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THE PEOPLE'S REPUBLIC OF BANGLADESH
DHAKA WATER SUPPLY AND SEWERAGE AUTHORITY
MINISTRY OF LOCAL GOVERNMENT, RURAL DEVELOPMENT AND COOPERATIVES, LOCAL GOVERNMENT DIVISION

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

MAIN REPORT

FEBRUARY 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the People's Republic of Bangladesh, the Japanese Government decided to conduct an Updating Study on the Storm Water Drainage System Improvement Project in Dhaka City and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Bangladesh a study team headed by Mr. Naohito Murata of Pacific Consultants International from July to December 1989.

The team held discussions with concerned officials of the Government of Bangladesh and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

February, 1990

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

UPDATING STUDY

ON

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

Mr. Kensuke YANAGIYA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit the final report entitled the "UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY". This report has been prepared by the Study Team in accordance with the contract signed on 7 July 1989 between the Japan International Cooperation Agency and Pacific Consultants International.

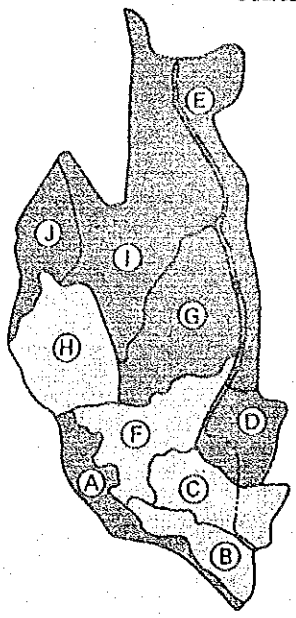
In the study, the original 1987 project has been revised to account for the disastrous flood of 1988 and for more recent related projects, the team identified urgent projects within the first priority area, comprising khal improvements, and construction of a pump station and sluice gate.

All members of the Study Team wish to express appreciation to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, and Embassy of Japan in Bangladesh for their assistance. The Team also would like to thank the officials and individuals of the Government of the People's Republic of Bangladesh, and sincerely hope that the results of study will increase to the well-being of the residents of Dhaka City.

Yours Faithfully,

Murata
Naohito MURATA
Team Leader

PHASING MAP

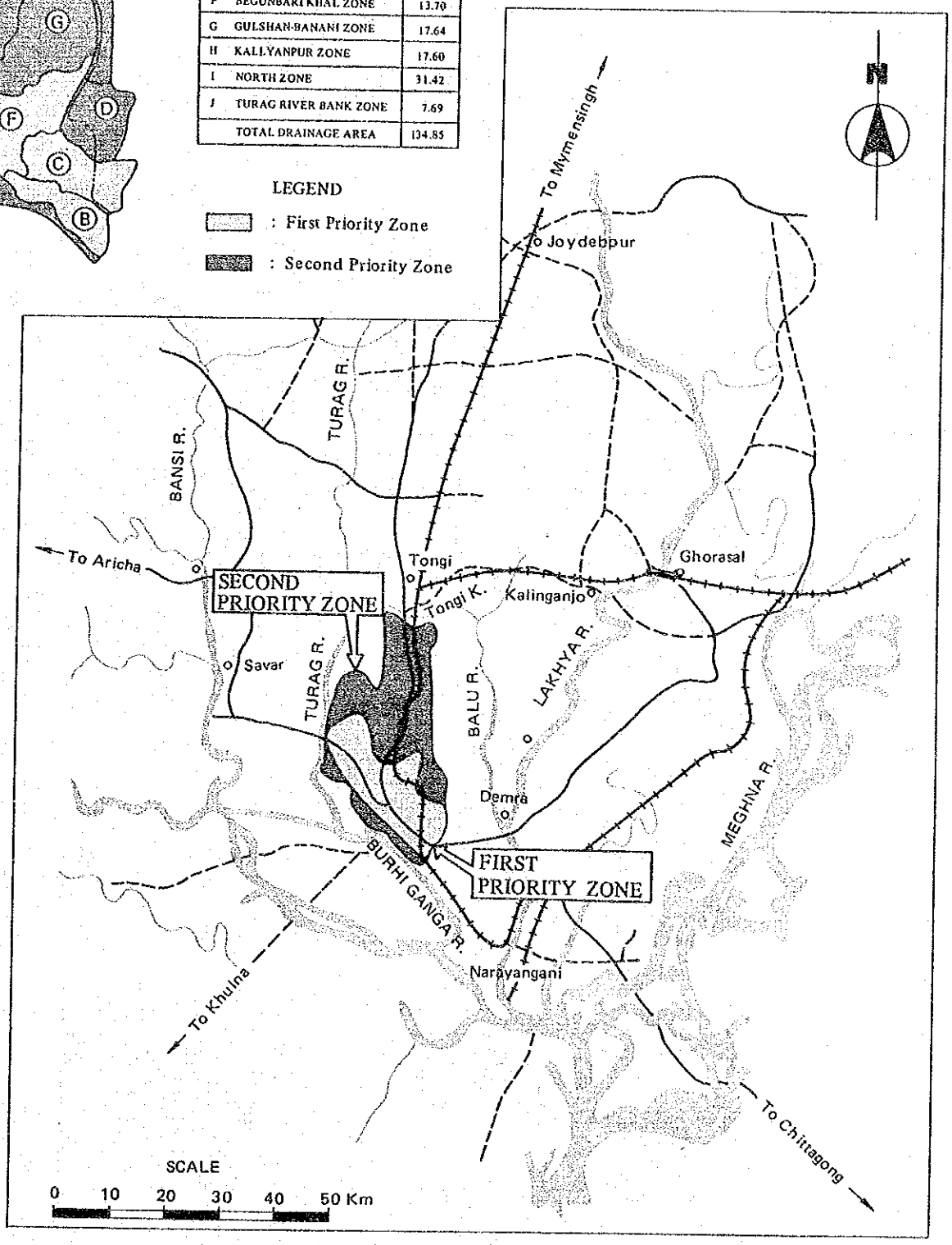


DRAINAGE ZONE AREA

DRAINAGE ZONE	Km^2
A BURIGANGA RIVER ZONE	7.25
B DHOLAIKHAL ZONE	7.24
C SEGUNBAGICHA KHAL ZONE	10.92
D BASHABO ZONE	7.46
E NORTH-EAST EDGE ZONE	13.93
F BEGUNBARI KHAL ZONE	13.70
G GULSHAN-BANANI ZONE	17.64
H KALLYANPUR ZONE	17.60
I NORTH ZONE	31.42
J TURAG RIVER BANK ZONE	7.69
TOTAL DRAINAGE AREA	134.85

First Priority Zone: A = 49.46 km^2
Second Priority Zone: A = 85.39 km^2

LEGEND
: First Priority Zone
: Second Priority Zone

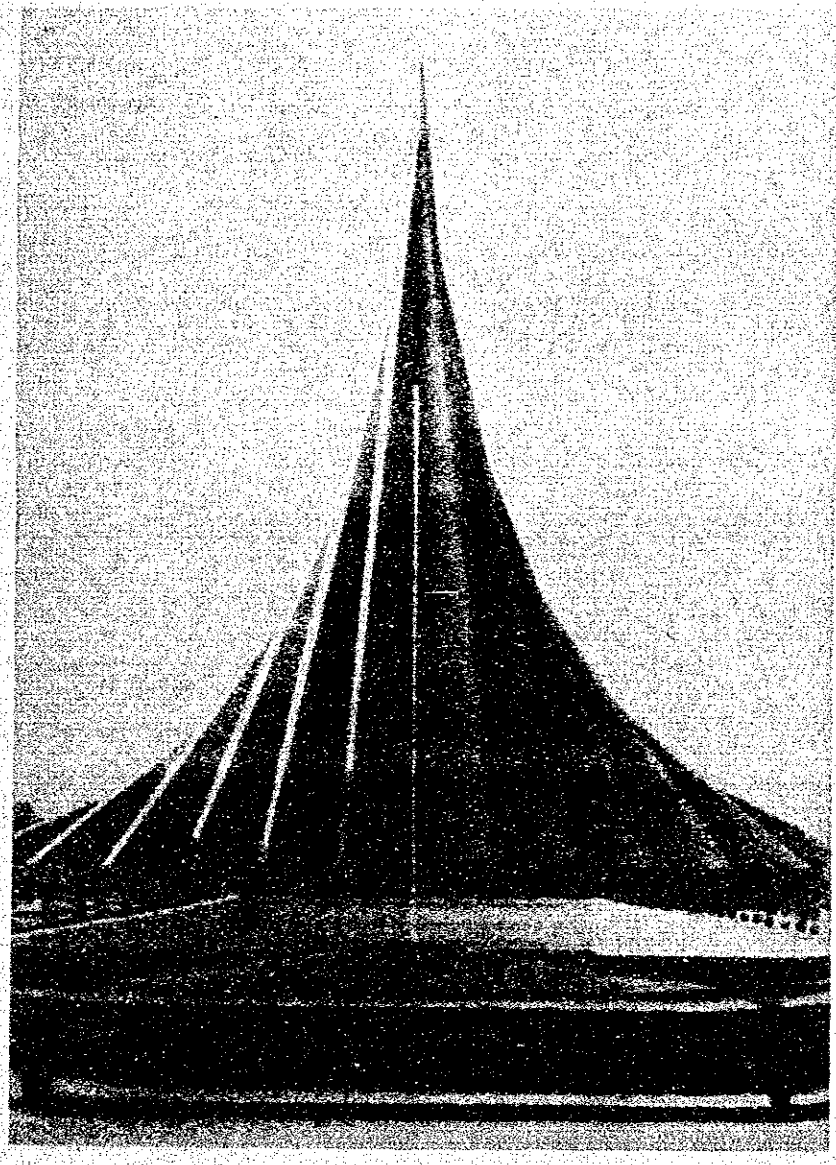


LOCATION OF STUDY AREA

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

JICA A.D 1990

SUMMARY



NATIONAL MARTYRS MEMORIAL

SUMMARY

1. INTRODUCTION

In 1987, the "Study on Storm Water Drainage System Improvement Project in Dhaka City" was conducted by the Japan International Cooperation Agency (JICA) in collaboration with officials of the Government of Bangladesh. The study proposed three phased programmes for drainage improvement for the city of Dhaka with a total area of 137.5 km^2. The study urged the immediate implementation of the highest priority programme or Phase-I which cost Tk 2.61 billion and covered an area of 31.30 km^2.

