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THE PEOPLE'S REPUBLIC OF BANGLADESH
DEPARTMENT OF PUBLIC HEALTH ENGINEERING
MINISTRY OF LOCAL GOVERNMENT RURAL DEVELOPMENT
AND COOPERATIVES, LOCAL GOVERNMENT DIVISION

STUDY ON
STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT
IN DHAKA CITY

SUMMARY

OCTOBER 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

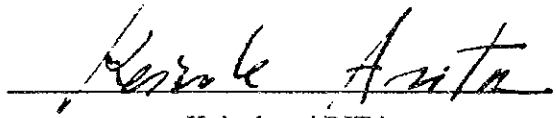
In response to the request of the Government of the People's Republic of Bangladesh, the Japanese Government has decided to conduct a study on Storm Water Drainage System Improvement Project in Dhaka City and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Bangladesh a study team headed by Mr. Naohito MURATA of Pacific Consultants International, from November 1986 to March 1987.

The team had discussions on the Project with the officials concerned of the Bangladesh Government and conducted a field survey in Dhaka City. After the team returned to Japan, further studies were made and the present report has been prepared.

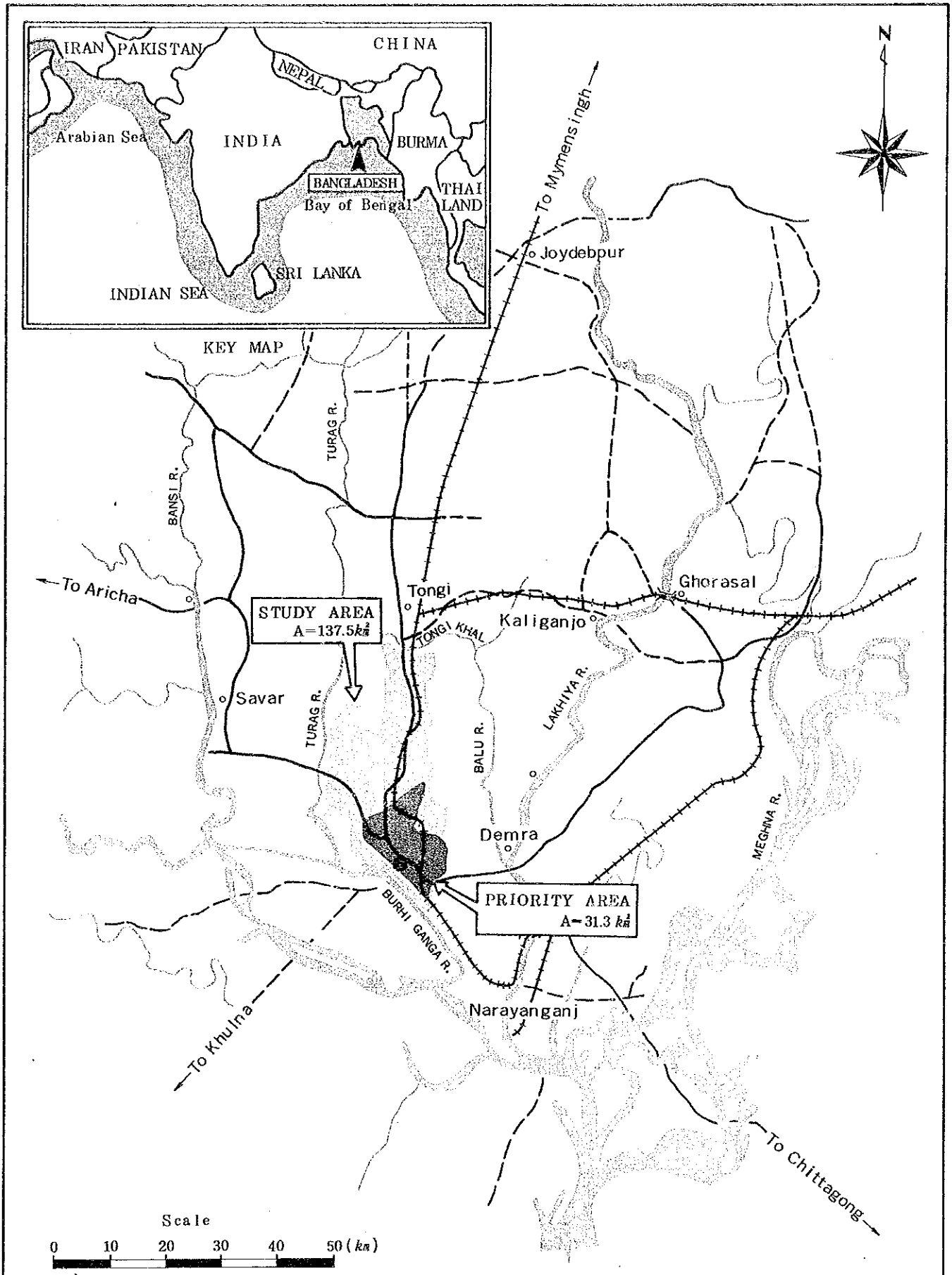
I hope that this report will be of use for the development of the Project and contribute to the promotion of the friendly relations between our two countries.

