500	1.57	0.17	1.03
64	ARIALKHAN-L	16.000	4.48	4.42	4.45	129	SWARUPKATI	14.500	1.53	0.13	0.98
65	ARIALKHAN-L	26.000	4.43	4.37	4.40	130	SWARUPKATI	16.500	1.52	0.15	0.98

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a8]

TABLE A9

Water Level (m.PWD) for September 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	1.52	1.32	1.41	66	PALANG	20.010	4.68	4.63	4.65
2	KOBADAK	109.500	1.67	0.77	1.18	67	NARIA-KH	0.000	4.68	4.53	4.60
3	BETNA	47.000	2.31	1.34	1.70	68	KUMAR-1	0.000	4.93	4.88	4.91
4	LABANGABATI	8.750	2.09	0.43	1.15	69	KUMAR-1	12.300	4.66	4.62	4.64
5	KHOLPETUA	21.000	2.24	-0.75	0.72	70	KUMAR-1	20.500	3.87	3.84	3.85
6	MALANCHA	0.000	1.88	-0.48	0.69	71	KUMAR-2	0.000	3.87	3.84	3.85
7	L_SOLMARI	8.500	2.59	0.72	1.59	72	KUMAR-2	10.333	3.74	3.71	3.72
8	SALTA	0.000	2.47	-0.77	0.88	73	TORKI-1	20.430	3.31	3.26	3.29
9	RUPSA	4.194	2.72	1.10	1.82	74	TORKI-2	0.000	2.92	2.62	2.77
10	KAZIBACHA	15.000	2.44	0.07	1.21	75	BISHKANDIA	31.500	1.69	0.55	1.24
11	SIBSA	21.915	2.18	-0.66	0.78	76	UZIRPUR	0.000	1.81	1.18	1.53
12	SIBSA	45.265	1.99	-0.58	0.73	77	UZIRPUR	10.500	1.70	0.92	1.39
13	PUSSUR	16.835	2.34	-0.27	0.98	78	SHANDHA	5.500	1.66	0.76	1.33
14	PUSSUR	65.995	1.82	-0.43	0.72	79	SHIKARPUR	0.000	2.10	1.62	1.85
15	PUSSUR	98.210	1.68	-0.30	0.68	80	AMTALI	3.500	1.99	1.47	1.73
16	NABAGANGA_L	29.000	3.18	2.81	2.97	81	AMTALI	10.500	1.87	1.31	1.60
17	NABAGANGA_M	17.250	3.32	3.02	3.14	82	LOWERMEGHNA	19.000	3.67	3.28	3.43
18	KATAKHALI-SW	13.500	3.40	3.17	3.28	83	LOWERMEGHNA	41.250	3.54	2.73	3.02
19	CHUNKURI	6.000	2.37	0.03	1.17	84	JOYANTI-1	6.500	3.47	3.04	3.22
20	HARIA	18.500	2.32	-0.69	0.83	85	JOYANTI-1	13.010	3.43	3.00	3.18
21	MADHUMATI	82.000	8.43	8.37	8.40	86	JOYANTI-2	5.667	3.41	3.01	3.19
22	MADHUMATI	108.000	7.01	6.97	6.99	87	S-MEGHNA	3.500	2.93	2.47	2.70
23	MADHUMATI	149.500	5.00	4.94	4.97	88	S-MEGHNA1	10.000	3.50	2.32	2.79
24	MADHUMATI	181.500	3.78	3.64	3.71	89	NAYABHANGANI	0.000	2.98	2.54	2.75
25	MADHUMATI	205.000	3.31	3.27	3.29	90	NAYABHANGANI	14.500	2.49	2.21	2.36
26	MADHUMATI	207.000	3.12	3.08	3.10	91	DHARMAGANJ	4.000	2.69	1.87	2.29
27	MADHUMATI	248.375	2.38	2.27	2.33	92	DHARMAGANJ	8.000	2.54	1.69	2.13
28	POYLAHARA	10.000	1.84	0.29	1.09	93	DHARMAGANJ	15.000	2.51	1.56	2.04
29	GASHIAKHALI	10.500	1.94	0.18	1.01	94	KALABADAR-1	9.000	2.32	1.56	1.97
30	BHAIRAB	8.500	1.84	1.02	1.42	95	KALABADAR-2	10.000	2.61	1.39	1.99
31	ATHAROBANKI	32.000	3.27	3.03	3.14	96	ILSHA	25.500	2.23	1.31	1.80
32	BALESWAR	64.000	1.88	0.04	0.92	97	SHAHABAZ-1	4.167	3.42	1.31	2.16
33	BALESWAR	93.000	1.87	0.25	1.01	98	SHAHABAZ-1	12.500	3.40	1.10	2.02
34	KALIGANGA	21.800	1.77	1.23	1.52	99	TENTULIA	8.000	1.86	1.20	1.57
35	BHAIRAB U	39.853	2.86	2.81	2.83	100	RANGAMATIA	3.360	1.94	1.29	1.65
36	BHAIRAB U	123.000	2.89	2.52	2.67	101	KIRTONKHOLA	14.000	1.87	1.29	1.62
37	KALIGANGA U	17.333	5.08	5.06	5.07	102	KIRTONKHOLA	24.000	1.77	1.15	1.51
38	CHITRA	131.500	3.24	2.89	3.04	103	BISHKHALI	3.250	1.66	0.69	1.25
39	CHITRA	151.505	3.19	2.86	3.00	104	BISHKHALI	21.500	1.64	0.45	1.14
40	NABAGANGA_U	98.000	3.69	3.66	3.67	105	BISHKHALI	44.500	1.82	0.15	0.98
41	NABAGANGA_U	123.000	3.39	3.22	3.29	106	BISHKHALI	70.000	1.92	-0.03	0.89
42	NABAGANGA_U	164.000	3.55	3.43	3.49	107	BISHKHALI	86.500	1.89	-0.18	0.84
43	CHANDANA	39.100	5.10	5.04	5.07	108	KHAIRABAD	31.000	1.75	0.61	1.22
44	KUMAR	42.900	4.62	4.57	4.60	109	PANDAB-1	4.250	1.70	0.67	1.28
45	KUMAR	99.300	3.43	3.41	3.42	110	DHULIA	9.750	1.80	1.06	1.44
46	SITALAKHYA	0.000	5.10	5.01	5.05	111	DHULIA	23.000	1.69	0.84	1.30
47	SITALAKHYA	24.800	4.75	4.69	4.72	112	PAIRA	19.175	1.81	0.38	1.10
48	SITALAKHYA	46.000	4.26	4.24	4.25	113	PAIRA	24.000	1.81	0.24	1.04
49	MBR	0.000	3.87	3.84	3.85	114	BURISWAR	5.000	1.81	0.21	1.02
50	BARASIA_ARBT	25.500	5.04	4.98	5.01	115	BURISWAR	30.000	1.82	-0.13	0.92
51	GORAI	13.000	12.48	12.41	12.45	116	BURISWAR	37.500	1.84	-0.11	0.88
52	GORAI	82.000	8.43	8.37	8.40	117	BURISWAR	47.000	1.89	-0.18	0.84
53	ARIALKHAN	9.000	5.94	5.89	5.92	118	PATUAKHALI	0.000	1.60	0.50	1.18
54	ARIALKHAN	30.500	5.06	5.01	5.03	119	LOHALIA	19.625	1.64	0.55	1.20
55	ARIALKHAN	53.000	4.17	4.09	4.13	120	LOHALIA	23.000	1.60	0.50	1.18
56	ARIALKHAN	64.000	3.95	3.85	3.89	121	LOHALIA	32.500	1.57	0.36	1.18
57	ARIALKHAN	101.000	2.92	2.62	2.77	122	LOHALIA	63.000	1.66	0.61	1.13
58	ARIALKHAN	125.500	2.08	1.59	1.83	123	PADMA	48.000	6.70	6.64	6.67
59	ARIALKHAN	143.000	1.99	1.40	1.73	124	PADMA	54.000	6.46	6.40	6.43
60	ARIALKHAN	149.500	2.02	1.38	1.75	125	PADMA	90.000	4.68	4.53	4.60
61	ARIALKHAN	161.000	1.96	1.27	1.67	126	TENTULIA	68.333	1.61	0.75	1.18
62	ARIALKHAN-L	0.000	5.33	5.28	5.30	127	SWARUPKATI	0.000	1.60	0.44	1.17
63	ARIALKHAN-L	6.000	4.73	4.68	4.70	128	SWARUPKATI	8.500	1.61	0.31	1.06
64	ARIALKHAN-L	16.000	4.71	4.65	4.68	129	SWARUPKATI	14.500	1.55	0.27	1.01
65	ARIALKHAN-L	26.000	4.67	4.61	4.64	130	SWARUPKATI	16.500	1.55	0.28	1.01

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a9]

TABLE A10

Water Level (m.PWD) for October 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	1.12	0.94	1.03	66	PALANG	20.010	2.98	2.89	2.93
2	KOBADAK	109.500	1.32	0.49	0.87	67	NARIA-KH	0.000	3.33	2.74	2.98
3	BETNA	47.000	2.04	1.06	1.43	68	KUMAR-1	0.000	3.21	3.13	3.16
4	LABANGABATI	8.750	1.77	0.25	0.91	69	KUMAR-1	12.300	2.99	2.91	2.95
5	KHOLPETUA	21.000	2.02	-1.00	0.48	70	KUMAR-1	20.500	2.24	2.15	2.19
6	MALANCHA	0.000	1.68	-0.75	0.46	71	KUMAR-2	0.000	2.24	2.15	2.19
7	L_SOLMARI	8.500	2.03	-0.30	0.79	72	KUMAR-2	10.333	2.56	2.50	2.52
8	SALTA	0.000	2.18	-1.08	0.56	73	TORKI-1	20.430	2.12	1.86	1.99
9	RUPSA	4.194	2.03	-0.15	0.87	74	TORKI-2	0.000	2.15	1.51	1.80
10	KAZIBACHA	15.000	1.99	-0.58	0.66	75	BISHKANDIA	31.500	1.51	-0.22	0.66
11	SIBSA	21.915	1.91	-0.97	0.48	76	UZIRPUR	0.000	1.47	0.39	0.93
12	SIBSA	45.265	1.77	-0.87	0.47	77	UZIRPUR	10.500	1.42	0.19	0.82
13	PUSSUR	16.835	1.88	-0.70	0.57	78	SHANDHA	5.500	1.39	0.09	0.77
14	PUSSUR	65.995	1.59	-0.70	0.46	79	SHIKARPUR	0.000	1.61	0.75	1.20
15	PUSSUR	98.210	1.49	-0.56	0.45	80	AMTALI	3.500	1.55	0.64	1.12
16	NABAGANGA_L	29.000	1.93	0.64	1.21	81	AMTALI	10.500	1.50	0.51	1.00
17	NABAGANGA_M	17.250	1.95	0.71	1.27	82	LOWERMEGHNA	19.000	2.95	2.08	2.46
18	KATAKHALI-SW	13.500	1.99	0.80	1.32	83	LOWERMEGHNA	41.250	2.91	1.56	2.13
19	CHUNKURI	6.000	1.93	-0.59	0.66	84	JOYANTI-1	6.500	2.80	1.73	2.23
20	HARIA	18.500	2.04	-1.02	0.52	85	JOYANTI-1	13.010	2.79	1.69	2.19
21	MADHUMATI	82.000	5.09	4.97	5.03	86	JOYANTI-2	5.667	2.76	1.70	2.20
22	MADHUMATI	108.000	4.02	3.91	3.96	87	S-MEGHNA	3.500	2.44	1.40	1.90
23	MADHUMATI	149.500	2.30	2.09	2.18	88	S-MEGHNA1	10.000	2.89	1.25	1.95
24	MADHUMATI	181.500	2.01	1.05	1.48	89	NAYABHANGANI	0.000	2.47	1.45	1.93
25	MADHUMATI	205.000	1.76	1.62	1.68	90	NAYABHANGANI	14.500	2.09	1.19	1.66
26	MADHUMATI	207.000	1.55	1.30	1.41	91	DHARMAGANJ	4.000	2.25	0.94	1.59
27	MADHUMATI	248.375	1.26	0.93	1.09	92	DHARMAGANJ	8.000	2.15	0.85	1.51
28	POYLAHARA	10.000	1.46	-0.19	0.62	93	DHARMAGANJ	15.000	2.13	0.80	1.46
29	GASHIAKHALI	10.500	1.52	-0.37	0.55	94	KALABADAR-1	9.000	1.97	0.80	1.41
30	BHAIRAB	8.500	1.41	0.42	0.85	95	KALABADAR-2	10.000	2.23	0.70	1.46
31	ATHAROBANKI	32.000	1.98	0.77	1.31	96	ILSHA	25.500	1.91	0.67	1.32
32	BALESWAR	64.000	1.48	-0.41	0.52	97	SHAHABAZ-1	4.167	2.84	0.70	1.63
33	BALESWAR	93.000	1.47	-0.32	0.54	98	SHAHABAZ-1	12.500	2.79	0.59	1.57
34	KALIGANGA	21.800	1.25	0.34	0.78	99	TENTULIA	8.000	1.62	0.65	1.16
35	BHAIRAB U	39.853	1.58	1.51	1.54	100	RANGAMATIA	3.360	1.64	0.67	1.20
36	BHAIRAB U	123.000	1.93	0.62	1.20	101	KIRTONKHOLA	14.000	1.53	0.51	1.06
37	KALIGANGA U	17.333	4.65	4.64	4.65	102	KIRTONKHOLA	24.000	1.44	0.36	0.96
38	CHITRA	131.500	1.84	0.91	1.34	103	BISHKHALI	3.250	1.42	-0.00	0.74
39	CHITRA	151.505	1.84	0.75	1.26	104	BISHKHALI	21.500	1.40	-0.17	0.64
40	NABAGANGA_U	98.000	3.27	3.25	3.26	105	BISHKHALI	44.500	1.51	-0.42	0.51
41	NABAGANGA_U	123.000	2.54	2.46	2.49	106	BISHKHALI	70.000	1.49	-0.55	0.45
42	NABAGANGA_U	164.000	1.86	1.19	1.48	107	BISHKHALI	86.500	1.46	-0.65	0.39
43	CHANDANA	39.100	3.20	3.14	3.17	108	KHAIRABAD	31.000	1.48	0.06	0.74
44	KUMAR	42.900	3.00	2.94	2.97	109	PANDAB-1	4.250	1.42	0.14	0.79
45	KUMAR	99.300	1.92	1.82	1.87	110	DHULIA	9.750	1.43	0.52	1.00
46	SITALAKHYA	0.000	3.38	3.31	3.34	111	DHULIA	23.000	1.37	0.34	0.87
47	SITALAKHYA	24.800	3.36	3.29	3.33	112	PAIRA	19.175	1.50	-0.10	0.64
48	SITALAKHYA	46.000	3.31	3.24	3.27	113	PAIRA	24.000	1.52	-0.23	0.58
49	MBR	0.000	2.24	2.15	2.19	114	BURISWAR	5.000	1.52	-0.27	0.56
50	BARASIA_ARBT	25.500	2.28	2.10	2.18	115	BURISWAR	30.000	1.49	-0.49	0.45
51	GORAI	13.000	8.73	8.61	8.67	116	BURISWAR	37.500	1.47	-0.55	0.43
52	GORAI	82.000	5.09	4.97	5.03	117	BURISWAR	47.000	1.46	-0.65	0.39
53	ARIALKHAN	9.000	4.22	4.11	4.16	118	PATUAKHALI	0.000	1.43	0.16	0.78
54	ARIALKHAN	30.500	3.35	3.26	3.30	119	LOHALIA	19.625	1.44	0.19	0.79
55	ARIALKHAN	53.000	2.54	2.34	2.44	120	LOHALIA	23.000	1.43	0.16	0.78
56	ARIALKHAN	64.000	2.40	2.07	2.22	121	LOHALIA	32.500	1.40	0.14	0.81
57	ARIALKHAN	101.000	2.15	1.51	1.80	122	LOHALIA	63.000	1.47	0.30	0.88
58	ARIALKHAN	125.500	1.60	0.73	1.18	123	PADMA	48.000	4.54	4.40	4.47
59	ARIALKHAN	143.000	1.65	0.63	1.15	124	PADMA	54.000	4.35	4.20	4.27
60	ARIALKHAN	149.500	1.73	0.69	1.25	125	PADMA	90.000	3.33	2.74	2.98
61	ARIALKHAN	161.000	1.69	0.67	1.22	126	TENTULIA	68.333	1.40	0.53	0.97
62	ARIALKHAN-L	0.000	3.59	3.47	3.53	127	SWARUPKATI	0.000	1.37	-0.23	0.63
63	ARIALKHAN-L	6.000	3.00	2.92	2.96	128	SWARUPKATI	8.500	1.37	-0.32	0.57
64	ARIALKHAN-L	16.000	3.00	2.91	2.95	129	SWARUPKATI	14.500	1.34	-0.35	0.54
65	ARIALKHAN-L	26.000	2.96	2.87	2.91	130	SWARUPKATI	16.500	1.33	-0.35	0.54

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a10]

