DETAILED DESIGN REPORT
ON
PILOT TELEMETRY NETWORK
FOR
THE IMPROVEMENT OF FLOOD FORECASTING AND WARNING SYSTEM
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

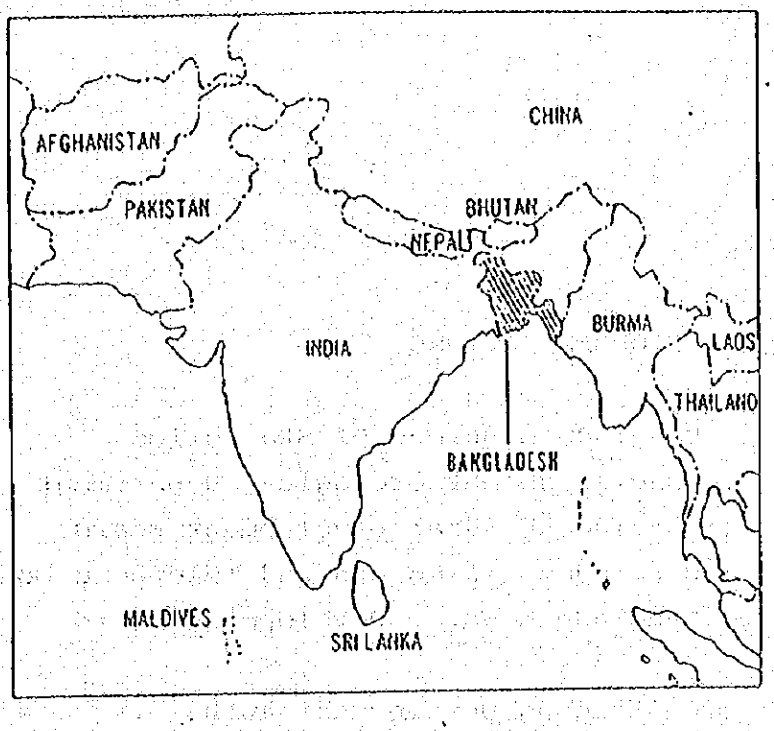
SEPTEMBER, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

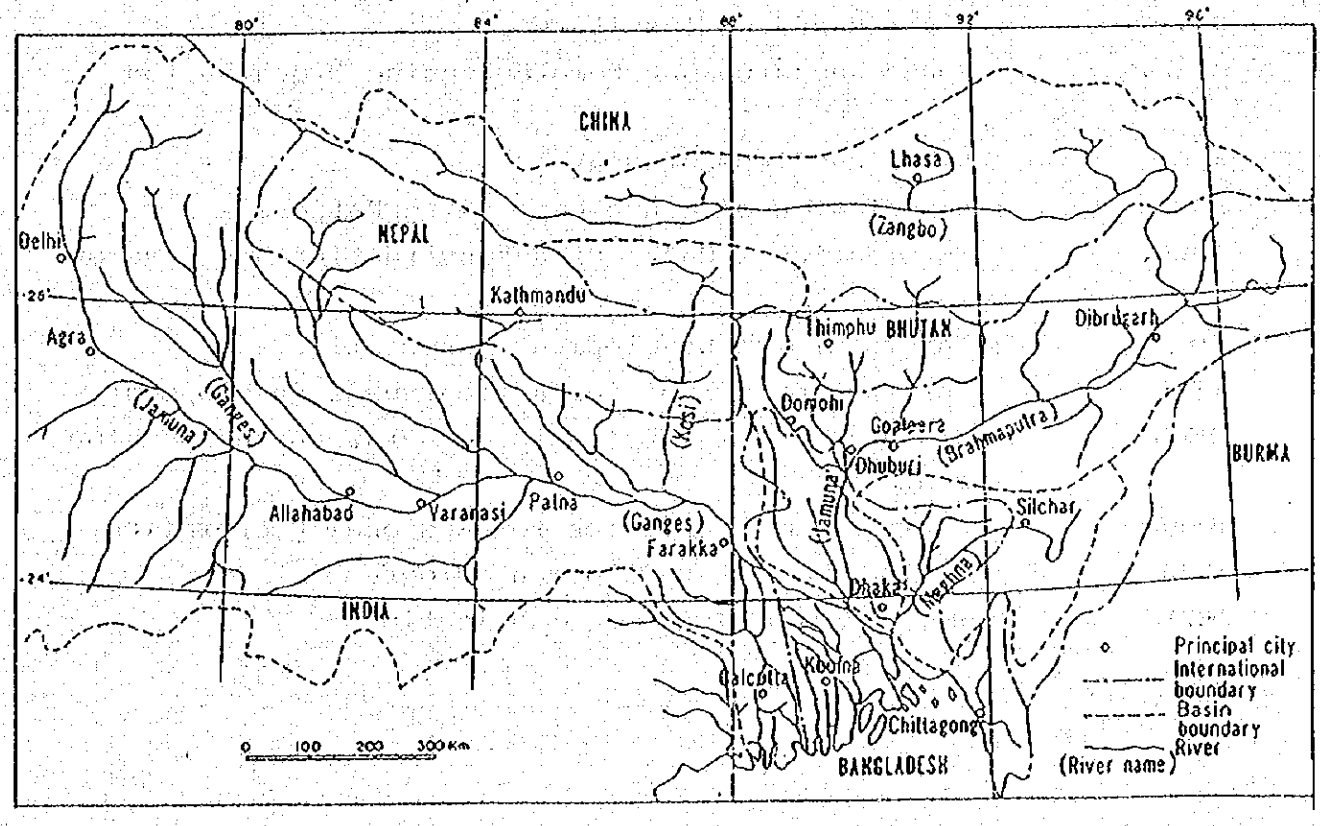
DETAILED DESIGN REPORT
ON
PILOT TELEMETRY NETWORK
FOR
THE IMPROVEMENT OF FLOOD FORECASTING AND WARNING SYSTEM
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

SEPTEMBER,1991

JAPAN INTERNATIONAL COOPERATION AGENCY



LOCATION OF BANGLADESH



MAJOR RIVER BASINS

ABBREVIATIONS

ABBREVIATIONS OF ORGANIZATIONS

BBS	:	Bangladesh Bureau of Statistics
BMD	:	Bangladesh Meteorological Department
BRDB	:	Bangladesh Rural Development Board
BTTB or T&T	:	Bangladesh Telegraph and Telephone Board
BWDB	:	Bangladesh Water Development Board
CDA	:	Chittagong Development Authority
FFWC	:	Flood Forecasting and Warning Center
MPO	:	Master Plan Organization
PWD	:	Public Works Department
RRI	:	River Research Institute
SPARRSO	:	Space Research and Remote Sensing Organization
ADB	:	Asian Development Bank
ASEAN	:	Association of South East Asian Nations
IBRD	:	International Bank for Reconstruction and Development
IDA	:	International Development Association
IFAD	:	International Fund for Agricultural Development
OECD	:	Organization for Economic cooperation and Development
SAARC	:	South Asia Association for Regional Cooperation
UNDP	:	United Nations Development Program
WMO	:	World Meteorological Organization

ABBREVIATIONS OF MEASUREMENT

Length

mm	: millimeter(s)
m	: meter(s)
km	: kilometer(s)

Area

ha	: hector(s)
km^2	: square kilometer(s)

Volume

m^3	: cubic meter(s)
MCM	: million cubic meter(s)

Time

s, sec	: second(s)
h, hr	: hour(s)

Other Measurements

HWL	: High Water Level
MSL	: Mean Sea Level
°	: degree
'	: minute
"	: second
%	: percent
°C	: degree centigrade
m^3/s	: cubic meter per second
KB	: kilobyte
MB	: megabyte
RAD	: radian
bps	: bit per second
AH	: Ampere Hour

ABBREVIATIONS OF TELECOMMUNICATION AND COMPUTER TERMS

FM	: Frequency Modulation
HF	: High Frequency
SSB	: Single Side Band
VHF	: Very High Frequency
UHF	: Ultra High Frequency
KHz	: Kilohertz
MHz	: Megahertz -10^3 KHz
GHz	: Gigahertz -10^6 KHz
CCU	: Communication Control Unit
CPU	: Central Processing Unit
MPU	: Main Processing Unit
FAX	: Facsimile
TEL	: Telephone
BPPI	: Bright Plan Position Indicator
SV/RC	: Radar Supervisory/Remote Control Equipment
T/R	: Transmitter/Receiver
MUX	: Multiplex Terminal Equipment
TSE	: Telemetering Supervisory/Control Equipment
MT	: Magnetic Tape
MD/HD	: Magnetic Disk/Hard Disk
LP	: Line Printer
UPS	: Uninterrupted Power Supply
AC	: Alternating Current
PPI	: Plan Position Indicator
PCM	: Pulse Code Modulated
FDM	: Frequency DIvision Multiplex

OTHER ABBREVIATIONS/ACRONYMS

GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GRP	:	Gross Regional Product
GPP	:	Gross Provincial Product
R/O	:	Regional Office
O & M	:	Operation and Maintenance
INTELSAT	:	International Telecommunications Satellite Organization

Table of Contents

APPENDICES

CHAPTER 1 INTRODUCTION

CHAPTER 1. INTRODUCTION

The large Ganges, Bramaputra and Megna rivers flow through the delta region which makes up most of the People's Republic of Bangladesh. The upper reaches of the delta region of the People's Republic of Bangladesh have some of the heaviest rainfall in the world, and this causes periodic flooding every year. This situation is the focus of worldwide attention. Therefore, with the efforts centered on those by the United Nations Development Program (UNDP), aid and assistance has been given for the development of a Flood Forecasting and Warning System.

Bangladesh gained its independence in 1971. From 1980 to today, aid and assistance from the UNDP has been almost continuous, especially in the form of instruction and cooperation in strengthening the monitoring network and the operation of flood forecasting and warning.

In 1989, the Japanese Government dispatched a survey team from Ministry of Foreign Affairs to study flood forecasting and warning.

Following up on a request by the UNDP, a Japanese specialist was dispatched from December 1989 to March 1990. He conducted a basic study and analysis for a nationwide Flood Forecasting and Warning System.

Because Japan had already promised assistance funds at international conferences, a plan for the introduction of a Pilot System based on Debt Relief Fund by Japan was broached during the above project study. The Japanese specialist mentioned above made a rough design for such a system.

In March 1990, the Japanese Government and the Government of the People's Republic of Bangladesh signed a formal agreement for the introduction of a Pilot System to be paid for by Japanese Debt Relief Fund.

In Regard to a nationwide Flood Forecasting and Warning System, it was decided that the Japanese Government would cooperate with the UNDP in future to conduct a feasibility study (FS). Through the above process, the Japanese Government decided to dispatch specialists from JICA to execute "The survey of a Detailed Plan for a Flood Forecasting and Warning Pilot Telemetry System in Bangladesh.

According, the JICA team of specialists have prepared this Report after having conducted an extensive survey for the selection of gauging station sites, Radiowave propagation tests for the selection of dedicated Radio Telemetry links and careful examination of the existing nationwide Telecommunications network to determine the suitability and possibility of its use in the Project.

CHAPTER 2 NATURAL CONDITION IN BANGLADESH

CHAPTER 2 NATURAL CONDITION IN BANGLADESH

2.1 Topographic Condition

Bangladesh covers parts of the Bengal Delta. Most of its flat land has been formed over the ages from silt deposited by major rivers, including the Ganges, Brahmaputra, and Meghna. The amount of silt carried by these major rivers is currently estimated at 2.4 billion tons a year. The location of Bangladesh and the major rivers is shown in the Location Map at the beginning of this report.

The topography of Bangladesh is extremely low and flat. Within the area drained by the three major rivers, the highest point, which is located in the northwest, is 90 m above sea level. The elevation of 50 % of the country is 8 m or lower. This plain is surrounded by the Shillong Heights in the north, the Chittagong Hills in the east, the Rajmahal Hills in the west, and the Bay of Bengal in the south.

Within the plain, the Brahmaputra, Ganges, and Meghna enclose two diluvial plateaus. These areas have risen in the Pleistocene Epoch due to an upsurge of tectonic activity in the orogenic zone of the Himalayas. The plateau located between the Brahmaputra and Meghna rivers is known as the Madhupur Jungle Plateau, while that between the Brahmaputra and the Ganges is called the West Barind Plateau.

The Madhupur Jungle Plateau is a triangular area with an elevation of 10-17 m. It is lowest in south east where the capital of Dhaka is located. The West Barind Plateau is an alluvial fan stretching from north to south. It is divided up by a number of rivers, including the Karatoya, Jamuna, and Atrai. The city of Bogra is located on this plateau.

With the exception of these plateaus and some hilly areas, Bangladesh consists entirely of alluvial plain. In the upper reaches of the Meghna River, an area to the northeast of the Madhupur Jungle Plateau, there is a large marshy region centering on Sylhet. Although located 230 km from the coast as the crow flies, it is no more than 5 m above sea level - only 3 m in some parts.

The alluvial fan spreads through the northern part of the West Barind Plateau, the upper reaches of the Brahmaputra, and the

southern area of the Sillong Plateau. The plain in the southern part of the Ganges Basin was formed primarily through the alluvial action of the Ganges River. The action of the Ganges prevails in the northern part of the plain, but the southern area is a tidal delta in which the action of the sea predominates.

2.2 Hydrological Condition

2.2.1 Rivers

Bangladesh is located in the lower reaches of three major international rivers, the Brahmaputra, Ganges, and Meghna.

From its source in the southern Himalayas, the Ganges flows down to the Ganges Plain of India before entering Bangladesh. The Brahmaputra traverses Chinese territory in the northern Himalayas before flowing into India via the Assam Valley and thence into Bangladesh. The Meghna has its source in the Barak River, which flows through the southern part of the Meghalaya region of India.

The Brahmaputra and Ganges converge near Goalundo-Aricha in central Bangladesh and then converge with the Meghna a further 100 km downstream near Chandpur before flowing into the Bay of Bengal. The river formed by the convergence of the Brahmaputra and the Ganges is called the Padma; the portion below the confluence of the Padma and the Meghna is called the Lower Meghna. The location of the major rivers are shown in Figure 2-1. Main features of the rivers are provided in Table 2-1.

The basins of the three rivers cover a total area of approximately 1.55 million square kilometers, spanning China, Nepal, India, Bhutan, and Bangladesh. The downstream areas within Bangladesh account for only 7.5 % of this total area, and most of the flow in Bangladesh consists of water that entered the rivers outside of Bangladesh territory.

The slopes of the major rivers are extremely slight. Those of the Ganges and Brahmaputra are on the order of 1/13,000-1/16,000. The Meghna has a slope of about 1/30,000 upstream, but near Bhairab Bazar it is virtually flat with a slope of only 1/180,000.

2.2.2 Climate

Bangladesh is located in the subtropical monsoon belt. Its climate consists of three seasons: The first is the monsoon, or rainy season, which lasts from May to October and is characterized by high temperatures and humidity and low sunshine hours. Bangladesh receives 90 % of its annual rainfall during this period. Cyclones frequently sweep in from the Bay of Bengal around the start and end of this season in May and October. The second season, lasting from November to February, is sunny, dry, and cool. The third season, consisting of March and April, is characterized by occasional heavy rain and highest temperatures of the year.

Bangladesh's average figure for annual precipitation nationwide is 2,320 mm, but there is considerable regional variation, from 1,250 mm in the west to 5,750 mm in the northeast. The capital of Dhaka receives around 2,200 mm of rain each year. Localized cloudbursts are common, and as much as 400 mm of rain can fall in some places in a single day. The regional distribution of annual rainfall is shown in Figure 2-2.

The highest and lowest temperatures on record are 43 C and 3 C, respectively. The records for Dhaka are 39.5 C and 8.3 C. Annual evaporation ranges from 1,000 mm to 1,400 mm.

The Assam region of India, which is located to the north of Bangladesh, is one of the rainiest areas on earth, and the Brahmaputra River that runs through it is prone to flooding even in normal years.

2.2.3 Characteristics of Floods in Bangladesh

Floods and chronic inundations in Bangladesh appear to result from combinations of the following factors:

- -Increased flows in the major rivers due to monsoon rainfall in the river basins.
- -Discharges due to localized heavy rainfall in hilly areas in the eastern and northern parts of the country.
- -Inundation within embankment/dike-protected areas due to the lack of sufficient drainage capacity to cope with local rainfall or to higher levels of the outfall rivers.
- -Backwater effects caused by rising water levels along the Bay of Bengal coast due to southwesterly monsoon winds and

high tides.
-The extremely low, flat topography of Bangladesh due to the country's location on the Bengal Delta.

The following factors have also been suggested as contributing causes of flooding:

-The coincidence of peak floods on major rivers.
-The reduction of river flow capacities and the closure of distributary channels due to the sedimentation of silt.
-The existence of roads, railways, and other artificial impediments to the efficient drainage of floodwaters in inundated areas.
-Increased peak flood flows in downstream areas due to the construction of embankments in upstream areas.
-Increased flood flows due to deforestation in upstream areas.

Data relating to the impact of the above factors is not at hand and quantitative analysis is inadequate; these points require further clarification.

Floodwaters flowing across the borders of Bangladesh down the major rivers tend to rise and fall at a relatively slow rate. During the 1988 flooding water levels in Dhaka exceeded the danger point for 23 days. Floods in the east and north are classed as flash floods. Water levels tend to rise suddenly and fall relatively quickly (over a period of several days). Inundations due to inadequate drainage capacity for local discharge are classified as local floods, and those caused by high tides as tidal floods. The southwest wind that blows during the monsoon season causes tide levels to rise by 0.6 - 1 m at the coast, while tidal variations due to spring tides can reach 3 - 5 m. These backwater effects magnify river inundations.

The monsoon season lasts from May to around October, with the result that the discharges of the major rivers remain high for prolonged periods. Flows normally start to increase from around June and decrease in September. The discharge of the Brahmaputra and the Ganges generally peak in July - August and August - September, respectively. The Brahmaputra generally peaks about one month earlier than the Ganges, but the gap between the peaks sometimes narrows to less than 10 days, and at the time of the 1988 flood the gap was just three days. Floods take approximately two days to travel along the Brahmaputra River from Gauhati in India to Bahadurabad(approximately 320 km) and a further two days to reach the Ganges confluence(approximately 200 km). Floods on

the Ganges River take approximately three days to cover the distance between Patna in India and the Hardinge Bridge in Bangladesh(approximately 500 km).

In a normal year, flood-related inundations affect about 26,000 km^2, or 18 % of Bangladesh's land area, and in some past years floods have covered more than 52,000 km^2 or 36 % of the nation's area, affecting almost 60 % of arable land. The floods of 1987 and 1988, however, both broke previous records in terms of the area they affected.

Table 2-1 Main Features of Major Rivers of Bangladesh

	Brahmaputra	Ganges	Meghna	Total
Length of river(km)	2,800	2,600	800	6,200
Length within Bangladesh(km)	270	230	400	900
Total catchment area(sq.km)	583,000	907,000	64,000	1,554,000
Catchment area within Bangladesh(sq.km)	31,000	39,000	46,500	116,500
Highest recorded discharge(cms)	99,500	76,000	19,800	-
Lowest recorded discharge(cms)	3,300	1,200	370	-
Average discharge(cms)	12,900	11,700	3,500	-

Source:Hossain,Islam and Saha, Floods in Bangladesh, 1987.
Ahmad, Flood in Bangladesh, 1989.
Note :Lowest recorded and average discharges are based on statistics up to 1986.
Unit ; sq.km:km^2 cms:m^3

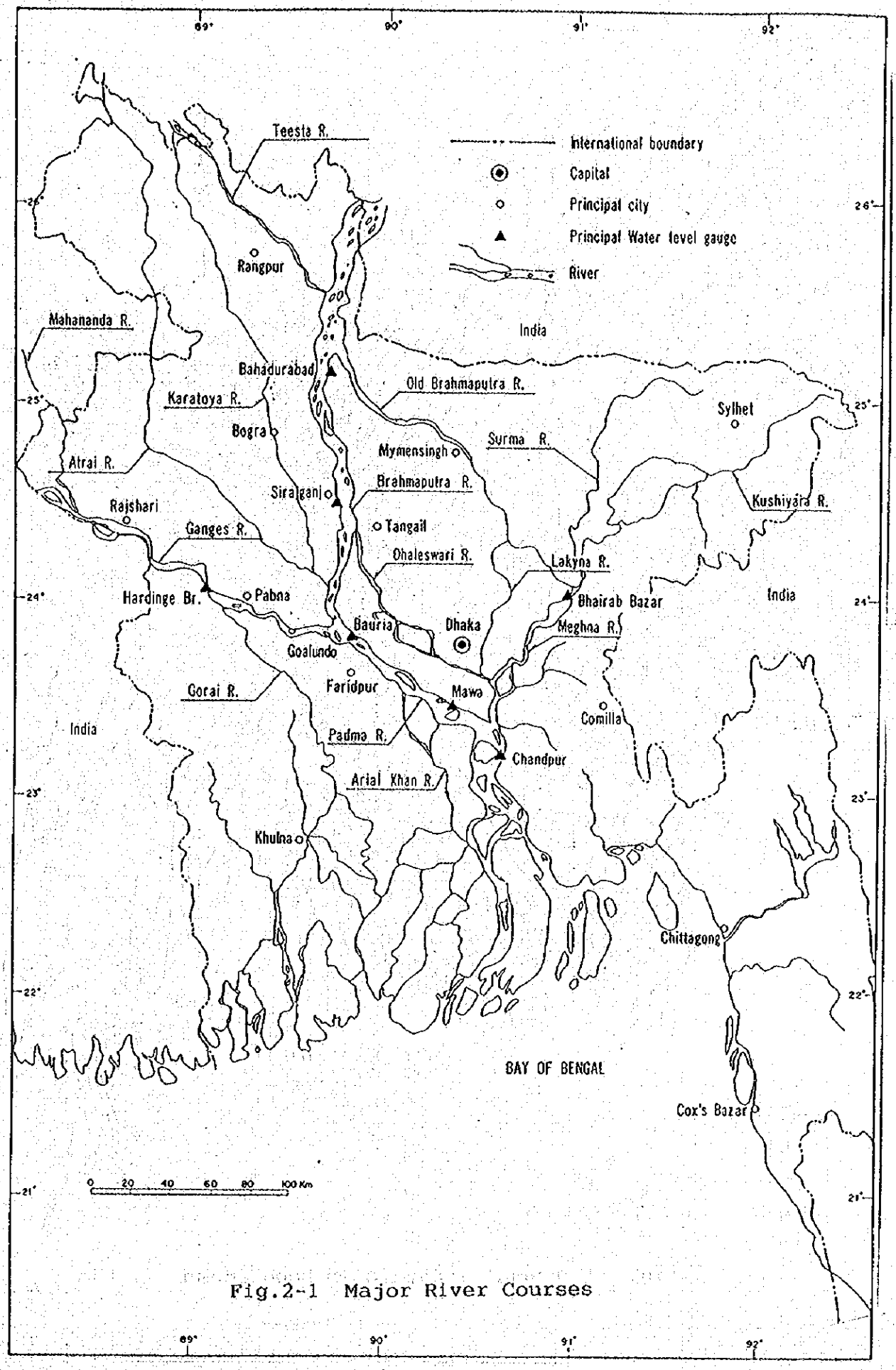


Fig.2-1 Major River Courses

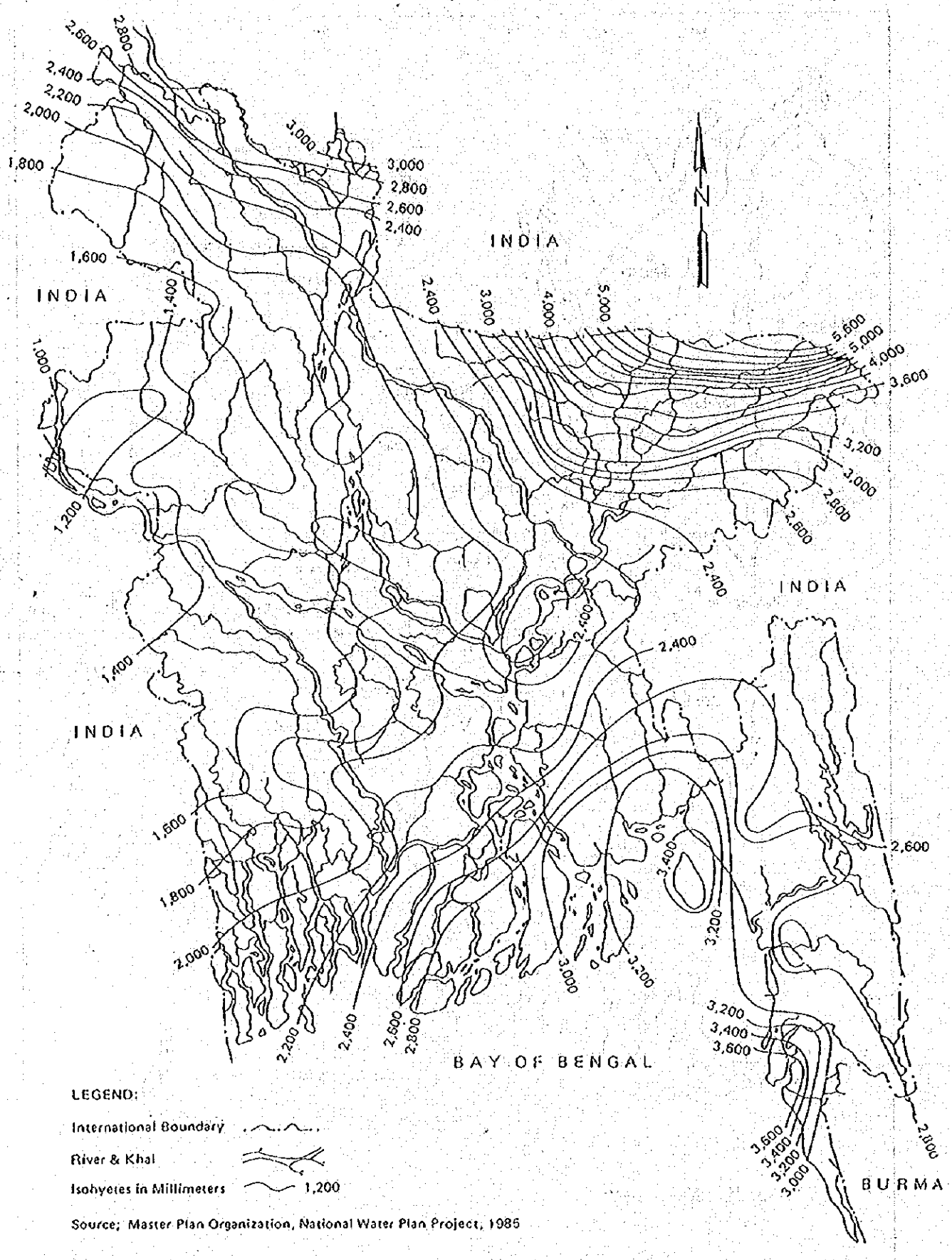


Fig.2-2 Annual Isohyets in Bangladesh

CHAPTER 3 EXISTING FLOOD FORECASTING AND WARNING SYSTEM

CHAPTER 3. EXISTING FLOOD FORECASTING AND WARNING SYSTEM

3.1 General

A separate Flood Forecasting and Warning project started operation from April, 1972, and an UNDP assisted project was implemented during the flood from October, 1980. With the implementation of the project, the following facilities are available for Flood Forecasting and Warning.

3.2 Existing Organization for Flood Forecasting and Warning

The organization of the existing FFWS is shown in Fig. 3-1 and Fig. 3-2.

3.3 Existing Facilities for Flood Forecasting and Warning

3.3.1 Hydrological observation network

(1) The existing wireless SSB network of 40 stations are operated for monitoring water-level and rainfall data from within the country. The network of this system is shown in Fig.3-5.

(2) The existing telemetering network of 4 water-level and 2 rainfall gauging stations is operated with the BWDB Maulvi Bazar control station. The network of this system is shown in Fig. 3-10.

(3) The existing hydrological radar is operated at Bangladesh Meteorological Department (BMD) building, Agargaon with Microwave link to Flood Forecasting Warning Center (presently through a dedicated telephone line).
This allows to view the movement of clouds over Bangladesh and the peripheral area such as Tipperah Hills and Meghalaya.

(4) The existing telemetering network of 4 rainfall gauging stations for the calibration of the above radar system are operated with the center station at BMD building. The network of this system is shown in Fig. 3-9.

(5) The data of related Indian area are available by the network of GTS. These data including hydraulic data are received at Flood Forecasting and Warning Center by the teleprinter system using T & T telephone network.

(6) Existing inter-relationship between different organizations is shown in Fig. 3-4.

3.3.2 Existing Facilities at FFWC and BMD

The equipment composition of FFWC is shown in Fig. 3-6.
The equipment composition of BMD is shown in Fig. 3-7

3.3.3 Existing Telephone Communication System

The schematic flow of existing radio telephone system is shown in Fig. 3-8.

LIST OF FIGURES (SECTION 3)

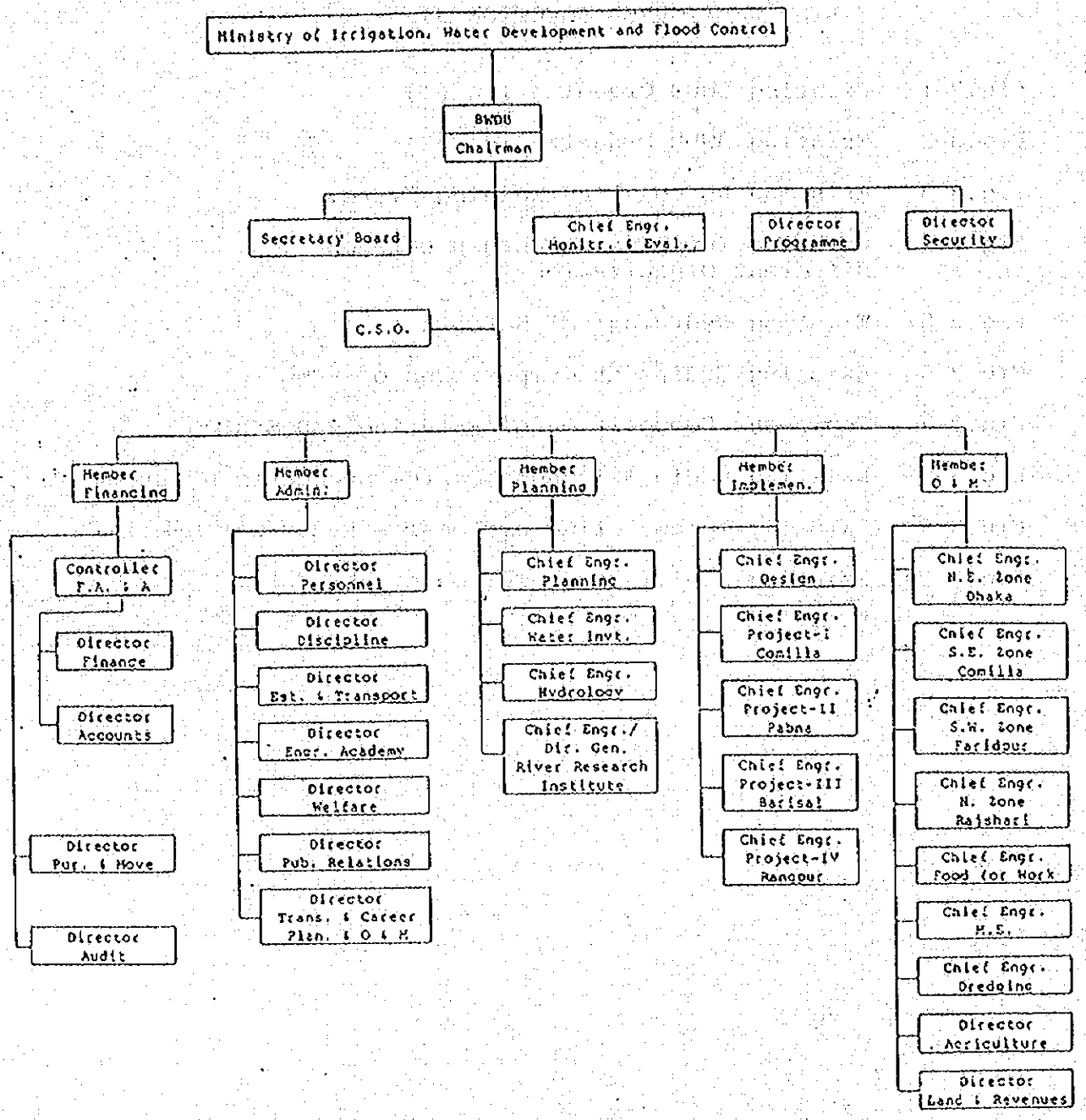


Fig.3-1 EXISTING BWDB ORGANIZATION (1)

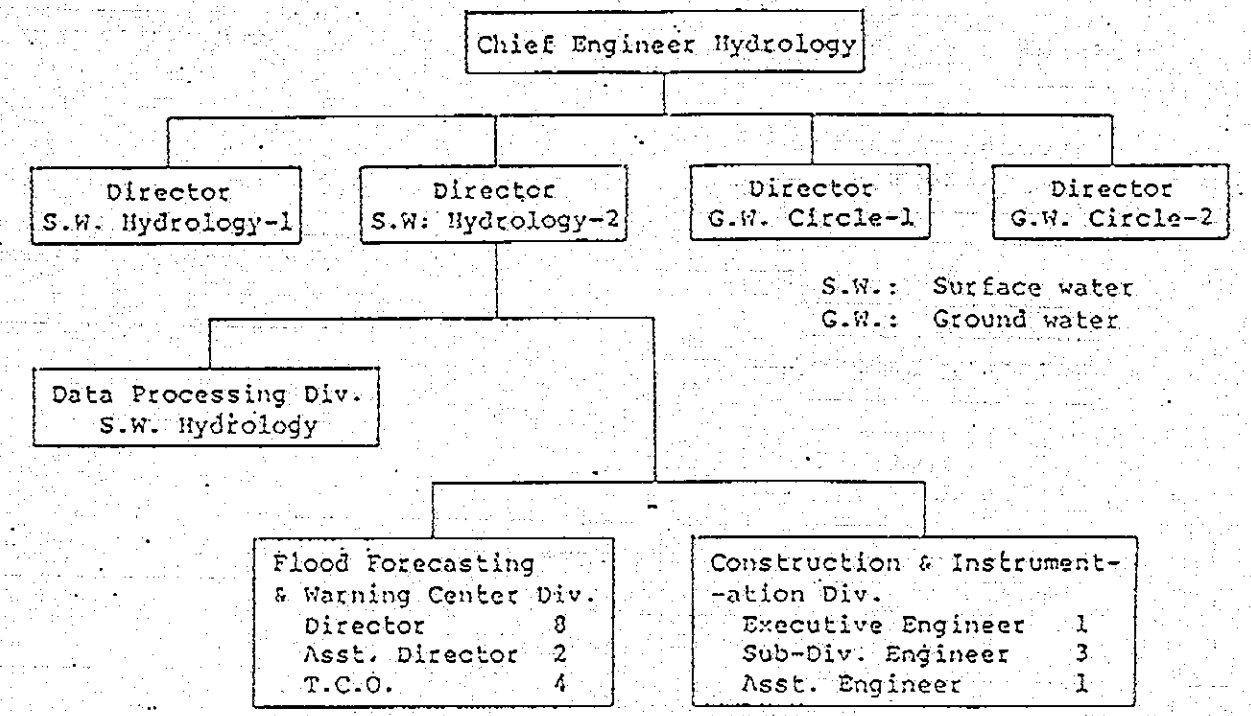


Fig.3-2 EXISTING BWDB ORGANIZATION (2)

