EMBANKMENT UNDER CONSTRUCTION ALONG TRUG RIVER
(GDFCD PROJECT)

COMPLETED EMBANKMENT AT MIRPUR

CHAPTER 3

RELATED ONGOING PROJECTS

CHAPTER 3 RELATED ONGOING PROJECTS

3.1 DHOLAI KHAL REHABILITATION AND AREA DEVELOPMENT PROJECT

In October 1986, BKH B.V. submitted to UNDP/UNCHS the Final Feasibility Report on the Dholai Khal Rehabilitation and Area Development Study, Housing Development Project Sub-contract A (hereinafter refered to as the World Bank Project), in cooperation with Dhaka Municipal Corporation (DMC), the execution agency of the Government of Bangladesh. The study area is 6.40 km^2 as illustrated in Fig. 3.1.

The purposes of the World Bank Project are :

(1) Improvement of the drainage system in the old part of Dhaka city
(2) Improvement of the communication facilities in the old area as previously made in other parts of Dholai khal
(3) Provision of new commercial activities along the side of the improved Dholai khal
(4) Provision of improved health and sanitation conditions.

For the above project purpose (1), the Consultant proposed rehabilitation measures consist of the following three major components:

- Construction of a pump station with sluice gates and storage basins
- Rehabilitation of the Dholai khal
- Rehabilitaion of Debdulai and Gerani khals

Three (3) rehabilitation alternatives for the Dholai khal were developed and investigated as shown in Fig 3.2. As a result of a feasibility study, it is concluded that Option 1 is the most feasible scheme for the purpose of making drainage improvements only. The Consultant, considering the other three above-mentioned purposes of the project, recommended that Option 3 is the best choice for developing the Dholai khal.

The proposed storm water drainage improvement works are as follows:

(1) Improvement of Dholai khal
    - Box culvert type: approx. 0.75 km
    - Open lined-canal section: approx. 0.35 km

(2) Improvement of Debdulai and Gerani khal by open lined-canal section
- Debdulai khal: approx. 1.25 km
- Gerani khal: approx. 1.40 km

(3) Construction of new pump station
- Location: at the confluence of the Dholai khal with the Buriganga river
- Capacity: 80,000 m^3/h (22.2 m^3/s)

(4) Construction of storage basin
- Narinda storage basin: 2.4 ha, 155,000 m^3
- Dayaganj/Tatrabari storage basin: 1.8 ha, 50,000 m^3

(5) Removal of the existing Narinda pump station

The proposed drainage plan and typical design of facilities are illustrated in Figs. 3.1 and 3.3 respectively.

The capital cost estimated using 1986 prices for the full scale of the Project is US$ 11.43 million, of which US$ 9.33 million is for the drainage improvement works.

The detailed design was started in October 1989 by the foreign consultant, BKH V.B., with financial assistance from UNDP/UNCHS. During the detailed design stage, the following items may be reviewed in order to correlate the Greater Dhaka Flood Control and Drainage Project, and JICA Project .

(1) The drainage zone boundary of the Dholai khal, including the Debdulai and Gerani khals shall be adjusted with the ones in the both projects, the World Bank and JICA projects.

(2) Design rainfalls adopted for the storm water drainage in the World Bank and JICA projects are 10-year and 5-year frequency rainfalls respectively.

(3) The design flood water level for a flood protection dike and sluice gates shall be correlate with that of the DGFCD Project.

(4) The invert elevation of the culvert shall be below zero (0) meter in GTS to connect the existing drainage pipe of 3.0 m dia. at the existing Narinda pump station.

Considering the improvement of the poor drainage condition around the Bakshi Bazar area, it would be desirable to have the H.W.L. of the Dholai khal at the existing Narinda pump station be 4.0 meters in GTS.

3.2 GREATER DHAKA FLOOD CONTROL AND DRAINAGE PROJECT (GDFCD PROJECT)

3.2.1 Committee for Flood Control and Drainage of Greater Dhaka

In the wake of the most disastrous 1988 flood the President, on October 24, 1988, organized a Committee for "Flood Control and Drainage of Greater Dhaka" comprized of thirteen members from related government offices and agencies with the Minister of Planning as the Chairman. The terms of reference of the Committee are as follows :

(1) To prepare a flood control plan for Greater Dhaka Metropolitan area, Mirpur, Tongi and Narayanganj

(2) The committee will also consider the following :

(a) Establishing link roads around Dhaka-Narayanganj, Tongi-Savar-Mirpur and neighbouring industrial areas

(b) Formation of lakes within Dhaka city to faciliate drainage

(c) Modernization of Dhaka's sewerage system

3.2.2 Recommendation by a Dutch Expert

In response to the request of the Government of Bangladesh, the Government of Netherlands sent the expert, Mr. T.G.H. Jansen, to Dhaka to assist the Committee in analysing the possibilities for protecting Greater Dhaka city from the serious inundation of November 1988 flood.

The study report prepared by the expert and local consultants consists of (1) the hydrological conditions in Dhaka city, (2) 1988 flood and flood damages faced, (3) the relevant studies carried out in the past and the existing plans, (4) considerations of how to solve the flooding problems in Dhaka city and (5) recommendations of actions to be taken.

As a result of technical, economic and social considerations on long term planning, Mr. Jansen proposed protecting Greater Dhaka city by constructing embankments along the Buriganga, Turag and Balu rivers, and Tongi khal in three (3) phases. This idea, as shown in Fig. 3.4, is almost the same as that of Halcrow's who was consulted in 1972.

The proposed plan which will cost almost Tk. 4,500 million (1988 prices) covers:

- 66 km of peripheral embankment
- 44 km of inner (secondary) embankment
- 4 km of flood protection wall along the Buriganga River
- 5 pumping stations
- sluices and other structures.

He suggested that the proposed plan be implemented through a policy decision made at an appropriate higher level for the solution of Greater Dhaka city flood problems and, when a decision is made to go for a permanent solution, a feasibility study should be made.

3.2.3 Recommendation by the Committee

The Committee proposed the Phased Programme of the GDFCD Project, after considering the existing conditions of Greater Dhaka city, previous studies and projects, ongoing projects and existing plans, and the recommendation by the Dutch expert.

As shown in Fig. 3.5, the Phase I Programme is proposed for most of the existing urbanized areas and the western part of the Greater Dhaka city that are surrounded by the Buriganga river, Turag river, Tongi khal, National Railway, DIT road, etc. The remaining eastern part of the Greater Dhaka city will be protected by the Phase II Programme.

The proposed 13 projects for the Phase I Programme and three (3) projects for the Phase II Programme are listed in Tables 3.1 and 3.2, and illustrated in Fig. 3.6. The typical design of flood protection embankments and walls are given in Fig.3.7.

The proposed Phase I Programme is now under construction by the agencies concerned. The Government of Bangladesh reported that almost 70% of the urgent work was completed by the beginning of September 1989.

3.3 KHAL IMPROVEMENT PROJECT

There are three (3) groups of major drainage khals in the city: (1) Digun-Ibrahimpur-Kallyanpur khal; (2) Gulshan-Banani-Begunbari-Dhanmondi khal; and (3) Dholai-Gerani-Segunbagicha khal.

During the previous JICA study, an observation was made that many portions of these khals were occupied by encroachment without proper sanction, earth filling, deposition of city garbage, and buildings and roads. It is clear that this is one of the major causes of floods in Dhaka city. JICA has strongly recommended the enforcement of controls to prevent any reduction of the minimum cross sectional area of the khals.

The Greater Dhaka Flood Control and Drainage Committee also recommended implementing khal cleaning work. The DPHE proposed Khal Reexcavation Project to the MLGRDC at the beginning of January 1989. The MLGRDC decided that the project was to be executed by DWASA and seventy six officials of DPHE were transfered to DWASA on 20 March 1989 in order to implement the project satisfactorily. The Project (preliminary emergency work) was implemented from the beginning of March until the end of June 1989 under a TK. 7 million budget.

The above project is for the urgent khal cleaning work only. For the Drainage Circle, DWASA is now preparing a project for the demarcation of land acquisition, eviction or resettlement of unauthorized houses or structure, and the reexcavation of thirteen khals that are immediately required. This is in accordance with the khal improvement plan of the previous JICA study. The DWASA has already taken up the matter of land acquisition with the District administration and in some cases with RAJUK. Locations of the proposed thirteen khals are illustrated in Fig. 3.8.

In addition, DWASA and RAJUK are going to execute additional khal improvement work by using box culvert types for the Begunbari and Paribagh khals as mentioned below.

(1) Begunbari Khal

- DWASA : Railway crossing to Airport Rd. (600 m)
- RAJUK : Airport Rd. to Green Rd. (1,000 m)

(2) Paribagh Khal

- DWASA : New Escaton Rd. to New Elephant Rd. (700 m)

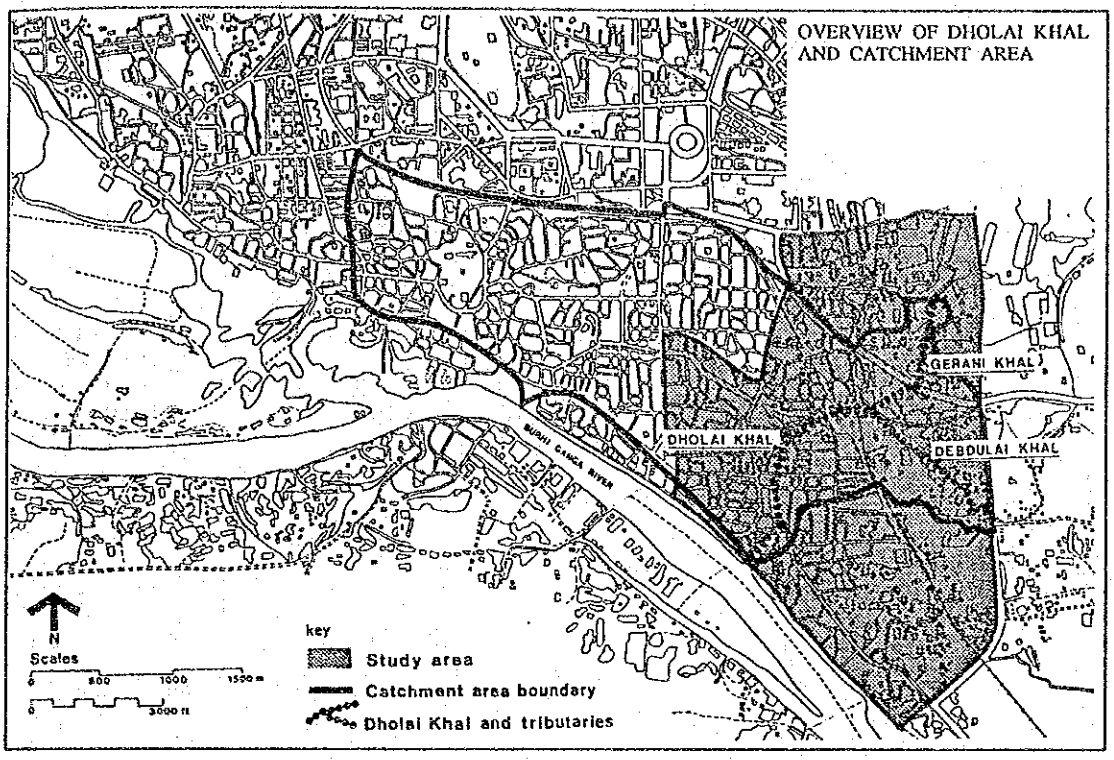
The above projects will be started during the dry season in fisical year 1989 by a special budget approved by the President.

TABLE 3.1 GREATER DHAKA FLOOD CONTROL AND DRAINAGE PROJECT (PHASE I) PROPOSED BY THE COMMITTEE

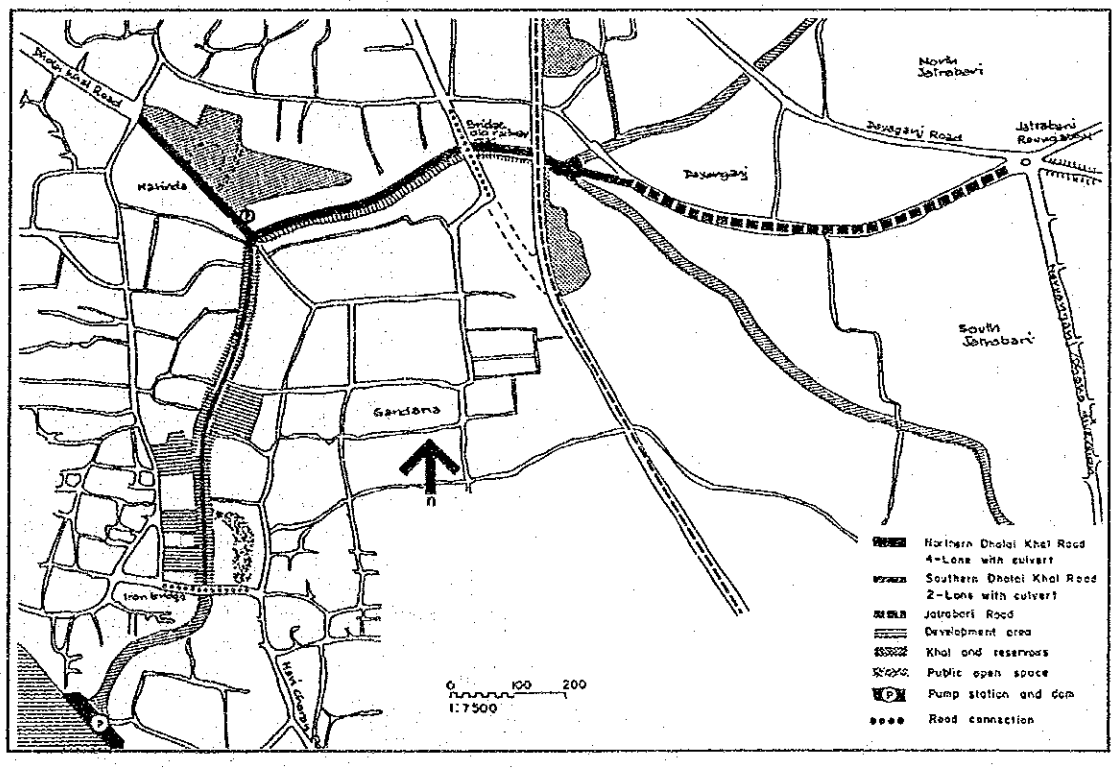
	Project	Agency	Cost (Million Tk)
(1)	17.62 km embankment from Tongi railway bridge up to Shirnir Tek with 5 sluice gates	BWDB	785.00
(2)	2.27 km embankment and flood protection wall from Shirnir Tek up to Mirpur Bridge	DMC	95.38
(3)	0.77 km road construction from Shirnir Tek up to Mirpur Mazar	RAJUK	47.50
(4)	4.25 km embankment from Mirpur Bridge up to Satmasjid Road	DMC	176.14
(5)	5.76 km embankment from Satmasjid Road up to Kellar Morh	DMC	341.11
(6)	7.20 km flood protection wall from Kellar Morh up to Friendship Bridge	DMC	
(7)	29.40 km flood protection wall around Dhaka-Narayanganj-Demra Project	RHD	118.80
(8)	1.40 km new road construction from Kamlapur up to Saidabad Bus Terminal	RAJUK	107.44
(9)	2.5 km road raising of Rampura Road	DMC	22.97
(10)	6.0 km road raising of Pragati Sarani Road with Temporary gates	RAJUK	46.00
(11)	Flood protection bund around Zia International Airport	CAAB	77.20
(12)	Cleaning of 13-Khals/Canals of the city	DWASA	252.00
(13)	Repair and restoration of sewerage in Dhaka City	DWASA	16.80
	Total		2,086.34

TABLE 3.2 GREATER DHAKA FLOOD CONTROL AND DRAINAGE PROJECT (PHASE II) PROPOSED BY THE COMMITTEE

	Project	Agency	Cost (approx.) (Million Tk)
(1)	The proposed self-financing road from Demra DND to Tongi bridge should be realigned to follow the western bank of the Balu river. This should be a by-pass road. In designing this by-pass road/dam, the eastern part should be raised to prevent flooding. On the inside at a lower level, a minimum of four lane road should be built. Similarly on the northwestern side of the city from Tongi bridge to Shirnir Tek a similar design should be considered. A proper survey should be carried out and the technical aspects for the above work should be taken into consideration.		1,500.00
(2)	A four lane road should be built along the inside part of the western flood embankment (from Tongi bridge to Shirnir Tek)		100.00
(3)	Installation of 5 pumping stations		2,000.00
	Total		3,600.00



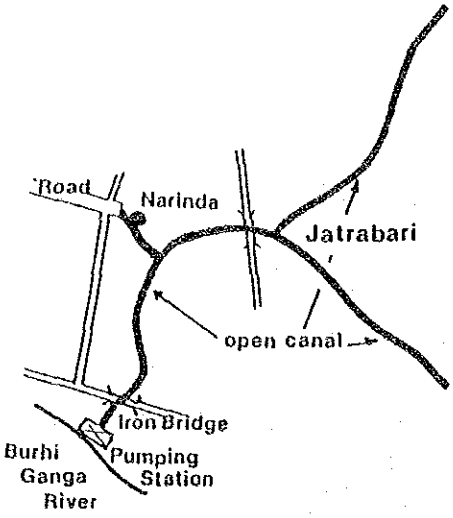
STUDY AREA AND CATCHMENT AREA OF DHOLAI KHAL



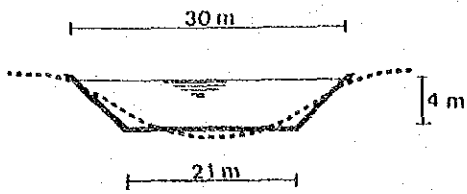
PROPOSED PLAN OF DHOLAI KHAL IMPROVEMENT