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

October, 1987



Keisuke ARITA
President
Japan International Cooperation Agency



LOCATION OF STUDY AREA

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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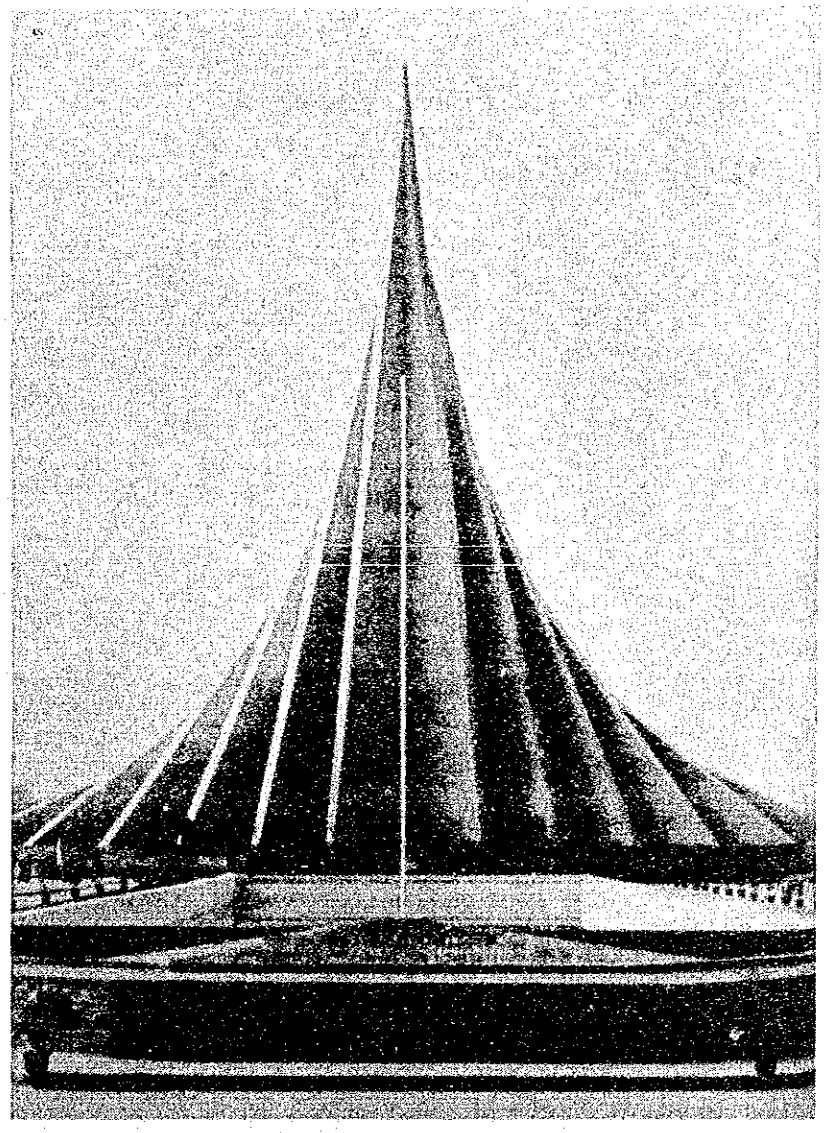

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SUMMARY

1. Introduction

Dhaka City is located on the southern edge of the Madhupur Jungle Terrace and is surrounded by rivers on all sides. Flood waters overflowing the river banks frequently inundates 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. The rapid urbanization in recent years has further worsened the flooding of Dhaka City.

