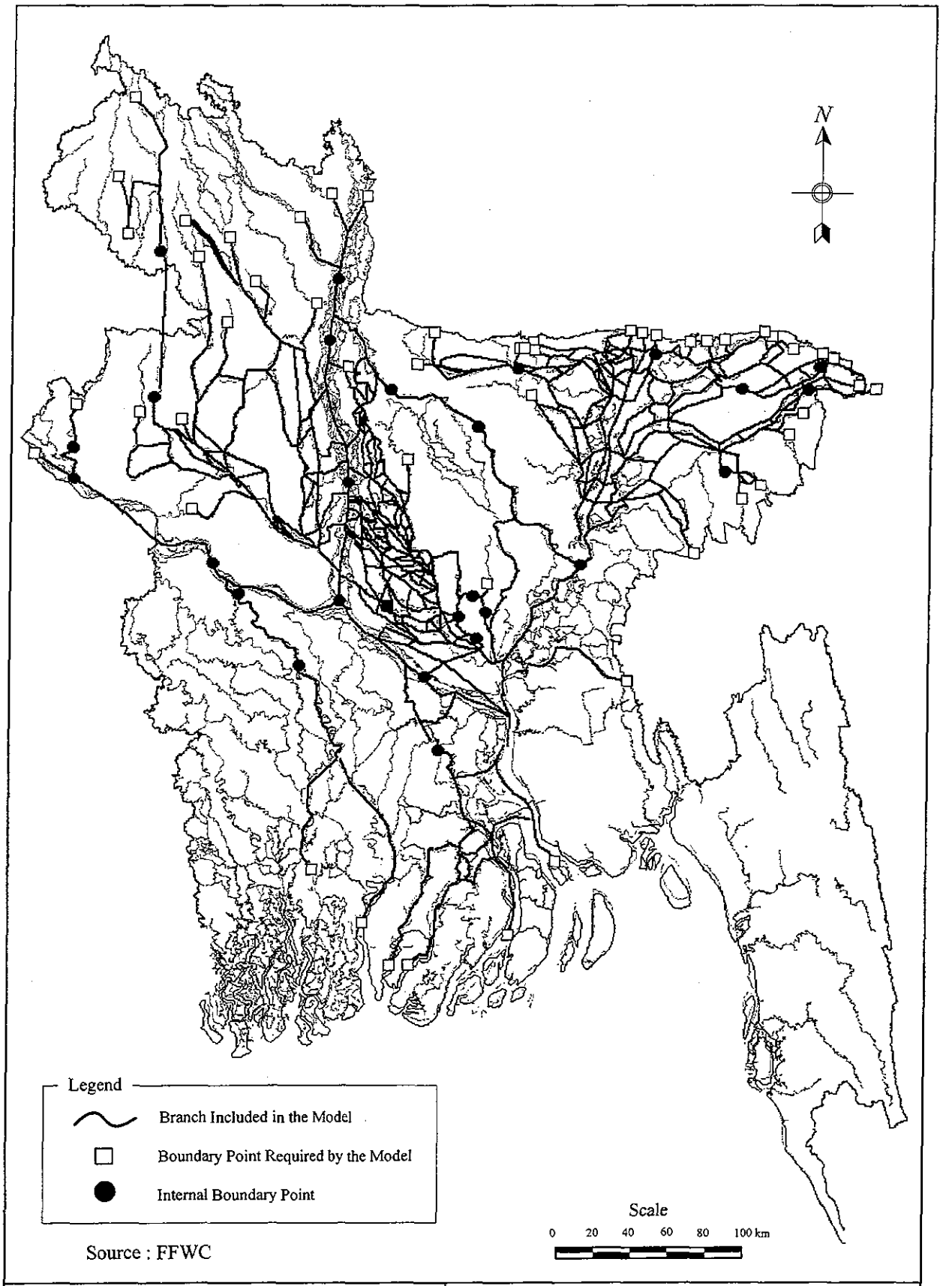
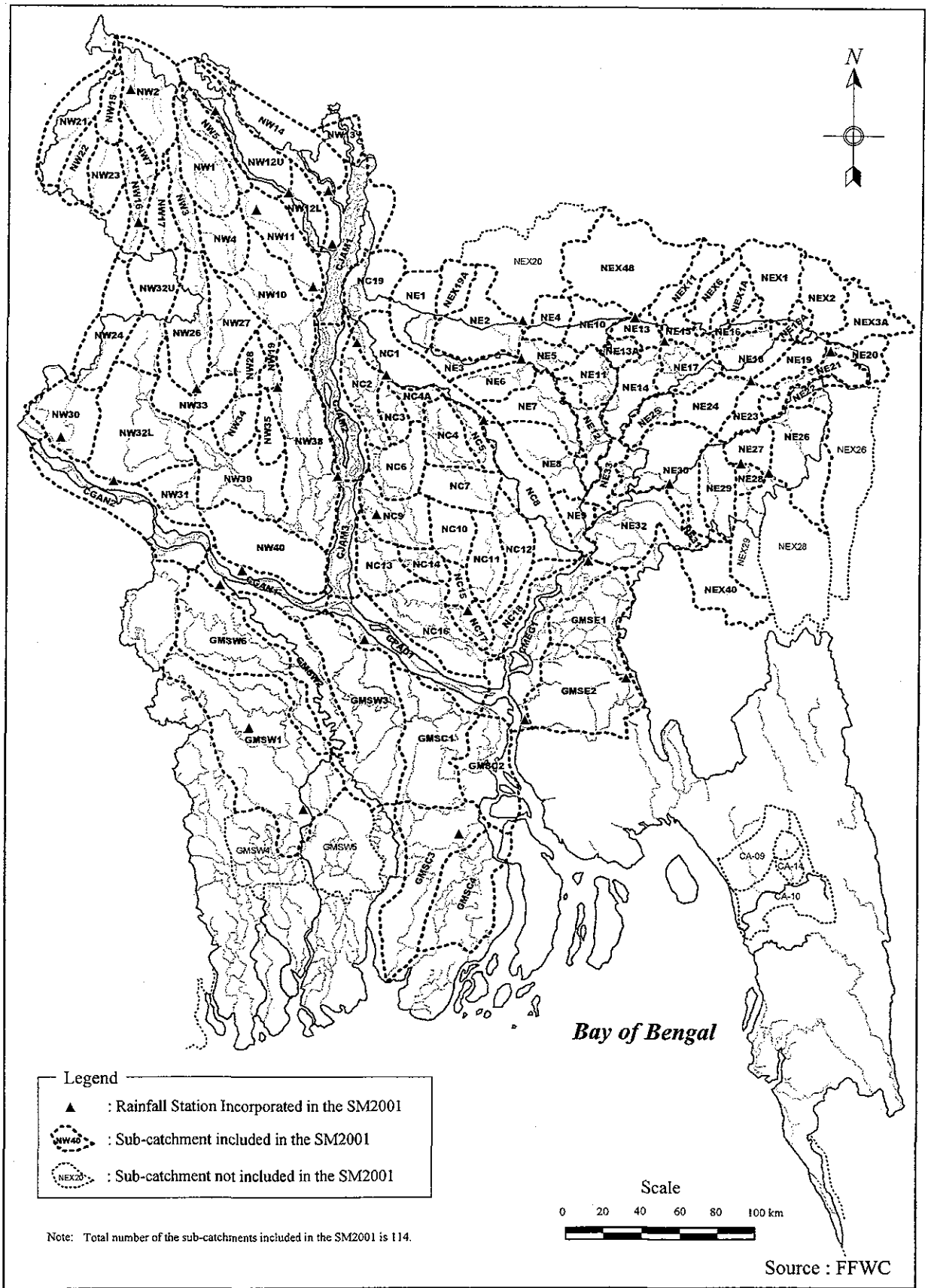


Source : FFWC

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 3.5.5
JAPAN INTERNATIONAL COOPERATION AGENCY	Branch Network of Supermodel 2001

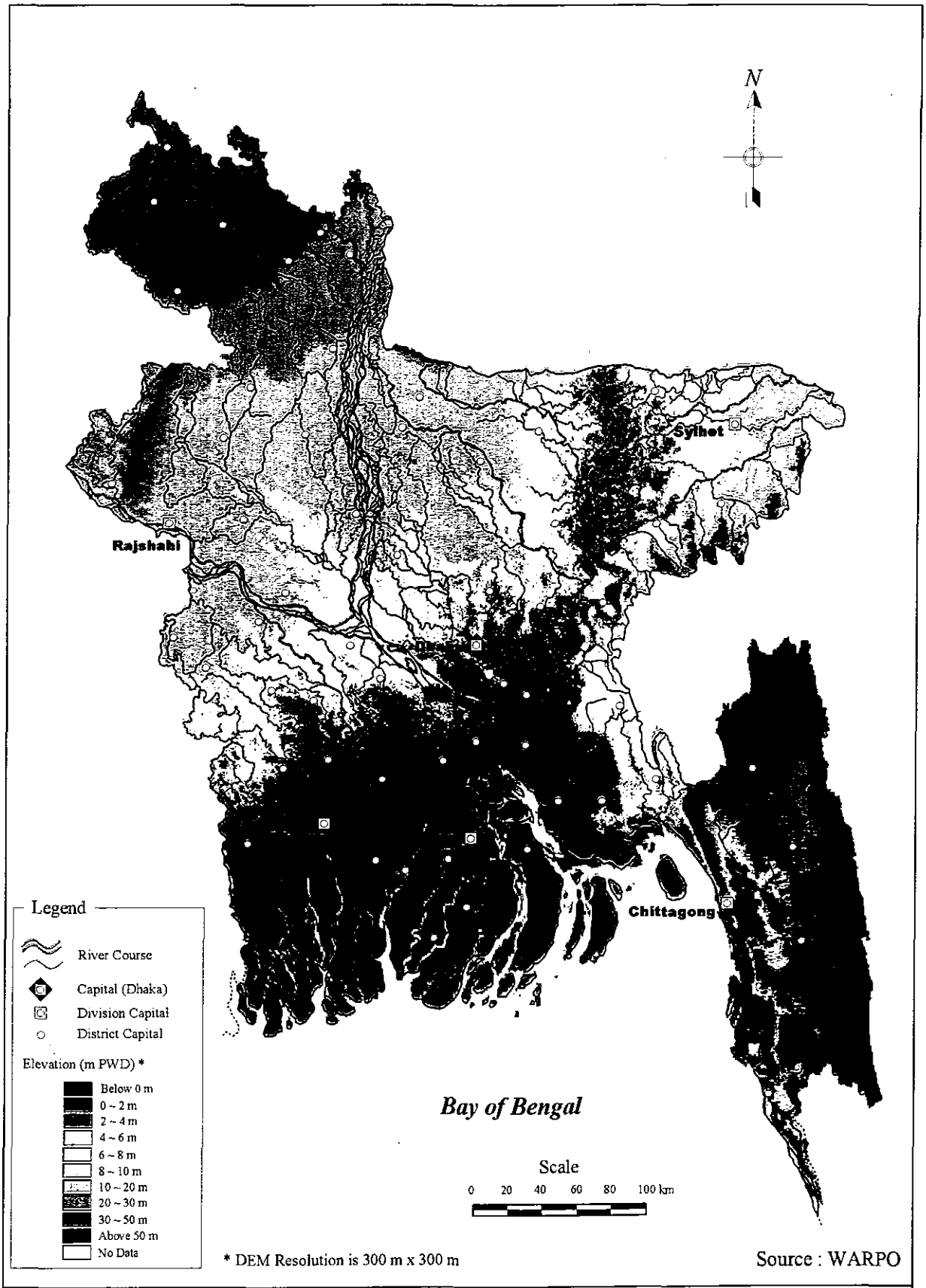


Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.5.6

Basin Division in the Supermodel 2001

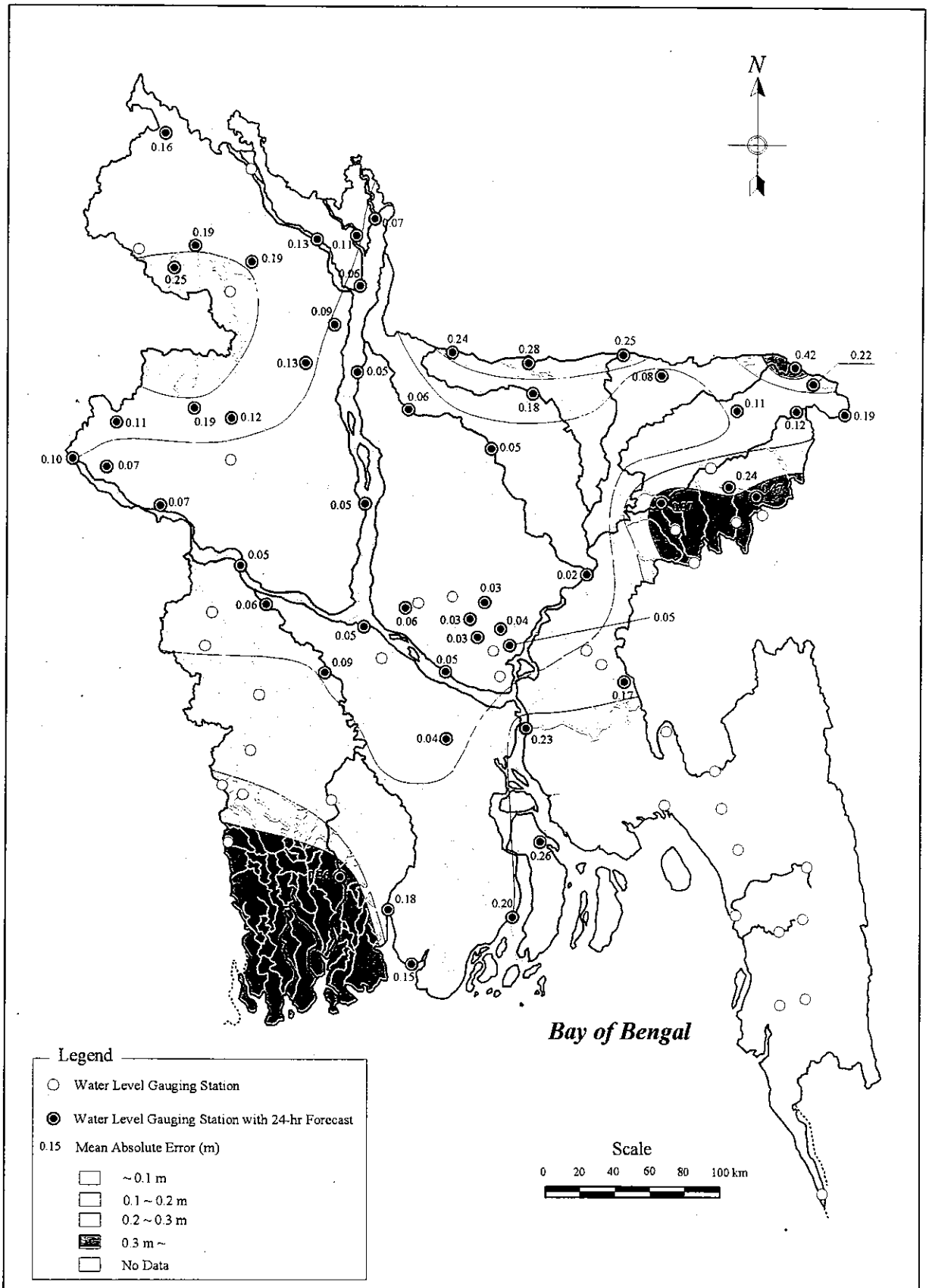


Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

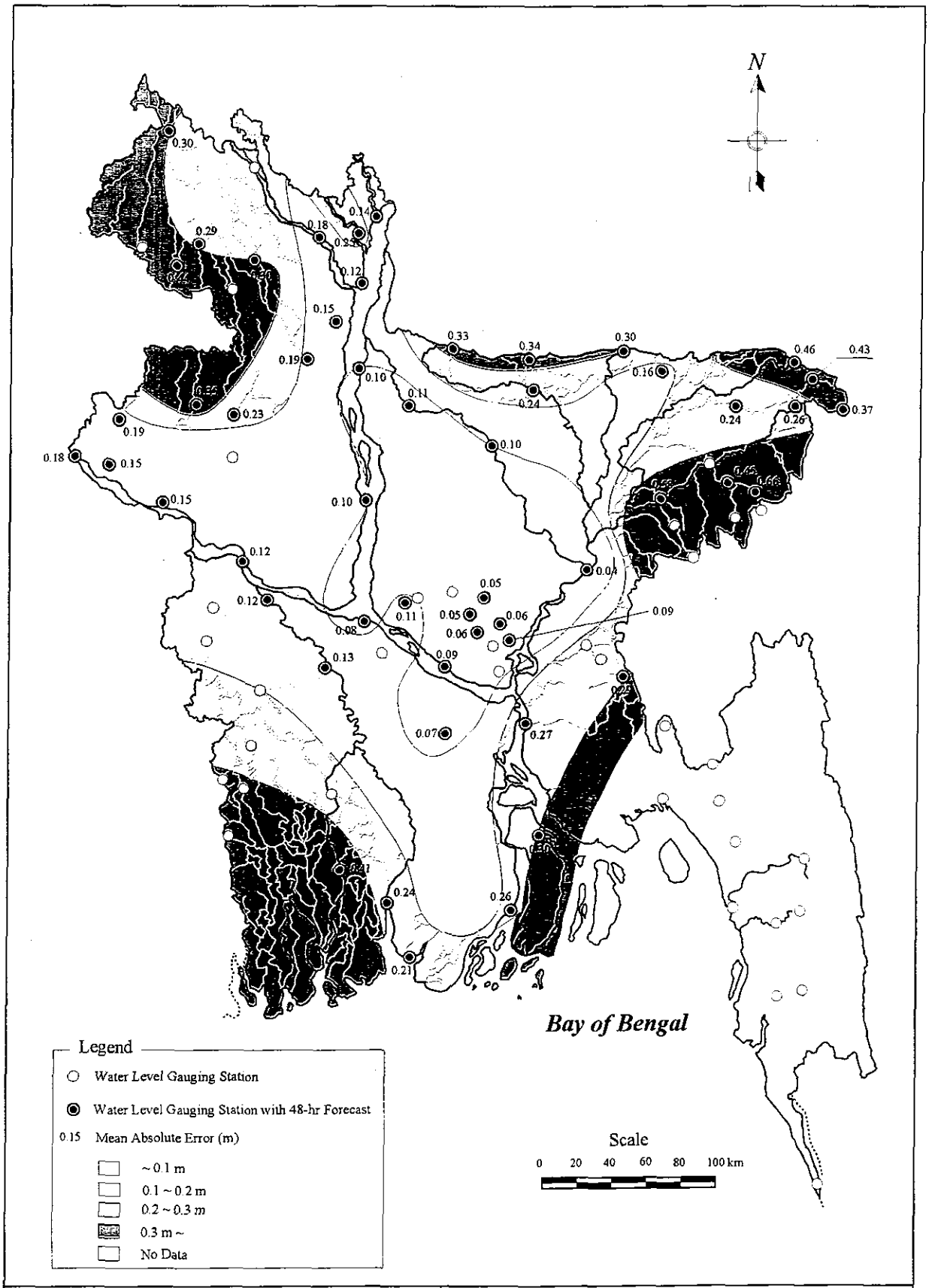
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.5.7

Digital Elevation Model of Bangladesh



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 3.5.8 Mean Absolute Errors in 24-hr Forecast
JAPAN INTERNATIONAL COOPERATION AGENCY	