TABLE A11

Water Level (m.PWD) for November 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.81	0.61	0.71	66	PALANG	20.010	1.93	1.84	1.90
2	KOBADAK	109.500	1.11	0.26	0.65	67	NARIA-KH	0.000	2.62	1.57	2.02
3	BETNA	47.000	1.83	0.58	1.06	68	KUMAR-1	0.000	2.15	2.04	2.09
4	LABANGABATI	8.750	1.62	0.07	0.73	69	KUMAR-1	12.300	1.93	1.84	1.88
5	KHOLPETUA	21.000	1.95	-1.24	0.30	70	KUMAR-1	20.500	1.10	1.03	1.07
6	MALANCHA	0.000	1.62	-0.97	0.29	71	KUMAR-2	0.000	1.10	1.03	1.07
7	L_SOLMARI	8.500	1.88	-0.65	0.49	72	KUMAR-2	10.333	1.70	1.62	1.65
8	SALTA	0.000	2.10	-1.30	0.37	73	TORKI-1	20.430	1.53	1.09	1.31
9	RUPSA	4.194	1.85	-0.56	0.54	74	TORKI-2	0.000	1.68	0.87	1.28
10	KAZIBACHA	15.000	1.84	-0.88	0.41	75	BISHKANDIA	31.500	1.39	-0.49	0.44
11	SIBSA	21.915	1.83	-1.22	0.30	76	UZIRPUR	0.000	1.31	0.02	0.67
12	SIBSA	45.265	1.70	-1.10	0.29	77	UZIRPUR	10.500	1.30	-0.14	0.58
13	PUSSUR	16.835	1.76	-0.96	0.36	78	SHANDHA	5.500	1.29	-0.21	0.54
14	PUSSUR	65.995	1.53	-0.93	0.28	79	SHIKARPUR	0.000	1.41	0.29	0.87
15	PUSSUR	98.210	1.43	-0.79	0.28	80	AMTALI	3.500	1.35	0.24	0.83
16	NABAGANGA_L	29.000	1.51	-0.01	0.70	81	AMTALI	10.500	1.31	0.12	0.73
17	NABAGANGA_M	17.250	1.51	0.03	0.72	82	LOWERMEGHNA	19.000	2.44	1.14	1.74
18	KATAKHALI-SW	13.500	1.59	0.09	0.76	83	LOWERMEGHNA	41.250	2.43	0.86	1.57
19	CHUNKURI	6.000	1.81	-0.87	0.42	84	JOYANTI-1	6.500	2.37	0.95	1.62
20	HARIA	18.500	1.96	-1.26	0.33	85	JOYANTI-1	13.010	2.37	0.93	1.61
21	MADHUMATI	82.000	3.74	3.71	3.72	86	JOYANTI-2	5.667	2.36	0.93	1.61
22	MADHUMATI	108.000	2.75	2.72	2.73	87	S-MEGHNA	3.500	2.10	0.79	1.41
23	MADHUMATI	149.500	1.38	1.06	1.18	88	S-MEGHNA1	10.000	2.46	0.67	1.47
24	MADHUMATI	181.500	1.50	0.21	0.81	89	NAYABHANGANI	0.000	2.11	0.82	1.43
25	MADHUMATI	205.000	0.99	0.86	0.92	90	NAYABHANGANI	14.500	1.89	0.64	1.25
26	MADHUMATI	207.000	0.90	0.51	0.70	91	DHARMAGANJ	4.000	1.99	0.45	1.22
27	MADHUMATI	248.375	0.83	0.40	0.61	92	DHARMAGANJ	8.000	1.93	0.41	1.17
28	POYLAHARA	10.000	1.37	-0.40	0.44	93	DHARMAGANJ	15.000	1.92	0.39	1.14
29	GASHIAKHALI	10.500	1.48	-0.56	0.40	94	KALABADAR-1	9.000	1.79	0.39	1.11
30	BHAIRAB	8.500	1.23	0.17	0.59	95	KALABADAR-2	10.000	2.04	0.33	1.17
31	ATHAROBANKI	32.000	1.61	0.08	0.77	96	ILSHA	25.500	1.76	0.33	1.06
32	BALESWAR	64.000	1.39	-0.57	0.39	97	SHAHABAZ-1	4.167	2.60	0.33	1.31
33	BALESWAR	93.000	1.44	-0.52	0.40	98	SHAHABAZ-1	12.500	2.53	0.25	1.28
34	KALIGANGA	21.800	1.05	0.01	0.50	99	TENTULIA	8.000	1.52	0.36	0.96
35	BHAIRAB U	39.853	0.86	0.79	0.83	100	RANGAMATIA	3.360	1.52	0.34	0.97
36	BHAIRAB U	123.000	1.54	0.00	0.71	101	KIRTONKHOLA	14.000	1.39	0.15	0.80
37	KALIGANGA U	17.333	4.80	4.78	4.79	102	KIRTONKHOLA	24.000	1.32	0.04	0.73
38	CHITRA	131.500	1.33	0.27	0.78	103	BISHKHALI	3.250	1.34	-0.26	0.55
39	CHITRA	151.505	1.39	0.11	0.73	104	BISHKHALI	21.500	1.34	-0.40	0.47
40	NABAGANGA_U	98.000	2.81	2.77	2.79	105	BISHKHALI	44.500	1.49	-0.62	0.38
41	NABAGANGA_U	123.000	1.92	1.83	1.87	106	BISHKHALI	70.000	1.47	-0.73	0.33
42	NABAGANGA_U	164.000	1.27	0.51	0.86	107	BISHKHALI	86.500	1.45	-0.81	0.29
43	CHANDANA	39.100	2.62	2.59	2.60	108	KHAIRABAD	31.000	1.39	-0.17	0.59
44	KUMAR	42.900	1.62	1.59	1.60	109	PANDAB-1	4.250	1.34	-0.10	0.63
45	KUMAR	99.300	1.00	0.91	0.95	110	DHULIA	9.750	1.32	0.27	0.82
46	SITALAKHYA	0.000	1.69	1.66	1.68	111	DHULIA	23.000	1.26	0.11	0.71
47	SITALAKHYA	24.800	1.64	1.62	1.63	112	PAIRA	19.175	1.43	-0.30	0.51
48	SITALAKHYA	46.000	1.55	1.52	1.54	113	PAIRA	24.000	1.47	-0.42	0.46
49	MBR	0.000	1.10	1.03	1.07	114	BURISWAR	5.000	1.48	-0.45	0.44
50	BARASIA_ARBT	25.500	1.30	1.06	1.18	115	BURISWAR	30.000	1.47	-0.66	0.34
51	GORAI	13.000	7.64	7.61	7.62	116	BURISWAR	37.500	1.44	-0.72	0.32
52	GORAI	82.000	3.74	3.71	3.72	117	BURISWAR	47.000	1.45	-0.81	0.29
53	ARIALKHAN	9.000	2.92	2.74	2.83	118	PATUAKHALI	0.000	1.36	0.02	0.65
54	ARIALKHAN	30.500	2.25	2.13	2.19	119	LOHALIA	19.625	1.36	0.03	0.65
55	ARIALKHAN	53.000	1.82	1.38	1.58	120	LOHALIA	23.000	1.36	0.02	0.65
56	ARIALKHAN	64.000	1.79	1.15	1.44	121	LOHALIA	32.500	1.36	0.03	0.68
57	ARIALKHAN	101.000	1.68	0.87	1.28	122	LOHALIA	63.000	1.42	0.21	0.77
58	ARIALKHAN	125.500	1.40	0.28	0.87	123	PADMA	48.000	3.13	2.88	3.00
59	ARIALKHAN	143.000	1.52	0.22	0.88	124	PADMA	54.000	3.02	2.71	2.85
60	ARIALKHAN	149.500	1.61	0.34	1.00	125	PADMA	90.000	2.62	1.57	2.02
61	ARIALKHAN	161.000	1.58	0.34	0.99	126	TENTULIA	68.333	1.33	0.40	0.87
62	ARIALKHAN-L	0.000	2.71	2.42	2.56	127	SWARUPKATI	0.000	1.29	-0.47	0.43
63	ARIALKHAN-L	6.000	1.98	1.89	1.94	128	SWARUPKATI	8.500	1.28	-0.54	0.39
64	ARIALKHAN-L	16.000	1.97	1.88	1.94	129	SWARUPKATI	14.500	1.27	-0.56	0.38
65	ARIALKHAN-L	26.000	1.96	1.84	1.91	130	SWARUPKATI	16.500	1.26	-0.55	0.38

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a11]

TABLE A12

Water Level (m.PWD) for December 1982

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.61	0.41	0.51	66	PALANG	20.010	1.55	1.45	1.51
2	KOBADAK	109.500	0.92	0.08	0.46	67	NARIA-KH	0.000	2.28	1.11	1.61
3	BETNA	47.000	1.70	0.44	0.92	68	KUMAR-1	0.000	1.77	1.63	1.71
4	LABANGABATI	8.750	1.44	-0.06	0.57	69	KUMAR-1	12.300	1.57	1.45	1.51
5	KHOLPETUA	21.000	1.84	-1.46	0.11	70	KUMAR-1	20.500	0.79	0.72	0.76
6	MALANCHA	0.000	1.49	-1.20	0.10	71	KUMAR-2	0.000	0.79	0.72	0.76
7	L_SOLMARI	8.500	1.71	-0.89	0.27	72	KUMAR-2	10.333	1.36	1.01	1.12
8	SALTA	0.000	1.98	-1.46	0.18	73	TORKI-1	20.430	1.25	0.79	1.01
9	RUPSA	4.194	1.68	-0.81	0.30	74	TORKI-2	0.000	1.48	0.54	1.00
10	KAZIBACHA	15.000	1.68	-1.09	0.20	75	BISHKANDIA	31.500	1.32	-0.65	0.33
11	SIBSA	21.915	1.72	-1.44	0.10	76	UZIRPUR	0.000	1.20	-0.19	0.51
12	SIBSA	45.265	1.57	-1.33	0.10	77	UZIRPUR	10.500	1.22	-0.32	0.44
13	PUSSUR	16.835	1.61	-1.16	0.16	78	SHANDHA	5.500	1.22	-0.38	0.41
14	PUSSUR	65.995	1.41	-1.15	0.09	79	SHIKARPUR	0.000	1.26	0.03	0.68
15	PUSSUR	98.210	1.32	-1.01	0.09	80	AMTALI	3.500	1.23	-0.01	0.64
16	NABAGANGA_L	29.000	1.26	-0.34	0.40	81	AMTALI	10.500	1.19	-0.11	0.56
17	NABAGANGA_M	17.250	1.26	-0.32	0.41	82	LOWERMEGHNA	19.000	2.13	0.72	1.37
18	KATAKHALI-SW	13.500	1.33	-0.23	0.46	83	LOWERMEGHNA	41.250	2.13	0.50	1.24
19	CHUNKURI	6.000	1.66	-1.09	0.21	84	JOYANTI-1	6.500	2.08	0.58	1.28
20	HARIA	18.500	1.83	-1.48	0.14	85	JOYANTI-1	13.010	2.07	0.56	1.26
21	MADHUMATI	82.000	2.44	2.38	2.41	86	JOYANTI-2	5.667	2.07	0.57	1.27
22	MADHUMATI	108.000	1.74	1.70	1.72	87	S-MEGHNA	3.500	1.88	0.48	1.12
23	MADHUMATI	149.500	0.87	0.53	0.67	88	S-MEGHNA1	10.000	2.17	0.34	1.16
24	MADHUMATI	181.500	1.22	-0.20	0.46	89	NAYABHANGANI	0.000	1.88	0.49	1.14
25	MADHUMATI	205.000	0.73	0.63	0.68	90	NAYABHANGANI	14.500	1.74	0.35	1.00
26	MADHUMATI	207.000	0.71	0.29	0.50	91	DHARMAGANJ	4.000	1.79	0.16	0.96
27	MADHUMATI	248.375	0.67	0.23	0.45	92	DHARMAGANJ	8.000	1.74	0.14	0.92
28	POYLAHARA	10.000	1.28	-0.53	0.29	93	DHARMAGANJ	15.000	1.73	0.12	0.91
29	GASHIAKHALI	10.500	1.45	-0.69	0.30	94	KALABADAR-1	9.000	1.62	0.13	0.88
30	BHAIRAB	8.500	1.04	0.05	0.42	95	KALABADAR-2	10.000	1.86	0.07	0.92
31	ATHAROBANKI	32.000	1.35	-0.20	0.48	96	ILSHA	25.500	1.61	0.09	0.84
32	BALESWAR	64.000	1.35	-0.66	0.31	97	SHAHABAZ-1	4.167	2.37	0.04	1.03
33	BALESWAR	93.000	1.43	-0.65	0.31	98	SHAHABAZ-1	12.500	2.31	-0.05	1.00
34	KALIGANGA	21.800	0.96	-0.13	0.38	99	TENTULIA	8.000	1.40	0.13	0.76
35	BHAIRAB U	39.853	0.53	0.46	0.49	100	RANGAMATIA	3.360	1.40	0.10	0.76
36	BHAIRAB U	123.000	1.30	-0.31	0.42	101	KIRTONKHOLA	14.000	1.29	-0.08	0.63
37	KALIGANGA U	17.333	4.63	4.63	4.63	102	KIRTONKHOLA	24.000	1.22	-0.16	0.57
38	CHITRA	131.500	1.00	-0.08	0.44	103	BISHKHALI	3.250	1.29	-0.42	0.44
39	CHITRA	151.505	1.13	-0.22	0.42	104	BISHKHALI	21.500	1.33	-0.54	0.37
40	NABAGANGA_U	98.000	2.16	2.13	2.15	105	BISHKHALI	44.500	1.50	-0.75	0.30
41	NABAGANGA_U	123.000	1.22	1.09	1.14	106	BISHKHALI	70.000	1.48	-0.85	0.26
42	NABAGANGA_U	164.000	0.86	0.19	0.51	107	BISHKHALI	86.500	1.47	-0.92	0.22
43	CHANDANA	39.100	2.45	2.44	2.45	108	KHAIRABAD	31.000	1.34	-0.34	0.47
44	KUMAR	42.900	0.99	0.98	0.99	109	PANDAB-1	4.250	1.29	-0.28	0.50
45	KUMAR	99.300	0.74	0.65	0.69	110	DHULIA	9.750	1.20	0.05	0.65
46	SITALAKHYA	0.000	1.13	1.11	1.12	111	DHULIA	23.000	1.21	-0.07	0.56
47	SITALAKHYA	24.800	1.07	1.06	1.06	112	PAIRA	19.175	1.41	-0.44	0.40
48	SITALAKHYA	46.000	0.98	0.97	0.98	113	PAIRA	24.000	1.45	-0.56	0.36
49	MBR	0.000	0.79	0.72	0.76	114	BURISWAR	5.000	1.46	-0.58	0.35
50	BARASIA_ARBT	25.500	0.79	0.54	0.67	115	BURISWAR	30.000	1.46	-0.79	0.26
51	GORAI	13.000	6.68	6.63	6.66	116	BURISWAR	37.500	1.46	-0.83	0.25
52	GORAI	82.000	2.44	2.38	2.41	117	BURISWAR	47.000	1.47	-0.92	0.22
53	ARIALKHAN	9.000	2.47	2.25	2.36	118	PATUAKHALI	0.000	1.32	-0.16	0.51
54	ARIALKHAN	30.500	1.86	1.71	1.79	119	LOHALIA	19.625	1.31	-0.14	0.52
55	ARIALKHAN	53.000	1.55	0.99	1.24	120	LOHALIA	23.000	1.32	-0.16	0.51
56	ARIALKHAN	64.000	1.52	0.78	1.12	121	LOHALIA	32.500	1.32	-0.12	0.54
57	ARIALKHAN	101.000	1.48	0.54	1.00	122	LOHALIA	63.000	1.34	0.01	0.61
58	ARIALKHAN	125.500	1.27	0.02	0.67	123	PADMA	48.000	2.67	2.37	2.51
59	ARIALKHAN	143.000	1.40	-0.02	0.69	124	PADMA	54.000	2.59	2.20	2.37
60	ARIALKHAN	149.500	1.48	0.10	0.79	125	PADMA	90.000	2.28	1.11	1.61
61	ARIALKHAN	161.000	1.44	0.11	0.78	126	TENTULIA	68.333	1.17	0.22	0.69
62	ARIALKHAN-L	0.000	2.38	1.98	2.16	127	SWARUPKATI	0.000	1.25	-0.61	0.32
63	ARIALKHAN-L	6.000	1.61	1.51	1.57	128	SWARUPKATI	8.500	1.24	-0.68	0.28
64	ARIALKHAN-L	16.000	1.61	1.51	1.56	129	SWARUPKATI	14.500	1.23	-0.69	0.28
65	ARIALKHAN-L	26.000	1.63	1.46	1.55	130	SWARUPKATI	16.500	1.23	-0.68	0.28

Source : Consultant's Model Analaysis based on BWDB Data

;vp\vol8\table\tab-a12]

TABLE A13

Water Level (m.PWD) for January 1983

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.59	0.40	0.49	66	PALANG	20.010	1.19	1.05	1.13
2	KOBADAK	109.500	0.88	0.07	0.44	67	NARIA-KH	0.000	1.94	0.81	1.29
3	BETNA	47.000	1.67	0.45	0.91	68	KUMAR-1	0.000	1.48	1.35	1.42
4	LABANGABATI	8.750	1.41	-0.07	0.55	69	KUMAR-1	12.300	1.27	1.17	1.22
5	KHOLPETUA	21.000	1.78	-1.48	0.09	70	KUMAR-1	20.500	0.56	0.50	0.53
6	MALANCHA	0.000	1.45	-1.22	0.07	71	KUMAR-2	0.000	0.56	0.50	0.53
7	L_SOLMARI	8.500	1.65	-0.95	0.22	72	KUMAR-2	10.333	0.95	0.57	0.70
8	SALTA	0.000	1.94	-1.47	0.16	73	TORKI-1	20.430	0.88	0.51	0.69
9	RUPSA	4.194	1.62	-0.87	0.24	74	TORKI-2	0.000	1.14	0.27	0.70
10	KAZIBACHA	15.000	1.61	-1.14	0.16	75	BISHKANDIA	31.500	1.06	-0.88	0.06
11	SIBSA	21.915	1.66	-1.46	0.08	76	UZIRPUR	0.000	0.94	-0.44	0.24
12	SIBSA	45.265	1.53	-1.35	0.07	77	UZIRPUR	10.500	0.96	-0.56	0.18
13	PUSSUR	16.835	1.54	-1.20	0.12	78	SHANDHA	5.500	0.96	-0.62	0.15
14	PUSSUR	65.995	1.36	-1.18	0.06	79	SHIKARPUR	0.000	0.97	-0.22	0.39
15	PUSSUR	98.210	1.26	-1.05	0.07	80	AMTALI	3.500	0.94	-0.25	0.36
16	NABAGANGA_L	29.000	1.18	-0.44	0.30	81	AMTALI	10.500	0.92	-0.35	0.29
17	NABAGANGA_M	17.250	1.18	-0.42	0.31	82	LOWERMEGHNA	19.000	1.79	0.42	1.05
18	KATAKHALI-SW	13.500	1.23	-0.33	0.36	83	LOWERMEGHNA	41.250	1.79	0.24	0.94
19	CHUNKURI	6.000	1.60	-1.13	0.17	84	JOYANTI-1	6.500	1.75	0.30	0.97
20	HARIA	18.500	1.78	-1.51	0.11	85	JOYANTI-1	13.010	1.74	0.29	0.96
21	MADHUMATI	82.000	1.36	1.33	1.34	86	JOYANTI-2	5.667	1.74	0.29	0.96
22	MADHUMATI	108.000	0.97	0.94	0.95	87	S-MEGHNA	3.500	1.57	0.22	0.84
23	MADHUMATI	149.500	0.61	0.28	0.43	88	S-MEGHNA1	10.000	1.85	0.10	0.87
24	MADHUMATI	181.500	1.10	-0.34	0.33	89	NAYABHANGANI	0.000	1.57	0.24	0.85
25	MADHUMATI	205.000	0.52	0.45	0.49	90	NAYABHANGANI	14.500	1.44	0.10	0.71
26	MADHUMATI	207.000	0.41	0.01	0.21	91	DHARMAGANJ	4.000	1.47	-0.08	0.68
27	MADHUMATI	248.375	0.38	-0.02	0.17	92	DHARMAGANJ	8.000	1.44	-0.10	0.64
28	POYLAHARA	10.000	1.09	-0.66	0.14	93	DHARMAGANJ	15.000	1.42	-0.10	0.63
29	GASHIAKHALI	10.500	1.20	-0.93	0.07	94	KALABADAR-1	9.000	1.33	-0.09	0.61
30	BHAIRAB	8.500	0.87	0.00	0.34	95	KALABADAR-2	10.000	1.56	-0.15	0.65
31	ATHAROBANKI	32.000	1.25	-0.28	0.38	96	ILSHA	25.500	1.32	-0.12	0.57
32	BALESWAR	64.000	1.09	-0.94	0.08	97	SHAHABAZ-1	4.167	2.04	-0.19	0.76
33	BALESWAR	93.000	1.16	-0.87	0.05	98	SHAHABAZ-1	12.500	1.97	-0.28	0.72
34	KALIGANGA	21.800	0.69	-0.37	0.11	99	TENTULIA	8.000	1.13	-0.07	0.51
35	BHAIRAB U	39.853	0.43	0.36	0.40	100	RANGAMATIA	3.360	1.12	-0.11	0.51
36	BHAIRAB U	123.000	1.21	-0.39	0.33	101	KIRTONKHOLA	14.000	1.00	-0.32	0.35
37	KALIGANGA U	17.333	4.61	4.60	4.60	102	KIRTONKHOLA	24.000	0.97	-0.40	0.30
38	CHITRA	131.500	0.89	-0.17	0.34	103	BISHKHALI	3.250	1.10	-0.65	0.17
39	CHITRA	151.505	1.04	-0.32	0.32	104	BISHKHALI	21.500	1.13	-0.76	0.11
40	NABAGANGA_U	98.000	1.70	1.70	1.70	105	BISHKHALI	44.500	1.24	-0.98	0.04
41	NABAGANGA_U	123.000	1.00	0.65	0.80	106	BISHKHALI	70.000	1.20	-1.08	-0.01
42	NABAGANGA_U	164.000	0.73	0.09	0.39	107	BISHKHALI	86.500	1.20	-1.18	-0.05
43	CHANDANA	39.100	2.46	2.45	2.45	108	KHAIRABAD	31.000	1.09	-0.58	0.21
44	KUMAR	42.900	0.79	0.79	0.79	109	PANDAB-1	4.250	1.04	-0.51	0.23
45	KUMAR	99.300	0.52	0.46	0.49	110	DHULIA	9.750	0.93	-0.17	0.39
46	SITALAKHYA	0.000	0.95	0.94	0.94	111	DHULIA	23.000	0.96	-0.30	0.31
47	SITALAKHYA	24.800	0.88	0.88	0.88	112	PAIRA	19.175	1.15	-0.68	0.14
48	SITALAKHYA	46.000	0.79	0.79	0.79	113	PAIRA	24.000	1.19	-0.79	0.10
49	MBR	0.000	0.56	0.50	0.53	114	BURISWAR	5.000	1.20	-0.82	0.09
50	BARASIA_ARBT	25.500	0.54	0.31	0.43	115	BURISWAR	30.000	1.19	-1.03	0.00
51	GORAI	13.000	5.69	5.66	5.68	116	BURISWAR	37.500	1.19	-1.08	-0.02
52	GORAI	82.000	1.36	1.33	1.34	117	BURISWAR	47.000	1.20	-1.18	-0.05
53	ARIALKHAN	9.000	2.16	1.96	2.06	118	PATUAKHALI	0.000	1.13	-0.37	0.27
54	ARIALKHAN	30.500	1.55	1.42	1.49	119	LOHALIA	19.625	1.11	-0.36	0.28
55	ARIALKHAN	53.000	1.20	0.66	0.91	120	LOHALIA	23.000	1.13	-0.37	0.27
56	ARIALKHAN	64.000	1.18	0.45	0.79	121	LOHALIA	32.500	1.15	-0.31	0.31
57	ARIALKHAN	101.000	1.14	0.27	0.70	122	LOHALIA	63.000	1.13	-0.17	0.39
58	ARIALKHAN	125.500	0.97	-0.23	0.39	123	PADMA	48.000	2.35	2.08	2.21
59	ARIALKHAN	143.000	1.10	-0.25	0.41	124	PADMA	54.000	2.26	1.91	2.06
60	ARIALKHAN	149.500	1.20	-0.11	0.53	125	PADMA	90.000	1.94	0.81	1.29
61	ARIALKHAN	161.000	1.17	-0.10	0.53	126	TENTULIA	68.333	0.95	0.02	0.47
62	ARIALKHAN-L	0.000	2.12	1.71	1.89	127	SWARUPKATI	0.000	0.99	-0.84	0.06
63	ARIALKHAN-L	6.000	1.29	1.22	1.26	128	SWARUPKATI	8.500	1.00	-0.90	0.03
64	ARIALKHAN-L	16.000	1.29	1.21	1.26	129	SWARUPKATI	14.500	1.00	-0.90	0.02
65	ARIALKHAN-L	26.000	1.31	1.16	1.24	130	SWARUPKATI	16.500	1.00	-0.90	0.02