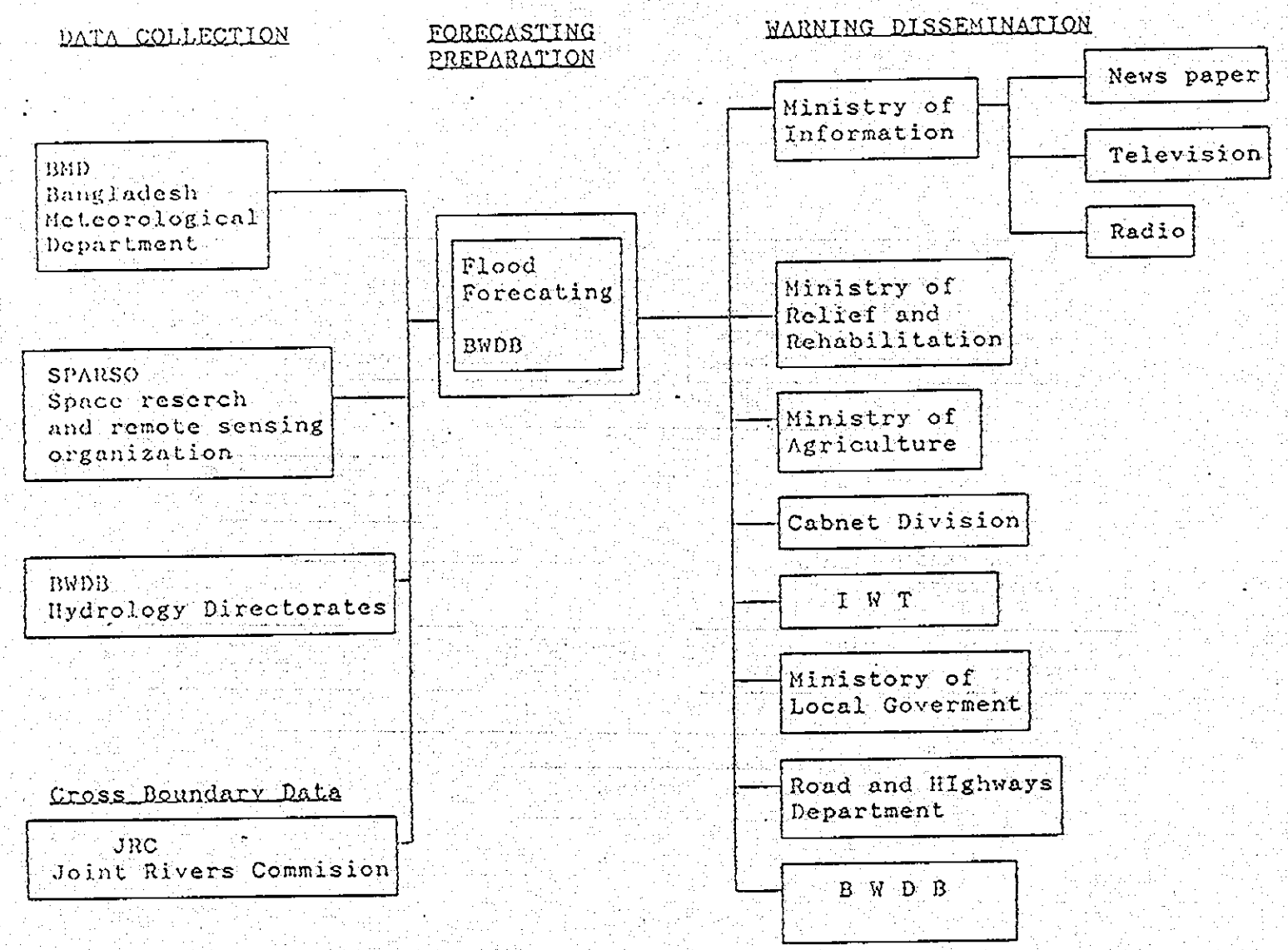


Fig.3-3 EXISTING FORECASTING AND WARNING SYSTEM

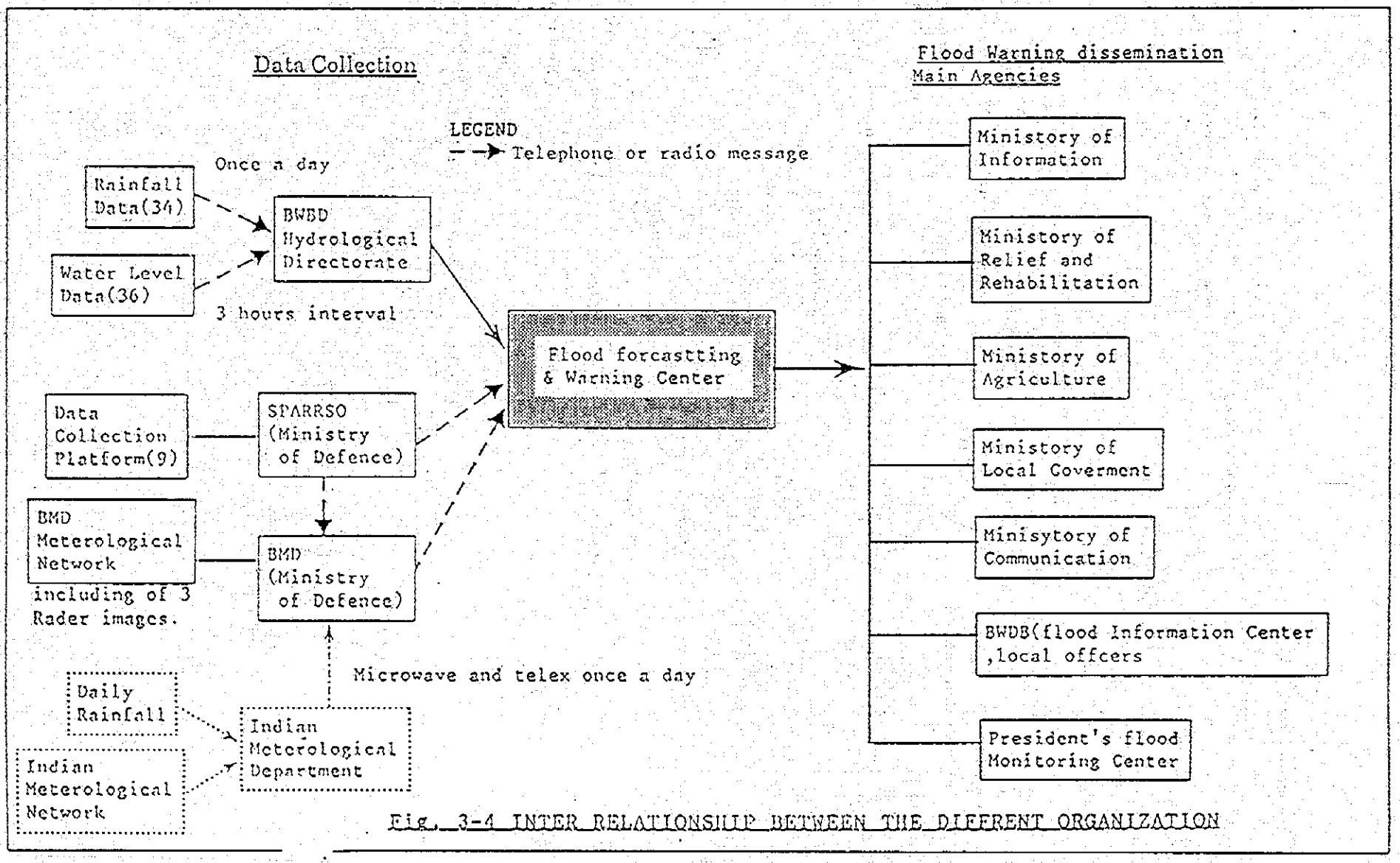


Fig. 3-4 INTER RELATIONSHIP BETWEEN THE DIFFERENT ORGANIZATION

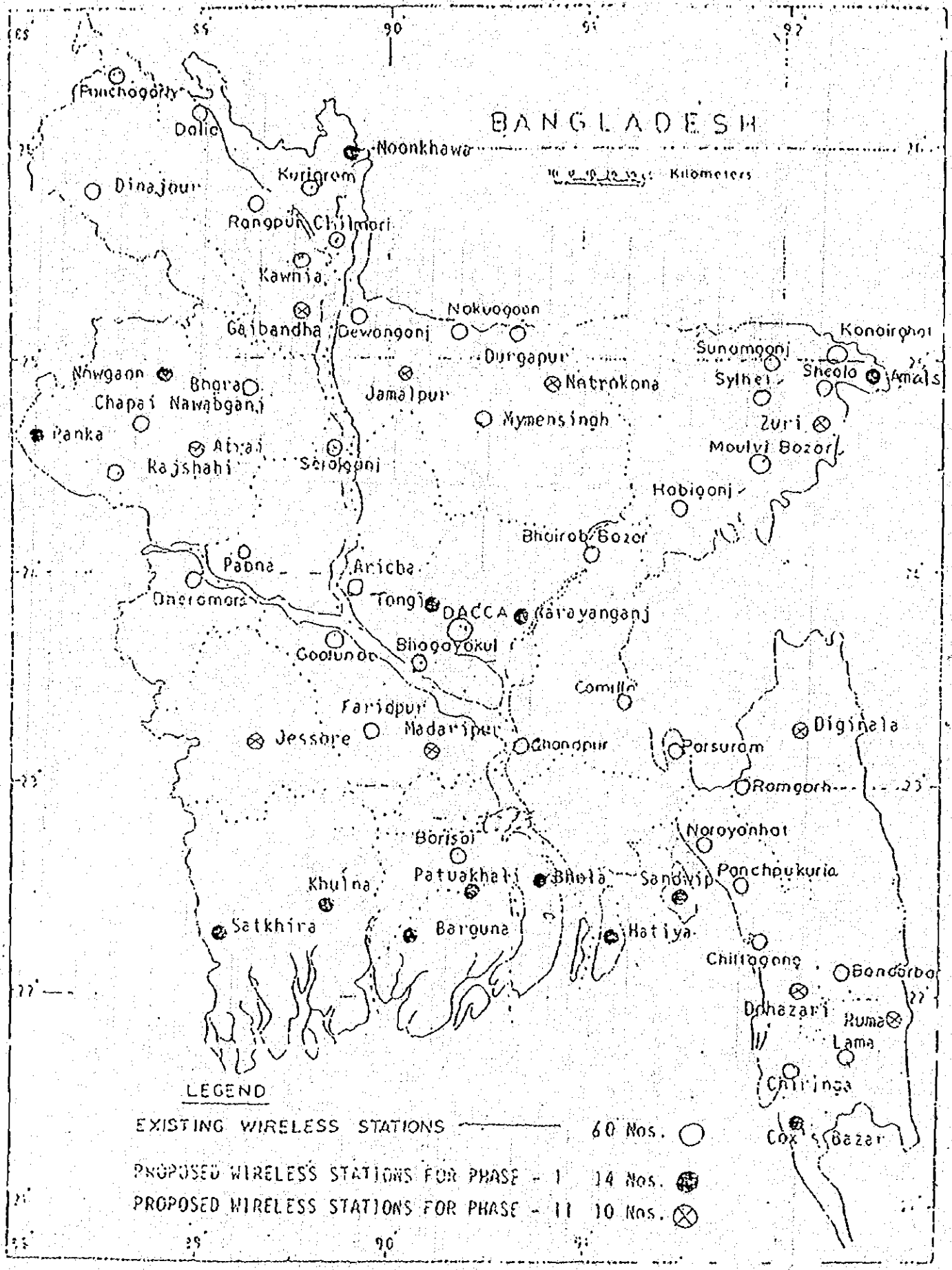


Fig.3-5 EXISTING HYDROLOGICAL NETWORK (SSB NETWORK)

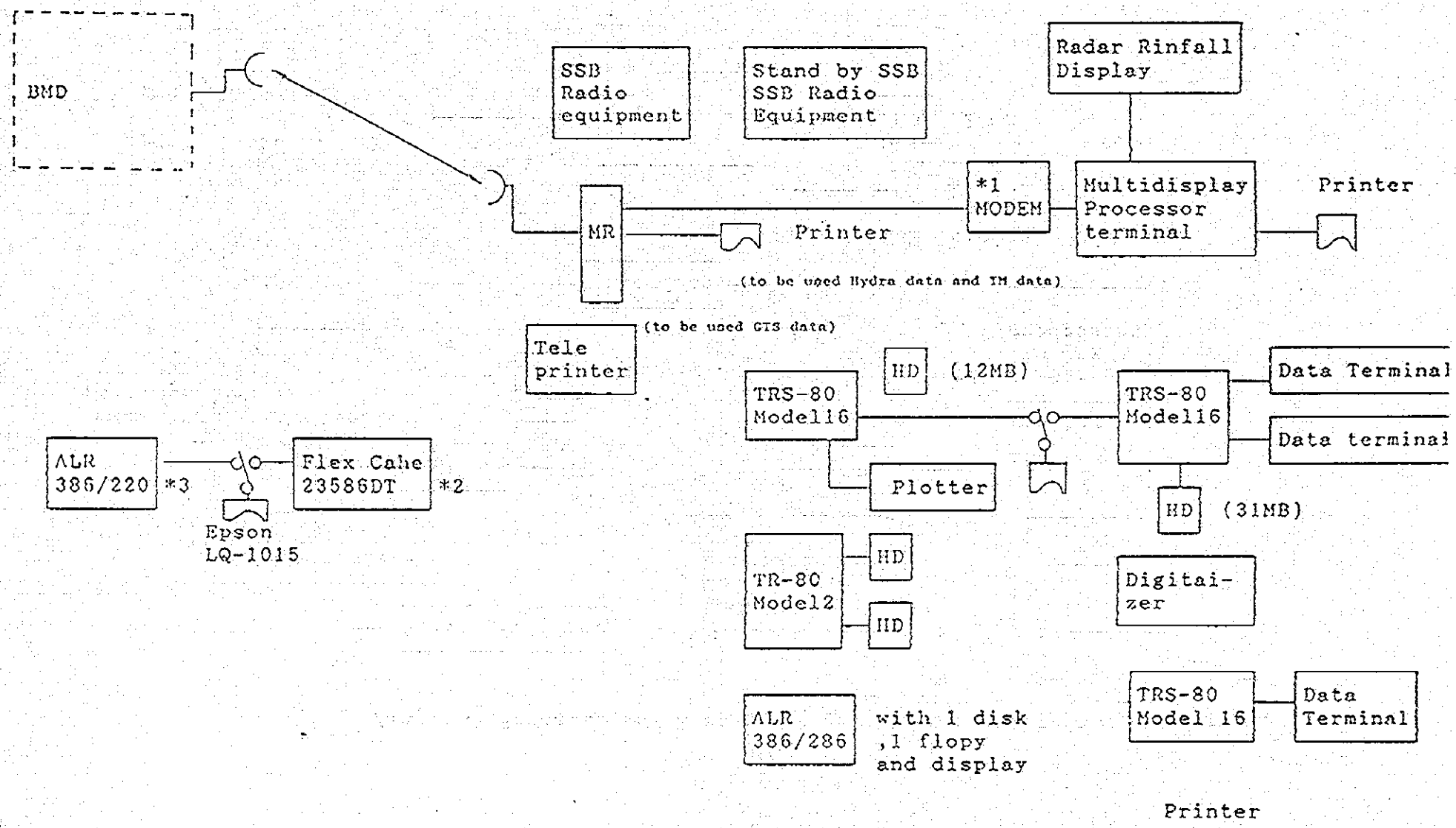


Fig. 3-6 EXISTING EQUIPMENT AT PFWC FLOOR(8F)

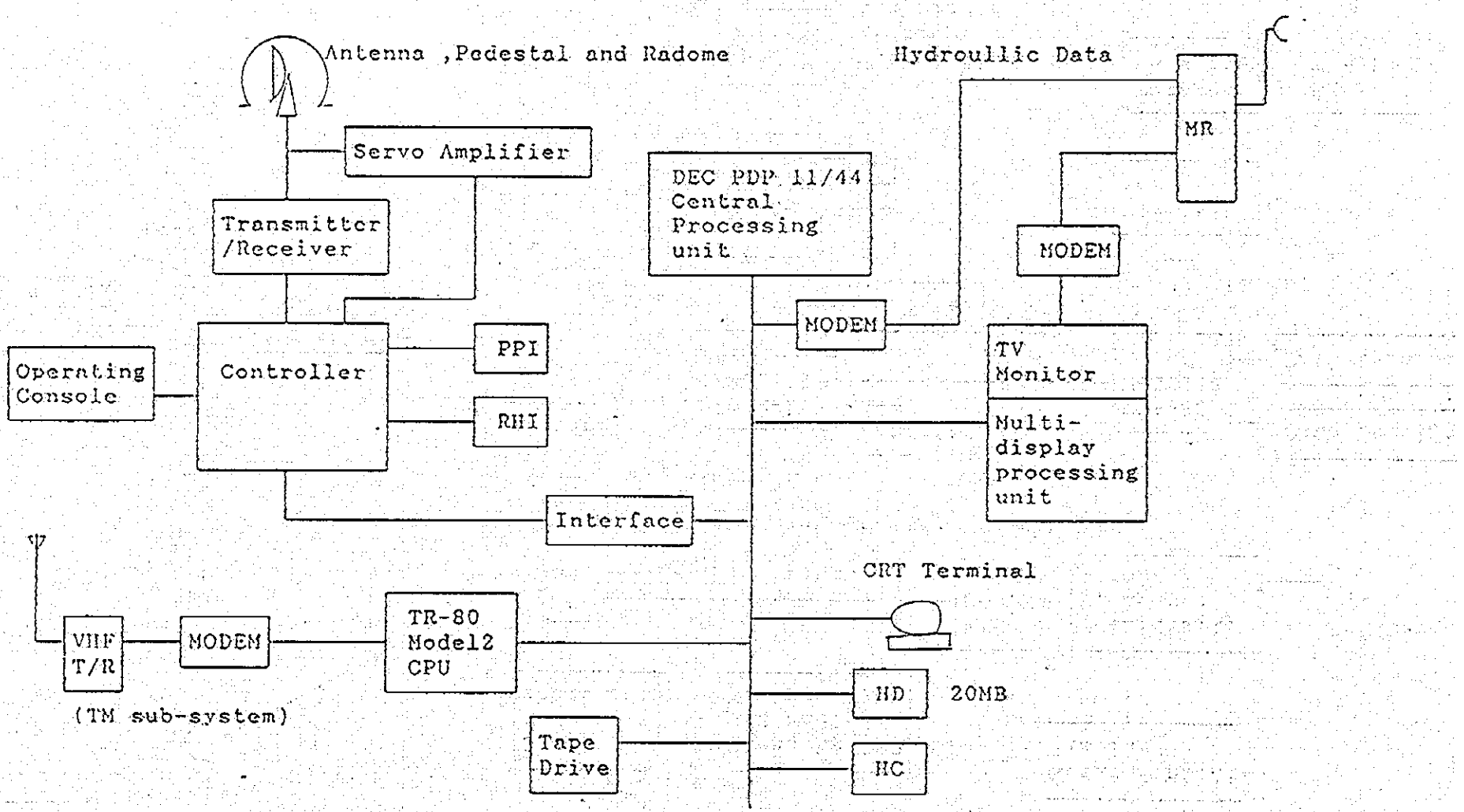
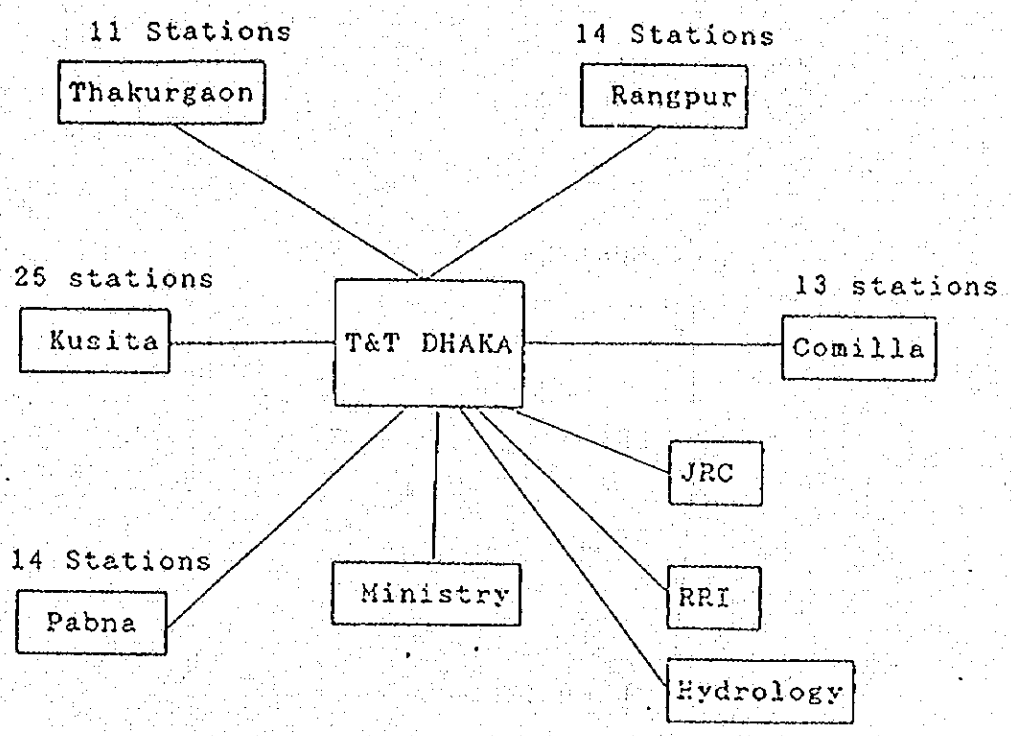


Fig. 3-7 EQUIPMENT COMPOSITION OF EXISTING BMD SYTEM

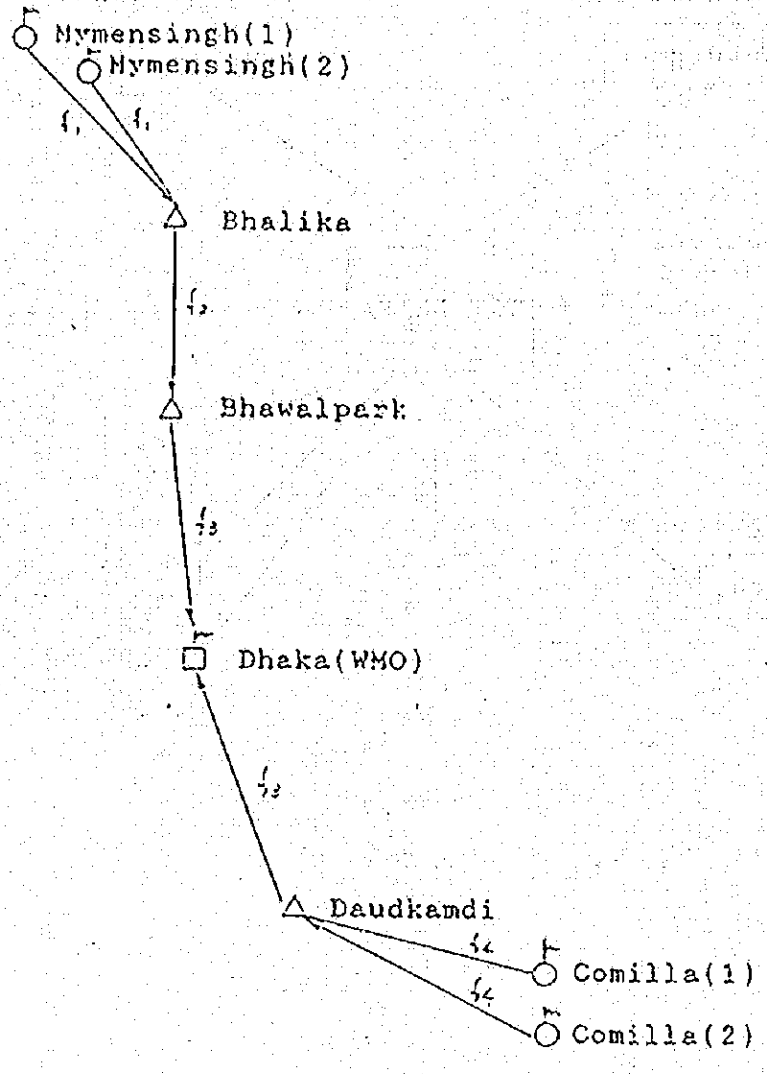


Legend

1. Network between each station above uses a hired exclusive T&T telephone circuit (1CH(4w) each).

2. Network between division office and local office uses a VHF(150MHz band) duplex radio network (each 6 CH).

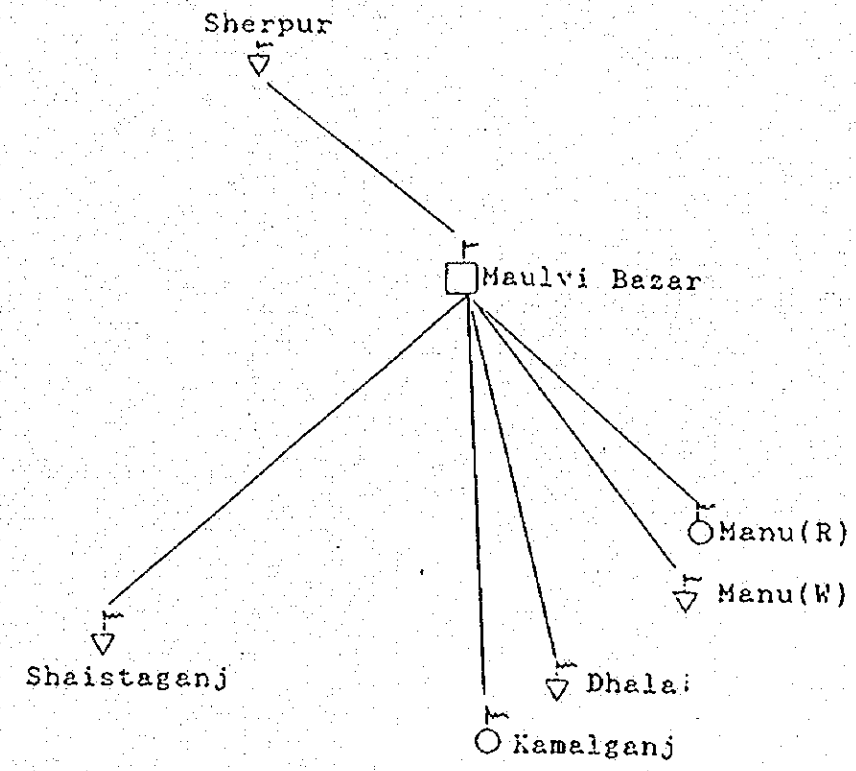
Fig. 3-8 Existing Radio Telephone System Schematic Diagram



LEGEND

- : Center station
- △ : Repeater station
- : Rainfall gauging station
- —: VHF radio simplex network (149,250 MHz)
  f1(170.3 MHz)/f2(166.075 MHz)/f3(169.00MHz)
  /f4(172.9000)

Fig. 3-9 EXISTING TELEMETERING SYSTEM FOR RADAR CALIBRATION



LEGEND

: Control station
: Water-level gauging station
: Rainfall gauging station
: VHF radio simplex network (149.250 MHz)

Fig. 3-10 EXISTING MAULVI BAZAR TELEMETERING SYSTEM

26

CHAPTER 4 CONTENTS OF THE STUDY

CHAPTER 4. CONTENTS OF THE STUDY

4.1 General

The Pilot Telemetry Network of the Flood Forecasting & Warning System of Bangladesh has been designed keeping in view the recommendations made by a specialist on the subject in a UNDP study in 1990.

The selection of the hydrological system for the Pilot Telemetry Network is the result of an extensive survey undertaken by the JICA team followed by detailed discussions with BWDB. The gauging station sites were selected after an extensive survey and examination of the hydrological and civil engineering conditions, telecommunications facilities and other relevant conditions. Various types of water-level and rainfall gauges were considered and the selection of the appropriate type was made taking into account the existing river conditions, ease of maintenance and serviceability. Detailed designs of the structural arrangements for the installation of the gauges, housing for the telemetry and associated equipment, antenna tower etc. were made.

Data collection systems were examined in detail and the Polling System was recommended for its advantage of high reliability, easy expansion capability, flexibility of operation and simple control for a complex nationwide telemetry system.

Data processing system was examined in detail and the processing functions of CCU and EWS were discussed.

The design requirements of the telecommunication network was formulated. A survey of the existing T&T multiplex network, communications and other associated equipment, facilities, premises etc. was conducted with the cooperation of BTTB officials and the suitability and possibility of their use for the Flood Forecasting & Warning System was determined. Radiowave propagation tests were conducted between the selected gauging station sites and the nearby T&T Microwave stations. The test results were analyzed in detail and the best partner T&T Microwave stations were determined for the dedicated VHF Radio Telemetry links.

The possibility of establishing a PCM Multiplex Digital Radio link between the T&T terminal in Dhaka and the FF&WC at WAPDA building was examined in detail and appropriate recommendations were made.

4.2 Formulation of Hydrological Gauging System

The Pilot Telemetry Network of the Flood Forecasting and Warning System of Bangladesh is based on a rough design made on the subject by a Japanese specialist in 1990 under a UNDP assisted project. In this study, 4 sites of rainfall and water-level telemetering stations and 5 sites of water-level telemetering stations were proposed for obtaining the data of upper reches in three major rivers, namely the Ganges, the Brahmaputra and the Meghna, and the data of the flood condition around the capital of Dhaka as shown below. These proposed sites are also shown in Figure 4-1.

Rainfall and Water-level Telemetering Station
-Pankha in the Pagla River not far from the effluent point with the Ganges
-Noonkhawa in the Brahmaputra
-Amalshid in the Kushiyara River of tributary of the Meghna
-Narayanganj around Dhaka area

Water-level Telemetering Station (around Dhaka area)
-Tongi
-Mirpur
-Savar
-Mill Barak
-Rekabi Bazar

In this phase the following work items shall be carried out for the detailed design of F.F.W Pilot System, based on hydrological and civil engineering study.

(1) Selection of Gauging Station Sites

In the design outline of the pilot system, the gauging sites were mainly based on the requests of the Bangladesh government. The finalized gauging sites shall be determined on the detailed site survey, considering the conditions for hydrology, civil work and telecommunication facilities.

(2) Selection of the Type of Gauging Instruments

Succeeding to the UNDP study in 1990, appropriate instruments to observe water-level and rainfall shall be determined taking the river conditions and ease of maintenance and repairing work into account.

(3) Detailed Design of Hydrological Gauging Station

Hydrological gauging system, including observation facility, gauging house and antenna tower, shall be designed for the detailed phase. This detailed design consists of civil engineering design, implementation plan and cost estimate.

4.3 Examination of Data Collection System

There are two kinds of data collection system : one is a "polling system in which measured data at a gauging station are sent out in response to a calling signal from the control station; and the other is a "event reporting system" in which measured data are sent out without any reference when a change of status takes place. In case of measured data being sent out when transmission of other data is in progress, the both sets of data will be neglected as improper information. Such possibility of sets of data overlapping each other will become high, if there are many gauging stations and/or a rain storm widely covers the nation wide basin. The principal features and differences of the polling and event reporting systems are summarized in the Table. 4-1.

The Polling system is recommended from the following advantages.

(1) High reliability of data collection.
(2) Possibility of incremented gauging stations.
(3) Possibility of arbitrary data collection.
(4) Possibility of individual calling anytime when required.
(5) Possibility of simple control for network of complex nation wide telemetering systems.

4.4 Examination of Data Processing System

The Data Processing System will consist of CCU, EWS and its peripheral equipment which will enable the processing of rainfall and water-level data gathered by the Telemetering system, and will have following functions :

(1) Processing Function of CCU

a. Input of rainfall, water-level and related data.

b. Primary processing and of input data for daily report and alarm judgment.

c. Printing of system status and maintenance required.

d. Backup of input data by MD (fixed time interval data for 10 days)

e. Distribution of the processed data.

(2) Processing function of EWS

a. Secondary processing of input data and data display.

b. Printing of daily, weekly,monthly and annual report.

c. Processing of input data for Flood Forecasting.

d. Data storage for statistical analysis calculation by using File Server.

e. Data storage for preservation using Cartridge Magnetic Tape (CMT).

(3) All telemetry system outputs should be compatible for direct linkages to the existing Local Area Network (LAN) of the Flood Forecasting and Warning Center.

4.5 Examination of Telecommunication Network

Design requirements for the telecommunication network of this system are as follows:

a. The network must be highly reliable ensuring the avail ability of accurate data for flood forecasting round the year,especially during the flooding season.

b. The gauging stations should be distributed nationwide.

c. The system must be easy and economic to maintain; spare parts should be easily available.

d. The system should be of a type which can be easily imple mented.

e. The system must have expansion capability.