In 1988, after Dhaka suffered the worst flood in its history, the Government of Bangladesh approved the "Greater Dhaka Flood Control and Drainage Scheme" for implementation. It also requested the Government of Japan to re-evaluate and update its previous JICA study taking into account the results of related projects which began after the 1988 flood as well as the information gained from the flood itself.

2. 1988 FLOOD

In the 1988 flood, almost 58% of the study area was inundated with a duration which ranged from 3 to 60 days and an average flood depth of 1.2 m. The population effected is estimated to have been about 1.8 million or about 56% of the total population. The corresponding flood vulnerable population by the year 2000 is estimated to be close to 2.7 million or 59% of the total city population. The 1988 flood in Dhaka city was caused by external floods which although potentially of great magnitude have a very low frequency of occurrence, and are consequently not used as the basis of the design for internal drainage facilities (Fig. S.1).

The conditions of the flood itself were worse in the northwest parts of the study area than they were in central Dhaka. The poor discharge capacity of the existing khals aggravated the length of the flood duration for inland areas and intensified the damage.

3. RELATED ONGOING PROJECTS

3.1 Dholai Khal Rehabilitation and Area Development Project (World Bank Project)

The Dhaka Municipal Corporation (DMC) is currently executing the captioned project with the financial assistance of World Bank and the UNDP/UNCHS. The project consists of not only improvement of the Dholai Khal and the installation of the new Narinda pump station, but also improvement of communications, provision of new commercial activity, and improved health and sanitation conditions in old Dhaka city. Currently in the detailed design stage, the proposed drainage facilities should be reviewed in order to correspond with other ongoing projects. (Fig. S.2) Since construction will be implemented by DMC in the near future, the Dholai khal improvement work including the installation of the pump station for drainage Zone B will be omitted from the JICA project.

3.2 Greater Dhaka Flood Control and Drainage Project (GDFCD Project)

The "Flood Control and Drainage of Greater Dhaka Committee" proposed a phased programme for the GDFCD Project after the consideration of the 1988 flood, existing conditions of Dhaka, previous studies and projects, ongoing projects, and the recommendation by independent experts. Phase I of the project, which consists of 13 major tasks (Tk 2,086 million) is proposed for the urbanized parts of western Dhaka. The remaining eastern parts of the metropolitan area will be protected by Phase II comprising three tasks with a total cost of Tk 3,600 million (Fig. S.2). The study area will be protected from external floods by embankment or wall after completion of the GDFCD project. Therefore, the construction of the embankment and road elevation proposed in the previous JICA study is omitted from this one.

3.3 Khal Improvement Project

DWASA has begun the urgent cleaning of the 13 existing khals as a part of the GDFCD Project in order to improve flood water drainage. At the same time, it is also preparing a project for the demarcation of land for acquisition, elimination of unauthorised houses and structures through resettlement or eviction. In addition, DWASA and RAJUK are preparing to implement an additional khal improvement using a box culvert in Begunbari khal (1,600 m) and Paribagh khal (700 m). This project will be started in

the dry season of 1989. Due to these planned projects, the improvement work for the above khal sections will be omitted from the urgent project in this study.

4. UPDATING THE PHASED PROGRAMME

The total drainage area consisting of ten zones has been revised for this study from 137.5 to 134.85 km^2. By taking into account the related ongoing projects, the measures proposed in this study are the construction of two new pump stations with new sluice gates, extensive khal improvement (except for Dholai khal), and drainage pipe improvement.

The two (2) pump stations which will have a total capacity of 24.5 m^3/s and two (2) related regulating ponds with a total area of 242 ha and a total storage capacity of 2.59 million m^3 are proposed for drainage zones H and I. Pumped drainage for other zones is expected to be supplied by the World Bank and the GDFCD projects.

The khal improvement plan for the 25 existing khals is reviewed in terms of design discharge, khal length to be improved, khal improvement type (open or covered type), and profile/cross section. In the previous study, an open channel was proposed for the khal improvement for all stretches of the existing khals. The covered channel type (box culvert) is, however, applied for the Segunbagicha khal (L=2,300 m), Begunbari khal (L=2,800 m) and Paribagh khal (L=700 m) located in the highly urbanized area, considering social needs and the difficulties involved in maintaining strict control of the operation and maintenance of the khals.

No revision of the 14 drainage pipe trunks is recommended in this study except for the installation of sluice gates at their outlets to the Buriganga and Turag rivers.

In addition to the capital construction involved in the project, non-structural measures which are recommended are to reserve swampy areas (totalling 242 ha)for the proposed pump regulating pond and to strictly enforce controls to prevent any reduction of the minimum cross sectional areas of the khals.

The estimated cost of the proposed structural measures is summarized below:

	Construction Works	Quantity	Cost (million Tk)
A.	Sluice Gate	7 places	135.5
B.	Pump Station	2 stations, 24.5 m^3/s	624.5
C.	Khal Improvement	36.35 km	1,933.1
D.	Drainage Pipe	17.00 km	775.5
	Sub-total		**3,468.6**
E.	Contingency/Engineering Service		693.7
F.	Land Acquisition	18 ha	316.4
	Total		**4,478.7**

The work in the ten drainage zones shown in Fig. S.3 is divided into areas with two different levels of priority. The zones with the highest priority are zones B, C, F, and H which have a total area of 49.46 square kilometers. Second priority zones are zones A, D, E, G, I, and J with an area of 85.39 km^2. In this new organization, Zone H is included as a high priority area along with zones B, C, and F which were proposed in the previous study, due to its rapid urbanization and the serious damage it suffered in the 1988 flood. The remaining zones are designated as the a second priority due to the limited on the availability of funds.

The programme which originally consisted of two phases has been revised as shown on the following page. This revised programme takes into account the efficiency of each task in mitigating the intensity of flood damage.

5. URGENT PROJECT

5.1 Identification of Urgent Project

The priority sequence as described in Section 4 was used to develop the following project for which implementation is considered as the most urgent portions of the Phase I programme. In order to define the project for urgent implementation, a number of projects which are considered as necessary to complete Phase I were omitted due to their being included in other projects or due to their being considered as postponable. Thus, the Urgent Project will include the following works.

PROPOSED PHASED PROGRAM

Unit : MillionTk. at 1989 price

ZONE	WORKS	PHASE			
		I		II	
A	(1) Drainage Pipe	-		L=3.80km	127.5
	(2) Khal Improvement			L=0.30km	6.3
	(3) Sluice Gate			n=4places	63.5
B	(1) Drainage Pipe	*		L=4.28km	295.2
	(2) Khal Improvement	*			
	(3) Pump Station	*		n=1place	6.0
	(4) Sluice Gate				
C	(1) Drainage Pipe			L=4.81	206.3
	(2) Khal Improvment	L=5.30km	593.9	L=1.00km	17.5
D	(1) Drainage Pipe	-		L=0.70km	29.5
	(2) Khal Improvement			L=4.45km	80.9
E		-		-	
F	(1) Drainage Pipe			L=3.4km	117.0
	(2) Khal Improvement	L=3.50km	755.3		
G	(1) Khal Improvement	-		L=2.90km	44.0
H	(1) Khal Improvement	L=3.30km	24.0	L=8.70km	207.1
	(2) Pump Station	L=10.0m3/s	226.7	Q=10.0m3/s	226.7
	(3) Sluice Gate	n=1place	50.9		
I	(1) Khal Improvement	-		L=6.9km	204.1
	(2) Pump Station			Q=4.5m3/s	171.1
	(3) Sluice Gate			n=1place	15.1
J		-		-	
	. Sub-Total	1,650.8		1,817.8	
	. Contingency and Engineering	336.4		357.3	
	. land Acquisition	A=9.0ha	185.6	A=9.0ha	131.6
	TOTAL	2,172.0 Million Tk.		2,306.7 Million Tk.	

Note : Proposed works with (*) into the B-Zone are included in the World Bank Project.

Work	Phase I Total	Urgent Portion	Percentage of Phase I
1) Khal Improvement			
River dredging	7,200 m	7,200 m	100%
Slope protection	1,000 m	1,000 m	100%
Channel culvert	5,800 m	2,200 m	38%
Bridge culvert	5 places	5 places	100%
2) Pump station	10 m^3/s	10 m^3/s	100%
3) Sluice gate	1 place	1 place	100%

5.2 PRELIMINARY DESIGN

5.2.1 Pump Station

Basically, the pump station will be designed to operate with three vertical axial flow pumps, each with a flow capacity of 3.3 m^3/s, or a combined discharge flow of 10 m^3/s. This flow rate will be possible with an actual pump head of 2.0 meters. Electric power for the pumping station will be supplemented in emergencies by a back-up electric power source. The main building of the pumping station will be a two storey reinforced concrete framed brick structure. It will be equipped with not only the equipment room, but workshop, storage room, control room, and toilet. A smaller auxiliary building will provide for a bunk room and meeting room for staff manning the facility during the continuous operations during the rainy season.

5.2.2 Sluice Gate

The sluice gate associated with the pumping station consists of a 60 m long double channel gate-culvert lying under the flood protection dike and two gate leaves at each end of the culvert. The channels themselves will measure 2.5 m x 2.5 m in cross-section, for a total sectional area of 12.5 m^2. The gates on either end can be opened or closed as needed in both the wet and dry seasons to regulate the level of water in the river and will be made of an steel material, and will be of the "roller" gate type.