To solve the above problems, the Study on Storm Water Drainage System Improvement Project in Dhaka City was carried out by the Study Team of the Japan International Cooperation Agency (JICA) in collaboration with officials of the Government of Bangladesh from November 1986 to October 1987.

2. Study Area

The Study Area covers 137 km^2 of developed land in Dhaka City. The central part of Dhaka City is developed on the hilly land with an elevation of 6 to 8 m above mean sea level (G.T.S.). The fringe areas are, however, located in the flood plains of the Buriganga and Balu Rivers with levels of 2 to 6 m G.T.S. The fringe areas are constantly flooded.

Average annual rainfalls in Dhaka is 2,060 mm. The monsoon season extends from May to October during which period about 90% of the rainfall occurs. Floods in the surrounding rivers of the Study Area usually reach their peaks in August or September after a slow steady rise throughout the monsoon season. The maximum flood water level of the Buriganga River at Dhaka City in the past was 6.59 m G.T.S.

The population of the Study Area has seen an increase of from 2.4 million in 1981 to 3.2 million in 1986 because of the large influx of people from the rural areas to Dhaka. It is expected that further increase will take place to 4.8 million in 2000. Due to the pressure of the increasing population, the rate of the built-up area in the Study Area will increase from 65% in 1986 to 77% in 2000. It will result in further aggravation of flood problems.

3. Existing Drainage System and Flood Damage

The land of the Study Area is divided into sections by reentrant valleys called "Khal". Storm water collected by drainage pipes is normally drained through these khals into the surrounding rivers. The major existing drainage facilities are a pump station, khals (drainage channels) and drainage pipes.

Floods of the Study Area are classified into two (2) types: one is of flood waters coming from the surrounding rivers (external floods), and the other is of floods by storm rainfall (internal floods). External floods generally occur in the low-lying fringe areas once every five (5) or ten (10) years. However, in some very low-lying areas, the floods occur annually.

On the other hand, internal floods occur in the inner areas of the city several times a year.

The estimated damage potentials of habitual and 10-year frequency floods in the years 1986 and 2000 are shown in Table S.1.

Table S.1 Estimated Flood Damage Potential

	Year	Flood Area (km^2)		Affected Population (10^3)	Flood Damages (million TK)
		Total Area	Built-up Area		
Habitual Flood	1986	45.7	10.8	586	187
	2000	45.7	15.0	1,008	335
10-year Frequency Flood	1986	57.3	19.3	1,012	404
	2000	57.3	24.8	1,521	700

External floods occur due to the lack of flood protection works. Internal floods are mainly caused by insufficient drainage facilities and their improper operation and maintenance as follows:

(1) Insufficiency of drainage pipe length
(2) Small discharge capacity of existing drainage pipes
(3) Clogging of existing drainage pipes
(4) Electrical breakdown of equipment at the existing pump station
(5) Impediment of khal waters due to encroachment of buildings and by bottlenecks caused by road and railway crossings.

4. Preparation of Phased Program

The phased program is prepared, based on the following planning policies and design criteria, for the efficient removal of surplus waters.

(1) The Study Area is divided into 10 drainage zones for which flood protection and internal drainage plans are proposed. The plans include not only structural measures but also non-structural measures.

(2) The proposed plans are prepared to meet the population and land use forecasted for the year 2000.

(3) The structural measures to be proposed are limited to major works required to meet a mid-term range necessity for flood protection and internal drainage improvements with the limited financial resources.

Lateral drains and branch drainage pipes are excluded from the phased program. They may be laid after completion of the proposed scheme, as and when necessary.