Keeping in view the above design requirements and examining the existing telecommunications network of the country in de tail, the following was decided :

a. To install VHF Radio Telemetry links between the gauging stations and the nearest T&T UHF or Microwave stations, i.e.

Pankha gauging station --- Nawabganj T&T station
Jatrapur gauging station --- Kurigram T&T station
Zakiganj gauging station --- Beani Bazar T&T station
Existing Maulvi Bazar area gauging stations --- Maulvi-Bazar T&T station
Dhaka area gauging stations --- Dhaka (Ramna) T&T station.

The above T&T stations will, in effect, operate as Radio Telemetry Repeater stations

b. To use exclusive leased circuits from nationwide T&T Multiplex network between the remote T&T terminals and Dhaka (Ramna) Carrier terminal, i.e.

T&T Nawabganj terminal --- Dhaka (Ramna) Carrier termi nal
T&T Kurigram terminal --- Dhaka (Ramna) Carrier terminal
T&T Beani Bazar terminal --- Dhaka (Ramna) Carrier terminal
T&T Maulvi Bazar terminal --- Dhaka(Ramna) Carrier terminal

c. To install a PCM Multiplex (2 Mbit/s ; 30 channels) Digi-tal Radio link between Dhaka (Ramna) T&T station and FF&WC at WAPDA building.

The interface conditions between the T&T terminal equipment and the BWDB equipment at all stations must be based on CCITT recommendations.

Table 4-1(1)

ITEMS	Polling system	Event reporting system
1.Operation	This system is one in which the slave stations are called in sequence for data to be transmitted. The slave stations are activated by the master station call signal (Operation) Calling signal from master station Transmitted signal from slave station 1 Transmitted signal from slave station 2 Received signal at master station	A system in which the slave stations automatically transmit data to the master station when a preset time is reached. (according to the slave station timer). For instance, data is automatically transmitted each time a tipping bucket rain gauge tips, indicating that one 1mm of rain has fallen. (Operation sequence) Tipping bucket rainfall gauge Transmitted signal from slave station Received Signal at master station

Table 4-1 (2)

ITEMS	Polling system	Event reporting system
2.Transmission system	Half duplex system(Master station calls slave station to request data transmission.)	Unidirectional Transmission system Data is transmitted from slave stations (Depending on data transmission frequency and data quantity)
3.Transmission capacity	Applicable for one to a few dozen measurements per slave station.	Data transmission duration restricts the system capacity(about one or two measurements per slave station).
4.System scale	Maximum of about thirty slaves or more stations. (Larger systems are possible)	Suitable for up to ten slave stations(Depending on data transmission frequency and data quantity).
5.Reliability	Enhanced reliability is assured by redundancy and check functions.	Channel contention for data transmission cause loss of data.(Loss data station and frequency of data transmission.)
6.Application	Usable for large number of observation stations. Usable for collecting large quantity of data with enhanced reliability Usable for collecting specially time data (such as water-level). And collecting data as required.	A small number of stations. for systems with small quantities data and which can tolerate a certain amount of data loss. treating one mm of rainfall as an event makes the system well suited for rainfall observation.

Table 4-1 (3)

ITEMS	Polling system	Event reporting system
7.Expandability	Flexible:both the number of slave stations and data transmitted can be increased. Compatible with the event reporting function (transmission of rainfall start or warning water-level as an event, accompanied by a shortened polling interval).	Limited expandability due to a limitation on the number of stations and data quantity.
8.Transmission function	Half duplex system with press to talk function used for maintenance and emergency telephone calls.	No telephone communication function due to the un-directionality. if necessary, a transceiver system must be used
9.Installation	Station building is generally required. There are two types of installation:outdoor antenna tower installation and indoor installation.	The need for a station structure is eliminated by the use of the pole-type station, which decreases the installation period (with the exception of the water-level station, which requires installation of a water-level gauge).
10.Economy	High reliability of the system costs more, but it may be more economical in cases where large quantities of data are handled.	Total cost can be reduced when compared with a polling system, allowing the construction of a small and economical system.

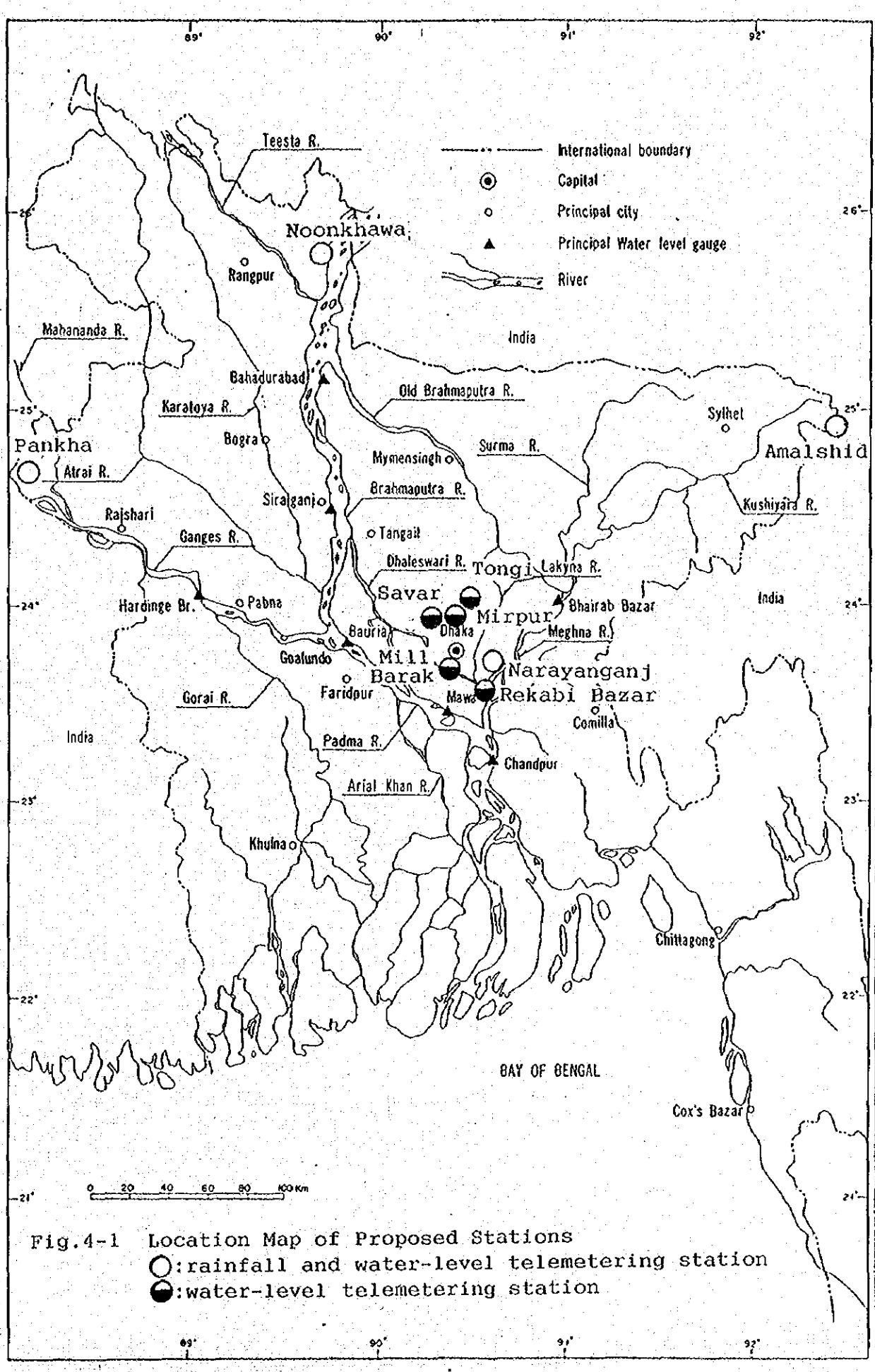


Fig.4-1 Location Map of Proposed Stations
○:rainfall and water-level telemetering station
◒:water-level telemetering station

CHAPTER 5 SITE SUEVEY RESULT OF TELECOMMUNICATION NETWORK AND SITE ALLOCATION

CHAPTER 5 SITE SURVEY RESULTS OF PROPOSED GAUGE SITES AND TELECOMMUNICATION NETWORK

5.1 Site Survey Results of Proposed Gauge Sites

5.1.1 Procedure of Survey

The gauge sites proposed in the UNDP report were inspected precisely in this detailed phase, and their tasked functions were precisely checked based on the collected hydrological data and river cross section survey result.

Site survey including river cross section survey was executed on the following program in 1991.

Site	River	Date
Pankha	Pagla (Effluent of Ganges)	June10,27
Jatrapur	Brahmaputra	June12,July15
Zakiganj	Kushiyara (Tributary of Meghna)	June16,July 4
Tongi	Tongi Khal(Tributary of Meghna)	June20,July24
Mirpur	Turag (Tributary of Meghna)	June20,July22
Nayarhat	Bangshi (Tributary of Meghna)	June20,July22
Mill Barak	Buriganga (Tributary of Meghna)	June20,July23
Narayanganj	Lakhya (Tributary of Meghna)	June21,July23
Rekabi Bazar	Dhaleswari(Tributary of Meghna)	June21,July23

At the respective site, suitable location to install and maintain the gauging station and rough design of the structural arrangement were discussed by and between JICA experts and BWDB counterparts, based on the hydrological and telecommunication condition.

After this site survey, yearly hydrographs at the equivalent staff gauges were collected and arranged to estimete the required gauging range for respective stations.

5.1.2 Proposed Type of Recorder

Float type gauge is preferably selected for the water-level gauges, however, pressure type gauge is also considered for adoption according to site condition. And tipping bucket type is selected for rainfall gauges. The reasons for recommendation are described below, and the detailed specifications of equipment are described in CHAPTER 7 .

(1) Water-level Gauge

In the UNDP report the following two type of water-level gauge was recommended.

- Float type gauge
- Pressure type gauge

Float type gauge, which has been used world wide, is a well-known direct measurement gauge by a float which is to be installed in a gauge well. This type is advantageous to wide range of measurement, high accuracy, applicability to any water-level measurement in natural rivers, reservoirs, lakes, etc..

Pressure type gauge measures a differential pressure between water and atmospheric pressure by utilizing the characteristics of quartz. The measuring range is 0 - 50 m, measurement accuracy is $\pm$0.1% for stilling water, and no limitation is required for the installation. However, the dynamic hydropressure, if existing, is not measurable. With a natural river flow which has such a high flow of velocity as 2 m or more, this type of gauge is not suitable since dynamic pressure is considerable. In case of adoption of pressure type gauge, the maintenance work to keep it in water is most important. And the cost of equipment is usually high in comparison with that of float type gauge.

In consideration of the above factors, great amount of siltation in respective rivers and easy maintenance work, float type gauge should be selected for measuring water-level. However, pressure type gauge has the advantage at sites where, for anticipated shifting of the channel, extension of the tube enables easy adaptation. Therefore pressure type gauge is also considered for adoption for paticular sites.

(2) Rainfall Gauge

In the UNDP report tipping bucket type was recommended for rainfall gauge. This type has been used world wide and also popular in Bangladesh. Therefore in this phase tipping bucket type is selected for the same reason.

5.1.3 Site Selection and Structural Arrangement

Site survey was executed as per the schedule shown in 5.1.1, and selected location of respective stations are shown in Table 5-1 and location map is shown in Appendix E. However, the final location of the gauging stations in each site may be changed to within 500 m of the selected points, if necessary with the approval of BWDB. Recorded water levels at the equivalent staff gauges, which are close to proposed sites,are shown in Table 5-2.

Structural arrangement of stilling well and gauging range is determined by reference to "Hydrological Observation, Ministry of Construction, Japan", in which criteria related to hydrological gauging stations is described on the basis of much experience of construction and maintenance work in Japan. Standard of stilling well and gauging range is shown as follows:

- -The bottom of stilling well shall be set up at least at 1 m below the lowest water level.
- -The top of stilling well shall be set up at 1.5 m above High Water Level / the recorded highest water level, or at 0.5 m above the top of embankment, this range means equivalently free board for a gauging station.
- -Inlet pipe shall be set up at least at 0.5 m below the lowest water level.
- -Diameter of inlet pipe shall be determined by various factors, in particular by easy maintenance work. However, section-area of inlet pipe may be empirically designed approximately 10 per cent of section-area of stilling well.

Regarding the site conditions, three type of stilling well supports is considered, namely, bank type, river type and bridge type.

- -On bank type, stilling well is laid under the river bank and supports itself with the weight of soil. River water comes into well through inlet pipe.

-On river type, trianglar piles shall support stilling well and river water comes into well through inlet pipe/hole.
-On bridge type, stilling well shall be fixed to bridge pier with connection work and river water comes into well from the bottom.

On the basis of these points, recorded water level and river cross section survey result and radio propagation survey result, structural arrangement can be summarized for respective stations as shown in Table 5-3. Proposed gauge site condition and required structural arrangement for respective stations are described below, and these are also summarized as shown in Figure 5-1 respectively.

(1) Pankha Station

This station is selected to obtain the information of flood on upstream of the Ganges River in the earliest stage.

Pankha is located along the left bank of the Pagla River, which is one of the effluents of the Ganges River. This area is classified as back swamp or delta according to the geomorphologic land classification.

Selected point is located at 12 km downstream from the off-take of the Pagla river,and also located at 300 m downstream from Pankha ferry ghat on the left bank in the Pagla River. At the time of site survey, the river flow was not connected with the Ganges River due to silting up at the upstream of the Pagla River.The water level at that time can be regarded as low water level of the Pagla River.

The gauging range at the Pankha station is approximately 9.0 m, which is the sum of 7.0m between low water level and bank, 1.5 m between bank and the top of embankment and 0.5 m as freeboard. One staff gauge should be installed to enable comparison of direct readings and the recorded stages.

At present the river bank is cultivated as farm land, it is noticed that soil erosion by "rain-cut" is occurring due to rainfall. Therefore, soil protection work such as compaction should be also carried out around station house in addition. Furthermore, bank erosion may be accelerated by disordered flow due to the influence of the stilling well. Bank protec-

tion work such as brick-revetment work should be carried out on the bank slope around the stilling well, i.e. each 10 m upstream and downstream from this point as usual. For installation of gauge house and antenna tower, land condition appears sufficient.

(2) Jatrapur Station

This station is selected to obtain the information of flood on upstream of the Brahmaputra River in the earliest stage.

Jatrapur is located along the right bank of the Brahmaputra River, and this area is classified as sandy alluvial fan with gentle slope according to the geomorphologic land classification.

Selected point is located at the Jatrapur Market, which is protected by spur dike, and also at 5 km downstream from Noonkawa staff gauge site which was proposed as a telemetering station in the UNDP report. Upper reaches of the Brahmaputra River in Bangladesh forms a braided channel, where the river courses are repeating divergence and confluence. Regarding this type of rivers, it is difficult to observe the water level for a long term during a whole year, i.e. from the lowest water level to the highest water level, due to the frequent change of river courses. And the major concern to select the location of gauging station is ability of bank stability against erosion. Therefore Jatrapur point is selected in expectation of the effectiveness of spur dike.

The gauge site is selected at the front of the spur dike, where the main flow exists at present. This point may enable observance of the water level during the whole year by the fixing type of gauge. Considering above-mentioned river condition,however, it is difficult to install the float type gauging station in the upper reaches of the Brahmaputra. On the other hand, pressure type gauge has the advantage in setting up the sensors at some points. Therefore,two sensors shall be set up,one is located at the front of the spur dike to observe the low water level, and the other is located at the front of upstream embankment at the spur dike to observe the high water level. The low water sensor should be removed during the flood season. For this site, the ceramic sensor is selected, because this sensor is more durable than the

quartz sensor. Furthermore one staff gauge should be installed to enable comparison of direct readings and recorded stages.

At this site maintenance work is very important for the continuous recording of the water-level, especially, the following items shall be given attention:

- -Maintenance of the riprap at the top of spur dike including reinforcement shall be executed continuously.
- -Inspection of the low water level sensor shall be done carefully, because the guide pipe of this sensor will be projected from the dike slope.
- -Inspection around the high water sensor and gauge house shall be done not to be crashed into this sensor by a boat and also not to be moored to the pole of the gauge house or antenna, during flood season.

Land condition is sufficient for installation of gauge house and antenna tower. But banking work behind the embankment is necessary for foundation of these structures.

(3) Zakiganj Station

This station is selected to obtain the information of flood on upstream of the Meghna River in the earliest stage. The river system of upper reaches in the Meghna River is complicated, therefore this information can be effective for the limited area, especially in northeastern part of the Sylhet District.

Zakiganj is located along the right bank of the Kushiyara River,which is a tributary of the Meghna River,and this area is classified as sandy alluvial fun with gentle slope according to the geomorphologic land classification.

Selected point is located at 200 m downstream from the junction of the Kushiyara River and the road from Zakiganj Market, where the protection work for Zakiganj is being carried out. This point is also located at 14.5km downstream from Amalshid staff gauge site which is located at effluent point of the Kushiyara and the Surma Rivers, and Amalshid site was proposed as a telemetering station in the UNDP report. Therefore one staff gauge should be also installed

as a check gauge at Zakiganj site.

Point bar has been formed between the junction and selected point. Along this bank, reverse flow is occurring because of river meandering, especially because of the influence of point bar. Therefore bank stability against erosion at this point can be expected more than the other points.

The gauging range is approximately 14.0 m, which is the sum of 13.5m between the recorded lowest water level and the top of embankment, and 0.5 m as free board. For installation of gauge house and antenna tower, leasing land or land acquisition and banking work behind the embankment will be required.

(4) Tongi Station

This station is selected to obtain the information of flood around Dhaka area in the earliest stage. Tongi is located 20 km north from Dhaka and along the Tongi Khal which is a tributary of the Meghna River. This area is classified as valley plain in the Maduhupur Jungle according to the geomorphologic land classification.

Selected point is located at the downstream side of the Tongi R&H Bridge.There are two bridges side by side.In order to connect the pier as foundation, downstream side pier is considered to be suitable,because the space for construction work can be easily obtained.

The gauging range is approximately 8.5m, which is the sum of 7.0 m between the recorded lowest water level and the recorded highest water level,and 1.5m as free board. Upstream side on right bank is appropriate for installation of gauge house and antenna tower. Earthwork will be conducted along the road, and on this flat land these structures will be constructed.

(5) Mirpur Station

This station is selected for the same purpose as Tongi station. Mirpur is located 10 km northwest from Dhaka and along the left bank of the Turag River which is a tributary of the

Meghna River. This area is classified as back swamp or delta according to the geomorphologic land classification.

Selected point is located at the downstream side on the third pier from the left bank of the Mirpur R&H Bridge.

The gauging range is approximately 9.0m, which is the sum of 8.5 m between the recorded lowest water level and recorded highest water level,and 0.5 m as free board.Upstream side on the left bank is appropriate for installation of gauge house and antenna tower. Earthwork will be conducted there, and on this flat land these structures will be constructed.

(6) Nayarhat Station

This station is selected for the same purpose as Tongi station. Nayarhat is located 30km northwest of Dhaka, and along the left bank of the Bangshi River which is a tributary of the Meghna River. This area is classified as back swamp or delta according to the geomorphologic land classification.

Selected point is located at the downstream side on the second pier from left bank of the Nayarhat R&H Bridge. This point is considerably more suitable to observe water-level than Savar point which was proposed as a telemetering station in the UNDP report. As the shape of the river cross section at Savar point is very flat, water-level may not be recorded during the whole year by float type gauge.

The gauging range is approximately 11.0m,which is the sum of 9.5 m between the recorded lowest water level and recorded highest water level,and 1.5m as free board. Upstream side on the left bank is appropriate for the installation of gauge house and antenna tower.

(7) Mill Barak Station

This station is selected for the same purpose as Tongi station. Mill Barak is located at the southeastern side of Dhaka, and along the left bank of the Buriganga River which is a tributary of the Meghna River. This area is classified as lower terrace of Maduhupur Jungle according to the geo-

morphologic land classification.

Selected point is located at the same position as the existing Mill Barak gauging recorder site. At this point the gauging recorder and telemetering system will be newly constructed.

The gauging range is approximately 9.0m, which is the sum of 7.5 m between the recorded lowest water level and recorded highest water level,and 1.5m as free board. For installation of gauge house and antenna tower, a plot of ground in Police Office is appropriate. Therefore land acquisition will be required.

(8) Narayanganj Station

This station is selected for the same purpose as Tongi station. Narayanganj is located 12.km southeast from Dhaka, and along the right bank of the Lakhya River which is a tributary of the Meghna River. This area is classified as natural levee according to the geomorphologic land classification.

Selected point is located close to the Narayanganj BWDB Dredger Office, and along the narrow ship canal.

The gauging range is approximately 8.0m, which is the sum of 6.5 m between the recorded lowest water level and recorded highest water level,and 1.5m as free board.Around this point there is no appropriate site to install gauge house and antenna tower. Therefore , this station must be designed to combine these structures with a stilling well.

(9) Rekabi Bazar Station

This station is selected for the same purpose as Tongi station. Rekabi Bazar is located 17 km southeast of Dhaka, and on the left bank of the Dhaleswari River, which is tributary of the Meghna River. This area is classified as natural levee according to the geomorphologic land classfication.

Selected point is the foundation of a transmission line in

the river, located about 200 m downstream of ferry ghat. The upstream side on this foundation is selected for Rekabi Bazar gauging site.

The gauging range is approximately 8.0m, which is the sum of 6.5 m between the recorded lowest water level and recorded highest water level,and 1.5m as free board. For installation of gauge house and antenna tower,this site is suitable. However, land acquisition will be required.

5.2 Radiowave Propagation Tests (150 MHz VHF Band)

The JICA team conducted Radiowave Propagation Tests between the selected hydrological gauging station sites and the nearby T&T UHF & Microwave stations. The tests were conducted by setting up a Radio link at 149.25 MHz between the gauging station site and the T&T station. The T&T station was termed as the Master station and the gauging station as the Field station. The equipment setup for the Master and the Field stations is shown in Appendix- E. The following measurements were conducted at the Master and Field stations :

a. Master Station Measurements

1. Measurement of the standard receiving input voltage level.

2. Measurement of the external noise field and recording it on chart paper.

3. Measurement of signal to noise ratio (S/N).

4. Measurement of the interference from adjacent channels (at least 1 MHz below and above 149.25 MHz) and other sources.

5. Determination of the exact location of the Master station using Global Positioning Satellite (GPS) receiver.

b. Field Station Measurements

1. Measurement of the standard receiving input level.

2. Measurement of external noise field and recording it on chart paper.

3. Measurement of signal to noise ratio (S/N).

4. Measurement of interference from adjacent channels (at least 1 MHz below and above 149.25 MHz) and other sources.

5. Measurement of horizontal directivity pattern.

6. Measurement of antenna vertical pattern.

7. Determination of the exact location of the Master station using Global Positioning Satellite (GPS) receiver.

The test results were analyzed in detail and the best partner T&T station for each gauging station was determined. The stability and reliability of the VHF Radio Telemetry link was the prime factor considered in determining the suitability of the partner T&T station. A summary of the test results is given in Tables 5-4 & 5-5

5.3 Survey of T&T Multiplex Network, Equipment, Facilities etc.

The JICA team conducted a survey on T&T Multiplex network, Communications and other associated equipment, facilities etc. in connection with the Flood Forecasting and Warning Pilot Telemetry project. The survey was conducted with the close cooperation of the officials of Bangladesh Telegraph & Tele phone Board. All the relevant T&T Microwave stations were visited for the purpose. The items surveyed and the results obtained are discussed below.

a. Survey of Multiplex Network, Equipment & Facilities

The following items were surveyed in detail in each T&T Micro-wave station.

1. Multiplex network details and the availability of spare channels from the respective T&T Microwave station to Dhaka terminal.

2. Communications and other associated equipment currently in use and their main features.

3. Antenna tower installations and the height at which BWDB antenna may be installed.

4. Existing Power Supply (AC & DC) and the possibility of its use by BWDB for its equipment.

5. Availability of space in the Equipment Room and the possi bility of its use by BWDB for the installation of its equip ment.

The result of the above survey is shown in Appendix - E

b. Possibility of Establishing a Multiplex Radio Link Between Mogh Bazar (Dhaka) and FF&WC at WAPDA Building.

The possibility of establishing a Multiplex Radio link T&T Mogh Bazar and FF&WC at WAPDA building was thoroughly investi gated. It may be mentioned here that the signals from and to the gauging statins such as Pankha (near Nawabganj), Jatra pur (near Kurigram), Zakiganj (near Beani Bazar) and the existing Maulvi Bazar Telemetering station, through dedicated VHF Radio Telemetry links and leased T&T Microwave circuits, would be made available at Dhaka (Mogh Bazar) Carrier termi nal. These signals are then required to be transmitted to the FF&WC at WAPDA building through a Multiplex link. Three possi bilities were investigated throughly

1. Direct Multiplex Radio link between T&T Mogh Bazar and WAPDA building.

2. Multiplex Radio link between T&T Mogh Bazar and WAPDA

building via a Passive Reflector or Repeater at T&T Ramna.
3. Use the existing Coaxial Cable link between T&T Mogh Bazar and T&T Ramna for transmitting the signals collected at T&T Mogh Bazar terminal to T&T Ramna terminal for onward transmission to FF&WC at WAPDA building by installing a Multiplex Radio link (2 Mbit/s PCM Multiplex Digital Radio System) between T&T Ramna and WAPDA building.

Visual inspection of the propagation path indicate that Options 1 and 2 are not very promising as the T&T Mogh Bazar antenna tower is almost completely blocked in the southern side by a new high-rise building (Century Tower) and direct line of sight propagation is possible only if the upper portion of the antenna tower is used. It is also feared that a high-rise building may come up in future in the commecial area and completely block propagation as it happened with the Microwave Radio link between BMD and WAPDA building. Moreover, the top portions of both Mogh Bazar and Ramna towers are filled with different types of antennas and the installation of a new antennas at the top is not recommended.

The third option of using the existing Coaxial Cable link between T&T Mogh Bazar and T&T Ramna appears to the best choice. Investigation with the cooperation of relevant BTTB officials has shown that a Group (12 channnels) or even a Super Group (60 channels) may now be used from this Coaxial cable link, if required. This has become possible due to the transfer of many circuits from this link to the newly installed Optical Fiber link between Mogh Bazar and Ramna terminals in connection with the Dhaka - Khulna Digital Microwave link.

Establishing a Multiplex Radio link between T&T Ramna and WAPDA building is relatively simple as direct line of sight propagation is possible. Visual inspection and Mirror tests using a strong bceam of focused light, conducted between T&T Ramna antenna tower and WAPDA building roof, bears testimony to this. The possibility of a new high-rise building coming up in the propagation path is very remote as there is only Bangabhavan in between. A Grid Parabolic antenna may be installed at a relatively lower height (50 m) in the T&T Ramna tower. The tower at this is quite free.

The result of Mirror tests conducted between T&T Mogh Bazar tower --- T&T Ramna tower, T&T Mogh Bazar tower --- WAPDA building roof and T&T Ramna tower --- WAPDA building roof is shown in Appendix. E

c. Yearly Leasing Fee of T&T Circuits

An approximate estimate of the yearly fee for leased T&T circuits was made. The charges are for the circuits from the remote T&T Carrier terminal to T&T Dhaka (Ramna) Carrier terminal. It may be mentioned here that at all T&T stations, signals from BWDB equipment will be terminated on the Voice

Frequency Distribution Frame (VDF) or Terminal Blocks (Tag Blocks) as is known here.

1. Charges per channel

Application Fee : Tk. 500.00

Installation Charge : Tk. 30,000.00

Microwave Circuit Charge : Tk. 1,400.00 per km per year

Minimum Circuit Charge : Tk. 150,000.00 per year

Yearly Leasing Fee for Dhaka --- Nawabganj (332.9 km)
: Tk. 466,060.00
Yearly Leasing Fee for Dhaka --- Kurigram (341.5 km)
: Tk. 478,100.00
Yearly Leasing Fee for Dhaka --- Beani Bazar (274.6 km)
: Tk. 346,640.00
Yearly Leasing Fee for Dhaka --- Maulvi Bazar (264.7 km)
: Tk. 370,580.00

Table 5-1 Selected Sites of Gauging Stations

Station	Location Name	Site	Gauge	
			Water Level	Rainfall
Pankha	Pankha ferry ghat	Long. 88:09:49 E Lat. 24:38:45 N	*	*
Jatrapur	Down of the Jatrapur Market	Long. 89:43:55 E Lat. 25:47:43 N	*	*
Zakiganj	Zakiganji town	Long. 92:21:54 E Lat. 24:52:39 N	*	*
Tongi	Tongi R&H bridge	Long. 90:24:03 E Lat. 23:52:52 N	*	
Mirpur	Mirpur R&H bridge	Long. 90:20:12 E Lat. 23:46:58 N	*	
Nayarhat	Nayarhat R&H bridge	Long. 90:13:51 E Lat. 23:54:42 N	*	
Mill Barak	BWDB auto-gauge station	Long. 90:25:14 E Lat. 23:41:58 N	*	
Narayanganj	Near BWDB Dredger Office	Long. 90:30:44 E Lat. 23:37:50 N	*	*
Rekabi Bazar	Mukhtarpur ferry ghat	Long. 90:31:02 E Lat. 23:34:18 N	*	

Legend: * : To be installed

Table 5-2
Recorded Water Level by Existing Gauge near the Proposed Sites

Proposed Site	Existing Gauge	RHWL (m)	AMWL (m)	RLWL (m)	Recorded Period
Jatrapur	Noonkhawa	28.100 (29/8/88)	24.457 22.535	19.980 (30/1/90)	1962-1989 (26years)
Zakiganj	Amalshid	17.910 (1/8/89)	11.819 9.650	6.020 (16/3/79)	1977-1989 (13years)
Tongi	Tongi	6.900 (22/8/87)	3.244 2.789	0.530 (27/2/84)	1979-1989 (9years)
Mirpur	Mirpur	8.350 (4/9/88)	3.494 2.963	0.480 (21/2/86)	1977-1989 (11years)
Nayarhat	Nayarhat	9.900 (3/9/88)	4.038 3.336	1.060 (23/2/86)	1977-1989 (13years)
Mill Barak	Mill Barak	7.580 (4/9/88)	3.301 2.859	0.390 (20/2/86)	1977-1989 (11years)
Narayanganj	Narayanganj	6.413 (5/9/88)		0.378 (26/2/84)	1981-1990 (10years)
Rekabi Bazar	Rekabi Bazar	6.430 (3/9/88)	3.143 2.862	0.470 (20/2/86)	1983-1989 (7years)

Legend: RHWL:Recorded Highest Water Level
( ):Date
AMWL:Annual Mean Water Level
upper row:Highest value
lower row:Lowest value
RLWL:Recorded Lowest Water Level
( ):Date

Table 5-3 Structural Arrangement of Gauging Stations

Station		Stilling Well			Inlet Pipe	Antenna		Staff
Name	Type	Support Type	Height (m)	Diameter (mm)	Diameter (mm)	Type	Height (m)	Gauge
Pankha	Separate	River	10.0	900	305	Tower	20	Install
Jatrapur	Separate	(Pressure)	-	-	-	Pole	15	Install
Zakiganj	Separate	River	14.8	900	305	Tower	30	Install
Tongi	Separate	Bridge	8.5	600	-	Pole	15	-
Mirpur	Separate	Bridge	10.0	600	-	Pole	15	-
Nayarhat	Separate	Bridge	11.0	600	-	Pole	15	-
Mill Barak	Separate	River	10.2	900	305	Pole	10	-
Narayanganj	Combine	River	9.0	900	305	Pole	15	-
Rekabi Bazar	Separate	River	9.0	900	305	Pole	15	Install

Table5-4Summary of 150 MHz band Radiowave Propagation Tests

Test Span	Transmitting Power (W)	Distance (km)	Gauging Station antenna height (m)	Partner T&T Station antenna height (m)	Received input Voltage (dBμV)	Remarks
T & T Rajshahi - Pankha	10.0	53.0	10.0	60.0	14.0	
T & T Nawabganj - Pankha	10.0	13.0	10.0	30.0	32.5	
T & T Rangpur- Jatrapur	10.0	48.6	10.0	60.0	18.0	
T & T Kurigram - Jatrapur	10.0	17.0	10.0	30.0	50.0	
T & T Sylhet - Amalshid	10.0	61.0	10.0	30.0	5.0	
T & T Beani Bagar - Amalshid	10.0	33.7	10.0	30.0	17.0	
T & T Maulvi Bazar -BWDB Maulvi Bazar	10.0	1.0	10.0	60.0	65.5	
T & T Maulivi Bazar - Shaistaganj	10.0	38.0	10.0	60.0	25.0	Monitoring data of
T & T Ramna - Nayarhat	10.0	27.7	10.0	78.5	25.0	Existing System
T & T Ramna - Mirpur	10.0	10.0	10.0	78.5	43.0	- do -
T & T Ramna - Narayanganj	10.0	14.7	10.0	78.5	32.0	
T & T Ramna - Rikabi Bazar	10.0	20.1	10.0	78.5	33.0	
T & T Ramna - Milbarrak	10.0	2.9	10.0	78.5	58.0	
T & T Ramna - Tongi	10.0	17.4	10.0	78.5	22.0	
T & T Mogh Bazar - Nayarhat	10.0	25.6	10.0	30.0	19.0	
T & T Mogh Bazar - Mirpur	10.0	8.2	10.0	30.0	42.0	
T & T Mogh Bazar - Narayanganj	10.0	16.8	10.0	30.0	11.5	
T & T Mogh Bazar - Rikabi Bazar	10.0	22.5	10.0	30.0	5.0	
T & T Mogh Bazar - Milbarrak	10.0	5.6	10.0	30.0	14.0	
T & T Mogh Bazar - Tongi	10.0	14.7	10.0	30.0	22.0	
T & T Mogh Bazar - Nayarhat	10.0	25.6	10.0	60.0	19.0	
T & T Mogh Bazar - Mirpur	10.0	8.2	10.0	60.0	42.0	
T & T Mogh Bazar - Narayanganj	10.0	16.8	10.0	60.0	36.0	
T & T Mogh Bazar - Rikabi Bazar	10.0	22.5	10.0	60.0	-	
T & T Mogh Bazar - Milbarrak	10.0	5.6	10.0	60.0	43.0	
T & T Mogh Bazar - Tongi	10.0	14.7	10.0	60.0	22.0	
WAPDA Building - Navarhat	10.0	28.5	10.0	30.0	0.0	

* Very high interference from Police Communications and other Sources at 149.25 MHz at Mogh Bazar T&T station. Therefore, this station is not recommended to be used as a Radio Telemetry Repeater station.