5.2.3 Khal Improvement

The proposed khal improvement works will consist of dredging, both sodding and brick bank protection, the construction of box and bridge culverts, and the construction of one steel railway bridge. For khal sections where fairly easy access is required and

feasible, a trapezoidal cross section will be employed. Bank slopes will be protected by either sodding or brick embankments, depending on the suitability for different locations. Box culverts will be rectangular in cross section and constructed of reinforced concrete with a spread foundation. Existing bridge culverts for roads and bridge for the railway crossing will be either repaired or reconstructed in order to illuminate bottle-necks for flood discharge. Bridge culverts will be similar to box culverts in construction. The type of railway bridge proposed is to be a girder type bridge in order to speed construction and to accommodate existing rail traffic.

5.3 Operation, Maintenance, and Organization

The operation and maintenance of all drainage facilities will be the responsibility of DWASA, which took over the responsibility from DPHE in March, 1989. The major tasks of operation and maintenance will be the cleaning and dredging of the khals, cleaning of drainage pipes, and the operation of the pump station and sluice gate. To sustain the expected effects of the existing and proposed drainage system of the project area (Zones C, F, and H), the operation and maintenance programme shall include the following major activities:

1) Dredging of deposits and removal of garbage from the 22.1 km of both open and closed khals
2) Cleaning of the 68.1 km of existing drainage pipes
3) Operation and maintenance of one pump station with sluice gate
4) Land use control, in cooperation with the agencies concerned, to maintain the regulating pond and khal areas, and to assure the required elevation of new land development

All of the khals and drainage pipes should be cleaned one time per year. The cleaning is to be done by both cleaning machines and manual operations. In order to achieve satisfactory results in cleaning operations, strengthening of the existing organization is necessary, both in terms of equipment and manpower.

Equipment needed for efficient maintenance includes various trucks, numerous pieces of cleaning equipment, small pumps for dewatering, and a number of vehicles for supervisors. In terms of manpower, the staff should include a minimum of 15 engineers along with additional auxiliary staff.

In addition to normal operation and maintenance procedures, necessary land use control measures should include the preservation of the 208 ha regulating pond area at Kallyanpur, strict control of the use of the land adjacent to the khals, and land fill prior to development in the low lying areas of the Kallyanpur.

5.4 Project Cost

The project cost estimates consist of construction costs, engineering and contingency costs, land acquisition and compensation costs, and customs duties and sales tax costs. The total project cost is summarized below:

A.	Construction Cost	Tk 863.6 million
	(Pump Station	226.7 million)
	(Sluice Gate	50.9 million)
	(Khal Improvement	586.0 million)
B.	Physical Contingency	86.4 million
C.	Engineering	86.4 million
D.	Land Acquisition	157.6 million
E.	Office Establishment	26.4 million
F.	Customs Duty and Tax	115.0 million
	Total Cost	**Tk 1,335.4 million**

Operation and maintenance costs for the drainage facilities include personnel, electricity, and cleaning and repair expenses, and is estimated to average Tk 13.0 million annually. This cost represents approximately one percent of the construction cost of the project.

5.5 Implementation Schedule

The implementation schedule for the urgent project is divided into two packages for staged construction. The packages are divided as shown below:

	Package I (Zone F and Zone H)			Package II (Zone C)	
1)	Pump station	1 place	1)	Channel culvert	1.4 km
2)	Sluice gate	1 place	2)	Bridge culvert	3 places
3)	Channel culvert	0.8 km	3)	Railway bridge	1 place
4)	Bridge culvert	1 place	4)	Brick protection	1.0 km
5)	Dredging	3.3 km	5)	Dredging	3.9 km

The total estimated time for construction is approximately 2.5 years for each package.

6. PROJECT EVALUATION

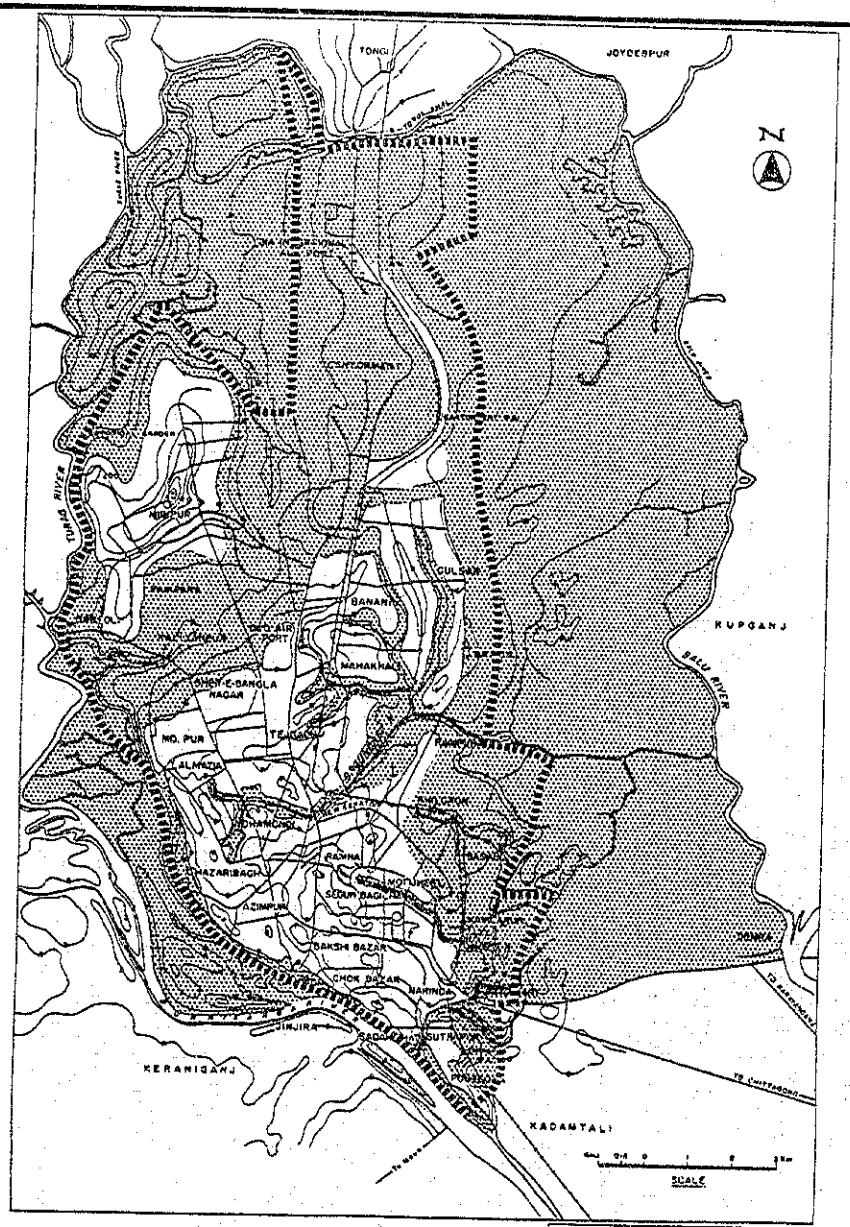
This drainage system improvement project not only has the potential for numerous social benefits for the people of Dhaka, but also shows a high investment efficiency in economic analysis, as shown by the major economic indicators below.

Package	Zone(s)	EIRR (%)	B/C	NPV (million Tk)
I	F and H	10.7	2.28	961.7
II	C	9.0	1.81	172.9
Total	C, F, & H	9.3	1.90	760.1

Aside from the economic benefits which were quantified in this economic analysis, a number of other benefits will accrue from project implementation, such as:

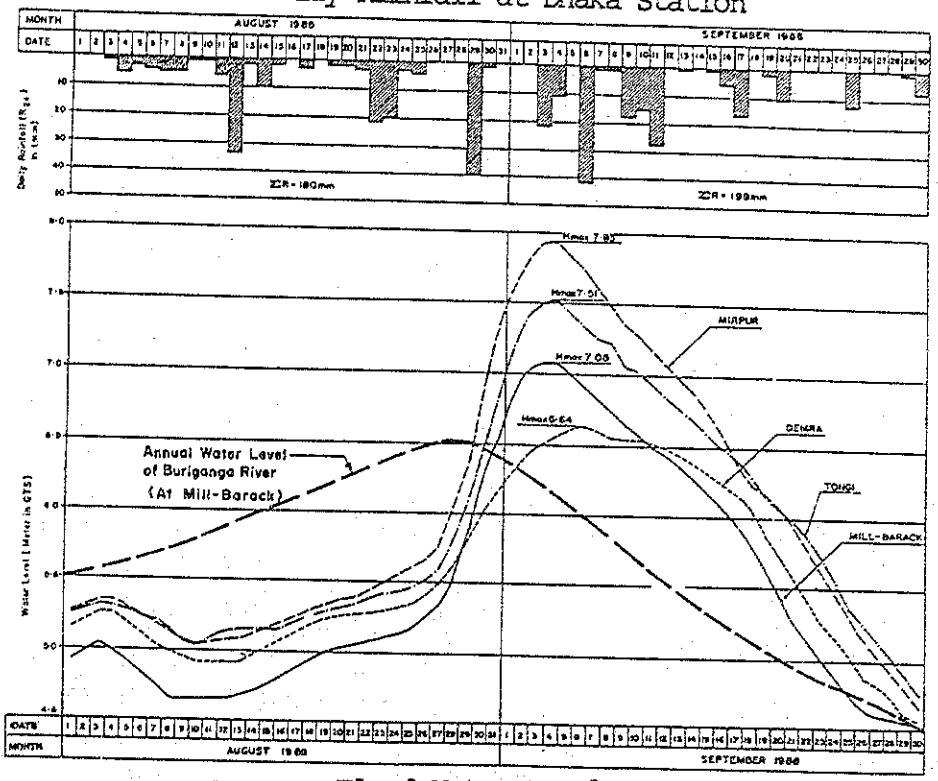
- The improvement of business efficiency
- The improvement of the potential for land use
- The improvement of sanitary conditions
- The overall improvement of the reputation of the city
- The creation of employment (estimated at 210,000 person-days) over the first three years of construction.