(4) The flood protection plan is prepared for all the low-lying built-up areas below the design flood water level. The proposed area covers not only the existing developed areas but also the future development areas.

The flood water level with a 30-year frequency is applied for the design of flood protection works.

(5) The internal drainage improvement will be attained by installation of additional trunk drainage pipes, improvement of the existing khals and installation of drainage pumps.

The rainfall intensity with a 5-year frequency is employed for the design of drainage pipes and khal improvements. for the design of pump stations, the two days consecutive rainfall with a 5-year frequency is proposed.

The proposed structural measures and estimated costs by drainage zone are summarized in Table S.2. Location of the drainage zones and proposed facilities is illustrated in Fig. S.1.

In addition to the structural measures, the following non-structural measures are recommended to improve the flood protection and drainage system:

(1) Reserving swampy areas totaling 264 ha for the proposed pump regulating ponds.

(2) Strict enforcement of controls to prevent any reduction of minimum khal sections proposed which could cause flood flows to be impeded and backing up of water in the upstream areas.

(3) Raising of low-lying fringe areas with land fill sufficiently higher than the proposed design flood level for future developments, except in the proposed flood protection areas.

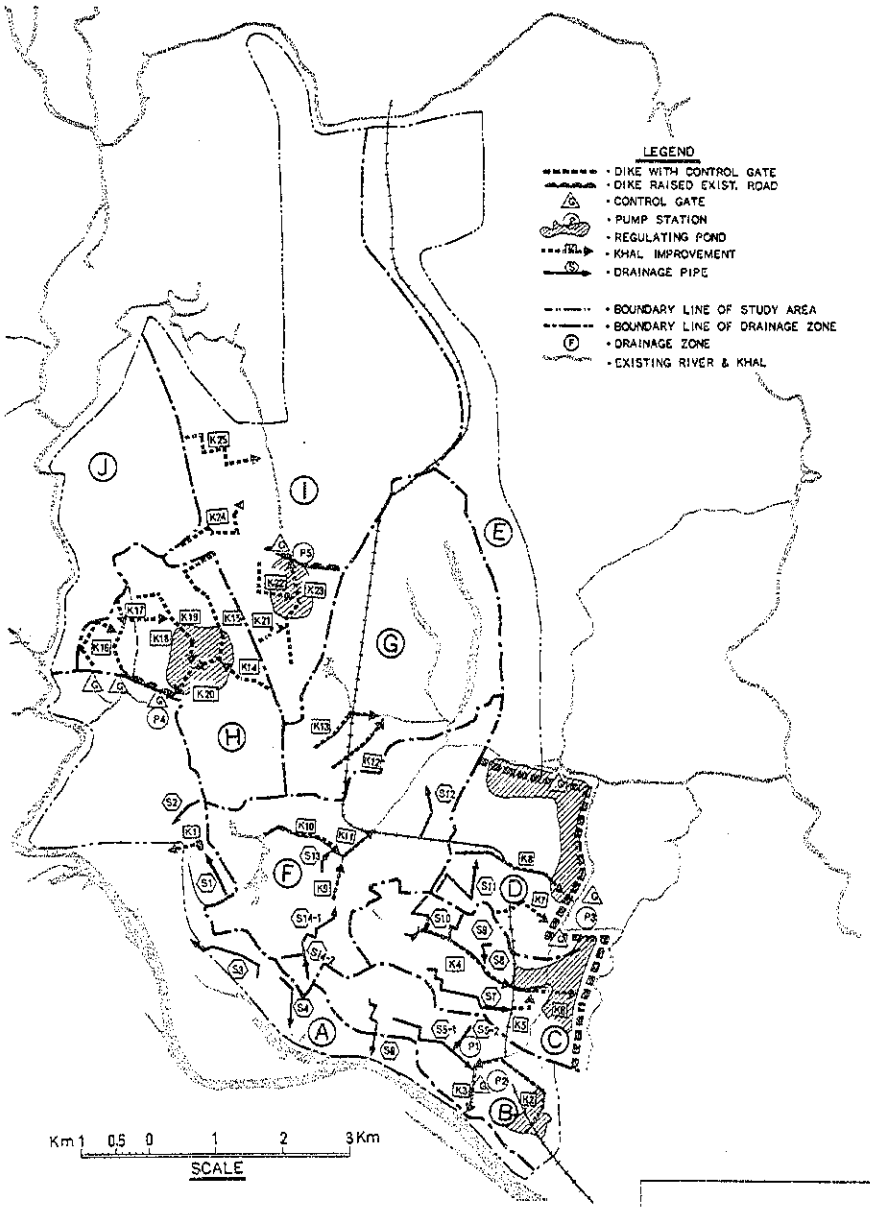
Table S.2 Proposed Facilities and Cost

(1986 price)

Drainage Zone	Flood Protection		Internal Drainage			Land Acquisition	Total Project Cost
	Protection Dike (km)	Control Gate (places)	Pump Station (m^3/s)	Khal Improvement (km)	Drainage Pipe (km)	(ha)	(million TK)
A	-	-	-	0.3	3.8	0.1	96.2
B	-	1	9.6**	4.2	4.3	4.5	430.1
C	2.4	1	7.5	5.1	4.8	23.5	728.8
D	7.0	2	9.5	4.6	1.7	59.9	921.1
E	-	-	-	-	-	-	-
F	-	-	-	3.8	3.4	4.8	214.0
G	-	-	-	2.9	-	2.2	41.0
H	3.0*	3	14.6	11.9	-	9.6	702.3
I	2.0*	1	4.5	6.9	-	4.9	299.9
J	-	-	-	-	-	-	-
TOTAL	14.4	8	45.7	39.7	18.0	109.5	3,433.4

Note (1): * Raising Existing Road Finish Level
** Utilizing Existing Narinda Pump Station

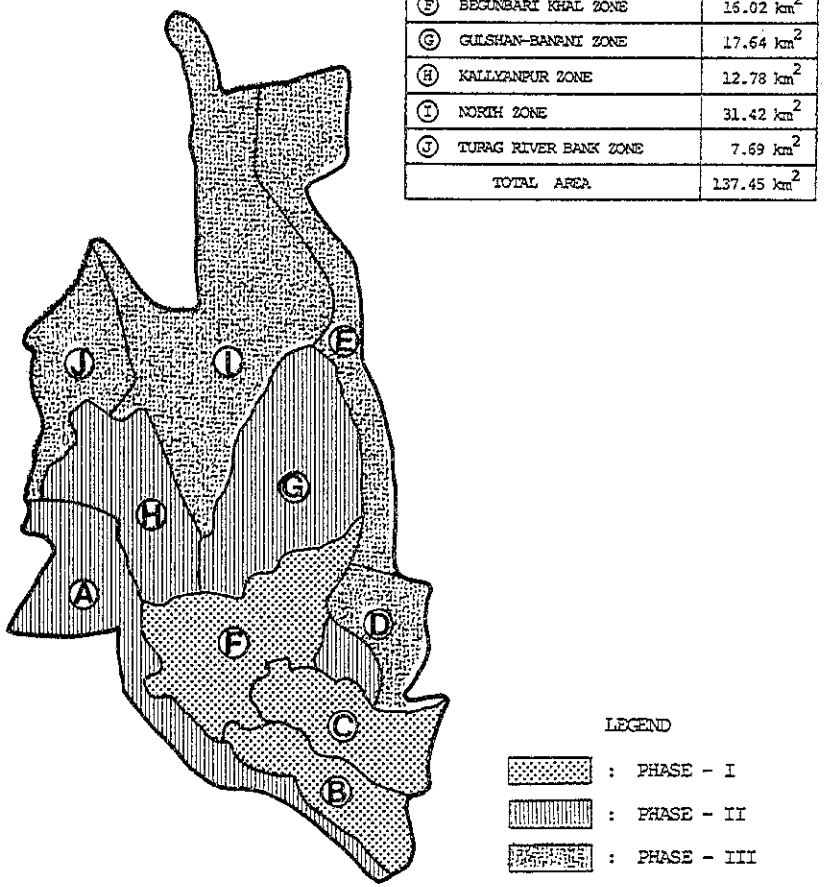
Note (2): Floods in E and J drainage zones shall be met by non-structural measures.