* Extreme interference from various sources in the WAPDA building site at 149.25 MHz did not allow the reception of any signal from Nayarhat. Consequently, this station is not recommended to be used as a Radio Telemetry Repeater station.

Table-1-1JICA/FFWTPS

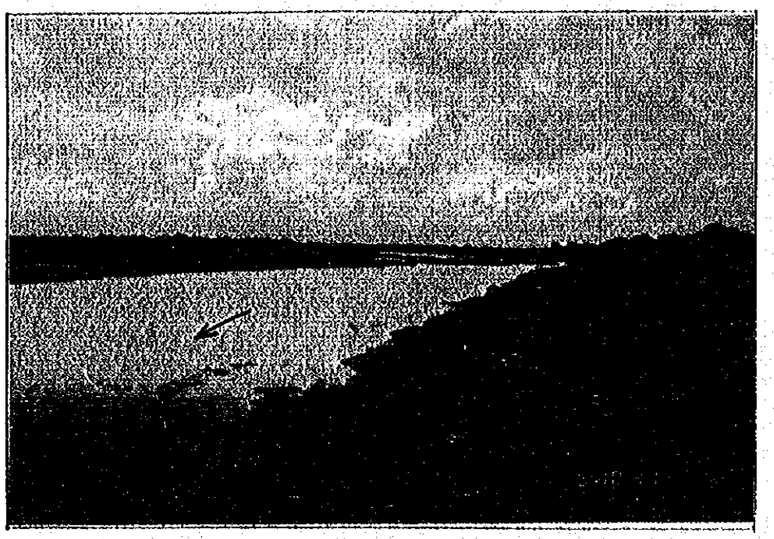
Table5-5Summary of 150 MHz Band Radiowave Propagation Tests

Gauging Station Name	Transmitting Power (W)	Antenna Used	Partner Station Name	Antenna Used	Received Input Voltage (dBμV)	Signal to Noise Ratio S/N (dB)	S/N at Fading (dB)	Judgement
Pankha	10.0	8 Element Yagi	T & T Rajishahi	3 Bay Collinear	11.2	29.2	20.8	No Good
Pankha	10.0	3 Element Yagi	T & T Nawapganj	Sleeve	36.8	Over 50.5	Over 50.5	Good
Jatrapur	10.0	8 Element Yagi	T & T Rangpur	3 Bay Collinear	12	30.0	22.1	No Good
Jatrapur	10.0	3 Element Yagi	T & T Kurigram	Sleeve	43.5	Over 50.0	Over 50.5	Good
Zakinganj	10.0	8 Element Yagi	T & T Sylhet	3 Bay Collinear	10.4	28.4	20.3	No Good
Zakinganj	10.0	3 Element Yagi	T & T Beani Bazar	5 Element Yagi	22.0	40.0	34.8	Good
Nayarhat	10.0	3 Element Yagi	T & T Ramna	3 Bay Collinear	28.6	46.6	41.3	Good
Mirpur	10.0	3 Element Yagi	T & T Ramna	3 Bay Collinear	43.6	Over 50.0	Over 50.5	Good
Narayanganj	10.0	3 Element Yagi	T & T Ramna	3 Bay Collinear	35.8	Over 50.0	49.3	Good
Rikabi Bazar	10.0	3 Element Yagi	T & T Ramna	3 Bay Collinear	33.8	Over 50.0	46.8	Good
Millbarrak	10.0	3 Element Yagi	T & T Ramna	3 Bay Collinear	58.8	Over 50.0	Over 50.5	Good
Tongi	10.0	3 Element Yagi	T & T Ramna	3 Bay Collinear	23.1	41.1	36.3	Good

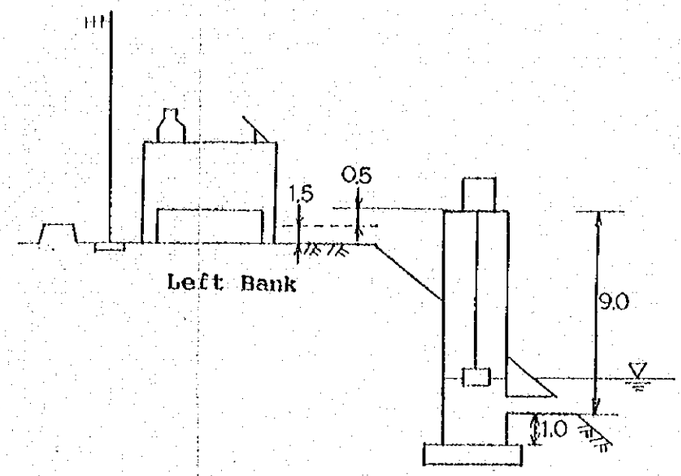
* For a stable and reliable Radio Telemetry Link the following requirements should be met.

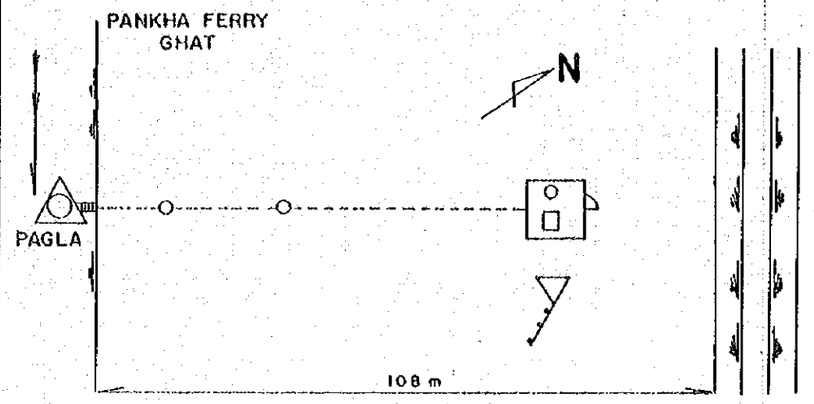
a) Signal to Noise Ratio (S/N) : More than 40 dB

b) S/N at Fading : More than 30 dB

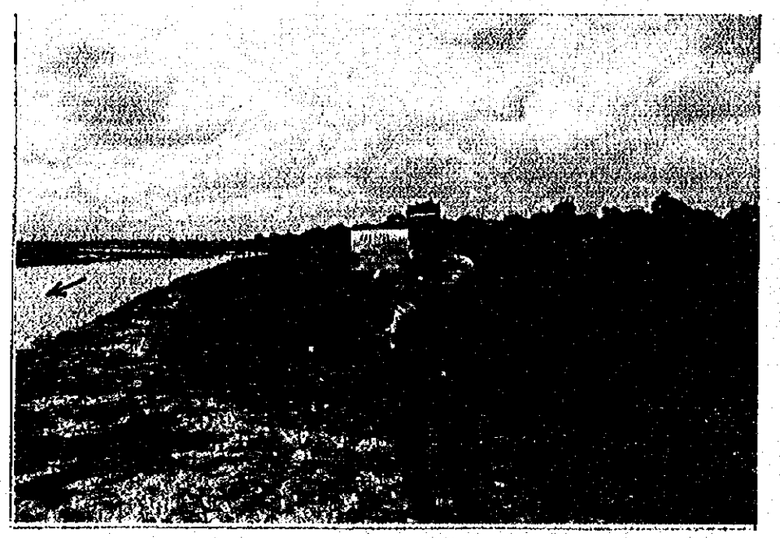


View of Gauge Site





Location Plan for Structures



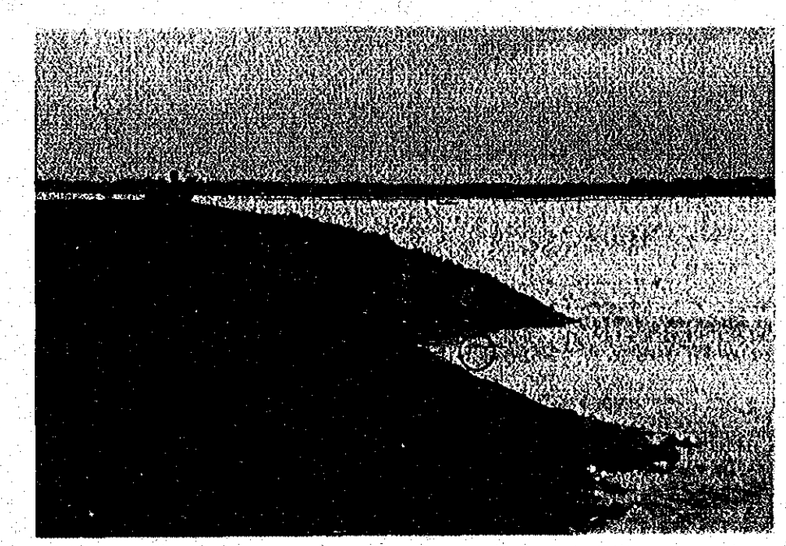
View of Station House Site

Description of Site Condition

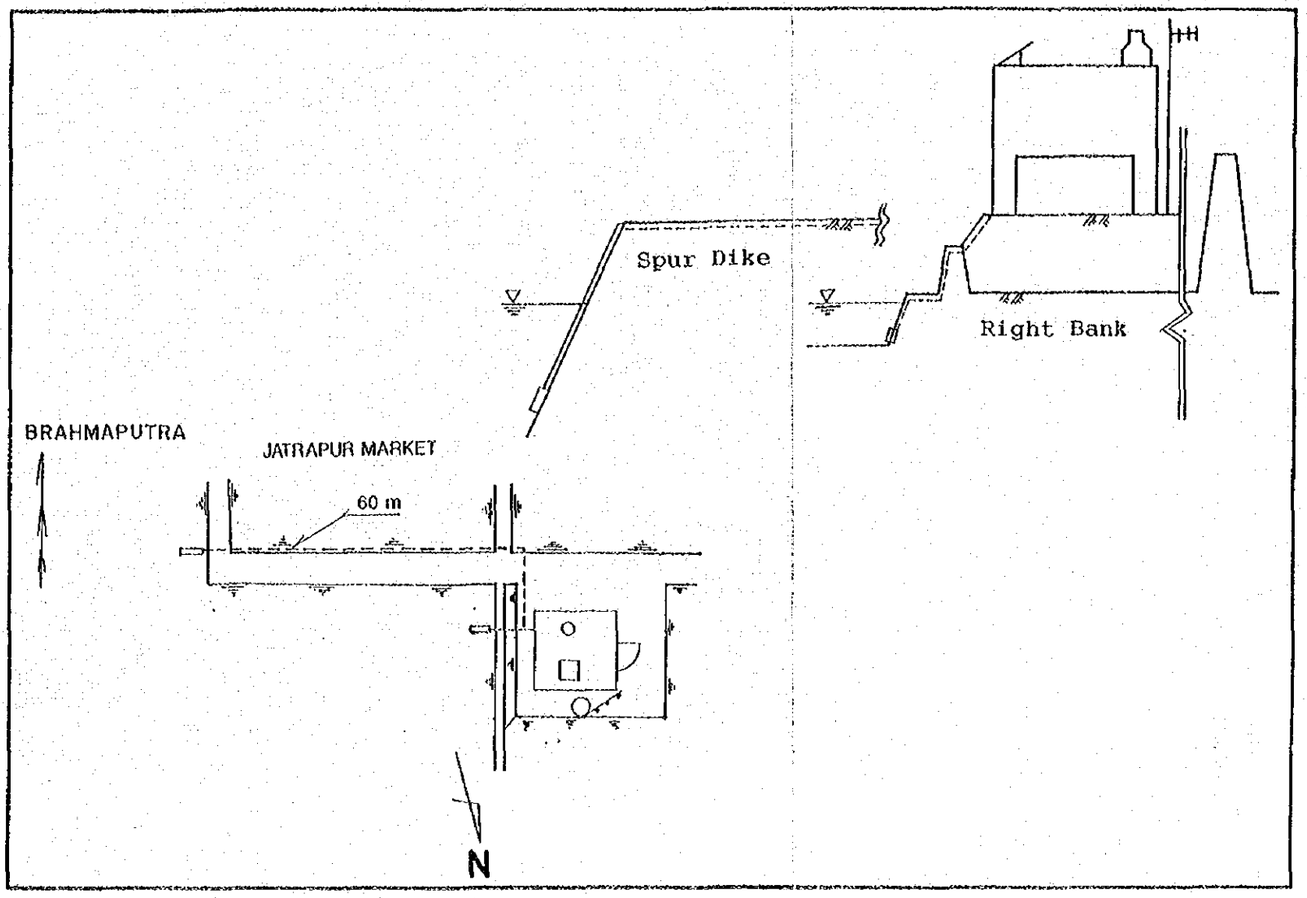
Pankha gauge site is selected at 300m downstream of Pankha ferry ghat on the left bank of the Pagla River. This site is located in the middle of the straight part of the river channel where the flow is steady and therefore,this site is suitable for the installation of hydrological gauging station.

Figure 5-1 Site Survey Result of Gauge Sites

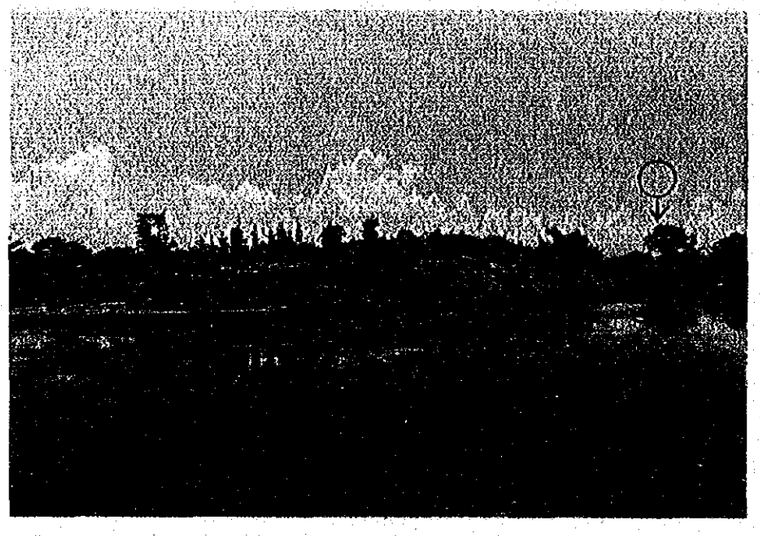
(1) Pankha Site



View of Gauge Site



Location Plan for Structures



View of Station House Site

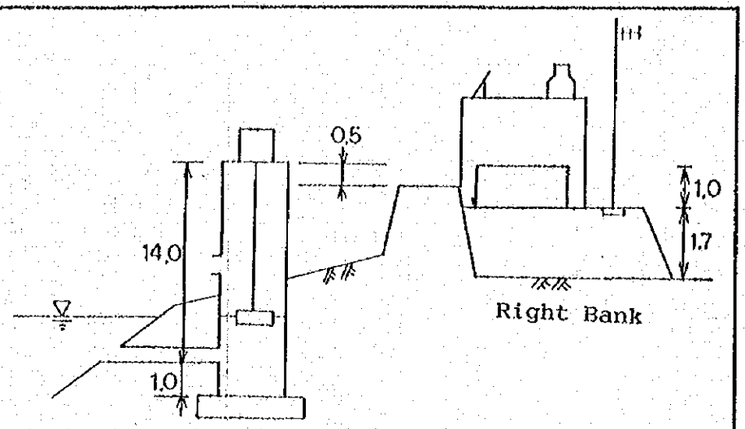
Description of Site Condition

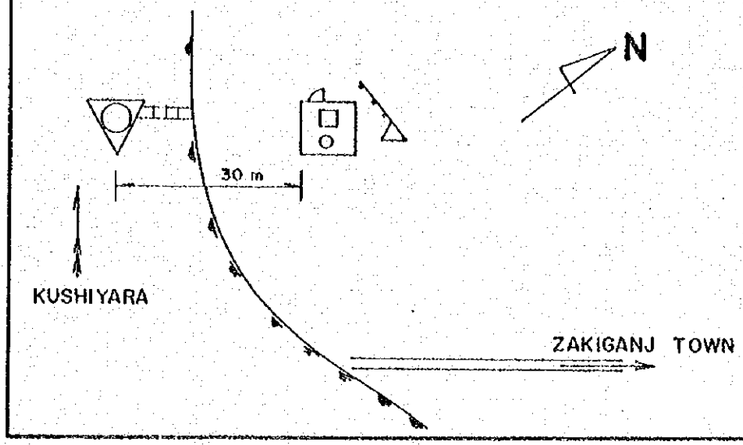
Jatrapur gauge site is selected at Jatrapur Market on the right bank of the Brahmaputra River. This area is protected by spur dike,accordingly,the bank at this site is more stable than the Noonkhawa site which was proposed as a gauge site in the UNDP report.
Upper reaches of the Brahmaputra River forms a braided channel, where the river courses are repeating divergence and confluence. For antcipated shifting of the channel, pressure type gauge is selected because of the advantage in setting up the sensors at some points. One gauge shall be set up at the front of the spur dike,and the other shall be set up on the upstream embankment.

Figure 5-1 Site Survey Result of Gauge Sites

(2) Jatrapur Site

View of Gauge Site





Location Plan for Structures

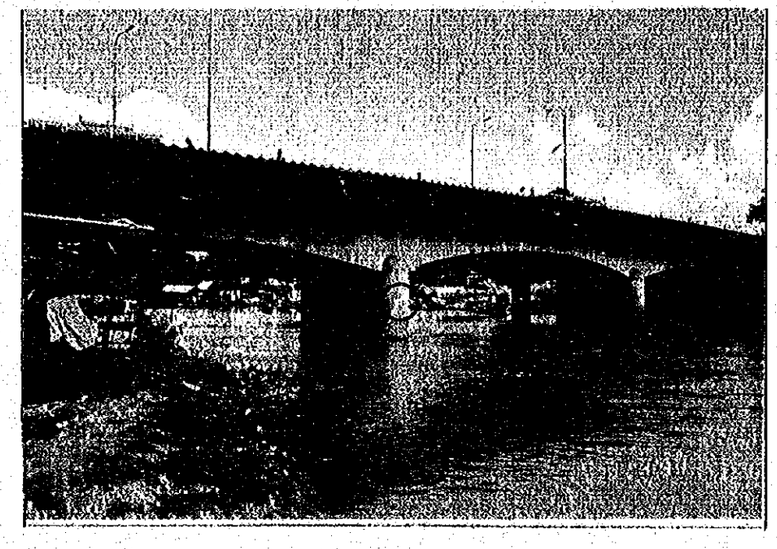
View of Station House Site

Description of Site Condition

Zakiganj gauge site is selected at 200m downstream of the junction of the Kushiyara River and the road from Zakiganj town, where the protection work for Zakiganj is being carrried out. This site is located at the downstream of point bar, accordingly, the bank of this site is expected to be more stable than the other sites around this area and the Amalshid site which was proposed as a gauge site in the UNDP report.

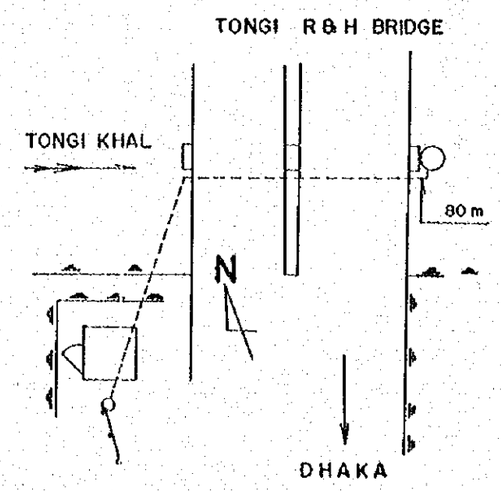
Figure 5-1 Site Survey Result of Gauge Sites

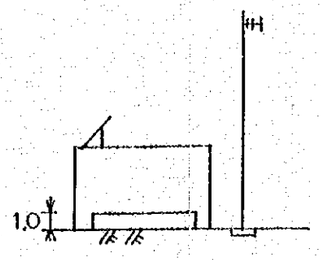
(3) Zakiganj Site

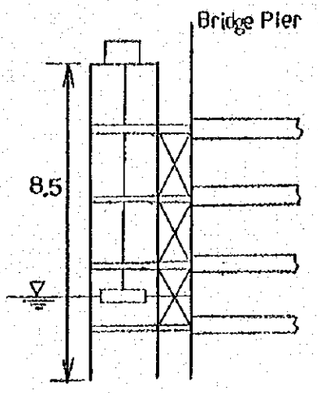


View of Gauge Site

View of Station House Site







Location Plan for Structures

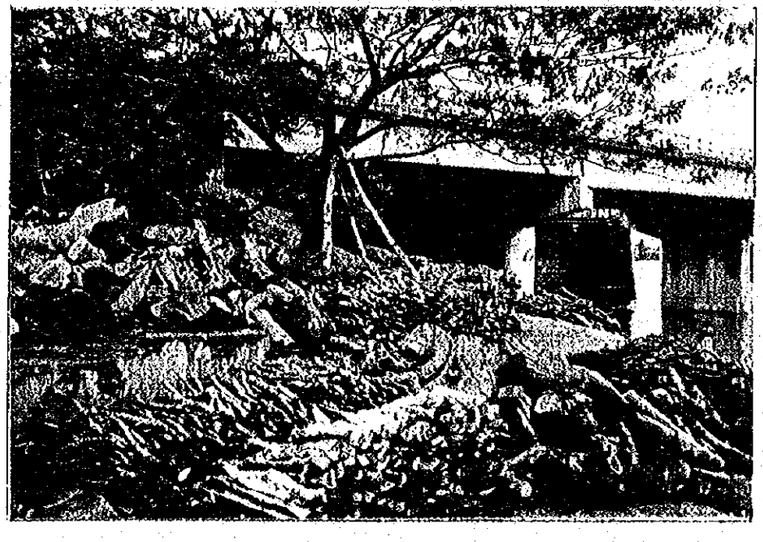
Description of Site Condition

Tongi gauge site is selected at the downstream side of Tongi R&H Bridge. There are two bridges side by side and the space for construction work can be obtained easily at this bridge.The gauge shall be set at the downstream side of the second pier from the right bank along the Tongi Khal, in order to obtain enough depth for observation of water-level during the whole year.

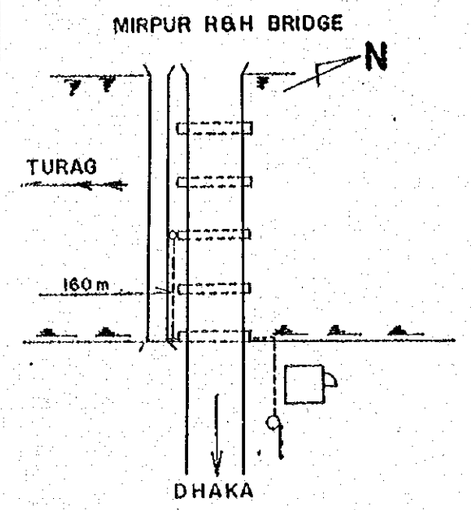
Figure 5-1 Site Survey Result of Gauge Sites

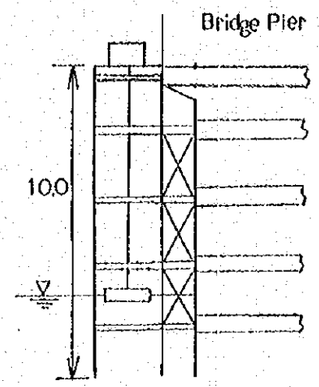
(4) Tongi Site

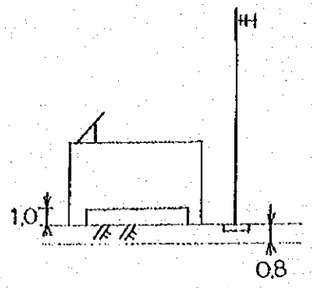
View of Gauge Site



View of Station House Site







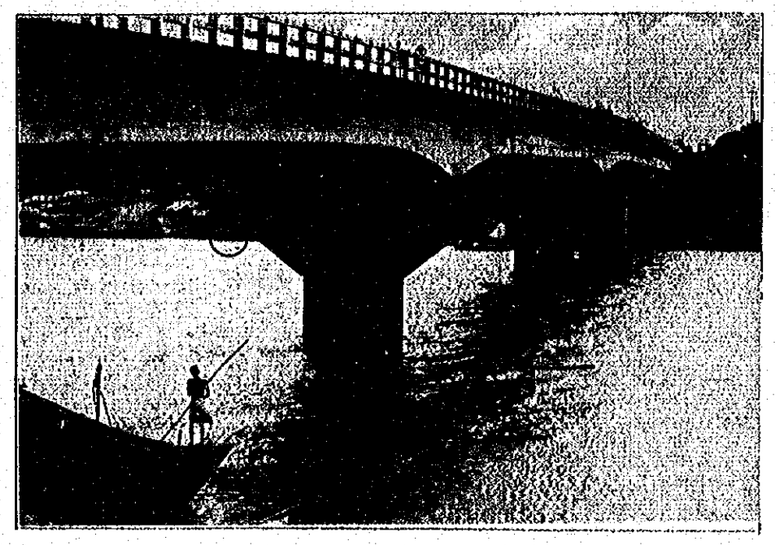
Location Plan for Structures

Description of Site Condition

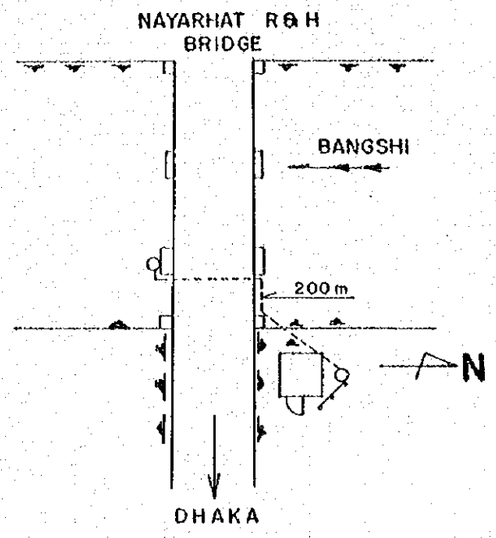
Mirpur gauge site is selected at the new Mirpur R&H Bridge. The gauge will be set at the downstream side of the third pier from the left bank along the Turag River, in order to obtain enough depth for observation of water-level during the whole year.

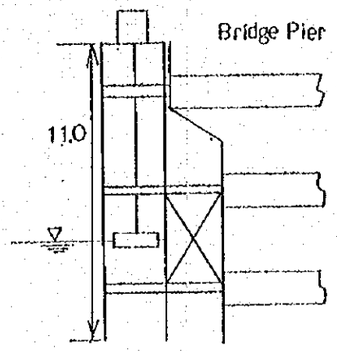
Figure 5-1 Site Survey Result of Gauge Sites

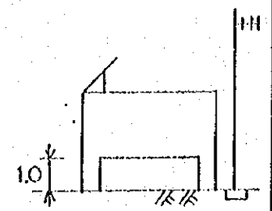
(5) Mirpur Site



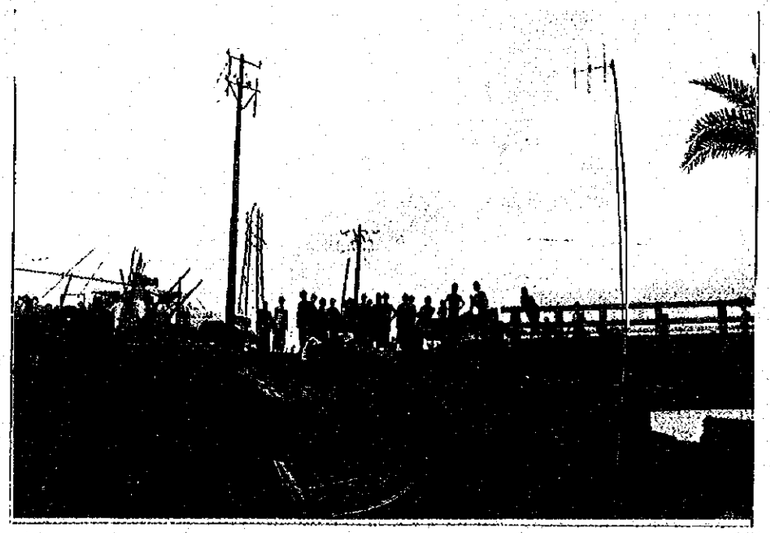
View of Gauge Site







Location Plan for Structures



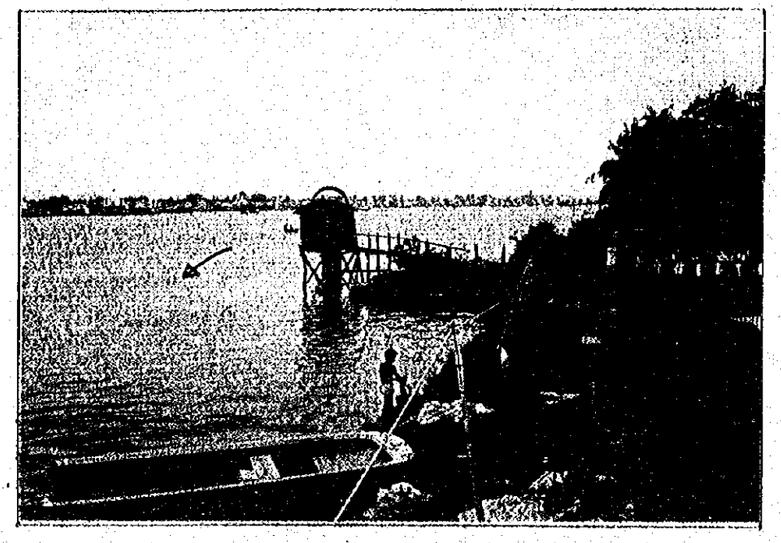
View of Station House Site

Description of Site Condition

Nayarhat gauge site is selected at the Nayarhat R&H Bridge. This site is considerably more suitable for water-level observations than the Savar site which was proposed as a gauge site in the UNDP report, because the shape of river cross section at Savar site is so flat that water-level may not be recorded during the whole year by float type gauge. The gauge shall be set at the downstream side of the second pier from the left bank along the Bangshi River, in order to obtain enough depth for observation of water-level during the whole year.

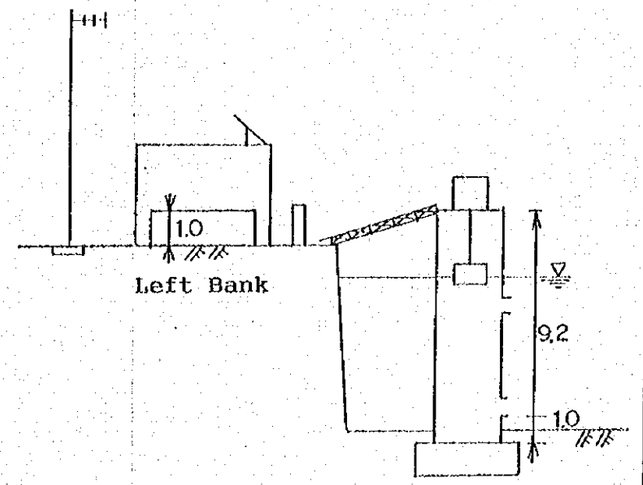
Figure 5-1 Site Survey Result of Gauge Sites

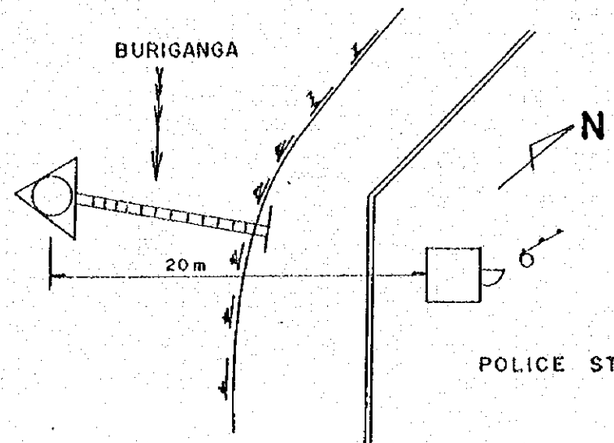
(6) Nayarhat Site



View of Gauge Site

View of Station House Site





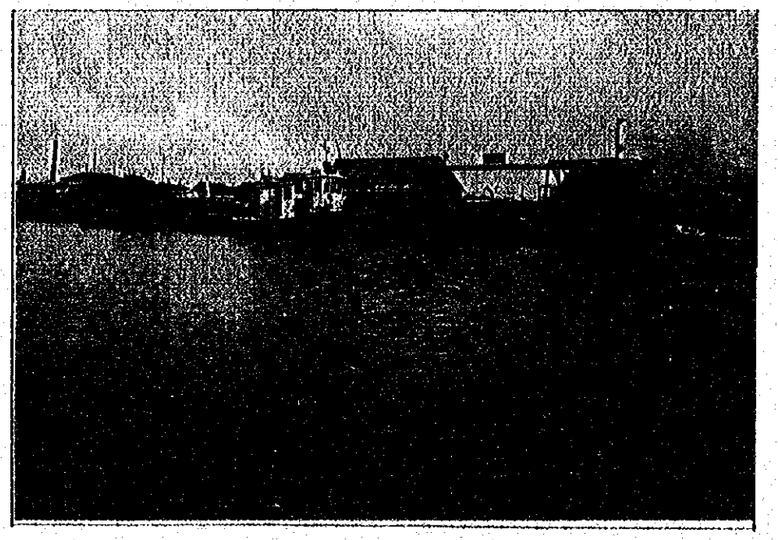
Location Plan for Structures

Description of Site Condition

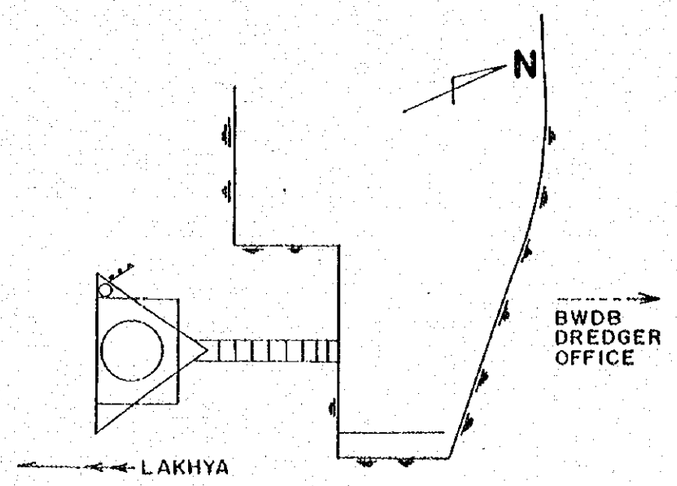
Mill Barak gauge site is selected at the same position as the existing Mill Barak gauging recorder site, which is located at the left bank along the Buriganga River. At this point the gauging station and telemetering system will be newly installed.