Thus, the implementation of the drainage system improvement is strongly recommended due both to a favourable economic evaluation and the magnitude of positive social impacts.



1988 FLOOD AREA

Daily Rainfall at Dhaka Station



Flood Water Level

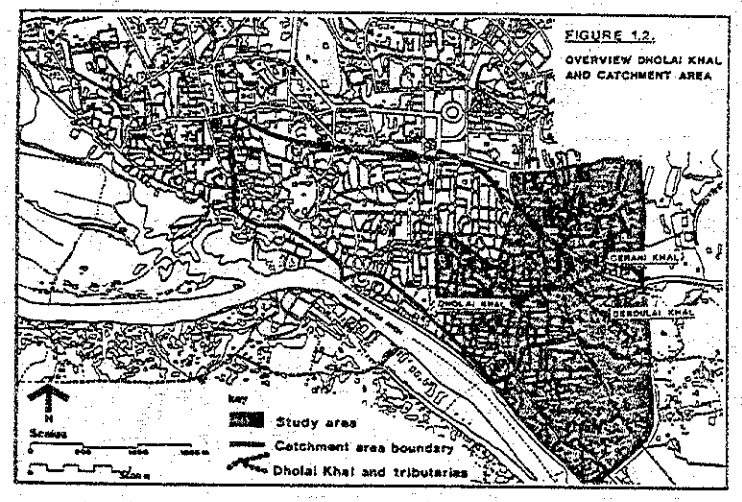
1988 FLOOD WATER LEVEL

Source: 1. Flood Area : Flood Survey by JICA Study Team
2. Rainfall and Water Level : BWDB

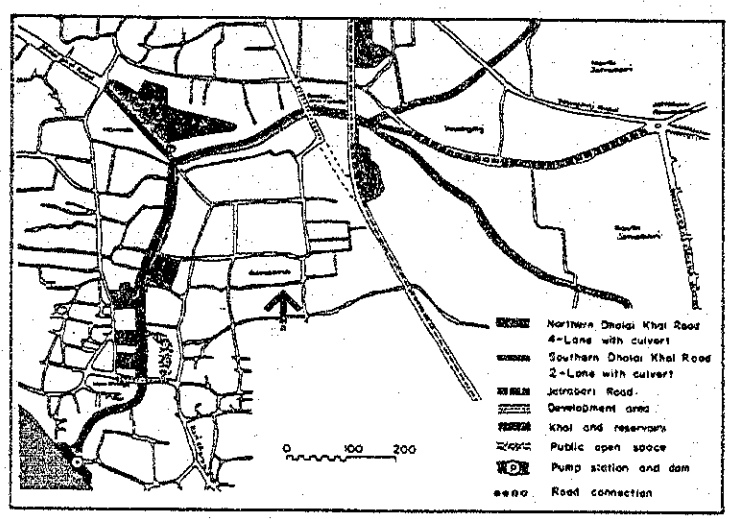
FIG. S. 1 1988 FLOOD CONDITIONS

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

JICA A.D 1990

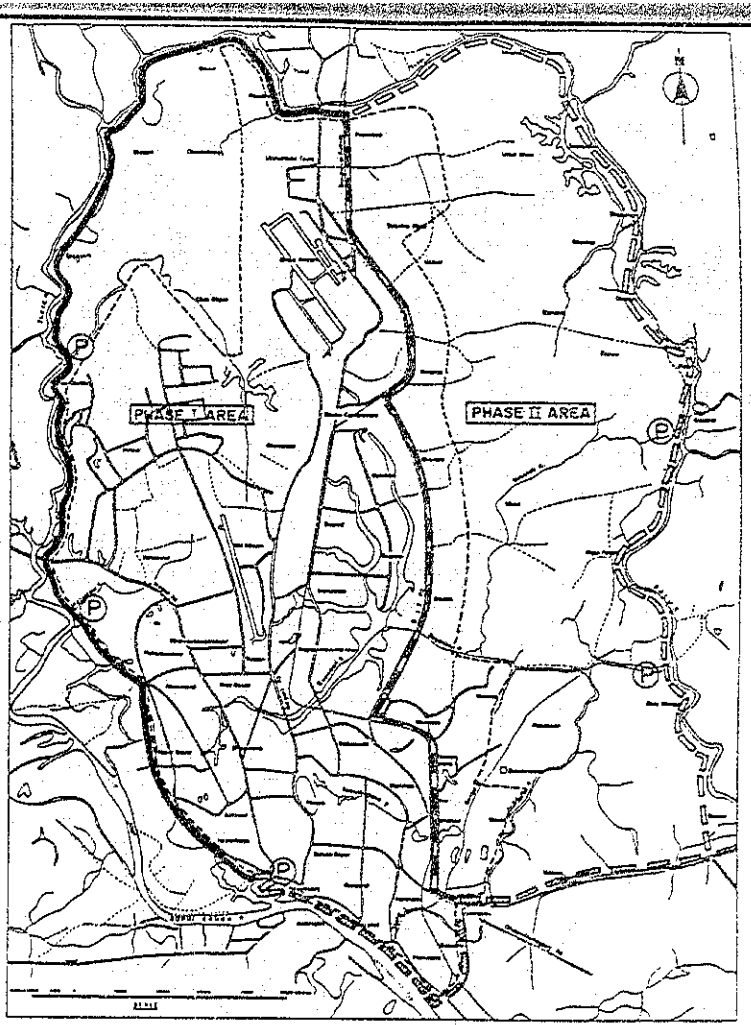


STUDY AREA AND CATCHMENT AREA OF DHOLAI KHAL



PROPOSED PLAN OF DHOLAI KHAL IMPROVEMENT

THE WORLD BANK PROJECT



GREATER DHAKA FLOOD CONTROL AND DRAINAGE PROJECT

Source: 1. World Bank Project : Final Report on Dholai Khal Rehabilitation and Area Development Study by B.K.H.V.B.
2. Report on Flood Control and Drainage of Greater Dhaka by Committee

FIG. S. 2 RELATED ONGOING PROJECTS

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

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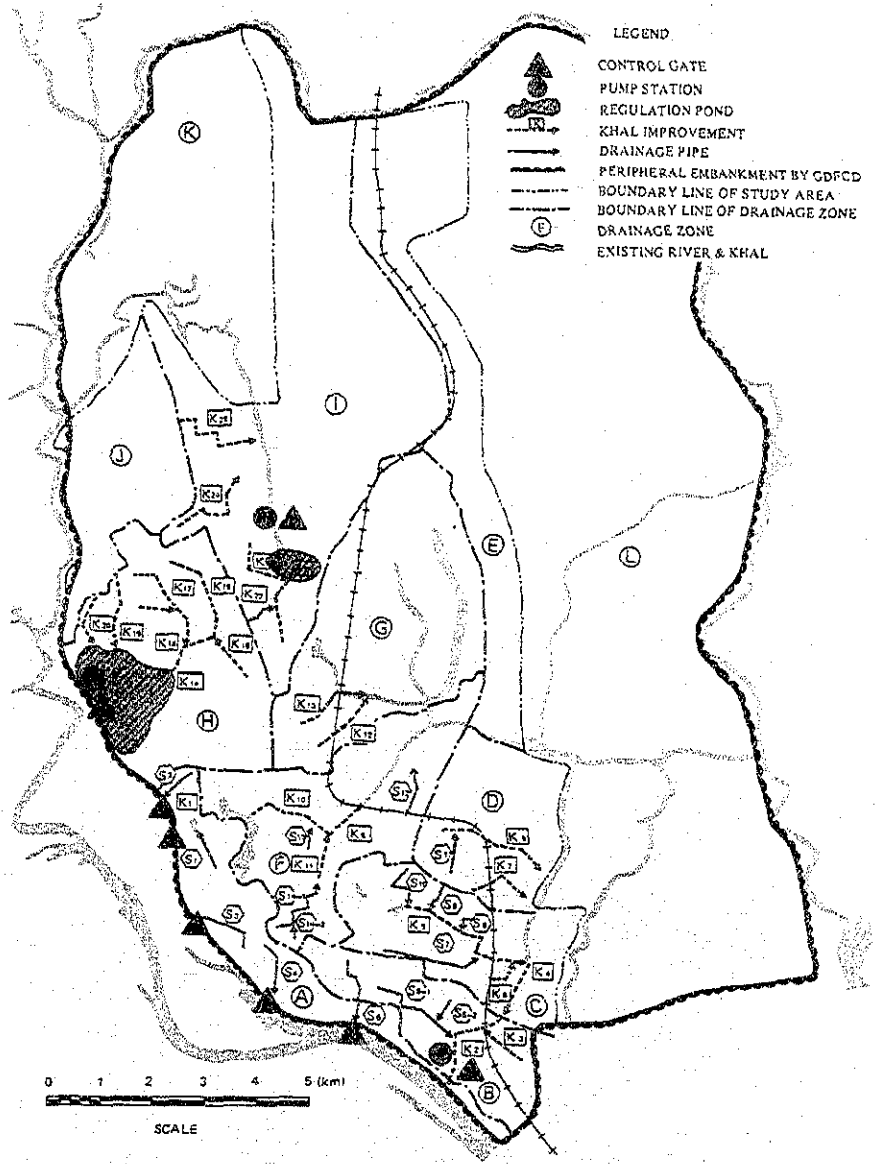
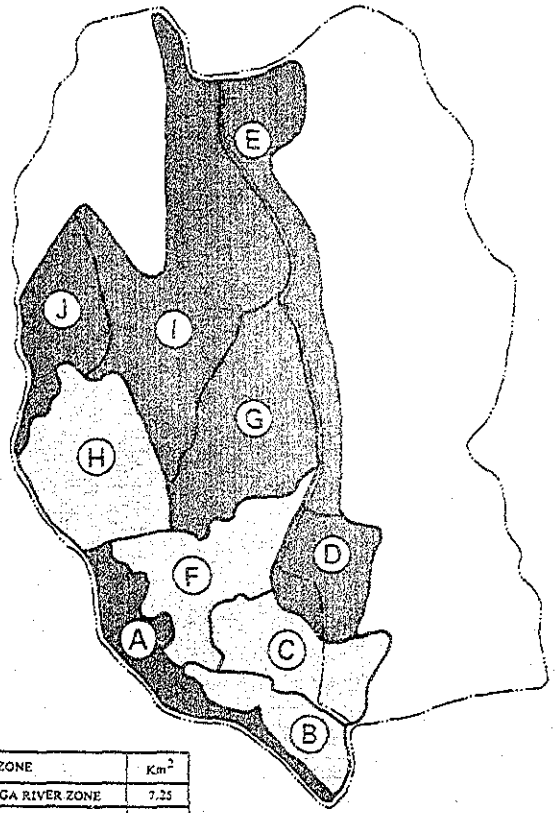