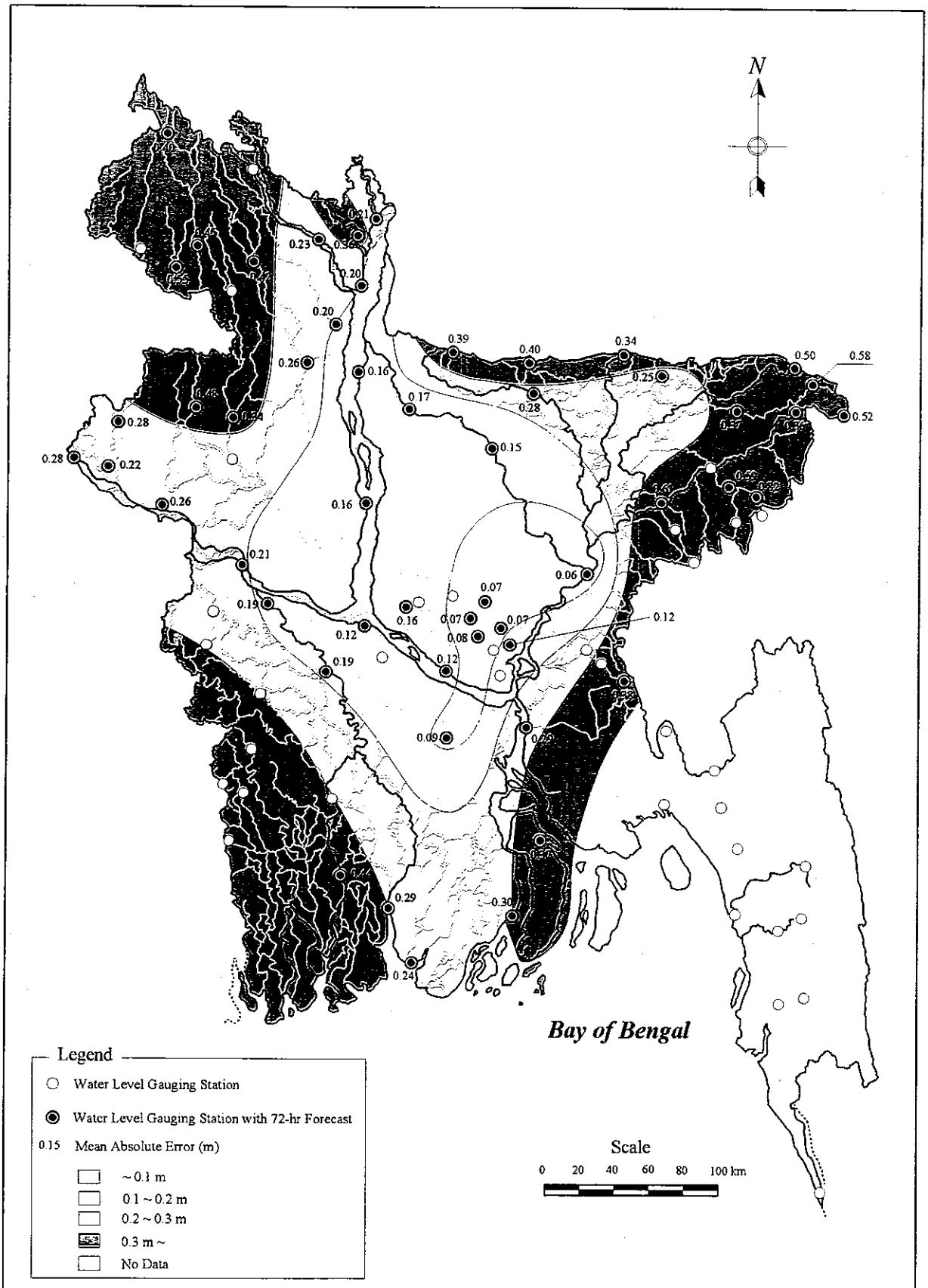


Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

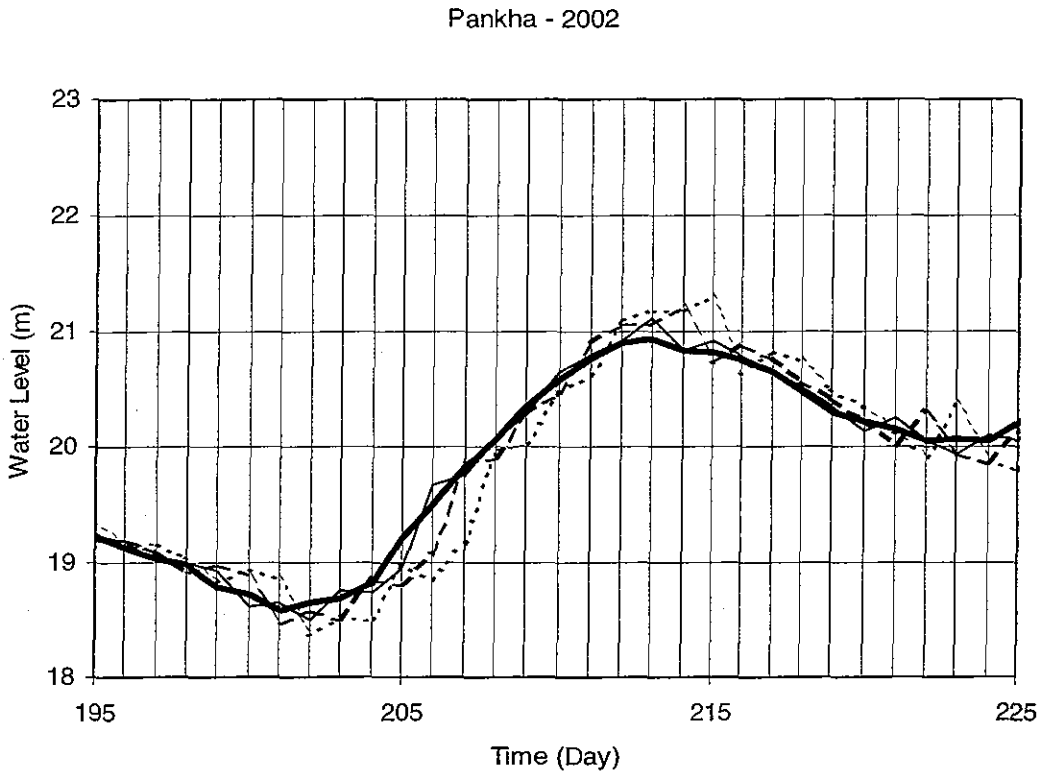
JAPAN INTERNATIONAL COOPERATION AGENCY

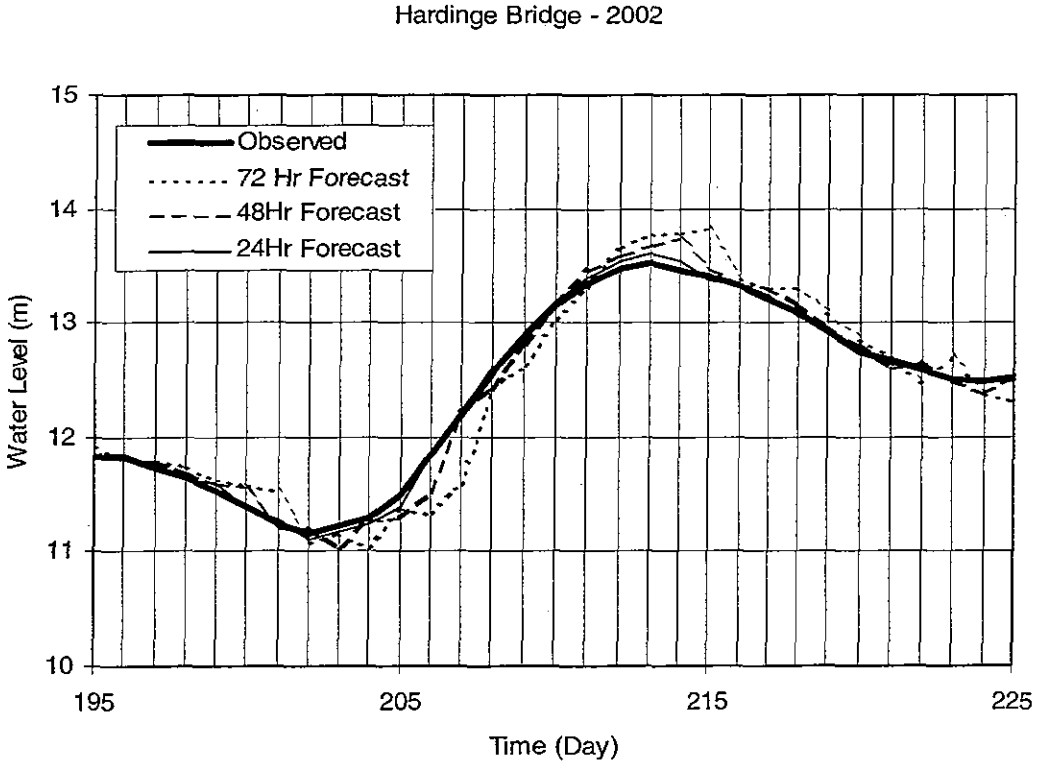
Figure 3.5.9

Mean Absolute Errors in 48-hr Forecast

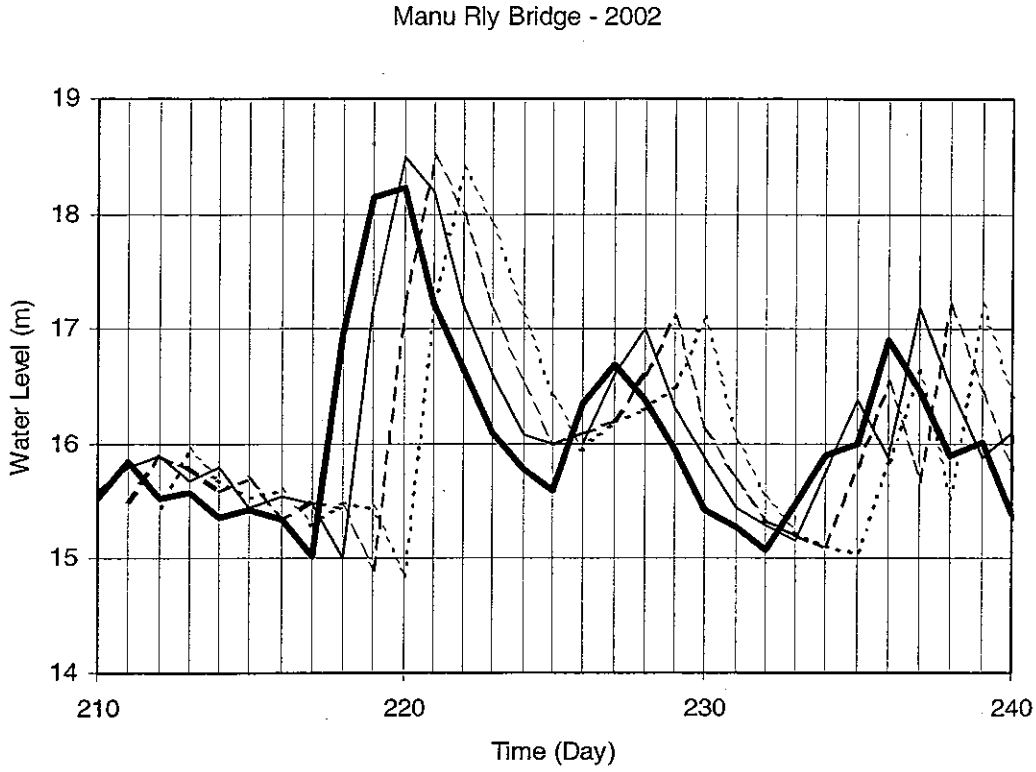


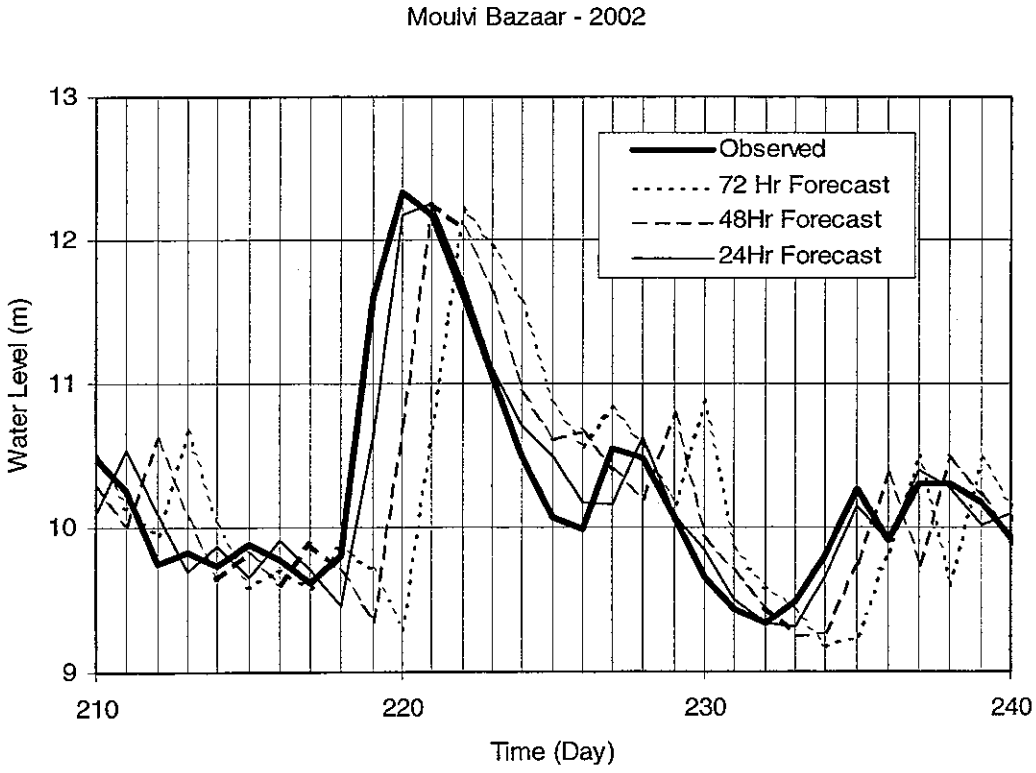
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 3.5.10 Mean Absolute Errors in 72-hr Forecast



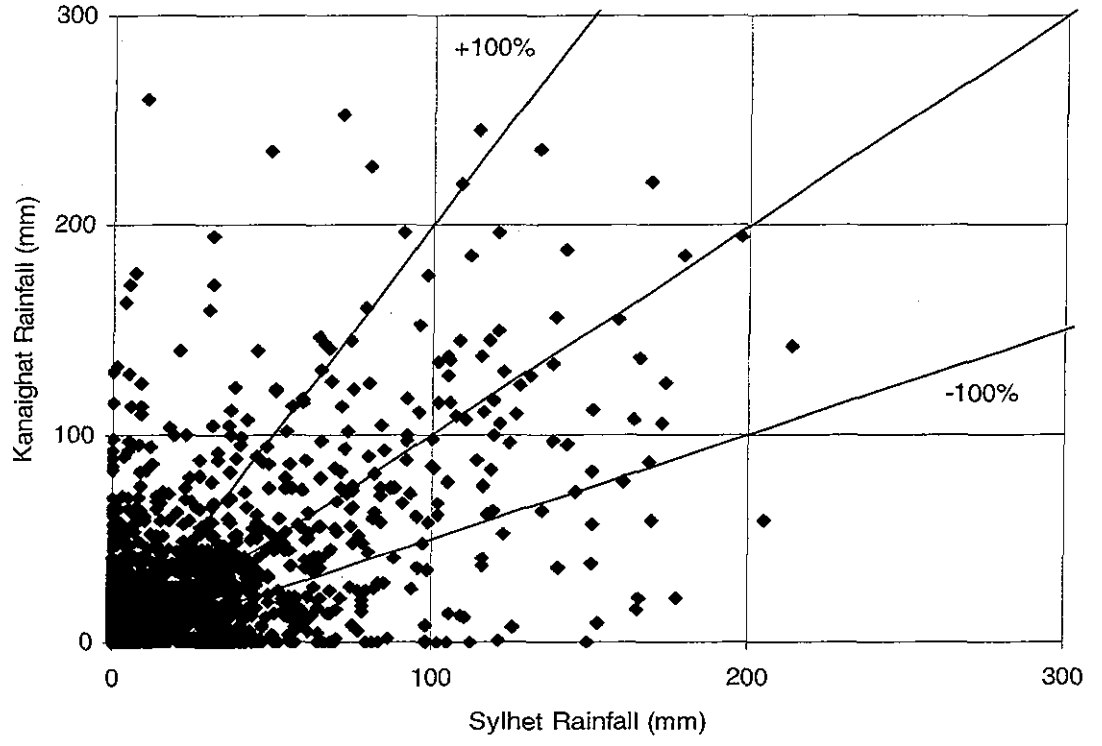


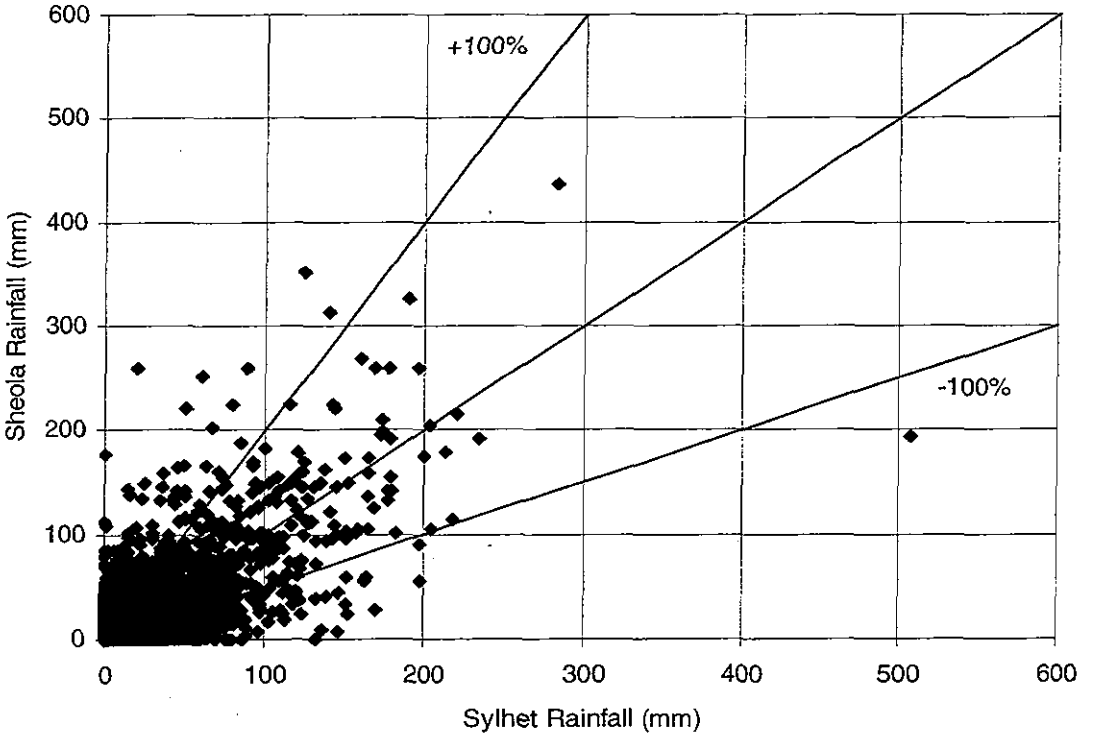
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 3.5.11 Comparison of Observed and Forecast Water Levels in Monsoonal Flood Regions
JAPAN INTERNATIONAL COOPERATION AGENCY	



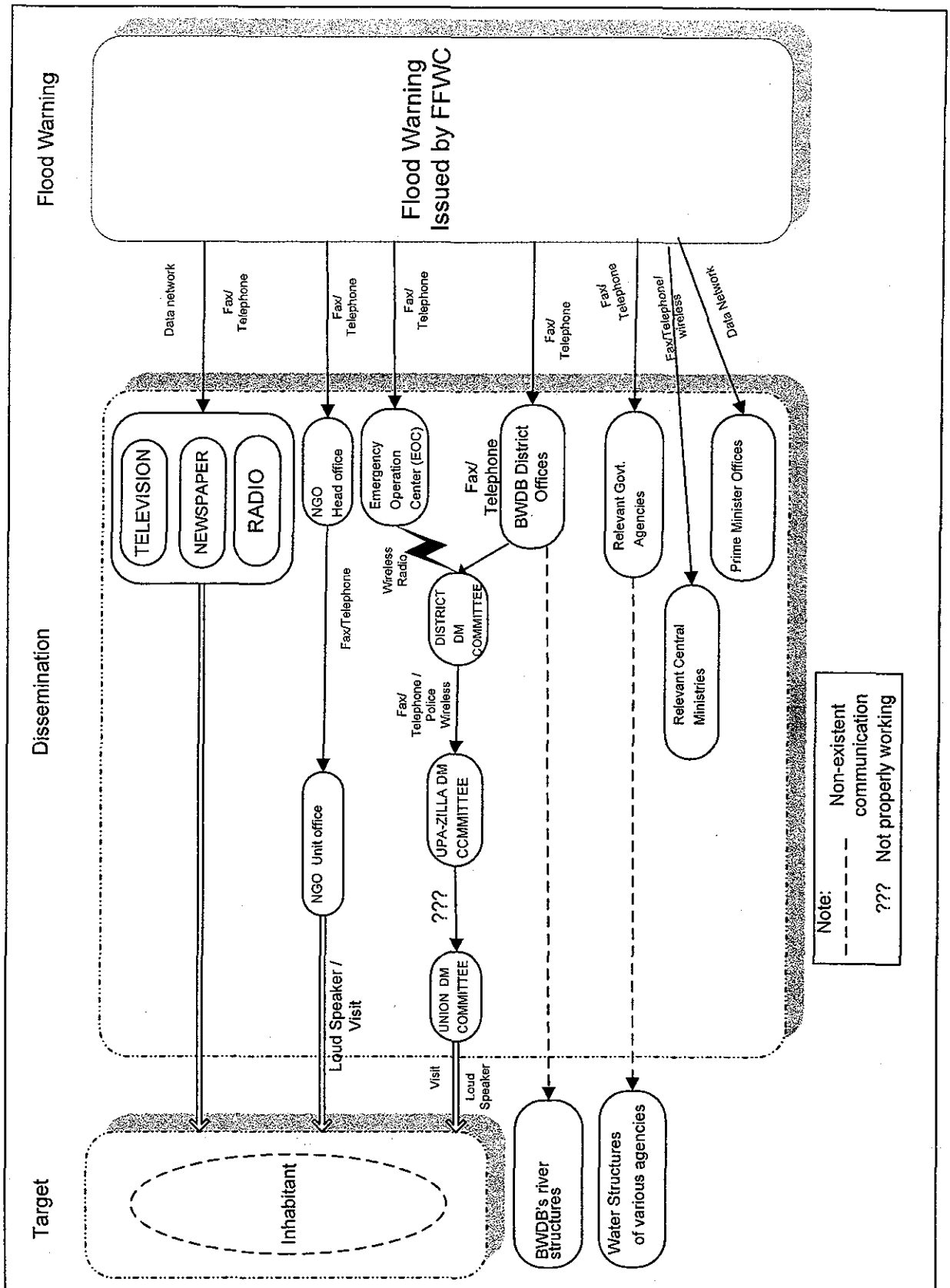


Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 3.5.12 Comparison of Observed and Forecast Water Levels in Flash Flood Regions





Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 3.5.13 Comparison of Daily Rainfalls in North-East Region of Bangladesh
JAPAN INTERNATIONAL COOPERATION AGENCY	

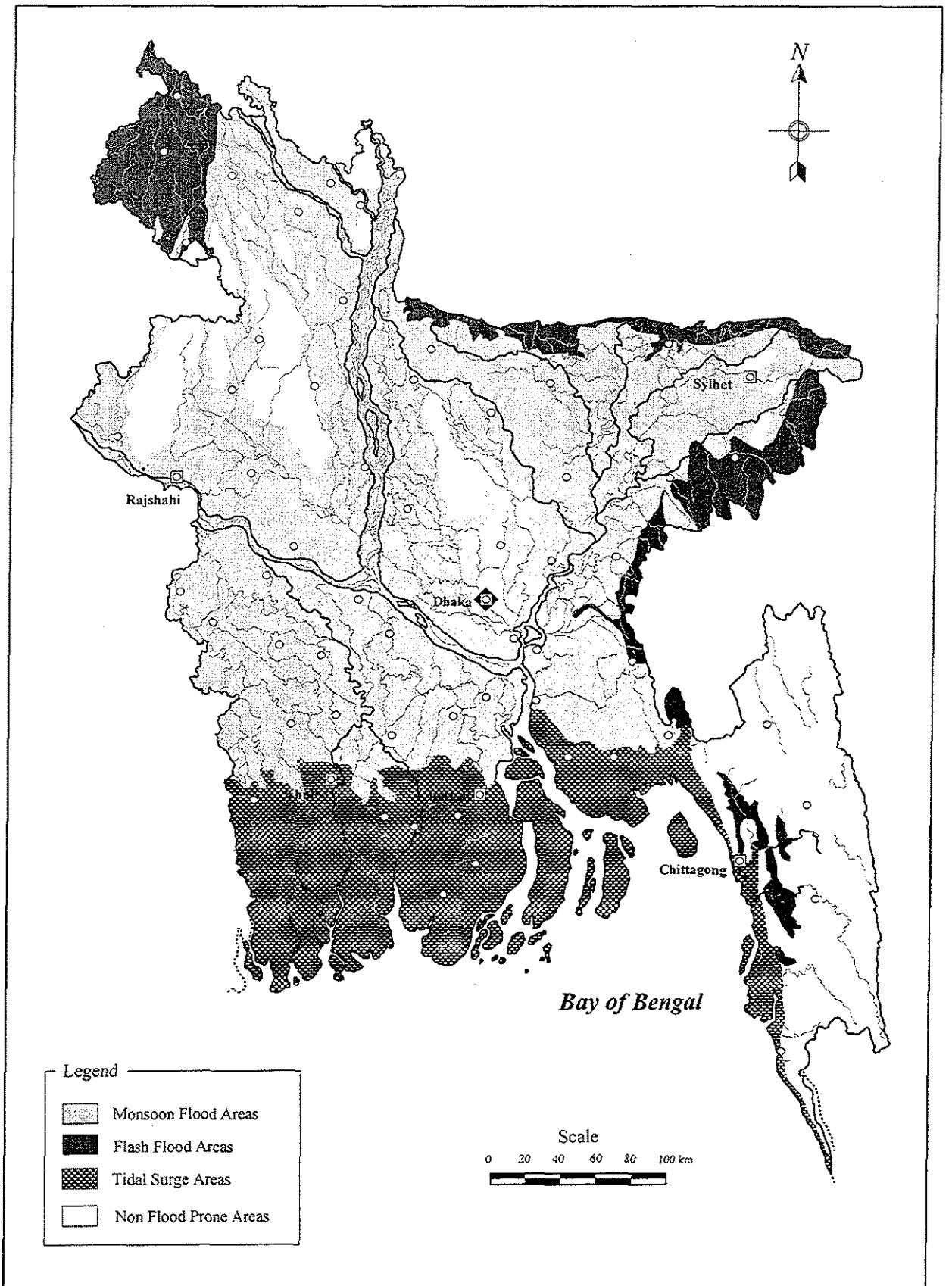


Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

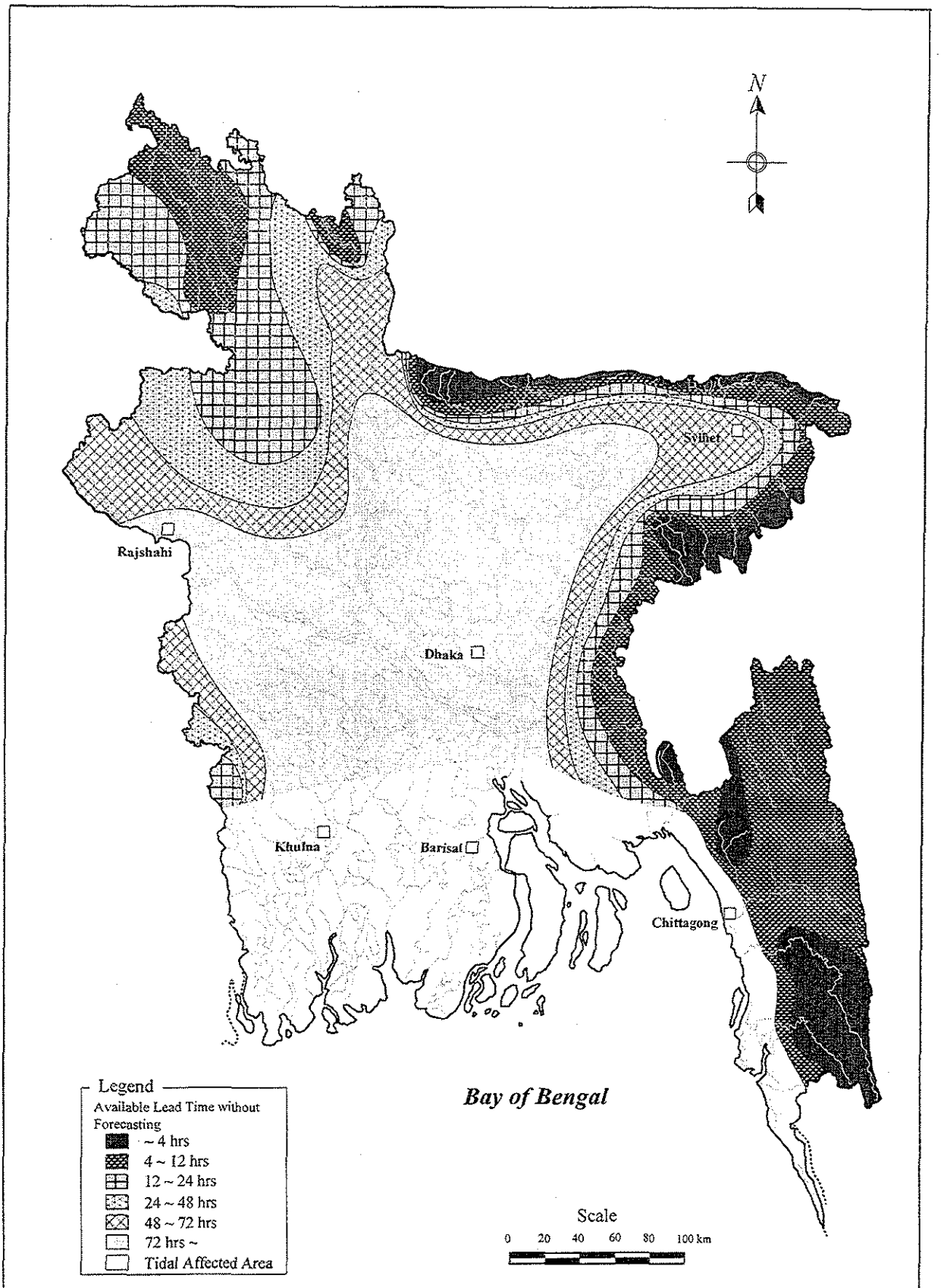
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.6.1

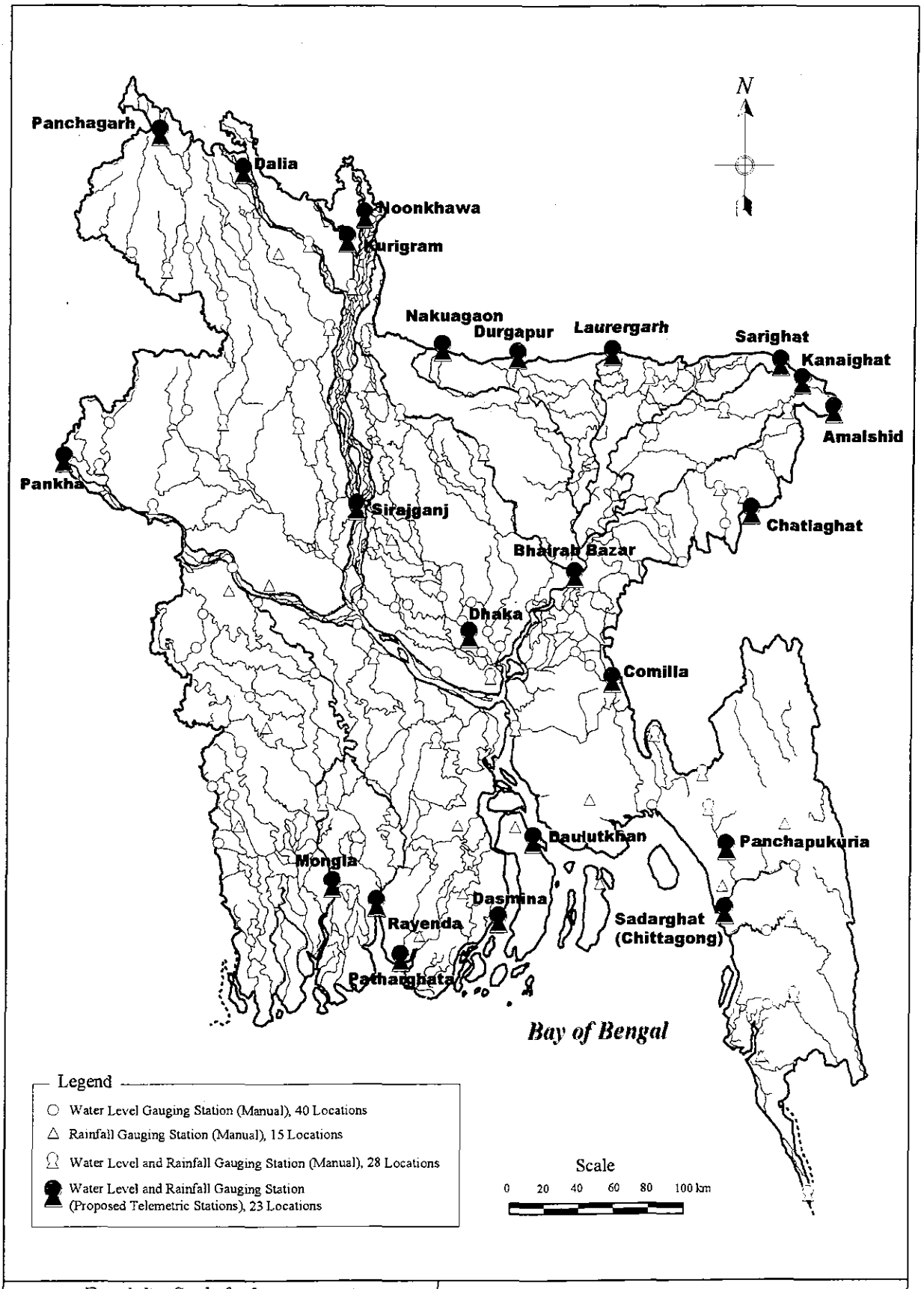
Existing Flood Warning Dissemination Flow