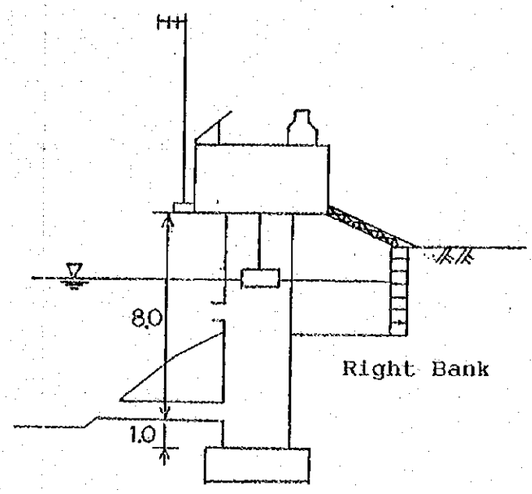
Figure 5-1 Site Survey Result of Gauge Sites

(7) Mill Barak Site

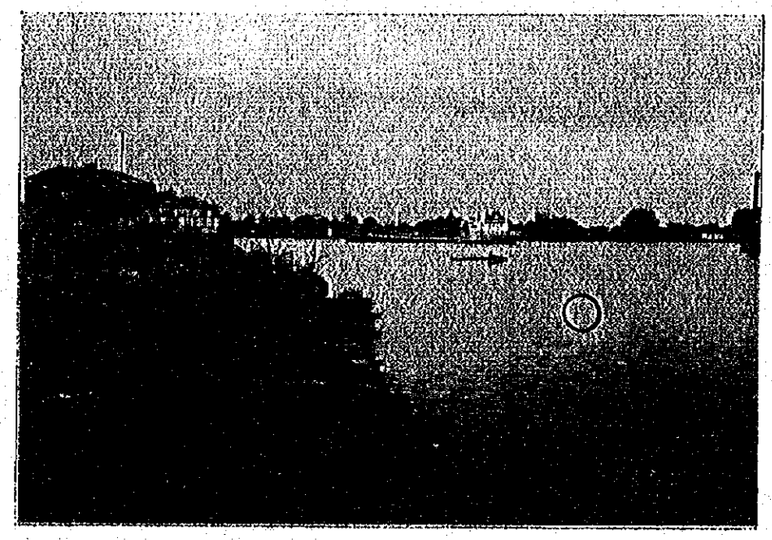


View of Gauge Site





Location Plan for Structures



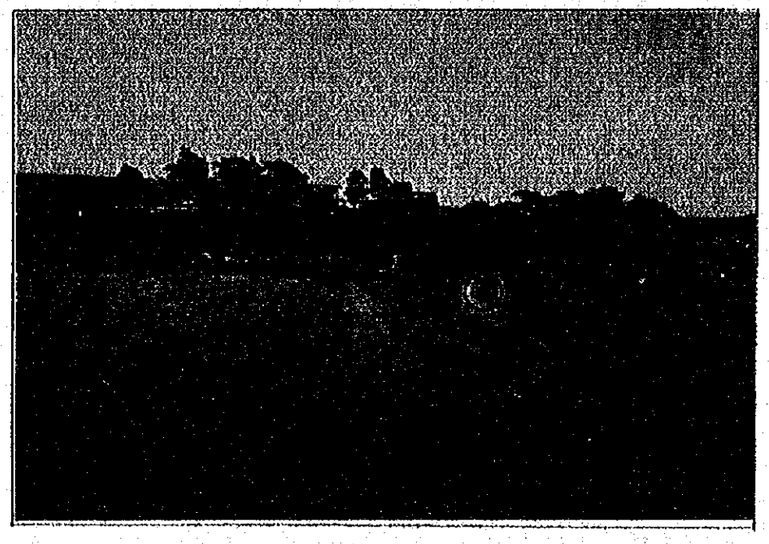
View of Station House Site

Description of Site Condition

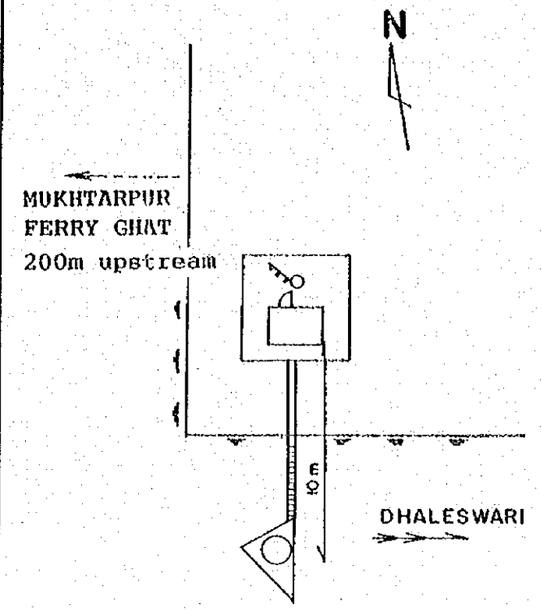
Narayanganj gauge site is selected at the downstream side close to the Narayanganj BWDB Dredger Office, which is located at the right bank of the Lakhya River. Around this area lots of dredging material and ships are placed along the bank, and the suitable site to observe the water-level must be limited. Close to this site, there is a narrow canal where the gauge can ba anstalled. This will allow observation of water-level round the year. At the same time, the gauging site will also be safe from damage by inland navigation.

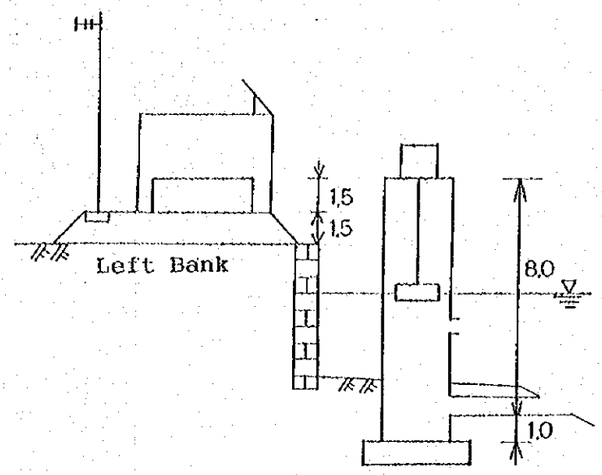
Figure 5-1 Site Survey Result of Gauge Sites

(8) Narayanganj Site



View of Gauge Site





Location Plan for Structures

View of Station House Site

Description of Site Condition

Rekabi Bazar site is selected at 200m downstream from Mukhtarpur ferry ghat on the left bank along the Dhaleswari River. The left bank is also suitable as there will be enough depth for observation of water-level round the year. The right bank is not suitable as a gauge site considering the safety of the gauge from inland navigation.

Figure 5-1 Site Survey Result of Gauge Sites

(9) Rekabi Bazar Site

CHAPTER 6 DESIGN AND INVESTIGATION OF SYSTEM

BAUG 06

CHAPTER 6. DESIGN AND INVESTIGATION OF SYSTEM

6.1 General

On the basis of the results of Site Survey,Radio Propagation Tests and subsequent detailed discussions with BWDB,it was decided that the system would consist of the following:

1. Telemetering system to collect the necessary observation data for flood forecasting, consisting of the following :

a. FF&WC Master station in WAPDA building, Dhaka.

b. Five (5) VHF Radio Telemetry Repeater stations at

1. T&T Dhaka (Ramna) station
2. T&T Nawabganj station
3. T&T Kurigram station
4. T&T Beani Bazar station
5. T&T Maulvi Bazar station

c. Four (4) Water-level and Rainfall gauging stations at

1. Pankha
2. Jatrapur
3. Zakiganj
4. Narayanganj

d. Five (5) Water-level gauging stations at

1. Tongi
2. Nayarhat
3. Mirpur
4. Millbarrak
5. Rekabi Bazar

2. Data processing system to carry out forecasting works exactly and quickly, consisting of main Computer equipment with File server equipment, Engineer working station equip ment, Printer and their peripheral equipment.

The data which will be collected at FF&WC at DHAKA are listed in Table.6-1.

The system block diagram of each stations of PILOT system for FF&WS of Bangladesh are described in Fig.6-3 to Fig.6-11.

6.2 Telecommunication Network

The telecommunication network of the PILOT system of FF&WS in Bangladesh was recommended on the basis of the result of the Radiowave propagation tests and the detailed survey of the existing T&T nationwide Multiplex network followed by detailed discussions with BWDB and BTTB.

The telecommunication network of the PILOT system can be seen in Fig.6-2. The following is a description of the recommendations to followed for implementing the project.

1. Pankha --- T&T Dhaka (Mogh Bazar)

a. Install a dedicated semi-duplex VHF Radio Telemetry link between the Pankha gauging station and Nawabganj T&T UHF station.

b. Use a leased circuit from the existing T&T FDM (Frequency Division Multiplex) UHF link operating between T&T Nawabganj and T&T Rajshahi and the FDM Microwave link operating between T&T Rajshahi and T&T Dhaka (Mogh Bazar).

2. Jatrapur --- T&T Dhaka (Mogh Bazar)

a. Install a dedicated semi-duplex VHF Radio Telemetry link between the Jatrapur gauging station and Kurigram T&T UHF station.

b. Use a leased circuit from the existing T&T FDM UHF link operating between T&T Kurigram and T&T Rangpur and the FDM Microwave link operating between T&T Rangpur and T&T Dhaka (Mogh Bazar).

3. Zakiganj --- T&T Dhaka (Mogh Bazar)

a. Install a dedicated semi-duplex VHF Radio Telemetry link between the Zakiganj gauging station and Beani Bazar T&T UHF station.

b. Use a leased circuit from the existing T&T PCM Multiplex UHF Digital link operating between T&T Beani Bazar and T&T Sylhet and the FDM Microwave link operating between T&T Sylhet and T&T Dhaka (Mogh Bazar).

4. Maulvi Bazar Area Gauging Stations --- T&T Dhaka (Mogh Bazar)

a. Install a dedicated semi-duplex VHF Radio Telemetry Repeater at T&T Maulvi Bazar Microwave station for communi cating with the existing hydrological gauging stations in the Maulvi Bazar area.

b. Use a leased circuit from the existing T&T FDM UHF link operating between T&T Maulvi Bazar and T&T Sylhet and the FDM Microwave link operating between T&T Sylhet and T&T Dhaka (Mogh Bazar)

5. Dhaka Area Gauging Stations --- T&T Dhaka (Mogh Bazar)

a. Install a dedicated semi-duplex VHF Radio Telemetry network between Dhaka area gauging stations at Narayanganj, Rekabi Bazar, Millbarrak, Tongi, Mirpur & Nayarhat and T&T Dhaka (Ramna)

* The Ramna T&T station is recommended as the Radio Teleme try Repeater site for the Dhaka area gauging sites on the basis of the Radiowave propagation test results which indi cate that it is the on it site in Dhaka area (compared to T&T Mogh Bazar and WAPDA building) which is relatively interference free and where the stability and reliability of the Radio Telemetry network can be ensured.
** All the T&T stations mentioned above are, in effect, VHF Radio Telemetry Repeater stations for the Pilot Telemetry System.

6. Multiplex Link Between T&T Dhaka (Mogh Bazar) And FF&WC at WAPDA Building

a. Use 4 channels from the existing Coaxial Cable link operating between T&T (Mogh Bazar) and T&T Dhaka (Ramna) terminals for the transmission of signals collected at the Mogh Bazar terminal from the remote gauging stations at Pankha, Jatrapur, Zakiganj and Maulvi Bazar area to the T&T Dhaka (Ramna) terminal and vice versa. The signals will be terminated on the Voice Frequency Distribution Frame (VDF) Tag Block by T&T.

A full Group (12 channels) from the existing Coaxial Cable link is recommended to be reserved now for facilitating easy expansion of the Flood Forecasting and Warning System in fut ure.

b. Install a PCM Multiplex (2 Mbit/s; 30 channels) Digital Radio link operating in the 2 GHz band between T&T Dhaka (Ramna) station and FF&WC at WAPDA building.

This system will be used for the transmission of signals collected at T&T Dhaka (Ramna) terminal from the remote and Dhaka area gauging stations together to FF&WC at WAPDA building and vice versa.

7. Recommended Preparatory Work

The following preparatory work is recommended for the smooth implementation of the Pilot Telemetry Network :

a. Obtain permission from BTTB for the installation of Radio Telemetry Repeater equipment, DC Power Supply System including batteries, Antenna etc. in each of the following T&T UHF & Microwave stations.

1. Nawabganj
2. Kurigram
3. Beani Bazar
4. Maulvi Bazar
5. Dhaka (Ramna)

b. Reserve a full Group (12 channels) from the existing Coaxial Cable link operating between T&T Dhaka (Mogh Bazar) and T&T Dhaka (Ramna) for present use and future expansion of the Flood Forecasting and Warning System.

c. Lease the following four (4) circuits from the existing nationwide Multiplex network.

1. Dhaka (Ramna) Carrier Terminal -- Nawabganj Terminal
2. Dhaka (Ramna) Carrier Terminal -- Kurigram Terminal
3. Dhaka (Ramna) Carrier Terminal -- Beani Bazar Terminal
4. Dhaka (Ramna) Carrier Terminal -- Maulvi Bazar Terminal

d. Obtain permission from BTTB to install a PCM Multiplex (2 Mbit/s; 30 channels) Digital Radio link between T&T Dhaka (Ramna) and FF&WC at WAPDA building.

e. Obtain the necessary frequency allocations to operate the VHF Radio Telemetry links or networks and the PCM Multiplex Digital Radio System.

1. Five (5) different frequencies in the VHF band, one for each of the following Radio Telemetry links or networks :

a. Nawabganj --- Pankha Radio Telemetry link
b. Kurigram --- Jatrapur Radio Telemetry link
c. Zakiganj --- Beani Bazar Radio Telemetry link
d. Dhaka area Radio Telemetry network
e. Maulvi Bazar area Radio Telemetry network (149.25 MHz has already been allocated by BTTB for the purpose)

2. Necessary frequencies in the 2 GHz band for the operation of the PCM Multiplex Digital Radio System between T&T Dhaka (Ramna) and FF&WC at WAPDA building

6.3 Requirements of telemetering system

6.3.1 Data collection

1. The Rainfall and Water-level data from the three stations in the boundary area,i.e. Pankha, Jatrapur and Zakiganj will be directly collected at FF&WC in Dhaka WAPDA building via VHF Radio Telemetry Repeater stations,leased T&T Microwave circuits and the BWDB PCM Multiplex Digital Radio link.

2. The Rainfall and Water-level data of the existing Maulvi Bazar Telemetering system will also be collected at FF&WC in Dhaka via VHF Radio Telemetry Repeater station in T&T Maulvi Bazar,leased T&T Microwave circuit and the BWDB PCM Multiplex Digital Radio link,in addition to being monitored by the Maulvi Bazar Telemetering station.

3. The Rainfall and Water-level data from the Dhaka area gauging stations will be collected at FF&WC in Dhaka via VHF Radio Telemetry Repeater station in T&T Dhaka (Ramna) and the BWDB PCM Multiplex Digital Radio link.

6.3.2 Transmission System

1.	Communication system	Semi-duplex communication
2.	Calling signal system	2-frequency series signal
3.	Data code system	Long-short pulse system
4.	Transmission speed	50 bauds
5.	Modulation system	Subcarrier frequency shift system
6.	Data code check system	Parity check at each digit and total number of bits check

6.3.3 Calling operation

This system will have the following four (4) kinds of calling operation at the FFWC station.

1. Automatic calling

This calling will be started automatically by the clock, and will be directed to all the managed stations except the stations which are shutdown, in the predetermined order. The calling will be made at the following three (3) intervals.

a. 10 minutes
b. 30 minutes
c. 1 hour

2. Manual calling

This calling will be started manually and will be directed to all the managed gauging stations arbitrarily selected in the predetermined order.

3. Recalling

If any error code has been detected in the data code from a gauging station, or if there is no response from a gauging station, that gauging station will be automatically recalled once more. If there is an error code or a called gauging station has failed to respond again, a visual and audible alarm will be actuated and the system will shift to the next operation.

6.3.4 Response mode

The gauging station called from the FFWC station will convert the measured values into digital signals and then send the signal measurement code to the FFWC station.

6.3.5 Data code check system

The FFWC station will perform the following code checks each time a data code is received:

a. Odd parity check at each digit
b. Check of total number of bits

6.3.6 Repeating system between multiplex radio link and semi-duplex radio link at T&T terminal station.

The repeating system will be of the Multiplex radio link and semi-duplex VHF Radio link repeating, called "micro-VHF repeating" hereinafter.

The transmitters will employ a No.1 unit/No.2 unit changeover system.

The receivers will employ a No.1 unit/No.2 unit parallel operation system.

When the output of transmitter has dropped to 1/2 or less, failure display will be actuated and operation will be automatically switched to other transmitter. However, switching will not be performed if the other transmitter is already faulty.

Forced switching between No.1 transmitter and No.2 transmitter by the local test buttons will be possible.

The receiver detection will be performed by the comparison and detection of the presence or absence of squelch voltage at the two receiver. However, disconnection of the receiver judged to have failed shall be unnecessary when the failed receiver is judged to be normal.

6.3.7 Voice communication

The voice communication between the FFWC station and managed gauging stations will be possible in this system. Moreover, automatic calling will have priority over voice communication.

6.4 The function of Data processing system

6.4.1 General

The data processing system will be a networked computer system consisting of File server equipment with disk and CMT, Engineering work station equipment with visual display, Floppy disk drive and Printer and their accessory equipment, and will have two (2) major functions of data storage and computations.

The data processing system will receive hydrological data from the telemetering system.

6.4.2 Flood forecasting analysis processing

Hydrological data processing and preliminary analysis work will be carried out by EWS to a level suitable for input into the existing data base and modeling system of FFWC. Such analysis and processing work will be carried out in a way compatible with real time operations of FFWC for which a suitable computer system is necessary.

The data to be processed by this system will consist of the following :

a. Water-level data
b. Rainfall data
c. GTS data from BMD (in future)
d. Hydrological data from BMD (in future)
e. Existing telemetering data of BMD (in future)
f. Existing radar raingauge data (in future)
g. Newly radar raingauge data (in future)

6.4.3 Data display at FFWC

1. On the EWS equipment for PILOT system the displayed items are as follows :

a. Illustrated display of the river conditions of all over Bangladesh .
b. Rainfall data table
d. Chronological water-level graph.
e. Chronological rainfall and water-level graph.

6.4.4 Connection with existing facilities in FFWC

The FFWC will shortly have its own new network computer system (LAN) with multi-access database,operating under UNIX open desktop software. The telemetry system output should be compatible with this and also allow direct data access via data processing system.

6.5 Typing and display of telemetering and data processing systems.

The data of water-level and rainfall to be received at FFWC station will be in accordance with Table.6-1.

The data output at FFWC station will be in accordance with Table.6-4 and 6-5.

The collected data, transmitted by the telemetering system, will be displayed on the EWS equipment and typed out on the recording paper by the typewriter.

The printed data on the typewriters and the displayed data on the EWS equipment will in be accordance with Table.6-5.

The received data by manual calling will be immediately print ed after the data are received at FFWC station of DHAKA.

Daily data will be printed every day at 6 AM.

Weekly report,monthly report and yearly report will be printed by the manual operation of EWS equipment.

The EWS equipment will be able to be independently operated by the manual operation. The items of the EWS display will be in accordance with Table.6-4.

The method of calculation for each data will be in accordance with Table.6-3.

6.6 Power Supply System for Each Station

Each stations will have following power supply system.

1. FF&WC

CVCF equipment (including battery)
Isolation transformer
Power distribution board

2. T&T Terminal station at Dhaka (Ramna)

DC Power supply equipment (including battery)
Automatic voltage regulator

3. T&T Terminal stations at Nawabganj, Kurigram, Beani Bazar and Maulvi Bazar

DC Power supply equipment (including battery)
Automatic voltage regulator

4. Rainfall and Water-level Gauging station

Solar cells (panels)
Solar cells distribution board
Alkaline battery

5. Water-level Gauging station

Solar cells (panels)
Solar cells distribution board
Alkaline battery

6.7 Ancillary Work

6.7.1 General

Based on the results of site survey formulated in Chapter 5 from the viewpoints of requirements and functions to conduct the effective flood forecasting and warning in Bangladesh, the detailed design works are dealt with in this Clause for each component of the system related to ancillary work. Structures of this kind should be designed keeping in mind the aspect of safty and economy. If catastrophic flood occurs and exceeding stress or unexpected scouring affects the structure,measures to protect the structure shall be taken or, if necessary,it will be moved to the bank for safety.

The components of ancillary work are water-level gauge stilling wells, station houses, antenna towers/poles including electric and mechanical works. All the design contents and procedure for these structures are herein explained with the following constitution.

In Clause 6.7.2 , all design work items are classified in accordance with the applied actual procedure for the design work. Clause 6.7.3 indicates the design criteria , materials and allowable stress to be followed for structural design calculation. Clause 6.7.4 describes the method and procedure for the structural calculation of ancillary work. Clause 6.7.5 deals with the detailed design for the structural components.

To conduct the detailed design for the above, the following code and standard were referred.

-American Concrete Institute(ACI 318-63)
-American Institute for Steel Construction(AISC)
-Uniform Building Code(UBC)

The required works subject to the detailed design are classified in the following:

-Design of the water-level gauge stilling wells
-Design of the station houses
-Design of the antenna towers/poles

River cross section survey was conducted in nine station sites to collect the input field data for the detailed design. The field work was conducted from the end of June to the end of July, 1991.

6.7.2 Classification

The works required for the structural design at the selected stations are allocated based on the results of site survey in Chapter 5 and the structural components of ancillary work are classified as shown in Table 6-6.

6.7.3 Design Criteria

(1) Design Load

a) Dead Load

Dead load, the self weight of the structure and the equipment/facilities to be installed, is calculated with the following unit weight:

Unit Weight of Structural Materials:		
-Steel	:77.5	KN/m^3
-Plain Concrete	:19.0	KN/m^3
-Reinforced Concrete	:23.6	KN/m^3
Unit Weight of Assembled Elements:		
-Ceiling and finishes at roof	: 1.0	KN/m^2
-Ceiling and finishes at raised floors	: 0.75	KN/m^2
-250 masonry wall, plastered both faces	: 5.75	KN/m^2

b) Live Load

The minimum uniformly distributed live loads for floors of houses, according to ACI Building Code requirment, are applied.

Station House		
-Roof	: 1.0	KN/m^2
-Raised Floor	: 3.0	KN/m^2
-Verandah	: 4.0	KN/m^2
-Stairs	: 4.0	KN/m^2
Stilling Well Support		
-Platform	: 4.0	KN/m^2
-Service Ladder	: 4.0	KN/m^2
Antenna Tower/Pole		
-On top of Antenna Tower/Pole	: 1.5	KN

c) Lateral Load

The lateral loads are the horizontal loads due to earthquake, wind force, and following water pressure. The lateral loads are assumed to come against structure from any horizontal direction.

Seismic Load:

Seismic load is determined by the following formula specified in the UBC.

$V = Z*I*K*C*S*W$

Where: V:total base shear(KN)
Z:seismic coefficient(0.75)
I:occupancy importance factor(=1.5)
K:horizontal force factor(=1.0)
$C:1/15(T)^{0.5}$
$T:0.09h/(D)^{0.5}$
$S:1.0+T/Ts-0.5(T/Ts)^2$
Ts:characteristic site period
W:total dead load(KN)

In the above, since T and Ts are not clearly determined the maximum value of C*S=0.14 is applied in accordance with the code of UBC. Thus, the seismic load is determined by V=0.157W.

Wind Load:

Design wind pressure is calculated as the basic wind pressure multiplied by the load factor as follows:

$q=qo*m$

where: qo:basic wind pressure(KN/m^2)
m:load factor

Basic wind pressure is determined in accordance with the standard of UBC. The load factor is given at 1.0 for ordinary house, at 1.5 for antenna tower /pole in accordance with UBC Standard.

Water Pressure:

Flowing water pressure acting on the structure is determined from the following formula:

$Pf=k*V^2*A$

where: Pf:flowing water pressure(KN)
k:constant determined by shape of the structure
-square or rectangular:0.7
-circle or oval :0.4
V:maximum current velocity(m/s)
-Zakiganj site:3 m/s
-Another sites:2 m/s
A:projected area (m^2)

(2) Materials

a) Concrete

Concrete

Type	Plate	f'c(N/m^2)
Type A	Foundation of antenna tower, pole and concrete pavement	20
Type B	Station house	20
Type C	Leveling concrete	15

Legend: f'c:Minimum specified strength at 28 days

b) Reinforcement Bar

The reinforced bar is of plane billet-steel bars, intermediate grade with a minimum yield strength of $275N/m^2$ to conform to ASTM A615 and modulus of elasticity of $200,000N/mm^2$. The dimensional requirement and weight are as follows:

Reinforcement Bar

Nominal Diameter(mm)	Unit Wt. (kg/m)	Perimeter (mm)	Nominal Area(mm^2)
10	0.616	31.42	78.54
12	0.888	37.70	113.10
16	1.579	50.27	201.10
20	2.466	62.83	314.20
25	3.854	78.54	491.90

b) Steel

Structural steel materials to be used in this project are classified into two kinds:

-Steel materials of quality, shape and size specified in AISC which are used in the antenna tower.

-Structural materials of quality, shape and size specified in ASTM which are used in the antenna pole, stilling well and support, and all steel members of house. Quality and size are:

-Structural steel : A36

-Structural tubing : A570, A501

-High-strength bolt : A325

Physical constants for steel materials are follows:

-Modulus of elasticity : $2.0*10^5$ N/mm^2

-Shear modulus : $7.7*10^4$ N/mm^2
-Poison's ratio : 0.3

(3) Allowable Stress

a) Concrete

Allowable Stress of Concrete

TYPE	Stress
Type A and B :	
Compressive strength (fca)	: 9.0 N/mm^2
Shear stress (4 fsa)	: 0.4 N/mm^2

b) Reinforced Bar
Allowable tensile stress : 124 N/mm^2

c) Steel (AISC Steel Materials)

Allowable Stress of AISC Steel

Type	Stress
Allowable tensile stress	: 160 N/mm^2
Allowable shear stress	: 100 N/mm^2
Allowable compressive stress	: 150 N/mm^2

6.7.4 Structural Design Calculation

The method and procedure for the structural calculation of ancillary works are briefly described hereunder.

(1) Station House

-Framing of the structure
-Calculation of vertical loads
-Calculation of lateral loads
-Determination of reactions, shear and bending moment caused by vertical and lateral loads
-Determination of steel reinforcements
-Checking of the assumed member sizes based on the allowable stress. (In most cases, the sizes of members are governed by the architectural requirements of the

structure.)

The structural calculation for station houses is conducted manually by approximate method.

For slabs with two-way reinforcements the bending moments are determined from ACI moment coefficient.

In accordance with the ACI code provisions, the bending moments, shears and reactions due to vertical loads obtained from the methods of analysis mentioned above are combined with stresses caused by the lateral loads. The bigger value of load combination is applied in the design of the structural members.

(2) Stilling Well Support

Stilling well support is designed considering dead load, live load, wind pressure and water pressure. The wind and water pressure is calculated considering that wind and water passing parallel to any one face, which will produce maximum stress in any one of the vertical members, and produce maximum stress in connecting members. Two type of pressure is considered : water pressure in high flood season and wind pressure in dry season.

Wind pressure is considered for design and checking the stability because wind pressure is greater than water pressure.

(3) Antenna Tower/Pole

The structural calculation of self-supporting antenna pole is done on the following methods/procedures:

-Calculation of loads on pole and antenna
-Design of pole for moment

The structural calculation for guided triangular tower is done by computer using stiffness matrix method.

The wind loads on tower are calculated in one wind direction such as parallel to any one to the face of tower/pole. The wind loads on antenna are calculated with wind acting on antenna surface from eight directions to obtain the maximum wind load.

The direction angle of tower at the elevation of a governing antenna is checked not to exceed the allowable deflection angle. The deflection angle is given from the deflection calculated at each nodal joint.

(4) Foundation

The foundation type applied for house and antenna tower is the spread footing foundation. To ensure the stability and to reduce the magnitude of the maximum bearing pressure, the resultant force was limited to be within the middle-third of the footing, considering the contact pressure, up-lift force and allowable bearing capacity of sub-soil.Allowable bearing capacity was adopted by assumption and taking information from local people.

6.7.5 Detailed Design for Structural Components

The rasults of detailed design for structural components are shown in following drawings as shown in Appendix I :

Gauging Station

-Pankha Station	: Drawing No.1
-Jatrapur Station	: Drawing No.2
-Zakiganj Station	: Drawing No.3
-Tongi Station	: Drawing No.4
-Mirpur Station	: Drawing No.5
-Nayarhat Station	: Drawing No,6
-Mill Barak Station	: Drawing No.7
-Narayanganj Station	: Drawing No.8
-Rekabi Bazar Station	: Drawing No.9
-Stilling Well	: Drawing No,10

Station House

-Type I (Brick Type)	: Drawing No.11
-Type II(Metàl Type)	: Drawing No.12

Antenna Tower/Pole

-Antenna Tower	: Drawing No.13,14
-Antenna Pole	: Drawing No.15

The methods, procedures and designing for each structure are described below.

(1) Station House

a) Type I : 8 Stations (except for Narayanganj)

The station house is one-storey square shaped simple structure with reinforced concrete. The size of house is:

- Floor size : 1.80*1.80 m
- Ceiling height (above ceiling floor level) : 2.50 m
- Total height (above ground level) : 3.80 m
- Roof water drainage : 100 mm thick lime terracing in 1/80 slope
- Provision of ventilation pipe : 200 mm dia. inlet/outlet steel pipes (2pairs)
- Provision of door : 4.5 cm thick steel flush door
- Provision of concrete self : 600mm wide to be fixed to masonry wall for equipment
- Finishing of floor/ wall/ceiling : Cement plaster
- Provision for placing : One raingauge bucket and one solar battery

Beside this, the entire station house is enclosed by barbed-wire fence to protect the structure from burgalars and animals.

b) Type II : Narayanganj Station

The station house is one-storey square shaped steel structure. The house is composed of steel angle frame cladded with 55 mm thick sandwitch metal wall. A 50 mm thick heat insulation is placed between two plyes of metal plain sheets.Same insulted panel is also provided in roof to reduce the heat.

Size of Station House

Item	Contents
Floor size	: 2.0 m * 2.0 m
Ceiling height	: 1.75 m
Total height	: 2.0 m
Floor height from recorded highest water level	: 1.2 m

The platform is made of square mesh of 16mm dia. M.S

bar. The platform is supported on stilling well supporting tower. The plat form elevation is decided to 1.2m above the recorded highest flood level. For access to platform from nearby height land, a steel fabricated ladder is provided. In the roof 12.5% slope is provided to pass the water rapidly. The roof is made of metal plain sheet.

(2) Stilling Well Support

a) River Type

The river type stilling well is 900 mm dia. mild-steel pipe, which is supported by three legged steel frame. The vertical members are of 100 mm dia. welded M.S pipe filled with lean concrete. Horizontal and inclined members are 32mm dia. pipes connected by bolt and double nuts. The vertical members are sufficiently driven into the river-bed for stability and no extra foundation is provided.

Frame stability is checked for both wind pressure and as well as water pressure. The velocity of water is approximately 2.0 m/s and wind velocity is approximately 60 m/s. All members in contact with soil will be painted with anti-corrosive paint.

b) Bridge Type

The bridge type stilling well is 600mm dia. mild-steel pipe supported on existing bridge by hanging from bridge pier. The supporting system is composed of mild-steel plate belt and mild-steel angled frame. Steel plate belts of 100mm width and 6mm thick provided around the existing bridge pier fastening by bolts and nuts. Rubber gaskets are provided between two pieces of steel plate for ease of fastening. To keep the stilling well perfectly in position two angled frames are provided on two oposite side of stilling well. These angled frames are attached with stilling well and the belt by bolts and nuts.

(3) Antenna Tower/Pole

a) Antenna Tower

The designed antenna tower is 30.0m and 20.0m high guyed supported triangular tower made of mild-steel pipes. The tower is constructed beside the station house about 3.0 m apart from the house wall.

The tower height is determined to cover the required antenna height according to the radio propagation test. The trianglar type is selected to secure the structural rigidity keeping deflection and torsional deflection angle within the allowable deflection angle.

The sides of the main tower is 0.40m all through, which is made of mild-steel pipes and each nodal joint is connected by welding and nut bolt joint.

The tower is constructed by piece wise of 3.0 m height. Each piece is ended with flange at the end of main vertical mamber. These pieces are connected by at least three bolts. High strength steel wire guyes are provided at 10 m interval to keep in vertical position with in tolerable deflection.

The tower is erected on the one isolated foundations. The size of foundation is determined by stability calculation against dead load and wind load.

b) Antenna Pole

The designed antenna poles are two types, one is 15.0m height and other is 10.0 m height. Both of them are self-supporting. The poles are constructed about 3.0m away from the station house wall.

Antenna poles height are determined to cover the required respective site antenna height according to the radio propagation test. All poles are round type mild-steel welded pipe.For 15.0m height pole,bottom diameter of the pole is 200 mm dia. mild-steel seam welded pipe, middle dia. 150 mm, and top diameter is 100 mm. For 10.0 m height pole, bottom diameter is 150 mm and top diameter is 100 mm.The antenna poles attached with ladder bars from 6.0 m height to do the maintenance work.

The antenna poles are erected on pedestal type isolated footing foundation. The size and the depth of the footings are determined by stability calculation against dead load and wind load.