Source : Final Report on Dholai Khal Rehabilitation and Area Development Study by B.K.H. B.V. in October 1986

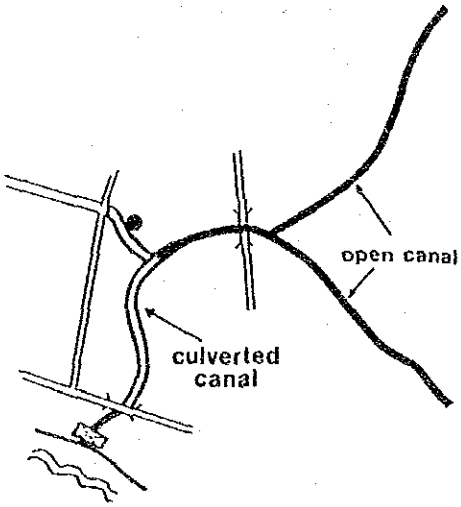
FIG. 3. 1 STUDY AREA AND PROPOSED PLAN OF THE WORLD BANK PROJECT



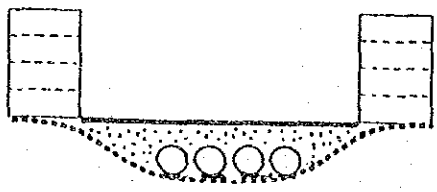
OPTION 1: OPEN CANAL



Dholai Khal and tributaries re-shaped and lined over the full length

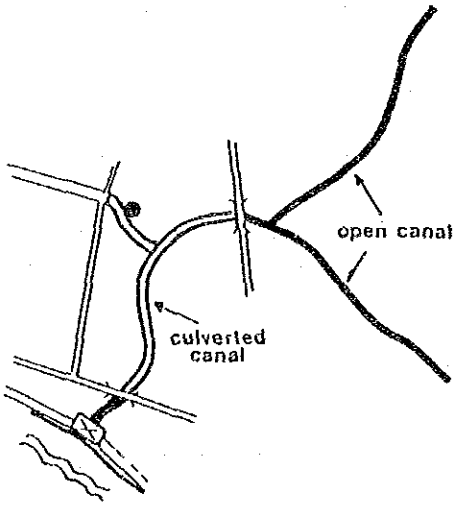


OPTION 2: PARTLY CULVERTING

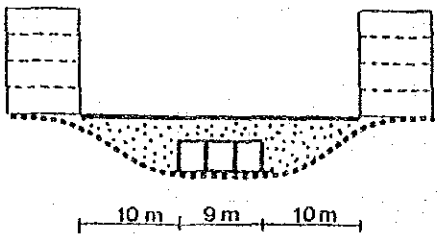


Dholai Khal culverted between Iron Bridge and Narinda

All other Khal sections and tributaries as open canals



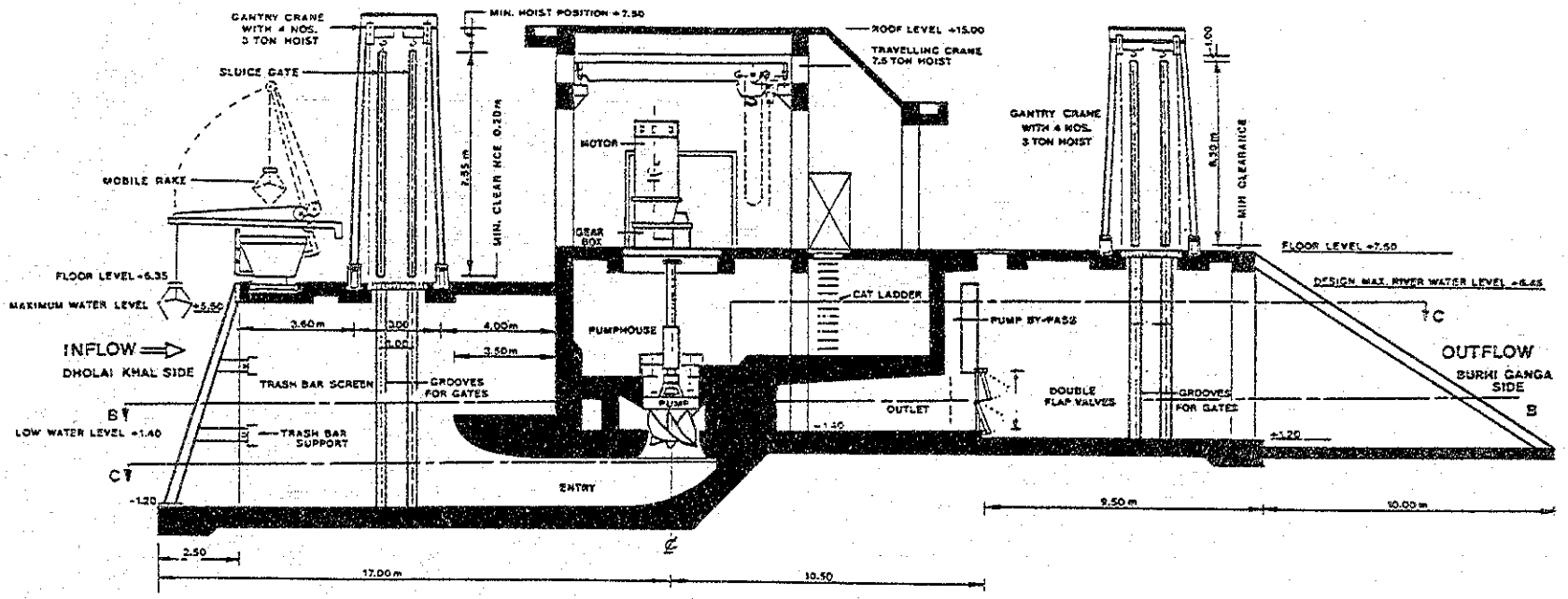
OPTION 3: COMPLETE CULVERTING

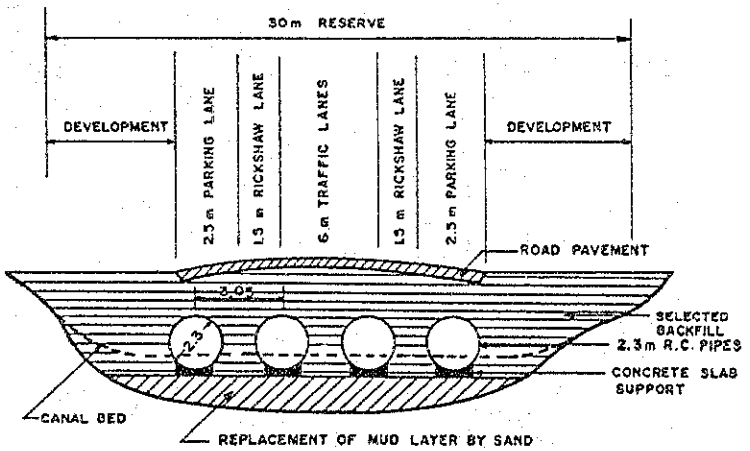


Dholai Khal culverted between Iron Bridge and Jatrabari with major road on top

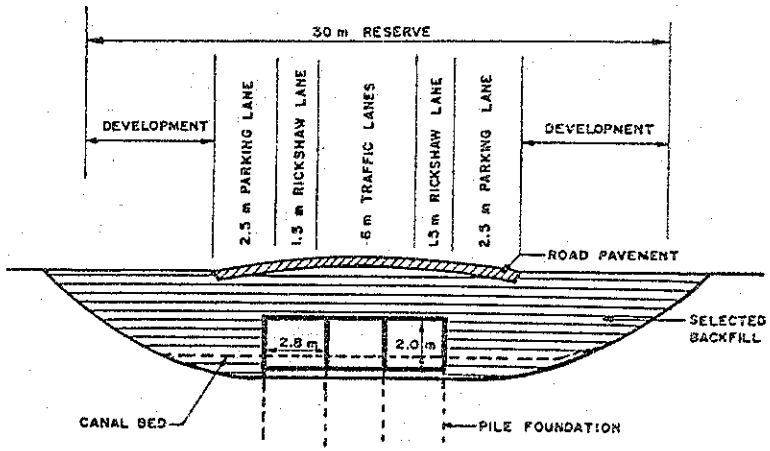
Tributaries as open canals

FIG. 3.2 DHOLAI KHAL REHABILITATION ALTERNATIVES





TYPICAL CROSS-SECTION OF MULTIPLE-CELL PIPE CULVERT



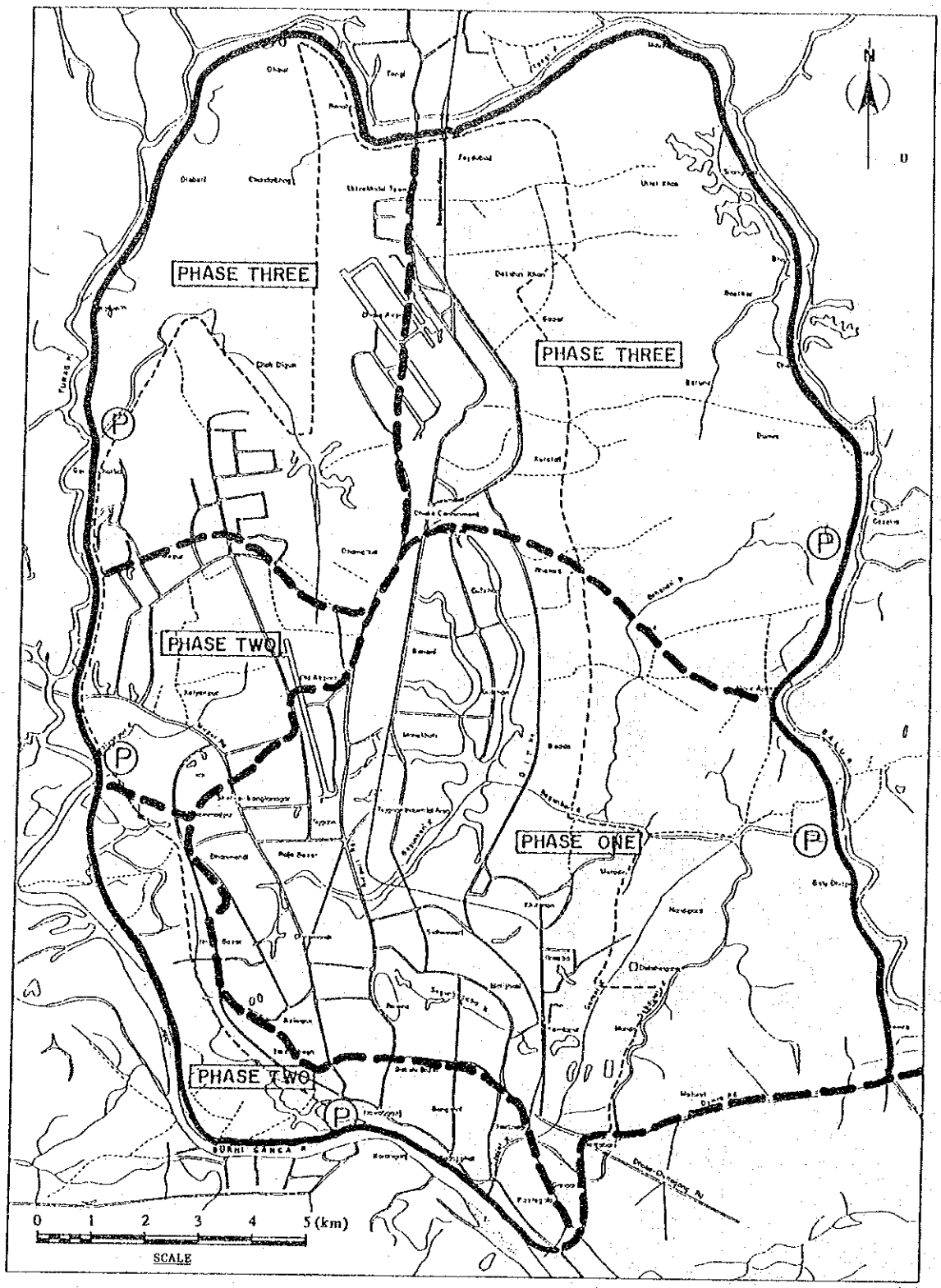
CROSS-SECTION BOX CULVERT

Source : Final Report on Dholai Khal Rehabilitation and Area Development Study by B.K.H. B.V. in October 1986

FIG. 3.3 TYPICAL DESIGN OF PUMP STATION AND CULVERTS PROPOSED IN THE WORLD BANK PROJECT

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

JICA A.D 1990



LEGEND

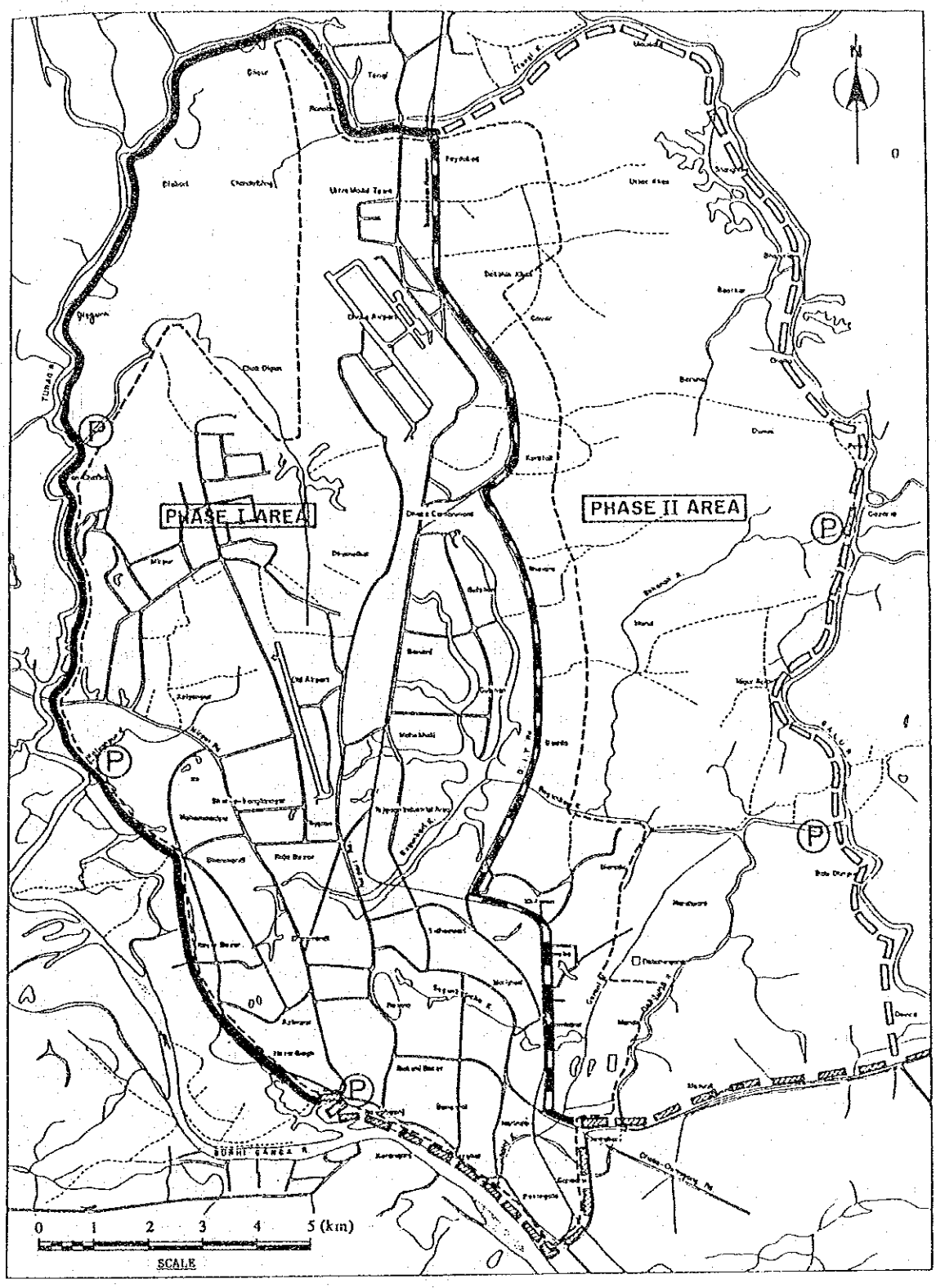
- ROAD
- RIVER/KHAL
- RAILWAY
- PROPOSED PERPHERIAL EMBANKMENT
- PROPOSED SECONDARY EMBANKMENT
- Ⓟ PROPOSED PUMPING STATION-CUM SLUICE
- BOUNDARY OF JICA STUDY AREA

Source : Recommendations to the Committee on Greater Dhaka Flood Control by T.G.H.Japan in Nov. 1988