PROPOSED FACILITIES

DRAINAGE ZONE AREA

Ⓐ	BURIGANGA RIVER BANK ZONE	12.85 km^2
Ⓑ	DHOLAI KHAL ZONE	7.76 km^2
Ⓒ	SEGUNBAGICHA KHAL ZONE	9.04 km^2
Ⓓ	BASABO ZONE	8.32 km^2
Ⓔ	NORTH-EAST EDGE ZONE	13.93 km^2
Ⓕ	BEGUNBARI KHAL ZONE	16.02 km^2
Ⓖ	GULSHAN-BANANI ZONE	17.64 km^2
Ⓗ	KALLYANPUR ZONE	12.78 km^2
Ⓘ	NORTH ZONE	31.42 km^2
Ⓙ	TURAG RIVER BANK ZONE	7.69 km^2
	TOTAL AREA	137.45 km^2



PHASING MAP

FIG. S.1 PROPOSED FACILITING IN STUDY AREA AND PHASING MAP OF DRAINAGE ZONE

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Priority sequence of the drainage zones are decided by weighing and comparison of the following factors:

(1) Benefitting population
(2) Required project cost
(3) Required land acquisition area
(4) Flood conditions
(5) Damage to commercial and institutional activities
(6) Hindrance to traffic
(7) Land use classification

The whole project will be completed through a three (3) phase program carried out in conformity with the priority sequence obtained from the above comparison.

Phase-I Zone (First Priority Zone): B, C, F
Phase-II Zone (Second Priority Zone): A, D (part), G, H
Phase-III Zone (Third Priority Zone): D (part), E, I, J

5. Feasibility Study for the Priority Area

5.1 Selected Priority Area

The feasibility study was made for the flood protection and internal drainage projects of the priority areas selected in the phased program. The selected priority areas are B, C and F drainage zones covering the central part of Dhaka City.

The areas of B, C and F drainage zones proposed for the feasibility study are as follows:

B zone:	6.68 km^2
C zone:	10.92 km^2
F zone:	13.70 km^2
Total:	31.30 km^2

5.2 Proposed Plan

(1) Flood Protection

The low-lying areas of B zone are flooded by backwaters of the Buriganga River flowing backwards through the Dholai Khal. To prevent the backwaters, installation of a control gate is proposed at Narinda site.

The east fringe areas of C zone are affected by floods of the Balu River. Construction of the dikes having an overall length of 4.8 km is proposed to protect the fringe areas. The design crest elevation of the dikes is 7.6 m G.T.S.

F zone is generally free from floods of the surrounding rivers.

(2) Pump Drainage

Pump drainage is required for the low lands of B and C zones. A pump drainage system integrating the two (2) drainage zones is proposed.

The total required pump capacity is 18.8 m^3/s of which:

- 9.6 m^3/s is met by rehabilitation of the existing Narinda Pump Station.
- 9.2 m^3/s is performed by construction of an additional pump station.

The new pump station is proposed at a site near the existing Narinda Pump Station.

The above pump drainage system includes the following two (2) regulating ponds:

- Jatrabari Pond with a surface area of 1.38 km^2 (C zone)
- Gandaria Pond with a surface area of 0.47 km^2 (B zone)

(3) Khal Improvement and Drainage Pipe

Improvement of the existing six (6) khals and installation of additional nine (9) drainage pipe lines are proposed to attain a satisfactory level of storm water drainage together with the proposed pump drainage for B, C, and F zones.

The total length of the proposed khal improvement and drainage pipe installation are 13.1 km and 12.5 km, respectively.

The proposed flood protection works and internal drainage facilities are summarized in Table S.3. Location of those works and facilities are illustrated in Fig. S.2.