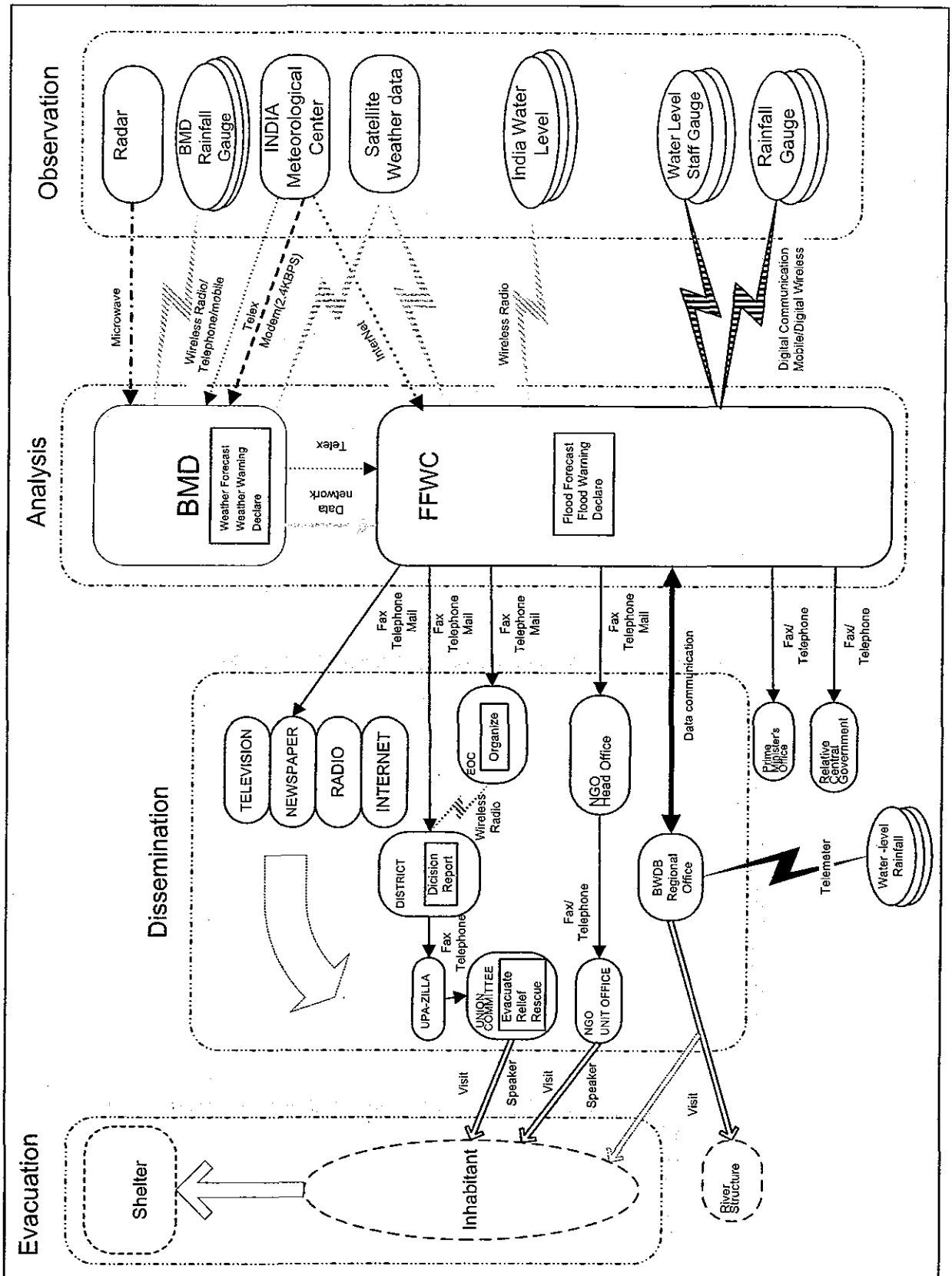
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 4.1.1 Delineation of Flood Types Based on Available Data/Information
JAPAN INTERNATIONAL COOPERATION AGENCY	



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 4.1.2 Minimum Available Time for Preparedness
JAPAN INTERNATIONAL COOPERATION AGENCY	



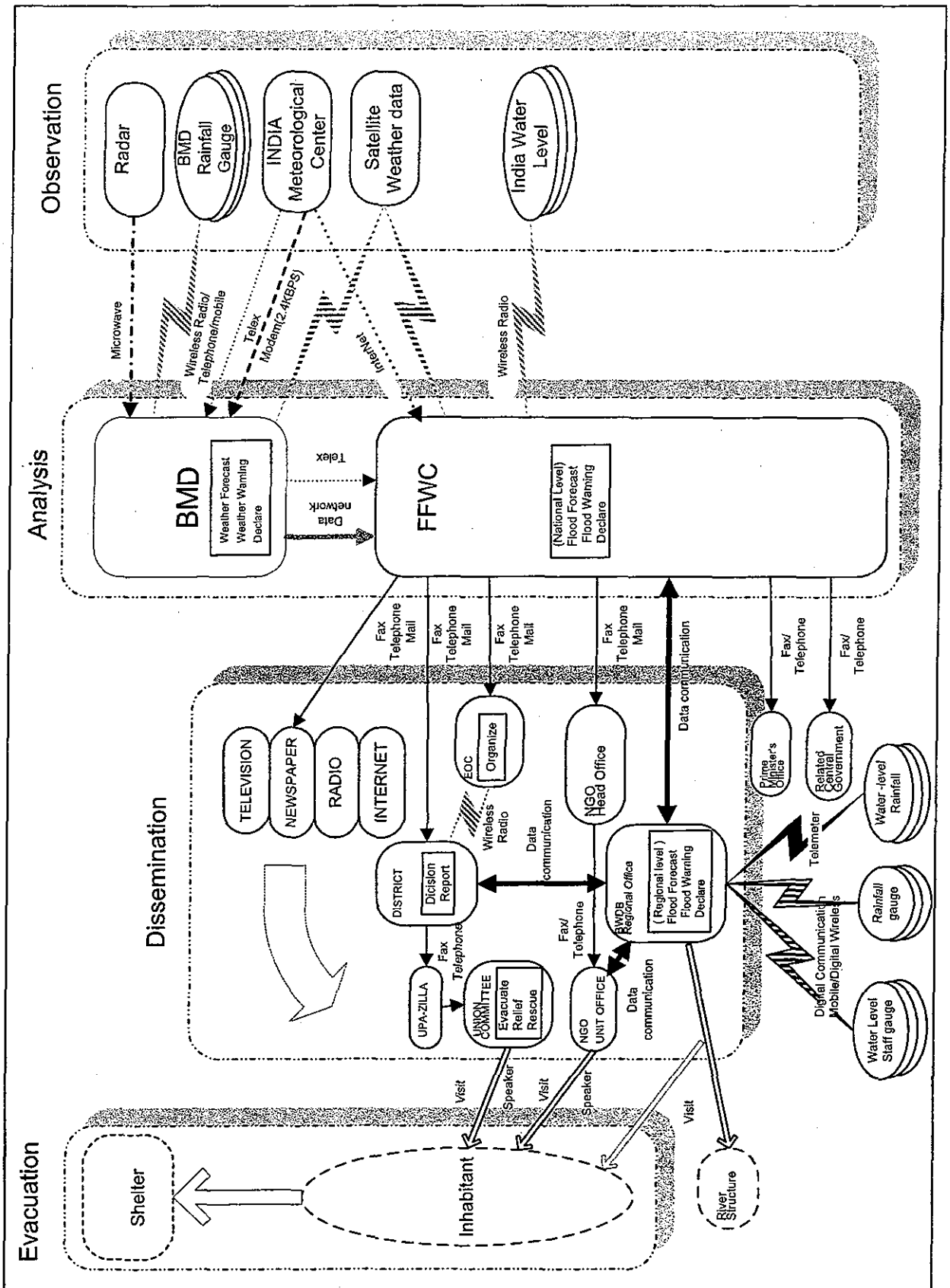
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.1 Proposed Network of FFWC Observatories



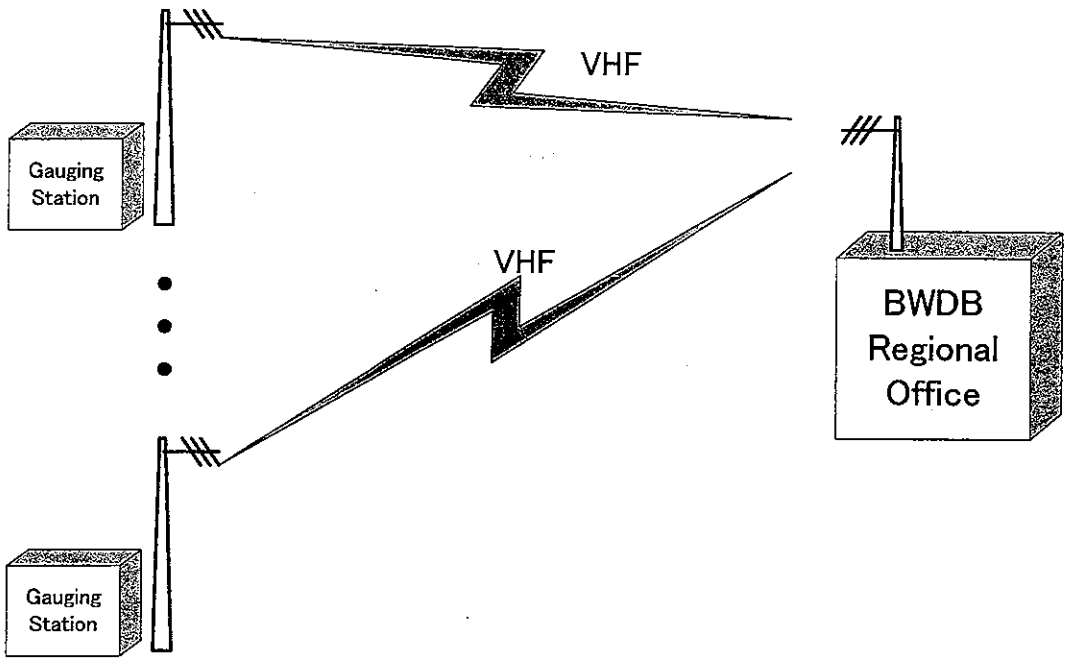
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.2.2
Alternative Communication Network
(Central Control Plan)



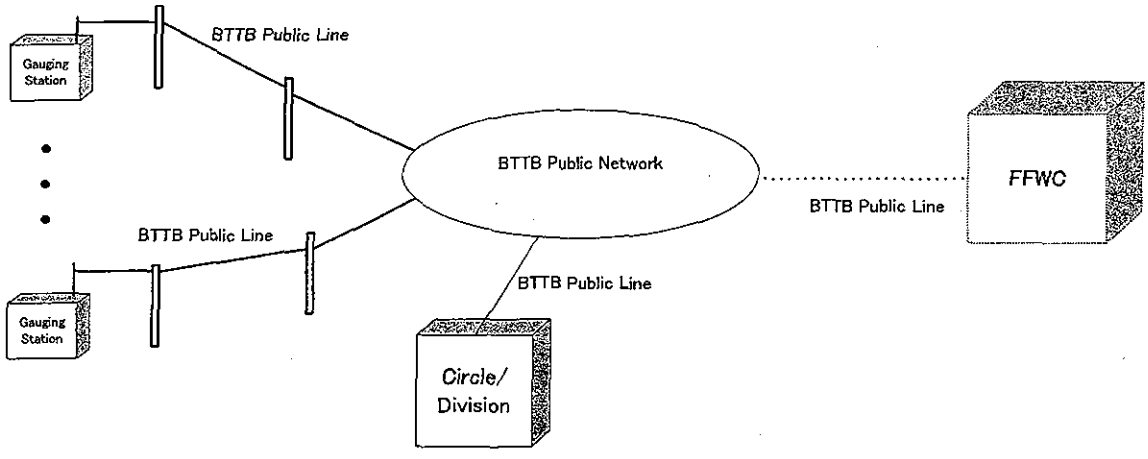
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 4.2.3 Alternative Communication Network (Regional Control Plan)
JAPAN INTERNATIONAL COOPERATION AGENCY	



OUT LINE	BWDB's VHF Line : Gauging Station – Regional Office
MERIT	Direct Monitoring at Regional Office BWDB's own Network BWDB have O/M Technology for VHF High Reliability
DEMERIT	Strengthen OM system Another high speed transmission is needed from Regional Office to FFWC
O/M	VHF Radio : BWDB have O/M Technology
Install Cost	VHF(Gauging Station):15 (Lakh)*23=345(Lakh) VHF(Repeater Station):20(Lakh) *28=560(Lakh) VHF(Regional Office):50 (Lakh)*5=250 (Lakh) Total: 1155 (Lakh)
Annual Cost	Depreciation Cost :84.5 (Lakh)

Region: 5, VHF Repeater Station: 28 Gauging Station: 23

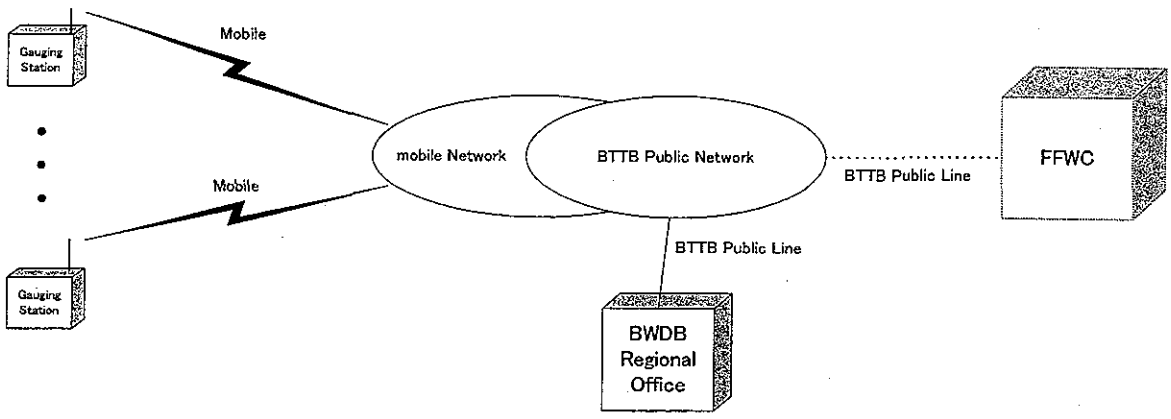
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.4 VHF Plan (Alternative 1-a)



OUT LINE	BTTB Public Line : Gauging Station – Regional Office
MERIT	Easy Install Flexible communication among Gauging station, FFWC and Regional Office
DEMERIT	Reliability of BTTB public network is not high Coverage area of BTTB public network is limited
O/M	BTTB Line : Out saucing
Install Cost	Gauging St. : 5(Lakh)*23=115(Lakh) Regional Office:5(Lakh)*5=25 (Lakh) Total :140 (Lakh)
Annual Cost	BTTB: (150(Tk)*12 +1.7(Tk)*24*365)*23=383,916(Tk)=4 (Lakh) Depreciation Cost :14.5 (Lakh) Total :18.5 (Lakh)

Region: 5, Gauging Station: 23

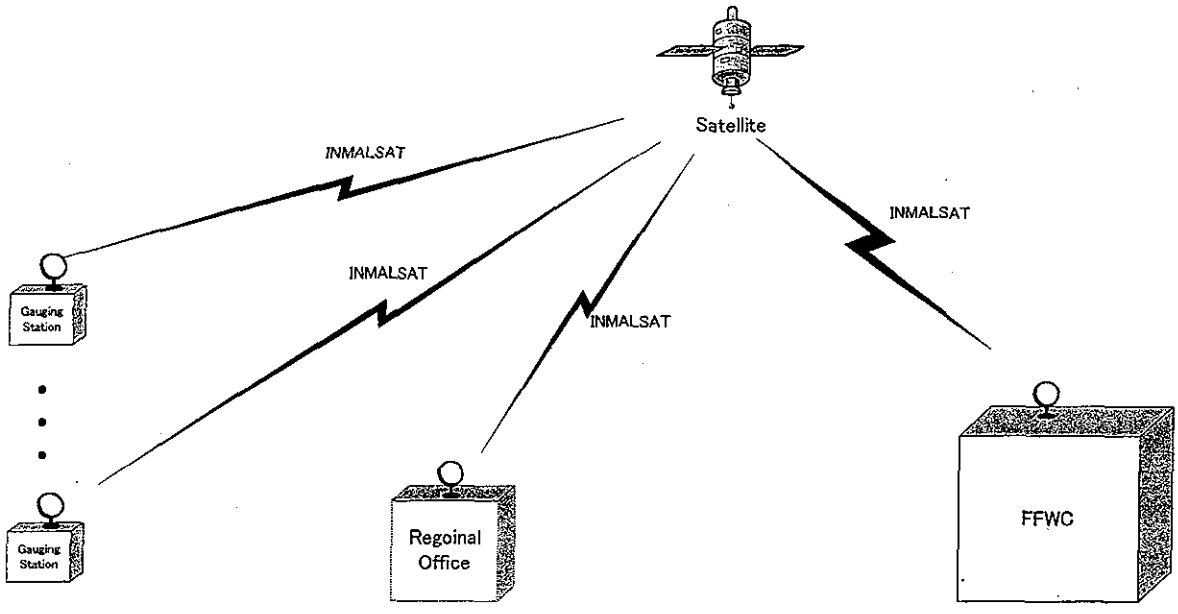
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.5 BTTB (Public Line) Plan (Alternative 1-b)



OUT LINE	Mobile Line : Gauging Station – Regional Office
MERIT	Easy Install Connectivity between mobile network and BTTB public network is good. Flexible communication among Gauging station, FFWC and Regional Office
DEMERIT	Reliability of Mobile network and BTTB public network is not high
O/M	Mobile Line : Out saucing
Install Cost	Gauging St. : 5(Lakh)*23=115 (Lakh) Regional Office:5(Lakh)*5=25 (Lakh) Total :140 (Lakh)
Annual Cost	Mobile:(300(Tk)*12+4(Tk)*24*365)*23=888,720(Tk) =9Lakh) Depreciation Cost :14.5 (Lakh) Total :23.5 (Lakh)

Region: 5, Gauging Station: 23

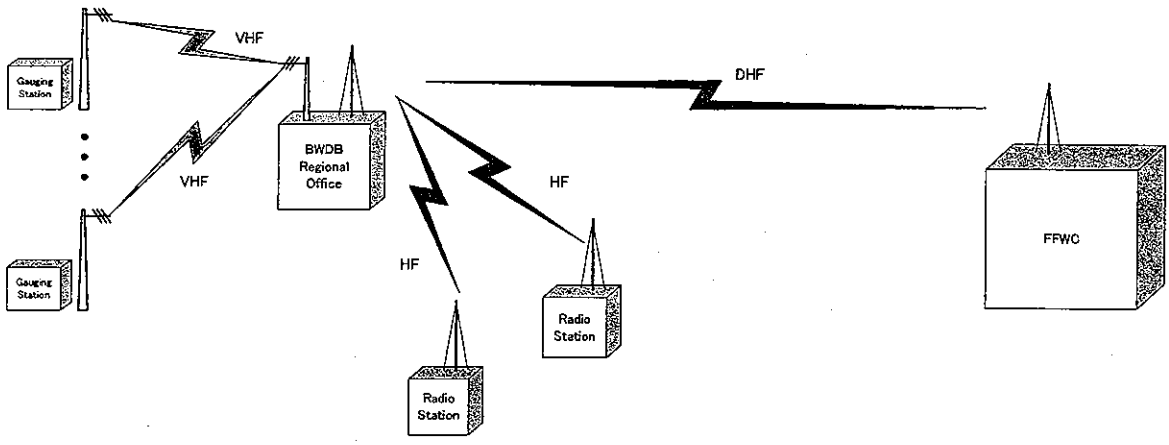
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.6 Mobile Network Plan (Alternative 1-c)



OUT LINE	INMALSAT : Gauging Station – Regional Office
MERIT	Easy Install Flexible communication among Gauging station, FFWC and Regional Office
DEMERIT	Monthly Cost INMALSAT Equipment should be maintenance by BWDB(or lease company)
O/M	BWDB or lease company
Install Cost	*Gauging St. :20(Lakh)*23=460 (Lakh)* Regional Office: 20(Lakh)*5=100 (Lakh) *Total :560 (Lakh)*
Annual Cost	250(Tk) *24*365*23=50,370,000(Tk)=504 (Lakh) Depreciation Cost :58 (Lakh) Total :562 (Lakh)

Region: 5, Gauging Station: 23

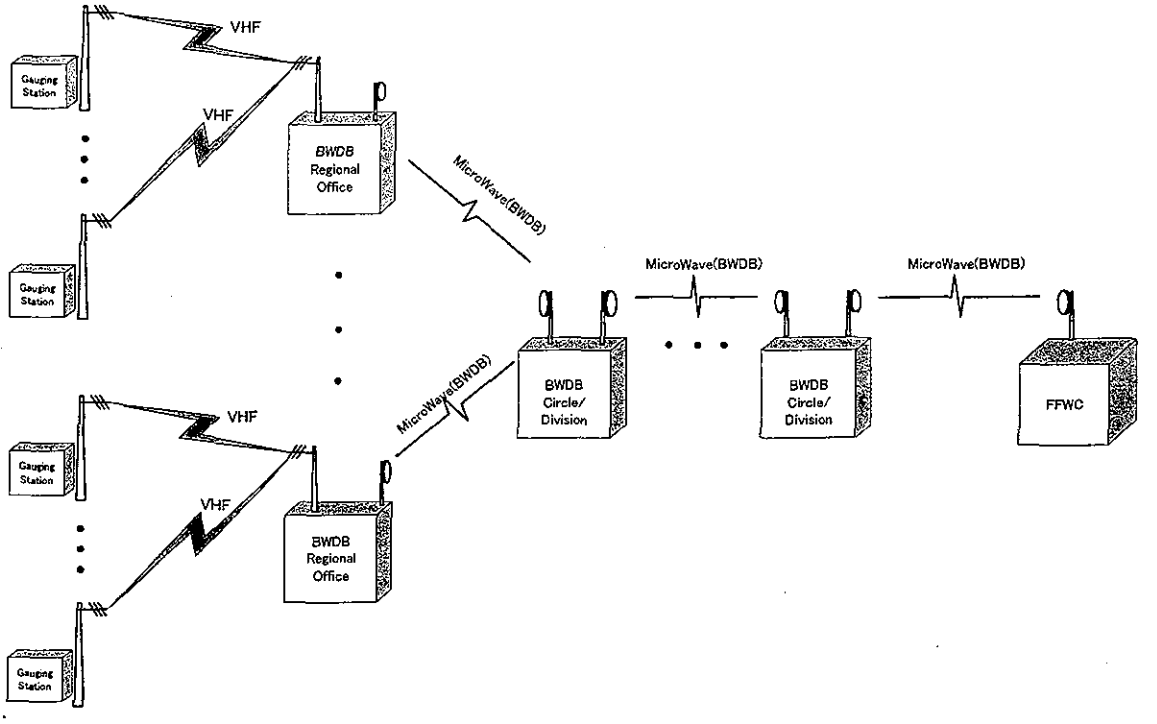
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.7 INMALSAT Plan (Alternative 1-d)



OUT LINE	BWDB's DHF Line: Regional Office – FFWC
MERIT	Direct Monitoring at Regional Office BWDB own network Both data and voice communication between Regional Office and FFWC Effective Usage of HF Frequency (HF radio is used for manual observation)
DEMERIT	Low Reliability of DHF(for Data transmitting) (Data check function or Back up line is needed)
O/M	DHF : BWDB have O/M Technology
Install Cost	Regional Office : 6(Lakh)*5=30 (Lakh) FFWC : 6(Lakh)*1=6 (Lakh) Total :36 (Lakh)
Annual Cost	Frequency using cost :1,150,000(Tk)=11.5(Lakh) Depreciation Cost :4.2 (Lakh) Total :15.7 (Lakh)

FFWC: 1, Region: 5

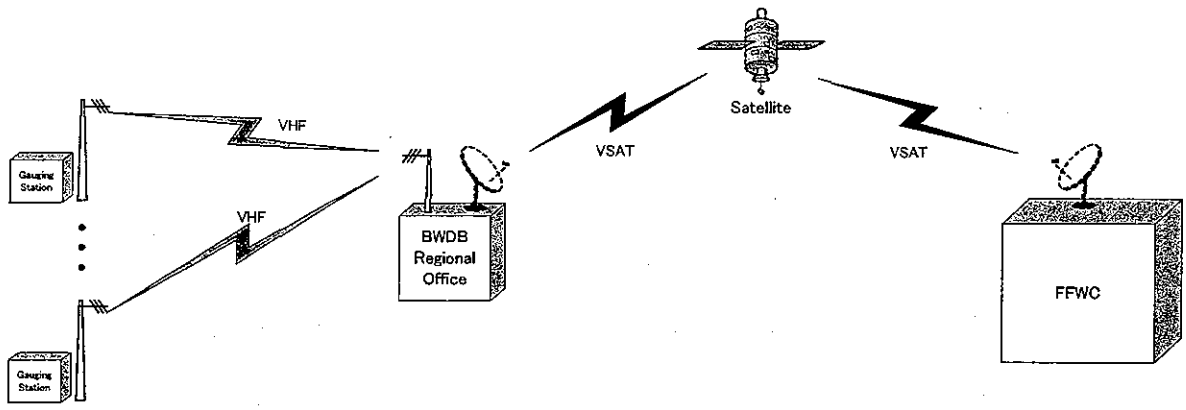
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.8 Digital HF (DHF) Plan (Alternative 2-a)



OUT LINE	BWDB's MICROWAVE : Regional Office – FFWC
MERIT	BWDB own network High reliable and High capacity Data Communication between Regional Office and FFWC
DEMERIT	OM System (Cost, Staff, Organization) for Microwave
O/M	MICROWAVE : BWDB should have O/M Technology
Install Cost	Regional Office: 20(Lakh)*5=100 (Lakh) Repeater St.: 20(Lakh)*13=260 (Lakh) FFWC: 20(Lakh)*1=20 (Lakh) Total :380 (Lakh)
Annual Cost	Depreciation Cost :34 (Lakh)

FFWC: 1, Region: 5, Microwave repeater station: 13

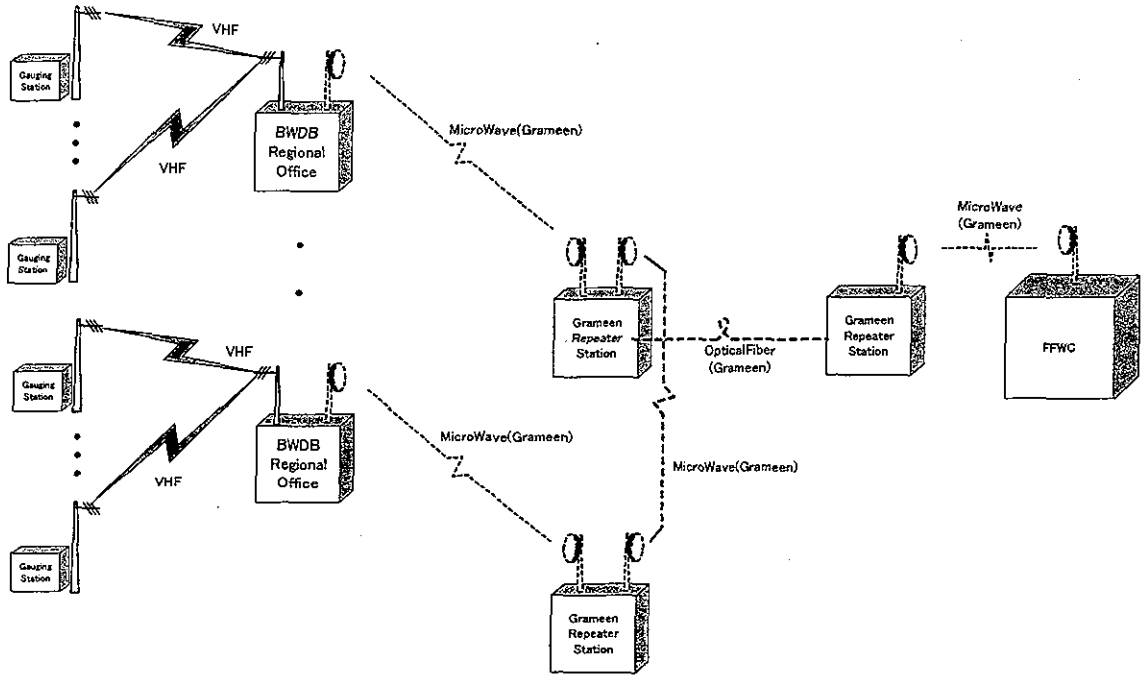
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.9 BWDB-Microwave Plan (Alternative 2-b)