FIG. 3. 4 FULL FLOOD PROTECTION SCHEME RECOMMENDED BY A DUTCH EXPERT

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

JICA A.D 1990

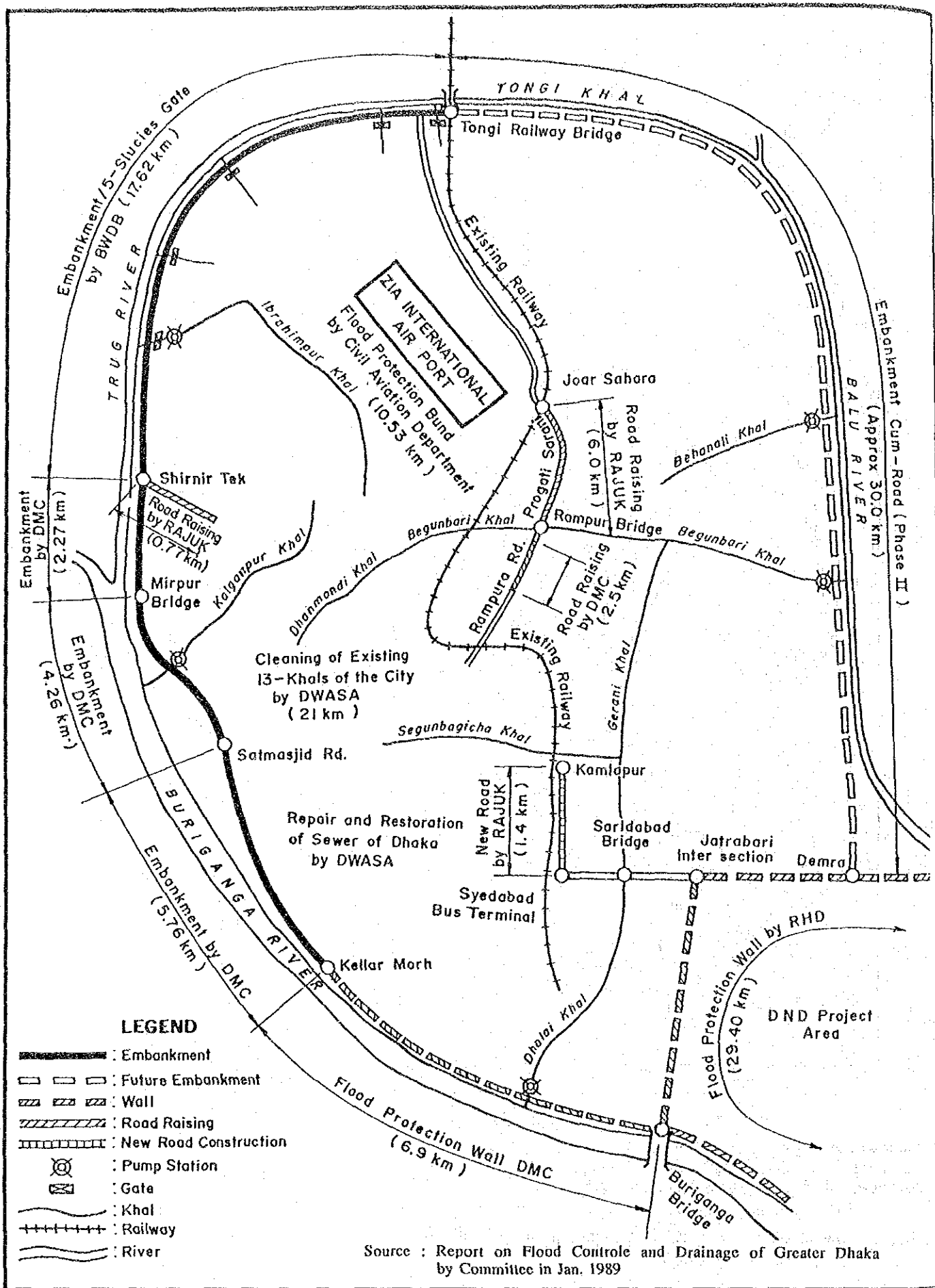


LEGEND

- Embankment (Phase I)
- Flood Protection Wall (Phase I)
- Temporary Flood Protection Boundary with Interim Works (Phase I)
- Embankment (Phase II)
- Pumping Station (Phase II)
- Boundary of JICA Study Area

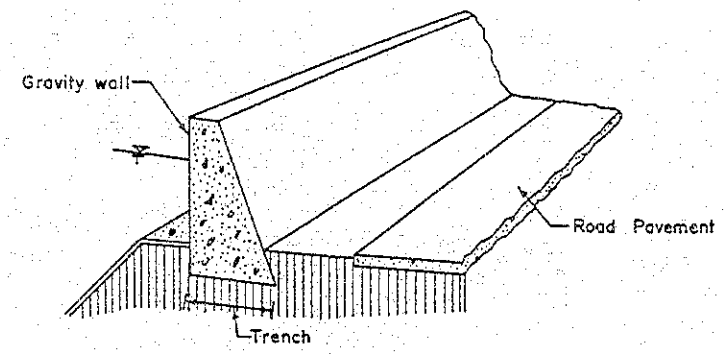
Source : Report on Flood Controle and Drainage of Greater Dhaka by Committee in Jan.1989

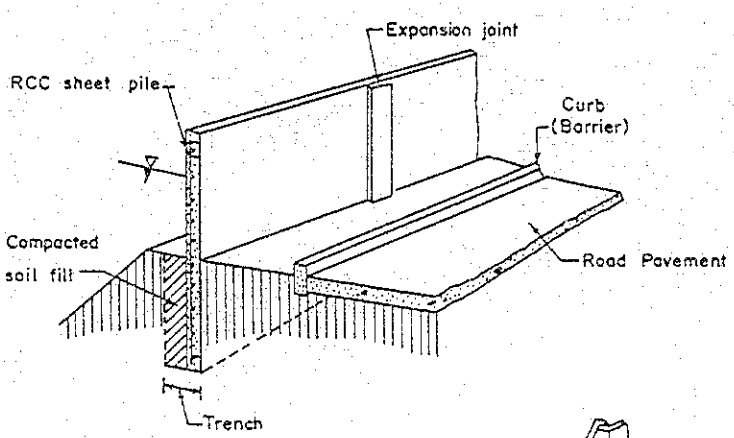
FIG. 3.5 GREATER DHAKA FLOOD CONTROL AND DRAINAGE SCHEME PROPOSED BY COMMITTEE

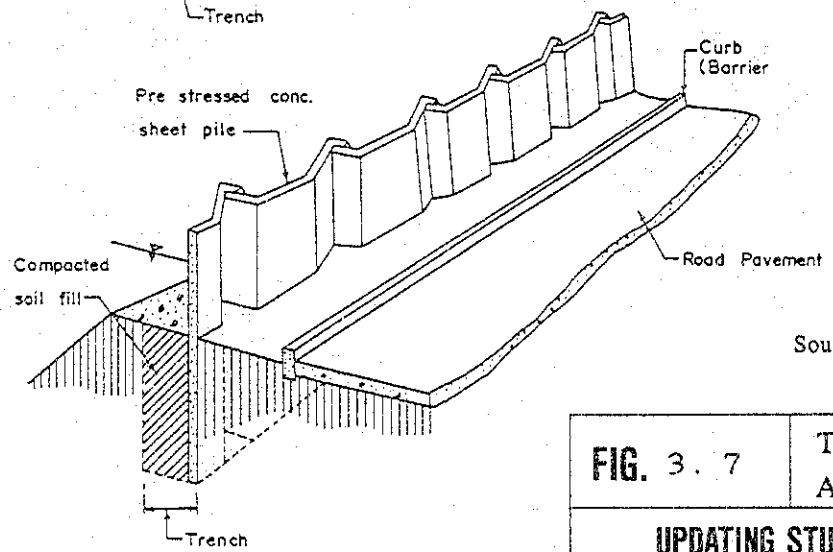


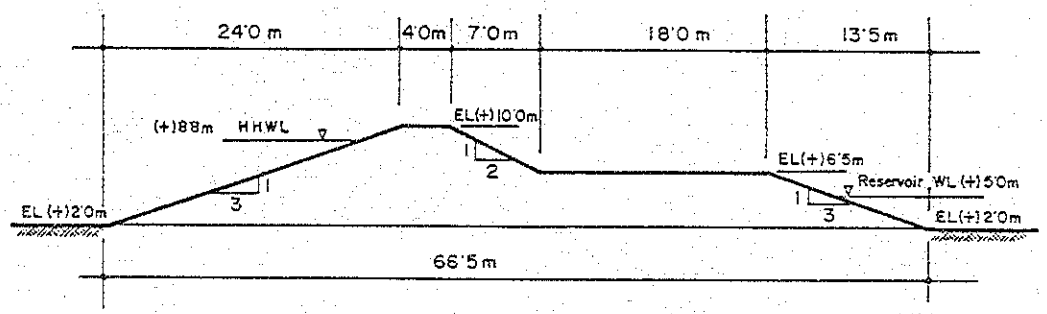
Source : Report on Flood Controle and Drainage of Greater Dhaka by Committee in Jan. 1989

FIG. 3. 6 PROPOSED PROJECTS IN GDFCD PROJECT



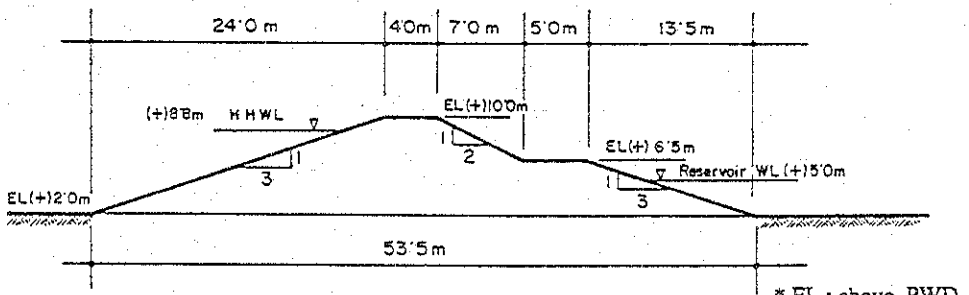






* EL : above PWD

TYPICAL SECTION (INCLUDING 4 LANE HIGHWAY)



* EL : above PWD

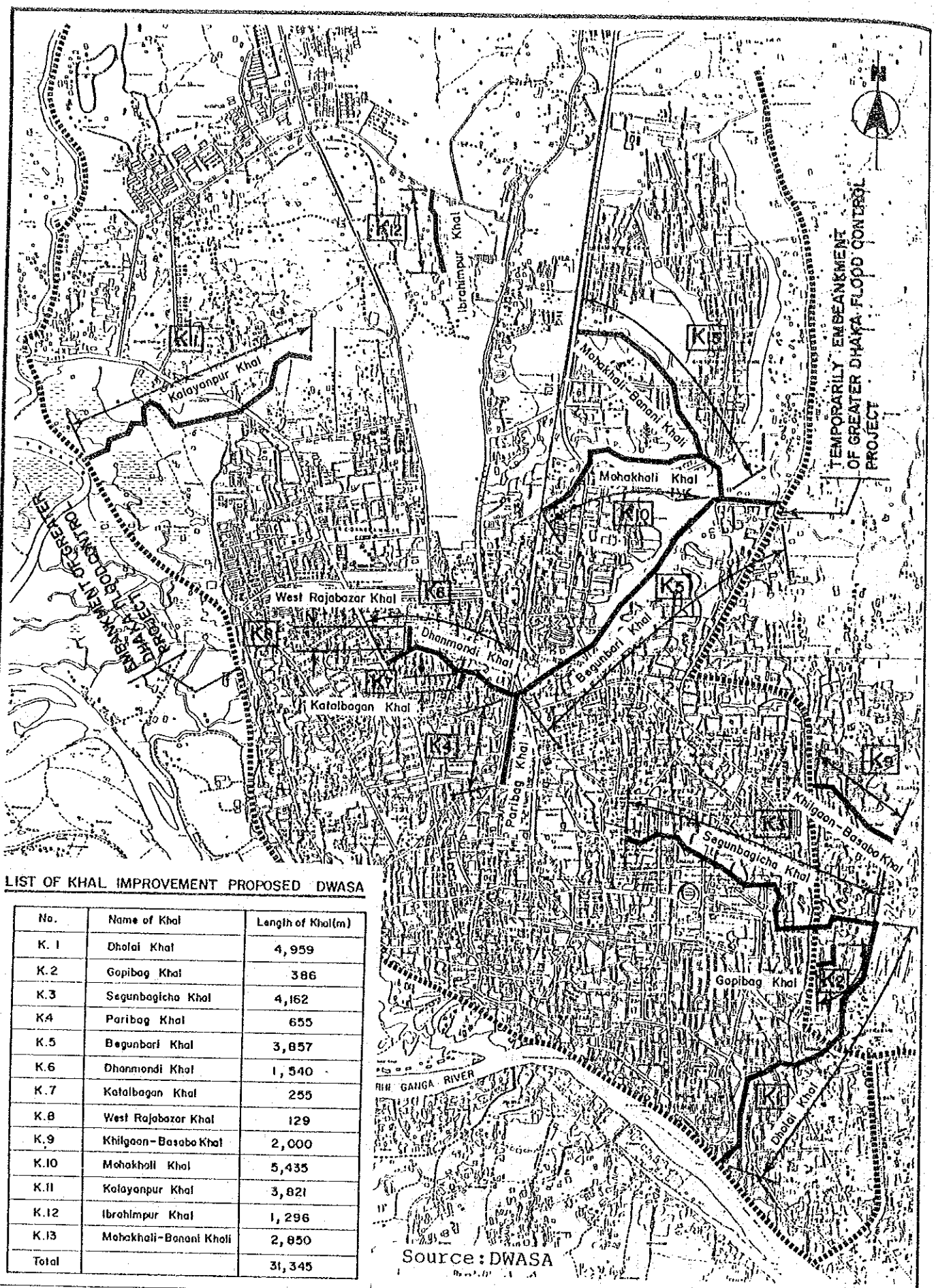
TYPICAL SECTION (ONLY EMBANKMENT

Source : Report on Flood Controle and Drainage of Greater Dhaka
by Committee in Jan. 1989

FIG. 3. 7 TYPICAL DESIGN OF FLOOD PROTECTION EMBANKMENT AND WALL OF GDFCD RPOJECT

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

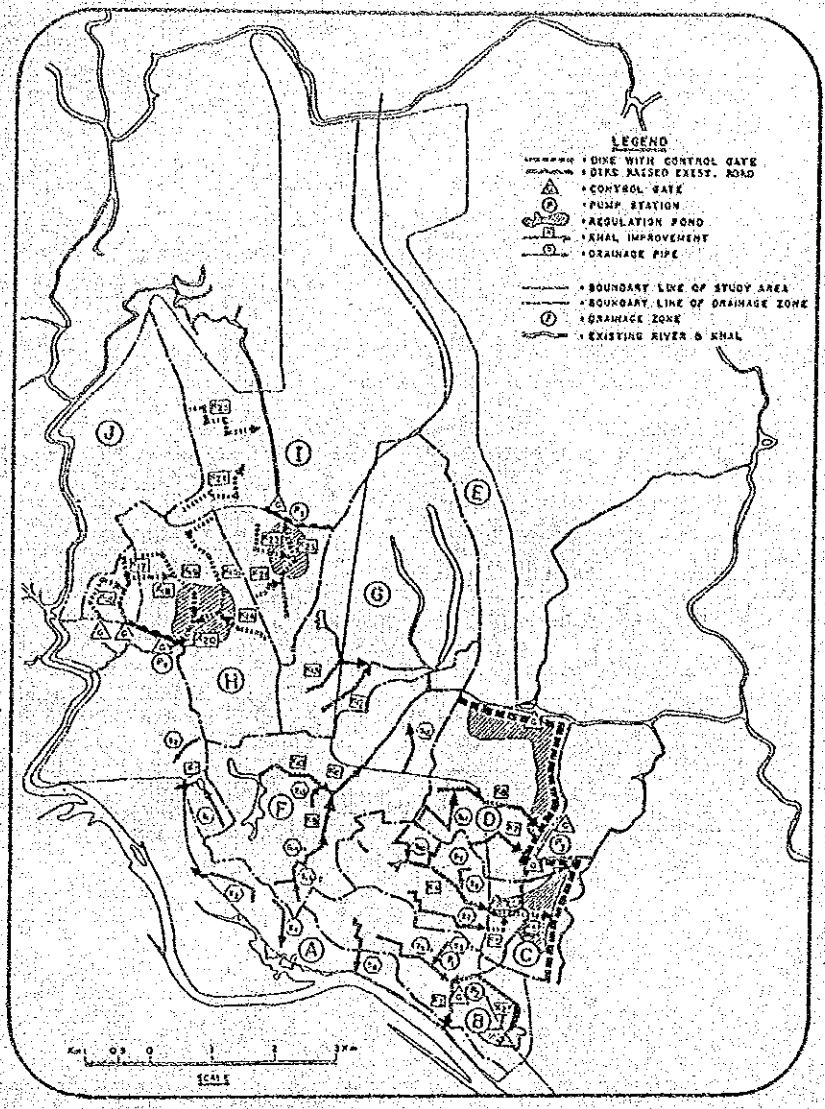
JICA A.D 1990



LIST OF KHAL IMPROVEMENT PROPOSED DWASA

No.	Name of Khal	Length of Khal(m)
K. 1	Dholai Khal	4,959
K.2	Gopibag Khal	386
K.3	Segunbagicha Khal	4,162
K4	Paribag Khal	655
K.5	Begunbari Khal	3,857
K.6	Dhanmondi Khal	1,540
K.7	Katalbagan Khal	255
K.8	West Rajabazar Khal	129
K.9	Khilgaon-Basabo Khal	2,000
K.10	Mohakhali Khal	5,435
K.11	Kalayanpur Khal	3,821
K.12	Ibrahimpur Khal	1,296
K.13	Mohakhali-Banani Khali	2,850
Total		31,345

FIG. 3.8 LOCATION OF KHAL IMPROVEMENT PROJECT BY DWASA



PROPOSED FACILITIES IN THE PREVIOUS JICA STUDY

CHAPTER 4

UPDATING THE PHASED PROGRAMME

CHAPTER 4 UPDATING THE PHASED PROGRAMME

4.1 GENERAL

The previous JICA study proposed three phased implementation programmes of flood protection and drainage improvement measures for the Study Area (A = 137.5 km^2). The feasibility study was then conducted for the selected area of 31.3 km^2 (zones B, C and F) as a Phase-I Programme with a total estimated cost of Tk 2.61 billion (1986 prices).

Since the Study Area will be enclosed by the flood protection dike proposed in the GDFCD Project, hydrological conditions of its surrounding areas will be changed. Moreover, some of facilities proposed in the previous JICA study will be built by related ongoing projects. In this Chapter, the flood protection and drainage plan of the Study Area will be reviewed and the Phased Programme will be revised.