(4) Lightning Arrester

A lightning arrester and its pertinent facilities as per design and specified standard shall be provided on the top of all antenna towers and poles. This lightning arrester shall be connected to the ground rod by copper wire of size not less than 9 mm dia.. At least two ground rods of size not less than 25mm dia. galvanized iron(G.I) pipe of length not less than 10.0 m shall be provided at each site. Care shall be taken so that distance between two ground rods shall be not less than they have been sunk to the ground. These ground rods shall be connected by ground wire of size not less than 10mm dia..

LIST OF TABLES

Table 6-1 LIST OF TELEMETERING STATIONS FOR PILOT SYSTEM

No.	Name of station		Water-level	Rainfall	Data collection
(DHAKA Basin)					
1.	Mill Barak		*		Dhaka
2.	Narayanganj		*	*	Dhaka
3.	Tongi		*		Dhaka
4.	Rekabi Bazar		*		Dhaka
5.	Mirpur		*		Dhaka
6.	Nayarhat		*		Dhaka
(Maulvi Bazar basin)(Data of 2 to 7 are monitored at DHAKA)					
1.	Zakiganj		*	*	DHAKA
2.	Shaistaganj	(Existing)	*		Maulvi.B
3.	Manu	(Existing)	*		Maulvi.B
4.	Dhalai	(Existing)	*		Maulvi.B
5.	Sherpur	(Existing)	*		Maulvi.B
6.	Manu	(Existing)		*	Maulvi.B
7.	Kamalganj	(Existing)		*	Manlvi.B
(PABNA basin)					
1.	Pankha		*	*	DHAKA
(Rangpur basin)					
1.	Jatrapur		*	*	DHAKA
			13 data	6 data	

1. Newly
   - Water-level and Rainfall station 4 stations
   - Water-level station 5 stations

   Total 9 stations

2. Existing
   - Water-level station 4 stations
   - Rainfall station 2 stations

   Total 6 stations

Table 6-2 CONDITION OF WATER LEVEL GAUGE

No.	Name of station	Gauge type	Measuring Range (m)	Accuracy (cm)
1.	Mill Barak	Float	10.2	1
2.	Narayanganj	Float	9.0	1
3.	Tongi	Float	8.5	1
4.	Rekabi Bazar	Float	9.0	1
5.	Mirpur	Float	10.0	1
6.	Nayarhat	Float	11.0	1
7.	Zakiganj	Float	14.8	1
8.	Shaistaganj	Float		1
9.	Manu	Float		1
10.	Dhali	Float		1
11.	Sherpur	Float		1
12.	Pankha	Float	10.0	1
13.	Jatrapur	Pressure	9.9	1

Table 6-3 LIST OF CALCULATION METHOD OF TELEMETERING DATA

Table.6-3 LIST OF CALCULATION METOD OF TELEMETERING DATA

Classification	Item	Calculated method	Collection of defetective data	Alarm	Dimensions	REMARK
Rainfall	Hourly rainfall	Rh=R(t)-R(t-1) Rh :Hourly rainfall R(t):rainfall amount at gauged at o'clock R(t-1):rainfall amount at t-1 o'clock	If data of R(t) or R(t-1) is defective ,calculation is not executed.	Upper limit	1mm/h	
	Cumulative rainfall and the	Rot+R(t)-Ro Rot:Cumulative rainfall at t o'clock R(t):rainfall amount gauged at t'oclock Ro:rainfall gauged at the begining accumlation.	If data of R(t) or Ro is defective ,calculation is not executed. The latest value of Ro at the time of data recovery is supplemented as initial data.	Upper limit	1mm	for the start and finish of rainfall accumlation, reset and start of calculation can be made simultaneously either by automatic operation or by by manual operation. Automatic operation of reset and start of calculation is made by the judgementof time duration of no rainfall . Manual operation is made by pressing reset switch.
	Water level	Ht=Hr Ht:Water-level Hr:gauged water-level	If data of Hr is defective, calculation is not executed	3 stage	1cm	Alarm is to be set at 3 stage.
	Discarge	Qr=a*(Ht+b)^2 Qr:dincharge Ht:water level a,b:constant	If dat of Ht is defective calculation is not executed.		1 m3/s	Constant of a and b to be change evry year

Table 6-3 LIST OF CALCULATION METOD OF TELEMETERING DATA

Classification	Item	Calculated method	Collection of defetective data	Dimensions	REMARK
Rainfall	Daily rainfall	Rd=R(d,6)-R(d-1,6) Rd:Daily rainfall Rd(d,6):Ranfall data gauged at 6:00 of the day;d Rd(d-1,6):rainfall data gauged 6:00 of the day brfore ;d-1	If data of R(d,6) or R(d-1,6) is defective ,calculation is not executed.	1mm	
	Maximum rainfall and the occurrence time	Max. value is selected among the data from 7 o'clock of the day before to 6 o'clock of the day. If there are same MAX. values, nearest time to 6 o'clock of the day is selected as the occurence time	If the number of defective data is less than 3, calculation is executed excluding the number of defective data.	1 mm and hour:min	

Table 6-3 LIST OF CALCULATION METOD OF TELEMETERING DATA

Classification	Item	Calculated method	Collection of defetective data	Dimensions	REMARK
Water-level	Daily mean Water-level	Hra=(Hrt)/n Hra:daily mean water level Hrt:Water-level gauged at evry hour n:number of effective data	Defective data are excluded	1 cm	
	Maximum water-level and the occurence time	Max. value is selected among the data from 7 o'clock of the day before to 6 o'clock of the day. If there are same MAX. values, nearest time to 6 o'clock of the day is selected as the occurence time	If the number of defective data is less than 3,calculation is executed excluding the number of defective data	1 cm and hour:min	
	Minimum water-level and the occurence time	Min. value is selected among the data from 7 o'clock of the day before to 6 o'clock of the day. If there are same Min. values, nearest time to 6 o'clock of the day is selected as the occurence time	If the number of defective data is less than 3,calculation is executed excluding the number of defective data	1 cm and hour:min	

Table 6-4 LIST OF DISPLAYED DATA ON THE EWS

ITEM	Pictures of EWS (1)	(2)	(3)	(4)	(5)	(6)
1. River water-level						
(1) Measured value	*		*	*	*	*
(2) Calculated discharge	*		*	*	*	*
(3) Daily mean W.L			*			
(4) Daily MAX. W.L			*			
(5) Daily MIN. W.L			*			
(6) Daily mean discharge			*			
(7) Daily MAX. discharge			*			
(8) Daily MIN. discharge			*			
(9) Alarm	*		*	*	*	*
2. Rainfall						
(1) Hourly rainfall	*	*			*	
(2) Daily rainfall		*				
(3) cumulative Rainfall	*	*			*	
(4) Daily Max. hourly rainfall		*				
(5) Alarm (Hourly and cumulative	*	*			*	
3. Observed time	*	*	*	*	*	*
4. Illustrated map of Bangladesh whole area	*					
5. Present time	*	*	*	*	*	*

LEGEND

(1) : Illustrated of the river conditions of nationwide Bangladesh area
(2) : Rainfall data table
(3) : Water-level and discharge data table
(4) : chronological water-level graph
(5) : Chronological water-level with rainfall graph
(6) : Chronological water-level and discharge graph

Table 6-5 LIST OF PRINTED DATA ON THE EACH PRINTER FOR PILOT SYSTEM

ITEM	Printer for TM	Console printer	Printer for EWS
1. River water-level			
(1) Measured value	*		*
(2) Calculated discharge			*
(3) Daily mean W.L			*
(4) Daily MAX. W.L			*
(5) Daily MIN. W.L			*
(6) Daily mean discharge			*
(7) Daily MAX. discharge			*
(8) Daily MIN. discharge			*
(9) Alarm		*	*
2. Rainfall			
(1) Measured value	*		
(1) Hourly rainfall			*
(2) Daily rainfall			*
(3) cumulative Rainfall			*
(4) Daily Max. hourly rainfall			*
(9) Alarm (Hourly and cumulative		*	*
3. Observed time	*	*	*
4. System condition including alarm		*	
5. Power supply condition of gauging station and repeater	*		

Table 6-6 Structural Components of Ancillary Work

(1) Stilling Well

Station	Type	Height (m)	Diameter (mm)	Inlet Pipe Number	Inlet Pipe Length (m)	Inlet Pipe Diameter (mm)	Ladder
Pankha	River	10.0	900	1	4.0	305	*
Zakiganji	River	14.8	900	1	18.0	305	*
Tongi	Bridge	8.5	600	-	-	-	*
Mirpur	Bridge	10.0	600	-	-	-	*
Nayarhat	Bridge	11.0	600	-	-	-	*
Mill Barak	River	10.2	900	1	13.0	305	*
Narayanganj	River	9.0	900	1	16.0	305	*
Rekabi Bazar	River	9.0	900	1	10.0	305	*

Legend: *:To be installed

(2) Station House

Station	Type	Material	Size (m)	Floor Height (m)	Earth-work (m)	Cable Length (m)
Pankha	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.3	-	100
Jatrapur	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.5	2.2	120 (Max)
Zakiganj	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.0	1.7	30
Tongi	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.0	0.7	60
Mirpur	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.0	0.8	160
Nayarhat	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.0	-	100
Mill Barak	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.0	-	20
Narayanganj	Combine	Metal	2.0x2.0x2.5	-	-	-
Rekabi Bazar	Separate	Brick/RCC Frame	2.4x2.4x2.5	1.5	1.5	10

Legend : Earthwork :Banking Height
Cable Lenght:Distance between recorder/sensor and house

(3) Antenna Tower/Pole, Staff Gauge, Bench Mark

Station	Antenna Tower/Pole	Antenna Type	Antenna Height (m)	Staff Gauge Number	Staff Gauge Type	Bench Mark
Pankha	Tower	Guyed Triangular	20	2	Fixing on Well Movable	*
Jatrapur	Pole	Self-support	15	1	Movable	*
Zakiganj	Tower	Guyed Triangular	30	2	Fixing on Well Movable	
Tongi	Pole	Self-support	15	-		
Mirpur	Pole	Self-support	15	-		
Nayarhat	Pole	Self-support	15	-		
Mill Barak	Pole	Self-support	10	-		
Narayanganj	Pole	Self-support	15	-		
Rekabi Bazar	Pole	Self-support	15	2	Fixing on Well Movable	*
WAPDA Bldg.	Pole	Self-support	8	-		

Legend : *:To be installed

LIST OF FIGURES

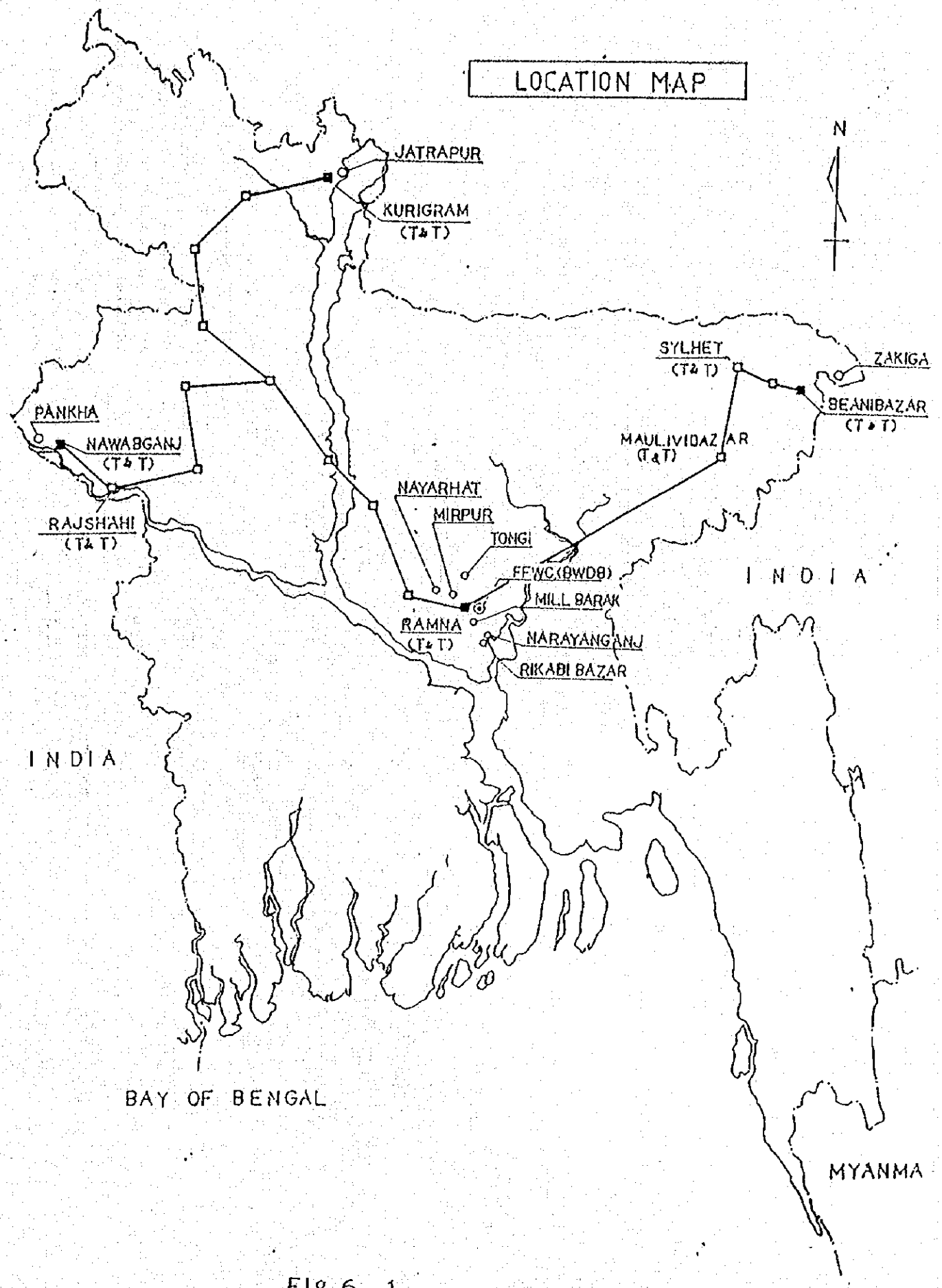
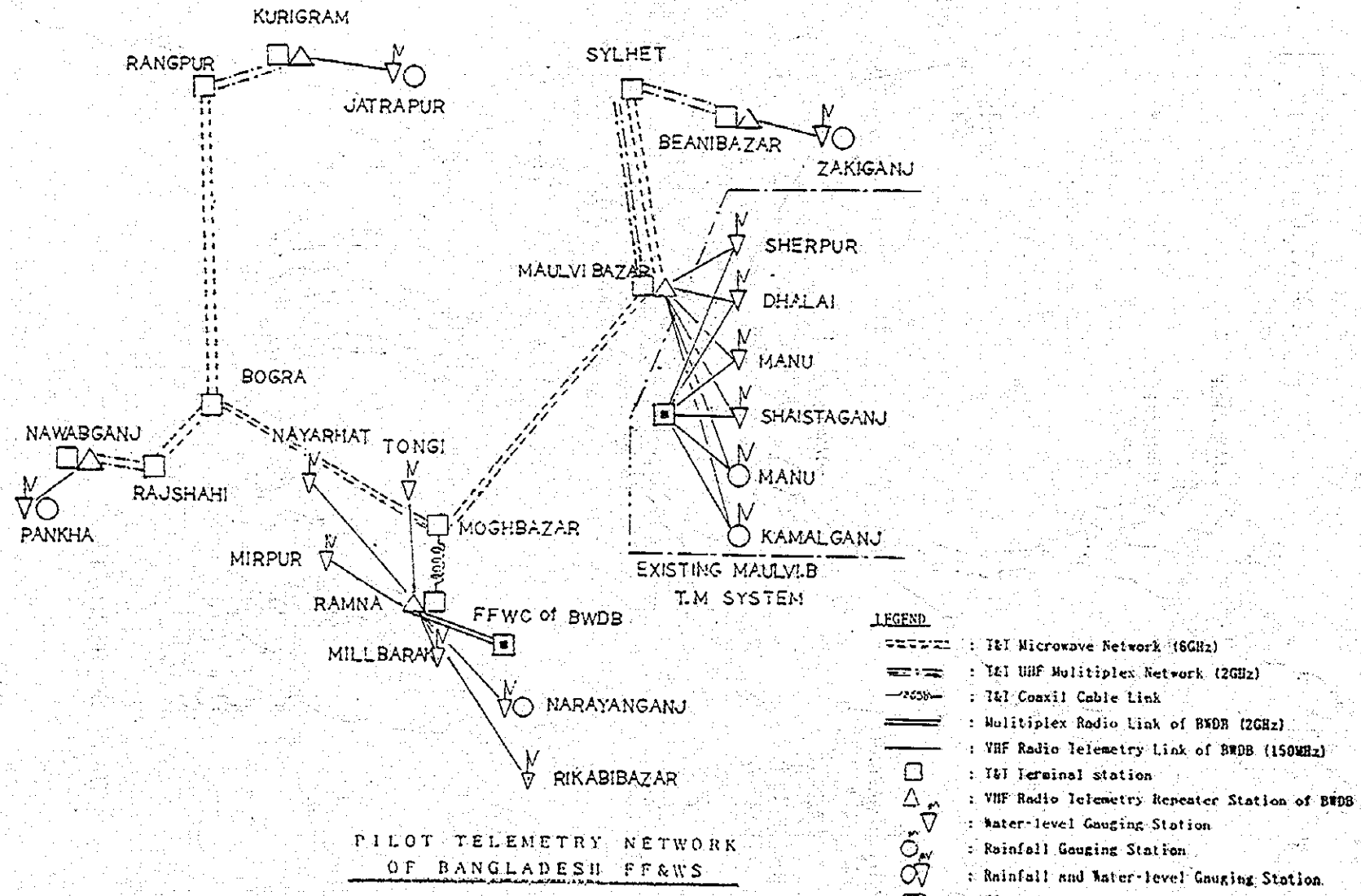
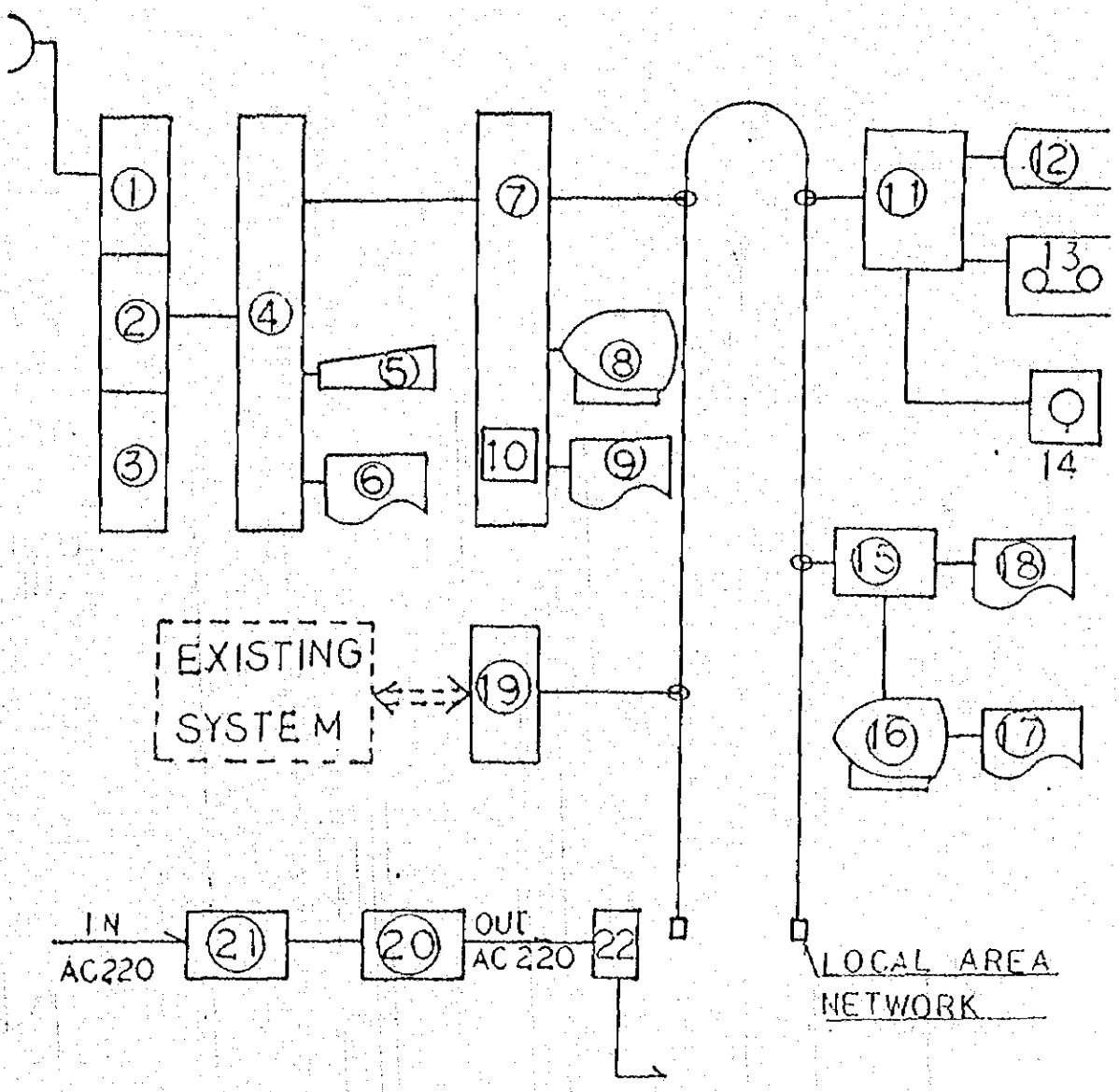

LOCATION MAP
N
JATRAPUR
KURIGRAM
(T & T)
SYLHET
(T & T)
ZAKIGA
BEANIBAZAR
(T & T)
PANKHA
NAWABGANJ
(T & T)
MAULVIBAZAR
(T & T)
NAYARHAT
MIRPUR
TONGI
RAJSHAHI
(T & T)
FFWC(BWDB)
MILL BARAK
RAMNA
(T & T)
NARAYANGANJ
RIKABI BAZAR
INDIA
INDIA
BAY OF BENGAL
MYANMA

FIG 6—1

Fig 6-2



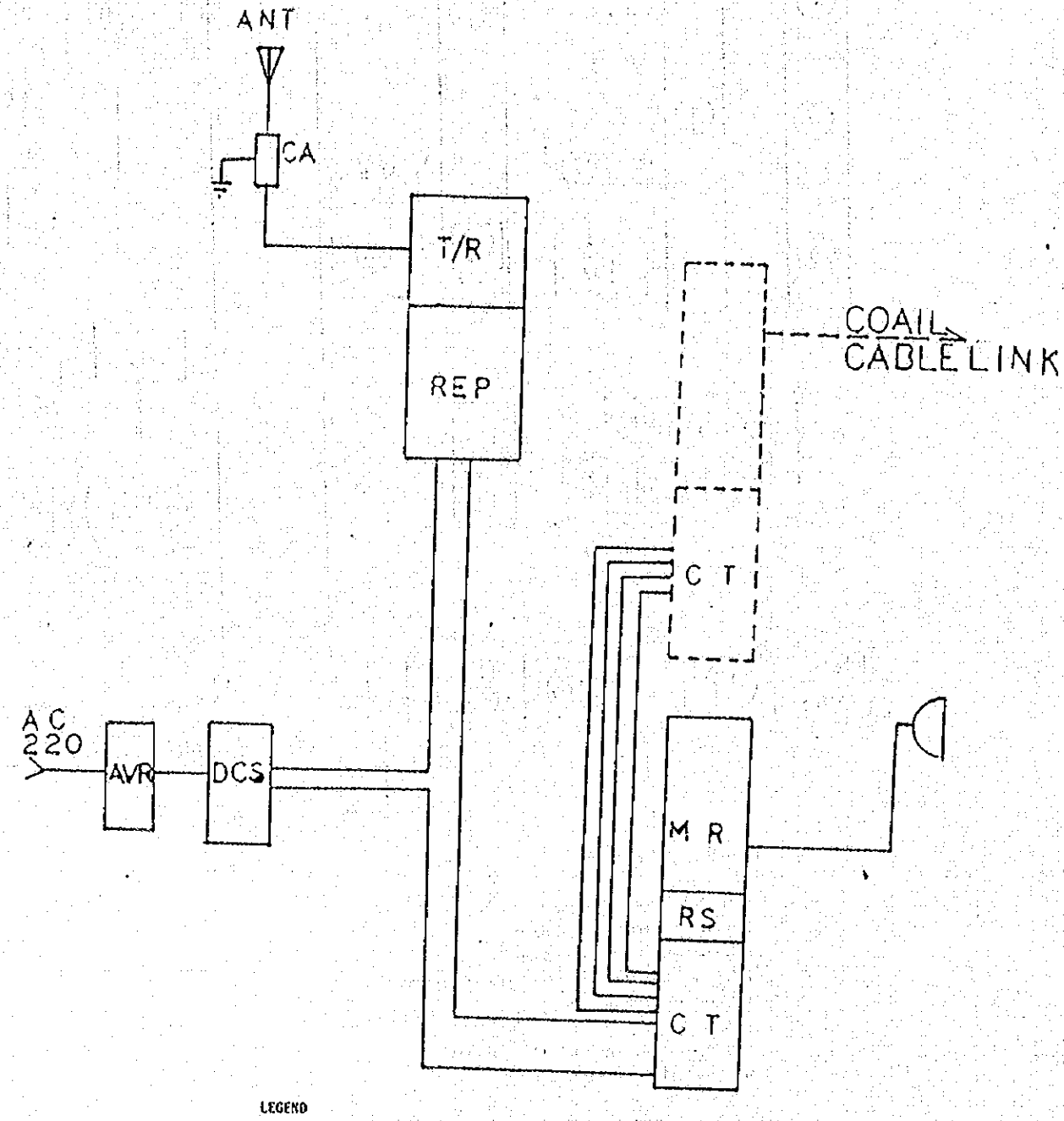
PILOT TELEMETRY NETWORK
OF BANGLADESH FF&WS



LEGEND

1. Multiplex Radio Equipment
2. Multiplex Terminal Equipment
3. Remote Supervisory Equipment
4. Telemetering Supervisory/Control Equipment
5. Operation Console
6. Teleprinter
7. Communication Control Unit Equipment
8. Console Visual Display for CCU
9. Console Printer for CCU
10. Hard Disk Unit for CCU
11. CPU unit for File Server Equipment
12. Magnetic Disk for File Server Equipment
13. Cartridge Magnetic Tape Drive Unit
14. Floppy Disk Unit
15. Controller for Engineering Work Station
16. Display Equipment for EWS
17. Hard Copy Equipment for EWS
18. Laser Beam Printer for EWS
19. File Server Equipment for Existing Facilities
20. CVCF
21. Isolation Transformer
22. Power Distribution Board

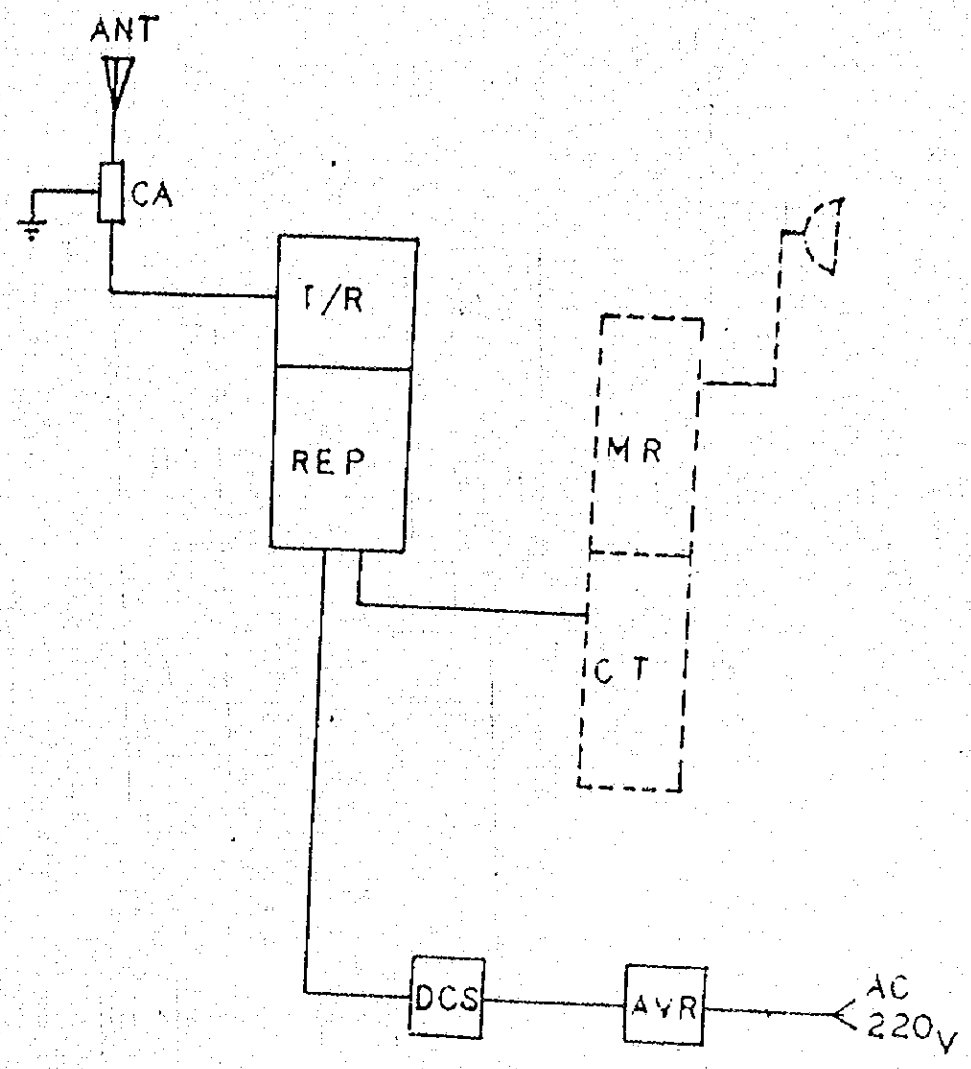
Fig.6-3 BLOCK DIAGRAM OF FF&WC



LEGEND

MR	: Multiplex Radio Equipment
CT	: Multiplex Terminal Equipment
RS	: Remote Supervisory Equipment
REP	: Telemetry Repeater Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
CT	: Ramna T&T Multiplex Terminal Equipment

Fig.6-4 BLOCK DIAGRAM OF T&T TERMINAL STATION AT RAMNA

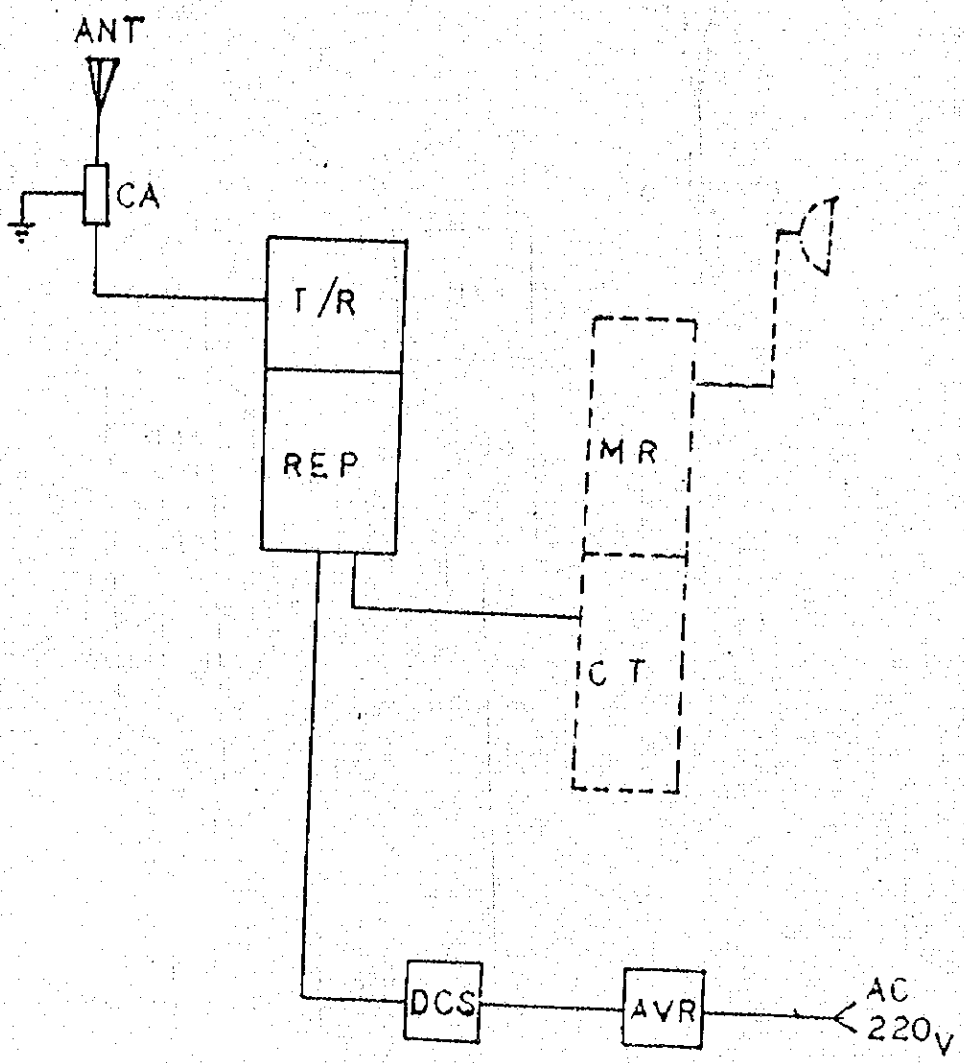


LEGEND

MR	: Multiplex Radio Equipment
CT	: Multiplex Terminal Equipment
RS	: Remote Supervisory Equipment
REP	: Telemetry Repeater Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
CT	: Nawabganj T&T Multiplex Terminal Equipment
MR	: Nawbganj T&T Multiplex Radio Equipment