OUT LINE	VSAT : Regional Office– FFWC
MERIT	Direct Monitoring at Regional Office High quality Data and voice Communication between Regional office and FFWC
DEMERIT	VSAT Monthly Cost VSAT Out sourcing to private company
O/M	VSAT : Out saucing
Install Cost	Regional Office : 3.5 (Lakh)*5=17.5 (Lakh) FFWC : 3.5 (Lakh)*1=3.5 (Lakh) Total :21.0 (Lakh)
Annual Cost	VSAT: 17,500(Tk) *12*5=1,050,000(Tk) =10.5(Lakh) Depreciation Cost :2.5 (Lakh) Total :13.0 (Lakh)

FFWC: 1, Region: 5

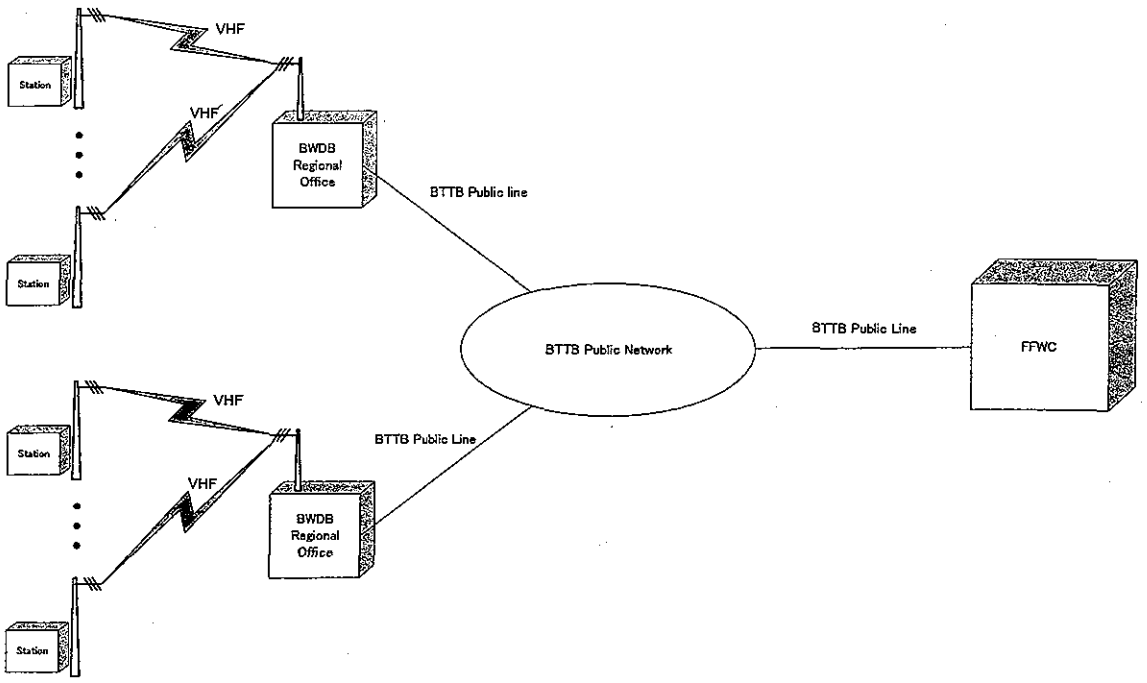
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.10 VSAT Plan (Alternative 2-c)



OUT LINE	GRAMEEN Line: Regional office – FFWC
MERIT	Direct Monitoring at Regional Office High quality Data and voice Communication between Regional office and FFWC
DEMERIT	Monthly Cost GRAMEEN is the private company
O/M	GRAMEEN Line : Out Sousing
Install Cost	Regional Office :2(Lakh)*5=10 (Lakh) FFWC : 2(Lakh)*1=2 (Lakh) Total :12 (Lakh)
Annual Cost	GRAMEE:240,000(Tk) *5=1,200,000(Tk)=12.0(Lakh) Depreciation Cost :1.4 (Lakh) Total :13.4 (Lakh)

FFWC: 1, Region: 5

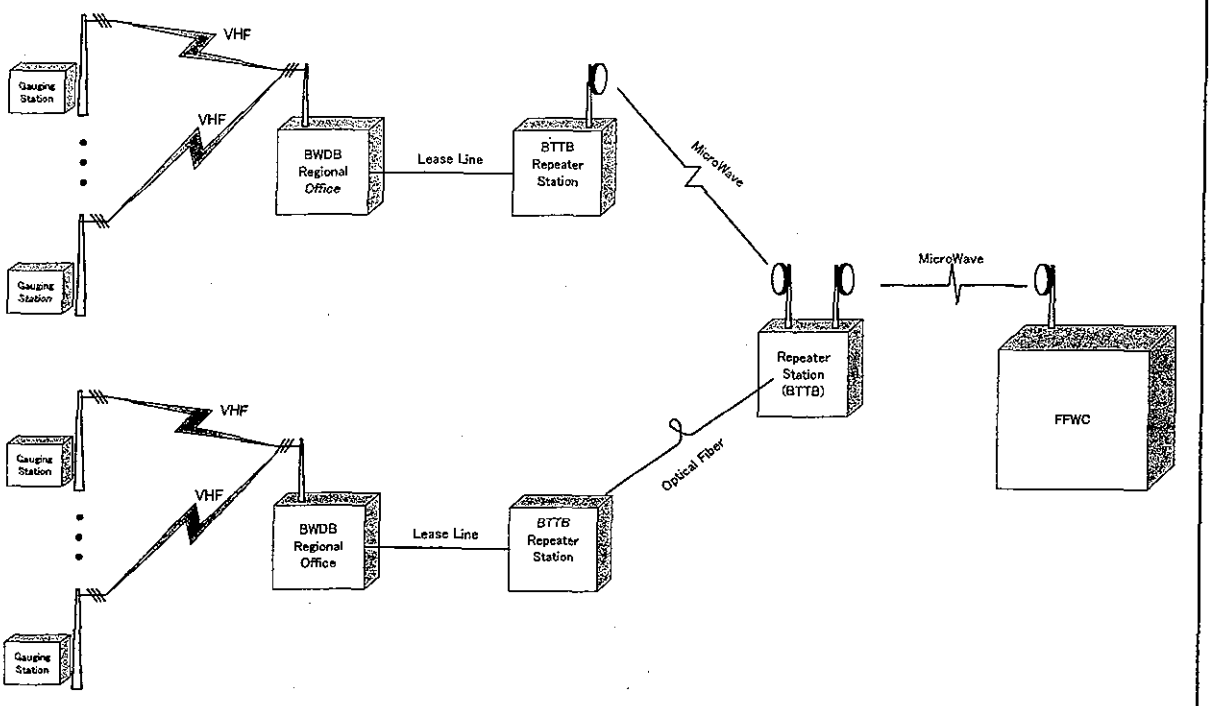
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.11 GRAMEEN Plan (Alternative 2-d)



OUT LINE	BTTB public Line : Regional Office – FFWC
MERIT	Direct Monitoring at Regional Office Install and Yearly cost of BTTB public line is low
DEMERIT	Reliability of BTTB public line is not high
O/M	BTTB Line : Out saucing
Install Cost	Regional Office :5(Lakh)*5=25 (Lakh) FFWC :5(Lakh)*1=5 (Lakh) Total: 30 (Lakh)
Annual Cost	BTTB: (150(Tk)*12 +1.7(Tk)*24*365)*5=83,460(Tk)=0.8(Lakh) Depreciation Cost :3.5 (Lakh) Total :4.3 (Lakh)

FFWC: 1, Region: 5

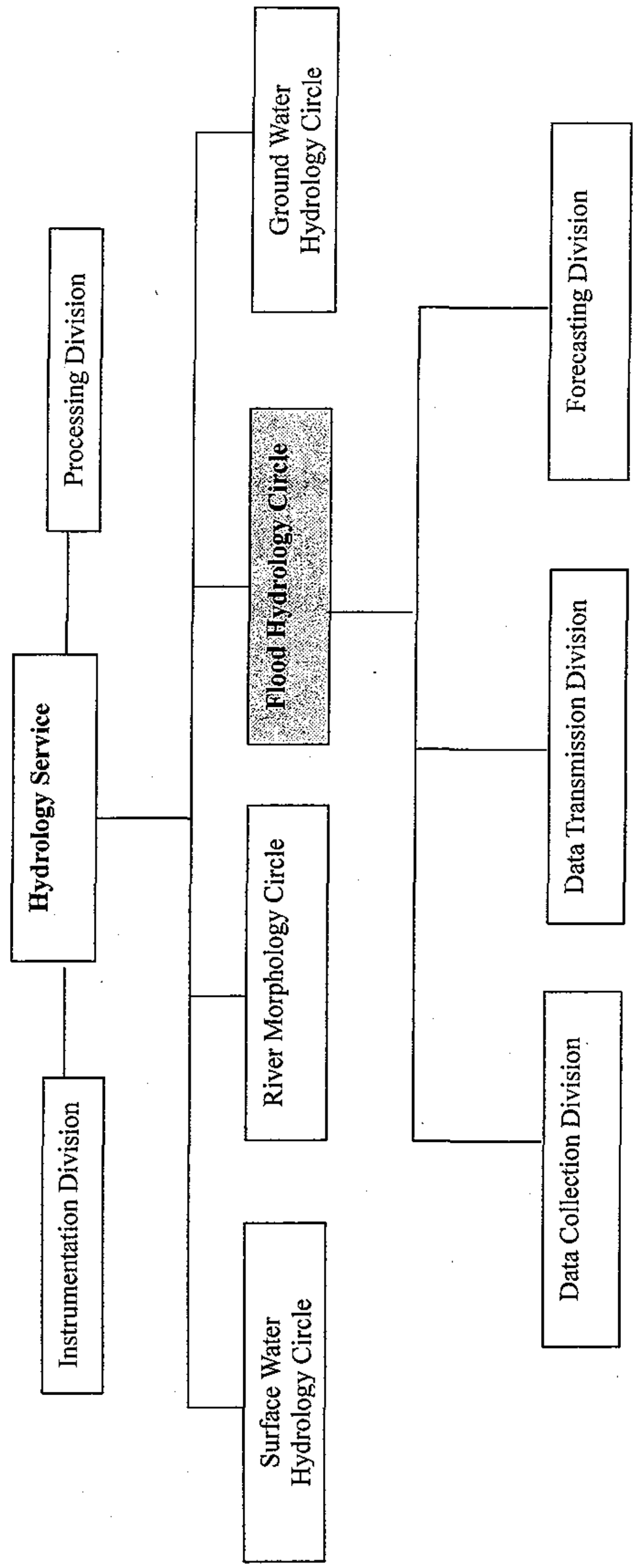
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.12 BTTB (Public Line) Plan (Alternative 2-e)



OUT LINE	BTTB Lease Line : Regional Office – FFWC
MERIT	Direct Monitoring at Regional Office
DEMERIT	Serviceability of BTTB Lease line is not good Yearly cost of BTTB public line is low
O/M	BTTB Line : Out saucing
Install Cost	Regional Office :5(Lakh)*5=25 (Lakh) FFWC :5(Lakh)*1=5 (Lakh) Total :30 (Lakh)
Annual Cost	BTTB: 5.5(Lakh)*5=27.5(Lakh) Depreciation Cost :3.5 (Lakh) Total :31.0 (Lakh)

FFWC: 1, Region: 5

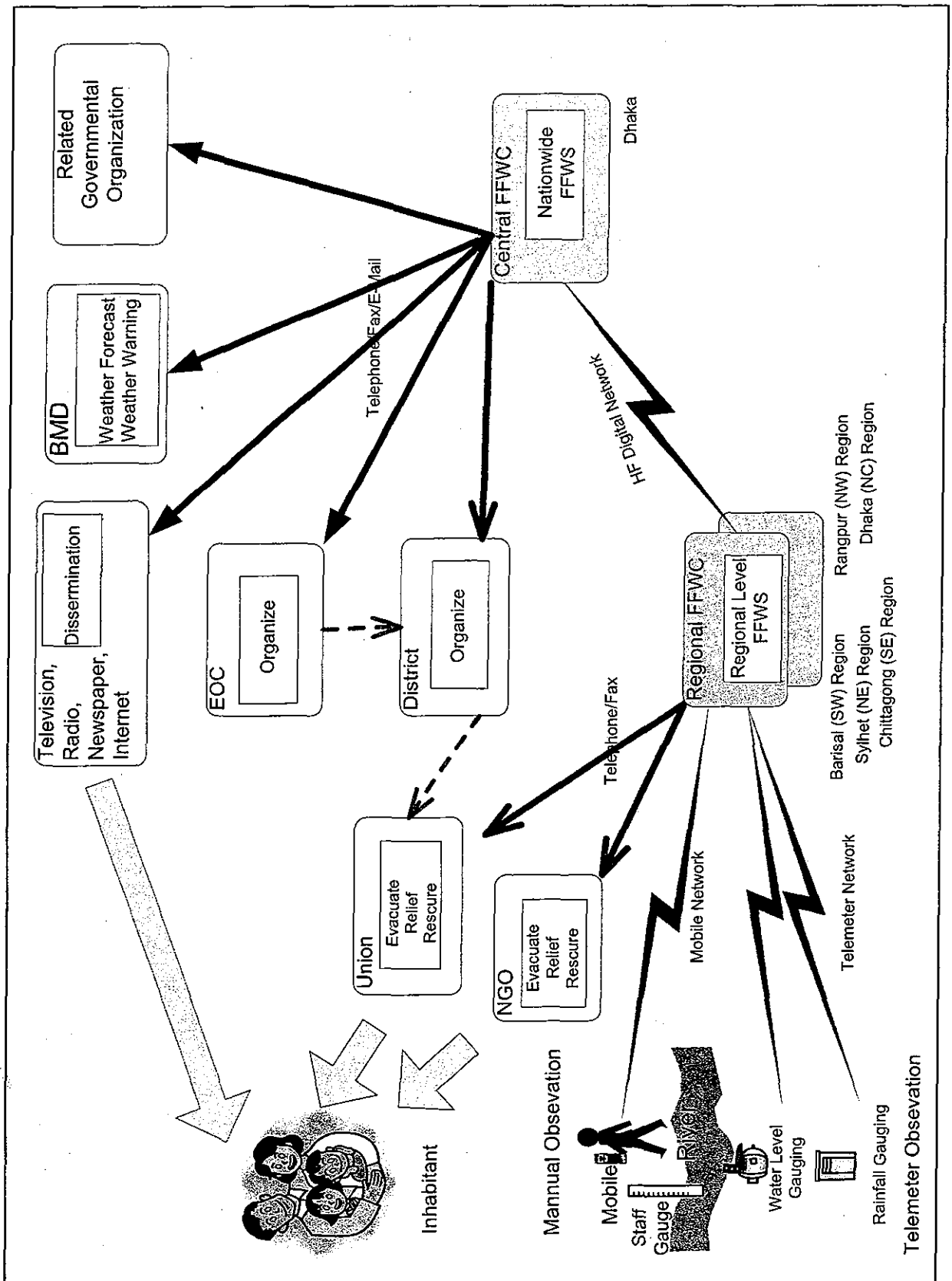
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 4.2.13 BTTB (Lease Line) Plan (Alternative 2-f)



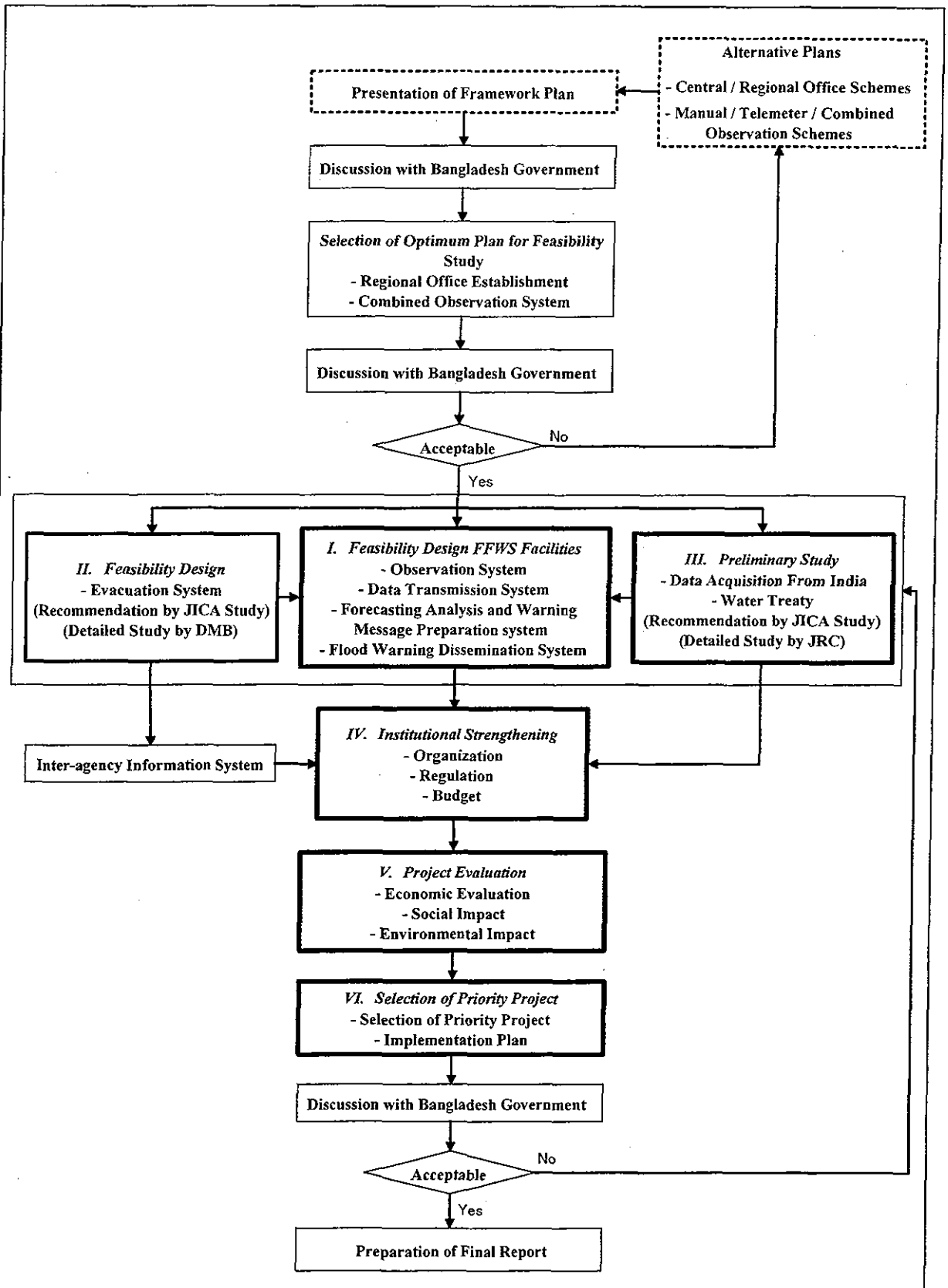
Note:
1. Present 3 processing branches of PFFC will be placed in Processing Division.
2. Part of the present C&I division will be placed in Data Transmission Division and the rest will become Instrumentation Division
3. Present FFWC will become Forecasting Division

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh
JAPAN INTERNATIONAL COOPERATION AGENCY

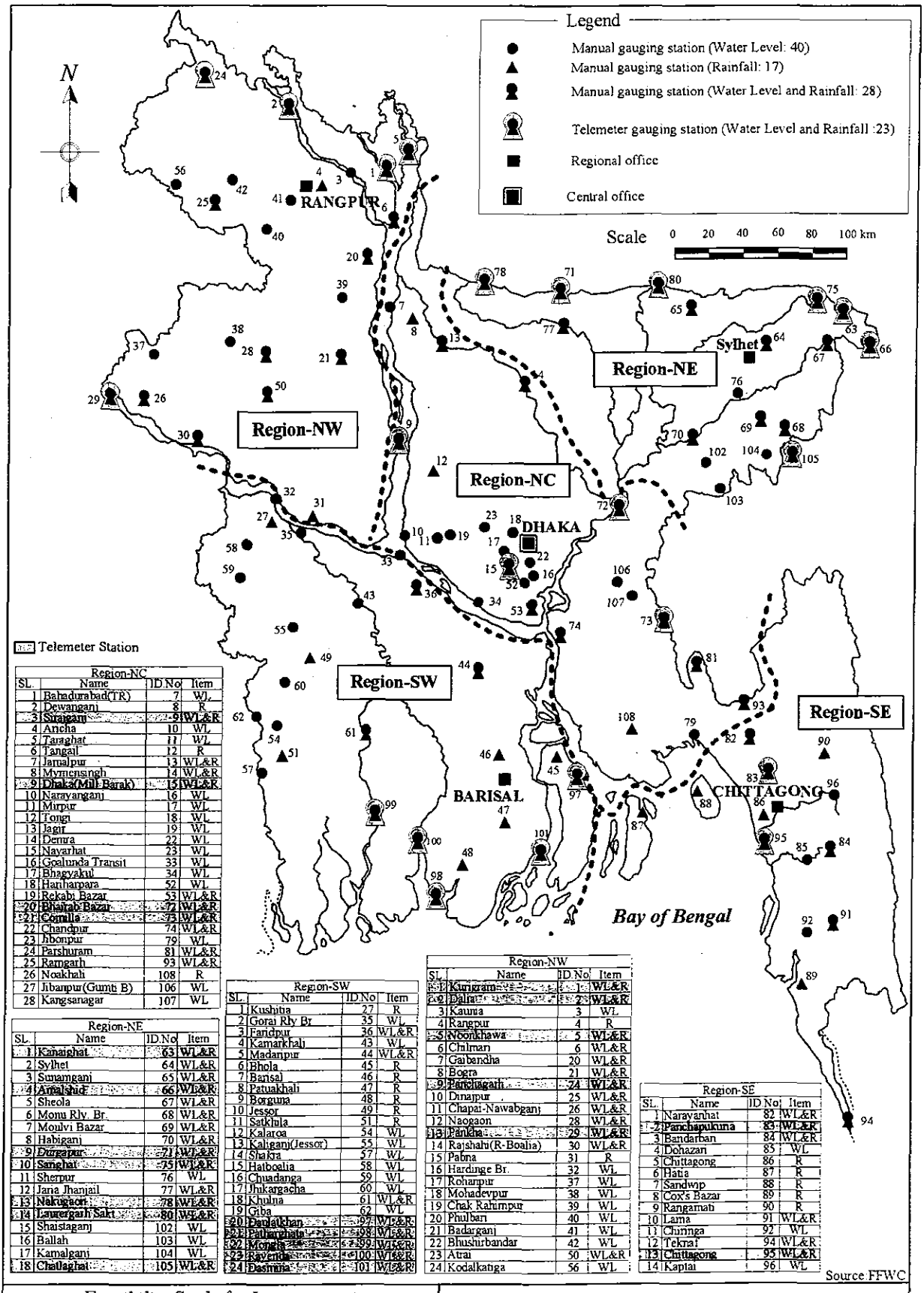
Figure 4.3.1
Proposed Organogram of Hydrology Service



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 4.4.1
JAPAN INTERNATIONAL COOPERATION AGENCY	Outline of Optimum Plan



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 6.1.1
JAPAN INTERNATIONAL COOPERATION AGENCY	Work Flowchart of Feasibility Study



Region-NC			
SL.	Name	ID.No	Item
1	Bahadurabad(TR)	7	WL
2	Dewanganj	8	R
3	Sirajganj	9	WL&R
4	Aricha	10	WL
5	Taraghat	11	WL
6	Tangail	12	R
7	Jamalpur	13	WL&R
8	Mymensingh	14	WL&R
9	Dhaka(Mill Barak)	15	WL&R
10	Narayanganj	16	WL
11	Mirpur	17	WL
12	Tongi	18	WL
13	Jagir	19	WL
14	Demra	22	WL
15	Nayarhat	23	WL
16	Goalunda Transit	33	WL
17	Bhagyakul	34	WL
18	Hariharpara	52	WL
19	Rekabi Bazar	53	WL&R
20	Bhairab Bazar	72	WL&R
21	Comilla	73	WL&R
22	Chandpur	74	WL&R
23	Jhonpur	79	WL
24	Parshuram	81	WL&R
25	Ramgarh	93	WL&R
26	Noakhali	108	R
27	Jibanpur(Gumti B)	106	WL
28	Kangsanagar	107	WL

Region-NE			
SL.	Name	ID.No	Item
1	Kanaighat	63	WL&R
2	Sylhet	64	WL&R
3	Sunamganj	65	WL&R
4	Amalshid	66	WL&R
5	Sheola	67	WL&R
6	Monu Rly. Br.	68	WL&R
7	Moulvi Bazar	69	WL&R
8	Habiganj	70	WL&R
9	Durgapur	71	WL&R
10	Sanghat	75	WL&R
11	Sherpur	76	WL
12	Jana Jhanjail	77	WL&R
13	Nakugaon	78	WL&R
14	Laurergarh Sakt	80	WL&R
15	Shaistaganj	102	WL
16	Ballah	103	WL
17	Kamalganj	104	WL
18	Chatlaghat	105	WL&R

Region-SW			
SL.	Name	ID.No	Item
1	Kushtia	27	R
2	Gorai Rly Br.	35	WL
3	Faridpur	36	WL&R
4	Kamarkhali	43	WL
5	Madanpur	44	WL&R
6	Bhola	45	R
7	Barisal	46	R
8	Patuakhali	47	R
9	Borguna	48	R
10	Jessor	49	R
11	Satkhila	51	R
12	Kalaroa	54	WL
13	Kaliganj(Jessor)	55	WL
14	Shakra	57	WL
15	Hatboalia	58	WL
16	Chuadanga	59	WL
17	Jhukargacha	60	WL
18	Khulna	61	WL&R
19	Giba	62	WL
20	Paulakhan	97	WL&R
21	Pathirghata	98	WL&R
22	Mongla	99	WL&R
23	Rayenda	100	WL&R
24	Dasmina	101	WL&R

Region-NW			
SL.	Name	ID.No	Item
1	Kurigram	1	WL&R
2	Dalia	2	WL&R
3	Kaunia	3	WL
4	Rangpur	4	R
5	Noonkhawa	5	WL&R
6	Chilmari	6	WL&R
7	Gaibandha	20	WL&R
8	Bogra	21	WL&R
9	Panchagarh	24	WL&R
10	Dinajpur	25	WL&R
11	Chapai-Nawabganj	26	WL&R
12	Naogaon	28	WL&R
13	Pankha	29	WL&R
14	Rajshahi(R-Boalia)	30	WL&R
15	Pabna	31	R
16	Hardinge Br.	32	WL
17	Rohanpur	37	WL
18	Mohadevpur	38	WL
19	Chak Rahimpur	39	WL
20	Phulbari	40	WL
21	Badarganj	41	WL
22	Bhushirbandar	42	WL
23	Atrai	50	WL&R
24	Kodalkatiga	56	WL

Region-SE			
SL.	Name	ID.No	Item
1	Narayanhat	82	WL&R
2	Panchapukuna	83	WL&R
3	Bandarban	84	WL&R
4	Dohazari	85	WL
5	Chittagong	86	R
6	Hatia	87	R
7	Sandwip	88	R
8	Cox's Bazar	89	R
9	Rangamati	90	R
10	Lama	91	WL&R
11	Chiringa	92	WL
12	Teknaf	94	WL&R
13	Chittagong	95	WL&R
14	Kaptai	96	WL