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a13]

TABLE 14

Water Level (m.PWD) for February 1983

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.61	0.41	0.51	66	PALANG	20.010	1.10	0.93	1.03
2	KOBADAK	109.500	0.87	0.10	0.46	67	NARIA-KH	0.000	1.78	0.72	1.19
3	BETNA	47.000	1.60	0.45	0.90	68	KUMAR-1	0.000	1.37	1.26	1.32
4	LABANGABATI	8.750	1.34	-0.04	0.56	69	KUMAR-1	12.300	1.18	1.09	1.14
5	KHOLPETUA	21.000	1.70	-1.40	0.12	70	KUMAR-1	20.500	0.54	0.47	0.51
6	MALANCHA	0.000	1.37	-1.14	0.10	71	KUMAR-2	0.000	0.54	0.47	0.51
7	L_SOLMARI	8.500	1.56	-0.91	0.23	72	KUMAR-2	10.333	0.90	0.50	0.64
8	SALTA	0.000	1.85	-1.42	0.18	73	TORKI-1	20.430	0.80	0.48	0.65
9	RUPSA	4.194	1.53	-0.84	0.25	74	TORKI-2	0.000	1.05	0.26	0.65
10	KAZIBACHA	15.000	1.53	-1.08	0.17	75	BISHKANDIA	31.500	1.08	-0.79	0.11
11	SIBSA	21.915	1.58	-1.38	0.10	76	UZIRPUR	0.000	0.93	-0.38	0.26
12	SIBSA	45.265	1.45	-1.27	0.11	77	UZIRPUR	10.500	0.96	-0.50	0.21
13	PUSSUR	16.835	1.46	-1.14	0.14	78	SHANDHA	5.500	0.96	-0.55	0.18
14	PUSSUR	65.995	1.29	-1.10	0.09	79	SHIKARPUR	0.000	0.91	-0.19	0.39
15	PUSSUR	98.210	1.19	-0.96	0.10	80	AMTALI	3.500	0.90	-0.22	0.36
16	NABAGANGA_L	29.000	1.11	-0.43	0.30	81	AMTALI	10.500	0.91	-0.31	0.30
17	NABAGANGA_M	17.250	1.12	-0.41	0.30	82	LOWERMEGHNA	19.000	1.63	0.36	0.95
18	KATAKHALI-SW	13.500	1.18	-0.31	0.36	83	LOWERMEGHNA	41.250	1.62	0.20	0.85
19	CHUNKURI	6.000	1.52	-1.08	0.19	84	JOYANTI-1	6.500	1.59	0.25	0.88
20	HARIA	18.500	1.70	-1.43	0.14	85	JOYANTI-1	13.010	1.59	0.24	0.87
21	MADHUMATI	82.000	0.89	0.86	0.87	86	JOYANTI-2	5.667	1.59	0.24	0.87
22	MADHUMATI	108.000	0.68	0.63	0.65	87	S-MEGHNA	3.500	1.45	0.19	0.77
23	MADHUMATI	149.500	0.55	0.24	0.39	88	S-MEGHNA1	10.000	1.68	0.07	0.78
24	MADHUMATI	181.500	1.04	-0.33	0.32	89	NAYABHANGANI	0.000	1.44	0.20	0.77
25	MADHUMATI	205.000	0.50	0.43	0.47	90	NAYABHANGANI	14.500	1.33	0.09	0.66
26	MADHUMATI	207.000	0.45	0.05	0.26	91	DHARMAGANJ	4.000	1.35	-0.08	0.62
27	MADHUMATI	248.375	0.42	0.04	0.22	92	DHARMAGANJ	8.000	1.33	-0.09	0.59
28	POYLAHARA	10.000	1.07	-0.60	0.18	93	DHARMAGANJ	15.000	1.31	-0.10	0.58
29	GASHIAKHALI	10.500	1.18	-0.82	0.14	94	KALABADAR-1	9.000	1.24	-0.09	0.56
30	BHAIRAB	8.500	0.88	0.01	0.35	95	KALABADAR-2	10.000	1.43	-0.15	0.59
31	ATHAROBANKI	32.000	1.20	-0.25	0.38	96	ILSHA	25.500	1.21	-0.12	0.53
32	BALESWAR	64.000	1.09	-0.78	0.14	97	SHAHABAZ-1	4.167	1.83	-0.22	0.66
33	BALESWAR	93.000	1.15	-0.77	0.12	98	SHAHABAZ-1	12.500	1.77	-0.31	0.63
34	KALIGANGA	21.800	0.72	-0.30	0.17	99	TENTULIA	8.000	1.04	-0.07	0.47
35	BHAIRAB U	39.853	0.45	0.37	0.41	100	RANGAMATIA	3.360	1.04	-0.10	0.47
36	BHAIRAB U	123.000	1.15	-0.37	0.33	101	KIRTONKHOLA	14.000	0.96	-0.28	0.36
37	KALIGANGA U	17.333	4.61	4.60	4.60	102	KIRTONKHOLA	24.000	0.96	-0.35	0.31
38	CHITRA	131.500	0.85	-0.14	0.34	103	BISHKHALI	3.250	1.10	-0.58	0.21
39	CHITRA	151.505	0.99	-0.30	0.32	104	BISHKHALI	21.500	1.14	-0.69	0.17
40	NABAGANGA_U	98.000	1.65	1.64	1.65	105	BISHKHALI	44.500	1.23	-0.88	0.11
41	NABAGANGA_U	123.000	0.97	0.60	0.74	106	BISHKHALI	70.000	1.19	-0.97	0.08
42	NABAGANGA_U	164.000	0.71	0.12	0.41	107	BISHKHALI	86.500	1.17	-1.04	0.04
43	CHANDANA	39.100	2.46	2.45	2.46	108	KHAIRABAD	31.000	1.06	-0.51	0.24
44	KUMAR	42.900	0.74	0.73	0.74	109	PANDAB-1	4.250	1.02	-0.46	0.26
45	KUMAR	99.300	0.51	0.44	0.47	110	DHULIA	9.750	0.88	-0.15	0.38
46	SITALAKHYA	0.000	0.89	0.89	0.89	111	DHULIA	23.000	0.93	-0.26	0.32
47	SITALAKHYA	24.800	0.83	0.83	0.83	112	PAIRA	19.175	1.12	-0.61	0.19
48	SITALAKHYA	46.000	0.74	0.74	0.74	113	PAIRA	24.000	1.17	-0.71	0.16
49	MBR	0.000	0.54	0.47	0.51	114	BURISWAR	5.000	1.18	-0.73	0.15
50	BARASIA_ARBT	25.500	0.50	0.27	0.39	115	BURISWAR	30.000	1.18	-0.92	0.08
51	GORAI	13.000	5.22	5.20	5.21	116	BURISWAR	37.500	1.18	-0.97	0.07
52	GORAI	82.000	0.89	0.86	0.87	117	BURISWAR	47.000	1.17	-1.04	0.04
53	ARIALKHAN	9.000	2.03	1.85	1.94	118	PATUAKHALI	0.000	1.10	-0.36	0.28
54	ARIALKHAN	30.500	1.44	1.32	1.39	119	LOHALIA	19.625	1.08	-0.35	0.28
55	ARIALKHAN	53.000	1.12	0.60	0.85	120	LOHALIA	23.000	1.10	-0.36	0.28
56	ARIALKHAN	64.000	1.09	0.40	0.74	121	LOHALIA	32.500	1.11	-0.31	0.30
57	ARIALKHAN	101.000	1.05	0.26	0.65	122	LOHALIA	63.000	1.07	-0.19	0.36
58	ARIALKHAN	125.500	0.92	-0.19	0.39	123	PADMA	48.000	2.20	1.95	2.08
59	ARIALKHAN	143.000	1.02	-0.22	0.40	124	PADMA	54.000	2.11	1.79	1.93
60	ARIALKHAN	149.500	1.11	-0.11	0.49	125	PADMA	90.000	1.78	0.72	1.19
61	ARIALKHAN	161.000	1.08	-0.10	0.49	126	TENTULIA	68.333	0.86	0.01	0.42
62	ARIALKHAN-L	0.000	1.98	1.60	1.77	127	SWARUPKATI	0.000	1.00	-0.75	0.11
63	ARIALKHAN-L	6.000	1.20	1.13	1.17	128	SWARUPKATI	8.500	1.01	-0.81	0.09
64	ARIALKHAN-L	16.000	1.20	1.13	1.17	129	SWARUPKATI	14.500	1.01	-0.82	0.09
65	ARIALKHAN-L	26.000	1.22	1.08	1.16	130	SWARUPKATI	16.500	1.02	-0.81	0.09

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a14]

TABLE A 15

Water Level (m.PWD) for March 1983

Map Ref. No.	River	Chain. (Km)	Average			Map Ref. No.	River	Chain. (Km)	Average		
			Max.	Min.	Mean				Max.	Min.	Mean
1	KOBADAK	44.500	0.67	0.49	0.59	66	PALANG	20.010	1.05	0.85	0.96
2	KOBADAK	109.500	0.89	0.17	0.51	67	NARIA-KH	0.000	1.68	0.65	1.13
3	BETNA	47.000	1.57	0.50	0.94	68	KUMAR-1	0.000	1.22	1.06	1.15
4	LABANGABATI	8.750	1.35	0.00	0.60	69	KUMAR-1	12.300	1.02	0.92	0.98
5	KHOLPETUA	21.000	1.67	-1.30	0.17	70	KUMAR-1	20.500	0.56	0.47	0.51
6	MALANCHA	0.000	1.35	-1.04	0.15	71	KUMAR-2	0.000	0.56	0.47	0.51
7	L_SOLMARI	8.500	1.54	-0.84	0.28	72	KUMAR-2	10.333	0.94	0.52	0.67
8	SALTA	0.000	1.83	-1.35	0.23	73	TORKI-1	20.430	0.85	0.56	0.71
9	RUPSA	4.194	1.50	-0.77	0.30	74	TORKI-2	0.000	1.10	0.35	0.71
10	KAZIBACHA	15.000	1.51	-1.00	0.23	75	BISHKANDIA	31.500	1.14	-0.63	0.23
11	SIBSA	21.915	1.55	-1.28	0.15	76	UZIRPUR	0.000	0.98	-0.24	0.37
12	SIBSA	45.265	1.42	-1.17	0.15	77	UZIRPUR	10.500	1.01	-0.35	0.32
13	PUSSUR	16.835	1.43	-1.05	0.19	78	SHANDHA	5.500	1.01	-0.40	0.30
14	PUSSUR	65.995	1.25	-0.99	0.14	79	SHIKARPUR	0.000	0.96	-0.05	0.49
15	PUSSUR	98.210	1.15	-0.86	0.15	80	AMTALI	3.500	0.95	-0.08	0.46
16	NABAGANGA_L	29.000	1.11	-0.37	0.35	81	AMTALI	10.500	0.96	-0.16	0.41
17	NABAGANGA_M	17.250	1.11	-0.36	0.35	82	LOWERMEGHNA	19.000	1.58	0.41	0.97
18	KATAKHALI-SW	13.500	1.17	-0.26	0.41	83	LOWERMEGHNA	41.250	1.62	0.28	0.89
19	CHUNKURI	6.000	1.49	-0.99	0.24	84	JOYANTI-1	6.500	1.58	0.33	0.92
20	HARIA	18.500	1.68	-1.34	0.19	85	JOYANTI-1	13.010	1.58	0.31	0.91
21	MADHUMATI	82.000	0.72	0.69	0.71	86	JOYANTI-2	5.667	1.58	0.32	0.91
22	MADHUMATI	108.000	0.61	0.54	0.58	87	S-MEGHNA	3.500	1.47	0.27	0.82
23	MADHUMATI	149.500	0.57	0.28	0.42	88	S-MEGHNA1	10.000	1.69	0.16	0.84
24	MADHUMATI	181.500	1.04	-0.27	0.36	89	NAYABHANGANI	0.000	1.47	0.27	0.83
25	MADHUMATI	205.000	0.53	0.44	0.49	90	NAYABHANGANI	14.500	1.38	0.19	0.74
26	MADHUMATI	207.000	0.52	0.16	0.35	91	DHARMAGANJ	4.000	1.39	0.04	0.70
27	MADHUMATI	248.375	0.51	0.14	0.33	92	DHARMAGANJ	8.000	1.37	0.02	0.68
28	POYLAHARA	10.000	1.13	-0.48	0.27	93	DHARMAGANJ	15.000	1.36	0.01	0.67
29	GASHIAKHALI	10.500	1.22	-0.66	0.25	94	KALABADAR-1	9.000	1.29	0.02	0.65
30	BHAIRAB	8.500	0.88	0.06	0.41	95	KALABADAR-2	10.000	1.47	-0.04	0.68
31	ATHAROBANKI	32.000	1.18	-0.20	0.43	96	ILSHA	25.500	1.25	-0.01	0.62
32	BALESWAR	64.000	1.15	-0.63	0.26	97	SHAHABAZ-1	4.167	1.85	-0.12	0.75
33	BALESWAR	93.000	1.19	-0.62	0.24	98	SHAHABAZ-1	12.500	1.77	-0.21	0.72
34	KALIGANGA	21.800	0.80	-0.18	0.28	99	TENTULIA	8.000	1.10	0.03	0.56
35	BHAIRAB U	39.853	0.49	0.42	0.45	100	RANGAMATIA	3.360	1.10	0.01	0.57
36	BHAIRAB U	123.000	1.14	-0.32	0.37	101	KIRTONKHOLA	14.000	1.01	-0.14	0.47
37	KALIGANGA U	17.333	4.61	4.60	4.60	102	KIRTONKHOLA	24.000	1.01	-0.21	0.42
38	CHITRA	131.500	0.85	-0.08	0.38	103	BISHKHALI	3.250	1.15	-0.43	0.33
39	CHITRA	151.505	0.99	-0.25	0.36	104	BISHKHALI	21.500	1.18	-0.54	0.29
40	NABAGANGA_U	98.000	1.66	1.66	1.66	105	BISHKHALI	44.500	1.27	-0.73	0.24
41	NABAGANGA_U	123.000	0.98	0.67	0.79	106	BISHKHALI	70.000	1.23	-0.81	0.20
42	NABAGANGA_U	164.000	0.72	0.18	0.44	107	BISHKHALI	86.500	1.21	-0.86	0.17
43	CHANDANA	39.100	2.47	2.46	2.47	108	KHAIRABAD	31.000	1.12	-0.36	0.35
44	KUMAR	42.900	0.69	0.67	0.68	109	PANDAB-1	4.250	1.08	-0.31	0.37
45	KUMAR	99.300	0.53	0.44	0.49	110	DHULIA	9.750	0.94	-0.01	0.49
46	SITALAKHYA	0.000	0.78	0.77	0.77	111	DHULIA	23.000	0.98	-0.13	0.43
47	SITALAKHYA	24.800	0.74	0.73	0.74	112	PAIRA	19.175	1.18	-0.45	0.31
48	SITALAKHYA	46.000	0.68	0.67	0.68	113	PAIRA	24.000	1.22	-0.56	0.28
49	MBR	0.000	0.56	0.47	0.51	114	BURISWAR	5.000	1.23	-0.58	0.27
50	BARASIA_ARBT	25.500	0.52	0.31	0.42	115	BURISWAR	30.000	1.23	-0.75	0.21
51	GORAI	13.000	4.90	4.88	4.89	116	BURISWAR	37.500	1.22	-0.79	0.19
52	GORAI	82.000	0.72	0.69	0.71	117	BURISWAR	47.000	1.21	-0.86	0.17
53	ARIALKHAN	9.000	1.72	1.46	1.59	118	PATUAKHALI	0.000	1.15	-0.23	0.38
54	ARIALKHAN	30.500	1.27	1.10	1.20	119	LOHALIA	19.625	1.14	-0.22	0.39
55	ARIALKHAN	53.000	1.11	0.60	0.85	120	LOHALIA	23.000	1.15	-0.23	0.38
56	ARIALKHAN	64.000	1.10	0.47	0.77	121	LOHALIA	32.500	1.15	-0.20	0.40
57	ARIALKHAN	101.000	1.10	0.35	0.71	122	LOHALIA	63.000	1.10	-0.09	0.45
58	ARIALKHAN	125.500	0.97	-0.06	0.49	123	PADMA	48.000	1.91	1.52	1.70
59	ARIALKHAN	143.000	1.08	-0.09	0.51	124	PADMA	54.000	1.87	1.40	1.61
60	ARIALKHAN	149.500	1.17	0.00	0.58	125	PADMA	90.000	1.68	0.65	1.13
61	ARIALKHAN	161.000	1.14	0.01	0.58	126	TENTULIA	68.333	0.91	0.11	0.51
62	ARIALKHAN-L	0.000	1.80	1.27	1.51	127	SWARUPKATI	0.000	1.05	-0.61	0.23
63	ARIALKHAN-L	6.000	1.10	1.03	1.07	128	SWARUPKATI	8.500	1.06	-0.66	0.21
64	ARIALKHAN-L	16.000	1.11	1.03	1.07	129	SWARUPKATI	14.500	1.06	-0.66	0.20
65	ARIALKHAN-L	26.000	1.15	0.94	1.05	130	SWARUPKATI	16.500	1.06	-0.66	0.20

Source : Consultant's Model Analaysis based on BWDB Data

[vp\vol8\table\tab-a15]

TABLE A 16
Annual Maximum Water Level (m.PWD)