4.2. PLANNING POLICY AND DESIGN CRITERIA

4.2.1 Basic Criteria

(1) Target Year

The target year will not be changed from that of the previous study. The plans should be prepared to meet the population and land use distribution in the year 2000.

(2) Future Land Use

The land use plan for the year 2000 that was prepared in the previous study will be applied because, even if the GDFCD Proejct will be completed, changes in the future land use plan in the Study Area will be negligible.

4.2.2 Hydrological Design Criteria

(1) Design Flood Water Level

In the GDFCD Project, the design flood water level with a 500-year frequency (+8.35 m in GTS) was applied for the design of flood protection works, e.g., dikes, walls , or sluice gates.

The frequent flood water level with a 2-year return period was employed as the design outlet water level for internal drainage works, e.g., pump stations, khal improvements and drainage pipes. Two (2) design flood water levels were applied for the Study Area.

- +5.36 m in GTS for the southern part including the Old Dhaka, Central Dhaka and Gulshan-Banani areas.(see Fig. 4.1)

- +6.00 m in GTS for the northern part including the Mirpur, Kallyanpur and Tongi areas. (see Fig. 4.1)

(2) Design Rainfall

As in the previous study, the rainfall intensity with a 5-year frequency was employed for the design of drainage pipes and khal improvements. The applied rainfall intensity-duration curves are illustrated in Fig. 4.1

As in the previous study, a 2-day consecutive rainfall with a 5-year frequency was applied for the design of pump stations. In the event that, a gigantic regulating pond capacity is expected, a weekly or monthly rainfall with a 5-year frequency is to be applied according to the pond capacity. Fig.4.2 shows the design rainfall for pump stations.

(3) Runoff Calculation Method

As in the previous study, the design discharge for the drainage pipes and khal improvements was calculated by the Rational formula.

(4) Runoff Coefficient and Runoff Ratio

The following runoff coefficients were used for the calculation of flood runoff peak by the Rational formula.

Land Use	Runoff Coefficient
Commercial Area	0.65
Industrial Area	0.55
High Class Residential Area	0.30
Middle & Low Class Residential Area	0.50
Green Zone and Others	0.20

The runoff ratio (total run-off/total rainfall) of 0.8 was employed in the estimate of flood runoff volume required for the calculation of pump capacity.

(5) Manning's Roughness Coefficient

Manning's roughness coefficients applied for hydraulic calculation of drainage pipes, culverts and khal improvements are as follows :

Drainage pipe (brick)	:	0.015
Concrete Box Culvert	:	0.015
Khal Improvement (smooth section)	:	0.025
Khal Improvement (rough section)	:	0.035

4.2.3 Scope of Structural Measures to be Proposed

In the previous study, flood protection work (dikes, gates, and existing road raisings) and internal drainage improvement work (pump stations, khal improvements, and drainage pipes) were proposed as structural measures, limited to major work required to meet a midterm range necessity with the limited financial resources.

Main project component of the related ongoing projects are:

- The World Bank Project : Dholai Khal improvement work including construction of a New Narinda pump station.

- The GDFCD Project : Construction of flood protection dikes or walls with sluice gates and five (5) pump stations. However, construciton of a dike along the Balu river and 5-pump stations are proposed in Phase II Programme.

- The Khal Improvement Project : Only the emergency reexcavation work of 13-khals by WASA.

Taking into account the above components of ongoing projects, flood protection work, except for a sluice gate for the drainage facilities, the Dholai khal improvement and a New Narinda pump station were deleted from the study. Therefore, the scope of the structural measures to be proposed in this study were:

(1) Installation of a pump station with sluice gate except at New Narinda pump station

(2) Improvement of khals except the Dholai khal in drainage zone B

(3) Installation of trunk drainage pipe and sluice gate at its outlet.

4.3. REVISION OF DRAINAGE PLAN

4.3.1 Drainage Zone

Revision of the drainage boundaries of zones, A, B and H, was conducted in correlation with the two (2) ongoing projects, the World Bank Project and the GDFCD Project.

(1) No. 1 revised area (Dholai Khal estuary area)

The Dholai Khal estuary area of 0.56 km^2 shall be incorporated into the B zone. The New Narinda pump station will be constructed at the mouth of Dholai Khal in the World Bank Project and it will cover this area as the pump drainage area.

(2) No. 2 revised area (Kallyanpur and Mahammadpur area)

The Kallyanpur and Mohammadpur area of 4.82 km^2 was enclosed and protected by the embankment constructed by DMC in the GDFCD Project. This area shall be annexed to zone H from A.

(3) No. 3 revised area (Kallyanpur khal estuary area)

The Kallyanpur khal estuary area of 2.60 km^2 shall be excluded from zone A, because it is an outer area of the GDFCD Project.

The entire revised Study Area is 134.85 km^2. Each revised drainage zone is listed in Table 4.1 and illustrated in Fig. 4.3.

4.3.2 Pump Drainage Plan

In the previous study, a pump drainage system was proposed for the drainage zones, B, C, D, H, and I, having a total pump drainage areas of 37.37 km^2. Installation of five (5) pump stations with a total capacity of 42.5 m^3/s and five (5) regulating ponds with a total area of 401 ha and a total storage capacity of 4.94 million m^3 were proposed.

The previous pump drainage plan shall be revised to correlate with ongoing projects. Location of the pump stations proposed by the previous study, the World Bank Project and the GDFCD Project, are illustrated in Fig. 4.4.

(1) Drainage Zone A

The existing built-up area is mostly higher than the 30-year frequency flood level of 6.6 m in GTS. The area drains directly into the Buriganga river through the drainage pipes by the gravity flow.

The installation of movable pumps having 150 mm diameters and 2.5 m^3/m capacities is proposed at the outlets of the drainage pipes by taking into account the following considerations :

- To drain storm water form part of the lowland that is being protected by the flood protection wall constructed by DMC in the GDFCD Project, and from the area that is under the frequent flood water level.

- To provide emergency measures for drainage during unexpected high flood water level periods of the Buriganga river.

(2) Drainage Zone B

The New Narinda pump station with a capacity of 80,000 m^3/h will be constructed at the mouth of the Dholai khal in the World Bank Project; therefore, no pump station is proposed in this study.

(3) Drainage Zones C, D, E, F and G

The existing built-up areas of the drainage zones E, F and G are mostly higher than the 30-year frequency flood water level of 6.60m in GTS. These areas can be drained by the gravity flow during the design flood water level period of 5.36 m in GTS.

Drainage zones C and D are, however, required to employ a pump drainage system based on newly urbanized areas with a ground elevation of 5.5 m in GTS. It is proposed HWL of the outlet of the khals shall be 4.5 m in GTS in order to cover a drainage improvement of inland areas.

After completing the Phase-II Programme of the GDFCD Project, these drainage zones will be integrated into one large zone of 167.95 km^2. The integrated drainage zone will be required to employ a pump drainage system.

Considering a gigantic effective storage volume of 136.5×10^6 m^3 (equivalent to almost 80% of the total inflow volume by design rainfall during a flood season between July and September) for the vast eastern lowland areas, the required pump capacity can be decreased by the long term pump operations.

The following two (2) alternatives for a pump drainage system are proposed :

Alternative I : The required pump station will be constructed at an east dike by the GDFCD Project and will drain into the Balu river.

Alternative II : To integrate with drainage zone B and drain into the Buriganga river by the New Narinda pump station constructed in the World Bank Project.

The total required pump capacity and construction costs for the above alternatives are estimated as follows :

Alternative I : Qr = 19.6 m^3/s, C = Tk 480.2 million
Alternative II : Qr = 20.5 m^3/s, C = Tk 502.3 million

If the east lowland areas are not urbanized in the year 2000 and if LWL of the regulating pond is maintained in 3.0~3.5 m in GTS, Alternative II is recommended,because the required pump capacity is estimated to be within the range of the New Narinda pump station of the World Bank Project.

When habitation is expanding into east lowland areas and the effective storage volume of lowland areas is decreasing, it may be necessary to adopt Alternative I where pump station will be constructed at the Balu river by the GDFCD Project; the pump capacity shall to be increased gradually.

(5) Drainage Zone H

Considering the construciton of a new flood protection dike by DMC in the GDFCD Project, the Kallyanpur pump station cum sluice gate is proposed to be relocated from the Mirpur road to the mouth of the Kallyanpur khal.

The total area of drainage zone H is 17.6 km^2. It consists of 10.8 km^2 of upland areas and 6.8 km^2 of a low-land areas. Of the existing low-land areas, the northern parts from the Mirpur Road (approx. 3.3 km^2) and the western parts from the Mahammadpur (approx. 0.7 km^2) will be built-up in the near future by the rapid urbanization. Future upland and lowland areas are estimated to be 14.8 km^2 and 2.8 km^2 respectively.

The future effective storage capacity of 3.36 x 10^6 m^3 of low-land area is only 18% of the total inflow volume by the design long term rainfall. The 2-days consecutive design rainfall is applied for estimating the required pump and regulating pond capacities.

The results by the mass curve method as shown in Fig. 4.5 are :

- Required pump capacity : 20 m^3/s
- Required regulating pond
  - Capacity : 2.08×10^6 m^3
  - Area : 208 ha
  - HWL. and LWL : 5.0 m and 4.0 m in GTS

(6) Drainage Zone I

A gravity drain system can be adopted for the drainage zone I except for the Katchuket area of 3.94 km^2. Since the existing ground elevation of the Katchuket area (6.2~6.5 m in GTS) is almost same as the design flood water level, a pump drainage system must be adopted. The location and required capacity of the proposed pump station cum sluice gate are the same as those recommended in the previous study as shown below :

- Location : Ibrahimpur Khal at the Darus Salam Road.
- Required pump capacity : 4.5 m^3/s
- Required regulating pond
  - Capacity : 0.51×10^6 m^3
  - Area : 34 ha
  - HWL and LWL : 5.5 m and 4.0 m in GTS

(7) Drainage Zone J

The existing built-up area is high land. As in the previous study, no pump station is recommended.

4.3.3 Khal Improvement and Drainage Pipe

In this section the khal improvement plans for the 25 existing khals that were propsed in the previous study are reviewed in view of the following points:

- Design discharge
- Khal length to be improved
- Khal improvement type (open or covered types)
- Longitudinal and cross section

Except for the installation of sluice gates at outlets at the Bariganga and Turag rivers, no revisions to the 14 trunks of drainage pipe are to be made in this study. Location of the revised khal improvement is shown in Fig. 4.6.

(1) Design Discharge

The design discharges of seven (7) khals in zone H were revised by the Rational formula because of the changes to the drain direction and the catchment area. Design discharge for the proposed 25 khal improvements including those revised for the above khals are illustrated in Fig. 4.7.

(2) Khal Length to be Improved

Considering survey results and the correlation with ongoing projects, the total length of the required khal improvement is revised from 39.7 km to 36.35 km. The revised khal improvement length is as follows:

- Dholai khal: to be shortened by 3.0 km
- Gandaria khal: to be shortened by 1.2 km
- Segunbagicha khal: to be lengthened by 0.5 km
- Kallyanpur khal: to be lengthened by 2.5 km
- K19, K20 khals: to be shortened by 2.4 km

(3) Khal Improvement Type

Considering the easiness of storm water collection, maintenance work and low investment cost, the open channel type was proposed in the previous study for the improvement of all stretches of existing khals.

However, for the following khal sections located in the highly urbanized area, the covered channel type of khal improvement is recommended in this study.

- Segunbagicha khal : Bangladesh Bank Building to DPHE Store Circle, L=2300m
- Begunbari khal : Tongi Diversion Rd.to Mirpur Rd., L=2800m
- Paribagh khal : New Elephant Rd.to New Eskatan Expansion Rd., L=700m

The major considerations for adopting the covered channel type (box culvert) to the khal sections mentioned above are as follows :

- Due to the inflow of sewerage and the illegal dumping of garbage in the khals in highly urbanized area, a sickly odour emanates from the khals during dry seasons. This is a serious problem. Agencies concerned have been strongly urged to solve this problem. They were also informed that planning considerations have to meet to social needs by adopting the covered channel method for khal improvement in highly urbanized areas.

- The flow capacities of open channel khals have been decreasing due to deposition of garbages, encroachment by squatters, illegal earth filling and so on. This causes a worsening of the flood problems by increasing the flood duration as well as the flood area along the khals. Additionally, the Agencies have been given the difficult assignments of maintaining strick control of discipline in khal area and for keeping the khals in good working order by providing the necessary maintenance.

- As a matter of fact, the covered channel type has been adopted for the khal improvement work executed by the concerned agencies over the past three years.

(4) Longitudinal and Cross Section

Revisions have been made to the longitudinal sections of the Begunbari and Paribagh khals. The longitudinal slopes are revised from 1:3,000 to 1:2,000 for the Begunbari khal and 1:2,000 to 1:1,000 for the Paribagh khal in order for them to connect smoothly with the bottom elevation of the existing box culvert between Airport Rd. and Sonargaon Rd., so that they will correlate with the GDFCD Project.

The cross sections for the Begunbari and Paribagh khals in the F zone, and the Kallyanpur and other khals in the H zone are reviewed based on the revised design discharge, khal bed slope and khal improvement type.

(5) Correlation of the Canal System with the World Bank Project

The 1.8 km of Gerani khal, connecting between the Segunbagicha and Dholai khals, shall be improved by dredging and providing slope protection work along a 1.0 km section. The khal bed elevation is proposed to be zero meter in GTS.

In the World Bank Project, the Dholai khal improvement work shall be considered to correlate with the upper stream stretches, the Gerani and Segunbagicha khals.

4.3.4 Proposed Drainage Plan

(1) Structural Plan

The proposed structural plan for internal drainage improvement work is as follows :

(a) Installation of sluice gate : Seven (7) sluice gates are to be installed at the outlets of the proposed khal and drainage pipes in the drainage zones A, B and at the proposed pump stations in zones H and I.

(b) Installation of drainage pipe : The additional trunk drainage pipes, ranging from 1.5 to 3.7 m in diameter are to be installed in the 14 routes for draining a total catchment area of 12.45 km^2. The total installation length is 17.0 km, of which 14.07 km is for a brick pipe and the remaining 2.93 km is for a R.C box culvert.

(c) Khal improvement : The existing khals are to be widened or dredged in 25 stretches. The total length to be improved reaches 36.35 km of which 5.8 km is for a box culvert section and the remaining 30.55 km is for a open channel. The major work consists dredging 560 x 10^3 m^3, the construction of bridge culverts at 45 places, and the installation of 8.8 km long brick protection.

(d) Installation of pump station : Two (2) pump stations with a total discharge capacity of 24.5 m^3/s will be installed . The pump stations cover drainage zones H and I having a total area of 21.54 km^2.

(e) The above mentioned major works are proposed for A,C,D,F,G, H and I zones, and are not recommended for E and J zones. Internal drainage improvement of E and J zones will, however, be attained by small-scale structural and non-structural measures. For drainage zone B, the installation of 4.3 km of drainage pipes and one sluice gate included only.

The proposed facilities and their locations are presented in Table 4.2. The location of the proposed facilities are illustrated in Fig. 4.8.

(2) Non-Structural Plan

(a) Reserving swampy areas totaling 242 ha for the proposed pump regulating ponds for the H and I zones.

(b) Strict enforcement of control to prevent any reduction of the proposed minimum khal sections which could cause flood flows to be obstructed and the water to back up in the upstream areas.

4.4. ESTIMATION OF PROJECT COST

The total project cost, including construction, engineering, land acquisition and contingencies, amounts to Tk 4,478.7 million (1989 prices) as shown below. The breakdown of the estimated project cost is summarized in Table 4.3.

Project Cost

Unit : million Tk

Item		Cost
A.	Construction Cost	3,468.6
	(1) Pump Station	624.5
	(2) Gate	135.5
	(3) Khal Improvement	1,933.1
	(4) Drainage Pipe	775.5
B.	Contingency and Engineering	693.7
C.	Land Acquisition	316.4
	Total	4,478.7

4.5 REVISED PHASED PROGRAMME

4.5.1 Prioritization of Drainage Zone

In the previous JICA report, priority sequences of the ten (10) drainage zones were discussed through the comparison of the seven (7) factors such as beneficial population, required project cost, required land acquisition, flood conditions, flood damage, hindrance to traffic and, land use grade. The decided priority sequences were :

. First Priority Zones	:	B, C, F
. Second Priority Zones	:	A, D (part), G, H
. Third Priority Zones	:	D (part), E, I, J

Considering the rapid changes in urbanization and the serious flood damages in 1988, however, the H-zone will be taken as the first priority area in this updating study. The particular considerations for this modification are given below :

- Since the H-zone adjoins the heart of the city and two major roads, namely Mirpur and Rokeya Sharoni roads, connect to the city core in both the east and west ends of the zone, progression of the urbanization of the zone is remarkably high. The population in the year 2000 is estimated at 670,000 for the H-zone while the population in the year 1988 is estimated at 440,000 by taking into account a 52% of population increase. The rapid urbanization has increased the flood damage potential as well as the flood vulnerability of the area.

- In addition, urbanization is expanding in a disorderly fashion to the lowland area in the H-zone. The survey result of the 1988 flood shows that the H-zone flood situation was the most serious among the 10 zones in the study area. The flood covering 70% of the H-zone, lasted more than one month and had an average depth of 1.5 m. Especially in the lowland area, the flood depth reached to more than 3.0 m.

- The GDFCP project has decided, therefore, that the west part of the city, including the H-zone, is defined as a high priority area for the implementation of the flood protection and has started to construct the flood bank to enclose the area in the earlier stage.

In the light of foregoing discussion, the H-zone is included as a first priority area in addition to the B, C, and F zones. The remaining zones are second priority area as in view of an attempt to balance the investment amount with the first priority area (see Fig. 4.9).