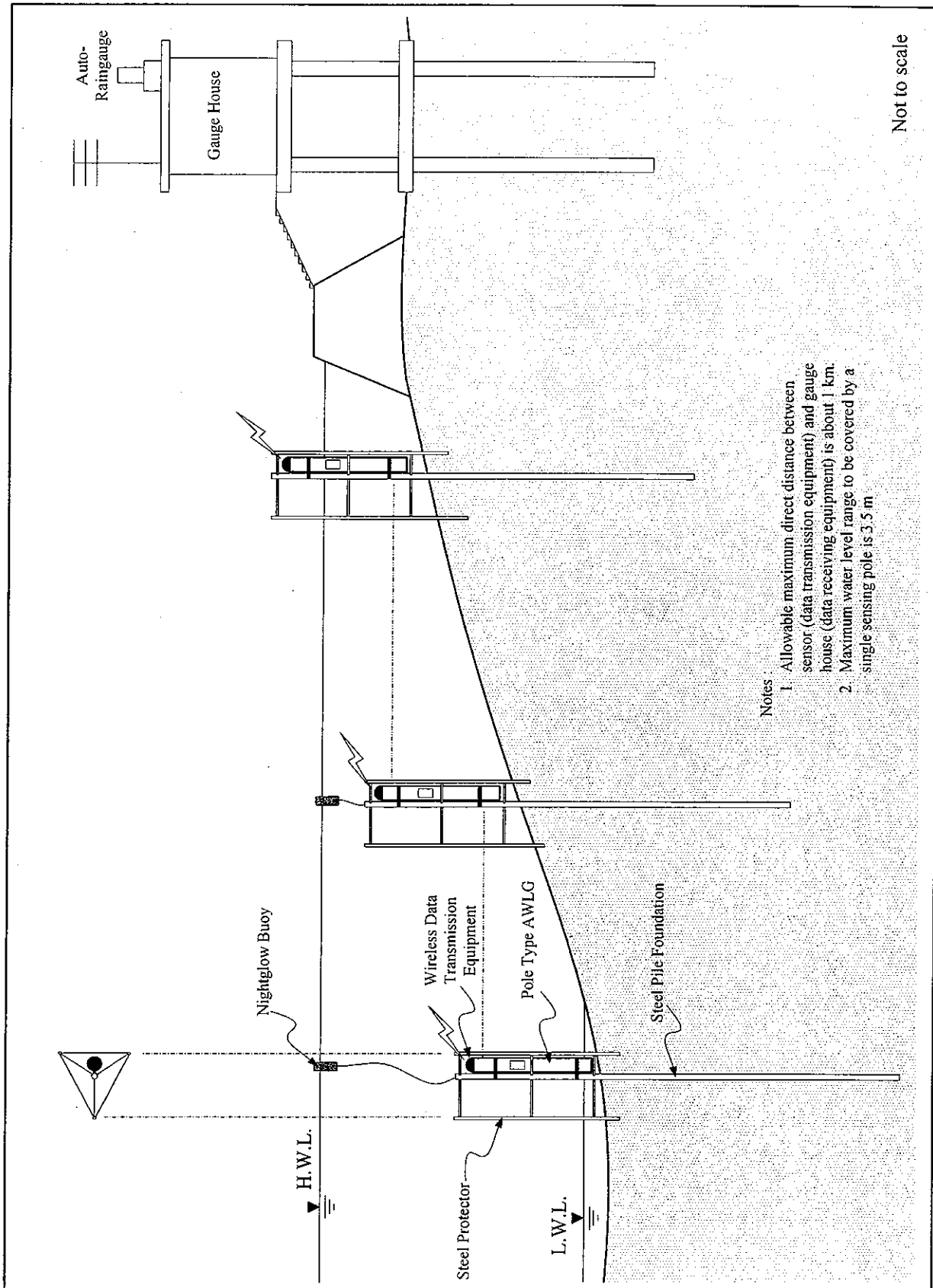
Source:FFWC

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

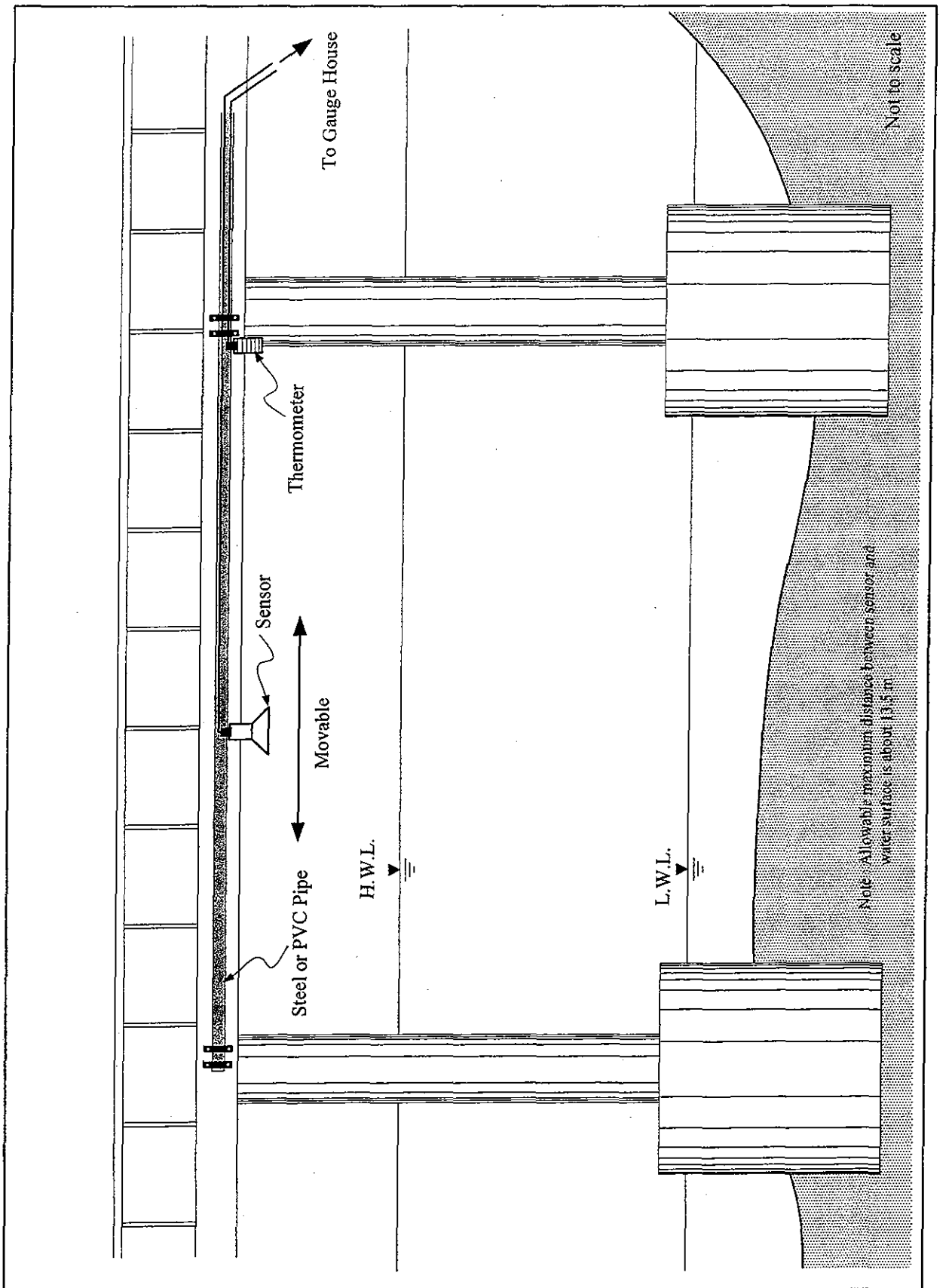
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.1.1

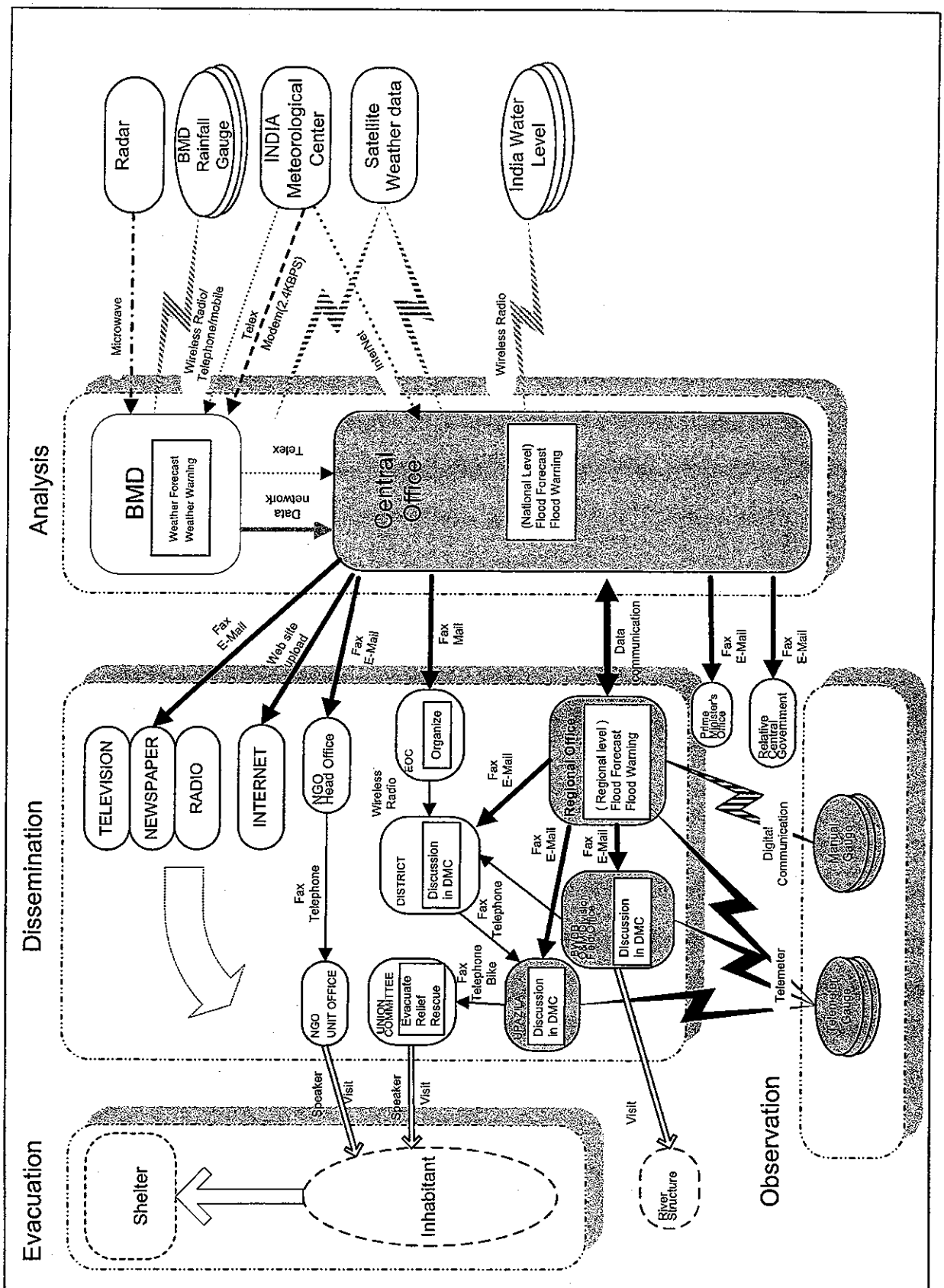
Observatories of Proposed FFWS



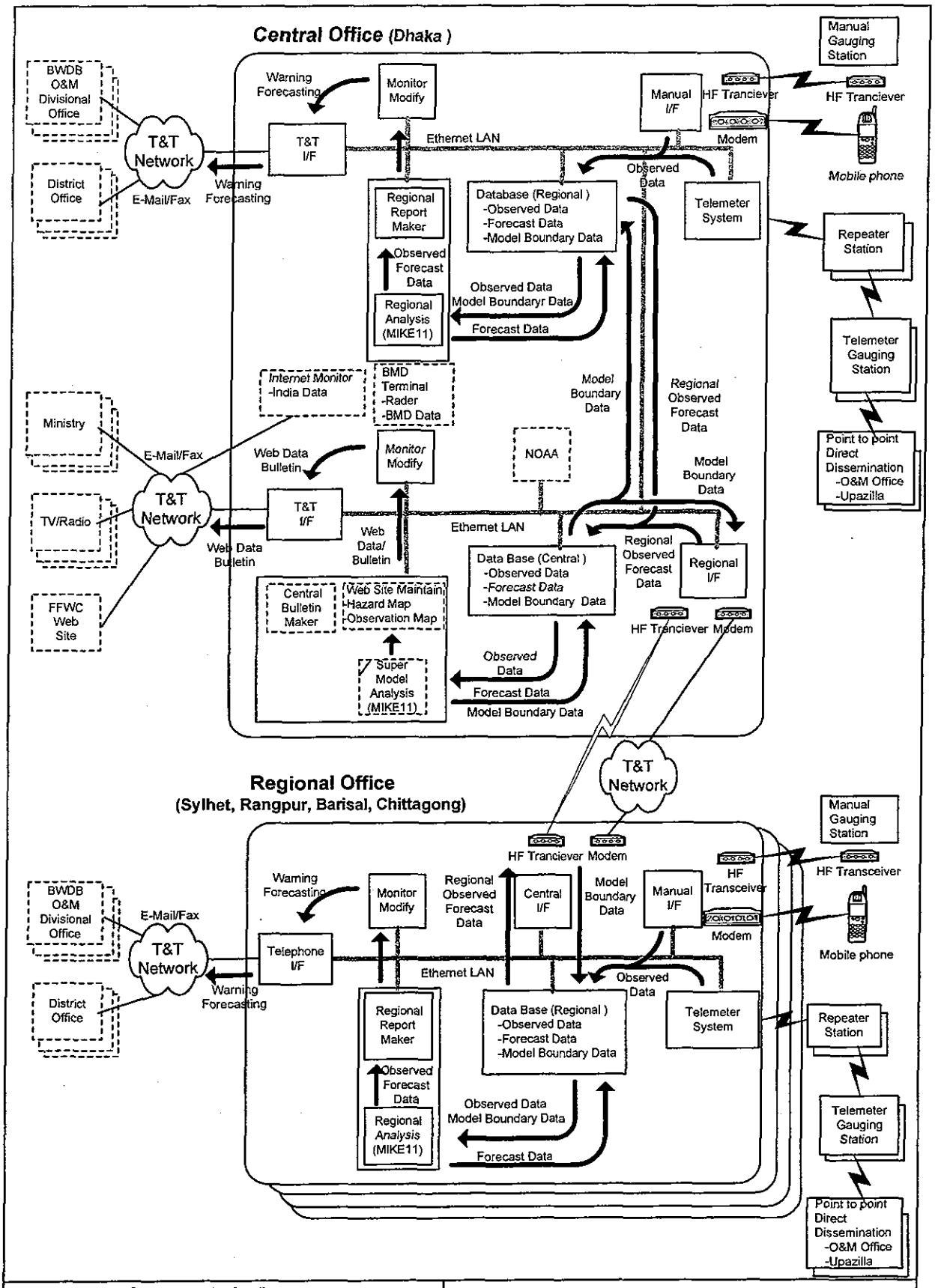
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.2.1 Schematic Layout Sketch of Automatic Gauges (Sensing Pole Float Type)
JAPAN INTERNATIONAL COOPERATION AGENCY	



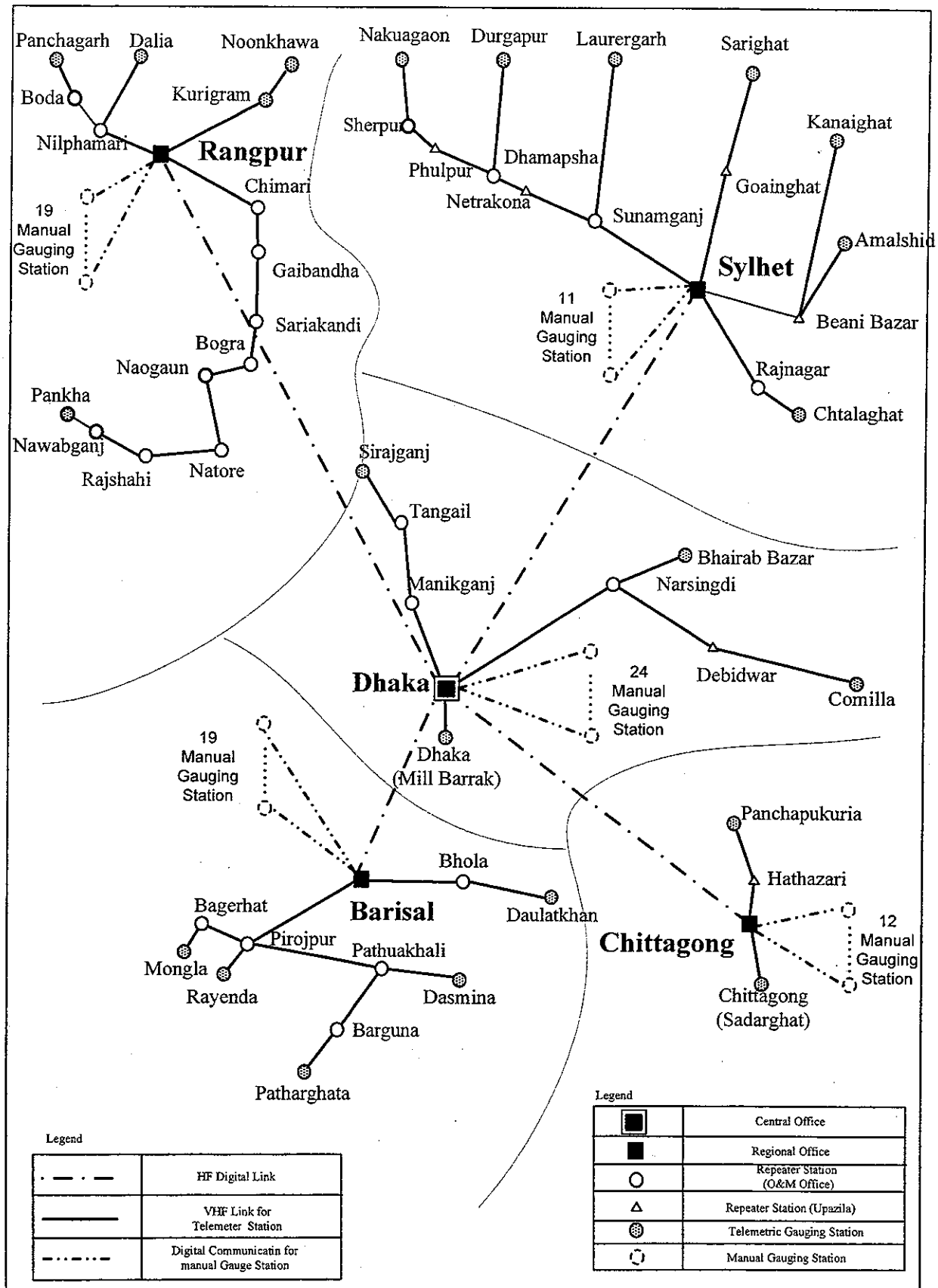
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.2.2 Schematic Layout Sketch of Automatic Gauges (Supersonic Sensor Type)



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.3.1 Proposed Data Communication Network
JAPAN INTERNATIONAL COOPERATION AGENCY	



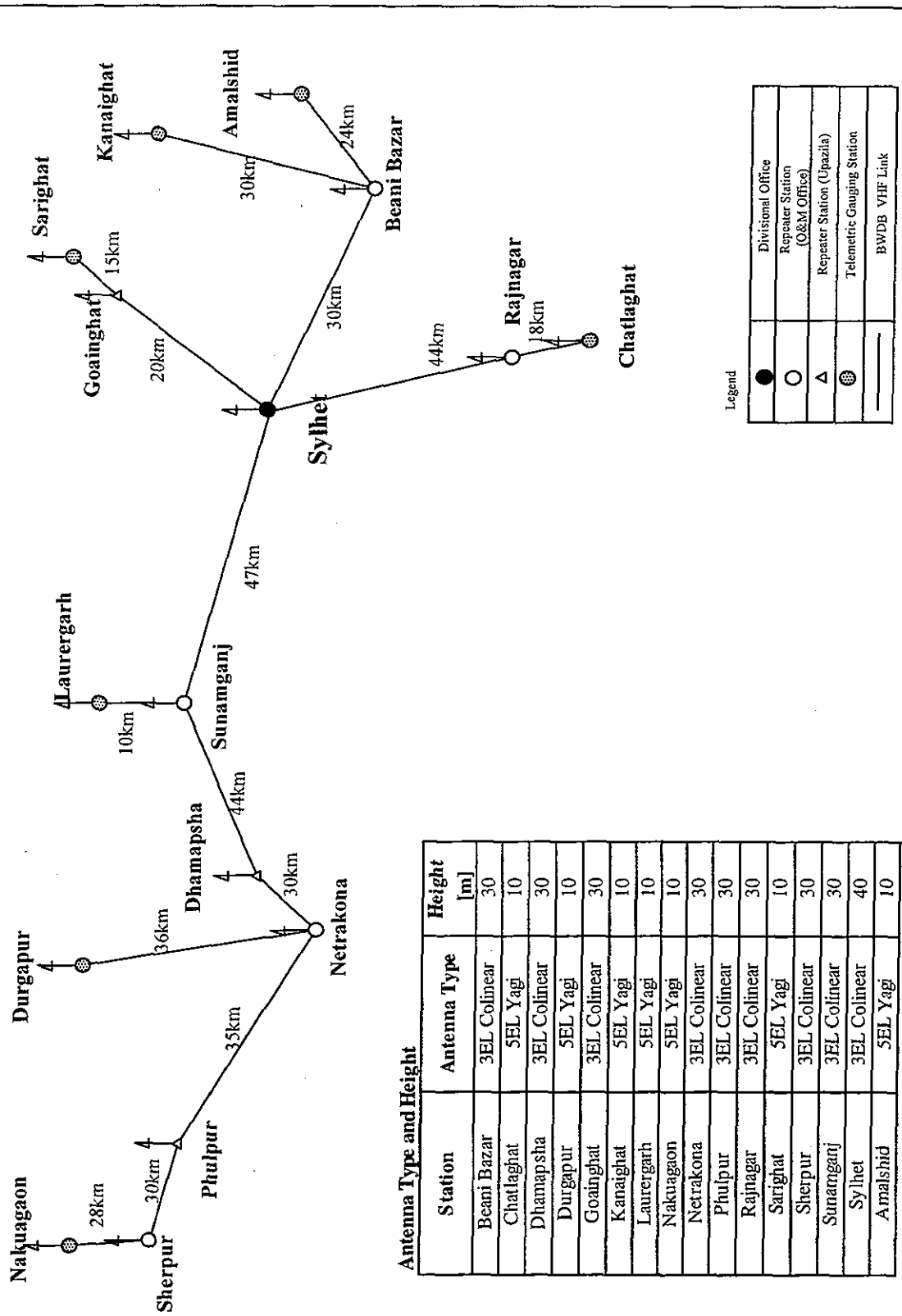
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.3.2
JAPAN INTERNATIONAL COOPERATION AGENCY	Proposed Data Transmission Flow



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.3.3
Proposed Data Transmission Network Diagram



Antenna Type and Height

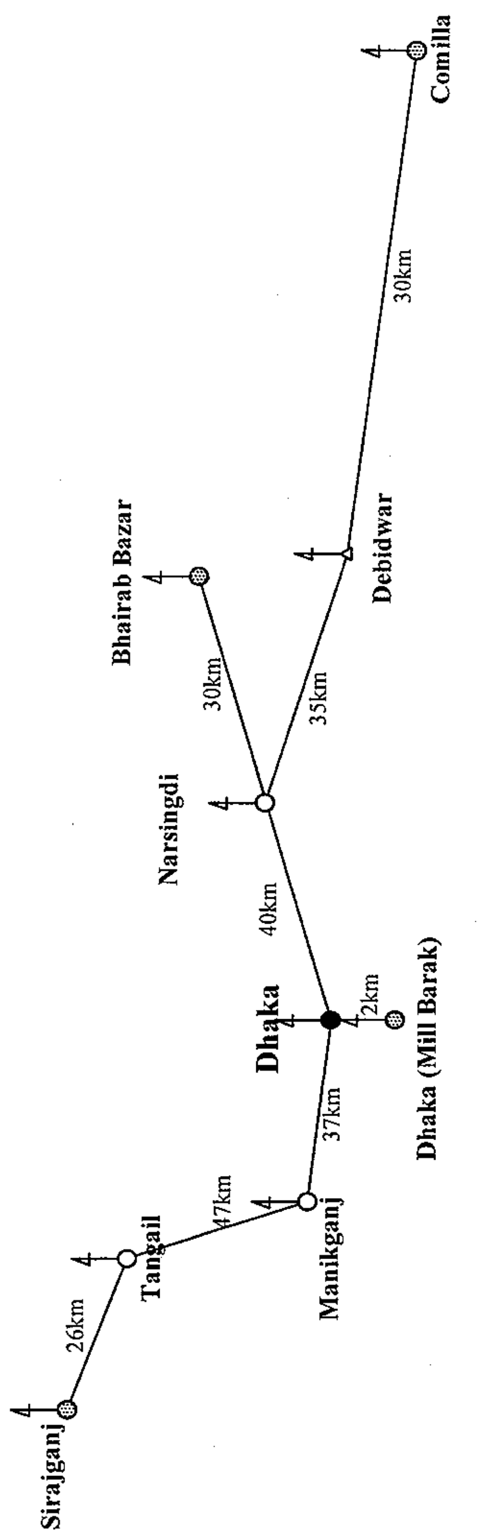
Station	Antenna Type	Height [m]
Beani Bazar	3EL Colinear	30
Chatlaghat	5EL Yagi	10
Dhamapsha	3EL Colinear	30
Durgapur	5EL Yagi	10
Goainghat	3EL Colinear	30
Kanaighat	5EL Yagi	10
Laurergarh	5EL Yagi	10
Nakuagaon	5EL Yagi	10
Netrakona	3EL Colinear	30
Phulpur	3EL Colinear	30
Rajnagar	3EL Colinear	30
Sarighat	5EL Yagi	10
Sherpur	3EL Colinear	30
Sunamganj	3EL Colinear	30
Sylhet	3EL Colinear	40
Amalshid	5EL Yagi	10

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.3.4

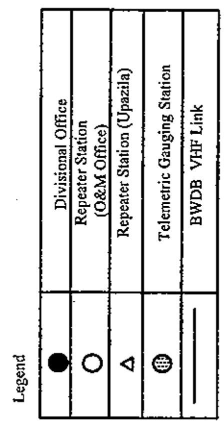
Telemeter Network Diagram (Region-NE)



Antenna Type and Height

Station	Antenna Type	Height [m]
Bhairab Bazar	5EL Yagi	10
Comilla	5EL Yagi	10
Debidwar	3EL colinear	20
Dhaka	3EL colinear	45 *
Dhaka (Mill Barak)	5EL Yagi	10
Manikganj	3EL colinear	40
Narsingdi	3EL colinear	20
Sirajganj	5EL Yagi	10
Tangail	3EL colinear	40

Remarks *: 40m (Height of FFWC building) + 5m

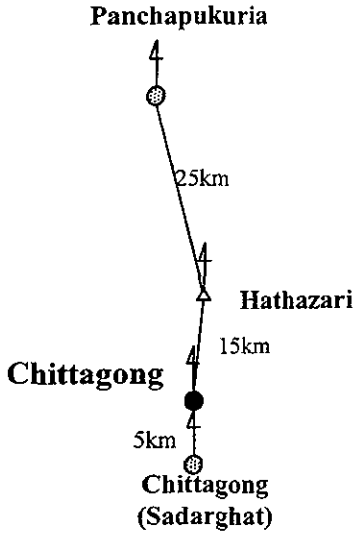


Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.3.5

Telemeter Network Diagram (Region-NC)