Map Ref No	River	Chainage (Km)	YEAR																							Average
			1965	1966	1967	1968	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	
1	KOBADAK	44.500	3.15	2.39	3.70	4.14	3.36	4.22	2.60	2.78	3.63	2.34	2.35	2.85	3.04	2.46	2.15	2.57	1.72	2.47	3.27	2.52	3.45	3.68	3.55	2.77	2.97
2	KOBADAK	109.500	2.63	2.59	2.55	2.46	2.53	2.92	2.45	2.58	2.93	2.26	2.40	2.55	2.43	2.32	2.29	2.49	2.08	2.34	2.74	2.87	2.58	2.49	2.80	2.88	2.55
3	BETNA	47.000	3.83	3.05	3.35	3.54	3.82	4.40	3.39	3.52	3.51	3.21	3.40	3.55	3.90	3.37	3.11	3.23	2.75	3.41	3.64	3.48	4.05	3.63	3.68	3.25	3.50
4	LABANGABATI	8.750	3.04	3.07	2.91	2.85	3.03	3.17	2.91	3.03	3.23	2.82	2.93	3.05	2.98	2.84	2.83	2.83	2.69	2.87	3.10	3.46	3.03	2.94	3.15	3.32	3.00
5	KHOLPETUA	21.000	3.27	3.36	3.10	3.04	3.25	3.19	3.02	3.28	3.42	3.06	3.04	3.31	3.20	3.04	3.02	3.05	2.98	3.07	3.30	3.79	3.21	3.19	3.36	3.47	3.21
6	MALANCHA	0.000	2.90	3.00	2.76	2.67	2.87	2.93	2.67	2.94	3.09	2.69	2.68	2.94	2.83	2.64	2.66	2.70	2.57	2.69	2.94	3.46	2.87	2.81	3.01	3.16	2.85
7	L_SOLMARI	8.500	3.33	3.38	3.25	3.22	3.36	3.36	3.18	3.37	3.66	3.21	3.28	3.27	3.39	3.23	3.21	3.13	3.03	3.24	3.47	3.57	3.32	3.28	3.48	3.54	3.32
8	SALTA	0.000	3.26	3.33	3.10	3.05	3.26	3.29	3.04	3.22	3.44	3.06	3.08	3.25	3.16	3.04	3.01	3.04	2.98	3.06	3.31	3.77	3.21	3.13	3.38	3.55	3.21
9	RUPSA	4.194	3.32	3.39	3.29	3.29	3.39	3.46	3.25	3.47	3.77	3.32	3.42	3.29	3.49	3.28	3.28	3.21	3.08	3.30	3.49	3.65	3.31	3.39	3.56	3.50	3.38
10	KAZIBACHA	15.000	3.32	3.33	3.18	3.12	3.35	3.30	3.15	3.26	3.56	3.13	3.20	3.20	3.31	3.14	3.12	3.09	2.96	3.19	3.40	3.60	3.30	3.23	3.40	3.50	3.26
11	SIBSA	21.915	3.13	3.20	2.98	2.89	3.13	3.16	2.90	3.12	3.36	2.90	2.91	3.15	3.01	2.85	2.85	2.90	2.80	2.89	3.16	3.65	3.10	3.02	3.23	3.40	3.07
12	SIBSA	45.265	2.81	2.90	2.73	2.61	2.81	2.88	2.66	2.81	3.03	2.62	2.65	2.85	2.72	2.56	2.58	2.64	2.54	2.62	2.84	3.24	2.80	2.75	2.94	3.01	2.78
13	PUSSUR	16.835	3.25	3.30	3.15	3.10	3.29	3.23	3.10	3.20	3.52	3.09	3.12	3.18	3.25	3.09	3.03	2.98	2.90	3.09	3.36	3.63	3.22	3.17	3.36	3.43	3.21
14	PUSSUR	65.995	2.74	2.78	2.61	2.52	2.72	2.82	2.54	2.74	2.90	2.52	2.55	2.76	2.62	2.48	2.49	2.55	2.43	2.54	2.74	3.15	2.72	2.63	2.82	2.93	2.68
15	PUSSUR	98.210	2.76	2.83	2.56	2.47	2.74	2.85	2.48	2.76	2.92	2.49	2.51	2.82	2.61	2.43	2.46	2.52	2.41	2.49	2.76	3.31	2.73	2.63	2.86	3.06	2.69
16	NABAGANGA_L	29.000	3.38	3.56	3.62	3.62	3.80	3.62	3.41	3.79	4.25	3.54	3.68	3.56	3.72	3.41	3.60	3.50	3.56	3.75	3.71	3.83	3.44	3.76	3.97	3.72	3.66
17	NABAGANGA_M	17.250	3.47	3.63	3.76	3.75	3.98	3.71	3.50	3.95	4.45	3.64	3.81	3.68	3.83	3.45	3.73	3.66	3.72	3.95	3.78	3.86	3.54	3.96	4.21	3.74	3.78
18	KATAKHALI-SW	13.500	3.52	3.69	3.83	3.82	4.05	3.75	3.54	4.01	4.48	3.71	3.88	3.77	3.88	3.50	3.82	3.75	3.81	4.01	3.82	3.81	3.61	4.01	4.27	3.71	3.84
19	CHUNKURI	6.000	3.24	3.31	3.15	3.08	3.28	3.22	3.08	3.22	3.55	3.09	3.09	3.20	3.24	3.06	3.01	3.00	2.91	3.08	3.35	3.61	3.23	3.16	3.35	3.47	3.21
20	HARIA	18.500	3.15	3.21	3.00	2.93	3.15	3.16	2.93	3.11	3.32	2.94	2.95	3.15	3.06	2.91	2.89	2.93	2.86	2.92	3.16	3.63	3.11	3.04	3.24	3.40	3.09
21	MADHUMATI	82.000	8.30	8.68	8.93	8.81	9.09	8.42	8.39	9.00	9.20	8.70	8.87	8.69	8.94	8.04	8.86	8.87	8.90	9.06	8.76	8.80	8.45	9.08	9.20	8.15	8.76
22	MADHUMATI	108.000	6.94	7.14	7.40	7.25	7.63	7.01	6.99	7.50	7.95	7.15	7.32	7.15	7.41	6.78	7.32	7.32	7.36	7.60	7.20	7.23	7.02	7.62	7.91	6.85	7.29
23	MADHUMATI	149.500	4.83	5.21	5.55	5.38	5.84	4.98	4.90	5.69	6.27	5.21	5.46	5.23	5.56	4.55	5.48	5.45	5.50	5.83	5.34	5.34	4.97	5.84	6.19	4.71	5.39
24	MADHUMATI	181.500	3.80	4.06	4.25	4.17	4.47	4.01	3.84	4.37	4.94	4.05	4.22	4.09	4.27	3.65	4.22	4.17	4.20	4.44	4.16	4.14	3.91	4.46	4.78	3.93	4.19
25	MADHUMATI	205.000	3.23	3.46	3.54	3.61	3.72	3.42	3.19	3.75	4.25	3.58	3.53	3.54	3.64	3.10	3.77	3.59	3.53	3.87	3.72	3.52	3.33	3.90	4.17	3.03	3.58
26	MADHUMATI	207.000	3.06	3.29	3.36	3.41	3.50	3.25	3.04	3.53	4.04	3.38	3.35	3.35	3.44	2.95	3.54	3.39	3.34	3.62	3.49	3.34	3.15	3.67	3.95	2.87	3.39
27	MADHUMATI	248.375	2.39	2.57	2.69	2.83	2.93	2.67	2.47	3.02	3.44	2.79	2.73	2.71	2.91	2.44	2.99	2.78	2.76	3.08	2.88	2.73	2.54	3.15	3.35	2.34	2.80
28	POYLAHARA	10.000	2.51	2.42	2.43	2.46	2.69	2.85	2.36	2.45	2.71	2.33	2.25	2.39	2.46	2.54	2.31	2.44	2.22	2.31	2.83	2.81	2.60	2.34	2.58	2.69	2.50
29	GASHIAKHALI	10.500	2.92	2.62	2.62	2.82	3.13	2.96	2.64	2.87	2.95	2.72	2.54	2.76	2.95	3.04	2.60	2.61	2.60	2.56	3.30	3.26	2.82	2.72	2.77	2.88	2.82
30	BHAIRAB	8.500	2.47	2.47	2.40	2.43	2.65	2.73	2.37	2.45	2.71	2.40	2.27	2.37	2.47	2.50	2.32	2.44	2.39	2.35	2.85	2.70	2.51	2.41	2.52	2.61	2.49
31	ATHAROBANKI	32.000	3.40	3.56	3.69	3.70	3.88	3.63	3.42	3.87	4.34	3.59	3.76	3.64	3.76	3.39	3.68	3.59	3.67	3.84	3.69	3.72	3.49	3.82	4.07	3.63	3.70
32	BALESWAR	64.000	2.51	2.35	2.42	2.45	2.73	2.56	2.50	2.47	2.78	2.61	2.35	2.58	2.55	2.69	2.36	2.47	2.36	2.39	2.95	2.69	2.43	2.31	2.43	2.47	2.52
33	BALESWAR	93.000	2.83	2.52	2.58	2.75	3.07	2.89	2.62	2.77	2.92	2.75	2.50	2.72	2.88	3.01	2.52	2.57	2.54	2.53	3.27	3.16	2.72	2.70	2.66	2.81	2.76
34	KALIGANGA	21.800	1.98	2.06	2.07	2.19	2.23	2.29	2.14	2.34	2.88	2.20	2.05	2.13	2.27	2.19	2.29	2.18	2.19	2.23	2.49	2.18	2.16	2.35	2.55	2.05	2.24
35	BHAIRAB U	39.853	3.11	3.06	3.31	3.38	3.41	3.30	3.04	3.41	3.72	3.12	3.26	3.27	3.25	2.90	3.20	3.15	3.14	3.40	3.37	3.14	3.24	3.58	3.60	3.21	3.27
36	BHAIRAB U	123.000	3.33	3.41	3.35	3.37	3.46	3.44	3.29	3.47	3.74	3.31	3.41	3.30	3.45	3.37	3.30	3.24	3.20	3.36	3.51	3.71	3.34	3.46	3.59	3.58	3.42
37	KALIGANGA U	17.333	5.58	5.43	5.97	6.10	6.19	5.81	5.26	5.57	5.86	6.08	5.67	5.76	5.66	5.71	5.36	5.61	5.25	5.76	6.49	5.70	7.11	7.24	6.00	5.38	5.86
38	CHITRA	131.500	3.47	3.54	3.71	3.70	3.89	3.71	3.46	3.87	4.30	3.62	3.74	3.64	3.79	3.36	3.63	3.57	3.61	3.84	3.82	3.85	3.54	4.01	4.06	3.74	3.73
39	CHITRA	151.505	3.39	3.53	3.65	3.65	3.84	3.64	3.39	3.83	4.28	3.56	3.70	3.58	3.73	3.33	3.60	3.53	3.58	3.79	3.73	3.82	3.45	3.84	4.01	3.69	3.67
40	NABAGANGA_U	98.000	4.67	4.38	5.03	5.19	5.27	5.01	3.93	4.75	5.01	5.09	4.53	4.78	4.82	4.62	4.29	4.64	3.81	4.88	5.55	4.88	6.10	6.25	4.93	4.28	4.86
41	NABAGANGA_U	123.000	3.86	3.82	4.27	4.28	4.39	4.18	3.58	4.18	4.42	4.23	3.91	4.07	3.96	3.79	3.84	3.90	3.67	4.17	4.66	4.07	5.01	5.21	4.25	3.83	4.15
42	NABAGANGA_U	164.000	3.64	3.83	4.08	4.01	4.28	3.82	3.63	4.19	4.70	3.82	4.03	3.89	4.05	3.47	4.01	3.95	3.97	4.25	4.02	3.94	3.70	4.34	4.54	3.81	4.00
43	CHANDANA	39.100	4.99	5.35	5.71	5.55	6.00	5.17	5.00	5.83	6.41	5.35	5.58	5.38	5.68	4.76	5.62	5.58	5.61	6.00	5.63	5.47	5.17	6.04	6.36	4.80	5.54
44	KUMAR	42.900	4.64	4.89	4.85	5.13	5.24	4.81	4.49	5.30	6.39	5.29	4.93	4.93	5.06	4.70	5.98	5.09	4.82	5.92	6.19	4.96	4.88	6.32	6.67	4.40	5.25
45	KUMAR	99.300	3.39	3.59	3.64	3.75	3.83	3.55	3.27	3.88	4.44	3.71	3.64	3.64	3.74	3.21	3.98	3.74	3.61	4.05	3.96	3.63	3.55	4.19	4.38	3.12	3.73
46	SITALAKHYA	0.000	5.02	5.33	4.92	5.40	5.50	5.16	4.77	6.05	7.63	6.21	5.36	5.33	5.47	5.14	7.31	5.76	5.77	6.91	7.32	5.86	5.12	7.58	8.16	4.96	5.92
47	SITALAKHYA	24.800	4.68	4.91	4.63	5.08	5.10	4.79	4.44	5.49	6.79	5.61	4.96	4.97	5.05	4.83	6.51	5.25	5.23	6.22	6.57	5.25	4.84	6.75	7.28	4.55	5.41
48	SITALAKHYA	46.000	4.36	4.41	4.26	4.57	4.54	4.51	3.99	4.78	5.53	4.71	4.45	4.56	4.56	4.39	5.21	4.62	4.41	5.11	5.26	4.51	4.55	5.40	5.75	4.05	4.69
49	MBR	0.000	3.82	4.01	3.85	4.06	4.04	3.89	3.66	4.16	4.78	4.11	4.03	4.03	4.06	3.81	4.43	4.06	3.99	4.41	4.40	4.00	3.87	4.63	4.86	3.74	4.11
50	BARASIA_ARBT	25.500	4.87	5.26	5.61	5.44	5.91	5.02	4.94	5.75	6.34	5.27	5.52	5.28	5.62	4.59	5.54	5.50	5.55	5.90	5.40	5.40	5.01	5.91	6.27	4.74	5.44
51	GORAI	13.000	12.32	12.79	13.09	12.97	13.27	12.48	12.46	13.14	13.75	12.83	13.04	12.81	13.10	12.01	13.03	13.04	13.07	13.23	12.87	12.97	12.54	13.24	13.74	12.16	12.91
52	GORAI	82.000	8.30	8.68	8.93	8.81	9.09	8.42	8.39	9.00	9.20	8.70	8.87	8.69	8.94	8.04	8.86	8.87	8.90	9.06	8.76	8.80	8.45	9.08	9.20	8.15	8.76
53	ARIALKHAN	9.000	6.26	6.32	5.72	6.30	5.84	6.38	6.09	6.54	7.18	6.62	6.36	6.32	6.30	6.33	7.06	6.46	6.46	6.86	7.02	6.53	6.31	7.15	7.57	6.28	6.51

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TABLE A 16
Annual Maximum Water Level (m.PWD)