- First Priority Zones : B, C, F, H (49.46 km^2)
- Second Priority Zones : A, D, G, E, I, J (85.36 km^2)

4.5.2 Phased Programme

A program consisting of two (2) phases is proposed in conformity with the priority sequence of the drainage zones decided above as well as the priority sequence of proposed drainage facilities. The priority sequences of the drainage facilities are given considering their efficiency to mitigate flood damages as described below :

(1) Construction of the pump station (Kallyanpur) with a sluice gate will be given high priority to cope with the flood protection dike constructed by the GDFC project. By virtue of this work, the flood water level of the vast inner areas will be lowered and the internal drainage through the drains will be facilitated.

Owing to the fact that the available regulating pond is large enough at present in comparison with the future demand proposed in the facility plan, the capacity of the pump station to be constructed will be 10 m^3/s in the first phase, which is a half of the future capacity proposed.

(2) Improvement of main khals, such as Segunbagicha, Begunbari etc., will be given high priority in order to facilitate the internal drainage through the lateral drains in addition to lowering the flood water level along the khals.

(3) For financial reasons, the remaining sub-khals and sub-drainage pipes will be constructed stage-by-stage in the later phase.

Although the first priority for implementation is given to the drainage zone B, the construction of pump station, gate and khal improvement along Dholai khal will be deleted from the Phase I as described in section 4.2.3. These constructions will be undertaken by the Dholai Khal Rehabilitation and Area Development Project.

The proposed phased program is shown in Table 4.4. The location of the facilities proposed in the Phase-I program is shown in Fig. 4.10 and typical sections of khal improvement for the Segunbagicha and Begunbari khals are shown in Figs. 4.11 and 4.12.

TABEL 4.1 REVISED AREA OF DRAINAGE ZONE

Name of Zone	Area (km^2)		Remarks
	Former	Rivised	
(A) Buriganga River Zone	15.23	7.25	0.56 km^2 to B zone 4.82 km^2 to H zone 2.60 km^2 out of zone
(B) Dholai Khal Zone	6.68	7.24	0.56 km^2 from A zone
(C) Segunbagicha Khal Zone	10.92	10.92	
(D) Basabo Zone	7.46	7.46	
(E) Northeast Edge Zome	13.93	13.93	
(F) Begunbari Khal Zone	13.70	13.70	
(G) Gulshan-Banani Zone	17.64	17.64	
(H) Kallyanpur Zone	12.78	17.60	
(I) North Zone	31.42	31.42	
(J) Trug River Bank Zone	7.69	7.69	
Study Area	137.45	134.85	
(K) Northwestern Area	-	25.85	Out of JICA Study Area
(L) Eastern Area	-	104.30	Out of JICA Study Area
Greater Dhaka City Area	-	265.0	

Note: (1) Former figures refer to the previous JICA Study Report (Supporting Report, page I-55)
(2) (K) (L) Areas are out of JICA Study Area

TABLE 4.2 SUMMARY OF PROPOSED FACILITY

ZONE	PUMP STATION		GATE	KHALIMPROVEMENT							DRAIN		
	PUMP CAPACITY	REGULAT-ING POND	SLUICE GATE	BOX CULVERT CHANNEL	RETAINING WALL CHANNEL	BRICK PROTEC-TION CHANNEL	SODDING PROTEC-TION CHANNEL	DREDGING	BRIDGE CULVERT	TOTAL KHAL LENGTH	BRICK PIPE	BOX CULVERT	TOTAL DRAIN LENGTH
	m3/s	ha	place	km	km	km	km	x 1000m3	places	km	km	km	km
A	-	-	4	-	-	-	0.30	2.7	1	0.30	3.80	-	3.80
B	*	*	1	*	*	*	*	*	*	*	2.05	2.23	4.28
C	-	-	-	2.30	-	1.50	2.50	198.1	3	6.30	4.11	0.70	4.81
D	-	-	-	-	-	1.40	3.05	42.2	12	4.45	0.70	-	0.70
E	-	-	-	-	-	-	-	-	-	-	-	-	-
F	-	-	-	3.50	-	-	-	56.8	-	3.50	3.41	-	3.41
G	-	-	-	-	-	-	2.90	43.4	4	2.90	-	-	-
H	20.0	208.0	1	-	-	5.90	6.10	129.7	7	12.00	-	-	-
I	4.5	34.0	1	-	0.80	-	5.90	87.5	18	6.90	-	-	-
J	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	24.5	242.0	7	5.80	0.80	8.80	20.75	560.4	45	36.35	14.07	2.93	17.00

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

TABLE 4.3 PROJECT COST

Unit : Million Tk at 1989 Price

Drainage Zone	Control Gate (places)	Pump Station (m^3/s)	Khal Improvement (km)	Drainage Pipe (km)	Construciton Cost	Contingency & Engineer-ing Super vision	Land Acquisition (ha)	Total Project Cost
A	4 63.5	-	0.30 6.3	3.80 127.5	197.3	39.5	0.10 4.8	241.6
B	1 6.0	*	*	4.28 295.2	301.2	60.2	*	361.4
C	-	-	6.30 611.4	4.81 206.3	817.7	163.5	2.90 84.8	1,066.0
D	-	-	4.45 80.9	0.70 29.5	110.4	22.1	1.20 19.2	151.7
E	-	-	-	-	-	-	-	-
F	-	-	3.50 755.3	3.41 117.0	872.3	174.5	1.10 36.8	1,083.6
G	-	-	2.90 44.0	-	44.0	8.8	1.20 19.2	72.0
H	1 50.9	20.0 453.4	12.00 231.1	-	735.4	147.1	8.40 114.4	996.9
I	1 15.1	4.5 171.1	6.90 204.1	-	390.3	78.1	3.10 37.2	505.6
J	-	-	-	-	-	-	-	-
Total	7 135.5	624.5	36.37 1,933.1	17.0 775.5	3,468.6	693.7	18.0 316.4	4,478.7

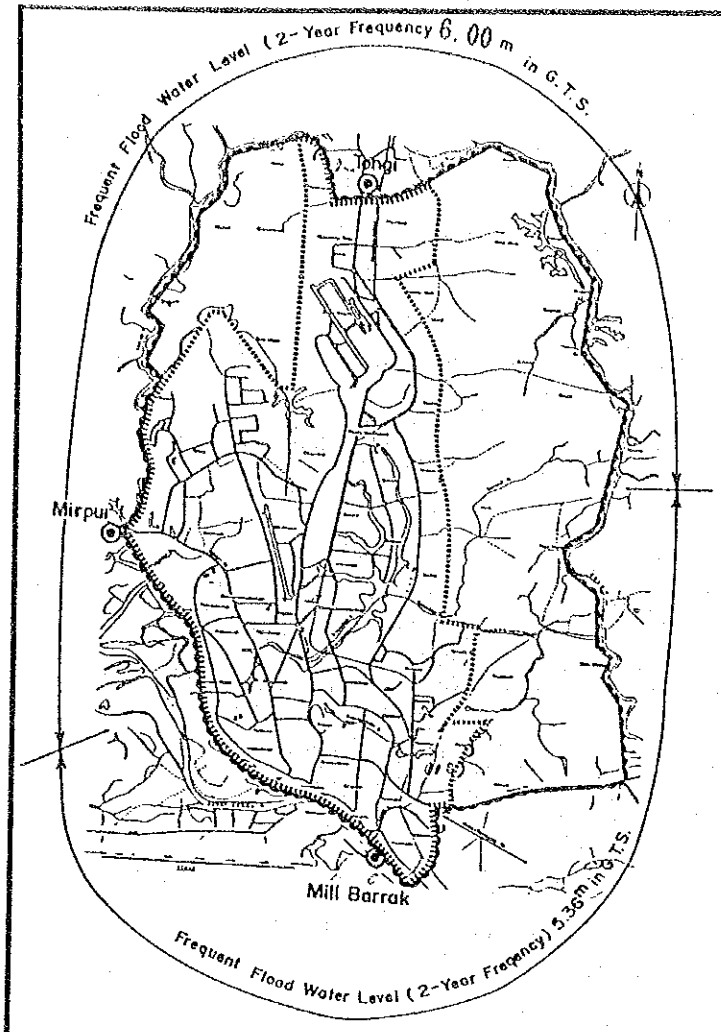
Note : (1) Costs with (*) in the B zone are included in the World Bank Project
(2) Upper figure in the cell shows quantity of work. Lower figure is construction cost.

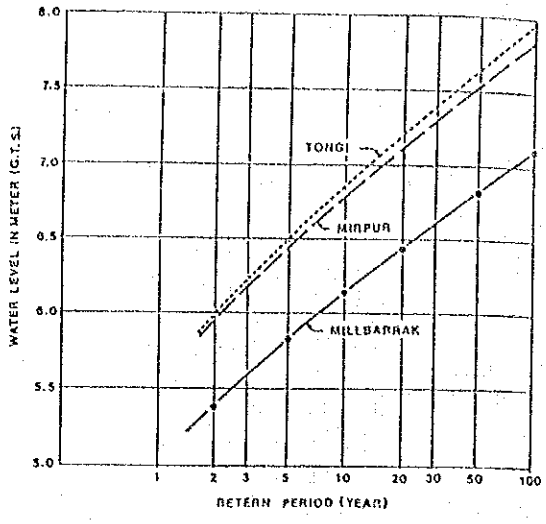
TABLE 4.4 PROPOSED PHASED PROGRAM

Unit : MIllion Tk at 1989 price

ZONE	WORKS	PHASE I		PHASE II		REMARKS
A	(1)Drainage Pipe			L=3.80km	127.5	.S1,S2,S3,S4
	(2)Khal Improvement	-		L=0.30km	6.3	.K1
	(3)Sluice Gate			n=4places	63.5	
	(4)Land Acquisition			A=0.10ha	4.8	
B	(1)Drainage Pipe			L=4.28km	295.2	.S5,S6
	(2)Khal Improvement	*				.K2,K3
	(3)Pump Station	*				
	(4)Sluice Gate	*		n=1place	6.0	
	(5)Land Acquisition	*				
C	(1)Drainage Pipe			L=4.81km	206.3	.S7,S8,S9,S10
	(2)Khal Improvement	L=5.30km	593.9	L=1.00km	17.5	.I=K4,K5,II=K6
	(3)Land Acquisition	A=2.60ha	80.8	A=0.3ha	4.8	
D	(1)Drainage Pipe			L=0.70km	29.5	.S11
	(2)Khal Improvement	-		L=4.45km	80.9	.K7,K8
	(3)Land Acquisition			A=1.20ha	19.2	
E		-		-		
F	(1)Drainage Pipe			L=3.41km	117.0	.S12,S13,S14
	(2)Khal Improvement	L=3.50km	755.3			.K9,K10,K11
	(3)Land Acquisition	A=1.10ha	36.8			
G	(1)Khal Improvement	-		L=2.90km	44.0	.K12,K13
	(2)Land Acquisition			A=1.20ha	19.2	
H	(1)Khal Improvement	L=3.30km	24.0	L=8.70km	207.1	.I=K14
	(2)Pump Station	L=10.0m3/s	226.7	Q=10.0m3/s	226.7	II= K15,K16
	(3)Sluice Gate	n=1place	50.9			K17,K18,K19
	(4)Land Acquisition	A=5.30ha	68.0	A=3.10ha	46.4	K20
I	(1)Khal Improvement			L=6.9km	204.1	.K21,K22,K23
	(2)Pump Station	-		Q=4.5m3/s	171.1	K24,K25
	(3)Sluice Gate			n=1place	15.1	
	(4)Land Acquisition			A=3.1ha	37.2	
J		-		-		
	. Sub-Total	1835.6		1949.4		
	. Contingency and Engineering	336.4		357.3		
	TOTAL	2172.0 Million Tk		2306.7 Million Tk		4478.7 M.Tk

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



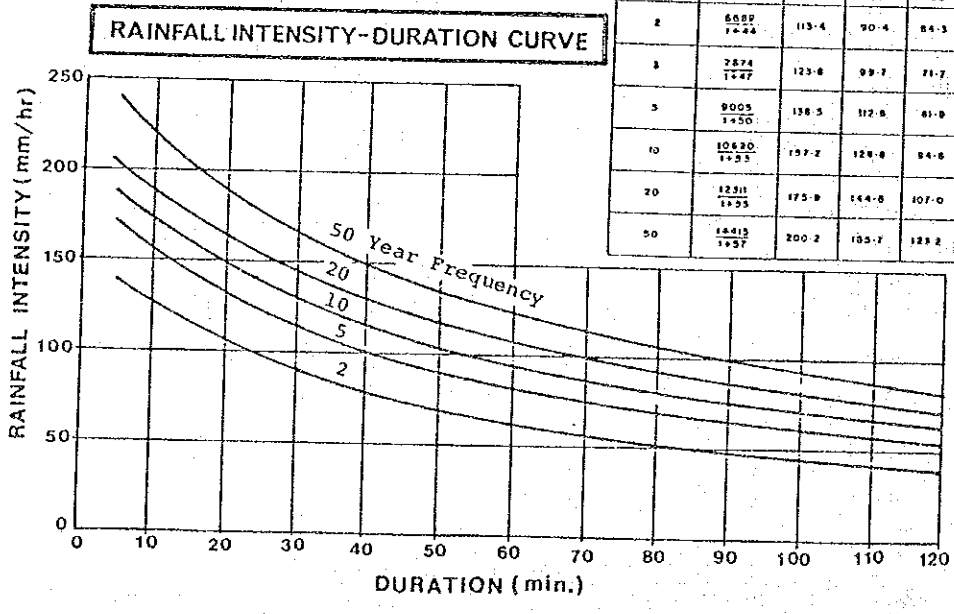


W.L. (m) : G.T.S.

Return Period in Year	MILL BARRAK	MIRPUR	TONGI
2	5.36	5.96	6.00
3	5.58	6.18	6.24
5	5.83	6.45	6.51
10	6.13	6.79	6.87
20	6.43	7.12	7.21
30	6.60	7.30	7.40
50	6.81	7.54	7.65
100	7.10	7.85	7.97

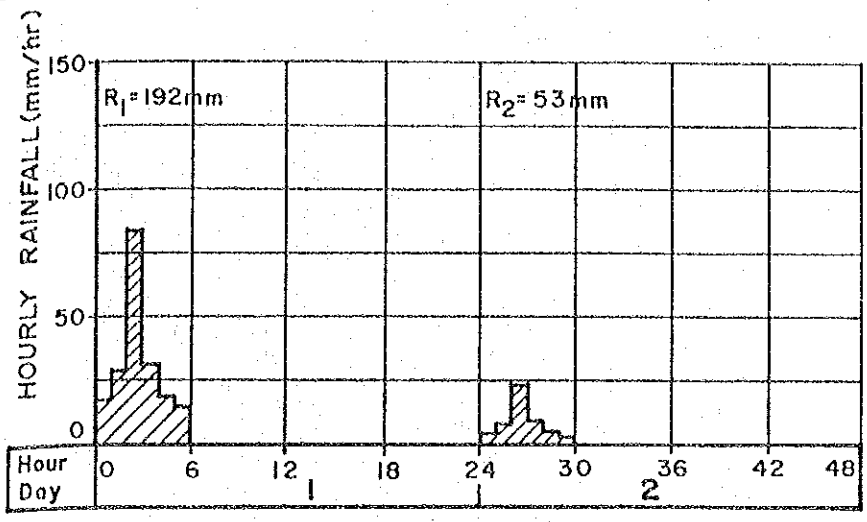
RAINFALL INTENSITY-DURATION FORMULA

RETURN PERIOD	EQUATION	RAINFALL INTENSITY			
		15	30	60	120
2	$\frac{6689}{T+44}$	113.4	90.4	64.3	40.8
3	$\frac{7874}{T+47}$	123.8	99.7	71.7	45.0
5	$\frac{9005}{T+50}$	136.5	112.6	81.9	53.0
10	$\frac{10630}{T+55}$	157.2	128.8	94.6	61.8
20	$\frac{12311}{T+55}$	175.9	144.6	107.0	70.3
50	$\frac{14413}{T+57}$	200.2	165.7	123.2	81.4



Source:Study on Storm Water Drainage System Improvement Project in Dhaka City by JICA in October 1987

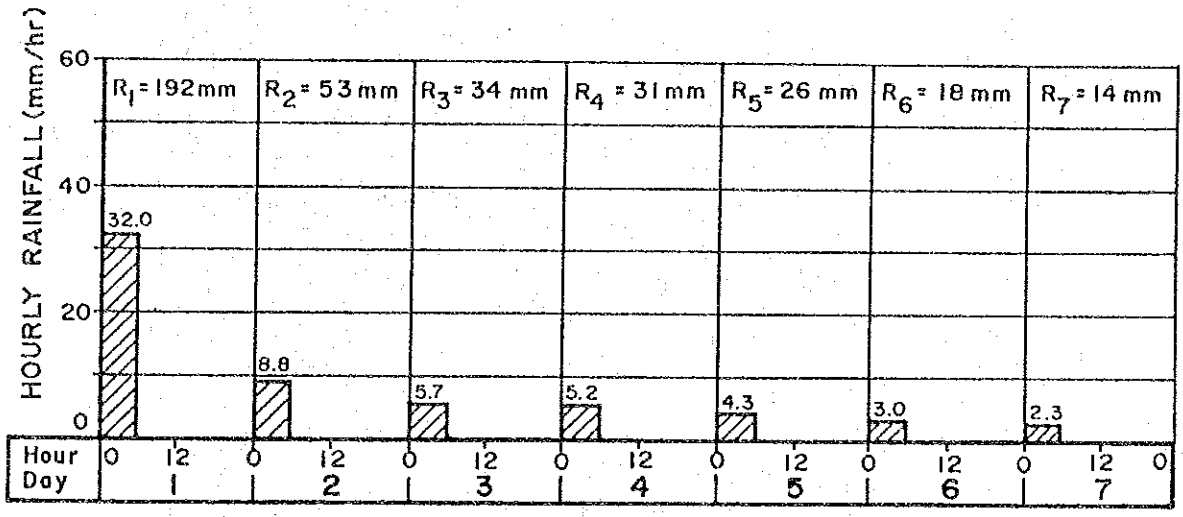
FIG. 4.1 DESIGN FREQUENCY OF FLOOD WATER LEVEL AND RAINFALL FOR KHAL IMPROVEMENT/DRAINAGE PIPE