Antenna Type and Height

Station	Antenna Type	Height [m]
Chittagong	3EL colinear	30
Hathazari	3EL colinear	20
Panchapukuria	5EL Yagi	10
Chittagong(Sadarghat)	5EL Yagi	10

Legend

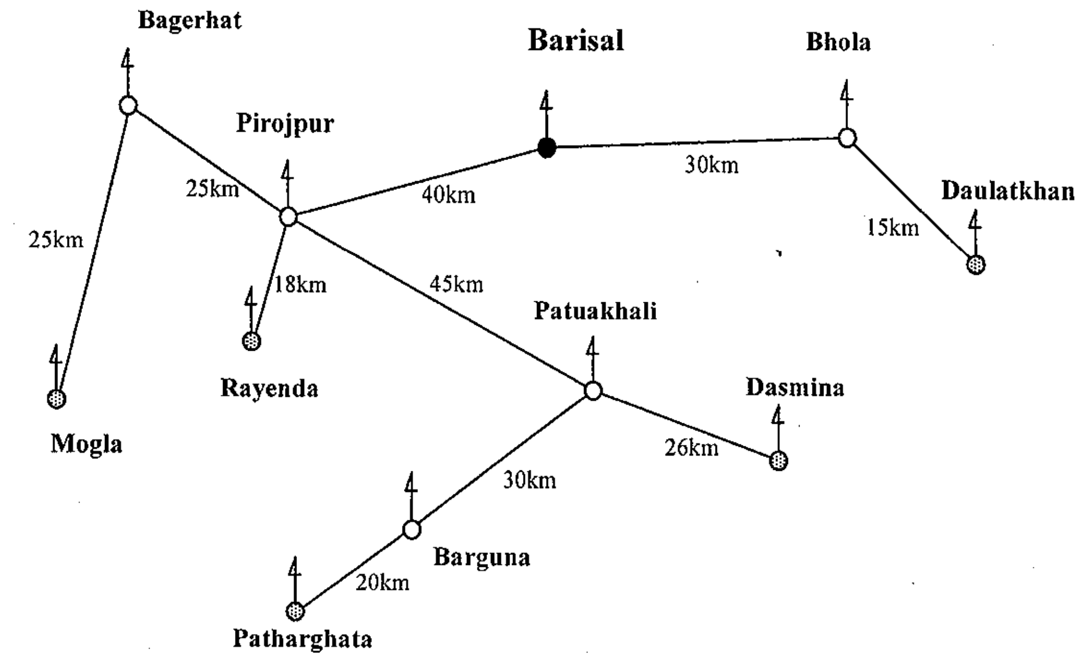
●	Divisional Office
○	Repeater Station (O&M Office)
△	Repeater Station (Upazila)
◍	Telemetric Gauging Station
———	BWDB VHF Link

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.3.6

Telemeter Network Diagram (Region-SE)



Legend

●	Divisional Office
○	Repeater Station (O&M Office)
◍	Telemetric Gauging Station
———	BWDB VHF Link

Antenna Type and Height

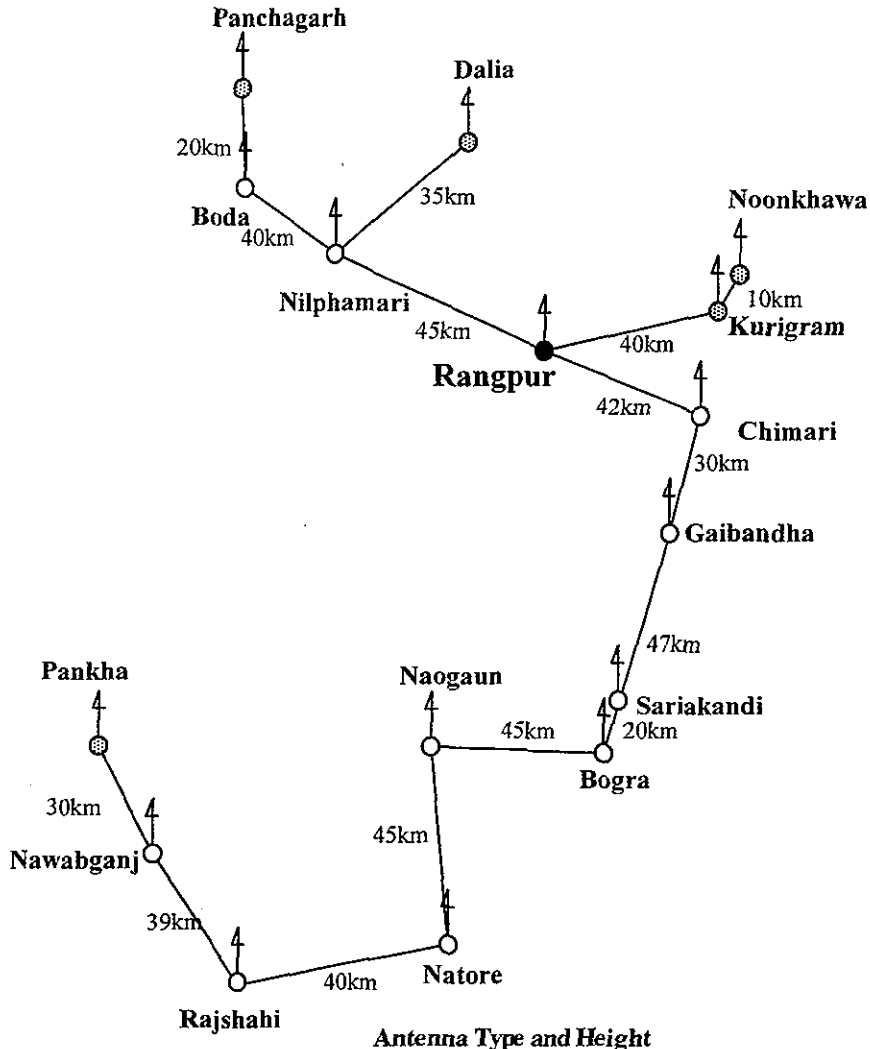
Station	Antenna Type	Height [m]
Bagerhat	3EL colinear	20
Barguna	3EL colinear	10
Barisal	3EL colinear	30
Bhola	3EL colinear	10
Dasmina	5EL Yagi	10
Daulatkhan	5EL Yagi	10
Mogla	5EL Yagi	10
Patharghata	5EL Yagi	10
Patuakhali	3EL colinear	30
Pirojpur	3EL colinear	30
Rayenda	5EL Yagi	10

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.3.7

Telemeter Network Diagram (Region-SW)



Antenna Type and Height

Station	Antenna Type	Height [m]
Boda	3EL colinear	30
Bogra	3EL colinear	30
Chimari	3EL colinear	30
Dalia	5EL Yagi	10
Gaibandha	3EL colinear	40
Kurigram	3EL colinear	30
Naogaun	3EL colinear	30
Natore	3EL colinear	30
Nawabganj	3EL colinear	40
Nilphamari	3EL colinear	30
Noonkhawa	5EL Yagi	10
Panchagarh	5EL Yagi	10
Pankha	5EL Yagi	10
Rajshahi	3EL colinear	40
Rangpur	3EL colinear	30
Sariakandi	3EL colinear	30

Legend

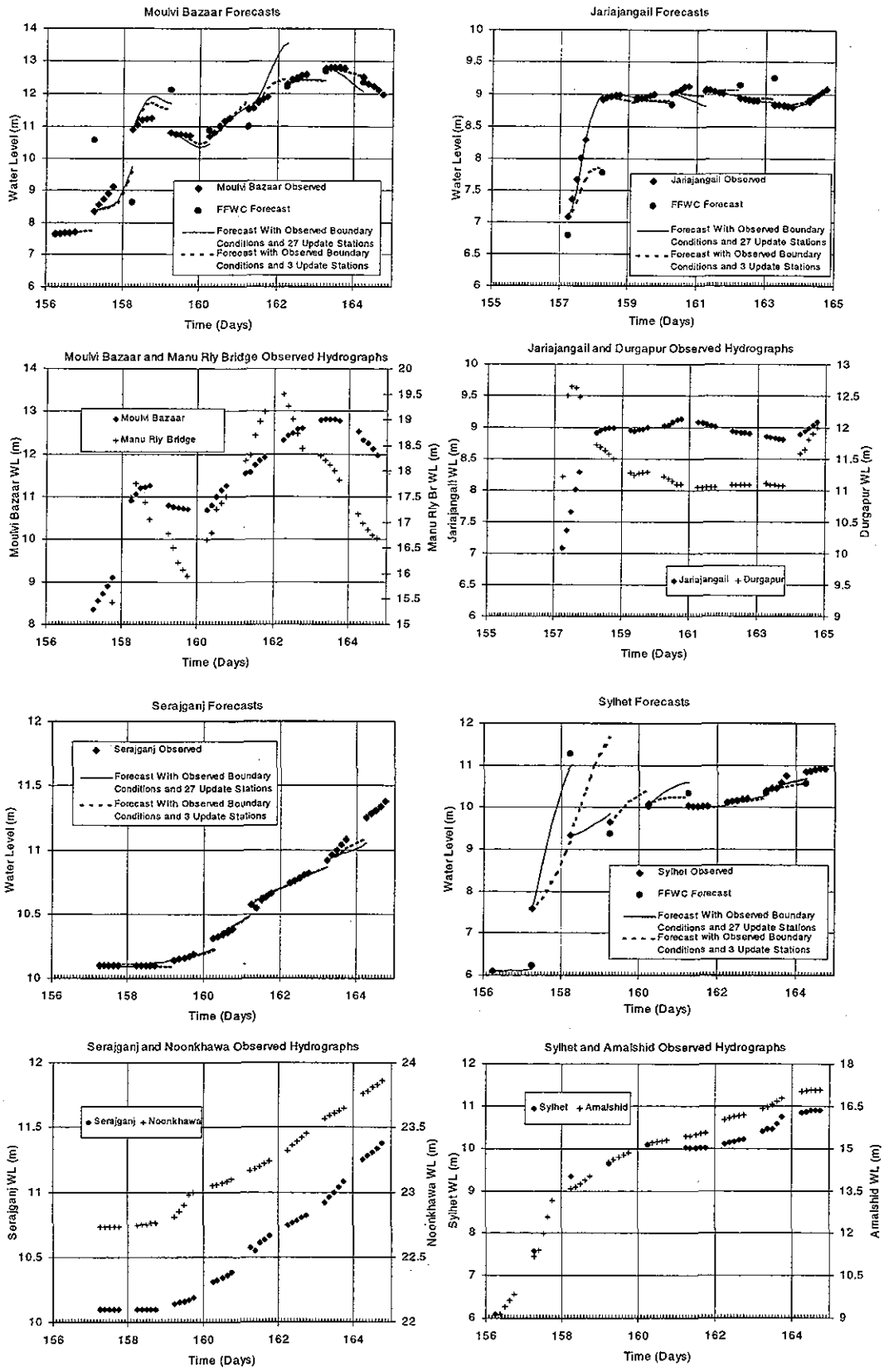
●	Divisional Office
○	Repeater Station (O&M Office)
△	Repeater Station (Upazila)
◎	Telemetric Gauging Station
———	BWDB VHF Link

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

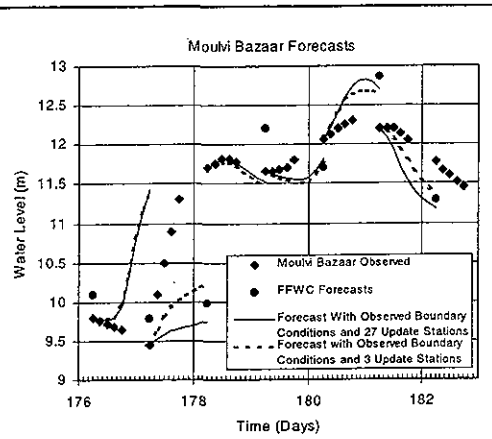
Figure 7.3.8

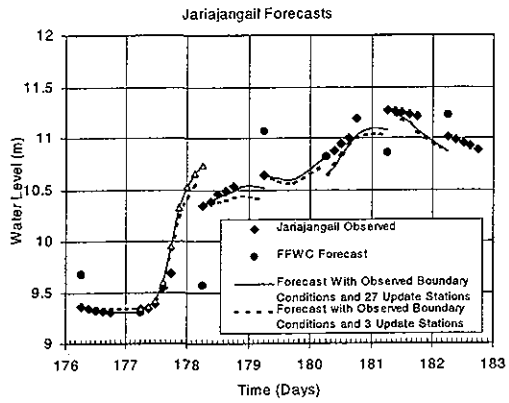
Telemeter Network Diagram (Region-NW)

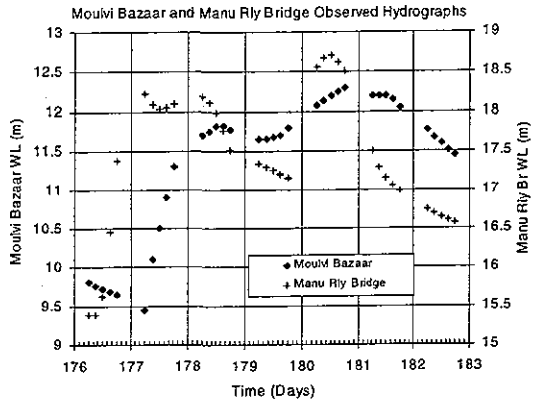


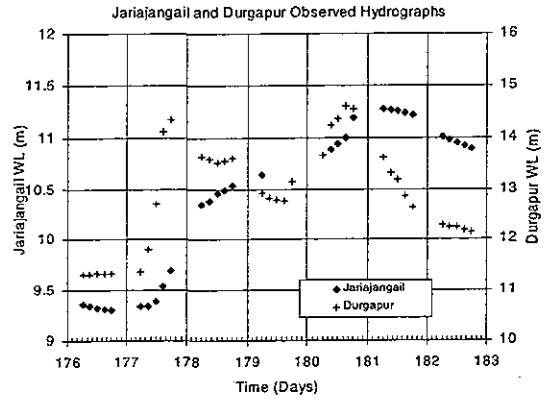
Note: Day 156 is 6 June, 2003

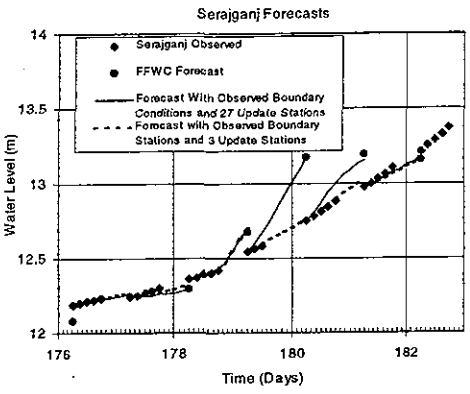
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.4.1 Result of Forecast Performance Assessment (1/2)
JAPAN INTERNATIONAL COOPERATION AGENCY	

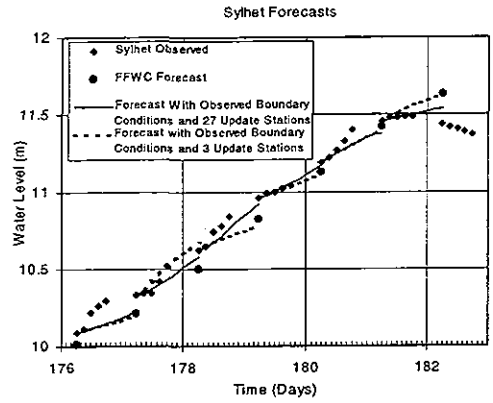


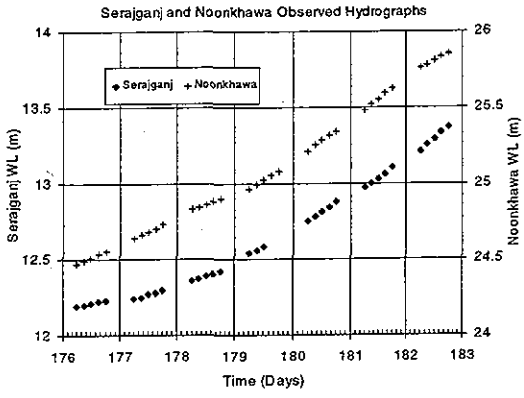


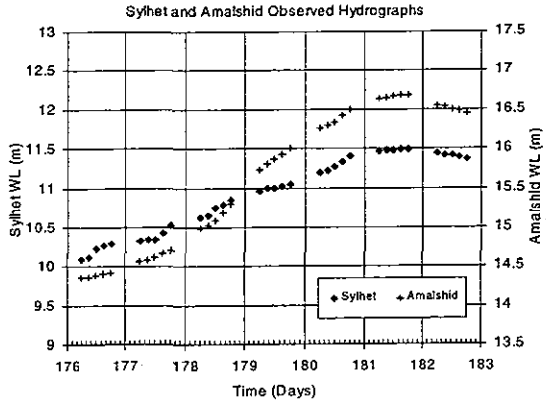






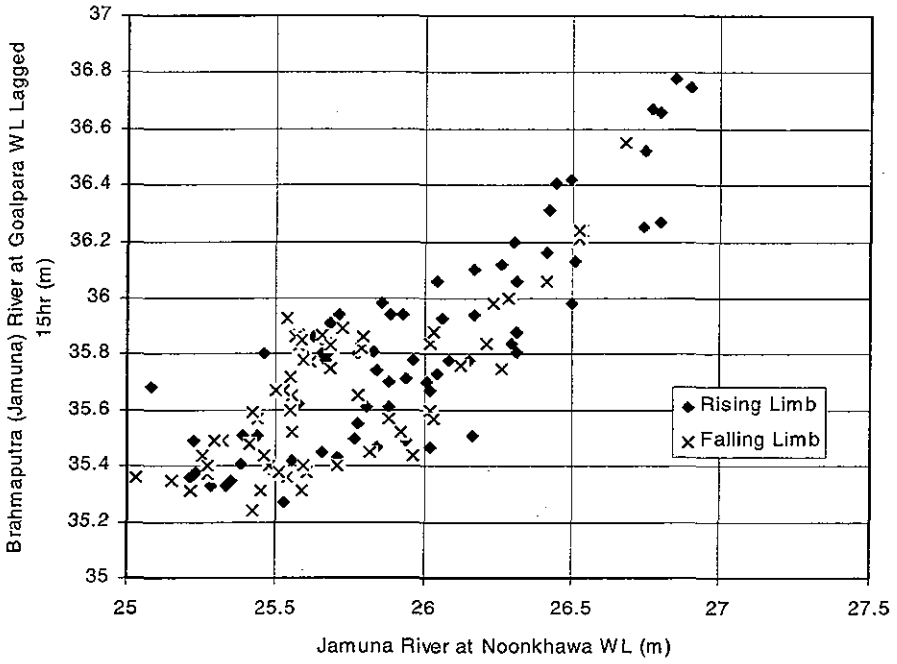


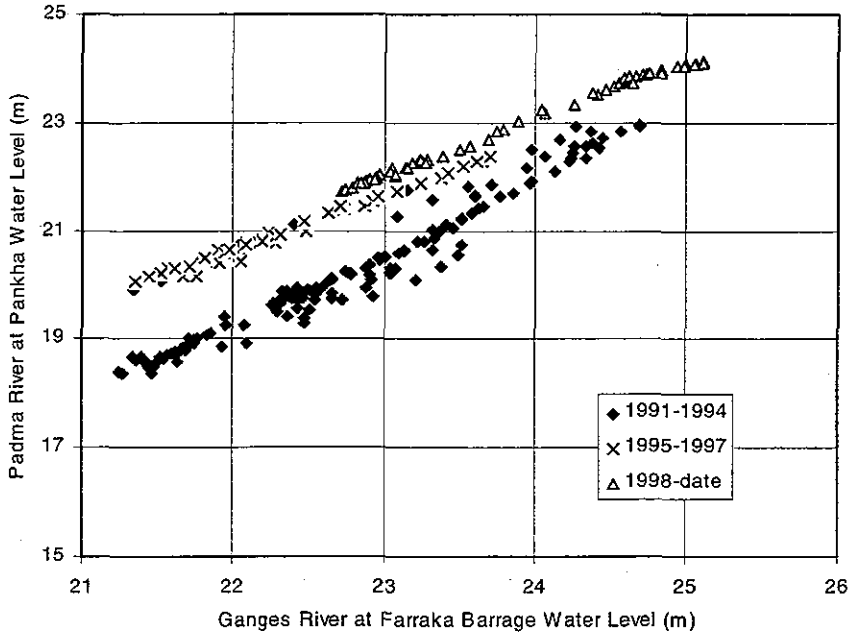




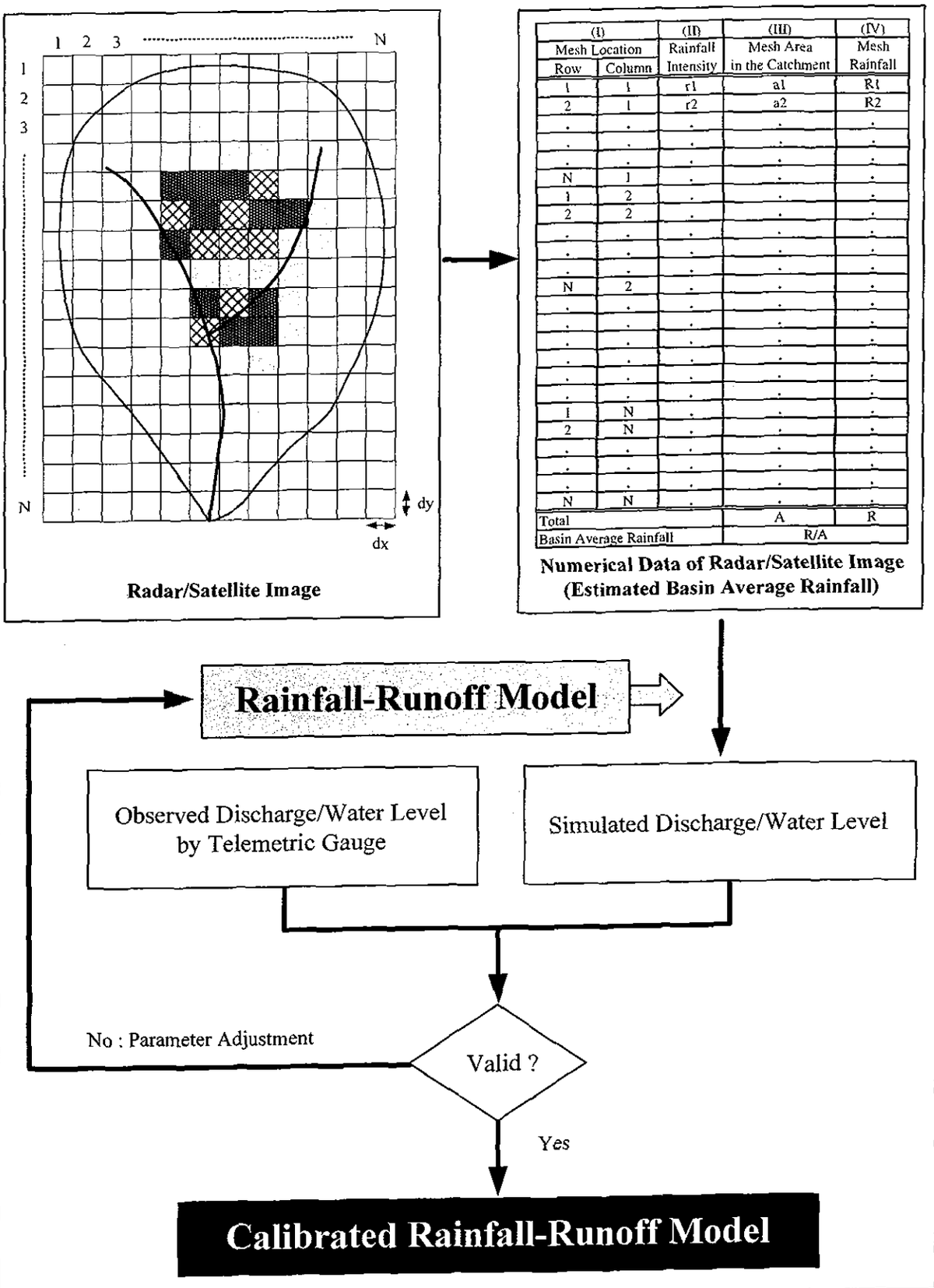
Note: Day 176 is 26 June, 2003

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.4.1 Result of Forecast Performance Assessment (2/2)
JAPAN INTERNATIONAL COOPERATION AGENCY	





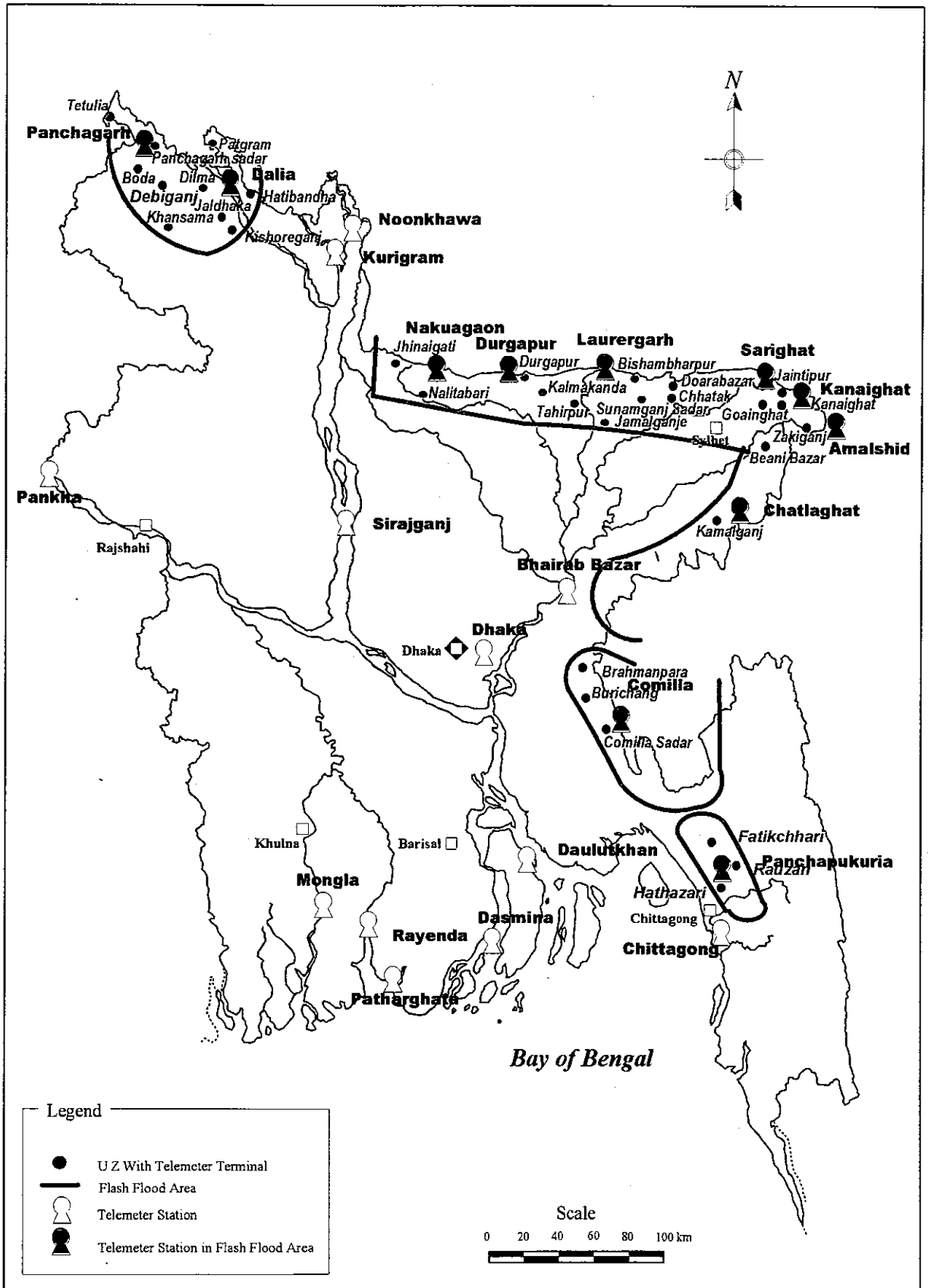
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.4.2 Correlation Plot of Water Level Record between Indian and Bangladeshi Observatories



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.4.3
Concept of the Rainfall-Runoff Model Setup Based on Radar/Satellite Data



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.5.1 Location of the Upa-zilla where Point to Point Dissemination to be provided
JAPAN INTERNATIONAL COOPERATION AGENCY	

Project Features

(1)Observation System

Manual Observation System

No change

Telemeter System

Water level observation: sonar type sensor / sensing pole type sensor
Rainfall observation: tipping bucket type

(2)Data Transmission System

Manual Observation System

Digital transmission system:
- mobile communication system (HF data transmission system)

Automatic recording system in computer in control station

Telemeter System

From Gauging station to Regional station:
- BWDB VHF Link

From Regional station to Central control station:
- BWDB HF Link

(3)Analysis System

All the data, manual observation and telemeter, are to be used

Regional Control System
- Forecasting with Regional model
- Monitoring with telemeter observed data

Central Control System
- Forecasting with Nationwide model (Supermodel)

(4)Warning Dissemination System

Warning Message Dissemination (Forecasted)

From Regional control station to O&M office, DC office, Upazilla office:
- E-mail, Fax , Telephone with T&T public line

Point to Point Direct Data Dissemination (Telemeter only)

From Telemeter Gauging Station to O&M office, Upazilla office:
- VHF Link

Warning Dissemination in Local Level

From Upazilla/Union to Inhabitant / Shelter:
- Fax, Telephone, Bike, Speaker & visit.