Map Ref No	River	Chainage (Km)	YEAR																							Average
			1965	1966	1967	1968	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	
54	ARIALKHAN	30.500	5.28	5.33	4.76	5.34	5.01	5.39	5.17	5.53	6.12	5.61	5.38	5.31	5.34	5.35	6.00	5.47	5.40	5.82	5.95	5.54	5.32	6.07	6.47	5.29	5.51
55	ARIALKHAN	53.000	4.45	4.55	3.82	4.57	4.17	4.58	4.27	4.71	5.16	4.77	4.60	4.52	4.56	4.55	5.05	4.66	4.57	4.90	5.00	4.74	4.53	5.11	5.39	4.47	4.65
56	ARIALKHAN	64.000	4.27	4.35	3.61	4.38	3.97	4.39	4.12	4.49	4.87	4.54	4.41	4.33	4.37	4.36	4.77	4.45	4.37	4.64	4.72	4.53	4.34	4.82	5.04	4.29	4.43
57	ARIALKHAN	101.000	3.07	3.06	2.98	3.11	3.07	3.09	3.08	3.16	3.40	3.24	3.12	3.09	3.16	3.20	3.29	3.13	3.06	3.19	3.35	3.25	3.12	3.27	3.48	3.18	3.17
58	ARIALKHAN	125.500	2.44	2.36	2.26	2.53	2.74	2.64	2.42	2.52	2.80	2.60	2.44	2.48	2.59	2.80	2.56	2.48	2.33	2.45	3.03	2.88	2.68	2.46	2.78	2.79	2.59
59	ARIALKHAN	143.000	2.37	2.28	2.20	2.46	2.70	2.59	2.33	2.45	2.73	2.53	2.36	2.39	2.52	2.80	2.45	2.40	2.25	2.38	3.02	2.86	2.63	2.34	2.64	2.78	2.52
60	ARIALKHAN	149.500	2.38	2.28	2.19	2.48	2.65	2.59	2.34	2.50	2.67	2.53	2.35	2.46	2.56	2.67	2.43	2.39	2.24	2.40	2.90	2.77	2.64	2.30	2.66	2.67	2.50
61	ARIALKHAN	161.000	2.36	2.26	2.14	2.47	2.63	2.59	2.35	2.48	2.65	2.54	2.36	2.42	2.51	2.66	2.42	2.39	2.21	2.40	2.92	2.76	2.63	2.30	2.63	2.67	2.49
62	ARIALKHAN-L	0.000	5.48	5.55	5.05	5.54	5.34	5.61	5.43	5.74	6.15	5.78	5.60	5.54	5.55	5.57	6.05	5.69	5.66	5.92	6.02	5.74	5.54	6.11	6.44	5.51	5.69
63	ARIALKHAN-L	6.000	4.92	5.01	4.41	5.03	4.74	5.07	4.85	5.21	5.75	5.29	5.08	4.98	5.03	5.03	5.62	5.15	5.06	5.46	5.57	5.24	5.01	5.70	6.07	4.97	5.18
64	ARIALKHAN-L	16.000	4.91	5.00	4.37	5.03	4.70	5.05	4.80	5.20	5.74	5.28	5.06	4.97	5.02	5.02	5.62	5.14	5.05	5.45	5.57	5.22	4.99	5.69	6.07	4.94	5.16
65	ARIALKHAN-L	26.000	4.89	4.99	4.33	5.00	4.63	5.03	4.72	5.18	5.73	5.26	5.04	4.96	5.00	5.00	5.61	5.12	5.03	5.44	5.56	5.20	4.97	5.68	6.05	4.91	5.14
66	PALANG	20.010	4.86	4.94	4.38	4.96	4.70	5.00	4.82	5.12	5.61	5.20	5.01	4.92	4.96	4.97	5.49	5.07	4.98	5.35	5.44	5.17	4.95	5.55	5.90	4.92	5.09
67	NARIA-KH	0.000	4.89	4.95	4.68	5.01	4.89	5.00	4.93	5.11	5.52	5.19	5.01	4.96	5.10	5.04	5.40	5.08	4.97	5.27	5.36	5.22	5.05	5.45	5.82	5.06	5.12
68	KUMAR-1	0.000	5.16	5.23	4.62	5.24	4.89	5.28	5.03	5.43	6.01	5.51	5.28	5.21	5.24	5.24	5.88	5.36	5.29	5.70	5.83	5.44	5.21	5.96	6.35	5.17	5.40
69	KUMAR-1	12.300	4.84	4.93	4.32	4.95	4.66	4.95	4.69	5.11	5.67	5.17	4.97	4.92	4.95	4.91	5.54	5.05	4.98	5.39	5.51	5.09	4.89	5.62	5.98	4.83	5.08
70	KUMAR-1	20.500	3.82	4.01	3.85	4.06	4.04	3.89	3.66	4.16	4.78	4.11	4.03	4.03	4.06	3.81	4.43	4.06	3.99	4.41	4.40	4.00	3.87	4.63	4.86	3.74	4.11
71	KUMAR-2	0.000	3.82	4.01	3.85	4.06	4.04	3.89	3.66	4.16	4.78	4.11	4.03	4.03	4.06	3.81	4.43	4.06	3.99	4.41	4.40	4.00	3.87	4.63	4.86	3.74	4.11
72	KUMAR-2	10.333	3.75	3.90	3.64	3.95	3.85	3.81	3.53	4.02	4.60	4.03	3.94	3.91	3.94	3.77	4.34	3.96	3.91	4.29	4.34	3.92	3.81	4.48	4.76	3.67	4.01
73	TORKI-1	20.430	3.63	3.73	3.09	3.73	3.39	3.76	3.46	3.85	4.20	3.90	3.77	3.72	3.73	3.70	4.04	3.78	3.61	3.94	3.97	3.84	3.63	4.23	4.24	3.55	3.77
74	TORKI-2	0.000	3.07	3.06	2.98	3.11	3.07	3.09	3.08	3.16	3.40	3.24	3.12	3.09	3.16	3.20	3.29	3.13	3.06	3.19	3.35	3.25	3.12	3.27	3.48	3.18	3.17
75	BISHKANDIA	31.500	2.01	1.95	1.97	2.03	2.24	2.27	2.07	2.03	2.29	2.14	1.94	2.07	2.08	2.18	1.99	2.00	2.02	1.97	2.46	2.23	2.13	1.94	2.06	2.06	2.09
76	UZIRPUR	0.000	2.18	2.12	2.08	2.24	2.42	2.32	2.15	2.23	2.46	2.32	2.15	2.23	2.25	2.41	2.22	2.20	2.13	2.17	2.68	2.47	2.31	2.17	2.36	2.36	2.28
77	UZIRPUR	10.500	2.06	2.00	2.01	2.10	2.30	2.29	2.09	2.10	2.34	2.19	2.00	2.12	2.12	2.26	2.05	2.06	2.05	2.03	2.54	2.34	2.22	2.03	2.17	2.18	2.15
78	SHANDHA	5.500	2.01	1.96	2.00	2.04	2.25	2.24	2.05	2.04	2.29	2.15	1.96	2.07	2.07	2.20	1.99	2.01	2.01	1.98	2.47	2.27	2.16	1.96	2.10	2.10	2.10
79	SHIKARPUR	0.000	2.48	2.38	2.28	2.55	2.75	2.66	2.44	2.55	2.84	2.64	2.47	2.50	2.62	2.82	2.59	2.51	2.37	2.48	3.05	2.89	2.69	2.49	2.86	2.81	2.61
80	AMTALI	3.500	2.35	2.28	2.18	2.43	2.64	2.54	2.31	2.43	2.65	2.49	2.34	2.39	2.48	2.69	2.43	2.38	2.25	2.36	2.92	2.76	2.58	2.33	2.60	2.67	2.48
81	AMTALI	10.500	2.24	2.17	2.12	2.30	2.49	2.38	2.20	2.30	2.52	2.38	2.22	2.28	2.31	2.50	2.30	2.26	2.17	2.24	2.75	2.57	2.38	2.23	2.44	2.46	2.34
82	LOWERMEGHN	19.000	4.24	4.14	4.00	4.29	4.36	4.32	4.17	4.20	4.49	4.37	4.14	4.20	4.42	4.43	4.32	4.24	4.11	4.19	4.53	4.45	4.36	4.26	4.66	4.35	4.30
83	LOWERMEGHN	41.250	4.21	4.07	3.96	4.24	4.33	4.27	4.10	4.19	4.33	4.32	4.07	4.16	4.37	4.40	4.28	4.21	4.05	4.16	4.50	4.39	4.34	4.20	4.39	4.32	4.24
84	JOYANTI-1	6.500	3.98	3.88	3.72	4.05	4.07	4.06	3.93	3.95	4.22	4.13	3.91	3.95	4.18	4.19	4.06	3.97	3.85	3.93	4.28	4.19	4.09	4.02	4.32	4.11	4.04
85	JOYANTI-1	13.010	3.88	3.77	3.65	3.94	3.97	3.94	3.85	3.86	4.15	4.02	3.83	3.86	4.05	4.05	3.98	3.89	3.79	3.84	4.18	4.09	3.97	3.92	4.26	3.99	3.95
86	JOYANTI-2	5.667	3.90	3.78	3.65	3.96	3.98	3.96	3.86	3.87	4.15	4.04	3.83	3.86	4.07	4.07	3.98	3.90	3.79	3.84	4.19	4.09	3.98	3.93	4.25	4.01	3.96
87	S-MEGHNA	3.500	3.31	3.21	3.12	3.36	3.42	3.39	3.29	3.32	3.58	3.45	3.28	3.32	3.46	3.50	3.39	3.32	3.21	3.29	3.65	3.49	3.45	3.31	3.65	3.47	3.39
88	S-MEGHNA1	10.000	4.22	4.10	3.92	4.22	4.37	4.32	4.11	4.15	4.31	4.34	4.08	4.14	4.41	4.43	4.27	4.17	4.04	4.14	4.48	4.40	4.35	4.19	4.34	4.34	4.24
89	NAYABHANGAN	0.000	3.40	3.30	3.19	3.44	3.50	3.47	3.36	3.40	3.64	3.54	3.36	3.40	3.55	3.59	3.48	3.40	3.28	3.37	3.73	3.58	3.53	3.39	3.71	3.55	3.47
90	NAYABHANGAN	14.500	2.87	2.77	2.64	2.92	2.99	2.98	2.85	2.91	3.15	3.01	2.87	2.89	3.00	3.06	2.96	2.88	2.75	2.87	3.22	3.06	3.02	2.87	3.20	3.04	2.95
91	DHARMAGANJ	4.000	3.09	2.99	2.90	3.15	3.23	3.20	3.06	3.12	3.36	3.23	3.07	3.12	3.25	3.31	3.17	3.09	2.98	3.08	3.46	3.30	3.27	3.07	3.39	3.28	3.17
92	DHARMAGANJ	8.000	2.91	2.81	2.73	2.98	3.07	3.03	2.89	2.95	3.16	3.04	2.88	2.95	3.07	3.13	2.96	2.90	2.80	2.89	3.29	3.15	3.11	2.87	3.17	3.11	2.99
93	DHARMAGANJ	15.000	2.89	2.79	2.70	2.96	3.05	3.02	2.86	2.95	3.13	3.03	2.86	2.93	3.05	3.13	2.95	2.89	2.77	2.89	3.28	3.13	3.09	2.85	3.13	3.10	2.98
94	KALABADAR-1	9.000	2.66	2.57	2.48	2.74	2.85	2.80	2.63	2.73	2.90	2.80	2.63	2.72	2.82	2.87	2.71	2.66	2.54	2.66	3.07	2.94	2.87	2.61	2.90	2.86	2.75
95	KALABADAR-2	10.000	3.05	2.93	2.85	3.11	3.23	3.16	3.00	3.07	3.24	3.16	2.99	3.08	3.21	3.25	3.07	3.01	2.92	3.01	3.40	3.32	3.24	3.00	3.22	3.22	3.11
96	ILSHA	25.500	2.61	2.52	2.43	2.69	2.83	2.77	2.57	2.69	2.85	2.75	2.60	2.67	2.77	2.86	2.66	2.61	2.49	2.62	3.05	2.95	2.84	2.56	2.87	2.84	2.71
97	SHAHABAZ-1	4.167	4.16	4.02	3.78	4.14	4.32	4.25	4.01	4.06	4.28	4.35	4.09	4.08	4.36	4.40	4.23	4.09	3.91	4.09	4.40	4.36	4.27	4.14	4.29	4.31	4.18
98	SHAHABAZ-1	12.500	4.31	4.20	3.89	4.37	4.63	4.57	4.10	4.30	4.47	4.53	4.21	4.26	4.63	4.78	4.39	4.22	4.08	4.29	4.80	4.76	4.61	4.34	4.49	4.53	4.41
99	TENTULIA	8.000	2.31	2.21	2.11	2.43	2.61	2.55	2.30	2.43	2.65	2.49	2.30	2.41	2.51	2.60	2.35	2.33	2.16	2.33	2.91	2.77	2.62	2.24	2.54	2.65	2.45
100	RANGAMATIA	3.360	2.31	2.23	2.14	2.40	2.59	2.50	2.30	2.43	2.58	2.49	2.30	2.38	2.46	2.61	2.38	2.33	2.19	2.34	2.85	2.73	2.55	2.25	2.59	2.61	2.44
101	KIRTONKHOLA	14.000	2.29	2.18	2.10	2.32	2.55	2.42	2.20	2.31	2.51	2.40	2.21	2.28	2.35	2.57	2.30	2.27	2.16	2.24	2.82	2.64	2.40	2.18	2.44	2.53	2.36
102	KIRTONKHOLA	24.000	2.21	2.10	2.05	2.22	2.46	2.31	2.10	2.19	2.40	2.30	2.07	2.20	2.21	2.45	2.16	2.15	2.09	2.12	2.66	2.50	2.31	2.07	2.26	2.32	2.25
103	BISHKHALI	3.250	2.10	2.00	1.99	2.12	2.36	2.36	2.09	2.09	2.33	2.23	1.99	2.14	2.16	2.35	2.07	2.06	2.05	2.05	2.57	2.33	2.18	1.95	2.10	2.15	2.16
104	BISHKHALI	21.500	2.14	2.02	2.06	2.12	2.37	2.41	2.14	2.09	2.31	2.22	1.98	2.16	2.16	2.37	2.03	2.09	2.06	2.05	2.60	2.33	2.23	1.95	2.06	2.17	2.17
105	BISHKHALI	44.500	2.67	2.42	2.49	2.55	2.87	2.75	2.55	2.65	2.83	2.72	2.46	2.63	2.70	2.85	2.46	2.48	2.42	2.46	3.08	2.92	2.54	2.59	2.50	2.61	2.63
106	BISHKHALI	70.000	3.06	2.69	2.74	2.95	3.29	2.98	2.81	3.01	3.07	2.90	2.76	2.88	3.15	3.23	2.71	2.86	2.72	2.73	3.50	3.40	2.88	2.85	2.75	2.93	2.95

Contd

TABLE A 16
Annual Maximum Water Level (m.PWD)

Map Ref No	River	Chainage (Km)	YEAR																						Average
			1965	1966	1967	1968	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	
107	BISHKHALI	86.500	3.12	2.76	2.76	3.01	3.36	3.06	2.83	3.03	3.06	2.86	2.78	2.90	3.23	3.29	2.75	2.94	2.80	2.73	3.57	3.51	2.94	2.90	2.83	2.98	3.00
108	KHAIRABAD	31.000	2.27	2.13	2.07	2.28	2.51	2.40	2.18	2.25	2.47	2.41	2.12	2.25	2.32	2.50	2.24	2.19	2.11	2.18	2.68	2.58	2.35	2.06	2.28	2.36	2.30
109	PANDAB-1	4.250	2.21	2.08	2.03	2.21	2.46	2.35	2.13	2.19	2.43	2.37	2.10	2.20	2.25	2.46	2.18	2.14	2.07	2.11	2.64	2.53	2.28	2.01	2.24	2.33	2.25
110	DHULIA	9.750	2.33	2.21	2.12	2.34	2.58	2.48	2.25	2.35	2.50	2.48	2.20	2.32	2.41	2.55	2.32	2.25	2.15	2.27	2.75	2.66	2.45	2.17	2.36	2.47	2.37
111	DHULIA	23.000	2.28	2.16	2.07	2.30	2.55	2.43	2.18	2.29	2.47	2.43	2.15	2.27	2.34	2.49	2.25	2.21	2.13	2.21	2.67	2.59	2.36	2.11	2.29	2.38	2.32
112	PAIRA	19.175	2.39	2.21	2.21	2.31	2.61	2.49	2.37	2.34	2.55	2.49	2.23	2.35	2.41	2.60	2.29	2.26	2.20	2.25	2.80	2.63	2.38	2.18	2.30	2.38	2.38
113	PAIRA	24.000	2.36	2.20	2.21	2.29	2.57	2.53	2.31	2.30	2.54	2.51	2.25	2.32	2.38	2.61	2.32	2.25	2.19	2.24	2.72	2.65	2.37	2.17	2.31	2.39	2.37
114	BURISWAR	5.000	2.38	2.20	2.20	2.30	2.59	2.54	2.32	2.29	2.52	2.48	2.24	2.32	2.40	2.62	2.33	2.24	2.20	2.23	2.73	2.66	2.37	2.18	2.27	2.38	2.37
115	BURISWAR	30.000	2.45	2.30	2.29	2.35	2.56	2.64	2.39	2.37	2.52	2.48	2.28	2.35	2.47	2.69	2.34	2.36	2.24	2.29	2.74	2.80	2.43	2.29	2.32	2.40	2.43
116	BURISWAR	37.500	2.57	2.40	2.43	2.48	2.69	2.71	2.51	2.55	2.60	2.58	2.42	2.45	2.62	2.81	2.48	2.53	2.35	2.38	2.90	2.96	2.46	2.43	2.39	2.51	2.55
117	BURISWAR	47.000	3.12	2.76	2.76	3.01	3.36	3.06	2.83	3.03	3.06	2.86	2.78	2.90	3.23	3.29	2.75	2.94	2.80	2.73	3.57	3.51	2.94	2.90	2.83	2.98	3.00
118	PATUAKHALI	0.000	2.03	1.92	1.94	1.99	2.19	2.10	1.99	2.00	2.11	2.10	1.89	1.95	2.00	2.13	1.91	1.94	1.88	1.93	2.39	2.32	2.09	1.97	2.01	2.13	2.04
119	LOHALIA	19.625	2.29	2.22	2.17	2.26	2.37	2.39	2.30	2.33	2.36	2.37	2.21	2.26	2.33	2.36	2.30	2.25	2.19	2.24	2.52	2.46	2.31	2.18	2.37	2.36	2.31
120	LOHALIA	23.000	2.03	1.92	1.94	1.99	2.19	2.10	1.99	2.00	2.11	2.10	1.89	1.95	2.00	2.13	1.91	1.94	1.88	1.93	2.39	2.32	2.09	1.97	2.01	2.13	2.04
121	LOHALIA	32.500	1.99	1.89	1.88	1.96	2.10	1.99	1.93	1.97	2.02	2.05	1.88	1.90	1.94	2.06	1.84	1.96	1.87	1.95	2.34	2.31	2.02	1.85	1.95	2.08	1.99
122	LOHALIA	63.000	2.35	2.22	2.05	2.35	2.68	2.54	2.25	2.50	2.41	2.48	2.22	2.35	2.47	2.63	2.21	2.26	2.06	2.30	2.82	2.97	2.70	2.19	2.35	2.62	2.42
123	PADMA	48.000	6.83	6.90	6.43	6.88	6.69	6.97	6.79	7.12	7.60	7.18	6.95	6.91	6.88	6.92	7.51	7.06	7.08	7.35	7.47	7.12	6.89	7.59	7.96	6.87	7.08
124	PADMA	54.000	6.60	6.66	6.21	6.65	6.46	6.73	6.56	6.88	7.36	6.94	6.72	6.67	6.65	6.68	7.27	6.82	6.84	7.11	7.23	6.88	6.66	7.34	7.72	6.64	6.85
125	PADMA	90.000	4.89	4.95	4.68	5.01	4.89	5.00	4.93	5.11	5.52	5.19	5.01	4.96	5.10	5.04	5.40	5.08	4.97	5.27	5.36	5.22	5.05	5.45	5.82	5.06	5.12
126	TENTULIA	68.333	2.37	2.22	2.00	2.47	2.75	2.61	2.34	2.63	2.55	2.38	2.30	2.50	2.67	2.63	2.29	2.30	2.12	2.30	2.82	3.16	2.89	2.16	2.46	2.68	2.48
127	SWARUPKATI	0.000	1.98	1.91	1.93	2.00	2.22	2.25	2.06	2.00	2.25	2.11	1.89	2.05	2.05	2.17	1.94	1.98	1.99	1.93	2.43	2.20	2.13	1.88	1.99	2.02	2.06
128	SWARUPKATI	8.500	2.03	1.95	2.03	2.06	2.25	2.22	2.13	2.07	2.31	2.17	1.95	2.10	2.10	2.19	2.01	2.07	2.05	2.00	2.49	2.25	2.13	1.93	2.07	2.10	2.11
129	SWARUPKATI	14.500	1.95	1.89	1.92	1.95	2.15	2.23	2.03	1.94	2.17	2.03	1.84	2.00	1.99	2.11	1.89	1.98	1.92	1.88	2.34	2.13	2.10	1.83	1.91	1.96	2.01
130	SWARUPKATI	16.500	1.91	1.87	1.90	1.92	2.13	2.24	2.03	1.93	2.17	2.04	1.82	1.98	1.95	2.08	1.88	1.97	1.92	1.87	2.39	2.11	2.07	1.83	1.89	1.95	1.99

Source : Consultant's Database incorporating BWDB Data

TABLE A 17
1982-83 Monthly Flow (m^3/s)