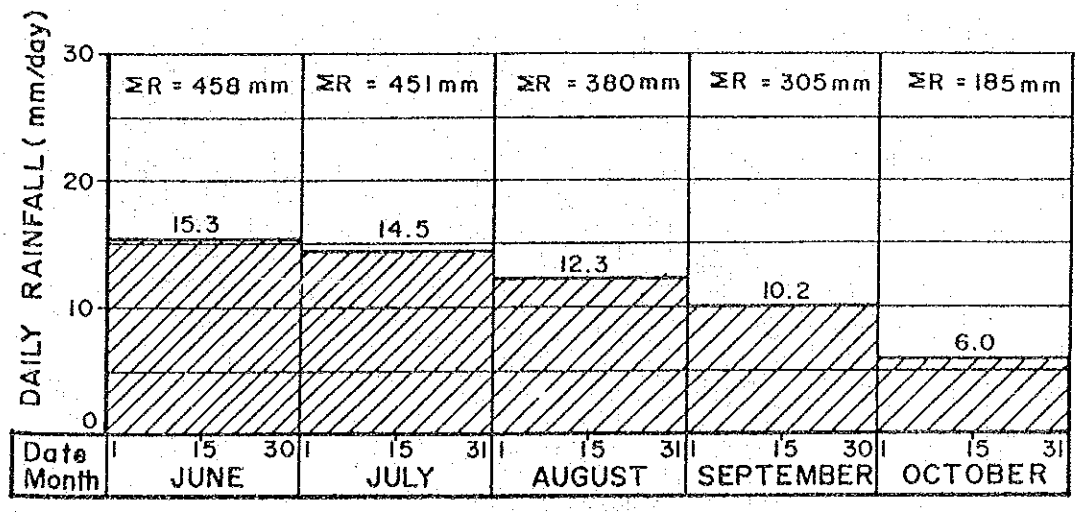
2-DAY CONSECUTIVE DESIGN RAINFALL

HOURLY DISTRIBUTION

hr	%	R1	R2
1	9	17.4	4.8
2	15	28.3	8.0
3	44	82.8	23.2
4	16	30.6	8.5
5	9	18.0	5.0
6	7	14.9	3.5
TOTAL	100	192.0	53.0



WEEKLY DESIGN RAINFALL



MONTHLY DESIGN RAINFALL

FIG. 4.2 DESIGN RAINFALL FOR PUMP DRAINAGE

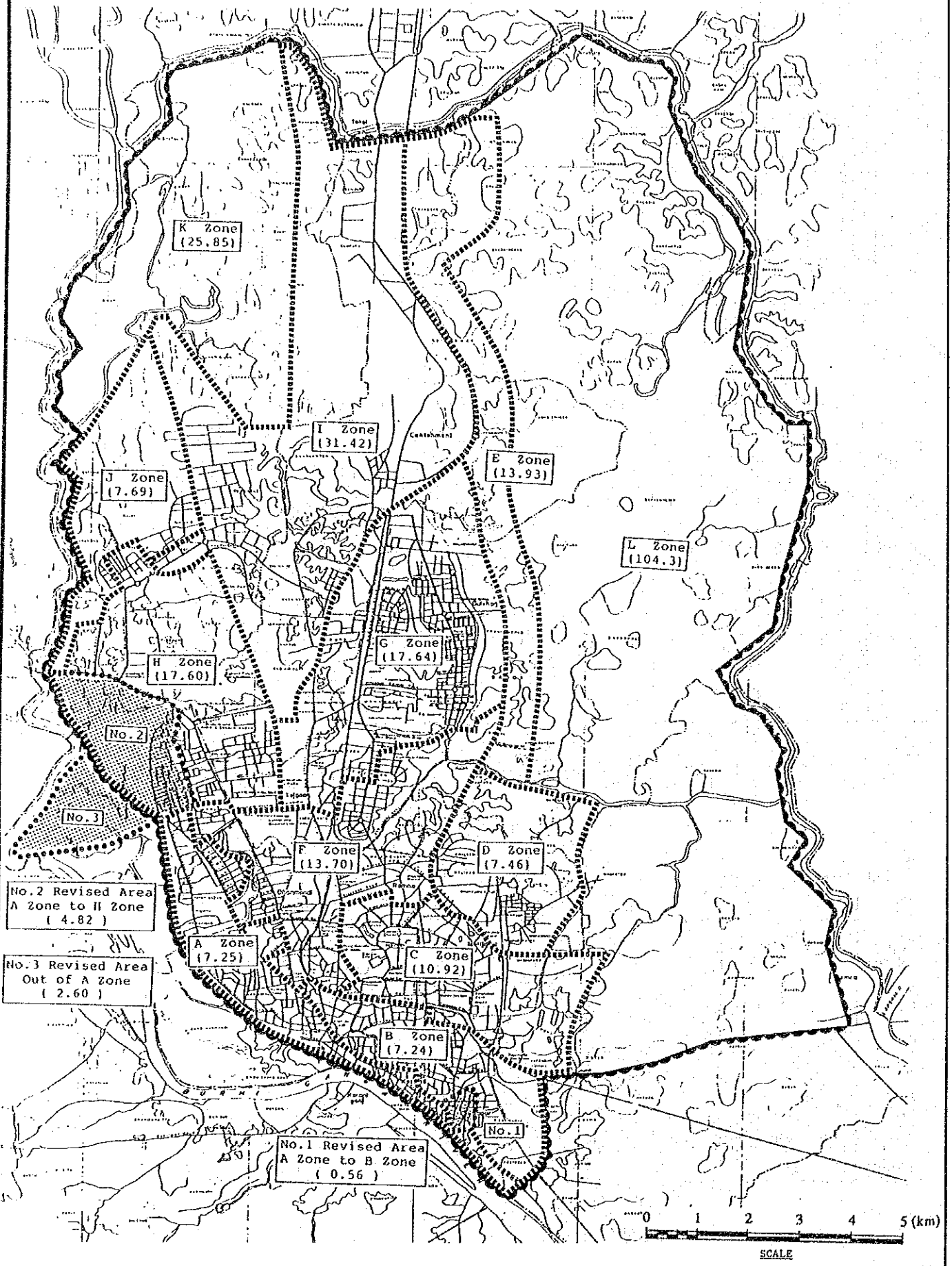
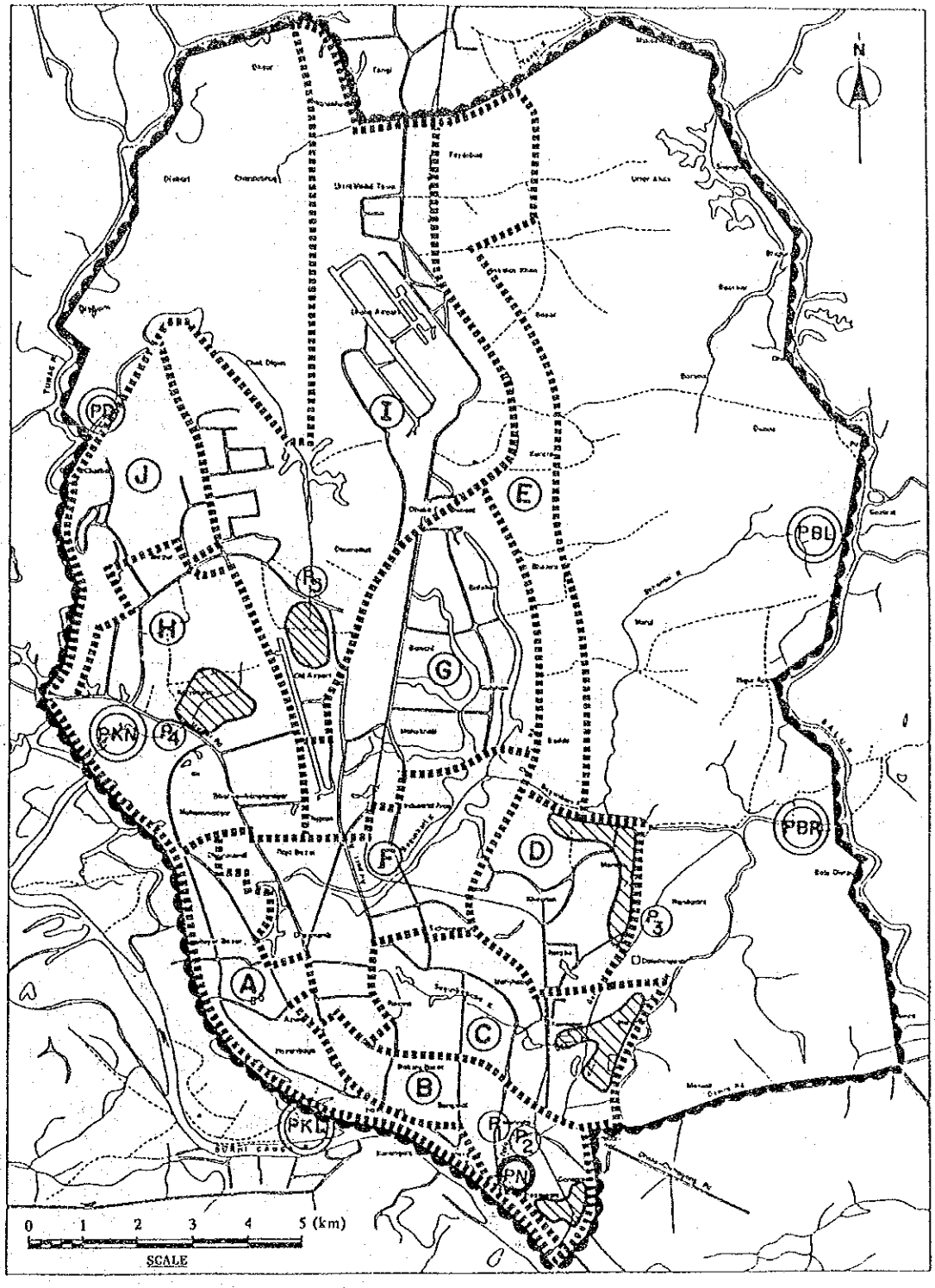


FIG. 4.3 REVISED DRAINAGE AREA

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

JICA A.D 1990



LEGEND

(A)~(J) : Drainage Zone

(P1)-(P5) : Pump Station Proposed by Previous JICA Study

: Regulating Pond Proposed by Previous JICA Study

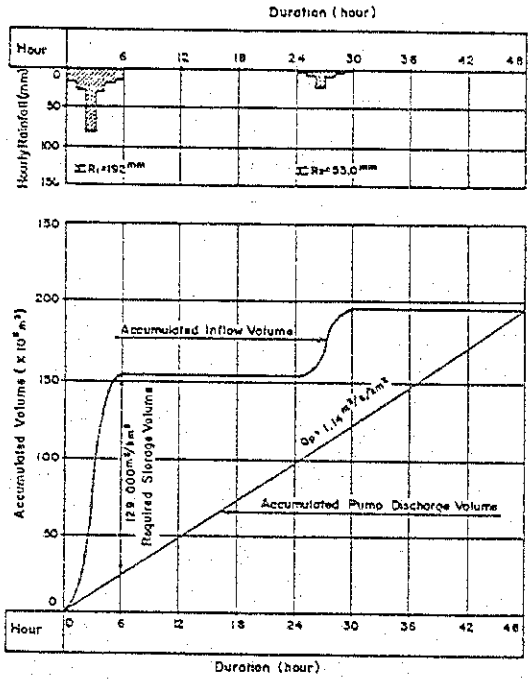
(PD) : Pump Station Proposed by GDFCD Project

(PN) : Pump Station Proposed by World Bank Project

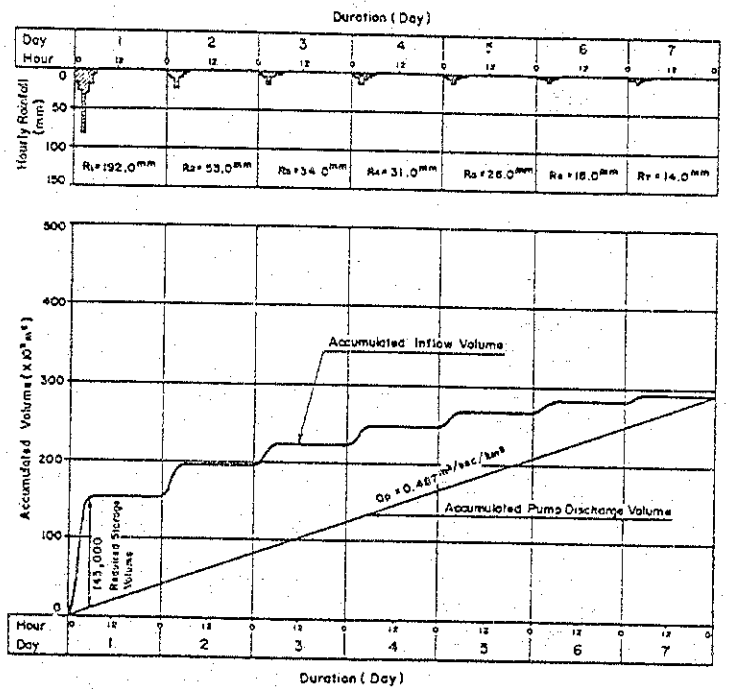
FIG. 4.4 LOCATIONS OF PUMP STATIONS PROPOSED BY RELATED ONGOING PROJECTS

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

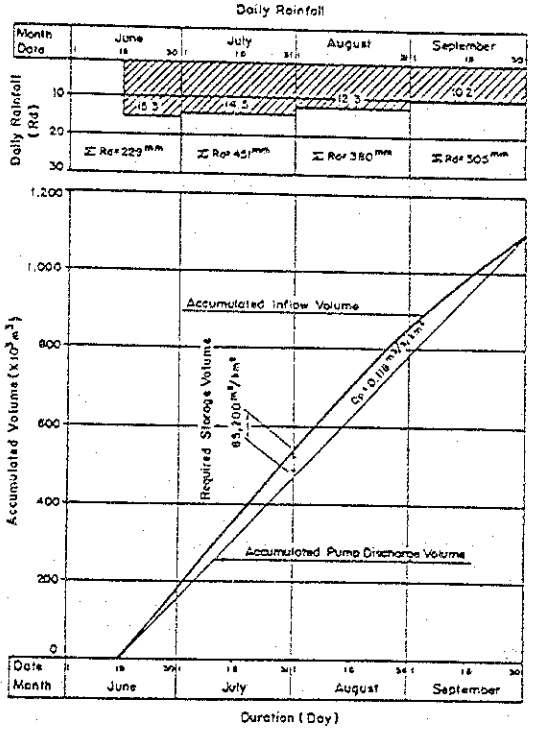
JICA A.D 1990



2-DAY CONSECUTIVE RAINFALL
WITH 5-YEAR FREQUENCY



WEEKLY RAINFALL
WITH 5-YEAR FREQUENCY



MONTHLY RAINFALL
WITH 5-YEAR FREQUENCY

FIG. 4.5 SPECIFIC REQURIED PUMP AND REGULATING POND CAPACITIES

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

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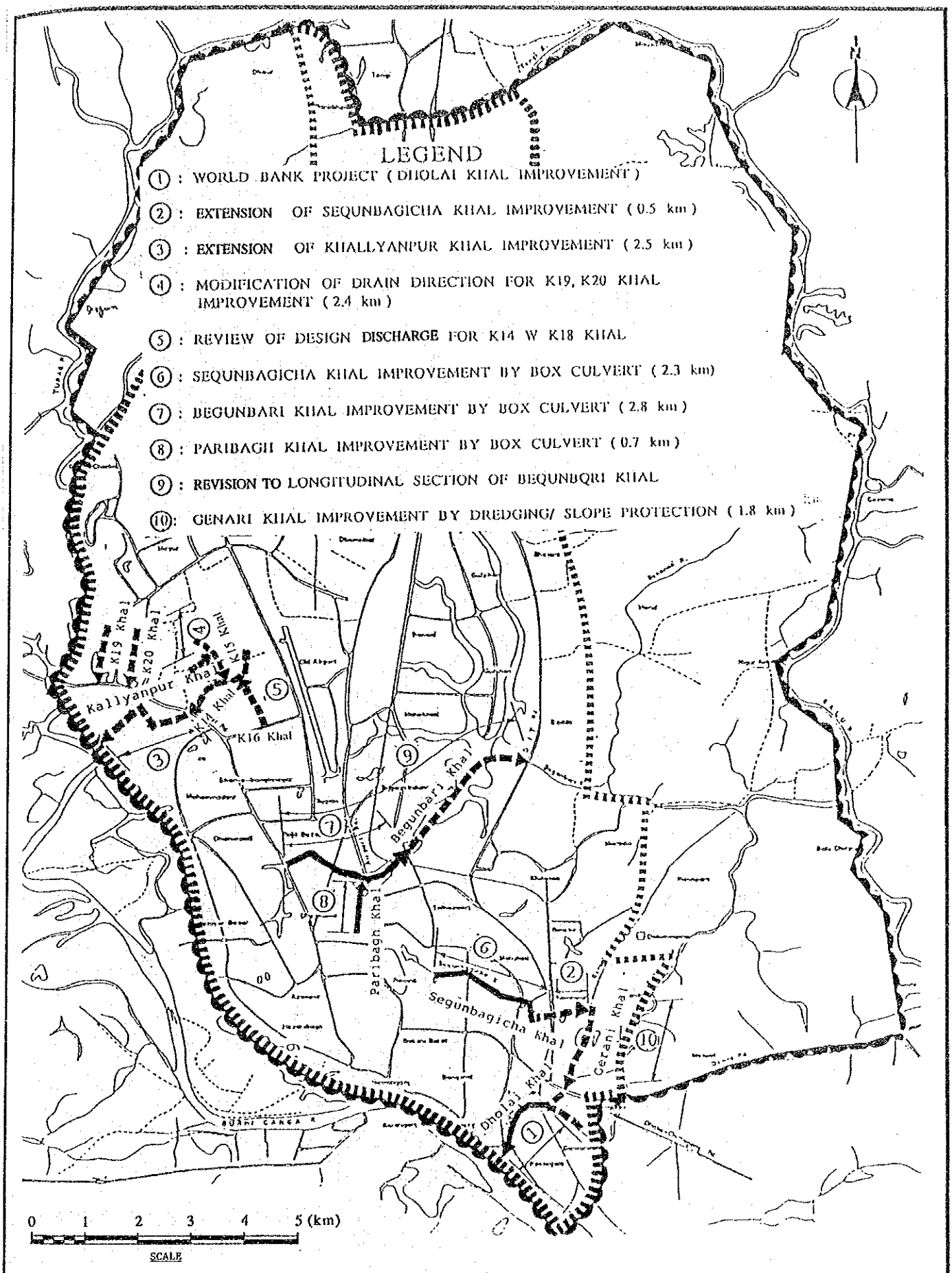