Table S.3 Summary of Proposed Works and Facilities

Item	Description	Unit	Zone			Total	Remarks
			B	C	F		
A. Dike	H=6.0 m	m	-	4,800	-	4,800	
B. Pump Station	9.2 & 9.6 m^3/s	place (m^3/s)	2 (18.8)	-	-	2 (18.2)	Rehabilitation and New Pump Stations
C. Gate	6.0mx6.0m	Place	1	1	-	2	
D. Khal Improvement Work	m	-	4,200	5,100	3,800	13,100	
1. Dredging	-	1,000 m^3	107	155	34	295	
2. Sodding	-	1,000 m^2	54	25	53	132	
3. Brick Protection	-	m	400	1,180	700	2,280	
4. Retaining Wall	Concrete Panel	m	-	480	280	760	
5. Box Culvert	B 4-7 m x H 4-6m	m Place	25 (1)	192 (12)	147 (8)	364 (21)	
6. Railway Bridge	L=12m x 3	Place	-	1	-	1	
E. Drainage Pipe		m	4,280	4,810	3,410	12,500	
1. Brick Pipe	D=1.5-3.7m	m	2,050	4,110	3,410	9,570	
2. Box Culvert	av. 3mx3m	m	2,230	700	-	2,930	

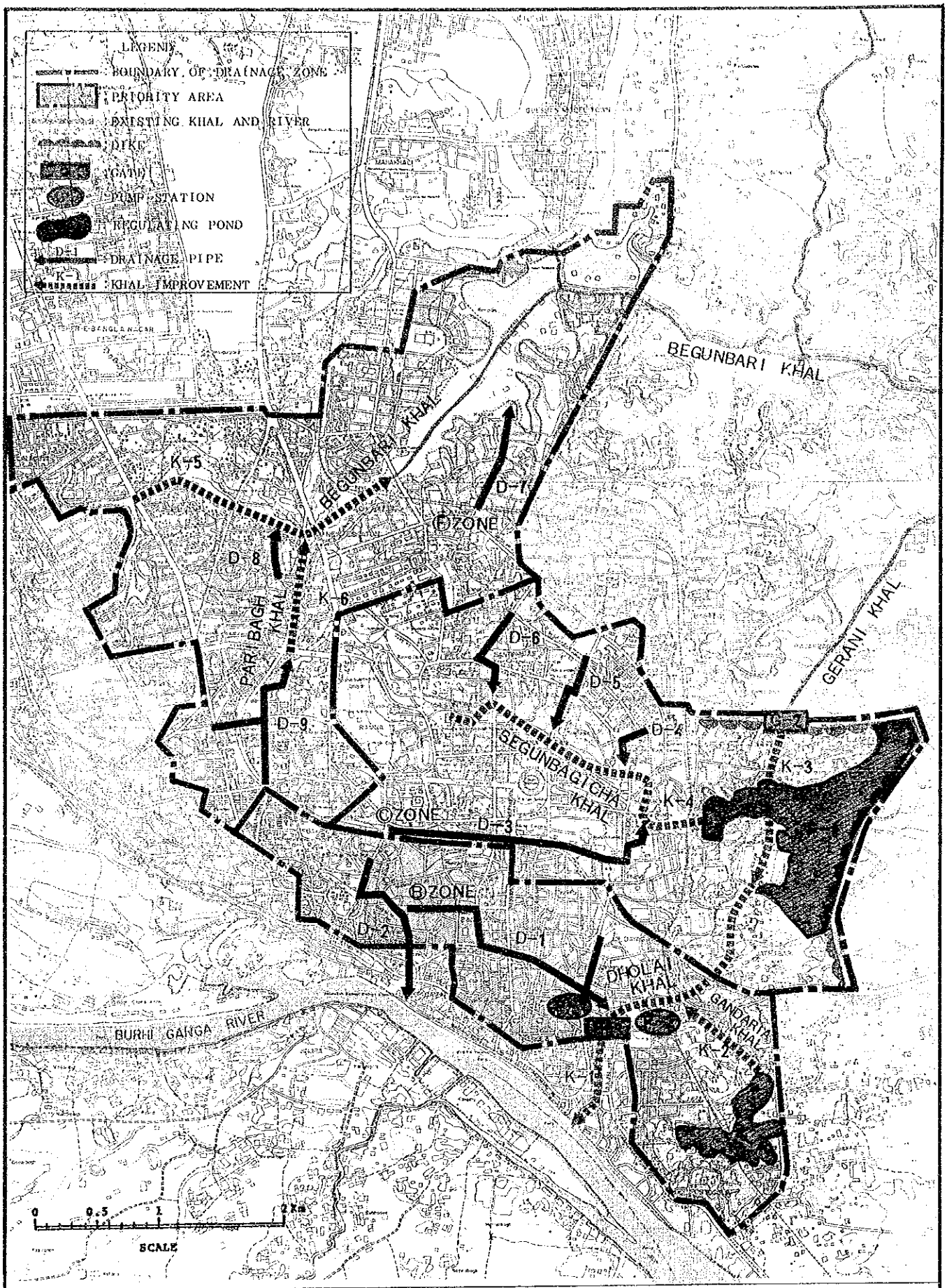

FIG. S. 2 PROPOSED FLOOD PROTECTION AND DARINAGE FACILITIES

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5.3 Project Cost and Implementation Schedule

The total project cost for the priority area is estimated to be 1,790.3 million TK at 1986 prices. The proposed works and facilities will be completed within six (6) years by staged construction.

The project cost including price contingency for six (6) years is estimated to be 2,609.2 million TK.

The breakdown of the project cost is shown in Table S.4.

Table S.4 Breakdown of Project Cost

Item		Cost
A.	Construction Cost	1,237.3
	(1) Dikes	(186.2)
	(2) Pump Stations	(319.9)
	(3) Gates	(69.5)
	(4) Khal Improvement	(286.7)
	(5) Drainage Pipe	(375.0)
B.	Physical Contingency	123.7
C.	Engineering	136.1
D.	Land Acquisition	83.0
E.	Office Establishment	25.5
F.	Customs Duty & Tax	184.7
	Total Project Cost (1) (At 1986 price)	1,790.3
G.	Price Contingency (1988/1989 - 1993/1994)	818.9
	Total Project Cost (2) (With Price Contingency)	2,609.2

5.4 Operation and Maintenance

(1) Operation and maintenance work

To sustain the expected effects of the existing and proposed drainage system of the Project area (B, C and F zones), the following major operation and maintenance works shall be performed:

- Cleaning the 91.2 km of drainage pipes (existing: 82.5 km, proposed: 12.5 km).
- Dredging of deposits and removal of garbage from the 13.1 km of khals.