Map Ref. No.	River	Chain. (Km)	April			May			June			July			August			September		
			Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
1	KOBADAK	38.000	0	6	-7	0	5	-7	1	7	-9	1	7	-8	1	8	-11	0	7	-10
2	BETNA	51.500	0	27	-50	0	23	-44	1	31	-55	2	48	-52	14	58	-37	8	42	-32
3	LABANGABATI	4.375	0	68	-65	0	72	-67	0	70	-77	0	77	-71	0	69	-63	0	65	-59
4	KHOLPETUA	26.008	-10	4100	-4214	-11	4178	-4152	0	4416	-4339	12	4151	-4297	62	4089	-3962	52	3793	-3879
5	ARPANGASIA	21.880	-201	8164	-9504	-199	8282	-9449	-194	8555	-9902	-174	8449	-9431	-130	8111	-8653	-125	7602	-8482
6	CHALKI GANG	8.750	173	6383	-7258	161	6626	-7315	153	6447	-7221	146	6268	-7027	137	6137	-6525	127	5915	-6397
7	SONA KHAL	7.250	-288	3809	-4387	-276	4094	-4425	-211	5274	-4377	-155	5236	-4364	-14	4593	-3971	37	3876	-3796
8	BARAPANGA	8.625	-200	3477	-3599	-199	3477	-3504	-204	3560	-3703	-204	3581	-3650	-203	3394	-3546	-199	3112	-3346
9	MALANCHA	2.000	-18	6267	-7172	-21	6407	-7183	5	6736	-7328	30	6687	-7068	85	6349	-6460	101	5845	-6226
10	MALANCHA	60.000	-155	7644	-9489	-158	7855	-9467	-160	8306	-9927	-157	8183	-9510	-135	7751	-8597	-127	7155	-8232
11	MALANCHA-E	9.050	-159	44992	-53217	-186	47639	-54021	-121	49736	-52871	-6	48476	-51318	180	45569	-46707	252	42418	-45443
12	L_SOLMARI	4.250	-38	1132	-898	-53	1065	-971	-138	982	-1018	-293	962	-1109	-698	589	-1310	-839	451	-1451
13	SALTA	1.750	1	46	-23	1	42	-22	1	39	-31	0	43	-34	-1	44	-33	-1	47	-37
14	RUPSA	4.596	28	2480	-3746	97	2494	-3711	521	3358	-3406	1606	3853	-2427	4212	5757	662	5037	6566	1861
15	GHENGRAIL	10.150	8	1710	-1787	8	1733	-1765	20	2005	-1834	32	2065	-1818	53	1825	-1873	62	1535	-1849
16	KAZIBACHA	13.500	-3	1594	-3011	24	1636	-3024	226	2128	-3260	902	2513	-2315	2446	3637	190	2906	4201	576
17	DELUTI	8.000	236	3011	-2309	242	2977	-2270	298	3709	-2361	353	3649	-2311	498	3327	-2138	543	2758	-2027
18	SIBSA	19.352	54	15611	-17207	93	15703	-17349	389	21693	-17366	874	20705	-16801	2079	18050	-14716	2463	15890	-13621
19	SIBSA	72.652	355	29426	-32831	367	29818	-33546	630	36554	-33115	1102	36887	-31429	2249	31807	-27858	2620	29252	-26104
20	PUSSUR	12.626	-9	4624	-6987	8	4928	-6953	161	6145	-7296	789	6272	-6029	2249	6753	-4547	2687	6724	-3677
21	PUSSUR	78.835	85	24865	-31174	25	25814	-31486	170	29530	-35277	711	30098	-33421	2086	30452	-28070	2599	28038	-23281
22	PUSSUR	94.710	450	69403	-77665	384	71029	-78719	783	83091	-83717	1810	83349	-81318	4317	76993	-70251	5210	70317	-60119
23	NABAGANGA_L	27.500	30	1898	-2824	97	1900	-2836	509	2737	-2607	1587	3325	-1745	4139	5509	1288	4917	6276	2226
24	KATAKHALI-SW	20.250	-16	97	-91	-14	106	-92	-3	107	-88	35	144	-117	148	212	56	176	226	66
25	CHUNKURI	4.650	-4	2001	-1778	13	2169	-1804	115	1965	-1683	260	1921	-1529	606	2040	-1422	694	2128	-1301
26	DHAKI	13.000	24	2020	-1817	36	2149	-1843	111	2309	-1919	214	2219	-1780	454	2105	-1528	517	1912	-1400
27	SUTARKHALI	27.900	-27	2173	-2118	-23	2108	-2222	9	3306	-2258	57	3472	-2043	170	2733	-1770	197	2071	-1711
28	JHAPJHAPIA	4.750	1	22	-10	1	21	-11	1	32	-13	1	20	-15	2	23	-27	3	24	-3
29	HARIA	17.850	-12	418	-390	-11	411	-398	-3	625	-725	8	585	-550	35	473	-516	42	493	-375
30	MADHUMATI	153.250	13	606	-893	70	646	-913	496	1561	-913	1623	3021	-190	4581	6028	2973	5372	6813	3031
31	MADHUMATI	199.375	-3	75	-41	-10	84	-45	-4	149	-92	11	238	-97	291	480	84	330	551	-88
32	MADHUMATI	207.250	29	110	-81	65	112	-43	132	310	-92	296	409	221	611	722	406	769	891	560
33	POYLAHARA	15.000	-1	421	-218	-1	350	-235	3	337	-253	6	362	-251	10	330	-254	8	354	-241
34	GASHIAKHALI	15.750	-76	3087	-3357	-14	3207	-3263	27	3198	-3661	133	3176	-3872	255	3043	-3544	164	2892	-3404
35	ATHAROBANKI	26.667	0	32	-57	0	29	-60	0	45	-71	0	39	-85	0	23	-36	3	17	-22
36	BALESWAR	57.005	-24	198	-510	-23	255	-461	-16	233	-517	-10	228	-527	0	286	-454	-3	263	-471
37	BALESWAR	95.625	713	13680	-13058	1480	14391	-12319	2193	15455	-13602	3598	16198	-13214	3962	15845	-11499	3979	17651	-9986
38	KALIGANGA	17.450	29	715	-784	67	612	-788	131	607	-706	294	638	-640	609	835	-231	764	1028	265
39	KOCHA	4.800	741	10668	-9588	1503	11134	-10267	2211	13123	-13086	3609	13760	-12761	3966	13620	-11054	3987	15270	-11161
40	BHAIRAB U	33.211	0	4	-4	0	4	-4	1	6	-6	1	6	-7	2	15	-20	4	19	-21
41	BHAIRAB U	130.000	-61	399	-788	-56	397	-781	-18	470	-773	93	524	-792	445	687	-290	579	796	49
42	GOBRAKHAL	4.500	0	29	-45	0	23	-48	3	35	-62	1	32	-73	-32	22	-69	-45	26	-81
43	CHITRA	125.750	1	226	-272	5	230	-270	10	263	-306	20	251	-328	56	207	-201	96	200	-113
44	CHITRA	155.752	1	345	-535	4	367	-533	14	407	-595	22	370	-633	26	271	-406	57	279	-233
45	NABAGANGA_U	91.000	0	1	0	2	5	0	3	8	1	3	7	0	5	8	1	11	15	7
46	NABAGANGA_U	128.250	1	24	-39	4	26	-33	7	34	-59	9	40	-73	18	62	-81	44	71	-33

Contd..

TABLE A 17
1982-83 Monthly Flow (m^3/s)

Map Ref. No.	River	Chain. (Km)	April			May			June			July			August			September		
			Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
47	NABAGANGA_U	157.000	0	17	-12	0	17	-13	-1	17	-14	-7	14	-22	-33	-9	-51	-44	-16	-64
48	KUMAR	48.608	0	1	0	1	2	0	2	6	0	8	19	5	28	36	19	36	44	22
49	KUMAR	103.950	1	14	-20	6	14	-13	12	48	-24	34	50	3	77	84	50	92	102	81
50	SITALAKHYA	18.600	1	3	0	4	7	2	7	17	1	27	68	14	74	105	46	99	166	36
51	SITALAKHYA	63.552	0	4	-7	3	5	-4	4	16	-5	19	37	8	46	55	24	65	83	49
52	KUMAR-CONN	2.000	2	3	1	4	5	3	9	23	4	33	82	11	60	122	15	91	218	39
53	MBR	7.500	31	68	-12	68	93	31	121	243	19	247	300	198	286	347	244	321	392	282
54	BARASIA_ARBT	31.875	0	312	-388	5	325	-405	-5	418	-750	56	309	-605	609	918	197	784	1034	280
55	GORAI	20.500	20	42	7	66	111	42	566	1248	64	1675	3146	1053	4615	6075	3146	5254	6808	2731
56	ARIALKHAN	1.815	156	395	47	311	473	190	605	1255	239	1303	1792	981	1717	2926	1223	2048	3249	1397
57	ARIALKHAN	49.875	122	266	-106	253	361	-15	497	1113	-21	1166	1470	847	1625	2683	1151	1960	2895	1432
58	ARIALKHAN	55.750	120	301	-162	251	382	-82	488	1103	-83	1139	1436	790	1593	2603	1110	1921	2800	1402
59	ARIALKHAN	66.000	146	452	-342	323	556	-225	618	1412	-224	1431	1799	906	1959	2999	1352	2321	3224	1740
60	ARIALKHAN	98.500	140	886	-1133	318	990	-960	607	1599	-916	1405	1830	393	1923	2923	972	2265	3223	1409
61	ARIALKHAN	115.250	604	2157	-1477	1222	2549	-1053	2005	3886	-848	3552	4453	2155	4026	5952	2925	4083	4884	3077
62	ARIALKHAN	119.250	640	2503	-1538	1306	2868	-1025	2147	4112	-858	3812	4718	2303	4333	5915	3083	4399	5303	3269
63	ARIALKHAN	127.750	363	1839	-1270	753	2015	-670	1289	3230	-960	2393	3546	434	2826	4242	1124	2958	4099	1398
64	ARIALKHAN	139.750	-18	1465	-1623	-15	1497	-1658	86	1832	-2189	348	2100	-1730	665	2347	-1401	962	2665	-782
65	ARIALKHAN	145.000	-367	4413	-3585	-878	4294	-3641	-1351	3490	-4058	-2278	1265	-5566	-2152	1449	-5262	-1690	1997	-4020
66	ARIALKHAN	151.750	831	2939	-1194	1205	2782	-581	1716	4943	-1919	2589	6290	-2426	3030	6469	-1250	3217	6114	358
67	ARIALKHAN	158.750	727	2471	-1483	946	2603	-1063	1321	4398	-2477	1850	6042	-3047	2252	5811	-1965	2557	6127	-453
68	ARIALKHAN-L	1.500	27	69	2	66	96	40	120	229	52	264	496	181	418	673	228	555	806	328
69	ARIALKHAN-L	17.250	-1	19	-37	6	25	-24	18	83	-40	79	132	-38	119	294	-34	125	308	-141
70	PALANG	2.500	26	69	4	60	97	35	101	238	30	183	332	93	316	548	142	446	645	311
71	PALANG	27.319	27	77	-59	72	105	-10	132	276	-42	291	352	225	354	434	290	394	454	352
72	NARIA-KH	1.750	6	106	-32	13	174	-30	50	239	-44	123	342	-96	11	430	-243	-63	202	-324
73	KUMAR-1	10.250	30	61	9	64	86	45	116	214	53	223	265	185	239	320	187	255	318	214
74	KUMAR-2	15.505	-1	14	-6	-2	3	-7	-9	1	-27	-29	-18	-39	-40	-26	-66	-48	-33	-71
75	TORKI-1	18.387	2	17	-9	6	17	-6	16	40	-9	42	54	30	66	132	43	81	143	27
76	TORKI-2	3.750	36	197	-176	77	204	-122	122	286	-130	210	331	124	226	313	160	224	301	135
77	BISHKANDIA	15.250	1	97	-107	2	103	-97	12	118	-117	33	121	-76	64	145	-67	73	151	-49
78	BISHKANDIA	37.000	2	589	-442	8	575	-474	28	622	-515	60	560	-459	102	478	-377	100	496	-374
79	BISHKANDIA	46.250	14	1768	-1028	43	1709	-1077	103	1815	-1023	202	1665	-873	269	1438	-751	253	1466	-727
80	SHATLA	6.000	-2	156	-136	-6	143	-142	-11	168	-182	-20	125	-153	-15	152	-186	-12	149	-183
81	HARTA	1.250	-13	273	-539	-35	256	-526	-74	261	-565	-142	184	-534	-163	131	-535	-150	134	-540
82	HARTA	4.875	-14	223	-325	-41	200	-293	-84	234	-375	-161	177	-374	-176	166	-358	-160	184	-349
83	UZIRPUR	4.125	650	5335	-3768	1320	5506	-3137	2067	5845	-2611	3477	5995	-38	3703	6045	991	3459	5703	721
84	SHANDHA	7.250	638	8063	-3466	1282	8652	-2926	1971	8702	-2388	3316	8868	-225	3523	8947	-452	3301	9163	-249
85	SHIKARPUR	8.750	273	1929	-1264	551	1982	-1022	860	2267	-884	1422	2341	344	1520	2372	622	1448	2284	658
86	AMTALI	8.750	378	3095	-2259	768	3168	-1868	1205	3488	-1634	2050	3592	-278	2173	3619	278	2003	3429	129
87	LOWERMEGHNA	17.000	9819	36378	-38865	20392	40387	-35146	31253	73783	-39915	63749	94677	-241	73165	100713	12978	76077	94266	40010
88	LOWERMEGHNA	33.000	9170	37907	-43503	19210	43849	-48100	29442	77559	-51504	61008	98377	-14706	70323	101454	-665	73341	92450	29159
89	LOWERMEGHNA	39.375	8765	41532	-54304	18519	49984	-60697	28168	83579	-70044	58981	103989	-42550	68409	106953	-21913	71552	96823	14288
90	LOWERMEGHNA	51.000	7994	44512	-60852	16993	52216	-64430	25667	81164	-77198	54700	98743	-39331	63872	102386	-21678	66808	92660	13020
91	LOWERMEGHNA	59.000	8039	52498	-78949	17440	60221	-78978	26616	88396	-107199	56494	105894	-83205	65959	111871	-64505	69138	98588	-14588
92	JOYANTI-1	8.125	615	2293	-1291	1187	5319	-1311	1759	9126	-1709	2720	9240	-587	2854	8312	-6	2755	6495	184

Contd..

TABLE A 17
1982–83 Monthly Flow (m^3/s)

Map Ref. No.	River	Chain (Km)	April			May			June			July			August			September		
			Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
93	JOYANTI-1	15.005	1018	4794	-1037	1901	8401	-424	2977	11291	-1158	4722	10293	2411	4807	9654	2995	4576	8189	3083
94	JOYANTI-1	26.125	505	2524	-773	979	3207	-498	1521	4341	-570	2360	4766	1141	2308	4398	1296	2044	3756	1048
95	JOYANTI-2	4.250	386	6313	-5005	691	11155	-5746	1263	16805	-5980	2027	16228	-5645	1911	15073	-5273	1798	12259	-4506
96	S-MEGHNA	1.000	509	1526	-152	923	2800	352	1465	4257	78	2383	4910	1482	2545	4709	1680	2566	4088	1898
97	S-MEGHNA	7.625	194	937	-652	386	1111	-662	686	1592	-664	1162	1684	-469	1264	1755	-195	1291	1733	150
98	S-MEGHNA	17.875	-648	1000	-3020	-1063	86	-3515	-1490	403	-4855	-2384	-1192	-5498	-2538	-1282	-5198	-2443	-1368	-4431
99	S-MEGHNA1	7.500	724	2696	-1797	1517	3712	-1768	2462	5959	-1978	4273	6298	-877	4547	6667	-345	4758	6682	341
100	S-MEGHNA2	3.750	70	4490	-7751	453	4395	-8812	969	5807	-11688	1890	5163	-8647	2011	5084	-7339	2317	5082	-5993
101	NAYABHANGANI	16.688	310	979	-449	541	1176	-238	781	1499	-287	1215	1575	413	1301	1626	747	1285	1600	756
102	DHARMAGANJ	2.000	837	2300	-1138	1450	2937	-694	2177	4225	-642	3549	4677	2275	3811	5027	2891	3740	4469	2899
103	DHARMAGANJ	10.875	345	1572	-1879	599	1958	-1657	928	2772	-1604	1588	3242	-183	1733	3296	145	1759	2999	359
104	KALABADAR-1	6.750	489	1875	-728	852	2107	-475	1250	2902	-357	1965	3297	834	2087	3415	866	1988	3137	821
105	KALABADAR-1	14.750	487	2136	-1236	853	2239	-1053	1252	3034	-1105	1968	3303	44	2096	3354	514	1993	3283	535
106	KALABADAR-2	2.000	-406	1196	-2008	-689	992	-2239	-1031	952	-2849	-1679	-122	-3169	-1772	7	-3221	-1620	126	-3067
107	KALABADAR-2	8.625	-63	2046	-3356	-89	2114	-3002	-102	3519	-3742	-87	3996	-4936	-31	4013	-4300	142	3303	-3959
108	ILSHA	5.250	1030	9860	-4246	1740	11819	-3685	2240	13325	-4584	3395	14800	-4754	3537	15063	-4733	3158	12944	-4158
109	ILSHA	30.375	953	4630	-2661	1655	4743	-2044	2143	5651	-1925	3327	6270	-184	3546	6326	16	3324	5931	-1180
110	SHAHABAZ-1	6.250	6934	65210	-100276	15674	73778	-103896	24345	95986	-112734	53137	111834	-95854	62509	112753	-73884	66010	104113	-37044
111	SHAHABAZ-1	39.000	5268	51454	-72325	10978	56019	-75732	16891	76817	-75249	34621	83769	-56300	40340	89541	-51273	42170	82518	-32915
112	TENTULIA	4.500	1670	7247	-5170	2604	7786	-3972	3461	9027	-4877	5175	9300	-4333	5805	9925	-3598	5880	9429	-2141
113	RANGAMATIA	14.583	100	1232	-1381	259	1214	-1430	396	1324	-1302	744	1385	-826	791	1417	-819	668	1350	-844
114	KIRTONKHOLA	11.750	345	3198	-3763	863	3259	-3661	1440	3863	-2689	2635	3973	257	2833	3929	1088	2658	4046	1256
115	KIRTONKHOLA	29.000	324	5013	-3999	845	5125	-3861	1376	5550	-4195	2503	5562	-3011	2722	5549	-3465	2514	5357	-2538
116	KATAKHALI	6.125	74	577	-460	106	563	-438	166	573	-378	236	623	-286	252	630	-241	218	600	-290
117	BISHKHALI	42.500	156	8779	-11039	702	8853	-11063	1077	9408	-12617	2084	10115	-12199	2278	9739	-11866	2011	10034	-10438
118	BISHKHALI	68.000	150	11305	-15106	701	11701	-15516	1085	12030	-16206	2102	12745	-15279	2308	12221	-13407	2030	12097	-11648
119	KHAIRABAD	10.375	27	457	-336	54	458	-275	69	436	-341	118	426	-379	133	413	-384	133	451	-319
120	KHAIRABAD	29.750	117	2006	-1812	278	2052	-1755	406	3375	-1597	732	3008	-1265	791	2920	-1263	679	3150	-1185
121	PANDAB-1	9.125	10	940	-518	36	974	-526	57	932	-694	123	1014	-650	129	954	-662	105	1014	-1008
122	PANDAB-2	4.500	159	4301	-3923	614	4418	-3701	824	4629	-3801	1707	4741	-3420	1756	4529	-3265	1357	4740	-3206
123	DHULIA	11.062	310	4807	-4423	799	4954	-4769	1134	4701	-4722	2171	4740	-4089	2279	4884	-3703	1856	4584	-3367
124	PAIRA	12.262	284	7455	-6573	928	7760	-6708	1288	9875	-6239	2572	9558	-5707	2684	9545	-5544	2132	9451	-5093
125	BURISWAR	2.500	231	10894	-10880	1136	10897	-10228	1554	15440	-12564	3281	16755	-13249	3365	14594	-10937	2626	15454	-10335
126	BURISWAR	31.000	222	29627	-27541	1073	29064	-27627	1567	30710	-37773	3348	31339	-39233	3338	30372	-34539	2751	29398	-36885
127	PATUAKHALI	6.000	-45	2762	-1893	225	2782	-1809	272	4293	-2254	675	5060	-1885	639	4527	-1956	432	4106	-2154
128	LOHALIA	30.500	192	2335	-2099	-38	1422	-2088	69	2646	-2263	-179	2706	-2102	-50	2413	-2243	133	2657	-1992
129	PADMA	92.500	8752	18426	-9215	16933	24539	-3039	27684	51687	-4278	52519	66526	35817	61840	76915	43908	69796	85298	55796
130	SHAHABAZ-2	4.792	1591	22530	-44914	4667	25373	-43386	7414	34399	-49152	18515	40599	-42620	22193	42873	-33762	23846	39332	-18649
131	TENTULIA	11.500	1351	6726	-4460	1805	6770	-3664	2322	8400	-5755	2997	8679	-6970	3530	8335	-6070	4017	8571	-4815
132	TENTULIA	91.750	1375	27447	-44916	1802	28095	-44875	2309	31233	-46234	2818	33397	-44007	3412	32890	-42691	4101	32808	-33656
133	SWARUPKATI	10.250	645	11253	-7177	1326	11331	-7156	1916	13774	-11049	3109	15502	-12339	3214	14570	-9834	3103	13944	-10694
134	SWARUPKATI	15.750	713	9471	-8704	1437	10004	-9397	2081	12076	-12995	3316	14042	-12893	3359	13181	-11872	3225	13743	-12051
135	SHAHABAZ-3	35.750	5124	94177	-115671	10903	102713	-120794	16799	115248	-125421	34591	126926	-113127	40332	133740	-98720	42158	131745	-74587

Source : Consultant's model results based on BWDB data.