PROPOSED FACILITIES



DRAINAGE ZONE	Km^2
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H KALLYANPUR ZONE	17.60
I NORTH ZONE	31.42
J TURAG RIVER BANK ZONE	7.69
TOTAL DRAINAGE AREA	134.85

PRIORITY SEQUENCE OF DRAINAGE ZONE

FIG. S.3 PROPOSED FACILITIES AND PRIORITY SEQUENCE OF DRAINAGE ZONE

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

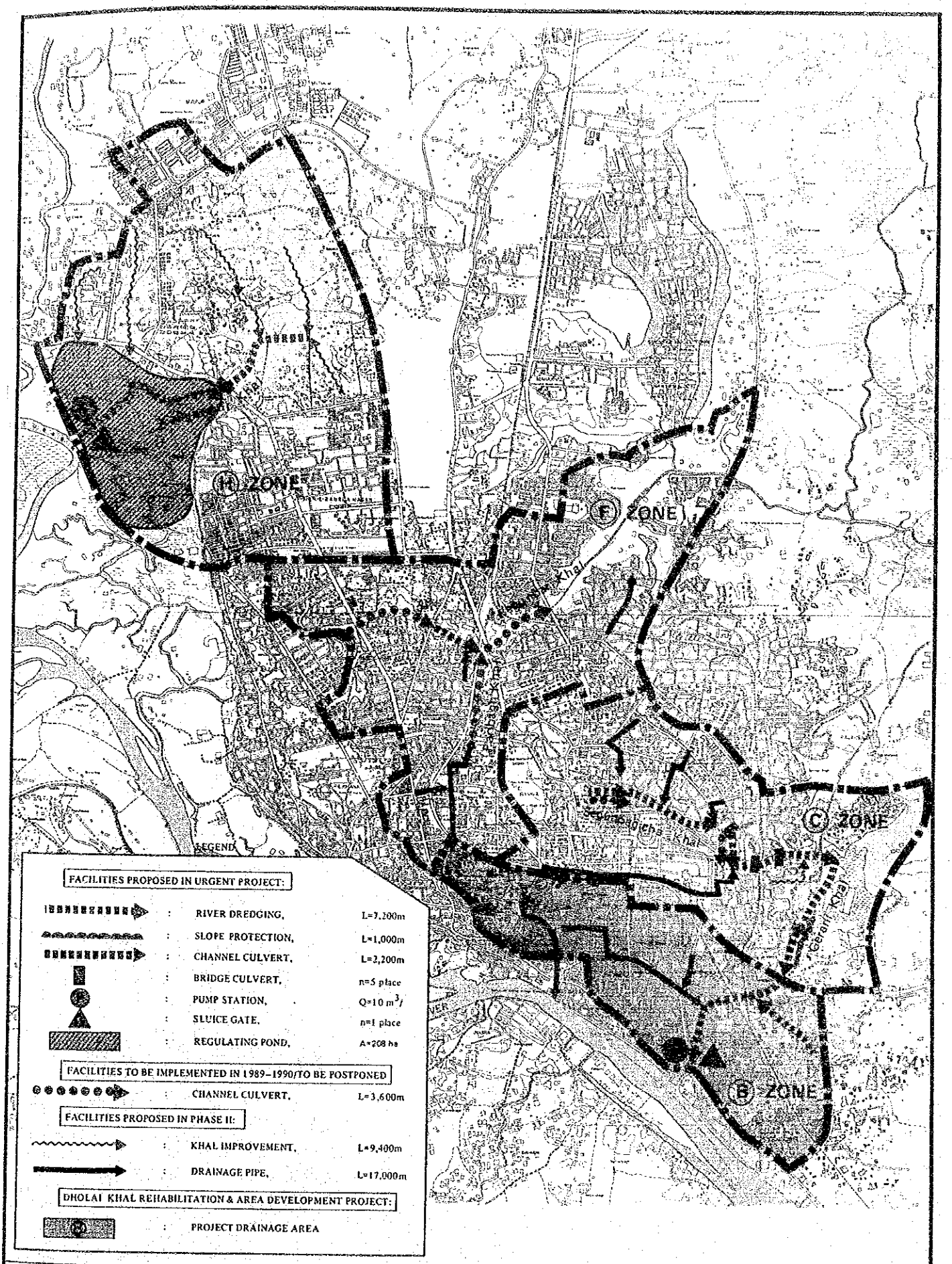

FIG. S.4 LOCATIONS OF PROPOSED FACILITIES IN URGENT PROJECT

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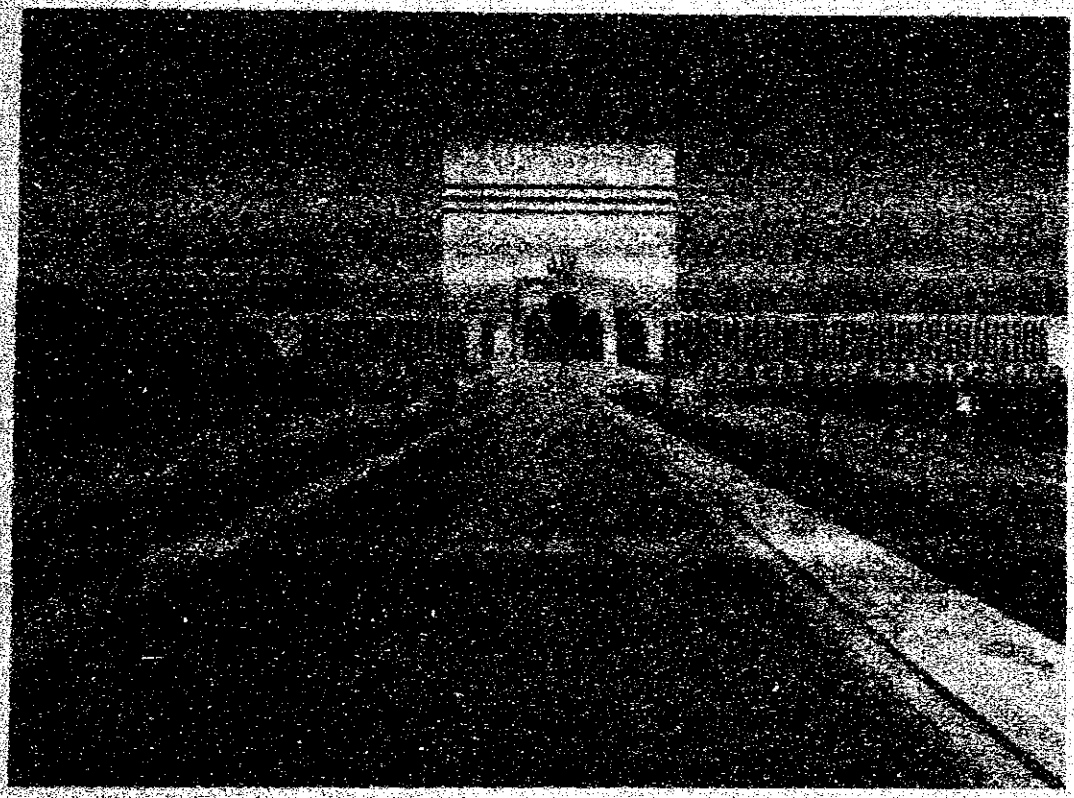
MAIN REPORT



BAITUL MUKARRAM MOSQUE

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ABBREVIATIONS

1. Government, International and Private Organizations

ADB	Asian Development Bank
BWDB	Bangladesh Water Development Board
BIWTA	Bangladesh Inland Water Transport Authority
BKH B.V.	Bongaerts, Kuyper and Huiswaard B.V.
BUET	Bangladesh University of Engineering and Technology
DMC	Dhaka Municipal Corporation
DPHE	Department of Public Health Engineering
DWASA	Dhaka Water Supply and Sewerage Authority
ERD	External Resources Division
GDFCD	Greater Dhaka Flood Control and Drainage Project
GOB	Government of the People's Republic of Bangladesh
GOJ	Government of Japan
HDA	Hokkaido Development Authority,
IDA	International Development Aid
JICA	Japan International Cooperation Agency
MLGRDC	Ministry of Local Government, Rural Development and Cooperatives, GOB
MOC	Ministry of Construction, GOJ
RAJUK	Rajdhani Unnayan Kartripakkhya
RHD	Roads and Highways Department
PCI	Pacific Consultants International
PWD	Public Works Department
SKK	Sangyo Kaihatsu K.K.
UNDP	United Nations Development Programme
UNCHS	United Nations Centre for Human Settlement

2. Others

BM	Bench Mark
GTS	Geographical Survey Datum of Bangladesh : GTS=PWD-0.45m (Example GTS+9.55m=PWD+10.00m)
PWD	Survey Datum of Public Works Department
Khal	A term Commonly used in Bangladesh for "Canal"
HHWL	Highest High Water Level
HWL	High Water Level
LWL	Low Water Level
LLWL	Lowest Low Water Level
Tk	Taka (Bangladesh Currency), 1 US Dollar = approx. Tk 32.2 =4.38 Japanese Yen
Fig.	Figure
mm	millimeter
cm	centimeter
m	meter
km	kilometer
m^2	square meter
m^3	cubic meter
m^3/s	cubic meter per second
m^3/m	cubic meter per minutes
m^3/h	cubic meter per hour
ha	hectare (10,000 m^2)
hr	hour

BURIGANGA RIVER DURING RAINY SEASON

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Dhaka city, the capital of Bangladesh, is located on the flat deltaic plain of the three major international rivers, the Ganges, Brahmaputra and Meghna, and is surrounded by their tributaries. Flood waters overflowing the river banks frequently inundate the low-lying areas of the city. Heavy monsoon rains cause water logging in many places within the city, creating manifold problems for the citizens.