FIG. 4.6 LOCATION OF REVISED KHAL IMPROVEMENT

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

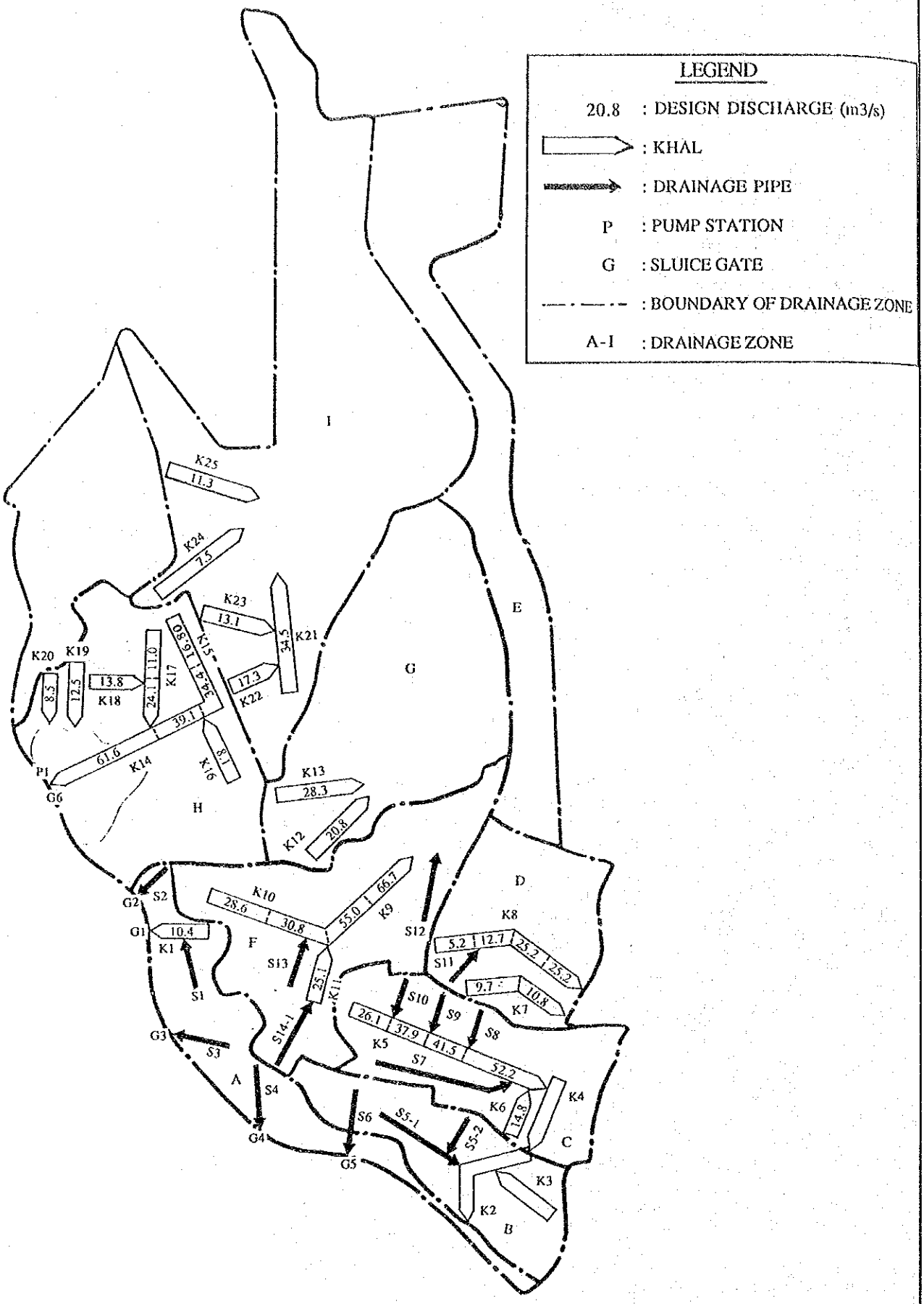

FIG. 4 . 7 DESIGN DISCHARGE OF KHAL IMPROVEMENT

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

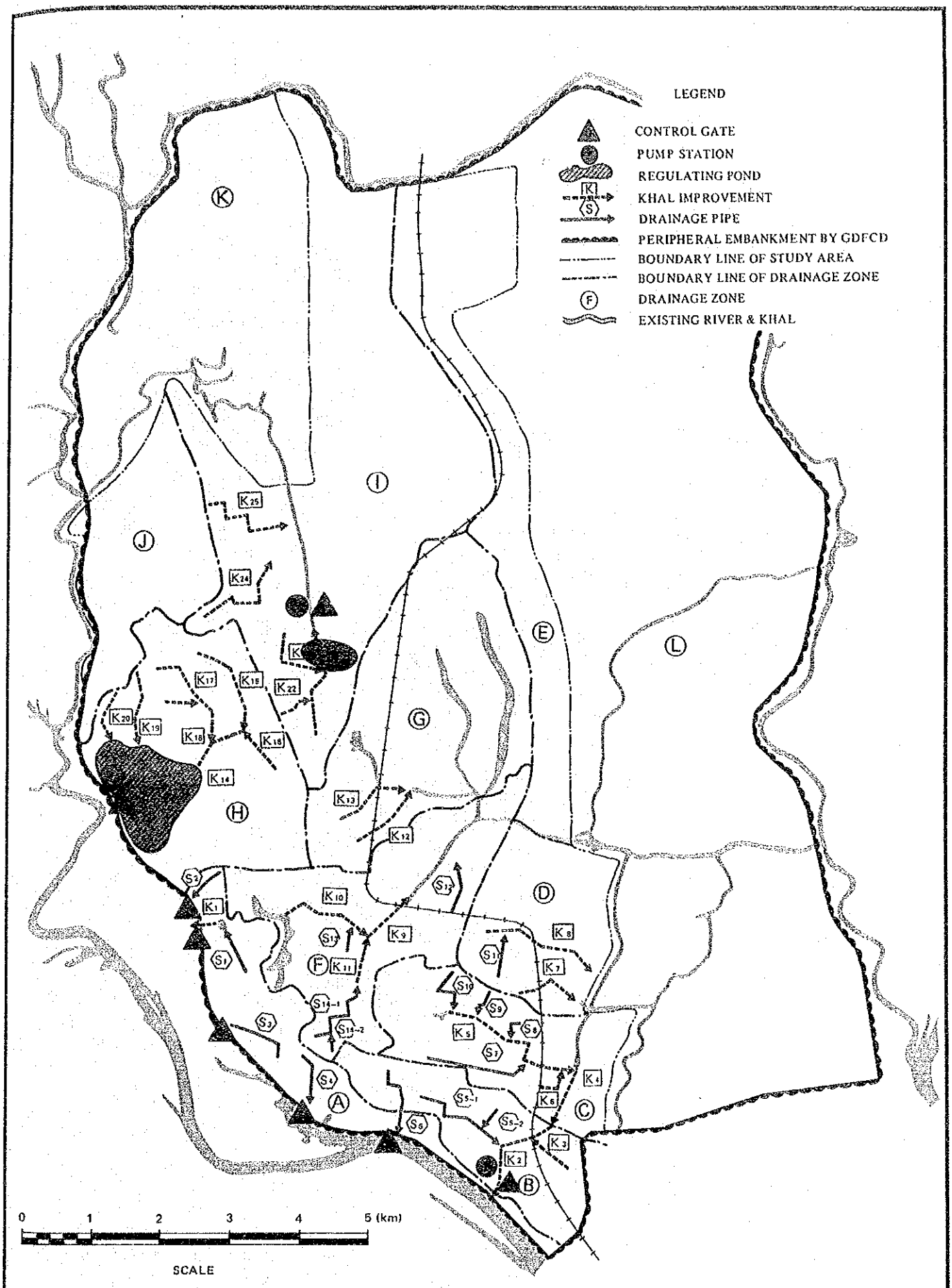

FIG. 4. 8 PROPOSED FACILITIES

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

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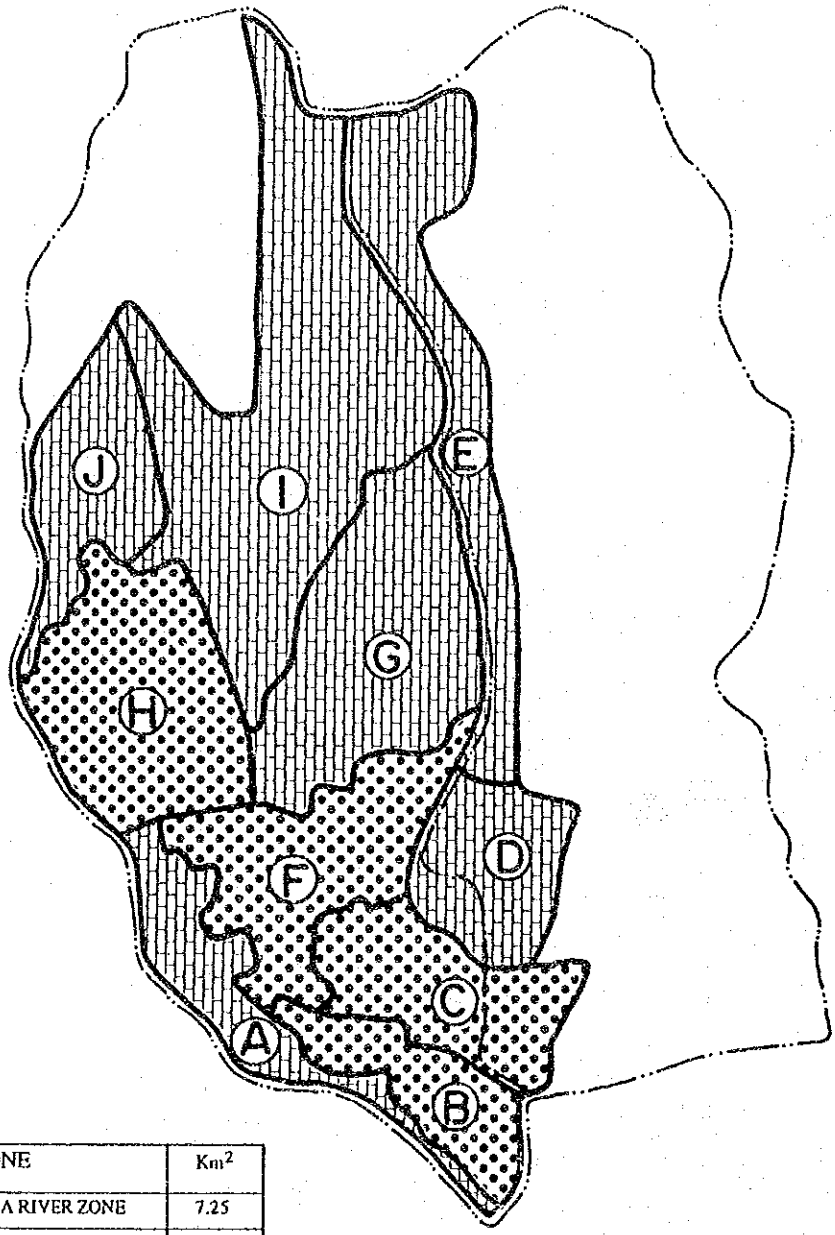


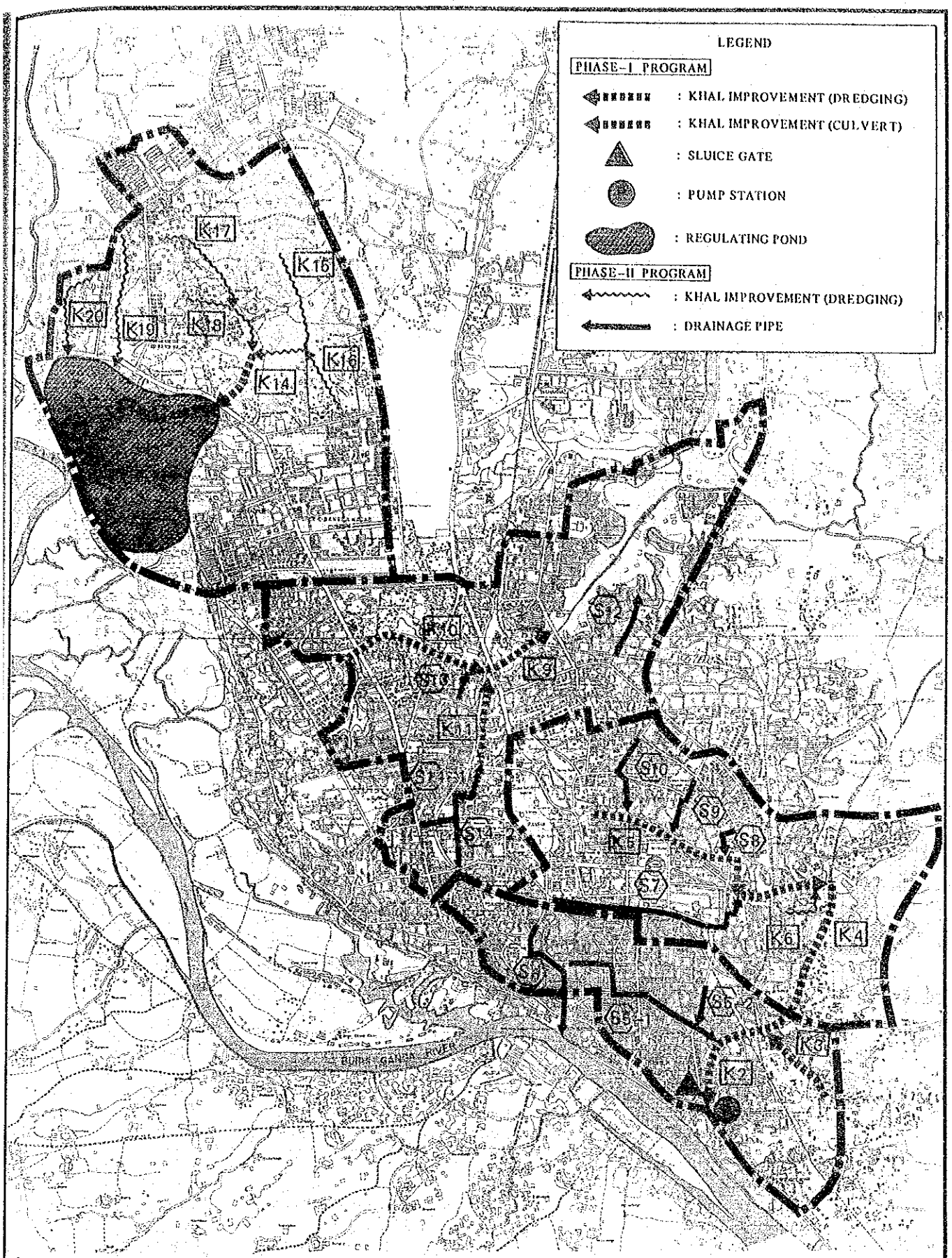
DRAINAGE ZONE		Km^2
A	BURIGANGA RIVER ZONE	7.25
B	DHOLAI KHAL ZONE	7.24
C	SEGUNBAGICHA KHAL ZONE	10.92
D	BASHABO ZONE	7.46
E	NORTH EAST EDGE ZONE	13.93
F	BEGUNBARI KHAL ZONE	13.70
G	GULSHAN-BANANI ZONE	17.64
H	KALLYANPUR ZONE	17.60
I	NORTH ZONE	31.42
J	TURAG RIVER BANK ZONE	7.69
	TOTAL DRAINAGE AREA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