TABLE A 18
1982–83 Monthly Flow (m^3/s)

Map Ref. No.	River	Chain. (Km)	October			November			December			January			February			March		
			Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
1	KOBADAK	38.000	0	4	-8	0	4	-5	0	4	-5	0	4	-4	0	4	-4	1	4	-5
2	BETNA	51.500	5	39	-32	0	20	-43	0	19	-38	0	20	-37	0	17	-37	0	17	-36
3	LABANGABATI	4.375	0	69	-59	0	65	-61	0	58	-65	0	60	-57	0	53	-50	0	54	-47
4	KHOLPETUA	26.008	9	3820	-3991	-6	4021	-3988	-9	4025	-4022	-5	3998	-3880	-13	3722	-3697	-5	3540	-3751
5	ARPANGASIA	21.880	-186	7605	-8906	-194	7930	-9287	-198	8163	-9341	-187	8066	-8905	-171	7621	-8459	-185	7427	-8425
6	CHALKI GANG	8.750	159	6004	-6757	173	6326	-6923	171	6649	-7274	189	6687	-6824	178	6265	-6334	189	6250	-6367
7	SONA KHAL	7.250	-212	3590	-4086	-262	3644	-4130	-278	3875	-4224	-289	3836	-3947	-285	3331	-3683	-301	3114	-3827
8	BARAPANGA	8.625	-203	3236	-3416	-193	3271	-3314	-192	3408	-3346	-185	3270	-3220	-168	3030	-3076	-190	2912	-3020
9	MALANCHA	2.000	8	5749	-6626	-9	6041	-6958	-17	6320	-7130	-8	6280	-6678	-15	5878	-6352	-13	5752	-6332
10	MALANCHA	60.000	-161	7041	-8680	-147	7441	-9136	-164	7877	-9393	-140	7733	-8682	-114	7210	-8169	-144	7031	-8167
11	MALANCHA-E	9.050	-104	41296	-49021	-138	45278	-50964	-206	47415	-54015	-128	47437	-50048	-18	44161	-45064	-126	42951	-46079
12	L_SOLMARI	4.250	-221	1011	-1143	-97	1086	-912	-56	1104	-808	-27	1038	-826	-12	1016	-721	-18	1077	-718
13	SALTA	1.750	0	45	-28	1	43	-28	1	38	-30	1	33	-22	1	28	-21	1	33	-24
14	RUPSA	4.596	1300	3948	-2451	459	2653	-3066	204	2460	-3466	73	2235	-3369	28	2106	-3070	29	2093	-2781
15	GHENGRAIL	10.150	44	1604	-1758	16	1660	-1673	10	1521	-1663	11	1586	-1600	4	1428	-1517	10	1399	-1565
16	KAZIBACHA	13.500	793	2640	-1795	278	1662	-2320	128	1539	-2730	81	1402	-2602	53	1308	-2213	55	1280	-1943
17	DELUTI	8.000	314	2719	-2110	252	2750	-2141	228	2657	-2187	219	2646	-2106	203	2461	-2020	219	2350	-1964
18	SIBSA	19.352	649	14885	-15217	241	14659	-16466	111	14878	-16757	31	14531	-16342	-55	13720	-15187	8	13188	-14712
19	SIBSA	72.652	901	27229	-29349	527	28041	-31607	387	29475	-32806	351	29209	-31452	271	27768	-28076	342	27235	-27733
20	PUSSUR	12.626	737	5348	-4854	265	4520	-5653	131	4629	-5760	114	4432	-5291	72	4340	-4563	90	3878	-4599
21	PUSSUR	78.835	574	24664	-26837	199	23664	-28027	150	24091	-26746	-6	23334	-24521	-18	21132	-22077	80	20088	-21417
22	PUSSUR	94.710	1452	64337	-67938	727	66870	-72074	511	68607	-75637	368	67578	-70453	337	62502	-64520	449	60823	-63577
23	NABAGANGA_L	27.500	1255	3539	-1815	450	2098	-2365	201	1910	-2584	72	1695	-2541	35	1611	-2318	29	1581	-2186
24	KATAKHALI-SW	20.250	23	128	-73	-3	98	-74	-10	101	-87	-12	101	-86	-14	98	-79	-15	97	-81
25	CHUNKURI	4.650	166	2083	-1469	44	2007	-1607	2	1796	-1729	-31	1924	-1657	-43	1343	-1428	-35	1138	-1357
26	DHAKI	13.000	146	1957	-1672	60	1938	-1801	30	1748	-1772	5	1882	-1758	-8	1554	-1742	1	1426	-1660
27	SUTARKHALI	27.900	28	1859	-1996	-13	1857	-2152	-26	1856	-2073	-32	1831	-2076	-36	1670	-1940	-32	1575	-1878
28	JHAPJHAPIA	4.750	2	20	-13	1	22	-12	1	23	-15	1	21	-12	1	21	-14	1	24	-9
29	HARIA	17.850	-3	421	-359	-8	396	-377	-9	407	-376	-12	380	-366	-10	375	-374	-13	358	-370
30	MADHUMATI	153.250	1164	3062	-518	422	871	-839	183	702	-854	62	506	-714	33	465	-696	17	451	-687
31	MADHUMATI	199.375	-23	207	-106	0	74	-42	-3	46	-25	1	49	-17	0	33	-15	1	33	-22
32	MADHUMATI	207.250	251	602	50	73	114	21	41	78	-18	31	76	-31	27	65	-30	21	80	-48
33	POYLAHARA	15.000	3	306	-219	0	296	-217	0	314	-209	0	286	-192	-1	256	-168	-1	296	-190
34	GASHIAKHALI	15.750	176	3112	-2965	92	3217	-3058	-8	3278	-3019	176	3084	-2949	115	3028	-2771	66	2744	-2795
35	ATHAROBANKI	26.667	2	48	-59	0	27	-63	0	34	-43	0	24	-42	0	17	-37	0	27	-39
36	BALESWAR	57.005	-15	187	-475	-20	162	-431	-23	233	-417	-16	225	-375	-18	179	-354	-21	178	-403
37	BALESWAR	95.625	2813	15483	-10292	1952	12842	-11359	1498	11623	-12223	1355	11038	-11763	1041	9197	-11285	1004	9222	-10510
38	KALIGANGA	17.450	263	761	-650	77	540	-742	44	544	-750	33	520	-718	26	461	-656	20	525	-692
39	KOCHA	4.800	2831	12637	-7112	1973	9627	-6586	1518	8342	-7199	1361	7234	-7228	1059	6839	-5986	1017	6468	-5901
40	BHAIRAB U	33.211	3	8	-8	0	4	-4	0	3	-3	0	2	-2	0	2	-2	0	2	-2
41	BHAIRAB U	130.000	70	418	-671	-23	382	-762	-45	388	-739	-54	297	-616	-58	331	-615	-58	359	-638
42	GOBRAKHAL	4.500	7	41	-72	0	22	-43	0	17	-38	0	15	-28	0	18	-29	0	19	-30
43	CHITRA	125.750	47	252	-296	19	221	-272	5	210	-254	1	199	-230	1	182	-218	1	183	-220
44	CHITRA	155.752	58	371	-548	20	350	-539	4	315	-517	0	306	-452	0	290	-397	0	291	-420
45	NABAGANGA_U	91.000	7	11	3	4	9	2	1	2	0	0	0	0	0	0	0	0	0	0
46	NABAGANGA_U	128.250	35	53	15	17	28	6	4	13	-31	1	14	-28	1	13	-24	1	12	-25

Contd..

TABLE A 18
1982-83 Monthly Flow (m^3/s)

Map Ref. No.	River	Chain. (Km)	October			November			December			January			February			March		
			Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
47	NABAGANGA_U	157.000	-5	15	-25	-1	15	-16	0	12	-11	0	9	-8	0	11	-10	0	12	-11
48	KUMAR	48.608	9	22	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
49	KUMAR	103.950	44	85	7	7	14	-3	2	7	-8	1	5	-8	1	5	-7	0	6	-11
50	SITALAKHYA	18.600	6	36	-2	4	5	2	2	2	1	1	1	1	1	1	1	1	1	1
51	SITALAKHYA	63.552	45	83	5	4	6	2	1	2	-2	0	1	-2	0	2	-3	0	2	-4
52	KUMAR-CONN	2.000	7	39	4	3	4	3	2	3	2	2	3	2	2	2	2	1	2	1
53	MBR	7.500	167	303	70	63	88	40	41	62	21	29	43	14	26	40	11	20	39	-6
54	BARASIA_ARBT	31.875	83	336	-473	8	332	-509	2	281	-430	0	251	-319	2	237	-288	0	245	-281
55	GORAI	20.500	981	2731	368	402	526	325	162	325	89	57	92	38	30	38	25	16	27	4
56	ARIALKHAN	1.815	607	1397	277	254	441	186	193	398	134	163	328	126	150	288	106	110	280	35
57	ARIALKHAN	49.875	599	1448	225	226	327	11	163	262	-63	136	205	-69	127	194	-53	89	182	-111
58	ARIALKHAN	55.750	599	1435	167	228	350	-77	163	288	-121	136	230	-146	127	221	-95	89	206	-165
59	ARIALKHAN	66.000	770	1826	65	296	522	-259	207	440	-310	165	363	-334	153	351	-268	105	333	-338
60	ARIALKHAN	98.500	773	1931	-446	294	933	-927	204	836	-1182	162	754	-1203	151	707	-1027	100	698	-1121
61	ARIALKHAN	115.250	2189	3975	-252	1277	2537	-1041	948	2243	-1452	796	1985	-1611	669	1905	-1386	603	1848	-1509
62	ARIALKHAN	119.250	2348	4309	-276	1365	2855	-1077	1010	2536	-1500	840	2194	-1597	703	2124	-1438	637	2046	-1550
63	ARIALKHAN	127.750	1358	3433	-77	676	1730	-729	478	1501	-923	371	1255	-1009	325	1168	-894	283	1115	-888
64	ARIALKHAN	139.750	-32	1798	-1477	-373	1246	-1868	-339	982	-1955	-372	941	-2031	-266	957	-1868	-272	1006	-2023
65	ARIALKHAN	145.000	-1896	3057	-4033	-1699	3847	-4290	-1322	4066	-4192	-1286	4182	-4099	-967	3643	-3965	-906	3955	-3873
66	ARIALKHAN	151.750	1408	3759	-1618	561	2228	-1244	387	1813	-1176	148	1632	-1162	226	1162	-1072	248	1381	-1002
67	ARIALKHAN	158.750	859	3202	-1730	136	1976	-1715	73	1704	-1783	-140	1329	-1658	2	1088	-1522	39	1340	-1418
68	ARIALKHAN-L	1.500	126	328	61	54	87	37	37	68	22	25	50	15	21	45	11	14	39	1
69	ARIALKHAN-L	17.250	46	171	6	9	24	-25	3	17	-27	1	10	-33	1	8	-26	0	9	-31
70	PALANG	2.500	106	312	54	51	91	34	35	66	23	25	46	15	20	41	11	14	35	3
71	PALANG	27.319	161	354	71	66	96	9	43	74	-34	30	55	-39	26	49	-28	17	47	-34
72	NARIA-KH	1.750	-2	260	-176	10	162	-38	7	115	-32	5	68	-25	5	74	-13	5	71	-17
73	KUMAR-1	10.250	113	214	64	56	78	42	39	59	29	29	43	21	25	39	18	20	34	9
74	KUMAR-2	15.505	-9	-1	-35	-2	3	-5	-1	6	-4	0	6	-2	0	10	-2	0	10	-2
75	TORKI-1	18.387	19	51	-5	5	15	-7	3	12	-7	2	10	-6	2	8	-6	1	10	-8
76	TORKI-2	3.750	131	259	-60	81	329	-124	59	189	-127	43	154	-122	34	167	-138	33	181	-158
77	BISHKANDIA	15.250	17	129	-87	3	103	-90	1	93	-87	0	85	-81	0	67	-79	0	66	-87
78	BISHKANDIA	37.000	31	620	-431	12	406	-443	7	390	-445	3	360	-423	0	319	-410	3	333	-434
79	BISHKANDIA	46.250	106	1780	-936	58	1086	-986	39	871	-970	30	911	-912	18	759	-886	22	762	-927
80	SHATLA	6.000	-9	144	-162	-8	146	-144	-5	120	-133	-2	123	-121	-2	106	-117	-3	109	-132
81	HARTA	1.250	-74	219	-526	-46	244	-363	-32	231	-289	-26	226	-265	-18	199	-212	-19	227	-217
82	HARTA	4.875	-82	210	-333	-54	203	-225	-37	199	-199	-28	204	-177	-21	192	-162	-22	194	-173
83	UZIRPUR	4.125	2397	5713	-2644	1741	5272	-3221	1354	4869	-3264	1211	4527	-3657	957	4068	-3283	904	4132	-3129
84	SHANDHA	7.250	2332	9046	-2435	1688	5184	-3125	1319	4930	-3493	1184	4671	-3618	933	4297	-3331	882	4154	-3393
85	SHIKARPUR	8.750	996	2181	-764	689	1891	-1009	533	1768	-1162	469	1674	-1207	374	1506	-1124	352	1604	-1122
86	AMTALI	8.750	1396	3374	-1578	1051	3063	-1836	820	2842	-1924	742	2689	-2087	586	2462	-1911	552	2526	-1886
87	LOWERMEGHNA	17.000	34042	69577	-21230	15233	37463	-37416	11509	35884	-40046	9913	32715	-35940	9449	31218	-33992	6552	30155	-32367
88	LOWERMEGHNA	33.000	32321	71779	-30786	14192	42296	-48688	10731	37378	-45239	9255	33778	-41142	8848	32742	-34462	6061	31734	-33787
89	LOWERMEGHNA	39.375	31092	75946	-43325	13366	47604	-56359	10083	41168	-55092	8692	36617	-46290	8409	35349	-44327	5572	33875	-41029
90	LOWERMEGHNA	51.000	28597	74098	-45992	12106	49587	-64723	9214	43877	-65415	7970	38815	-61603	7713	37434	-50952	5037	35799	-49251
91	LOWERMEGHNA	59.000	29587	80817	-71014	12271	57700	-76716	9235	52209	-82709	7944	44913	-71344	7686	43251	-63879	4934	40976	-58443
92	JOYANTI-1	8.125	1789	7790	-1514	1059	4526	-1298	783	2287	-1492	649	1281	-255	589	1226	-260	475	1156	-519

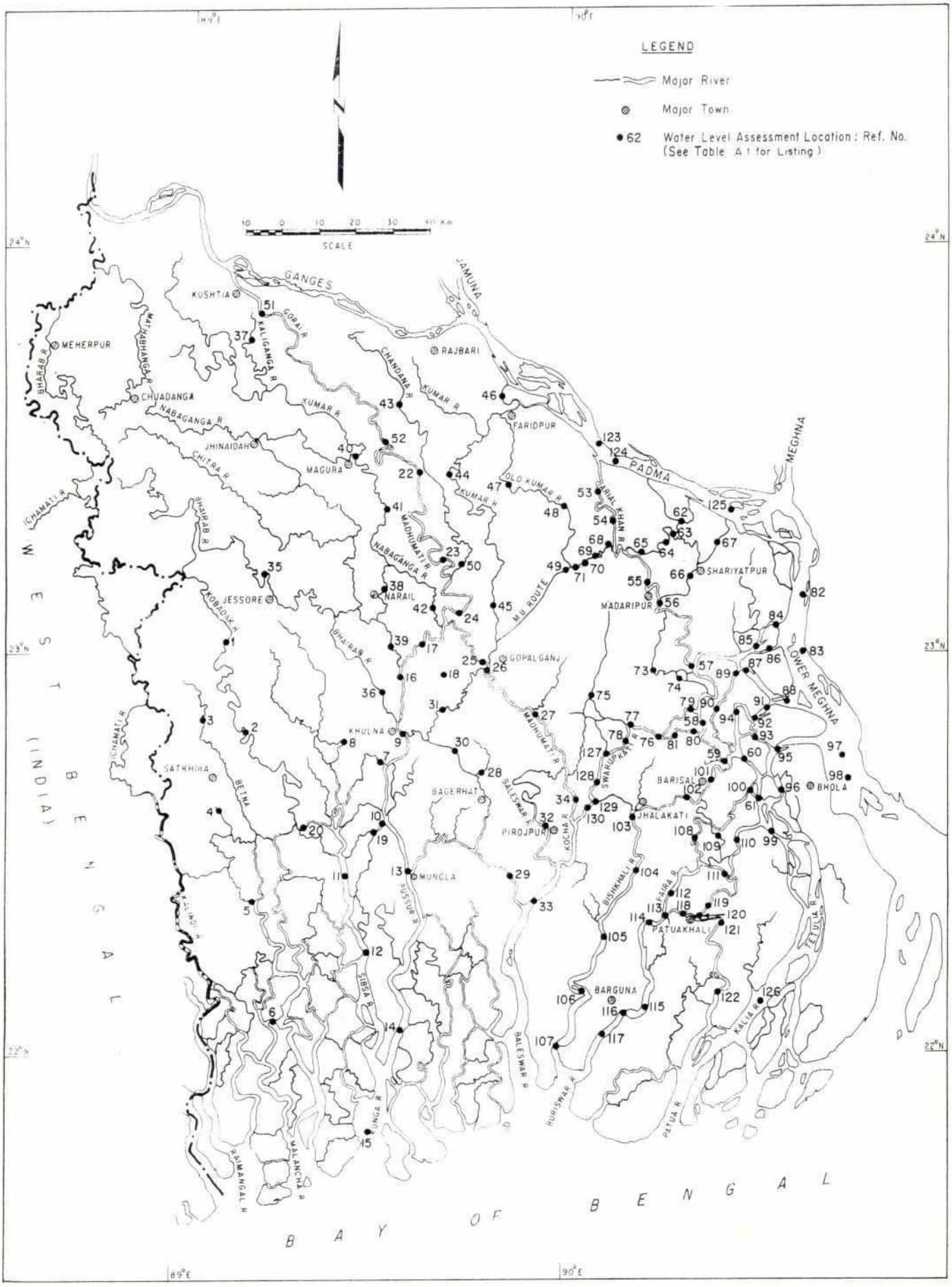
Contd..

TABLE A 18
1982–83 Monthly Flow (m^3/s)