Main Components

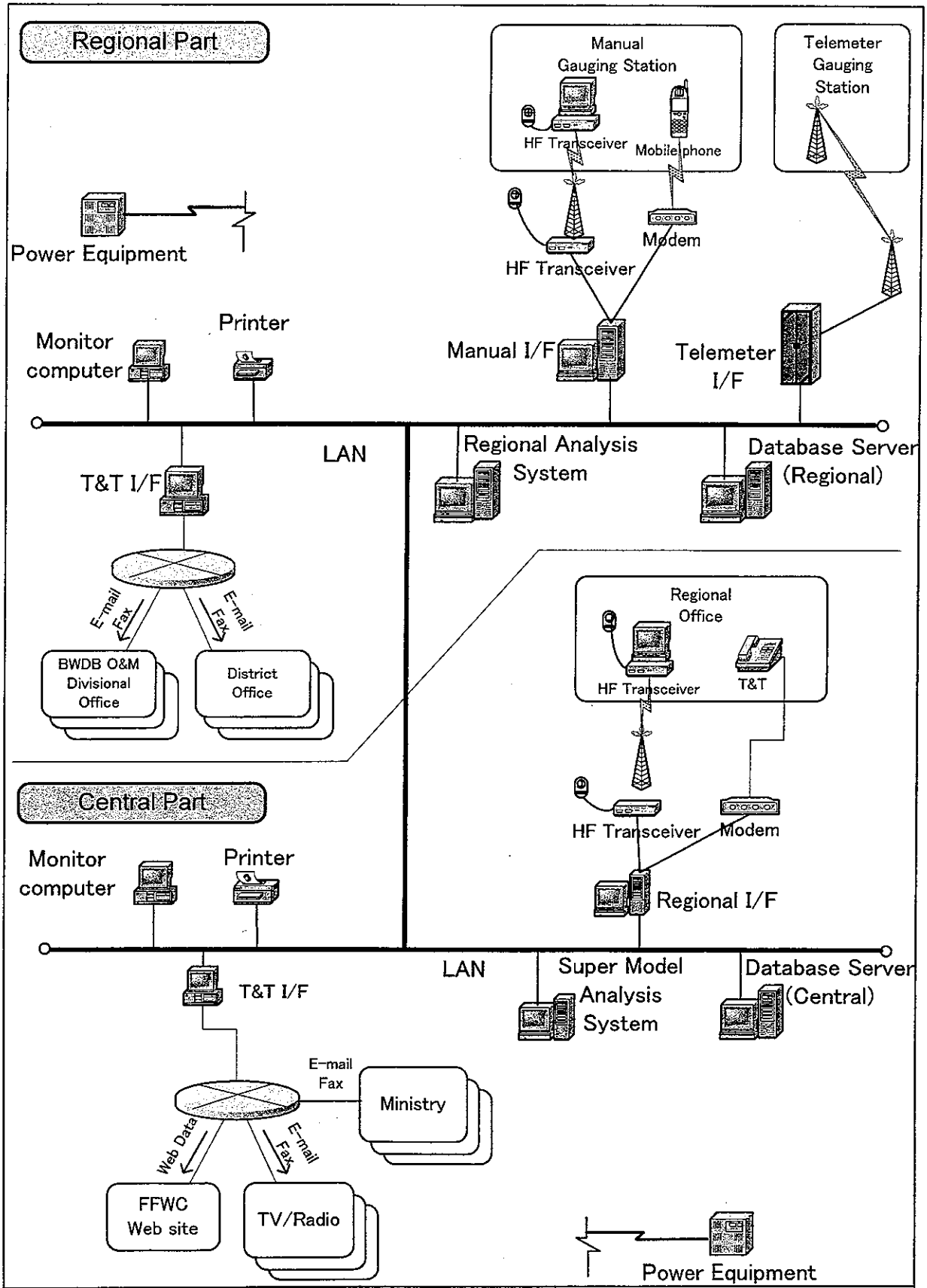
Place	Main Item	Item	Number
Central Office (Dhaka)	Equipment	Database Server (central)	1
		Super Model Analysis System	1
		Database Server (regional)	1
		Regional Analysis System	1
		Monitor Computer	2
	Office	(Existing FFWC)	
	Others	Vehicle	1
		Speed Boat	1
Regional Office	Equipment	Database Server (regional)	1x4
		Regional Analysis System	1x4
		Monitor Computer	1x4
	Office	New Office	1x4
	Others	Vehicle	3x4
		Speed Boat	1x4
Repeater Station (O&M office)	Equipment	Repeater Equipment	21
		Monitoring equipment	9
	Space	(Existing O&M office)	
Repeater Station (not O&M office)	Equipment	Repeater Equipment	6
	Space	New House	6
Telemeter Gauging Station	Equipment	Telemeter equipment	23
		Sonar type sensor	7
		Sensing pole type sensor	16
	Space	New House	23
Manual Gauging Station	Equipment	Mobile Phone	42
		Digital HF system	43
	Space	(Existing Wireless station)	
Point to Point Direct Dissemination	Equipment	Monitoring equipment	32
	Space	(Existing Upazilla office)	

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

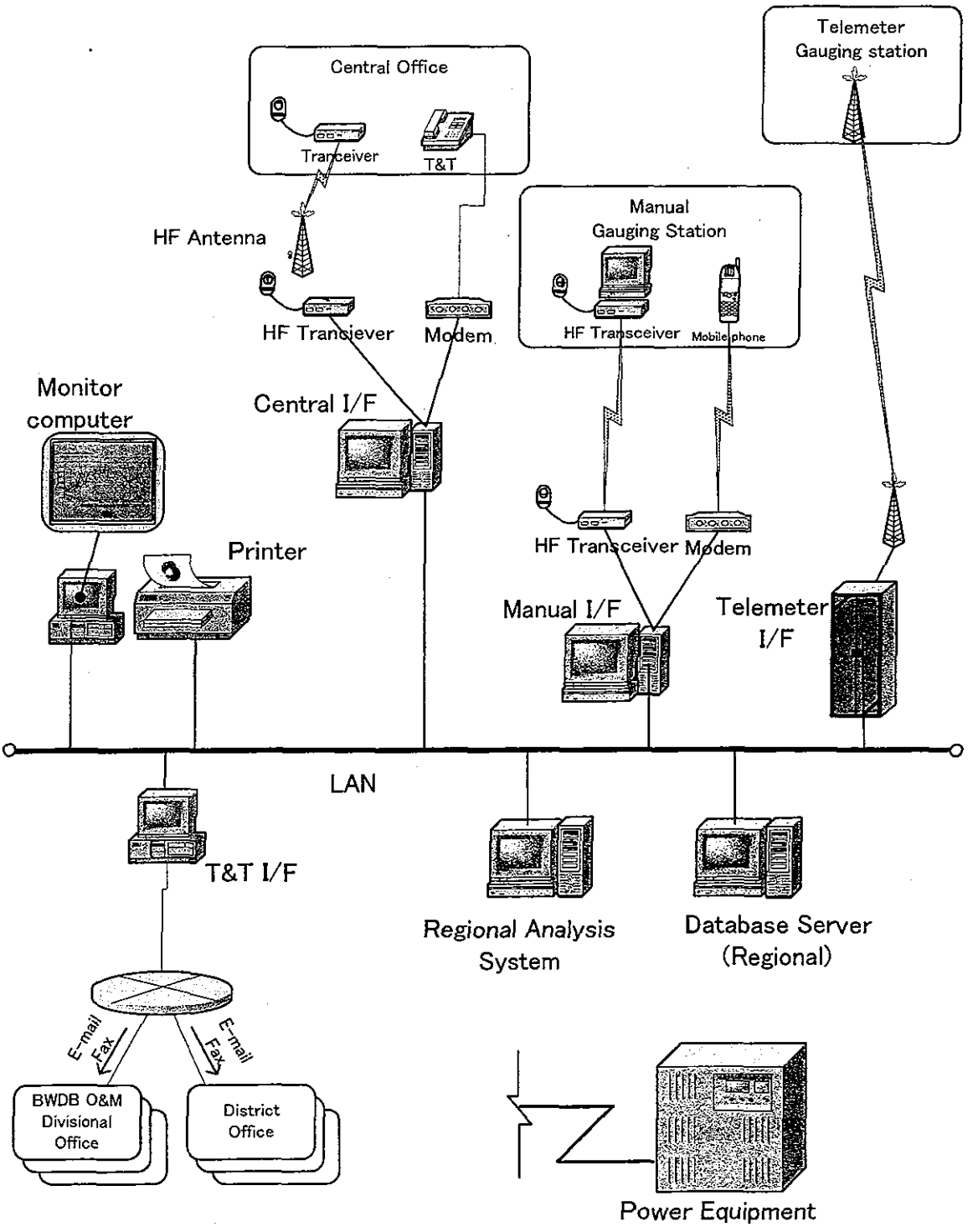
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 7.7.1

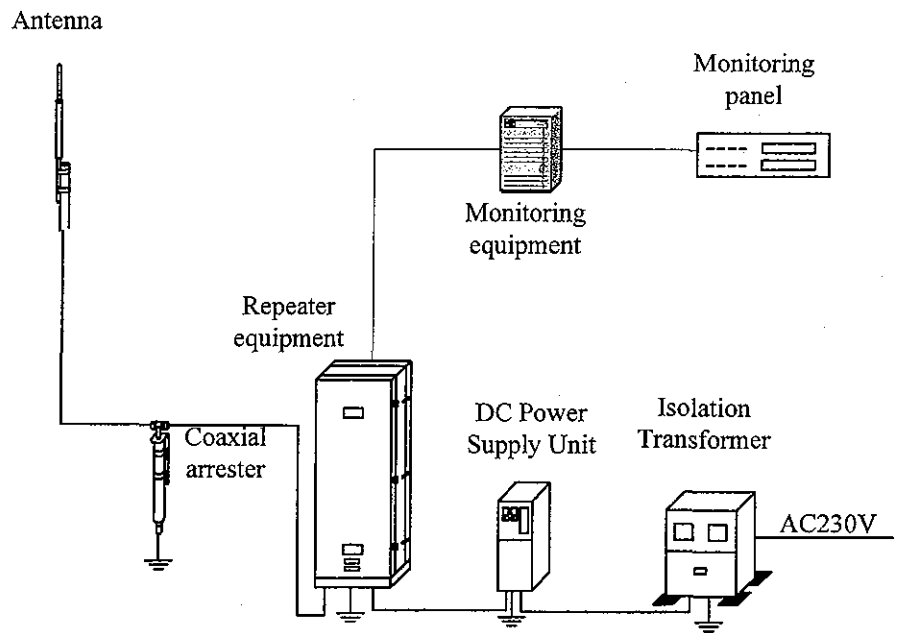
Summarized Features of Proposed Project



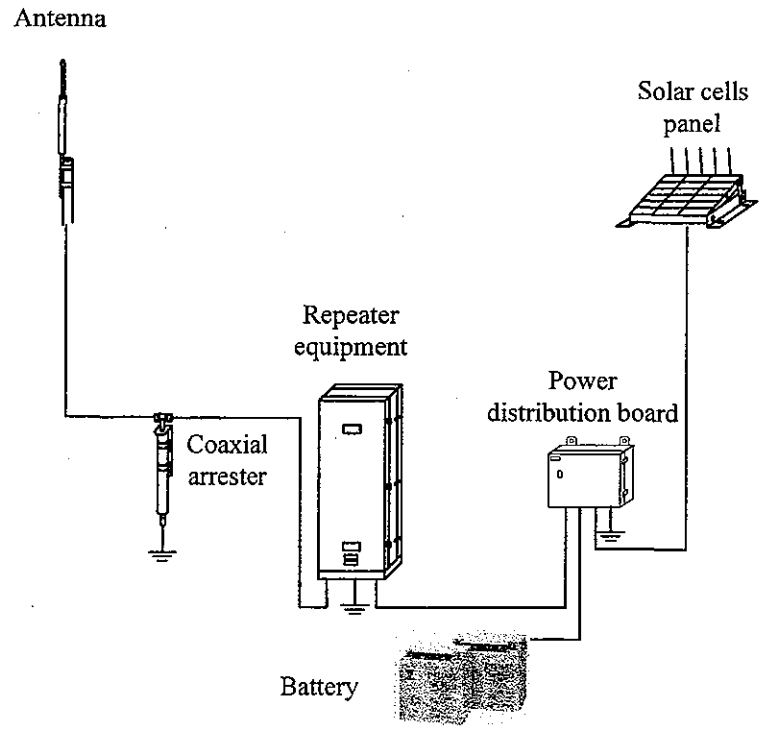
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.7.2
JAPAN INTERNATIONAL COOPERATION AGENCY	Block Diagram of Central Office



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.7.3
JAPAN INTERNATIONAL COOPERATION AGENCY	Block Diagram of Regional Office

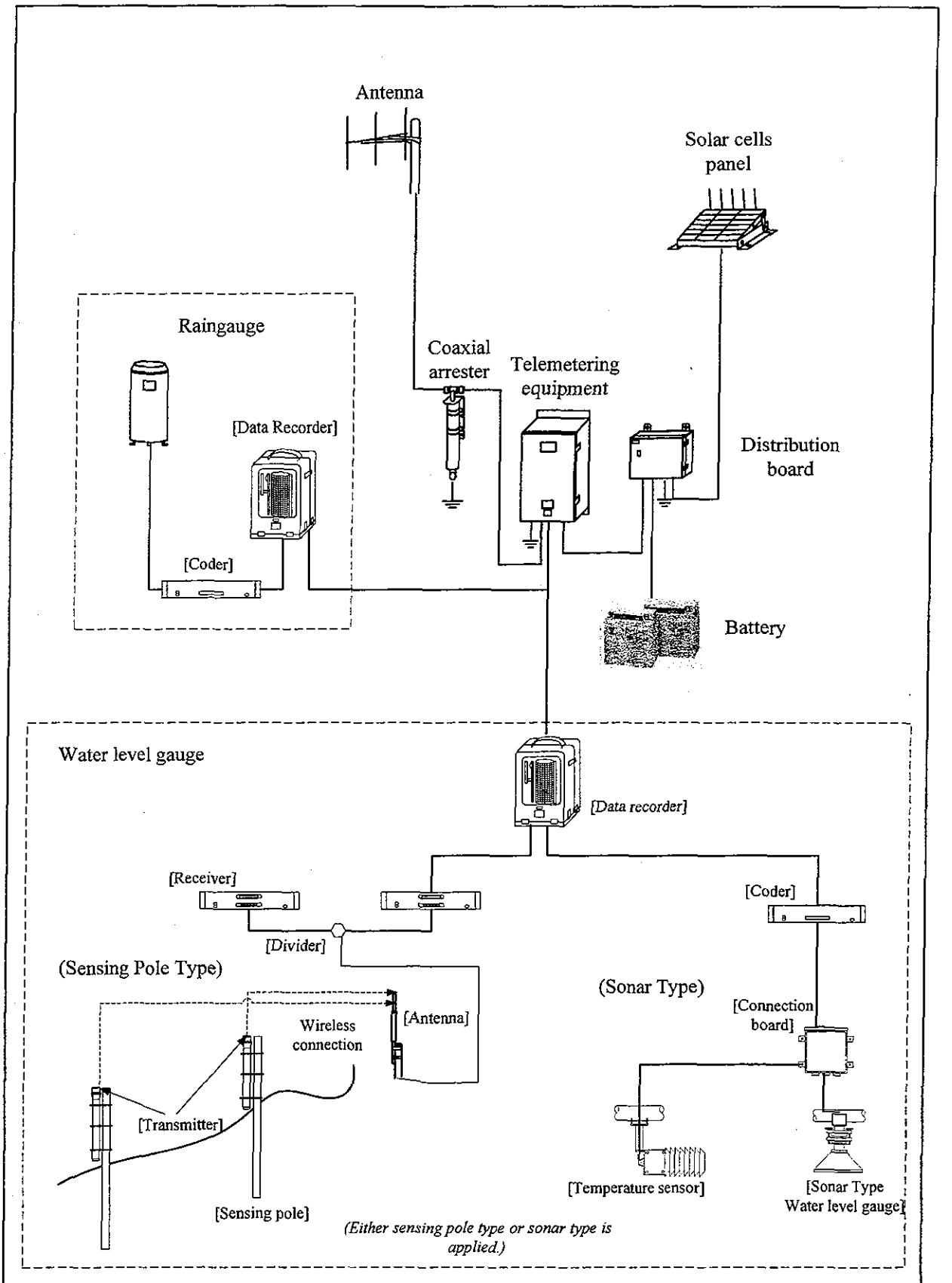


Repeater Station in O&M Office

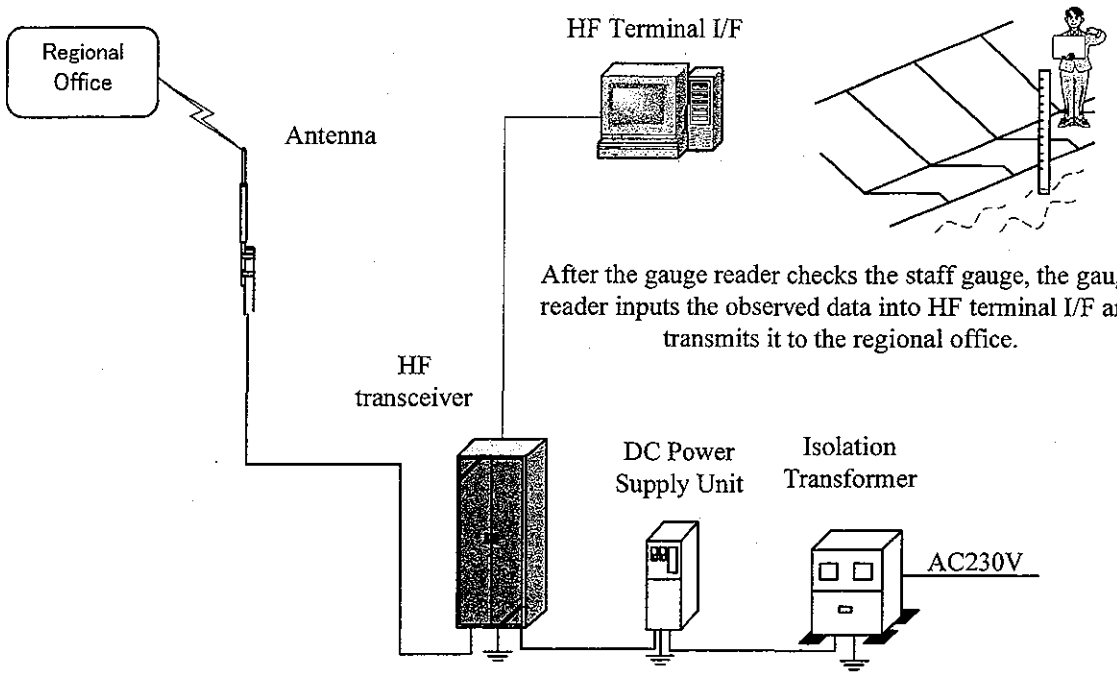


Repeater Station in Upazilla without O&M Office (not Upazilla office)

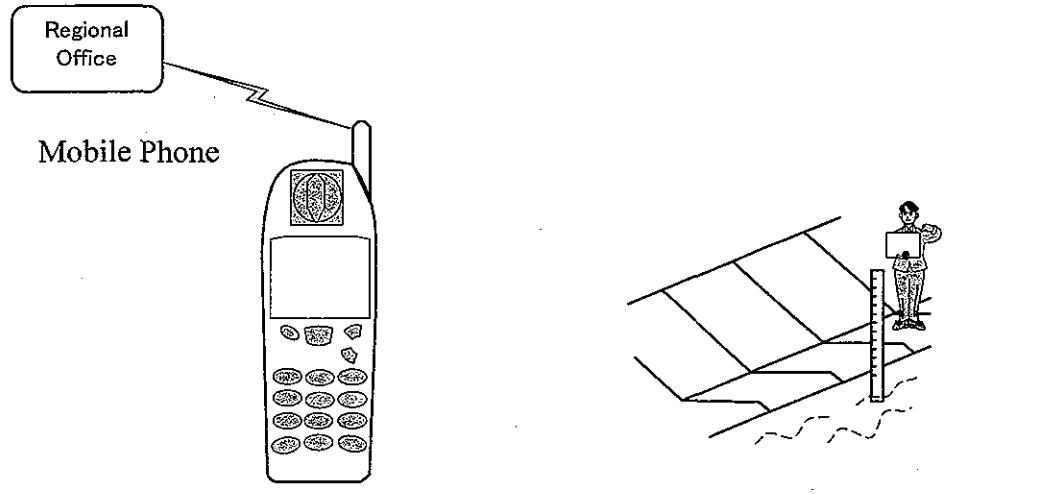
Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.7.4 Block Diagram of Repeater Station



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 7.7.5
JAPAN INTERNATIONAL COOPERATION AGENCY	Block Diagram of Telemeter Station

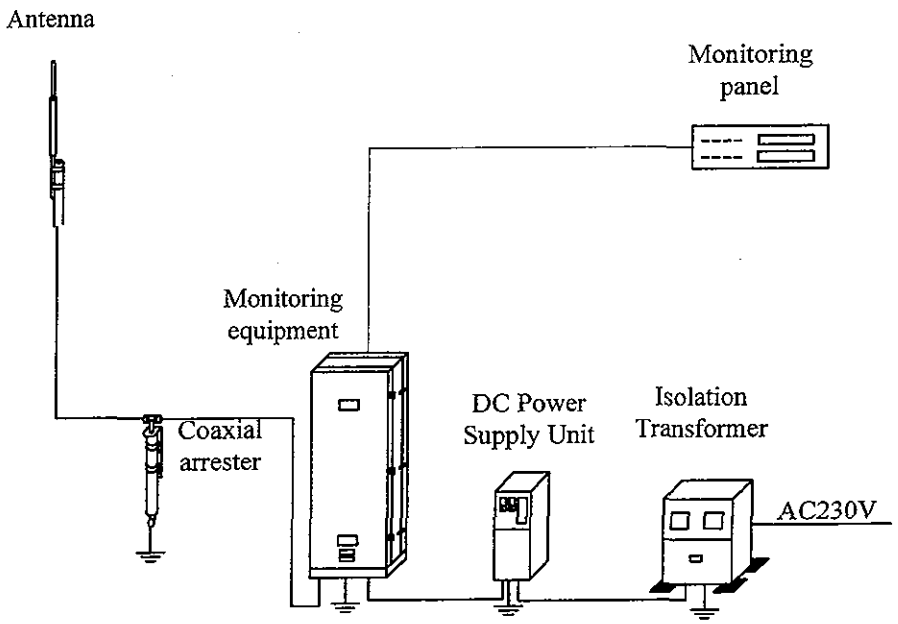


Manual gauging Station (by HF)



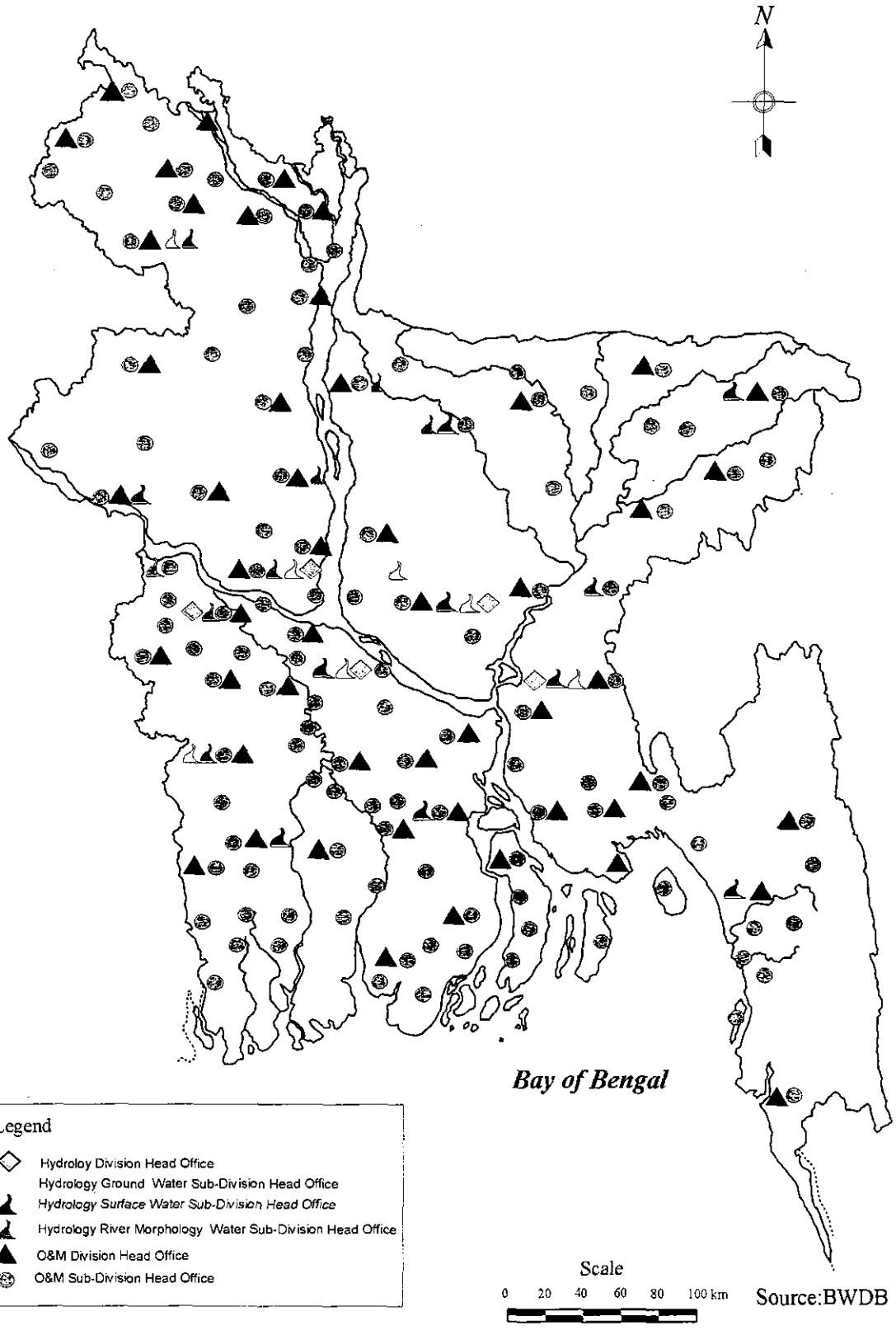
Manual gauging Station (by mobile)