Fig.6-5 BLOCK DIAGRAM OF T&T TERMINAL STATION AT NAWABGANJ

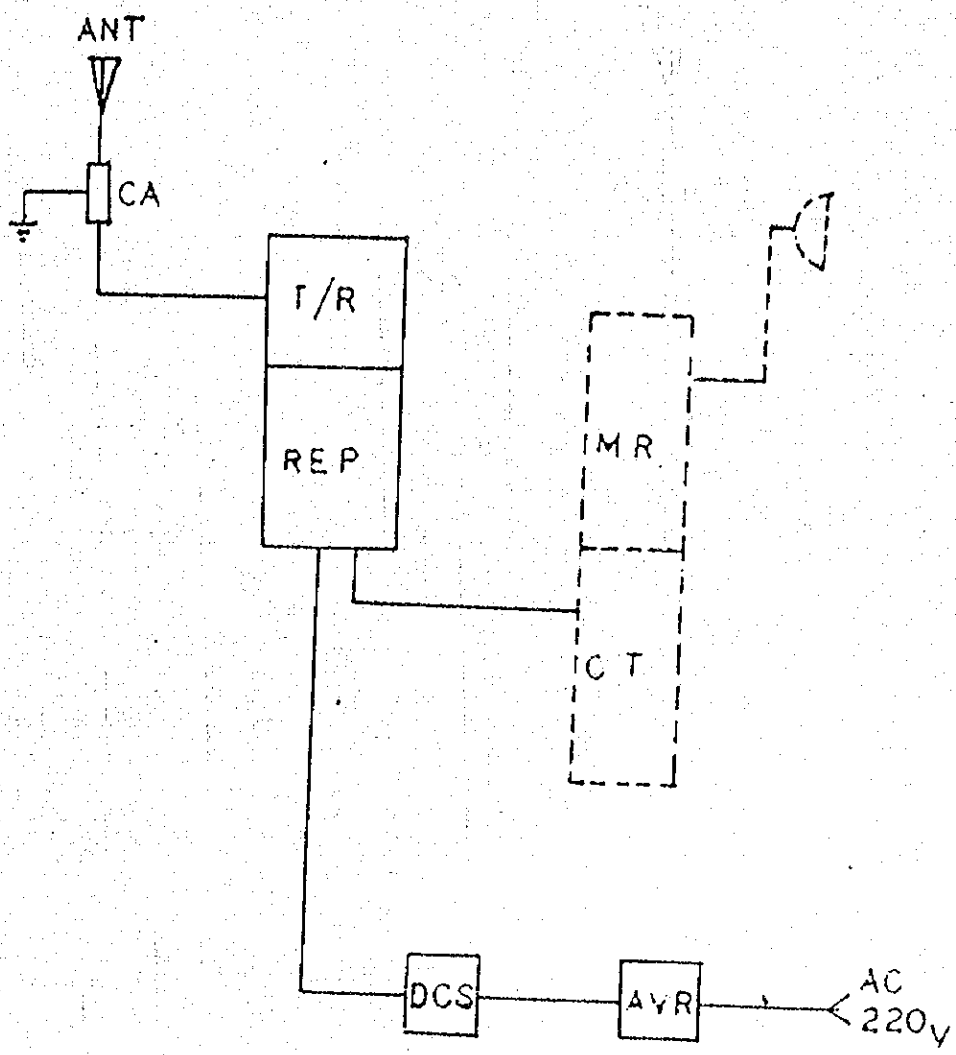
67



LEGEND

MR	: Multiplex Radio Equipment
CT	: Multiplex Terminal Equipment
RS	: Remote Supervisory Equipment
REP	: Telemetry Repeater Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
CT	: Kurigram I&T Multiplex Terminal Equipment
MR	: Kurigram I&T Multiplex Radio Equipment

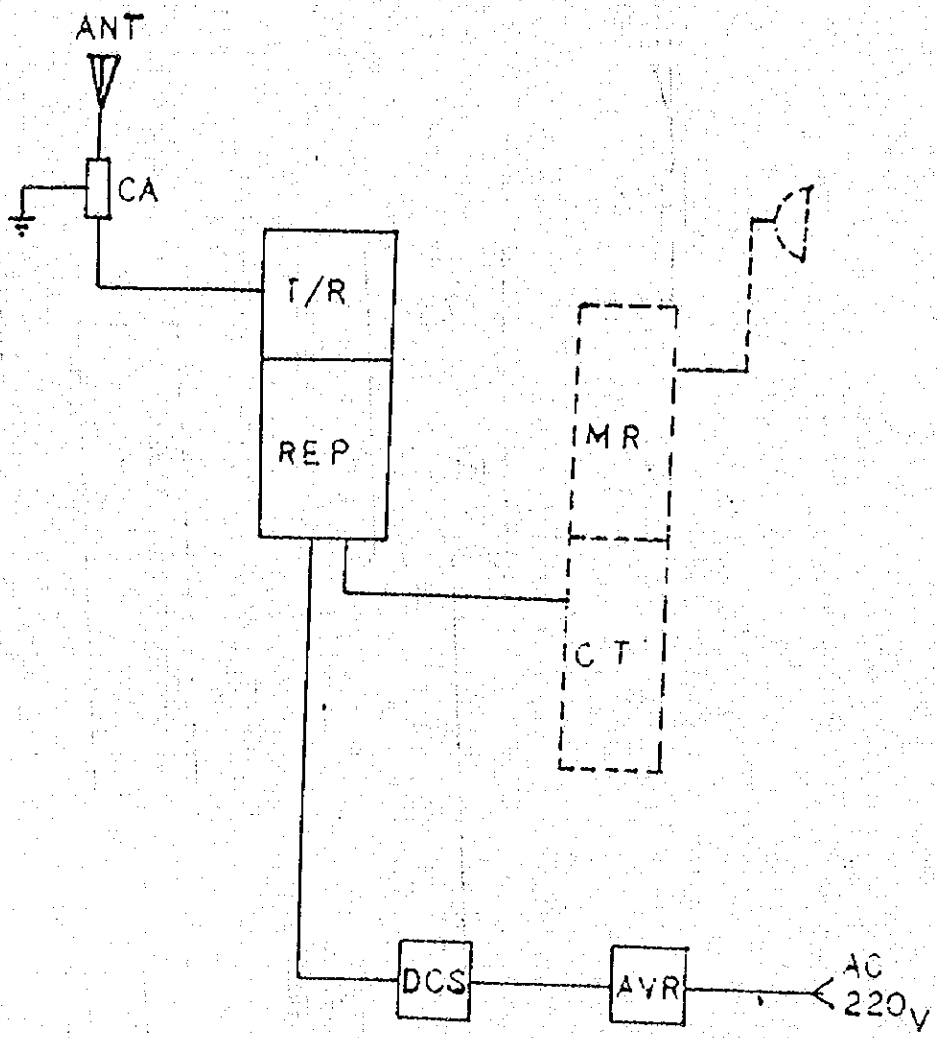
Fig.6—6 BLOCK DIAGRAM OF T&T TERMINAL STATION AT KURIGRAM



LEGEND

MR	: Multiplex Radio Equipment
CT	: Multiplex Terminal Equipment
RS	: Remote Supervisory Equipment
REP	: Telemetry Repeater Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
(CT)	: Beanibazar T&T Multiplex Terminal Equipment
(MR)	: Beanibazar T&T Multiplex Radio Equipment

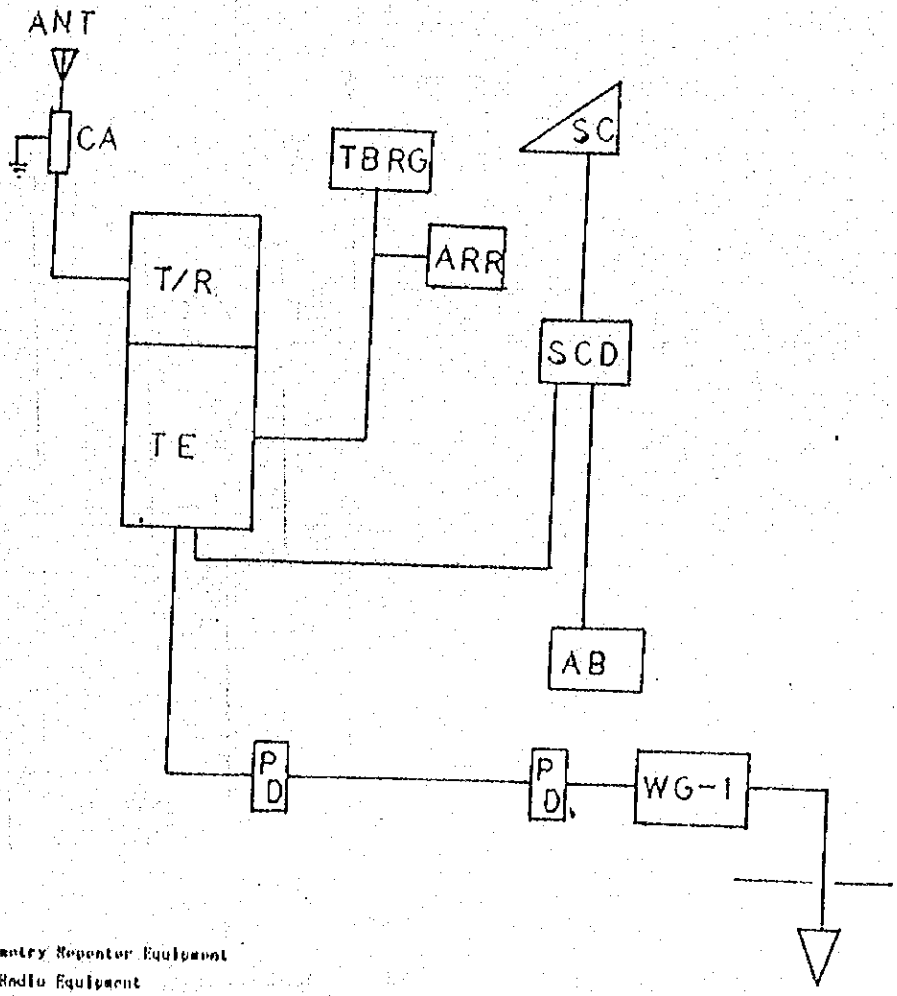
Fig.6-7 BLOCK DIAGRAM OF T&T TERMINAL STATION AT BEANIBAZAR



LEGEND

MR	: Multiplex Radio Equipment
CT	: Multiplex Terminal Equipment
RS	: Remote Supervisory Equipment
REP	: Telemetry Repeater Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
CT	: Maulvi Bazar T&T Multiplex Terminal Equipment
MR	: Maulvi Bazar T&T Multiplex Radio Equipment

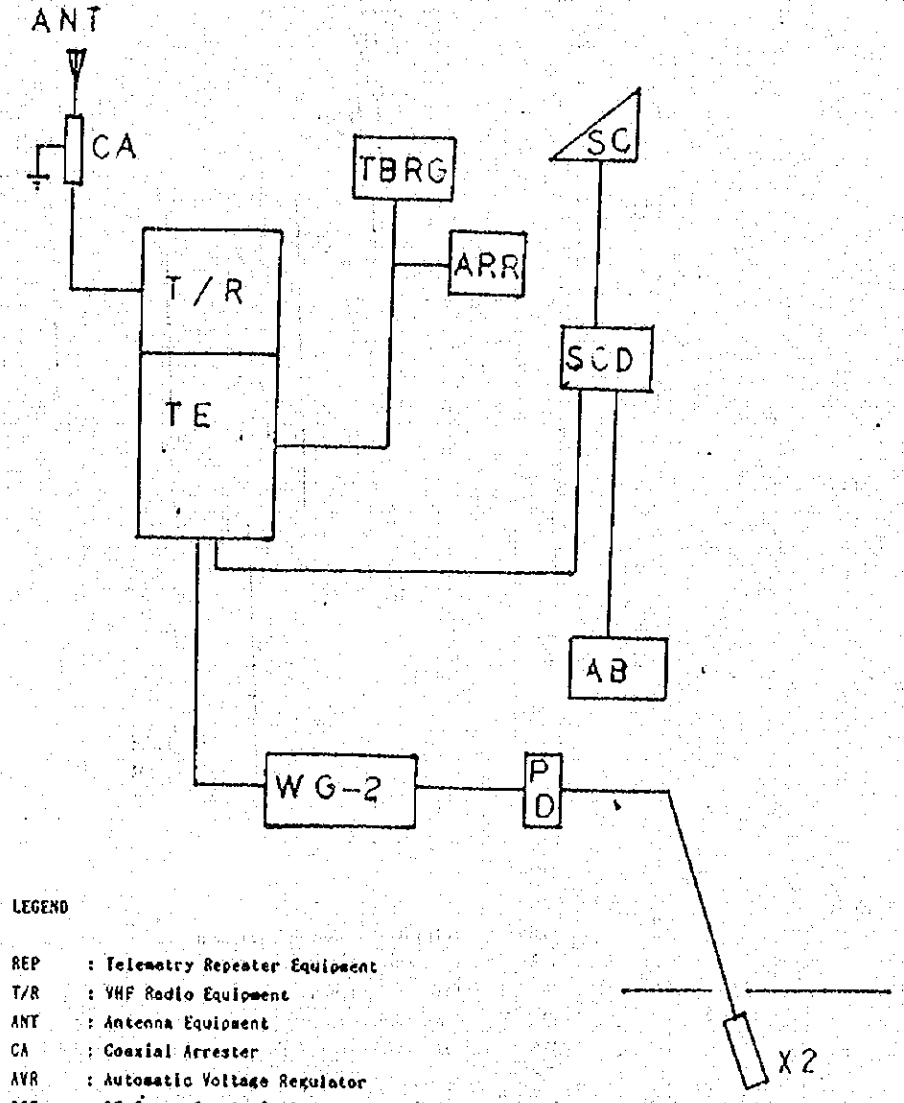
Fig.6-8 BLOCK DIAGRAM OF T&T TERMINAL STATION AT MAULVI BAZAR



LEGEND

REP	: Telemetry Reporter Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
TE	: Telemetering Gauging Equipment
WG-1	: Water-level Gauge (Float type)
WG-2	: Water-level Gauge (Pressure type)
TBRG	: Tipping bucket Rainfall Gauge
ARR	: Automatic Rainfall Recorder
SC	: Solar cells
SCDB	: Solar cells Distribution Board
AB	: Alkaline Battery
PD	: Protective Device

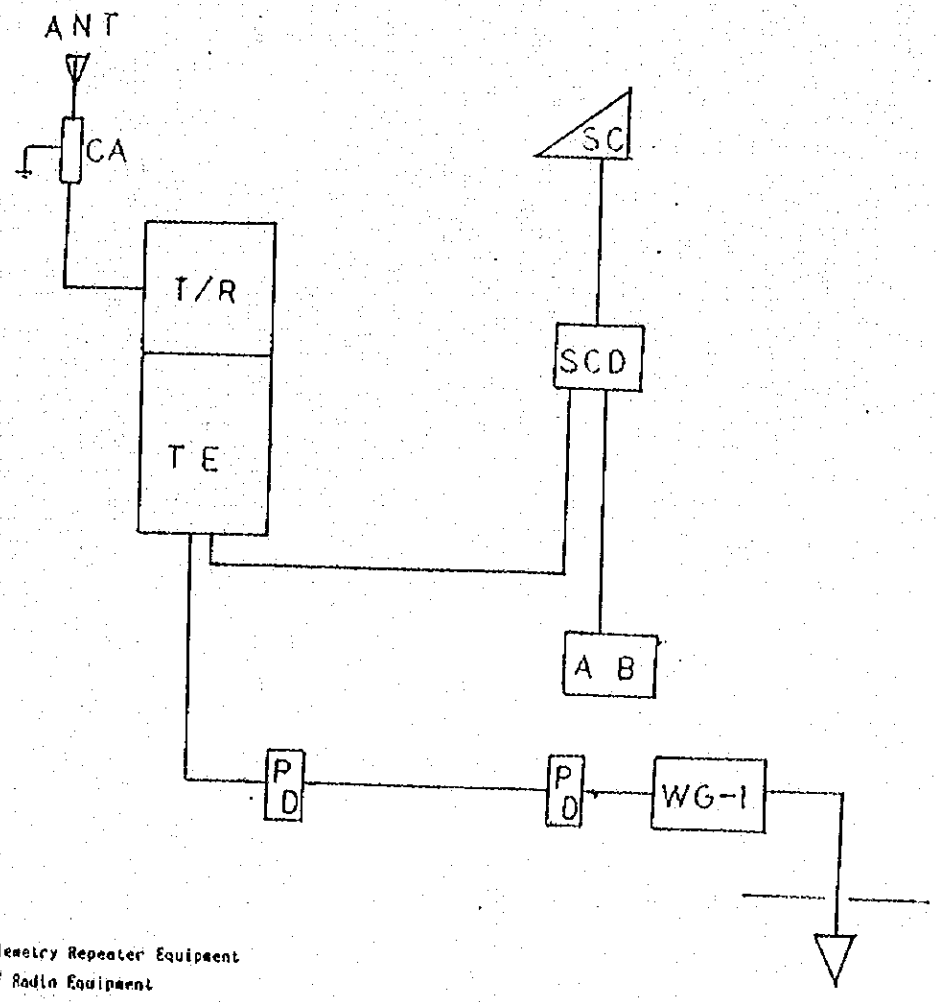
Fig.6-9 BLOCK DIAGRAM OF RAINFALL & WATER-LEVEL GAUGING STATION (EXCEPT JATRAPUR)



LEGEND

REP	: Telemetry Repeater Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
TE	: Telemetering Gauging Equipment
WG-1	: Water-level Gauge (Float type)
WG-2	: Water-level Gauge (Pressure type)
TBRG	: Tipping bucket Rainfall Gauge
ARR	: Automatic Rainfall Recorder
SC	: Solar cells
SCDB	: Solar cells Distribution Board
AB	: Alkaline Battery
PD	: Protective Device

Fig.6-10 BLOCK DIAGRAM OF RAINFALL & WATER-LEVEL GAUGING STATION (JATRAPUR)



LEGEND

REP	: Telemetry Repeater Equipment
T/R	: VHF Radio Equipment
ANT	: Antenna Equipment
CA	: Coaxial Arrester
AVR	: Automatic Voltage Regulator
DCS	: DC Power Supply Equipment
TE	: Telemetering Gauging Equipment
WG-1	: Water-level Gauge (Float type)
WG-2	: Water-level Gauge (Pressure type)
TBRG	: Tipping bucket Rainfall Gauge
ARR	: Automatic Rainfall Recorder
SC	: Solar cells
SCDB	: Solar cells Distribution Board
AB	: Alkaline Battery
PD	: Protective Device

Fig.6-11 BLOCK DIAGRAM OF WATER-LEVEL GAUGING STATION

23

CHAPTER 7 SPECIFICATIONS OF SYSTEM EQUIPMENT

BANG OT

CHAPTER 7. Specifications of System Equipment

7.1 FFWC station at DHAKA

7.1.1 Telemetering supervisory/control equipment

(1) The equipment will consist of modem unit, calling control unit, Receiving control unit, Printing control unit, I/O interface unit, test panel, Power supply unit, repeater control unit and others.

(2) Function and ratings

a. Calling control unit
Control gauging stations; Maximum 40 stations

b. Power supply unit
input: AC100/220V, 50/60Hz or D.C24V

c. Branching I/O interface
I/O level : Setting within a range of 0 to 25dB
I/O impedance : 600 20% balanced

d. Function of test panel and other unit

	Function	Operation	Display	Remarks
1	Test calling	o	-	Individual
2	Reset	o	-	For operation reset
3	Buzzer off	o	-	
4	Voice communication	o	-	
5	I/O level measurement	o	-	At U-links, etc. (By external measuring instruments)
6	Lamp test	o	-	
7	Calling frequency transmission	o	-	
8	Power ON/OFF	o	-	
9	Squelch adjustment	o	-	When equipped with radio equipment.
10	Printer printing ON/OFF	o	-	
11	Repeating start, stop control	o	-	When repeater station installed.
12	Data bit display	-	o	
13	Manual lock	-	o	
14	Receiving failure	-	o	
15	Transmitting	-	o	
16	Measuring	-	o	
17	Power	-	o	
18	Monitoring by voltmeter	-	o	Power supply voltage measurement use

7.1.2 Peripheral equipment of Telemetering supervisory/control equipment

(1) Operating console

	Function	Opera-tion	Dis-play	Remarks
1	Station selection	o	-	Maximum 40 stations
2	Calling interval setting	o	-	10min, 30min, 1hr
3	Measuring mode selection (All stations or individual stations)	o	-	
4	Manual starting, resetting	o	-	
5	Buzzer off	o	-	
6	Voice communication	o	-	
7	Transmitting	-	o	
8	Measuring	-	o	
9	Received data display	-	o	
10	Responding station	-	o	
11	Manual lock	-	o	
12	Receiving failure	-	o	
13	Time display, correction	-	o	Digital display
14	Power	-	o	
15	Burned out fuse	-	o	
16	Lamp test	o	-	
17	Repeater control and display	o	o	Optional function

(2) Printer

-Printer	:	ASCII 96 characters
-Printing system	:	24 dot matrix system
-Number of columns	:	137/163/line
-Paper width	:	381mm/15 inches
-Character code	:	ASCII
-Printing speed	:	108 characters/sec (average)

7.1.3 Communication control unit equipment (CCU)

-Number of received routes	: Maximum 8
-Data communication system	: HDLC or BSC
-Data transmitting rate	: 2400 bps as standard
-Telemetering and data communication network interface	: 4W + Ringer signals 300Hz to 3400Hz
-Parallel interface	: Digital I/O 48 signals or more
-LAN network	: IEEE 802.3

7.1.4 Peripheral equipment of CCU

(1) Console visual display (CRT)

-Screen size	: 12 inches or more
-Screen capacity	: 1920 characters or more
-Color	: Monochrome

(2) Console printer

The same description as 7.1.2.(2).

(3) Hard disk equipment

-Storage capacity	: 40MB or more
-Data transfer speed	: 625KB/sec or more

7.1.5 File Server Equipment for Statistical Processing and Analysis

(1) CPU unit

-Consist of bit	: 32 bit
-Kind of memory	: I.C memory
-Memory capacity	: 32 MB or more more for instruction
-Clock	: 50 MHz

(2) Magnetic disk unit

-Unit type	: Fixed type
-Storage capacity	: 600MB or more
-Transfer speed	: 800KB/s or more

(3) Cartridge magnetic drive unit

-Storage capacity	: 60MB or more (600 ft tape)
-Recording density	: 800 BPI or more
-Transfer speed	: 90KB/s or more

79

(4) Floppy disk drive unit

-Recording format	: Double density
-Storage capacity	: 1.2 MB
-Average search time	: 50ms or less

7.1.6 Engineering Work Station (EWS)

(1) Display Equipment

Screen size	: 19 inch or more
Raster scan size	: 1280 X 1024 dots or more
color of display	: 16 colors

(2) Controller

-Consist of bit	: 32 bits
-Capacity of main memory	: 16MB or more
-Capacity of magnetic disk unit	: 384MB or more
-Floppy disk drive	: 1.2 MB

(3) Hard copy equipment

Printing method	: Thermal print
Recording density	: 6 dots/mm or more
Recording size	: 29 cm x 21 cm or more
Printing speed	: 60 second or less

(4) Laser beam printer

-Printing system	: Laster beam printing system
-Dot resolution	: 240 dots/inch or more
-Character set	: 128 ASCII standard
-Printing speed	: 8 sheets/minute or more
-Paper width	: 35 cm x 25 cm or more

7.1.7 File Server Equipment for interfacing with Existing Facility

(1) CPU equipment

-Consist of bit	: 32 bits
-Memory	: IC Memory
-Capacity of main memory	: 16MB or more
-Network	: IEEE 802.3
-Interface Condition	: As descrived in Appendix J

7.1.8 Multiplex Radio Communication Equipment

(1) General

The digital radio link equipment shall be installed in the link between T&T Dhaka (Ramna) and FFWC of BWDB at WAP DA building. The radio link shall be designed to operate in 2 GHz band (1.7 - 2.3 GHz) and carry 2.048 Mb/s signal.

To furnish this link, the following equipment and materials shall be supplied and installed.

(1) Digital radio relay equipment,
(2) PCM multiplex terminal equipment,
(3) Antennas and feeders.

(2) Digital Radio Relay Equipment

General

- Frequency range : Range 1.7 GHz -2.3 GHz
- Transmission capacity : 2.048 Mb/s
- RF channel spacing : CCIR REC.
- Duplex spacing : 119 MHz as standard
- Repeater type : Regenerative
- Standby system : Tx = Hot standby system
  Rx = Paralel reception

Transmitter

- Modulation : PCM-4PSK on RF
- Frequency stability : 20×10^{-6}
- RF power to the antenna branching.
- Standard transmitter : 0,1 W - 1,0 W due to path design

Receiver

- Detection : Coherent
- Intermediate freq. : 70 MHz
- Bandwidth input/out base: HDB3 (CCITT G703)

Receive threshold level at (BER 10^{-3})
: -96 dBm or better

- Power supply : 24 VDC 15%, AC 220V

Remote supervisory and control function shall be included.

(3) PCM Multiplex terminal equipment

Main features.	
CCITT Recommendation	: G.742
Multiplex bit rate	: 2048 Kb/s
Multiplexing methode	: bit by bit interleaving positive justification
Digital interfaces	: 2048 Kb/s interface
CCITT Recommendation G.703	
Bit rate	: 2048 Kb/s 50ppm
Code	: HDB3 or AMI
Pulse shape	: rectangular
Peak voltage and impedance	
Symmetric interface	
Asymmetric interface	: 3V 10%/120ohms
Pulse width	: 244 20ns
Input signal attenuation	:
Interface repeater	: 0 to 8 dB/1MHz
Terminal repeater	: 0 to 35 dB/1MHz
Jitter	: CCITT Recommendation G.823 & G.742
- Voice Ch. freq. range	: 300 - 3.400 Hz
in/out impedance	: 600 ohm - Transmitter -16dBr to + 7.5dBr - Receiver 0dBr to + 8dBr
- Signaling	: for 4 wire E & M signaling
Main Characteristic.	
CCITT recommendation	: G.732, G.737 and G.711
Sampling rate	: 8 Khz
Number of bits per sample	: 8
Companding law	: CCITT A-law
Number of time slots per frame	: 32
Number of frames per multiframe	: 16
Number of signaling channel per speech channel	: 1,2,3, or 4
Bit rate	: 2048 Kbit/s
Audio frequency performance	
CCITT recomendation:	: G.703
Bit rate	: 2048 Kbit/s 50ppm
Code	: HDB3 OR AMI
Pulse Height	: 2.37 v 10% / 75 Ohms or 30 v 10%/120 Ohms
Impedance	: 75 Ohms unbalanced or 120 Ohms balanced
Power supply	: 24 V DC, AC220v

(4) Antenna

- Frequency band	:	1.7 GHz - 2.3 GHz
- Impedance	:	50 Ohms
- Type	:	Grid parabolic

(5) Coaxial cable and connector

- Frequency range	:	1.7 to 2.3 GHz
- Type	:	low-loss, low-VSWR coaxial cable with highly formed polyethylene insulation and corrugated copper tube outer conductor.

7.1.9 Power Supply Equipment

(1) CVCF (control voltage control frequency equipment)

-input voltage and frequency	:	AC 380V +/-15% three phase 50Hz +/-2Hz
-Output voltage and frequency	:	AC 220V +/-2% single phase 50Hz +/-1Hz
-Capacity of output power	:	10KVA
-Power supply duration	:	10 minutes

(2) Surge Absorb Transformer

-Phase	:	single/Three phases
-Input voltage	:	AC 220V/380V
-Output voltage	:	AC 220V/380V
-Capacity	:	20KVA
-Impulse withstand voltage	:	10KV 1 x 40 micro V between primary -secondary, primary -grounding

7.2 T&T Terminal Station at DHAKA(RAMNA)

7.2.1 Telemetry Repeater Equipment

(1) Consists of functional units
- -Repeating control unit
- -Status return unit
- -Remote changeover unit
- -Test panel
- -Power supply unit
- -Built-in radio equipment (transmitter and receiver, 2 each)
- -Combiner for receiver output
- -Frequency control unit

(2) Status return Item
- -Transmitter No. 1 working
- -Transmitter No. 2 working
- -No transmitter failure
- -Transmitter No. 1 failure
- -Transmitter No. 2 failure
- -No receiver failure
- -Receiver No. 1 failure
- -Receiver No. 2 failure
- -Station number
- -Power supply information

(3) Function of Test panel

a. Operation	:	Power ON/OFF, Speech, Repeating-Start Repeating-Stop, Transmitter No.1 working Transmitter No.2 working, Display OFF, Transmitter changeover lock, Receiver No.1 disconnect, Receiver No.2 disconnect.
b. Display	:	Transmitting display, Transmitter working or failure display (No.1, No.2) Receiver failure display (No.1, No.2)

(4) Multiplex Radio Equipment Interface

a. I/O level	:	Gettable within a range of 0 to -25dBm
b. I/O impedance	:	600 20% balanced

7.2.2 Antenna Equipment for VHF

(1) Antenna

-Operating frequency	:	140 to 170 MHz
-Type and gain	:	3-state collinear 8 dB or more
-Impedance	:	50 ohms
-Standing wave ratio	:	1.5 or less
-Polarization	:	Vertical as standard
-Insulation resistance	:	More than 500M ohms when measured by a 500 V megger at a feeding point under dry conditions
-Dielectric strength	:	AC 1000 V for one minute

(2) Coaxial Arrester

-Impedance	:	50 ohms
-Insertion loss	:	0.5dB or less
-Standing wave ratio	:	1.2 or less at the specified frequency

7.2.3 Radio Equipment for VHF

(1) General characteristics:

-Frequency	:	140 to 170 MHz
-Modulation system	:	Phase modulation
-Frequency stability	:	Within +/- 10 x 10^{-6}
-Radio frequency input and output impedance	:	50 ohms, unbalanced
-Load S.W.R.	:	Less than 2.0
-Output power	:	10W/5W/3W/1W
-Operating Voltage	:	DC 12V

(2) Transmitter ratings

-Type of emission	:	F2 and F3
-Rated output	:	10W/5W/3W/1W
-Modulation system	:	Phase modulation
-Modulation input	:	1 KHz, linear up to 70% input level required for 70% modulation will be within -4 dBm +/- 3 dB
-Maximum frequency deviation	:	within 5 KHz
-Occupied bandwidth	:	Within 16 KHz
-S/N ration	:	45 dB or more, at 1 MHz, 70% modulation
-Distortion	:	10% or less, at 1 KHz, 70% modulation
-Spurious	:	1 mW or less, -80 dB in-band, 69 dB or less out-of-band lower than average power of fundamental wave.

(3) Receiver ratings

-Receiving system	: Crystal controlled superheterodyne system
-Bandwidth	: 12 KHz or more at 6 dB down
-Selectivity	: Within 25 KHz at 70 dB down
-Spurious response	: More than 80 dB
-S/N ration	: 30 dB or more at dB micro V input at 1KHz 70% modulation
-Squelch	: Opened at 10 dB or less noise suppression voltage, continuously variable to 20 dB noise suppression voltage
-Receiving sensitivity	: 3 dB micro V or less
-Blocking	: With a desired signal 6 dB higher that the necessary input voltage for 20 dB noise quieting the input Voltage of an desired signal being 15 KHz retuned will be 80 dB micro or more.
-Intermodulation Characteristic	: Noise quieting will be 20 dB or less when an undesired signal causing an intermodulation is applied at 65 dB micro v input Voltage without any desired signal.

7.2.4 Multiplex Radio Communication Equipment

The same description as sub clause 7.1.8.

7.2.5 DC Power Supply Equipment

(1)	Input	: AC 220V
(2)	Output voltage	: DC 24V or 48V
(3)	Battery	: Lead paste,1hour back up

7.2.6 Automatic voltage Regulator

(1)	Input voltage regulation	: AC 180V to 240V
(2)	Output voltage	: AC 215V to 225V

7.3 T&T Terminal station at Remote
(Nawabganj,Kurigram,Beani bazar and Maulvi Bazar)

7.3.1 Temeletry Repeater equipment
The same description as subclause 7.2.1

7.3.2 Antenna equipment

-Operating frequency	:	140 to 170 MHz
-Type and gain	:	5 - element yagi/9.5 dB or more 8 - element yagi/12.5 dB or more sleeve/2.0 dB or more
	:	3 - element yagi/8.0 db or more
-Impedance	:	50 ohms
-Standing wave ratio	:	1.5 or less
-Polarization	:	Vertical as standard
-Insulation resistor	:	More than 500M ohms when measured by a 500 V megger at a feeding point under dry conditions
-Dielectric strength	:	AC 1000V for one minute

7.3.3 Radio Equipments for VHF

The same description as subclause 7.2.3.