Rapid urbanization, rise in standard of living and concentration of individual and social assets have increased the flood damage potential, in addition to flood vulnerability, of Dhaka city. It is anticipated that this situation would worsen in the future and the flooding problem would have a more serious effect on the social, economic, and industrial development activities.

To cope with these problems, the Study on Storm Water Drainage System Improvement Project in Dhaka City was conducted by a JICA Study Team in cooperation with officials of the DPHE, the Ministry of Local Government, Rural Development and Cooperatives, the Government of Bangladesh from November 1986 to October 1987. This Study proposed three phased implementation programmes (total project cost : Tk 3.43 billion) of drainage improvement measures for the Study Area (A = 137.5 km^2) and the feasibility study was conducted for the selected priority area (A = 31.30 km^2). The feasibility study recommended immediate implementation of Phase-I work (project cost : Tk 2.61 billion) in consideration of the serious flooding problems facing the city.

During August to September 1988, Bangladesh was devastated by the worst flood in its flood history. Dhaka city suffered very serious flood damage. To solve this problem, the Government of Bangladesh decided to implement the "Greater Dhaka Flood Control and Drainage Scheme" proposed by the Committee with the Minister of Planning as its Chairman ; also the Government of Japan was requested to undertake the Updating Study of the previous JICA study in consideration of the 1988 flood and the ongoing related projects.

The scope of work for the Updating Study was agreed upon between the ERD, the Ministry of Planning, the Government of Bangladesh, and the Japan International Cooperation Agency (JICA) on June 1, 1989.

1.2 OBJECTIVES AND AREA OF THE STUDY

The objectives of the Study are:

(1) To review and reassess the area under the Phase-I Programme to be included in the first priority zone, taking into consideration the flood of 1988 and the ongoing related projects.

(2) To identify the urgent project to be included in the related Phase-I Programme.

(3) To prepare the preliminary design for the urgent project mentioned above.

The Study Area shall cover the Phase-I Zone, (the First Priority Zone), of the 1987 JICA study and other related drainage zones as necessary, in consideration of the 1988 flood and other related ongoing projects.

1.3 IMPLEMENTATION OF THE STUDY

The Dhaka Water Supply and Sewerage Authority (DWASA), the Ministry of Local Government, Rural Development and Cooperatives was assigned as the counterpart executing agency of the Government of Bangladesh, while the Japan International Cooperation Agency (JICA) was assigned as the official agency responsible for the implementation of the technical cooperation programme of the Government of Japan.

The study was carried out by the Japanese consultant team retained by JICA and counterpart staff of the DWASA. The JICA Advisary Committee acted as advisors to JICA Study Team.

The study was conducted between July 1989 and January 1990 as shown in Fig. 1.1. The members involved in the study are listed below:

(1) JICA Study Team

Mr. N. Murata (PCI)	:	Team Leader
Mr. T. Tokumasu (PCI)	:	Deputy Team Leader/Drainage System Planning
Mr. T. Oshita (PCI)	:	Drainage Facility Planning/Design
Mr. S. Suzuki (PCI)	:	Mechanic/Electric Facility Design

Mr. K. Okada (SKK)	:	Construction Plan/Cost Estimate
Mr. E. Warashina (SKK)	:	Land Survey/Geological Survey
Mr. A. Kojima (PCI)	:	Economic/Financial Analysis

(2) JICA Advisory Committee

Mr. T. Obayashi (MOC)	:	Chairman
Mr. T. Kyoshi (HDA)	:	Member

(3) DWASA Officials

Brig (Ret.) Chowdhury Khalequzzaman	:	Chairman
Mr. S.A.N.M. Wahed	:	Chief Engineer
Mr. A.Q. Chowdhury	:	Superintending Engineer
Mr. Mostaq Ahmed	:	Executive Engineer
Mr. Iqbal Hossain Bhuiyan	:	Executive Engineer
Mr. M.A. Jalil	:	Assistant Chief (Planning)

Special Abbreviations

MOC	:	Ministry of Construction, Government of Japan
HDA	:	Hokkaido Development Agency, Govenment of Japan
PCI	:	Pacific Consultants International
SKK	:	Sangyo Kaihatsu K.K.

1.4 COMPOSITION OF REPORT

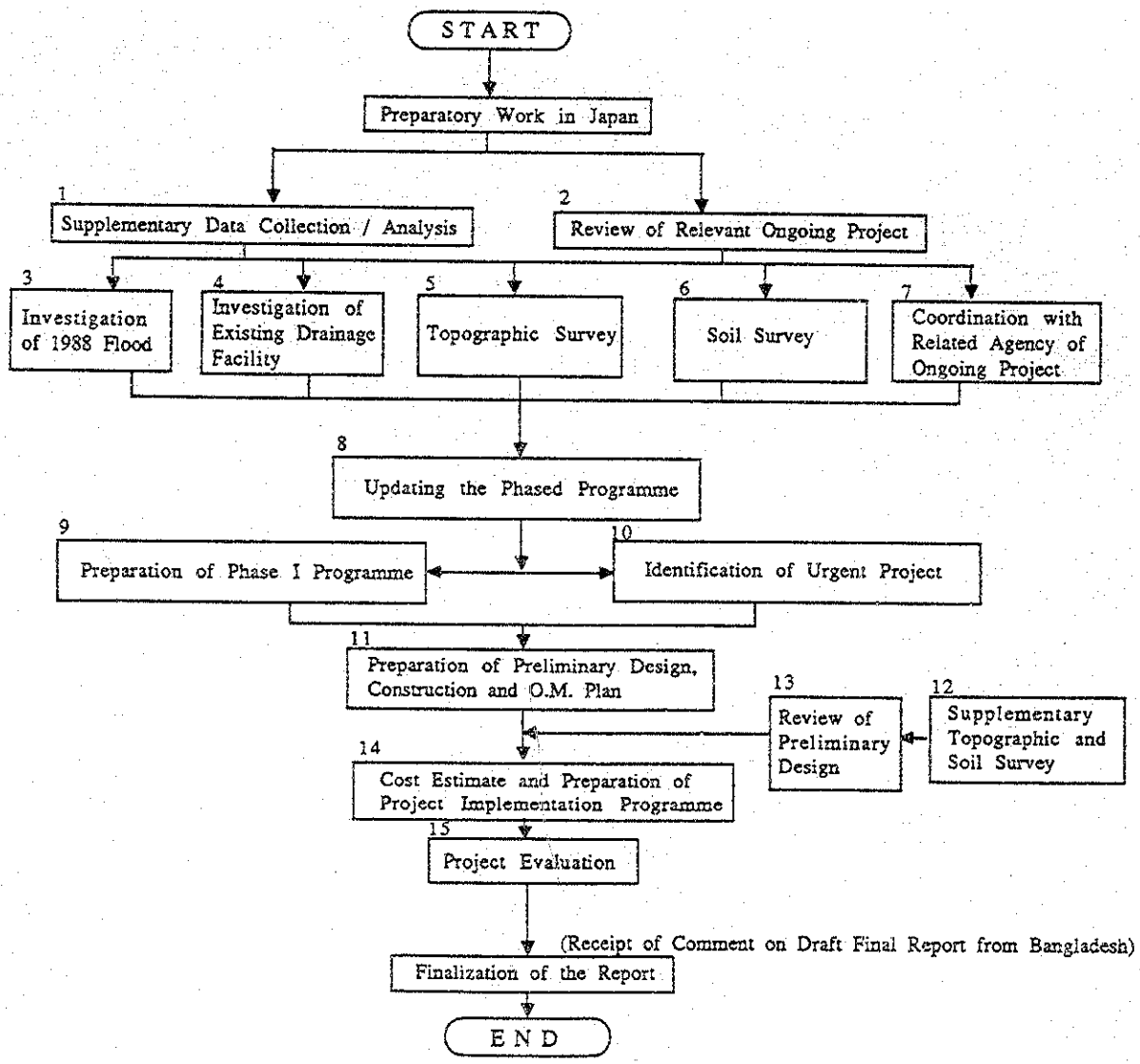
The report consists of two (2) volumes: Main Report; and Supporting Report.

The Main Report presents the summarized results of all studies. In Chapters 2 and 3, the basic information for the Updating Study are described. Chapter 4 deals with the updating of the phased programme. In Chapters 5 and 6, the feasibility study for the urgent project corresponding to one identified in the Phase I Programme is described. Conclusion and recommendations are presented in Chapter 7.

The Supporting Report includes the following studies:

A	:	1988 Flood
B	:	Related Ongoing Project
C	:	Updating the Phased Programme
D	:	Urgent Project
E	:	Project Cost and Implementation Schedule
F	:	Project Evaluation
G	:	Topographic Survey
H	:	Soil Survey
I	:	Scope of Work

FLOW CHART OF THE STUDY



Month		Stage	Item
1	Jul.	I	Home Office Work in Japan
			Inception Report
2	Aug.	II	Field Work in Bangladesh
3	Sep.		
			Progress Report
4	Oct.	III	Home Office Work in Japan
5	Nov.		Field Work in Bangladesh
6	Dec.		
			Draft Final Report
7	Jan.	IV	
8	Feb.		Final Report

FIG. 1.1 FLOW CHART AND TIME SCHEDULE OF THE STUDY

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

1988 FLOOD AT SAIDABAD

CHAPTER 2

1988 FLOOD

CHAPTER 2 1988 FLOOD

2.1 General

During the later part of August and early part of September 1988, Bangladesh was devastated by the most disastrous flood that it has ever experienced. It is reported that an unprecedented flood flow of the Brahmaputra that was synchronised with very high flows of the Ganges and Meghna. An approximately 80 thousand km^2 (56% of the total area of Bangladesh) and 47 million people (49% of the total population of Bangladesh) were adversely affected by the flood. Dhaka city also exerienced its worst flood and suffered extreme flood damage.