- Maintenance and repair of 4.8 km dikes.
- Operation and maintenance of two (2) pump stations and two (2) control gates.
- Land use control, in cooperation with the agencies concerned, to maintain the regulating ponds and the khal areas, and to assure the required elevation of new land development.

(2) Organization

The organization required for construction consists of 15 engineers and other supporting staffs. The organization will perform the operation and maintenance after completion of the construction work.

(3) Operation and maintenance cost

The annual cost required for operation and maintenance of the Project areas (B, C and F zones) is estimated to be 25.4 million TK at 1986 price.

5.5 Project Evaluation

The expected major contributions of the Project are as follows:

- Reduction of general and public property damages
- Reduction of income/sales loss and vehicle running costs
- Increase in available land and its value
- Improvement of public health and amenities
- Creation of employment opportunities

The estimated investment efficiency of the Project is as follows:

Economic Internal Rate of Return (IRR):	17.1%
Benefit Cost Ratio (B/C):	1.24
Net Present Value (NPV):	188.9 million TK

5.6 Conclusion and Recommendations

(1) The proposed Project is technically, economically and socially justified. Urgent implementation of the Project is recommended in consideration of the present serious flood problems which the city is faced with.

(2) Because of the high costs of the Project, foreign financial aid shall be obtained.

(3) In the detailed design stage, the proposed flood protection and drainage plans shall be coordinated in greater detail with the other relevant urban development plans. Especially, the multiple use of the proposed dikes for roads shall be discussed at greater length.

(4) The required land acquisition shall be completed before commencement of construction so that the smooth implementation of the Project, including financial aid procurement, can be achieved.

(5) A special organization for the Project shall be set up expeditiously in the Department of Public Health Engineering, Ministry of Local Government, Rural Development and Cooperatives.