7.3.4 DC Power Supply Equipment

(1)	Input	:	AC 220V
(2)	Rectifier output	:	within 5A
(3)	Constant voltage accuracy	:	within +/- 2%
(4)	Floationg charge voltage	:	13.7V to 15.3V
(5)	Constant charge voltage	:	15.0V to 16.5V
(6)	Battery	:	Alkaline,24 hour backup

7.3.5 Automatic Voltage Regulator

(1)	Input voltage Regulation	:	AC 180V to 240V
(2)	Output voltage stability	:	AC 215V to 225V

7.4 Telemetering Gauging Station

7.4.1 Telemetering Equipment

(1) Consist of functional units
- -Modem unit
- -Date transmitting control unit
- -Receiving control unit
- -Repeater control unit
- -Input interface
- -Built-in radio equipment
- -Power supply unit

(2) Operation Items
- -Speech
- -Data code test transmission
- -Measurement of the transmitter input level
- -Measurement of the receiver output level
- -Measurement of the calling signal selection filter input level
- -Measurement of the FS modulator input signal level

(3) Construction
Bay tube

(4) Power supply unit
Input : D.C12V(-ground)

(5) Electrically connected raingauge and water-level gauge
Output format : Non-potential make contacts

Code format
-Raingauge : Contact signal of every 1mm (1 pulse/mm)(An electric counter which counts 1 mm pulse from raingauge will be installed in the telemetering equipment)

-Water-level gauge : BCD code with odd parity bit per digit (max. 4 digits)

7.4.2 Radio Equipment for VHF

The same description as subclause 7.2.3

7.4.3 Antenna Equipment for VHF

The same description as subclause 7.3.2

7.4.4 Rainfall Gauging Equipment

(1) Rainfall Gauge

-Type	: Tipping backet
-Inlet diameter	: 200mm
-Resolution	: 1mm
-Output	: Normal Open contact

(2) Automatic Rainfall Recorder

-Input	: Normal Open contact
-Recording	: Circular chart
-Continuous recording period	: 3 months

7.4.5 Water-level Gauging Equipment (Float Type)

-Type	: Float
-Range	: 0 - 20m
-Accuracy	: 1cm
-Output	: Shaft encoder BCD 3-digit

7.4.6 Water-level Gauging Equipment (Pressure Type)

-TYpe	: Pressure(ceramic)
-Range	: 0 - 10m
-Accuracy	: 0.1 % FS
-Output mode	: BCD 4 digit odd parity w/contact signal

7.4.7 Solar Cells Power Supply Equipment

-Capacity of solar cells	: 9W or more, 49W or more(only Jatrapur)
-Alkaline battery	: DC 12V 40AH or more, DC 12V 100AH or more(only Jatrapur)

CHAPTER 8 PROJECT IMPLEMENTATION PLAN

CHAPTER 8 PROJECT IMPLEMENTATION PLAN

8.1 Project Construction Plan

8.1.1 Work Item for Construction

(1) Ancillary Work

The required ancillary work for the project are classified into the following work items.

a) Preparatory Work
- -Survey including the confirmation of structures location
- -Construction of temporary house
- -Transportation of construction equipment and construction materials
- -Clearing and grubbing

In addition to the above, the coffering and dewatering works are needed for Pankha,Zakiganj,Mill Barak, Rekabi Bazar and Narayanganj stations.

b) Stilling Well
- -Earthwork such as excavation,filling and backfilling: River type
- -Spreading of sand mat and gravel base: Bank type
- -Steel frame work: River type,Bridge type
- -Metal work for stilling well,hand rail and ladder: River type,Bridge type

c) House
- -Earthwork such as excavation,filling and backfilling
- -Spreading of sand mat and gravel base
- -Concrete work including arrangement of reinforcement bars
- -Brick masonry work including stairs
- -Finishing work
- -Door work
- -Mechanical work such as ventilating and anchor bolts for fixing equipment
- -Outdoor work such as fencing

At Narayanganj station, metal work for house is needed.

d) Antenna Tower/Pole
-Earthwork such as excavation and backfilling
-Spreading such as gravel base
-Concrete work including arrangement of reinforcement bars
-Erection of antenna tower/pole

(2) Telecommunication Work

To supply the system equipment such as hydrological gauge equipment, telemetry system equipment, multiplex radio communication system equipment, data processing system equipment, the following works are needed:

a) Supply of Equipment
-Design of system equipment including the calculation, system configuration and drawings.
-Manufacturing of equipment including materials, parts, assembly, wiring, etc.
-Factory test such as visual inspection, performance test, and electric level and capacity.
-Packing
-Transportation of equipment from the country of origin to the port of Chittagong.

b) Preparatory Work
-Site survey and inspection
-Transportation of equipment from the port of Chittagong to the stock room/yard and from the stock room/yard to each site.

c) Installation Work
-Installation of hydrological gauge equipment
-Installation of telemetry equipment
-Installation of multiplex radio communication equipment
-Installation of data processing equipment
-Installation of antenna, and necessary cabling work
-Cabling or wiring for the interconnection of equipment including earthing work
-Other necessary works

d) Adjustment and Test
-Adjustment and test on individual equipment
-Overall system adjustment and test on function and

operation of the total system
-Test on completion

The required works to construct the respective stations, are checked in detail and allocated as shown in CHAPTER 6.

8.1.2 Basic Conditions for Construction

(1) Construction Methods and Materials

The structures of the ancillary work are many in number but relatively small in scale/size. The telecommunication equipment is also not so big and heavy in its size and weight respectively that the construction work could be carried out by conventional method mostly depending on the labor force, together with the application of a few construction equipment such as trucks,concrete mixers,vibrators,piling hammers, etc., which are available on rental basis in Dhaka and rural area.

The telecommunication equipment is imported because of the requirement for high standard/quality of manufacturing. The other materials of stilling wells, station house and antenna towers/poles such as cement, brick, sand/gravel, reinforcement bars,M.S pipes,etc., are available in the local market.

(2) Working Conditions

The construction work, especially stilling well in ancilary work, can hardly be performed during the rainy season, i.e. April to September,as the earth and steel frame work at each site may be affected by the flooding water.

8.1.3 Execution of Construction

(1) Execution of System

The project construction work is needed to be executed by one-package contract because of the following:

-A small delay of ancillary work will cause difficulty in the smooth installation of the telecommunication equipment. The applicable construction period is sup-

posed to be only dry season for the stilling well work. The close coordination between the ancillary work and telecommunication work is a very important requirement for successful implementation of the construction work. This close coordination can be attained only by the one-package contract.

-Most of the structures of ancillary work such as station house are designed for housing the telecommunication equipment. Therefore, even the miscellaneous work such as studtype anchor bolts for fixing equipment and small opening for cabling work should be carefully provided at the exact location to suit the installation of telecommunication equipment. This kind of works should be carried out under the close collaboration between the ancillary work and telecommunication work.

-As for the antenna towers and poles, some modifications are commonly required in the actual construction to accomodate the contractor's preferable antenna installation. This kind of re-adjustment work including the redesign work can be attained only under the one-package contract.

In view of the above, all of the ancillary work and the telecommunication work should be executed under one-package contract, in which a principal contractor is responsible for all the construction work for the project. If the principal contractor decides to make sub-contracts to local contractors, the works must be executed under the overall management of the principal contractor.

(2) Construction Schedule

Assuming that the pre-construction phase to select the contractor is finished at the end of May, 1992, the construction works can be started on June 1, 1992, and the actual construction/installation of ancillary work and telecommunication work, including test and adjustment of equipment, will be finished at the end of July, 1993(four(4) months for ancillary work and twelve(12) months for telecommunication work by overlapping both work by four(4) months).

Factory training, which consists of theory of telemetry system, manufacturing the equipment, equipment testing and

visit tour of existing stations, by the contractor will be conducted during the manufacturing period (three(3) months) of the telecommunication work. OJT training will be conducted during the overall testing for two(2) months, and also O/M training will be conducted after finishing all of works for one(1) month.

Thus, all PILOT TELEMETRY NETWORK is completed at the end of August, 1993 (fifteen(15) months after commencement of project construction work).

The results of overall time schedule is summarized below:

Work Item	Period
a) Selection of Contractor:	Sep.1991-May 1992(8.5 months)
a-1 Acceptance of Tender Document	Sep.1991-Nov.1992(2.5 months)
a-2 Floating of Tender Document and Receipt of Tender	Dec.1992-Feb.1992(3 months)
a-3 Tender Evaluation and Selection of Contractor	Mar.1992-May 1992(3 months)
b) Ancillary Work:	Oct.1992-Jan.1992(4 months)
b-1 Preparatory Work	Oct.1992 (1 month)
b-2 Construction of Station House and Antenna Tower/Pole	Nov.1992-Jan.1992(3 months)
b-3 Construction of Stilling Well	Nov.1992-Jan.1992(3 months)
c) Telecommunication Work:	Jun.1992-Jul.1993(14 months)
c-1 Initial Mobilization	Jun.1992 (1 month)
c-2 Manufacturing	Jul.1992-Dec.1992(6 months)
c-3 Factory Test	Dec.1993 (0.5 month)
c-4 Shipping/Transportation	Jan.1993-Feb.1993(2 months)
c-5 Installation Work	Mar.1993-May 1993(3 months)
c-6 Overall Testing	May 1993-Jul.1993(3 months)
d) Guidance Service:	Oct.1992-Aug.1993(6 months)
d-1 Factory Training	Oct.1992-Dec.1993(3 months)
d-2 OJT Training	Jun.1993-Jul.1993(2 months)
d-3 O/M Training	Aug.1993 (1 month)

Figure 8-1 shows the overall time schedule, and the contents is summarized as follows:

-Pre-construction phase,which is consists of acceptance,

floating and receipt of Tender, Tender evaluation and selection of contractor, is scheduled to be completed at the end of May,1992.

-The construction of ancillary work will be done prior to the installation of telecommunication work. During the ancillary work,the design,manufacturing of telecommunication equipment will be carried out simultaneously.

-As for the construction of stilling well at eight(8) sites except for the Jatrapur site, the works are arranged to be carried out during the dry season.

-The erection of antenna tower/pole is arranged after the completion of houses because it will take several months after the erection to install the equipment.

-As for the telecommunication work, three(3) months will be required for the preparatory work and installation of equipment considering the number of station and the work volume.

-Factory training will be done for two trainees by contractor between the latter period of manufacturing and factory test.

-OJT and O/M training will be conducted by two trainers such as one telecommunication engineer and one CPU engineer from two months before completion of overall test.

-The main construction works are scheduled to be completed at the end of August 1993, to catch up with the scheduled date for the operation of PILOT TELEMETRY NETWORK within 1993.

8.1.4 Organization for Project Implementation

As the core of the organization for project implementation, the the Project Management Office will be situated as the executing office. One person shall be appointed and designated as the Engineer, who will be authorized and empowered to be responsible for the implementation of the project. Also the Engineer will check and evaluate the design and documents to be prepared by the contractor.

As for the organization of the contractor, a project office will be established in Dhaka City to manage all the construction works. The project office will be composed of three sections such as ancillary section, telecommunication section and administrative section.

8.1.5 Required Work Prior to The Construction

Prior to the construction works, the following works should be completed by the Government, and the required construction spaces are also to be secured for the contractor to carry out construction works on schedule.

(1) Land Acquisition for Construction Work

Land acquisition should be carried out and/or permission for construction work should be obtained by the Government before the commencement of project construction. According to the site survey, the land owner of each construction site appears to be as follows:

Pankha	: Private
Jatrapur	: Private
Zakiganj	: Private(Paddy Field)
Tongi	: Government and Private
Mirpur	: Government and Private
Nayarhat	: Government and Private
Mill Barak	: Government
Narayanganj	: Government and Private
Rekabi Bazar	: Government

(2) Required Permission from BTTB and Radio Frequency Allocations

The following preparatory work is to be carried out by BWDB for the smooth implementation of the Pilot Telemetry Network:

a) Obtain permission from BTTB for the installation of Radio Telemetry Repeater equipment, DC Power Supply System including batteries, Antenna etc. in each of the following T&T UHF and Microwave stations.
-Nawabganj
-Kurigram
-Beani Bazar
-Maulvi Bazar
-Dhaka (Ramna)

b) Lease the following four(4) circuits from the

existing nationwide Multiplex network.
-Dhaka(Ramna) Carrier Terminal--Nawabganj Terminal
-Dhaka(Ramna) Carrier Terminal--Kurigram Terminal
-Dhaka(Ramna) Carrier Terminal--Beani Bazar Terminal
-Dhaka(Ramna) Carrier Terminal--Maulvi Bazar Terminal

c) Obtain permission from BTTB to install a PCM Multiplex (2 Mbit/s; 30 channels) Digital Radio link between T&T Dhaka(Ramna) and FF&WC at WAPDA building.

d) Obtain the necessary frequency allocations to operate the VHF Radio Telemetry links or networks and the PCM Multiplex Digital Radio System.
-Five(5) different frequencies in the VHF band, one for each of the following Radio Telemetry links or networks:
  -Nawabganj--Pankha Radio Telemetry link
  -Kurigram--Jatrapur Radio Telemetry link
  -Zakiganj--Beani Bazar Radio Telemetry link
  -Dhaka area Radio Telemetry network
  -Maulvi Bazar area Radio Telemetry network
    (149.25 MHz has already been allocated by BTTB for the purpose)
-Necessary frequencies in the 2 GHz band for the operation of the PCM Multiplex Digital Radio System between T&T Dhaka(Ramna) and FF&WC at WAPDA building

8.2 Project Cost Estimate

8.2.1 Total Project cost

The estimated total Project cost is approximately 573,276,350 yen. It consist of the following components.

a) Direct cost comprised of the following item is 468,402,000 yen.

1. Supply of Equipment and Installation works and Adjustment Test	349,063,000 yen
2. Spare parts and units (for three year)	99,054,000 yen
3. Measuring Instrument	20,285,000 yen

b) Indirect Cost composed of the following items is 75,927,000 yen.

1. Site Survey	10,390,000 yen
2. Documentation Fee	16,159,000 yen
3. Office Expenses	36,430,000 yen
4. Factory Acceptance Test	1,148,000 yen
5. Factory Training (three months)	11,800,000 yen

c) Ancillary Work : 28,947,350 yen

The foreign exchange rates use for the cost estimates were: 1 US$ = 36.75 TK = 136.1 Yen (1 TK = 3.7 Yen) at the end of August 1992.

The summary of Bill of Quotation for Bangladesh FFWS Pilot Plan except for ancillary work is shown in APPENDIX G:,and list of Spare parts and units is shown in Table 8-5.

8.2.2 Ancillary Work

Project cost estimate for ancillary work has been prepared on the basis of local man and material available in the market for execution of works by the sub-contractor.

For the mechanical part, some other equipment has been considered for carrying pipes of bigger dia; hoisting, placing in position and support from the bottom specially if the water-level does not go to the lowest on that particular period and considered on rental basis from BWDB(if available) for a period of 90 days. And the total cost of equipment has been distributed to all activities of mechanical and tower part.

The local tax and price escalation has been added to all activities, hence comes as total figure.

The project cost is estimated on the basis of schedule of work items. These work items and bill of quantity are shown in Appendix H. Summary of cost estimate is shown in Table 8-2 , material price and hire charge of equipment are shown in Table 8-3 and labour cost is shown in Table 8-4 .

8.3 Maintenance Work

All equipment must be perfectly maintained and constantly checked to meet the objective for the system to operate stably for an extended period of time after completion of the Project. Therefore, maintenance personnel must be secured and technology must be continuously improved.

Maintenance is grouped into inspection, adjustment and repair. Inspection comprises the daily, monthly and annual inspection, and the daily inspections are performed for collecting daily data, monthly inspections are to monitor the operating state of each eqipment at the sites, and annual inspection is performed to inspect each equipment and to check the station housing and surrounding conditions especially before the flood season. Moreover, there is the emergency inspection performed to check and repair any abnormal condition in and around the station housing after cyclones and heavy floods.

Since inspection is the most basic form of maintenance, it must not be overlooked to minimize the failure rate by determining the trend of equipment and detecting trouble beforehand. Therefore, an inspection manual stipulating the inspectors, inspection period,inspection group personnel,check list,etc.,must be prepared.

Adjustment is performed on parts that have been found to exceed the allowable value by measurement at the time of inspection and must be performed by highly trained engineer.

Repair must be performed immediately after a failure occurs. Onsite is often difficult because of the environment, conditions such as measuring instruments, power supply, etc., are required, and repair must be performed by replacing the faulty unit with a spare unit. The faulty unit shall be taken to the Sub-control Station for repair. This also reduces the down time.

After inspection, adjustment and repair,the measured value, trouble conditions, repair contents, etc., must be recorded in a history log to serve as maintenance reference material.

The overall maintenance manual shall be prepared after installation of equipment, in which the maintenance work items are described in detail in accordance with equipment feature. The maintenance work should be carried out as per recommendations of the maintenance manual.

8.3.1 Daily Inspection

Daily inspection consists of daily checks on the telemetering condition. The following checks are to be performed:

(1) Hydrological Gauging Network

-Daily checks for the water-level gauges may be carried out by looking into the teletyped records. When a gauge has different rising as well as falling tendency from other gauges, the gauge is considered to be malfunctioning. This check will be effective for six(6) stations around Dhaka area.

-Daily checks for the pressure type gauge may be carried out verifying teletyped records. The sensor may be dried up (out of water) in following conditions:

a) When the records show the same value for a long period of time.

b) When the records show an unexpected value which differs widely from the previous records.

c) When the records show that the values differ widely from the direct reading sent through the SSB system.

If these abnormalities occur, site inspection and switching over to the low water level sensor should be done immediately.

-Daily checks about the following items for the pressure type gauge shall be carried out on the way of reading the staff gauge.

a) Confirmation of the guide pipe of the low water sensor to be fixed,

b) Confirmation of a boat not to crash into the high water sensor,

c) Confirmation of the pole of the gauge house and antenna not to be moored by a boat.

(2) Telecommunication System

Each station is sequentially called from FFWC and the response signal tone, volume, noise, etc., are monitored. The state of each station is aquired by typing out the data. The checking items are as follows:

-Calling control operation check
-Check of station status and measured data of each station
-Monitoring of response signal level and radio wave propagation conditions
-Check of typewriter operation and contents of recording
-Check of operating conditions of repeater station and power supply state of each gauging station
-Check of data display operation on display panel

If any abnormality is detected at daily inspection, it is recorded as one of the important inspection items for the next gauging station inspections.

8.3.2 Monthly Inspection

Patrol inspection of each gauging station is performed by a team composed of a hydrologist and a telecommunication engineer. The area surrounding the station housing is cleaned and the quality of circuit is monitored by voice communication with FFWC. Each item is inspected, measured and entered in the inspection table, and then simultaneously compared with the data of the previous inspection. The inspection items consists of the following:

(1) Hydrological Gauging Network

The following checks for the network should be conducted for the rainfall gauge, the water-level gauge and the station house, respectively:

Rainfall Gauge:
-Removal of all forms of dirt/waste in the receiver
-Tipping bucket movement and associated recording condition
-Trunk connection between receiver and recorder
-Recorder pen movement and ink-release condition
-Recording paper moving condition and remaining paper length for recording
-Water drain condition

Water-level Gauge:
a) Stilling Well for Float Type Gauge
-River-bed condition for scouring
-Bank condition for erosion

-Well condition for silting and clogging
-Inlet pipe condition for clogging and scum development on the pipe wall
-Float and wire connecting condition

b) Pressure Prove for Pressure Type Gauge
-Silting condition at pressure prove
-Condition of wire connecting pressure prove and indicator
-Condition of protection pipes

c) Recorder/Indicator
-Water-level difference between staff gauge reading and recorder-indicated and/or telemetered figures
-Recorder pen movement and ink-release condition
-Recording paper moving condition and remaining paper length for recording

Station House:
-Wall,floor,and roof cracks
-Water leakage into station house
-Inside cleanliness of station house
-Air-ventilator condition
-Drain condition
-Rusting condition on all metal parts
-Broken parts where repair is necessary
-Clearing around station house
-Antenna tower/pole condition

(2) Telecommunication System

-Visual inspection of antenna and feeder
-Inspection of solar cells for soiling and damage
-Removal of branches and leaves which obstruct the rain gauge and solar cells
-Measurement of current and voltage of each part
-Inspection of storage battery electrolyte level
-Speech test with FFWC and S/N measurement
-Calibration of measured values and telemetered values
-Inspection of loose terminal screws for wires and cables between equipment

Faulty points detected by inspection must be improved and repaired quickly, even if they are trifling.

8.3.3 Annual Inspection

Based on the monthly inspection items, especisally, river-bed scouring, bank erosion and other dangerous points around the stilling well and station house are serviced, and measures are taken so that flood can be coped with. Annual inspection must be performed directly by a highly qualified engineer. The inspection items for the hydrological and the telecommunication system are as follows:

- -Items checked at monthly inspection and modulation and/or demodulation characteristics check (performed by calling signals)
- -Inspection and repair of station house surrounding banking, etc.
- -Visual inspection and reinforcing of cable lines
- -Inspection and repair of damage at station house, stilling well and surroundings

8.3.4 Emergency Inspection

Emergency inspection is necessary when the value measured at the gauging station is abnormal, when an abnormal condition has been detected at daily inspection, and when the surrounding area has been flooded and there is the danger of bank erosion or collapse of stilling well and/or station house. The inspection items are as follows:

- -The station surroungings are inspected and reinforced or repaired at gauging station where abnormal flood or abnormal rainfall causes a danger.
- -When equipment are suspected to be faulty, the faulty point is judged from the measurement conditions, and the replacement and repair is performed by spare boards and parts.

8.3.5 Adjustment

When a measured value at inspection exceeds the allowable value, it must be set to the specified value by adjustment. Adjustment must be performed by a highly qualified engineer.

In connection with a telemetering system, there is a number of troubles and failures due to the effects of cables and lines connected to the system in addition to the internal troubles of

the telemetering hardware. Such troubles due to external effects cannot easily be detected at the time of installation of the equipment and are apt to be found as troubles due to unknown causes after the installation. Therefore, the causes of such troubles should be persued to be fully cleared, taking a lot of time. The typical causes for the troubles are briefly described hereunder.

a) Problems on radio links:
-Fluctuations of incoming field
-Jamming
-Interface problems (in case of using existing radio equipment)

b) Problems on other types of link:
-Level fluctuations
-Frequency deviation
-Link down,ringer off,etc.

c) Problems on connection to sensors:
-Interface problems and others

d) Power supply voltage variations:
-Variations in environmental conditions after the installation.

In following up the above causes of troubles,it is also necessary to make long-term records. If the above points are fully checked, any cause will be easily followed up by refferring to the records.

8.3.6 Repair

For hydrological gauging stations, a complete set of gauging station equipment should be provided as spare at FFWC and this equipment should be placed in the operating state for trouble-shooting training and for test use to permit check at FFWC when there is a faulty parts.

Since the recovery time must be extremely short and adequate repair at the gauging site is not always available when trouble occurs in the telecommunication system, various spare boards and parts must be stocked to promptly restore operation of the telemetry system by replacing the faulty parts at the site.The faulty boards should be repaired at FFWC for re-use as spare parts.

Fuses,lamps,distilled water, etc., are always stocked at the measuring site as spare parts; and semi-conductors,resistors,capaci-

tors,etc.,are stocked at FFWC. After the completion of repair,the trouble conditions, trouble points, replaced parts, etc., must be recorded. Moreover, the current stock of spare parts must be monitored and insufficient parts must always be replenished.

8.3.7 Recommendations for Maintenance Work

The maintenance work plays an important role in the proper functioning of the telemetry system. Therefore, the following specialists are recommended to be selected and trained for maintenance work in the Engineering section of FFWC (Pilot Telemetry Network):

- One(1) Hydrologist
- One(1) Telecommunication Engineer
- One(1) Computer System Engineer
- Two(2) Telecommunication/Electronic Technicians
- Two(2) Mechanical Technicians
- One(1) Computer Technician

Figure 8-1 Overall Time Schedule of Project Implementation

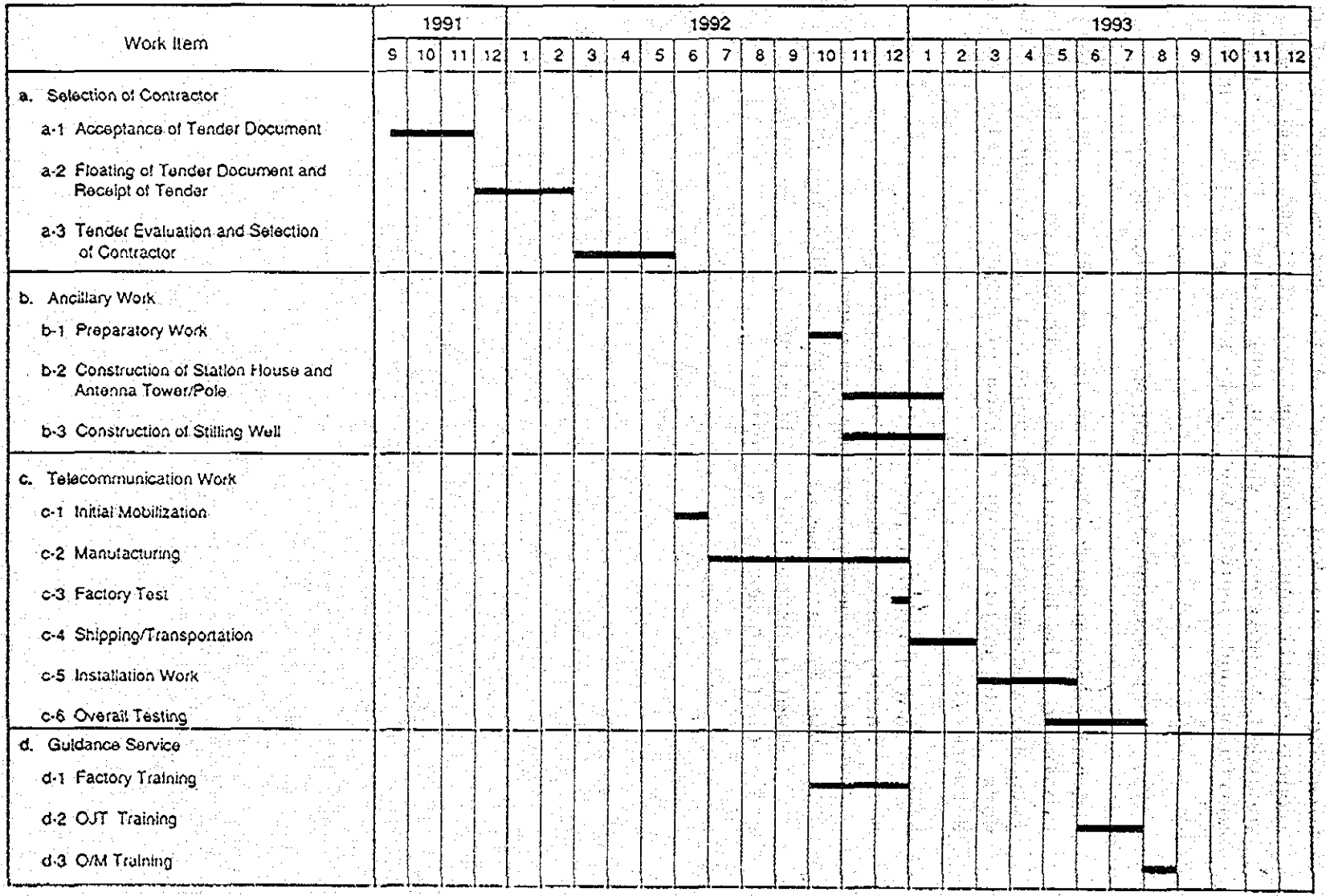


Table 8-2 Summary of Cost Estimate for Ancillary Work

	PAN KHA	JATRA PUR	ZAKI GANJ	TONGI	MIR PUR	NAYAR HAT	MILL BARAK	NARAYAN GANJ	REKABI BAZAR
PRELIMINARY	50,000	30,000	50,000	20,000	20,000	20,000	20,000	20,000	20,000
CIVIL	375,148	227,502	204,894	188,443	192,940	186,076	185,411	488	210,147
MECHANICAL	637,642	130,235	887,886	217,195	359,372	310,078	714,465	843,581	658,128
TOWER	207,489	77,330	299,911	77,330	77,330	77,330	58,142	91,785	77,330
SUB TOTAL =TK	1,270,279	465,067	1,442,691	502,968	649,642	593,484	978,018	955,854	965,605

GRAND TOTAL =T. K 7, 823, 608

EQUIVALENT TO YEN 28, 947, 350

Note:
This estimate has been prepared on the basis of local man & material for execution of work by the sub-contractor. This includes local tax but excludes the cost of acquisition/purchage of land & survey works etc.

Table 8-3 Material Price and Hire Charge of Equipment

MATERIAL PRICE — Dated, Aug. 1991

Sl. No.	Description of materials		Price in Tk.	/Unit
1	Bricks (1st. class)		2,250.00	/0% Nos.
2	Local sand (F.M. 1.5)		850.00	/% cft.
3	Sylhet sand (F.M. 2.5)		1,000.00	/% cft.
4	Cement ordinary		245.00	/Bag
5	Steel reinforcement, plain		19,000.00	/M. ton
6	M.S. Angle	1"X1"X3/16"	25,000.00	/M. ton
		1"X1"X1/8"	23,500.00	/M. ton
		1-1/2"X1-1/2"X1/4"	22,500.00	/M. ton
		2"X2"X1/4"	22,500.00	/M. ton
7	Flat bar	1"X1/4"	18,500.00	/M. ton
		1-1/2"X1/4	18,500.00	/M. ton
		2"X1/4"	18,500.00	/M. ton
8	G.I.Sheet, plain	18 gauge(8'X4')	1,400.00	/Sheet
		16 gauge(8'X4')	2,250.00	/Sheet
		14 gauge(6'X4')	1,500.00	/Sheet
9	M. S. Chaquared plate	3mm(6'X3')	4,000.00	/Sheet
		5mm(8'X4')	7,500.00	/Sheet
10	G. I. Pipe (National tube)	1/2"	70.00	/M
		3/4"	92.00	/M
		1"	135.00	/M
		1-1/2"	220.00	/M
		2"	350.00	/M
		3"	420.00	/M
		6"	1,640.00	/M
		8"	2,400.00	/M
11	M. S. Pipe (National tube)	1/2"	57.00	/M
		3/4"	85.00	/M
		1"	117.00	/M
		1-1/2"	190.00	/M
		2"	220.00	/M
		3"	380.00	/M
12	API Pipe (National Tube)	3/4"	110.00	/M
		1"	150.00	/M
		2"	320.00	/M
		3"	485.00	/M
		4"	750.00	/M
		6"	1,290.00	/M
		8"	1,900.00	/M
		8"	2,420.00	/M
13	PVC Pipe	2" dia.	12.00	/Rft
		1-1/2" dia.	9.50	/Rft
		1" dia	7.50	/Rft
		1/2" dia.	3.50	/Rft
14	M. S. Sheet	1/4" (6mm)X5'X10'	7,500.00	/Sheet
		1/4" (6mm)X4'X8'	4,600.00	/Sheet
		1/4" (6mm)X4'X10'	6,000.00	/Sheet
		3/8" (10mm)X5'X10'	11,800.00	/Sheet
		3/8" (10mm)X4'X8'	7,500.00	/Sheet
		1/2" (13mm)X4'X8'	9,500.00	/Sheet
15	Styropore Insulation	1Mx1Mx50mm	187.00	/Sheet
16	Pre-stressing tandom Guy wire,7 strand of	3/4" (20mm) dia	45.00	/Rft
		1/2" (13mm) dia	22.00	/Rft

HIRE CHARGE OF EQUIPMENT FROM BWDB

a.	Austin crane	2,000.00	/day
b.	Pipe carrying trolly	1,000.00	/day
c.	Barge 100 ton	1,500.00	/day
d.	Concrete mixture 1/2cu. yd.	1,200.00	/day

Table 8-4 Labour Cost

Description	Unit	Rate	working hrs.	Period
Carpenter for Centering	each	Tk. 120.00	per dayof 8Hrs.	Aug.1991
Carpenter for Joinery	each	Tk. 140.00	-do-	-do-
Carpenter helper	each	Tk. 80.00	-do-	-do-
Electrician Helper	each	Tk. 80.00	-do-	-do-
Electrician	each	Tk. 150.00	-do-	-do-
Head Mason	each	Tk. 140.00	-do-	-do-
Labour Sarder	each	Tk. 100.00	-do-	-do-
Mason	each	Tk. 120.00	-do-	-do-
Mechanic	each	Tk. 150.00	-do-	-do-
Machine Opeartor	each	Tk. 150.00	-do-	-do-
Machine Helper	each	Tk. 80.00	-do-	-do-
Ordinary Labour	each	Tk. 60.00	-do-	-do-
Painter	each	Tk. 120.00	-do-	-do-
Rod Binder	each	Tk. 120.00	-do-	-do-
Skilled Labour	each	Tk. 80.00	-do-	-do-
Welder	each	Tk. 140.00	-do-	-do-
Workshop Foreman	each	Tk. 140.00	-do-	-do-
Welder Helper	each	Tk. 80.00	-do-	-do-
Technician	each	Tk. 150.00	-do-	-do-

Tasble 8-5 List of Spare parts and Units 1/3

1. Spare Parts and Units

1.1 For telemetry Equipment

Description	Quantity	Remarks
a. Telemetry Equipment (For Rainfall & Water-level Gauging station	1 set	Exclude radio Equipment
b. Telemetry Equipment (For Water-level Gauging station)	1 set	Exclude radio
c. Repeater Equipment (Micro-V reaping)	1 set	Exclude radio Equipment
d. Radio Equipment	1 set	
e. D.C power supply Equipment	1 set	
f. Rain Gauge Equipment	1 set	
g. Automatic Recorder	1 set	
h. Water-level Gauge Equipment (Float Type)	1 set	
i. Water-level Gauge Equipment (Pressure Type)	1 set	
- Detector	3	With cable 100m
- Converter	3	
j. Solar cells Power Supply Equipment	1 set	
- 12V, 9.2W	2	
- 12V, 49W	2	
k. Alkaline Battery	1 set	
- 12V, 40AH	2	
- 12V, 100AH	2	
l. Printed Circuit Board	1 lot	One for each kind
- Telemetry Supervisory /Control Equipment	1 lot	
- Repeater Equipment	1 lot	
- Telemetry Equipment	1 lot	
- Water-level Gauge Equipment (Pressure Type)	1 lot	

Table 8-5 List of Spare parts and Units 2/3

1.2 For Computer Equipment

Description	Quantity	Remarks
a. Printed Circuit Board for CCU	1 lot	One for each kind
b. Console Visual Display unit	1 set	
c. Console printer	1 set	
d. Hard Disk Unit	1 set	
f. Magnetic Disk Unit	1 set	
g. CMT Drive Unit	1 set	
h. Floppy Disk Unit	1 set	
i. Controller with Display	1 set	
j. Hard copy	1 set	
k. Laser Beam Printer	1 set	

1.3 For Multiplex Communication Equipment

Description	Quantity	Remarks
a. Spare Unit for Radio Equipment	1 set	
b. Spare Unit for SV/RC Equipment	1 set	
c. Spare Unit for MUX. Equipment	1 set	

Table 8-5 List of Spare parts and Units 3/3

2. Consumables

2.1 For Telemetry Equipment

Description	Quantity	Remarks
a. Lamp and Fuse for three (3) years	1 lot	One for each stations
b. Recording paper, ink and pen for three (3) years	1 lot	One for each stations
c. Recording paper for three (3) years	1 lot	One lot for Telemetry printer

2.2 For Computer Equipment

Description	Quantity	Remarks
a. Printer Paper for CCU	300 packages	500 sheets/ 1 package
b. Printer Ribbon for CCU	150 peaces	
c. Color Hard Copy Paper	100 packages	
d. Ink sheet for Color Hard Copy	100 peaces	
e. Printer Paper for LBP	300 packages	
f. Flexible Disk	200 sheets	
g. Cartridge MT	100 peaces	
h. Lamp and fuse for three (3) years	1 lot	One set for each equipment