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.7.6 Block Diagram of Manual Gauging Station

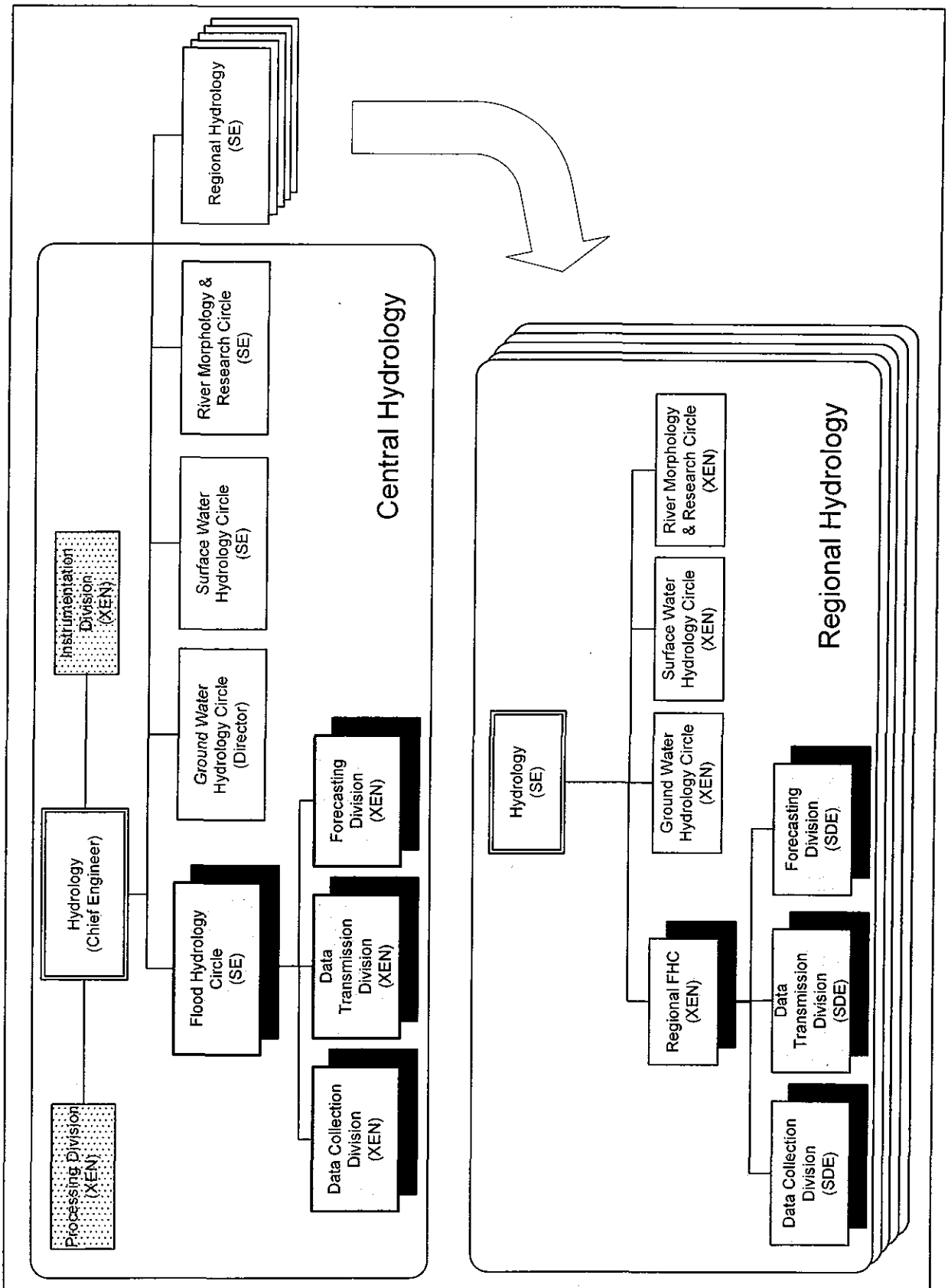


Point to Point Direct Dissemination

Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.7.7 Block Diagram of Point to Point Direct Dissemination



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh	Figure 8.1.1
JAPAN INTERNATIONAL COOPERATION AGENCY	Division and Sub-Division of BWDB

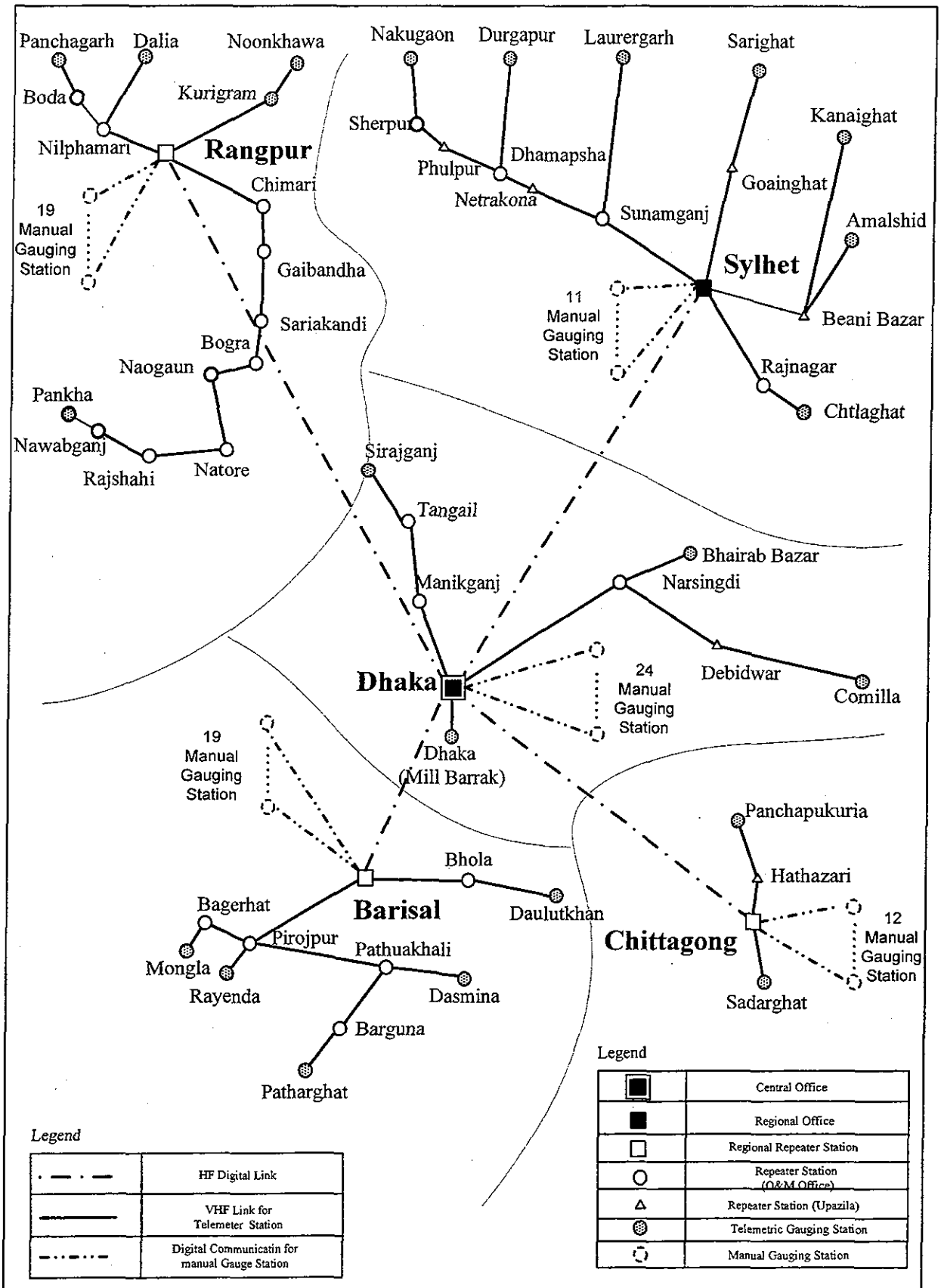


Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 8.2.1

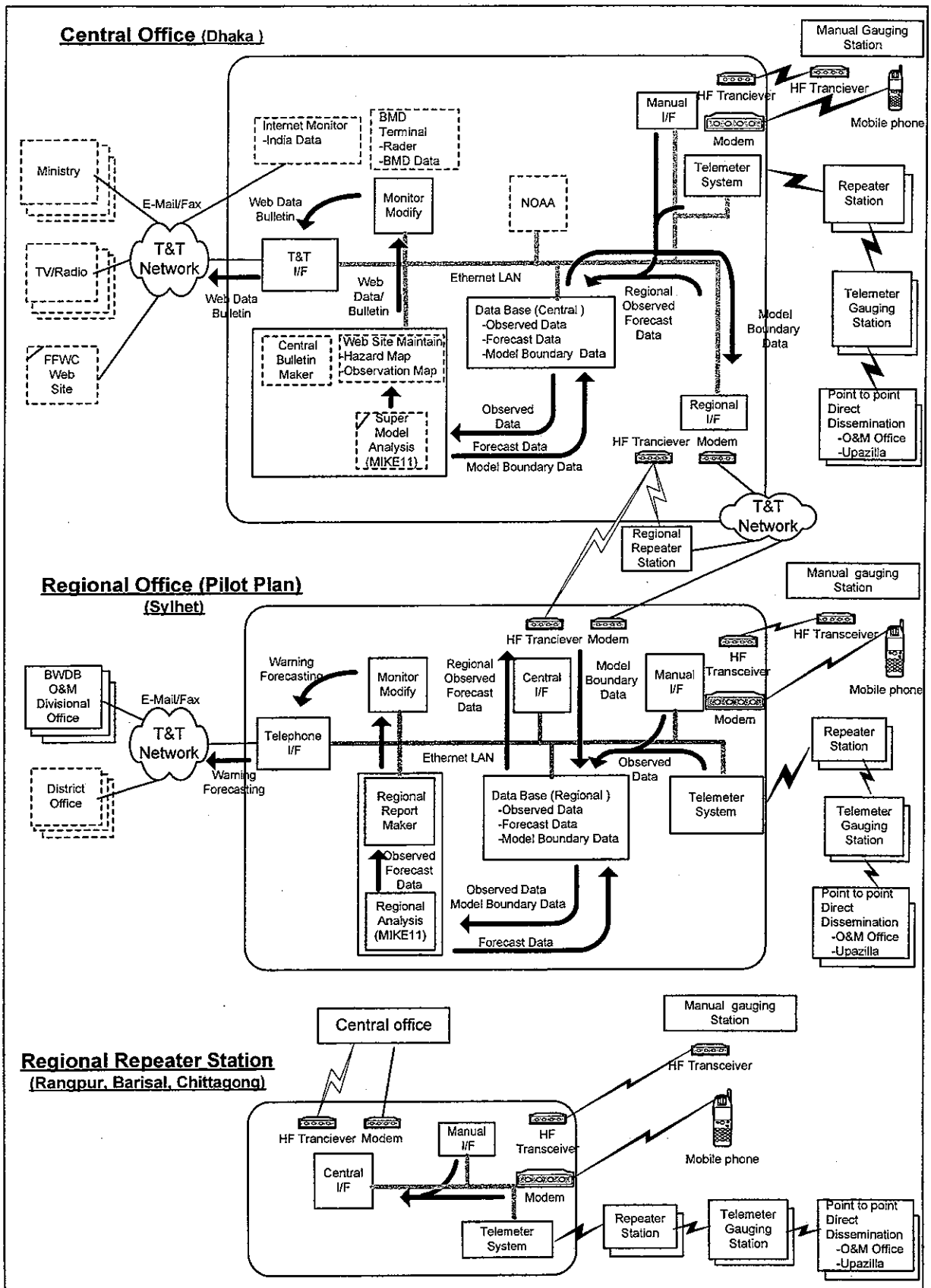
Proposed Organization of Hydrology



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 11.2.1
Data Transmission Network Diagram (Pilot Project)



Feasibility Study for Improvement of Flood Forecasting and Warning Services in the People's Republic of Bangladesh

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 11.2.2

Data Transmitting Flow (Pilot Project)

ATTACHMENT

ATTACHMENT-1

Terms of Reference for the Consulting Services for the Institutional Reform Study of BWDB in the People's Republic of Bangladesh

Terms of Reference

for

the Consulting Services

for

the Institutional Reform Study of BWDB

in

the People's Republic of Bangladesh

1. INTRODUCTION

Bangladesh is located in the delta of the three major international rivers, namely Padma (Ganges), Jamuna (Brahmaputra) and Meghna. The flood plains of the three major rivers together with smaller rivers and streams cover about 80% of the country. The total drainage area of three major rivers is 1.55 million km^2, out of which only 8% is within Bangladesh. The average river gradient is 6 cm/km and about 60% of the country is lower than 6 m above sea level. Under this condition, floods are regular phenomenon and it poses enormous threat to the population. On the other hand, water is one of the most important assets of the country. Rivers of Bangladesh directly influences the livelihood of the people including agriculture, fisheries, transport, etc.

Bangladesh Water Development Board (BWDB) is a national agency under the Ministry of Water Resources (MOWR) mandated for water resources development including flood forecasting and hydrological services. In the context of Bangladesh, this is very important organization that can directly contribute to the national economy. Hydrology services are also extremely important not only for flood forecasting but also for water resources management.

One of the basic policies of the Bangladesh Government regarding institutional reform is decentralization. Also, maximum utilization of manpower and resources is important aspect. However, the internal institutional setting of BWDB can not address these issues. The management is centralized top-down and work responsibility is highly segregated.

Taking into account the above-mentioned situation, a comprehensive study is needed for institutional reform of BWDB to select optimal organizational setup and strategies for smooth implementation to continue sustainable growth in the water resources sector of Bangladesh. Without proper functioning of BWDB, not only the water sector will be threatened but also the overall economic development will be jeopardized.

2. EXISTING CONDITION OF BWDB

Bangladesh Water Development Board (BWDB) has the total authority of planning, designing, implementation and operation of medium and large scale water resources projects of flood control, irrigation, river training, drainage and hydrology. Director General is the Chief Executing Officer of BWDB. There are five wings, namely, administration, finance, planning, OM-1 and OM-2. All field offices are under OM-1 and OM-2. Under the planning wing, there are three functions, planning, design and hydrology. Hydrology services is headed by Chief Engineer. Total staff of BWDB is around 8,860. The organizational structure of BWDB is shown in Fig. 1. Because of the present organizational set-up, the working procedure is segregated and duplicated.

3. JUSTIFICATION OF THE STUDY

BWDB is a centralized organization. The field offices of BWDB are responsible for only operation and maintenance of the existing facilities. Planning and design activities are carried out centrally. Projects are implemented by the project offices. Because of this, there is a lack of coordination among various units of BWDB at field level. Hydrology field level staffs cannot utilize properly the logistic facilities of OM offices.

Administration of Hydrology is also segregated, centralized and duplicated. Field offices just collect data. Data entry, validation, compilation, storage and flood forecasting is done centrally. As a result, regional context is not always possible to take into account. Since there is no field staff of maintenance division under Hydrology and since Hydrology cannot share with OM's maintenance facility, every time there is a problem with the data transmission, staff of Hydrology maintenance office has to go to the field from Dhaka.

Divisions and sub-divisions of Hydrology at field level are under different circles of Hydrology. In this situation, there are duplications of work. It may be mentioned here that there are seven locations where there are two sub-divisions of Hydrology at same place.

It is proposed that one regional office should be established as pilot project to demonstrate the efficiency of the regional system. Therefore, before start of pilot project, regional organization plan for pilot system should be formulated. After Pilot project implemented, guidance for pilot project should be done considering operating and maintenance and coordination with agencies concerned.

Under the above mentioned circumstances, without reform BWDB can not function properly and can not meet the requirement of the water sector development. This Study will take a comprehensive approach to identify the major constricts and prepare an executable solution for institutional reform of BWDB.

4. OBJECTIVES

The specific objectives of the Study are :

(1) To formulate comprehensive framework planning for institutional reform of BWDB.
(2) To formulate regional organization plan for Pilot Project.
(3) To guide the operation of Pilot Project.
(4) To conduct an implementation program on strategies identified in the framework planning.
(5) To carry out technology transfer to improve the technical capabilities of the counterpart staff.

5. SCOPE OF WORK

5.1 Contents of the study

This Study will, among other aspects, cover the following:

a. General data collection and analysis
b. Function analysis of BWDB
c. Rationalization analysis of BWDB services
d. Identification of overlaps and duplications of functions
e. Analysis of job responsibility
f. Identification of constraints
g. Formulation of regional organization plan for Pilot Project.
h. Guidance the operation of Pilot Project.
i. Conceivable alternatives for rationalization of functions
j. Policy implication analysis
k. Legal implication analysis
l. Staff complements analysis
m. Service code analysis
n. Human resources management analysis
o. Human resources development analysis
p. Financial analysis

q. Framework planning
r. Preparation of facilities inventory database
s. Preliminary cost estimation
t. Evaluation of Framework plan
u. Implementation program
v. Preliminary design for implementation

5.2 Duration of the Study

The Study is expected to be completed within 48 months.

5.3 Technology Transfer

The Study, which involves the formulation of framework plan and implementation program, will provide good opportunities to transfer the technical and planning knowledge to the personnel of relevant authorities to upgrade their capabilities for planning. In addition to this on-the-job training, a number of counterpart staff will visit foreign countries to obtain training opportunities to strengthen and upgrade technical and planning capabilities.

6. COUNTERPART AGENCY

Bangladesh Water Development Board (BWDB) will assume the role of the executing counterpart agency. The Study will be conducted by the selected Consultant's Study Team together with counterpart personals assigned by the executing agency and authorities concerned of the Government of Bangladesh.

7. EXPERT REQUIREMENT

The Study Team shall be composed of experts with extensive appropriate experiences in the field of water resources management, institutional aspect and other relevant fields to be led by a team leader. The required positions are as shown:

1. Team Leader
2. Water Resources Expert
3. Institutional/Organizational Expert
4. Policy and Legal Expert
5. Financial Expert

6. UNDERTAKING OF THE GOVERNMENT OF BANGLADESH

The Government of Bangladesh will accord privileges, immunities and other benefits of the Study Team and take necessary measures to facilitate smooth conduct of the Study through collaboration of the authorities concerned as follows :

(1) To furnish the Study Team with available relevant data, information and materials for the Study,

(2) To arrange for the Study Team appropriate office space, office equipment and other services for the execution of the Study,

(3) To provide full time counterpart staff necessary for performance of the duties of the Study and for on the job technology transfer,

(4) To provide security for all the members of the Study Team,

(5) To assist the Study Team to obtain other facilities and conveniences deemed necessary for the conduct of the Study.

ATTACHMENT-2

Terms of Reference for the Consulting Services for the Project of the Improvement of FFWS in the People's Republic of Bangladesh

Terms of Reference
For
The Consulting Services
For
Project of Improvement of FFWS
In
The People's Republic of Bangladesh

1. BACKGROUND

Bangladesh is located in the South Asia and surrounded by India in the North-East, North, North-West and West and Myanmar in the South-East and faces to the Bay of Bengal in the South. The country stands on the delta which has been formed by the three big international rivers, i.e. the Padma (Ganges), the Jamuna (Brahmaputra) and the Meghna all of which are originated in Indian Territory. The total drainage area of these three rivers is 1.55 million km^2, of which only 8% is within Bangladesh. The river gradient within Bangladesh is as gentle as 6 cm/km (1/17,000) and about 60% of the land in the country covers low-lying areas lower than 6m above mean sea level.

Owing to these topographic conditions, these three rivers have formed vast flood plains in Bangladesh which covers about 80% of its total land areas of about 147,000 km^2. Under these conditions, floods are regular phenomenon and have posed enormous threat to the people, although the rivers in Bangladesh have brought about the big benefit too to the people in social and economic activities in agriculture, fisheries, transport, etc.

According to the historical records, 19 floods with affected areas of more than 30,000 km^2 occurred after 1954. The most number of deaths was recorded in1988 (2,379 persons). The 1998 flood was recorded to have brought the largest damages amounting 160 Billion Taka according to the estimation by Bangladesh Government. This flood damage estimated however did not include the damages due to injury or death and the damage to homesteads. The flood damage, if counted those damages, become more than the estimated. The average annual flood damage is estimated at 12.2 Billion Taka.

Bangladesh Water Development Board (BWDB) is a national agency under the Ministry of Water Resources (MOWR) mandated for water resources development including flood forecasting and hydrological services. Flood Forecasting and Warning System was established in 1972 with Flood Forecasting and Warning Center (FFWC) in Bangladesh and has been developed with expansion of the number of gauging stations and flood analysis system year by year. Current FFWS has been facilitated with 91 water level gauging stations and 56 rainfall gauging stations, all of which are manually operated. Aside from those gauging stations, 14 telemeter stations were installed partly in 1985 and partly in 1996. However, these telemeter stations as well as manual observation system have not been operated effectively. The Government of Bangladesh (GOB) wishes to improve further the FFWS and asked the Japanese Government (GOJ) to conduct feasibility study for improvement of FFWS. In response to the request of GOB, GOJ decided to conduct the Feasibility Study. The Study was conducted from November 2002 to December 2003. The Study proposed the improvement plans of FFWS taking into account the problems being involved in the present FFWS and its possible solutions thereof.

The GOB is willing to implement the Proposed Project. Implementing agency of the Project will be BWDB.

2. GENERAL FEATURES OF THE PROJECT

The Feasibility Study has proposed the improvement of FFWS with such a basic concept that the Regional Operation System of FFWS plus manual & telemeter combined observation system as summarized below in order to eliminate man-made errors in manual observation, manual data transmission, etc.

(1) Regional Control System (Currently Central Control System has been adopted) with 5 regional control offices and Central Control System in Dhaka

a) Central Control System: Control Station in Dhaka
b) Five Regional Control System as;
- NE Region (Control Station in Sylhet)
- NW Region (Control Station in Rangpur)
- SE Region (Control Station in Chittagong)
- SW Region (Control Station in Barisal)
- NC Region (Control Station in Dhaka)

(2) Manual-Telemeter Combined Observation System
a) Water Level Gauging Stations
- Manual 68 stations
- Telemeter 23 stations

b) Rainfall Gauging Stations
- Manual 45 stations
- Telemeter 23 stations

(3) Project Cost
Construction cost: 1,148.2 Million Taka
Annual Operation and Maintenance Cost: 65.6 Million Taka

(4) Economic Evaluation of the Project
EIRR (Economic Internal Rate of Return): 26.4 %
Social & Environmental effect: All positive impact without negative impact

(5) Implementation Schedule
a) A Pilot Project (One regional control system) will be implemented first
b) Control System
- Central Control System
- Regional Control System: NE (Sylhet)

c) Observation System: All gauging stations proposed
d) Project Cost
Construction cost: 813.7 Million Taka
Annual Operation and Maintenance Cost: 51.2 Million Taka
e) Implementing agency: BWDB
f) Implementation period: Jan. 2004-Dec. 2008

3. OBJECTIVES OF CONSULTING SERVICES

As stated in the Report of the said Feasibility Study, the project implementation will need the consulting Services on the following objectives.

(1) To provide detailed design of the Project (***Design stage***)
(2) To assist the GOB for procurement in tendering and contracting with the contractor (***Pre-construction stage***)
(3) To assist the GOB for construction supervision (***Construction stage***)
(4) To assist the GOB for operation and maintenance of FFWS after completion of the construction / installation works (***guidance stage***)
(5) To assist the GOB to conduct the ***Special Study*** for effective operation of the proposed FFWS

4. SCOPE OF WORKS

The Consulting Services for the Project shall be conducted by the reputable international consultants in close cooperation with the Implementing agency. The Services shall be conducted through its Design Stage, Pre-construction Stage, Construction Stage, Guidance Stage and Special Study covering entire stages including but not necessarily be limited to the following.

A. Design Stage

(1) Review of the available data and information related to the Project including;
a) Collection of additional data and information
b) Review of the previous study

(2) Field investigation
   a) Geological investigation
   b) Topographic survey
   c) Land acquisition survey
(3) Detailed Design
   a) Preparation of design criteria
   b) Preparation of basic design with necessary revision of the layout plan
   c) Preparation of detailed design of the project facilities
   d) Preparation of Flood Forecasting Analysis Model for Sylhet Pilot project areas
   e) Preparation of construction program
   f) Preparation of construction cost estimate
   g) Confirmation of the project evaluation in terms of economic, social and environmental impacts
(4) Tender document
   a) Preparation of Pre-qualification document
   b) Preparation of Tender document

B. Pre-construction Stage

(1) Assistance in pre-qualification
   a) Assistance in selecting pre-qualified tenderers
(2) Assistance in tendering and contracting
   a) Assistance in tender calling
   b) Assistance in Tender evaluation and
   c) Assistance in Selection of the contractor
   d) Assistance in contracting with the Contractor
   e) Assistance in Contract award to the Contractor with issuance of notice to proceed
(3) Assistance in organizational set-up for Project Implementation

C. Construction Stage

(1) Supervision of Construction Works to be undertaken by the Contractor(s)
   a) Quality control
   b) Assistance in cost and schedule control
   c) Assistance in safety control
(2) Design modification as required
(3) Field and overseas technical training for the Project Staff of GOB

D. Guidance Stage

(1) Assistance and guidance for operation and maintenance of the FFWS
(2) Assistance in regional disaster management in relation with FFWS operation
(3) Assistance in river management in relation with FFWS operation

E. Special Study

(1) Assistance in river management
   a) Assistance in preparation of ledger sheets of river structures
   b) Assistance in preparation of operation manual of river structures at emergency
   c) Assistance in preparation of DEM
   d) Assistance in preparation of Hazard Map
   e) Assistance in formulating National Water Code in relation with River management
(2) Assistance in strengthening flood warning dissemination and evacuation in cooperation with BWDB and DMB
(3) Assistance in institutional study to establish a possible organization for more effective operation of BWDB

5. DURATION OF CONSULING SERVICES

The Consulting services are expected to be extended for the duration of 48 months covering all the Scope

of Works. Overall schedule is shown in the table below.
The duration of the Services is divided into aforesaid stages as follows.

Work Item / Year	2005	2006	2007	2008	Remarks
Design Stage					Task Concept
Pre-construction stage					Assistance concept
Construction Satge					Partly Task concept
Guidance Stage					Assistance concept
Special Study					Assistance concept

Design stage: 10 months
Pre-construction stage: 4 months
Construction stage: 10 months
Operation stage: 24 months
Special study: 48 months

6. COUNTERPART AGENCY

In view of the technology transfer to the counterpart of implementing agency, the GOB shall provide the Consultant with counterpart personnel on ***one expert-to-one counterpart and full time basis*** with sufficient basic knowledge of FFWS for total duration of Consulting Services

7. EXPERT REQUIREMENT

The Consultants shall be composed of experts with appropriate experiences in the respective fields of water resources management, institutional aspect and other relevant fields of the project. The required positions are as shown below.

1. Water Resourced Expert (Team Leader)
2. Telecommunication System Expert
3. River Management Expert
4. Hydrologist
5. Meteorologist
6. Economist
7. Design Engineer (Telecommunication and Electric)
8. Design Engineer (Civil and Building)
9. Design Engineer (System Design)
10. Construction Plan and Cost Estimate Specialist