In this chapter, 1988 flooding conditions in and around the Study Area will be discussed based on the hydrological records and the result of the JICA Study Team's flood survey wherein more than 1,000 inhabitants were interviewed.

2.2 Hydrological Parameters

1988 flood water levels at four (4) gauging stations, (Mill Barack, Mirpur, Tongi and Demra) were recorded as shown in Fig. 2.1. The flood water levels at each station started to rise rapidly from 29 August onward. The sharpest rise was at Mirpur. During five (5) consecutive days of rising waters, the daily change of water level was 39 cm at Mirpur and 30 cm at Mill Barack. Major flooding of the city continued for 18 days between 30 August and 16 September. During this period, the flood water levels at Mirpur and Mill Barack were above 6.5 m and 6.0 m in GTS respectively. The frequency of the 1988 flood at the each station is estimated as having a 40 to 100 year return period as listed below :

Based on isohyetal data, it is reported that rainfall within the country was not a big factor in the 1988 flood. The monthly rainfall at Dhaka from August to September 1988 was about half of that which is normal (see Fig. 2.1).

Maximum Water Level and Its Occurrence

Station	Observed HWL (m in PWD)	Modified HWL (m in GTS)	Date	Frequency
Mirpur	8.35	7.93	4 Sep. '88	1/100 years
Tongi	7.84	7.51	4 Sep. '88	1/40 years
Mill Barack	7.55	7.08	4 Sep. '88	1/100 years
Demra	7.09	6.64	6 Sep. '88	-

2.3 Flood Conditions in the Study Area

The 1988 flood survey for the Study Area was made by local surveyors employed and supervised by the JICA Study Team during the field investigation stage. The survey method was one that involved interviewing more than 1,000 inhabitants regarding survey points, flood depths and durations, etc.

(1) Flood Area

According to a flood area map drawn using the data collected (Fig. 2.2), it is estimated that almost 58% (Approx. 79 km^2) of the Study Area was inundated during the 1988 flood. Of the drainage zones A to J, zone I had the maximum flood area of 20.6 km^2; Zone A had the minimum one of 2.5 km^2. Drainage zones having flood area rates higher than the average one of 58% were D, E, H, I and J. Zone D was the worst one having the rate of 98%. Details of the flood area are shown in Table 2.1.

(2) Flood Depth

Observed flood depths ranged from 0.3 m for relatively high-land to 4.3 m for lowland. The average depth was estimated to be approximately 1.2 m. The drainage areas estimated to have exceeded the average flood depth of 1.2 m are zones B, E, H, I and J. Zone H had the greatest figure in average flood depth. Flood depths are shown in Table 2.1.

(3) Flood Duration

Flood durations for relativly highland and lowland range from 3 to 15 days and from 15 to 60 days respectively. From the interviews, however, it was learned

that although there are some inland city areas of zones C, D, and F having relatively high ground elevations and drainage khals, they neverthless had long flood durations. This means that most of the khals are choked by encroachment, earth filling, deposition of city garbage, etc. and require improvements to be able to for maintain satisfactory drainage conditions. Details of the 1988 flood durations are shown in Table 2.1.

(4) Flood Vulnerable Population

The total population of the Study Area in 1988 was estimated as being 3,267 x 10^3. This figure is based on the 1986 popuration and population growth rate given in the previous study. The 1988 flood affected approximately 1,823 x 10^3 (55.8% of the population) people. The population will increase to 2,709x10^3 by the year 2000. The flood vulnerable population in 1988 and 2000 are shown in Table 2.1 by drainage zone.

Flood area, depth, duration and vulnerable population by drainage zone are illustrated in Fig. 2.3.

2.4 Specific Characteristics of the 1988 Flood

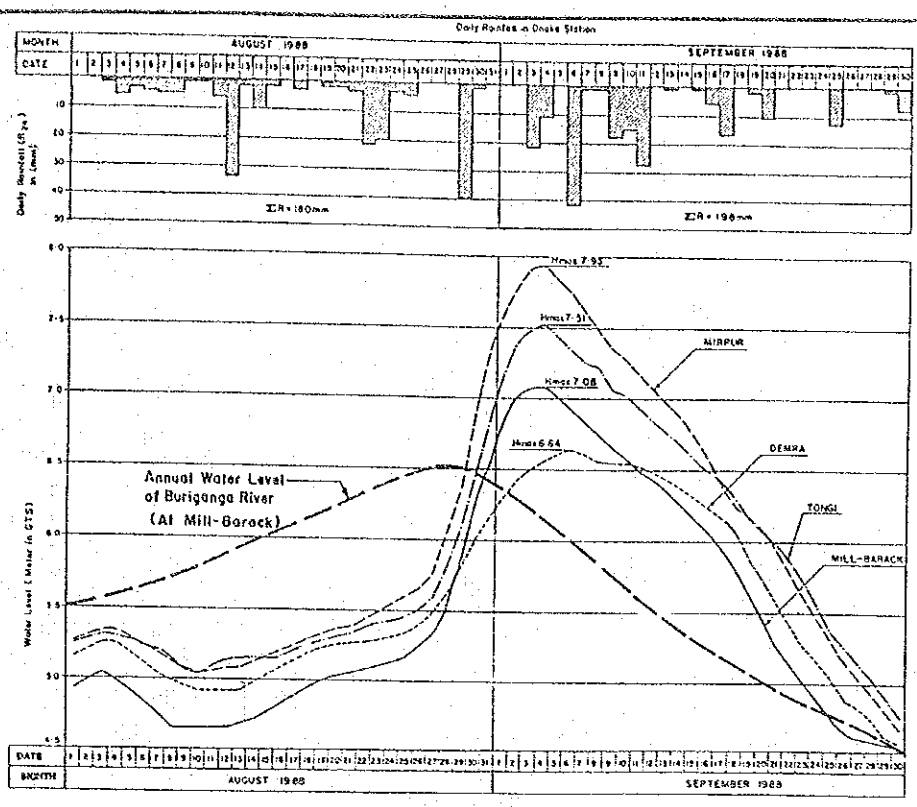
Specific characteristics of the 1988 flood to be considered for the Updating Study are summarized below:

- The 1988 floods in Dhaka city was caused by external flooding coming from the northwest upper catchment areas and its occurrence has a very low frequency.
- Flood conditions of the north or northwest parts of the Study Area were worse in comparison to those in central parts of Dhaka city.
- The poor discharge capacities of the existing khals caused the long flood durations at inland areas and aggravated the flood damage.

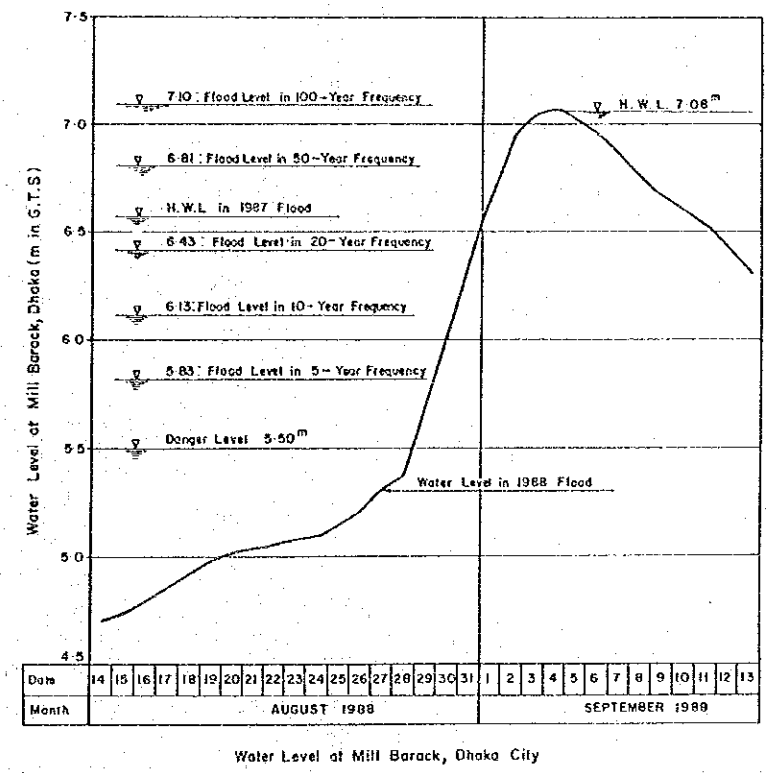
TABLE 2.1 1988 Flood Conditions

Drainage Zone	Area (km2)	Population (Density per ha.)		Number of Survey Points in Flood Area	1988 Flood			Flood Vulnerable Population	
		1988	2000		Area (km2) (% of Area)	Depth (m) min. ~ max. (Avg.)	Duration(days) min. ~ max. (Avg.)	Year 1988	Year 2000
A	7.25	259900 359	321800 444	49 * 73	2.50 (34.5)	0.30~2.13 (1.16)	7~42 (25.43)	89600	111000
B	7.24	565000 780	606100 837	77 * 78	3.38 (46.7)	0.30~2.44 (1.21)	15~60 (30.09)	263800	283000
C	10.92	385000 353	469200 430	163 * 177	5.72 (52.4)	0.30~1.75 (1.08)	3~64 (30.02)	201700	245800
D	7.46	332000 445	552000 740	106 * 106	7.32 (98.1)	0.30~2.13 (1.05)	7~60 (31.27)	325800	541600
E	13.93	93000 67	244000 175	51 * 52	9.93 (71.3)	0.30~3.05 (1.32)	14~48 (29.23)	66300	173900
F	13.70	429500 313	540300 394	83 * 104	3.57 (26.1)	0.30~4.27 (1.05)	14~50 (26.18)	111900	140800
G	17.64	243500 138	337000 191	115 * 146	7.90 (44.8)	0.30~1.83 (0.85)	7~60 (23.10)	109000	150900
H	17.60	435700 248	669500 380	150 * 175	12.34 (70.1)	0.30~3.35 (1.45)	13~47 (28.58)	305500	469400
I	31.42	382300 122	613300 195	93 * 102	20.58 (65.5)	0.30~3.66 (1.36)	13~52 (24.91)	250400	401700
J	7.69	141100 184	271700 353	43 * 55	5.42 (70.5)	0.30~2.44 (1.39)	12~45 (29.28)	99400	191500
SUMMATION	134.85	3267000 242	4624900 343	930 * 1068	78.66 (58.3)	0.30~4.27 (1.18)	3~64 (27.91)	1823400	2709600