Map Ref. No.	River	Chain. (Km)	October			November			December			January			February			March		
			Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
93	JOYANTI-1	15.005	3016	9090	-216	1929	6051	-678	1441	4747	-723	1203	3985	-32	1010	3550	-113	952	3520	-328
94	JOYANTI-1	26.125	1536	3898	226	1062	3060	-149	801	2424	-617	679	1952	-560	554	1815	-647	540	1876	-691
95	JOYANTI-2	4.250	1259	14588	-5483	832	9877	-5583	650	6464	-5500	557	5255	-1187	424	4832	-1157	480	4621	-1119
96	S-MEGHNA	1.000	1502	3905	570	871	2222	274	640	1443	57	522	1245	-31	454	1053	-21	409	994	-83
97	S-MEGHNA	7.625	689	1503	-577	346	1066	-710	238	882	-572	183	604	-449	160	593	-433	138	565	-530
98	S-MEGHNA	17.875	-1578	-443	-4296	-1108	-9	-3293	-859	303	-3011	-729	403	-2518	-630	156	-2166	-604	434	-2037
99	S-MEGHNA1	7.500	2552	5601	-1229	1267	3626	-1689	875	2892	-2267	712	2235	-1947	648	2047	-1628	516	1927	-1750
100	S-MEGHNA2	3.750	982	4731	-8914	160	4566	-8699	17	4418	-7586	-19	3963	-6560	10	3726	-5121	-92	3460	-6166
101	NAYABHANGANI	16.688	823	1479	-164	529	1206	-382	403	1025	-459	337	810	-435	293	757	-434	268	771	-458
102	DHARMAGANJ	2.000	2275	3884	-275	1456	2942	-842	1098	2518	-1050	910	2028	-1204	785	2085	-1140	739	1990	-1120
103	DHARMAGANJ	10.875	964	2604	-1347	545	1972	-1753	405	1707	-1775	327	1430	-1745	298	1381	-1619	266	1297	-1717
104	KALABADAR-1	6.750	1318	2778	-231	912	2155	-551	693	1962	-703	582	1685	-751	483	1635	-691	470	1565	-751
105	KALABADAR-1	14.750	1324	3035	-1067	913	2392	-1389	694	2343	-1563	581	2039	-1431	480	1981	-1394	469	1935	-1314
106	KALABADAR-2	2.000	-1147	508	-2687	-816	942	-2231	-610	1140	-2023	-519	1195	-1757	-427	1106	-1697	-423	1159	-1708
107	KALABADAR-2	8.625	-179	2501	-3115	-271	1967	-2990	-205	1712	-3140	-193	1530	-2738	-132	1330	-2241	-159	1287	-2362
108	ILSHA	5.250	2650	12314	-3131	2125	11202	-2953	1627	10893	-3241	1429	9799	-2812	1138	7904	-2550	1150	7322	-2543
109	ILSHA	30.375	2490	5574	-1206	1861	4974	-2139	1425	4816	-2329	1231	4370	-2380	984	4087	-2282	982	3951	-2561
110	SHAHABAZ-1	6.250	26988	89318	-78106	10141	71334	-107698	7594	64136	-109639	6486	56955	-101661	6415	53442	-91796	3745	50419	-84027
111	SHAHABAZ-1	39.000	18424	73628	-56122	7872	54237	-72444	5968	51413	-79136	4772	47983	-80452	4407	46499	-67201	3121	44777	-59605
112	TENTULIA	4.500	3355	8814	-4602	2000	7847	-5529	1501	7575	-5689	1088	6927	-4708	976	5874	-4808	1015	6065	-5033
113	RANGAMATIA	14.583	555	1323	-1259	426	1276	-1310	315	1333	-1342	285	1312	-1373	217	1230	-1288	205	1192	-1311
114	KIRTONKHOLA	11.750	1866	3873	-2739	1326	3556	-3286	984	3659	-3688	913	3500	-3508	696	3448	-3181	632	3313	-3338
115	KIRTONKHOLA	29.000	1781	5307	-3238	1289	5122	-3582	954	5021	-3635	888	4563	-3823	668	3568	-3544	611	3843	-3398
116	KATAKHALI	6.125	143	557	-404	123	515	-362	111	541	-380	102	545	-349	88	449	-348	91	519	-350
117	BISHKHALI	42.500	1568	8699	-7389	1141	7974	-8564	845	8041	-9260	812	8243	-8969	570	7473	-8042	533	7262	-7848
118	BISHKHALI	68.000	1570	11261	-11759	1139	10860	-13771	846	10904	-14736	822	11098	-14609	577	10622	-12944	539	10242	-12059
119	KHAIRABAD	10.375	92	362	-325	53	407	-303	36	372	-343	26	351	-311	21	243	-297	21	298	-284
120	KHAIRABAD	29.750	557	1778	-1531	419	1657	-1761	311	1602	-1848	278	1564	-1827	210	1496	-1698	201	1456	-1629
121	PANDAB-1	9.125	85	583	-532	62	521	-508	42	491	-487	35	338	-439	24	318	-395	24	311	-472
122	PANDAB-2	4.500	1492	4048	-3078	1263	4304	-3234	957	4125	-3545	936	3700	-3707	687	3411	-3301	628	3256	-3388
123	DHULIA	11.062	1746	4424	-4025	1405	4469	-4374	1060	4765	-4491	1007	4250	-4544	758	3969	-3971	700	3802	-4169
124	PAIRA	12.262	2136	6701	-5331	1744	6752	-6270	1312	6364	-6792	1254	6018	-6792	916	5797	-5997	855	5630	-5778
125	BURISWAR	2.500	2866	9385	-7404	2449	9489	-8604	1878	8780	-9339	1851	8285	-9490	1339	8148	-8657	1249	7676	-8281
126	BURISWAR	31.000	2874	13669	-12662	2448	12211	-14913	1877	13086	-16641	1865	12382	-16216	1350	11735	-14213	1259	11118	-12979
127	PATUAKHALI	6.000	724	2484	-1574	703	2581	-1628	567	2726	-1742	592	2437	-1668	425	2014	-1391	390	1968	-1473
128	LOHALIA	30.500	-453	2031	-1884	-559	1533	-1991	-461	1192	-1976	-517	985	-1862	-360	437	-1675	-315	847	-1658
129	PADMA	92.500	29462	57786	6036	14162	22073	-5225	11045	18961	-8991	9742	16278	-8674	9260	15565	-7622	6107	14557	-10580
130	SHAHABAZ-2	4.792	8619	32637	-34474	2282	24536	-45321	1699	22019	-47922	1705	18603	-43690	1836	17526	-36858	593	17000	-33123
131	TENTULIA	11.500	1613	6316	-5295	595	5812	-4494	445	5290	-4093	79	4327	-3601	206	3363	-3550	308	3730	-3790
132	TENTULIA	91.750	1177	28821	-38913	5	27748	-42644	38	27360	-46457	-401	26226	-41523	-214	25324	-36187	-12	24172	-35263
133	SWARUPKATI	10.250	2435	12489	-4889	1753	7854	-4597	1360	6313	-5032	1221	5544	-5205	947	5372	-4408	905	5072	-4399
134	SWARUPKATI	15.750	2567	11319	-7318	1896	8759	-6102	1473	6617	-6618	1325	6119	-6441	1035	5871	-4774	994	5501	-5278
135	SHAHABAZ-3	35.750	18463	114877	-94069	7866	98385	-116906	6117	98144	-127945	4898	92008	-126027	4077	84691	-106734	3158	79896	-100153

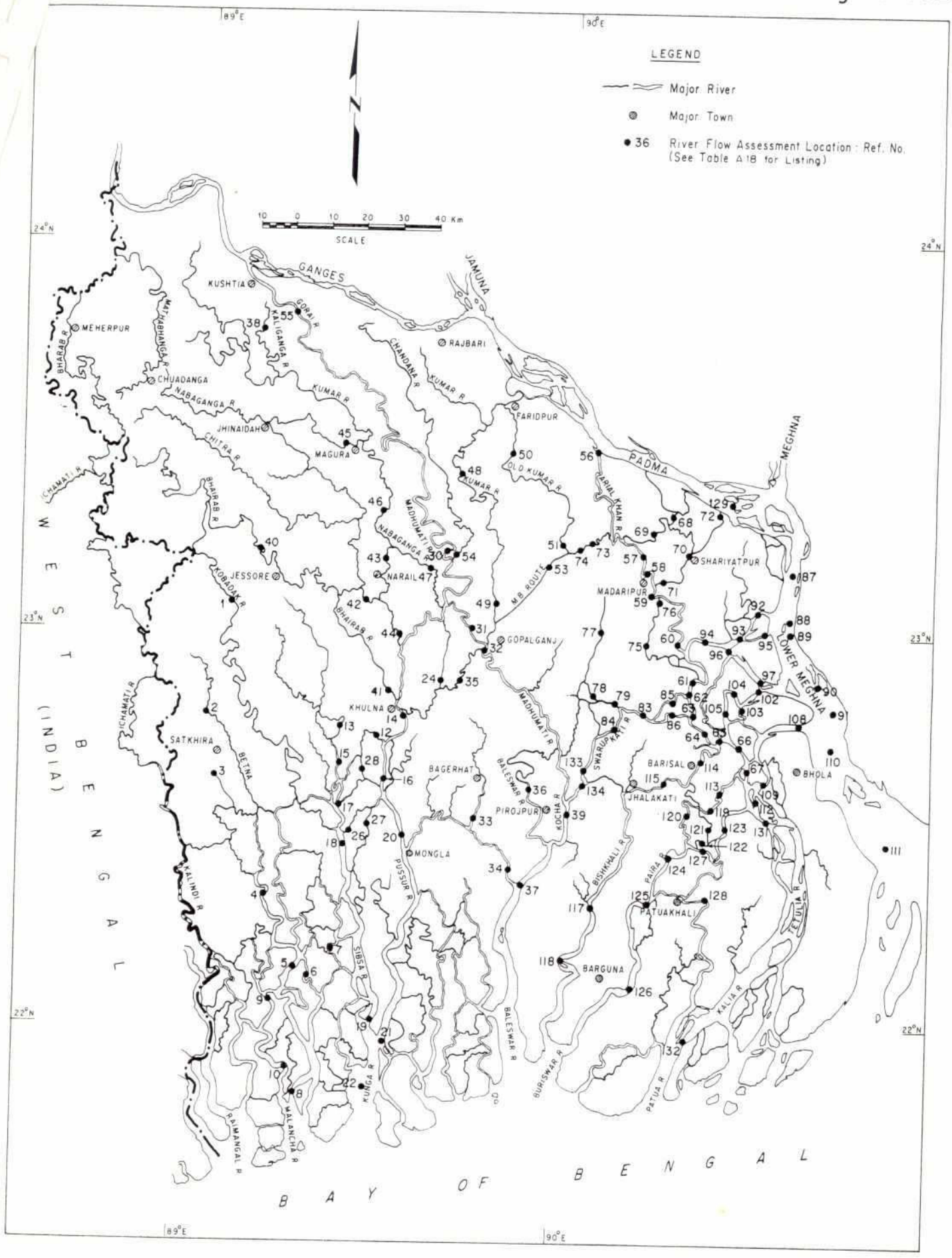
Source : Consultant's model results based on BWDB data.

Figure A 1



Location of Water Level Assessment

Figure A2



Location of River Flow Assessment

APPENDIX B

Project Profile Questionnaire (Sample)

HALCROW
DHI – EPC – SSL

Southwest Area Water Resources Management Study (FAP – 4)

Project Profile

Project Title	SWR Ref. No.
Construction of Shalgram - Barakhal Regulator Scheme.	

Relevant Reports	Consultant	Funding Agency	Government Executing Agent	Type (FC/D/I, etc.)
Identification	–	GOB	BWDB	
			MPO Planning Unit	Status * – Operational ✓ – Under Construction – Designed – Under Design – Feasibility Studied – Being Studied – Preafisibility Study – Identified only
			BWDB Area Jessore O&M DIV/KOMC/SWZ	
			Construction Dates (Years)	

* Delete inappropriate on

Water Resources

Summary Data	Unit	Existing	Future
Source of Surface Water	Name	Afra River	
Source of Surface Water	Name	–	
Total Capacity of Gravity Intakes	cumec		
Total Capacity of Low Lift Pumps	cumec		
Average Head of Low Lift Pumps	m		
Number of Shallow Tubewells (STW's)	No.		
Number of Deep Tubewells (DTW's)	No.		
Average Depth to Groundwater in rabi	m		

Engineering Data

Summary Data	Unit	Existing	Future
Length of Flood Embankments	km	—	
Average Height of Flood Embankments	m	—	
Length of natural main drainage channels	km	15	
Length of man-made drainage channels	km	—	
Length of main and branch canals - unlined	km	5	
Length of main and branch canals - lined	km	—	
Length of secondary canals - unlined	km	—	
Length of secondary canals - lined	km	—	
Length of tertiary canals - unlined	km	—	
Length of tertiary canals - lined	km	—	
Number of regulators	No.	1	
Number of drainage sluices	No.	—	
Number of check structures	No.	—	
Number of pump stations	No.	—	

Comments on water and engineering problems to be overcome

Additional Regulator needs to be constructed.
Check structure is required over Shalgram khal

Form completed by : .....

Date : 11/2/92

Md. Mizanur Rahman Khan
Sub Divisional Engineer
O & M Sub-Division BWDB Jessore.

HALCROW
DHI – EPC – SSL

Southwest Area Water Resources Management Study (FAP – 4)

Project Profile

PROJPROF.WK1

Project Title	SWR Ref. No.
Construction of Dalgram Bara Khal Regulator scheme	

Financial Data

Summary Data	Unit	Existing	Future	Incremental
Total Goverment cost of FCDI works (A)	M.Tk			
Total Goverment cost of Land Acquisition	M.Tk			
Total Goverment cost of Engineering Services	M.Tk			
Total Goverment Investment Cost (B)	M.Tk	2·78		
Estimated Cost of Private Tubewells	M.Tk			
Estimated Cost of Farmer-built channels etc.	M.Tk			
Total Private Sector Investment (C)	M.Tk	—		
Overall Investment Costs (B + C)	M.Tk	2·78		
Construction duration	years			
Cost of CEMENT as a proportion of (A) above	%			
Cost of AGGREGATES as a proportion of (A)	%			
Cost of LABOUR as a proportion of (A) above	%			
Cost of FUELS as a proportion of (A) above	%			
Proportion of (B) as Foreign Exchange	%			
Proportion of (C) as Foreign Exchange	%			
Public Sector Annual O&M Costs	M.Tk/year			
Public Sector Annual Energy Costs	M.Tk/year			
Private Sector Annual O&M Costs	M.Tk/year			
Private Sector Annual Energy Costs	M.Tk/year			

Unit Construction Rates

(as used in estimates above)

Item	Unit	Rate	Item	Unit	Rate
Reinforced concrete incl. steel, forms etc.	Tk./m3		Road surfacing, gravel or brick	Tk./m2	
Mass concrete including forms etc.	Tk./m3		Road surfacing, full metalled	Tk./m2	
Brick masonary	Tk./m3				
Structural excavation	Tk./m3		Cement	Tk./ton	
Structural steel for gates etc.	Tk./ton		Crushed aggregate	Tk./cum	
Average STW, complete installation	Tk each		Unskilled labour	Tk./day	
Average DTW, complete installation	Tk each		Skilled labour	Tk./day	
Existing channel excavation	Tk./m3		Diesel	Tk./litre	
New channel excavation	Tk./m3		Petrol	Tk./litre	
Embankment fill and compact	Tk./m3		Electricity	Tk./kwh	

Any other relevant engineering information

The project is now located within the ongoing scheme - Chitra Bairab Afra being financed by Dutch-Bilateral Grant.

DPHE
21/2/92

11/2/92

L28

HALCROW
DHI – EPC – SSL

Southwest Area Water Resources Management Study (FAP – 4)

05-Dec-91

Project Profile

PROJPROF.wk1

Project Title	SWR Ref. No.
Construction of Dhalgram-Barakhal Regulator Scheme	

Land Resources

Gross Areas of MPO Land Classes	Unit	Existing	Future
Land Flooding Class F0 - Light Soils *	ha	623	
Land Flooding Class F0 - Medium/Heavy Soils *	ha	621	
Land Flooding Class F1	ha	415	
Land Flooding Class F2	ha	1036	
Land Flooding Class F3	ha	1036	
Land Flooding Class F4	ha	415	
Total	ha	4146	

* Combine if unable to differentiate

Agriculture

Summary Data	Unit	Existing	Future
Total size of Project Area - Gross	ha	5000	
Size of Area under Flood Protection - net	ha		
Size of Area provided with Drainage - net	ha	3000	
Size of Area provided with Surface Irrigation - net	ha	300	
Size of Area provided with Groundwater Irrigation - net	ha	700	
Size of Area developed for Shrimp Culture - net	ha		
Size of Area developed for Fish Production - net	ha		

Representative Cropping Patterns	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Irrigated												
Land Flooding Class F0 - Light Soils *												
Land Flooding Class F0 - Medium/Heavy Soils *												
Land Flooding Class F1												
Land Flooding Class F2												
Land Flooding Class F3												
Land Flooding Class F4												
Rainfed												
Land Flooding Class F0 - Light Soils *												
Land Flooding Class F0 - Medium/Heavy Soils *												
Land Flooding Class F1												
Land Flooding Class F2												
Land Flooding Class F3												
Land Flooding Class F4												

* Combine if unable to differentiate

Comments

Agricultural problems, marketing difficulties, development constraints etc.

Due to insufficient vantage of Existing Regulator Drainage congestion occurs, which causes crop damage.

Form completed by : .....

Date : 11/12/91

M.G. Mizanur Rahman Khan
Sub-Divisional Engineer
O & M Sub-Division BWDB Jessore

HALCROW
DHI – EPC – SSL

Southwest Area Water Resources Management Study (FAP – 4)

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Project Profile

SWR Ref. No.

Project Title Construction of Dolagram Bara Khal Regulator Scheme

Agro-Economic Data

Crop Production Statistics	Rainfed				Irrigated			
	Variety	Planted Area (ha)	Average Yield (Ton/ha)	Local Market (Tk./kg)	Variety	Planted Area (ha)	Average Yield (Ton/ha)	Local Market (Tk./kg)
Broadcast Aus								
HYV Aus								
Broadcast Aman								
Transplanted local Aman								
HYV Aman								
Local Boro								
HYV Boro								
HYV Wheat								
Jute								
Sugarcane								
Cotton								
Vegetables - all types								
Pulses - all types								
Oilseeds - all types								
Totals								

Aquaculture

Name of Beel	Existing				Future		
	Wet Season Area (ha)	Dry Season Area (ha)	Annual Production (ton)	Local Market (Tk./kg)	Wet Season Area (ha)	Dry Season Area (ha)	Annual Production (ton)
Totals							

Shrimp Farming	Wet Season Area (ha)	Dry Season Area (ha)	Annual Production (ton)	Local Market (Tk./kg)	Wet Season Area (ha)	Dry Season Area (ha)	Annual Production (ton)
Goverment farms							
Private licensed farms							
Private unlicensed farms							
Totals							

Comments

Aquacultural problems, marketing difficulties, development constraints etc.

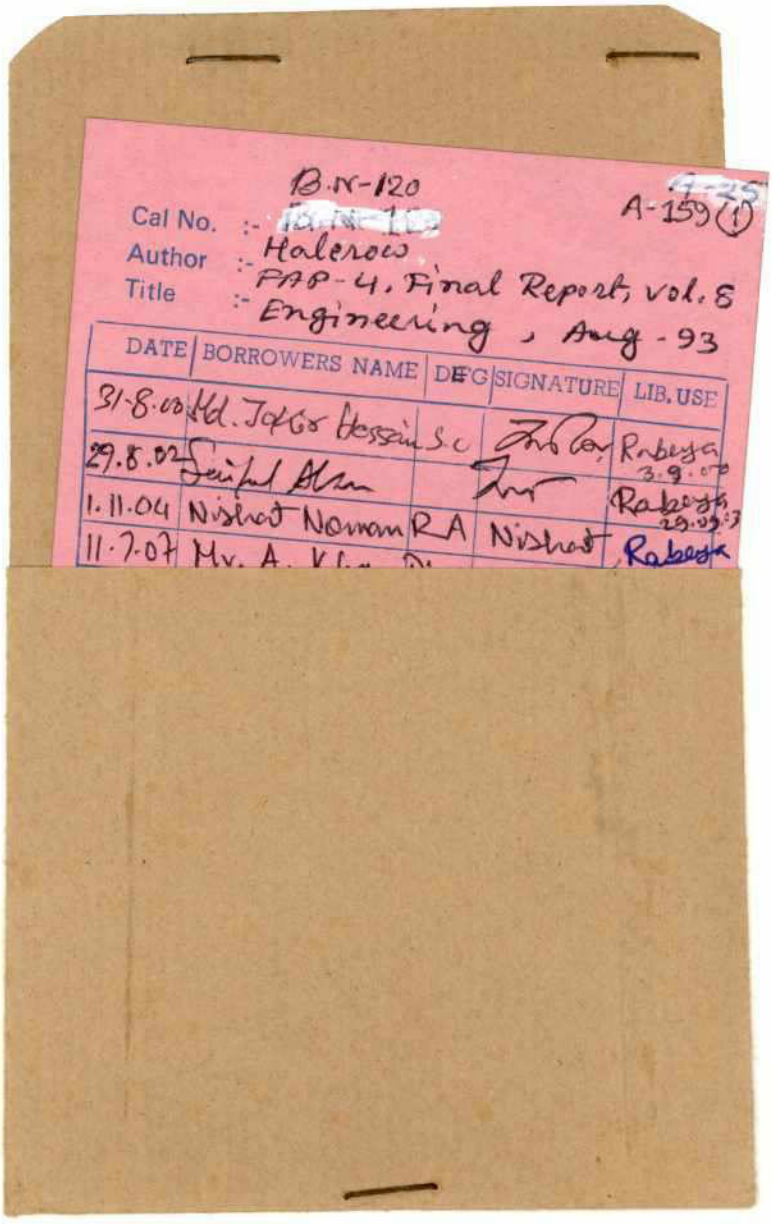
Post Project credit, Agro-Economic and Agricultural Survey are not carried out.

Form completed by : .....

Date : 11.2.92

Md. Mizanur Rahman Khan
Sub-Divisional Engineer
O & M Sub-Division BWDB Jessore.

11/2/92



B.R-120
A-159 (1)
Cal No. :-
Author :- Halcrow
Title :- FAP-4, Final Report, vol. 8
:- Engineering, Aug-93

DATE	BORROWERS NAME	DEG	SIGNATURE	LIB. USE
31-8-08	Md. Jakir Hossain	S.C		Rabeya 3.9.08
29.8.02	Saiful Alam			Rabeya 29.08.07
1.11.04	Nishat Nowrin	R.A	Nishat	Rabeya
11.7.07	Mr. A. K[illegible]			