LEGEND

: First Priority Area

: Second Priority Area

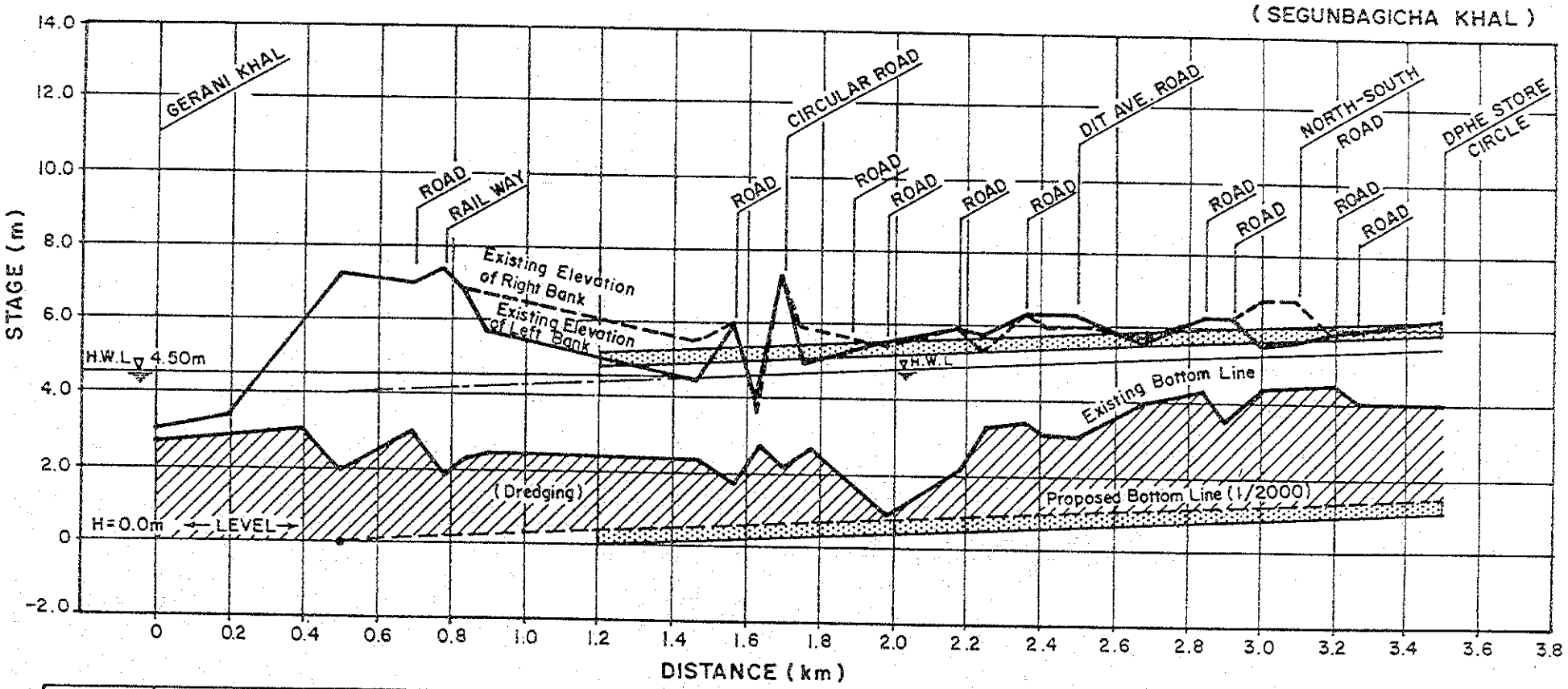
FIG. 4 . 9 PRIORITY SEQUENCE OF DRAINAGE ZONE



Note: The khal improvement works; K_2 and K_3, and construction of a pump station with gate in the B-zone, are included in the World Bank Project.

FIG. 4.10 LOCATIONS OF PROPOSED DRAINAGE FACILITIES IN PHASE – I PROGRAMME

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



Section No.	K-5-1	K-5-2	K-5-3	K-5-4	K-5-5

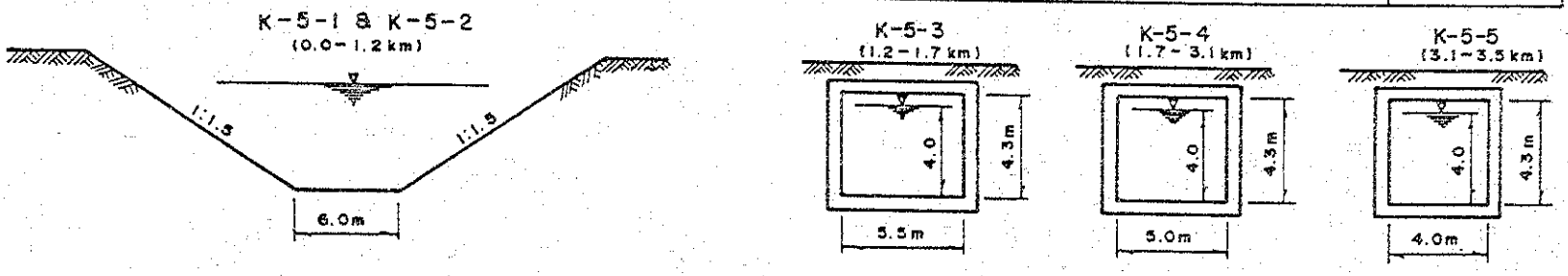
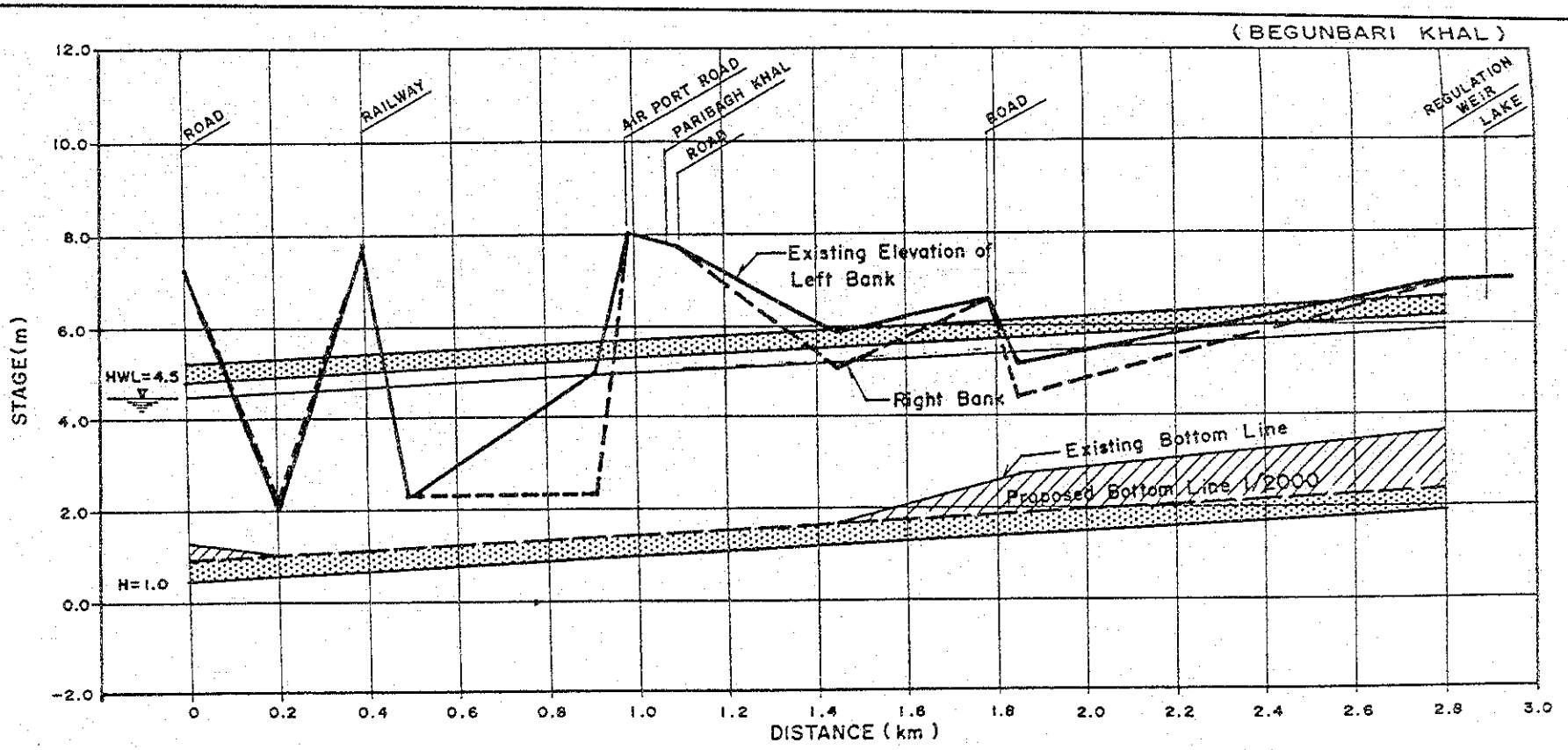


FIG. 4. 11 PROPOSED LONGITUDINAL AND CROSS SECTIONS OF SEGUNBAGICHA KHAL

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

JICA A.D 1990



Section No.	K-14-1	K-14-2	K-14-3	K-14-4

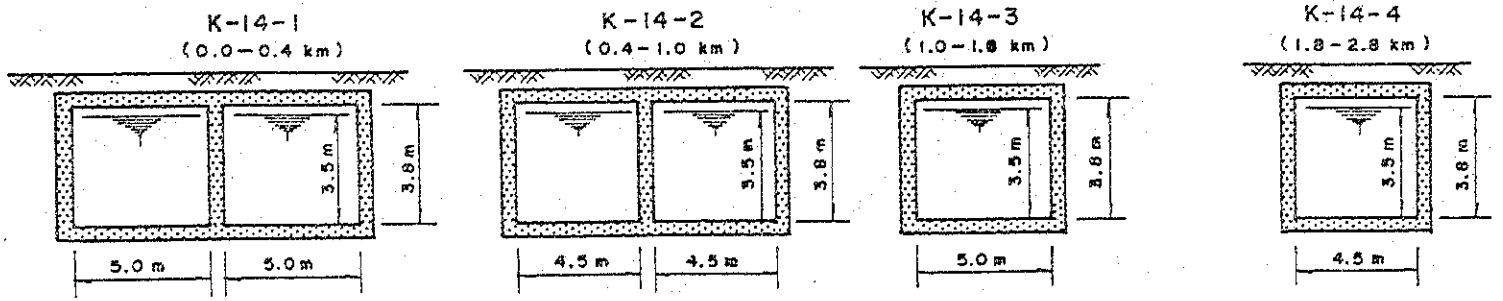
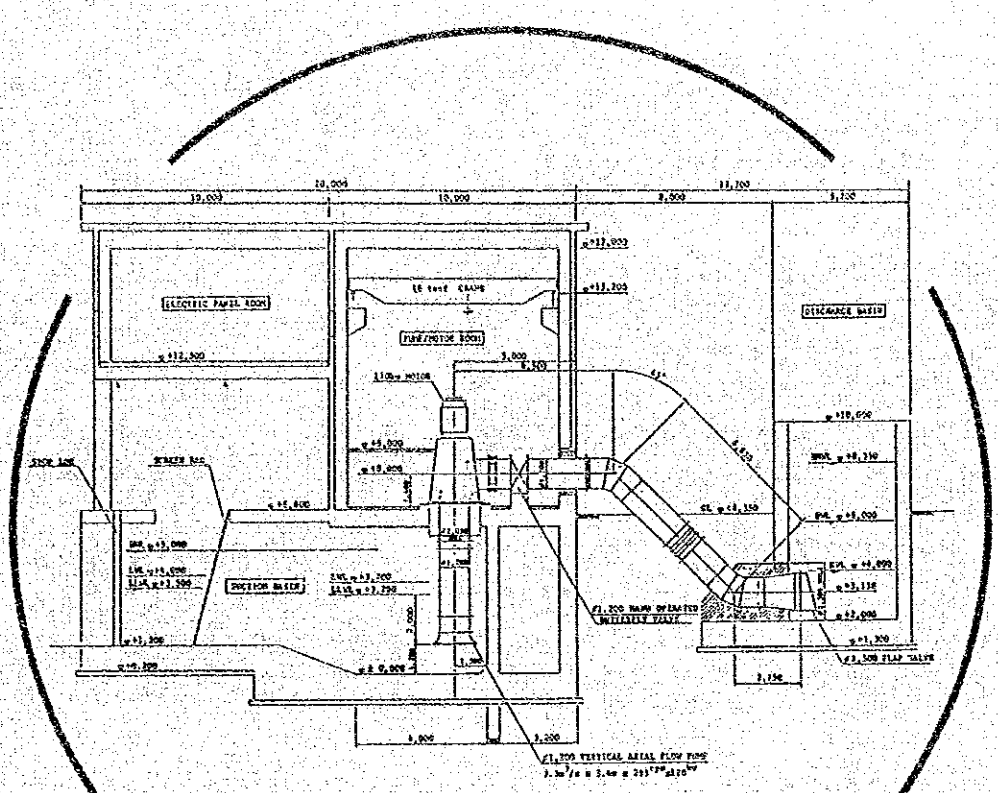


FIG. 4.12 PROPOSED LONGITUDINAL AND CROSS SECTIONS OF BEGUNBARI KHAL

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



PUMP STATION
IN KALLYANPUR

CHAPTER 5

URGENT PROJECT

CHAPTER 5 URGENT PROJECT

5.1. GENERAL

By taking into account the priority sequence of the drainage zones as well as the drainage facilities as outlined in the previous chapter, the implementation of the construction of phasing programs I and II is discussed.

In this chapter, the work requiring urgent implementation will be identified from the proposed phase I programme after which the preliminary design will be conducted for the work selected.

5.2. IDENTIFICATION OF URGENT PROJECT

To facilitate the selection of the urgent work, already planned and/or designed by concerned agencies and the postponable work of whose implementation is less urgent, will be deducted from the Phase I programme. The detailing of the ongoing and postponable work is described below:

1) The Begunbari khal improvement work of installing a 1,000 m long culvert between Mirpur and Green roads will be undertaken by RAJUK's ongoing programme during the construction of the proposed road.

2) The Begunbari khal improvement work of installing a 600 m long culvert between Airport road and the Railway will be undertaken by WASA's ongoing programme.

3) The Paribagh khal improvement work of installing a 700 m long culvert will be undertaken by DWASA's ongoing programme.

4) Because they are less urgent, the following three sections of khal improvement by installing culvert are postponable from the urgent work. The implementation of these improvements will be undertaken by DWASA as Phase I work in the near future.

   - 400 m of the Begunbari khal between the Railway and the Tongi Diversion road.

- 400 m of the Segunbagicha khal between the DPHE store circle and the North-South road. The dredging work for improving the khal's flow capacity will be included in the urgent work.

- 500 m of the Segunbagicha khal between the Circular road and the Bangladesh Bank building. The dredging work for improving the khal's flow capacity will be included in the urgent work.

A total of 3,600 m of culvert construction work is deducted form the Phase I work. The urgent work is identified below:

		Phase-I work		Urgent work (Percentage of Phase-I)		
1)	River Dredging:	7,200	m	7,200	m	(100%)
2)	Slope Protection:	1,000	m	1,000	m	(100%)
3)	Channel Culvert:	5,800	m	2,200	m	(38%)
4)	Bridge Culvert:	5	places	5	plc.	(100%)
5)	Pump Station:	10	m^3/s	10	m^3/s	(100%)
6)	Sluice Gate:	1	place	1	plc.	(100%)

The proposed urgent work in the drainage zones C, F and H are shown in Tables 5.1 and 5.2 and Fig. 5.1. The locations are shown in Fig. 5.2.

5.3 PRELIMINARY DESIGN

5.3.1 Pump Station

The pump facilities shall be principally designed to the required capacity at the actual head of 2.00 m between HWL + 6.00 m and LWL + 4.0 m of the river and the pond respectively. Even if the discharge efficiency is decreased, the pump facility shall be designed to discharge within the range of the actual heads of 3.35 m and 2.50 under the water level conditions shown below:

Pump's actual head		River side WL	Pound side WL
(1)	2.00 m	+ 6.00 m (HWL)	+ 4.00 m (LWL)
(2)	2.50 m	+ 6.00 m (HWL)	+ 3.50 m (LLWL)
(3)	3.35 m	+ 8.35 m (HHWL)	+ 5.00 (HWL)

Based on the actual pump head of 2.0 m and a total flow of 10.0 m^3/s proposed in the urgent stage, the use of the vertical axial flow pump type is proposed. For pumping large flows over low heads, it is common to envisage other various pump types: horizontal axial (mixed) flow; vertical mixed ; submersible flow; and screw pump types. Considering pumping efficiency, operation and maintenance characteristics and construction cost, these pump types are less suited for the Kallyanpur pump station.

The three (3) pump units each having a 3.3 m^3/s capacity, are provided by taking into account the operational risk and construction cost. The pumps will be operated by electric motors of 180 kw capacity each. A backup electric for power source will be provided to handle emergencies such as power failures.

The basic hydraulic requirements and main features incorporated into the design of the pump equipment are shown in Table 5.3.

A pump station's main building will be a two-storied RC-framed brick wall structure. The building will contain the necessary space for a pump/motor equipment room, an electrical panel room, a repair workshop, a storeroom for tools and spare parts, a control room and a toilet. A 90 m^2 RC-framed brick wall sub-building having a resting room and a meeting room will be constructed for use by the staff personnel who will be needed for the continuous operation of the pump during rainy seasons.

At the construction site, a silt layer of soft-medium stiff overlying stiff sand layers is found at a depth of 12 m from the ground surface of +5.0 m GTS. Considering the total weight of the pump station it will be necessary to provide a pile foundation. Approximately 100 piles having a load capacity of 35 ton/pile will be required.

The general layout of a pump station associated with a sluice gate is shown in Fig. 5.3; the typical design of civil works is shown in Fig. 5.4.

5.3.2 Sluice Gate

The sluice gate associated with the pumping station consists of a 60 m long gate-culvert lying under the flood protection dike, and two gate leaves at the inlet and the outlet of the gate-culvert as shown in Fig. 5.3. Since the pump discharge basin is connected to the gate-culvert between both gates, the outlet gate is fully opened and the inlet gate is closed for pump discharge during rainy seasons . In case there is no rain in spite of higher water level in the river, both gates are fully closed for flood protection, i.e., the