Note : The figure marked with * means number of total survey points



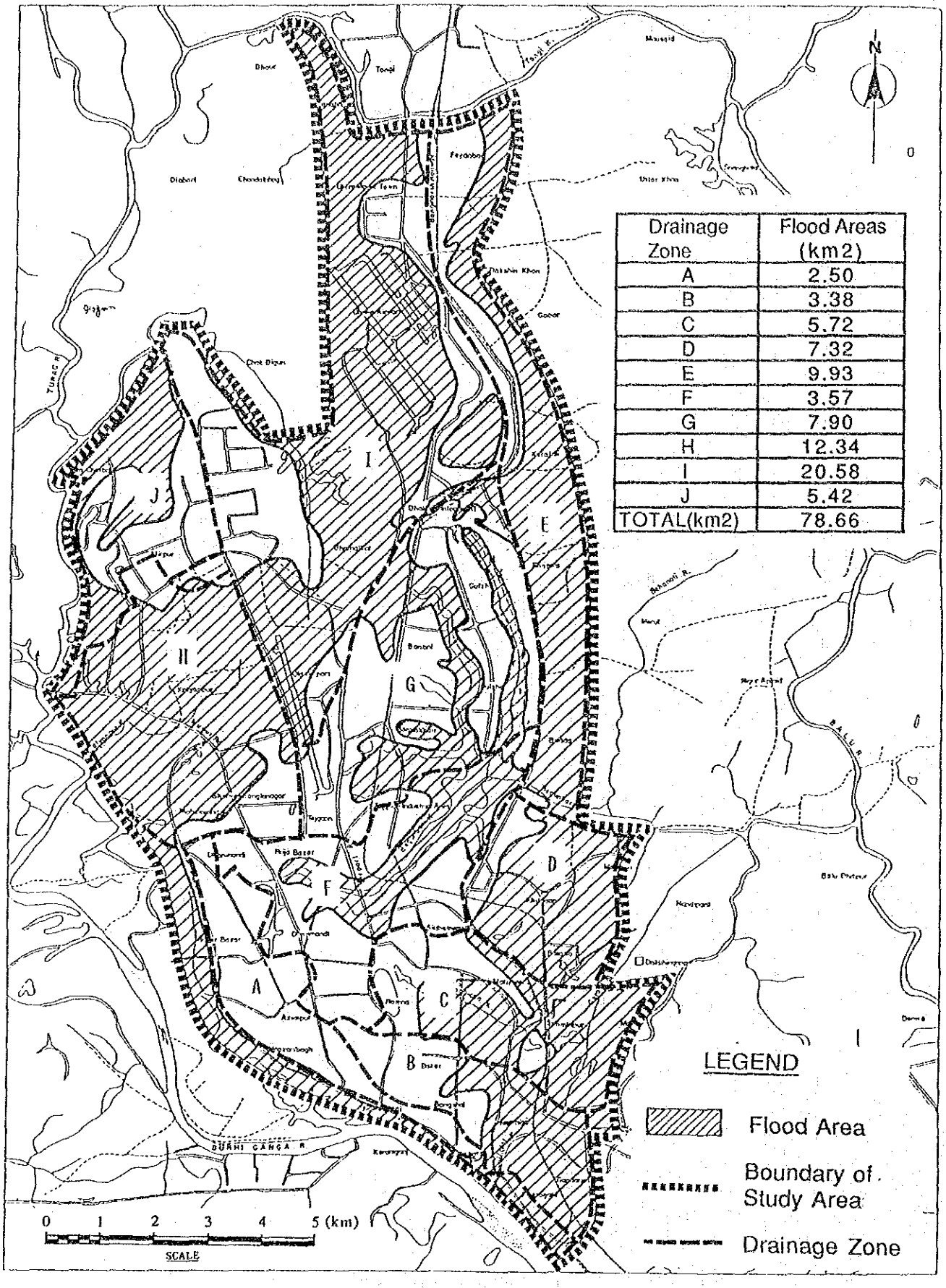
RAINFALL AND FLOOD WATER LEVEL VARIATION
AT DHAKA DURING 1988 FLOODS



Water Level at Mill Barack, Dhaka City

PROVABILITY OF FLOOD WATER LEVEL AT MILL BARACK

FIG. 2.1 HYDROLOGICAL PARAMETERS OF 1988 FLOOD

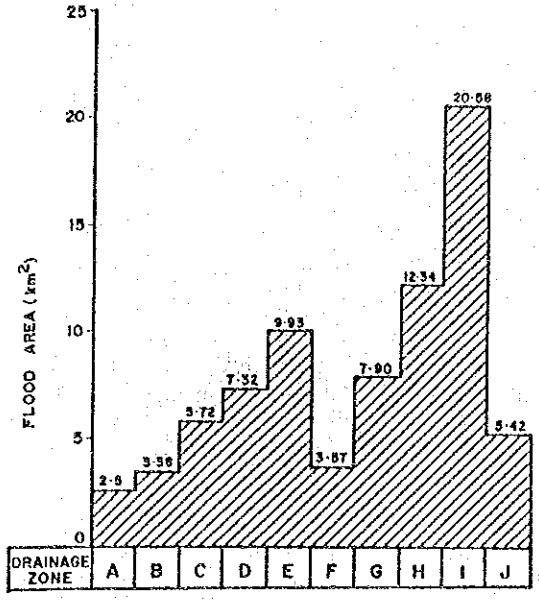


Source:Surveyed by JICA Study Team

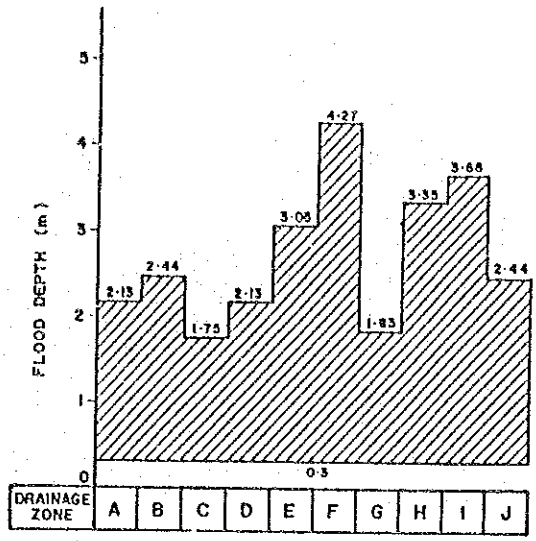
FIG. 2.2	1988 FLOOD AREA MAP

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY

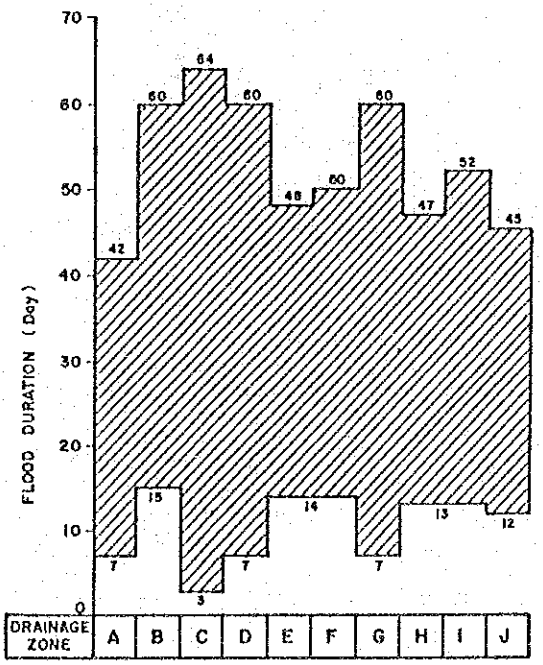
JICA



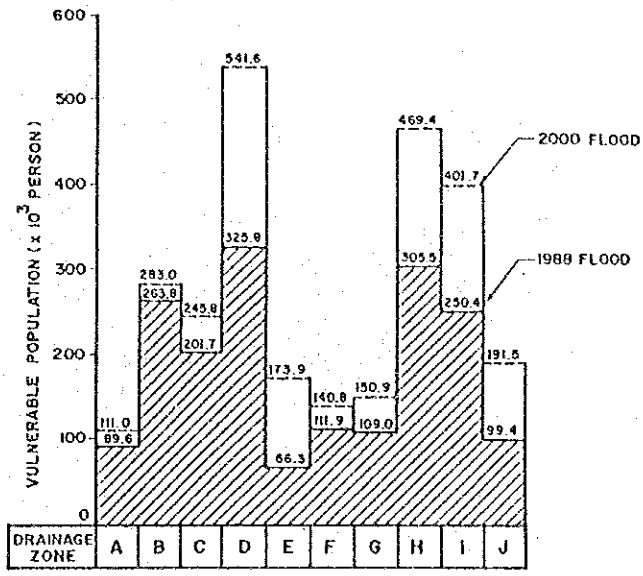
FLOOD AREA



FLOOD DEPTH



FLOOD DURATION



VULNERABLE POPULATION

Source:JICA Study Team

FIG. 2.3	1988 FLOOD CONDITIONS

UPDATING STUDY ON STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY