Flood Damage Records

	1987 Flood	1988 Flood
No. of Affected people	964,651	2,233,418
No. of Human Deaths	68	149
No. of Damaged Houses	95,009	268,042
No. of Damaged Schools	690	878
Length of Damaged Roads (km)	1,333	2,106
Area of Damaged Crops (ha)	19,729	29,377
No. of Livestock Deaths	2,968	2,356
Amount of flood Damages (million Tk.)	347	781

The above figures were found to be lower than the results of the detailed analysis based on data collected through the flood damage sample survey.

5.3.2 Estimated Flood Damages

1) Affected Population

The total population within the study area is estimated at 6,534,316 in 1990. If a 1987 (or 1988) size external flood had hit the study area in 1990, the numbers of affected population would have been as follows :

	1987 Scale Floods		1988 Scale Floods	
The Study Area	2,403,055	(36.8%)	3,751,456	(57.4%)
Dhaka	1,459,061	(32.6%)	2,432,305	(54.4%)
Narayanganj	277,144	(25.0%)	484,934	(43.7%)
Keraniganj	430,943	(97.5%)	441,788	(100.0%)
Savar	182,597	(49.9%)	261,427	(71.4%)
Tongi	53,310	(37.3%)	131,002	(91.6%)

In addition, internal floods would have affected 594,499 people or 13.3% in Dhaka. Similarly, the flood would have affected 52,337 people (4.7%) and 17,657 people (12.3%) in Narayanganj and Tongi, respectively. The two areas of Keraniganj and Savar would not have been affected. (Refer to Table 5.3.)

In the event that the flood protection and drainage project was not implemented by 2010, it is estimated that 5,700,984 people out of the population of 13,431,147 would be affected if a 1987 size external flood hit the study area. These numbers are 2.37 times larger than those in 1990.

Similarly, 8,532,717 people would be affected if a 1988 size external flood hit the study area in 2010. These numbers are 2.27 times larger than 1990.

In addition, 1,066,390 people would be affected if an internal flood hit the study area in 2010, 1.60 times larger than 1990.

For areal breakdown of the affected population in 2010, refer to Table 5.3.

2) Number of Properties in Inundation Areas

If a 1987-scale flood had affected the study area in 1990, 414,304 houses would have been inundated. This number corresponds to 37.7% of the total number of houses in the study area in the same year. 12,051 shops and 2,316 factories would also have been inundated, together corresponding to 29.4% of all shops and factories. In addition, 10,507 institutions would have been affected, accounting for 25.2% (Refer to Table 5.4.)

If the study area had been affected by a 1988-scale flood in 1990, the number of inundated houses would have reached 642,939 or 58.5%. Similarly, the number of inundated shops and factories would have reached 20,683 and 4,595, respectively, together accounting for 51.8% of the total, while the number of inundated institutions would have been 19,834 or 47.7%.

For areal distribution of inundated properties in 1990, refer to Table 5.4.

If flood protection and drainage projects were not implemented by the year 2010, 989,321 houses, 24,882 shops, 6,265 factories and 26,596 institutions in the study area would be inundated under a 1987-scale flood. 1,471,340 houses, 42,225 shops, 13,250 factories and 47,404 institutions would be inundated in a 1988-scale flood.

Area-wise breakdown of properties which would be inundated in 2010 is also shown in Table 5.4.

3) Estimated Damages in 1990 and in 2010

The questionnaire survey was intended to find a relationship between the depth/duration of inundation and the flood damage to household assets, shops and factories, and income losses for households, shops and factories.

External flood damages were estimated for the base year of 1990 and the target year of 2010, in cases of both 1987-scale floods and 1988-scale floods. Internal flood damages were estimated for 1990 and 2010, in cases of both annual floods and worst floods. Based on the probability density functions, average annual flood damages for 1990 and 2010 were estimated.

External flood damage of a 1987 scale flood and a 1988 scale flood in 1990 and in 2010 are estimated and shown in Table 5.5 and 5.6. Internal flood damage of an annual flood and a worst flood in 1990 and in 2010 are estimated and shown on Table 5.7.

As Table 5.5 shows, the total external flood damage of a 1987 scale flood over the study area would have come to Tk. 3,884.4 million in 1990. Those of a 1988 scale flood would have reached Tk. 13,655.8 million in the same year.

Similarly, as Table 5.6 shows, in the target year of 2010, the total external flood damage of a 1987 scale flood over the study area would increase 2.72 times to Tk. 10,565.3 million. Those of a 1988 scale flood would increase 2.90 times to Tk. 39,660.7 million in the same year.

Also, as Table 5.7 shows, the total internal flood damage of an annual flood and a worst flood over the Dhaka Area would have come to Tk. 312.4 million and Tk. 663.9 million, respectively in 1990. They are projected to increase to Tk. 600.1 million and Tk. 1,239.4 million, respectively in 2010. These estimates are based on the "Study on Storm Water Drainage System Improvement Project in Dhaka City" conducted by JICA in 1987. Internal flood damages over the Areas other than Dhaka are not immediately available.

4) Average Annual Flood Damage

(1) External Floods

The return period of the 1987 flood and 1988 flood is estimated to be 10 years and 70 years, respectively. Flood damage in annual external floods were found to be insubstantial.
Average annual flood damage potentials as of 1990, work out at Tk 1,707.8 million. (Refer to Table 5.8.)

Distribution of average annual flood damage potentials in the study area is as follows :

Dhaka	:	Tk	1,045.9 million	(61.2%)
Narayanganj	:	Tk	169.0 million	(9.9%)
Keraniganj	:	Tk	289.8 million	(17.0%)
Savar	:	Tk	150.3 million	(8.8%)
Tongi	:	Tk	52.8 million	(3.1%)
Total		Tk	1,707.8 million	

If damage to infrastructure and traffic are considered and added together, average annual flood damage potential over the study area will total Tk 2,049.4 million in 1990.

If no countermeasures were taken to protect the study area against external floods and internal floods up to the year 2010, then average annual flood damage potential would increase 2.75 times to Tk. 4,704.1 million.

Area wise, average annual flood damage potential in the Dhaka area would be Tk 3,057.5 million accounting for 65.0% of the total. Average annual flood damage potential in Narayanganj, Keraniganj, Savar and Tongi would be Tk 441.0 million (9.4%), Tk 638.2 million (13.6%), Tk 301.4 million (6.4%) and Tk 266.0 million (5.7%), respectively.

If damage to infrastructure and traffic are considered and added together, average annual flood damage potential over the study area would total Tk 5,644.9 million in 2010.

(2) Internal Floods

The return period of the worst internal flood is estimated to be 10 years.

Average annual flood damage potentials in the Dhaka Area as of 1990, work out at Tk. 383.3 million. They are projected to increase 1.89 times to Tk. 726.1 million in 2010. (Refer to Table 5.8). Flood damages for the Areas other than Dhaka are not immediately available.

Table 5.1 External Flood Conditions

Annual Flood

Name of Area	Area (ha)	Flood Area (ha)	Flood Depth (m)			Flood Duration (day)		
			Max.	Ave.	Min.	Max.	Ave.	Min.
Dhaka	27,527	11,803	0	0	0	0	0	0
Narayanganj	10,095	1,635	0	0	0	0	0	0
Keraniganj	17,035	14,416	0	0	0	0	0	0
Savar	24,318	10,641	0	0	0	0	0	0
Tongi	3,767	1,242	0	0	0	0	0	0
Study Area	82,742	39,737	0	0	0	0	0	0

1987 Flood

Name of Area	Area (ha)	Flood Area (ha)	Flood Depth (m)			Flood Duration (day)		
			Max.	Ave.	Min.	Max.	Ave.	Min.
Dhaka	27,527	16,917	1.65	0.51	0	32.0	12.4	0
Narayanganj	10,095	2,459	1.04	0.30	0	22.0	8.3	0
Keraniganj	17,035	16,685	1.13	0.40	0	21.0	10.3	0
Savar	24,318	11,714	1.07	0.43	0	20.0	10.4	0
Tongi	3,767	1,427	0.74	0.43	0	15.0	6.7	0
Study Area	82,742	49,202	1.65	0.42	0	32.0	10.5	0

1988 Flood

Name of Area	Area (ha)	Flood Area (ha)	Flood Depth (m)			Flood Duration (day)		
			Max.	Ave.	Min.	Max.	Ave.	Min.
Dhaka	27,527	21,456	3.20	0.94	0	65.0	22.8	0
Narayanganj	10,095	4,030	1.89	0.79	0	40.0	21.5	0
Keraniganj	17,035	17,035	2.65	1.24	0	45.0	23.9	0
Savar	24,318	16,071	2.21	1.11	0	40.0	20.2	0
Tongi	3,767	3,454	1.91	0.80	0	40.0	16.8	0
Study Area	82,742	62,046	3.20	1.03	0	65.0	22.1	0

Table 5.2 Internal Flood Conditions

Annual Flood

Name of Area	Area (ha)	Flood Area (ha)	Flood Depth (m)			Flood Duration (day)		
			Max.	Ave.	Min.	Max.	Ave.	Min.
Dhaka	27,527	1,013	0.61	0.38	0	0.9	0.6	0
Narayanganj	10,095	514	0.61	0.07	0	0.8	0.3	0
Keraniganj	17,035	0	0	0	0	0	0	0
Savar	24,318	0	0	0	0	0	0	0
Tongi	3,767	450	0.35	0.19	0	0.5	0.4	0
Study Area	82,742	1,977	0.61	0.38	0	0.9	0.6	0

Worst Flood

Name of Area	Area (ha)	Flood Area (ha)	Flood Depth (m)			Flood Duration (day)		
			Max.	Ave.	Min.	Max.	Ave.	Min.
Dhaka	27,527	1,051	4.00	0.48	0	6.0	1.4	0
Narayanganj	10,095	514	2.00	0.41	0	7.0	3.1	0
Keraniganj	17,035	0	0	0	0	0	0	0
Savar	24,318	0	0	0	0	0	0	0
Tongi	3,767	450	1.88	0.44	0	4.0	1.9	0
Study Area	82,742	2,015	0.61	0.38	0	7.0	1.5	0

Table 5.3 Affected Population in 1990 and 2010

1990

(Unit : Persons)

Area	External Flood		Internal Flood	Total Population
	1/10 Return Period	1/70 Return Period		
Dhaka	1,459,061 (32.6%)	2,432,305 (54.4%)	595,482 (13.3%)	4,472,633
Narayanganj	277,144 (25.0%)	484,934 (43.7%)	52,020 (4.7%)	1,110,616
Keraniganj	430,943 (97.5%)	441,788 (100.0%)	0 (0.0%)	441,788
Savar	182,597 (49.9%)	261,427 (71.4%)	0 (0.0%)	366,270
Tongi	53,310 (37.3%)	131,002 (91.6%)	17,234 (12.1%)	143,009
TOTAL	2,403,055 (36.8%)	3,751,456 (57.4%)	664,736 (10.2%)	6,534,316

2010

(Unit : Persons)

Area	External Flood		Internal Flood	Total Population
	1/10 Return Period	1/70 Return Period		
Dhaka	3,668,674 (42.7%)	5,483,959 (63.8%)	856,965 (10.0%)	8,588,909
Narayanganj	665,528 (26.0%)	1,083,529 (42.4%)	129,402 (5.1%)	2,558,436
Keraniganj	791,452 (97.4%)	813,191 (100.0%)	0 (0.0%)	813,191
Savar	333,105 (41.0%)	549,059 (67.6%)	0 (0.0%)	811,880
Tongi	242,226 (36.8%)	602,978 (91.5%)	80,022 (12.1%)	658,731
TOTAL	5,700,984 (42.4%)	8,532,717 (63.5%)	1,066,390 (7.9%)	13,431,147

Note : 1. 1987 size external flood : 1/10 return period
1987 size external flood : 1/70 return period
: 2. A percentage means the ratio to the total population.

Table 5.4 Properties in Inundation Area in 1990 and 2000

1990

(Unit : Number)

Name of Areas	1987 - Scale Flood				1988 - Scale Flood			
	Houses	Shops	Factories	Institutions	Houses	Shops	Factories	Institutions
Dhaka	247,700	7,905	665	7,726	410,651	14,027	1,191	14,348
Narayanganj	48,055	1,153	727	1,093	84,680	2,611	1,390	2,117
Keraniganj	77,999	2,221	272	616	79,916	2,312	283	635
Savar	30,701	231	82	295	43,456	381	301	787
Tongi	9,848	542	571	777	24,237	1,352	1,430	1,947
TOTAL	414,304	12,051	2,316	10,507	642,939	20,683	4,595	19,834

2010

(Unit : Number)

Name of Areas	1987 - Scale Flood				1988 - Scale Flood			
	Houses	Shops	Factories	Institutions	Houses	Shops	Factories	Institutions
Dhaka	630,735	16,509	1,092	18,637	933,373	27,171	1,997	30,424
Narayanganj	116,701	1,964	1,788	2,553	190,947	4,345	3,210	4,484
Keraniganj	141,241	3,482	538	1,130	144,983	3,622	561	1,167
Savar	55,824	423	198	671	90,407	822	840	2,291
Tongi	44,820	2,503	2,649	3,606	111,630	6,266	6,641	9,037
TOTAL	989,321	24,882	6,265	26,596	1,471,340	42,225	13,250	47,404

Table 5.5 1987- and 1988 - Scale Flood Damages in 1990

1987 Scale Flood

(Unit : Tk. Million)

Name of Areas	Residential			Commercial			Industrial			Institutional	Agricultural	Total
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	Cp	
Dhaka	1,505.5	106.5	315.5	0.0	0.0	4.3	0.0	0.0	0.0	0.0	456.9	2,388.7
Narayanganj	168.8	4.8	55.8	0.0	0.0	0.6	0.0	0.0	0.0	0.0	124.4	354.4
Keraniganj	472.3	15.1	105.8	0.0	0.0	1.4	0.0	0.0	0.0	0.0	91.2	685.8
Savar	187.0	8.7	40.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	117.6	354.2
Tongi	58.9	2.2	13.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0	26.7	101.3
TOTAL	2,392.5	137.3	531.1	0.0	0.0	6.7	0.0	0.0	0.0	0.0	816.8	3,884.4

1988 Scale Flood

(Unit : Tk. Million)

Name of Areas	Residential			Commercial			Industrial			Institutional	Agricultural	Total
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	Cp	
Dhaka	4,221.1	1,853.9	556.5	100.9	235.5	21.0	49.2	163.0	26.0	443.1	540.7	8,210.9
Narayanganj	770.8	365.4	111.3	19.4	43.4	4.0	58.3	198.0	28.6	63.9	148.3	1,811.4
Keraniganj	1,120.0	411.1	119.6	19.2	44.3	4.0	14.0	42.6	7.5	21.6	107.0	1,910.9
Savar	521.9	202.4	55.3	2.7	6.8	0.6	12.7	40.4	7.2	22.4	139.2	1,011.6
Tongi	202.2	95.9	25.5	8.5	22.1	1.8	55.3	185.6	30.5	52.4	31.2	711.0
TOTAL	6,836.0	2,928.7	868.2	150.7	352.1	31.4	189.5	629.6	99.8	603.4	966.4	13,655.8

Note : Bd = Building (s), H.E = Household Effects, Ic = Income, E&I = Equipment and Inventories, Pf = Profit, Cp = Crops

Table 5.6 1987- and 1988 - Scale Flood Damages in 2010

1987 Scale Flood

(Unit : Tk. Million)

Name of Areas	Residential			Commercial			Industrial			Institutional	Agricultural	Total
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	Cp	
Dhaka	5,436.3	332.7	1,118.4	0.0	0.0	12.8	0.0	0.0	0.0	0.0	108.5	7,008.7
Narayanganj	658.5	23.3	187.1	0.0	0.0	1.3	0.0	0.0	0.0	0.0	39.7	909.9
Keraniganj	1,125.5	35.6	253.4	0.0	0.0	2.8	0.0	0.0	0.0	0.0	80.2	1,497.5
Savar	459.2	21.3	99.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	98.4	678.2
Tongi	361.9	13.7	80.3	0.0	0.0	2.0	0.0	0.0	0.0	0.0	13.1	471.0
TOTAL	8,041.4	426.6	1,738.2	0.0	0.0	19.2	0.0	0.0	0.0	0.0	339.9	10,565.3

1988 Scale Flood

(Unit : Tk. Million)

Name of Areas	Residential			Commercial			Industrial			Institutional	Agricultural	Total
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	Cp	
Dhaka	13,261.5	5,714.2	1,735.0	269.4	616.3	56.1	111.2	365.5	58.6	1,297.1	128.2	23,613.1
Narayanganj	2,287.1	1,086.0	328.8	42.0	95.2	8.8	179.0	608.0	87.1	179.3	47.5	4,948.8
Keraniganj	2,677.4	984.8	286.2	39.9	91.8	8.3	36.2	110.8	19.3	52.1	94.1	4,400.9
Savar	1,378.7	544.7	147.3	7.6	19.3	1.6	45.9	147.4	26.0	84.8	116.6	2,519.9
Tongi	1,233.4	585.0	155.4	52.4	135.9	10.8	339.8	1,141.3	186.8	321.9	15.3	4,178.0
TOTAL	20,838.1	8,914.7	2,652.7	411.3	958.5	85.6	712.1	2,373.0	377.8	1,935.2	401.7	39,660.7

Note : Bd = Building (s), H.E = Household Effects, Ic = Income, E&I = Equipment and Inventories, Pf = Profit, Cp = Crops

Table 5.7 Internal Flood Damages by Scale of Floods

(Unit : Tk. Million)

Damageable Items	Annual Flood			Worst Flood		
	G.Dhaka West	G.Dhaka East	Total	G.Dhaka West	G.Dhaka East	Total
1. year 1990						
House	45.2	119.8	165.0	101.3	244.3	345.6
Household Articles	1.0	1.2	2.2	6.8	13.0	19.8
Public Properties	20.8	55.1	75.9	54.8	132.3	187.1
Income Losses	12.2	32.4	44.6	25.5	61.6	87.1
Traffic Damages	6.8	17.9	24.7	7.1	17.2	24.3
Total	86.0	226.4	312.4	195.5	468.4	663.9
2. year 2010						
House	63.6	183.4	246.7	121.7	360.8	482.5
Household Articles	2.3	2.5	4.8	15.5	29.1	44.6
Public Properties	43.8	126.2	170.0	106.2	314.7	420.9
Income Losses	32.0	92.7	124.7	60.1	178.1	238.2
Traffic Damages	13.8	39.8	53.6	13.5	39.7	53.2
Total	155.5	444.6	600.1	317.0	922.4	1,239.4

Note : 1. The return period of a worst internal flood is estimated at 10 years.

2. Internal flood damages over the Areas other than Dhaka are not available.

Table 5.8 Average Annual Flood Damages

1. External Floods

(Unit : Tk. Million)

Name of Areas	1990		2010		Average Annual	
	1987-Scale	1988-Scale	1987-Scale	1988-Scale	1990	2010
Dhaka	2,388.7	8,210.9	7,008.7	23,613.1	1,045.9	3,057.5
Narayanganj	354.4	1,811.4	909.9	4,948.8	169.0	441.0
Keraniganj	685.8	1,910.9	1,497.5	4,400.8	289.8	638.2
Savar	354.2	1,011.6	678.2	2,519.9	150.3	301.4
Tongi	101.3	711.0	471.0	4,178.0	52.8	266.0
TOTAL	3,884.4	13,655.8	10,565.3	39,660.7	1,707.8	4,704.1

Note : Flood damages = Flood damages to houses, shops, factories, institutions and agricultural crops

2. Internal Floods

(Unit : Tk. Million)

Name of Areas	1990		2010		Average Annual	
	Annual	Worst	Annual	Worst	1990	2010
Dhaka	312.4	663.9	600.1	1,239.4	383.3	726.1
Narayanganj	-	-	-	-	-	-
Keraniganj	-	-	-	-	-	-
Savar	-	-	-	-	-	-
Tongi	-	-	-	-	-	-
TOTAL	312.4	663.9	600.1	1,239.4	383.3	726.1

Note : Internal flood damages for the Areas other than Dhaka are not available.

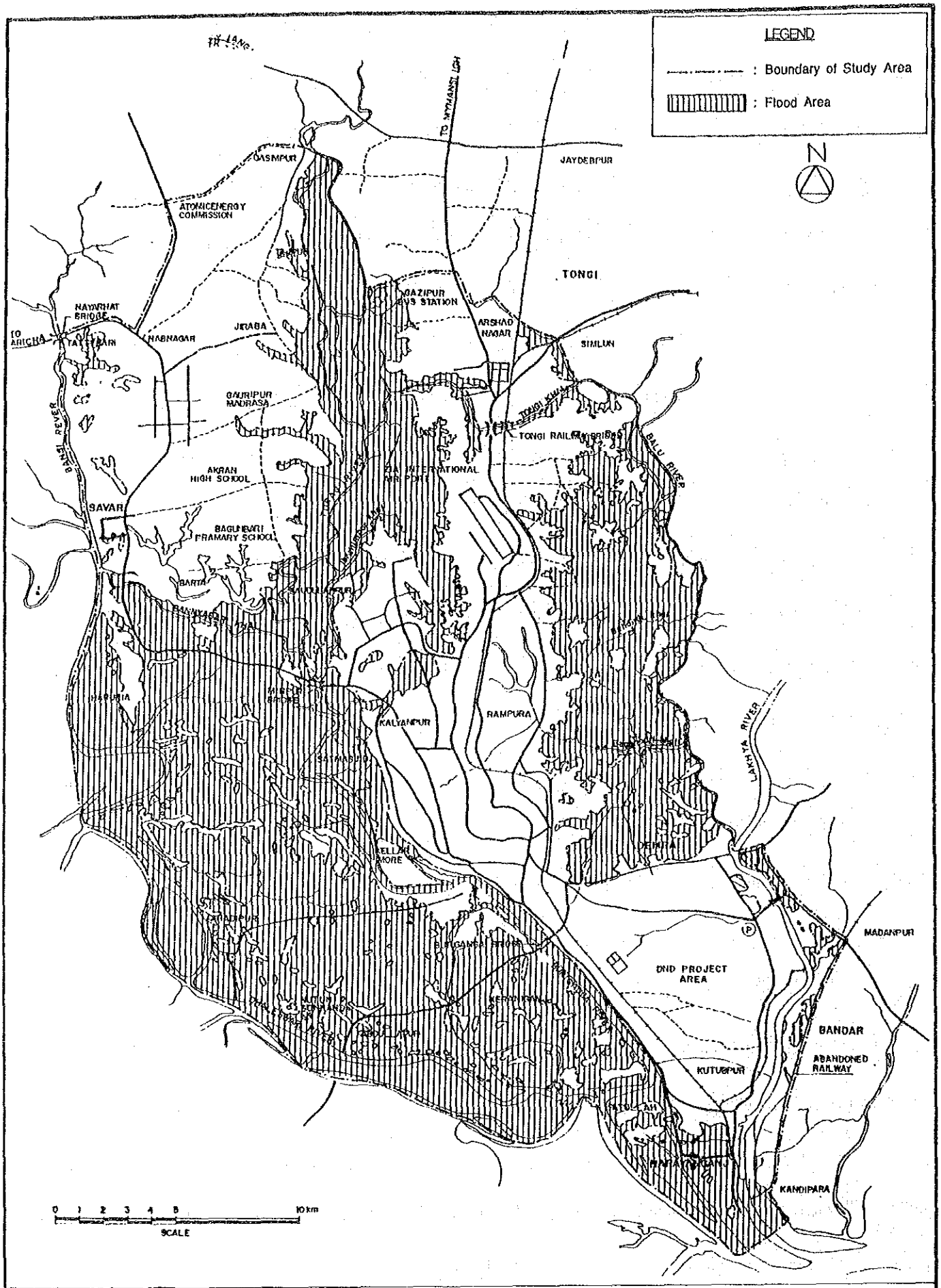

FIG. 5.1 EXTERNAL FLOOD MAP - ANNUAL FLOOD

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA

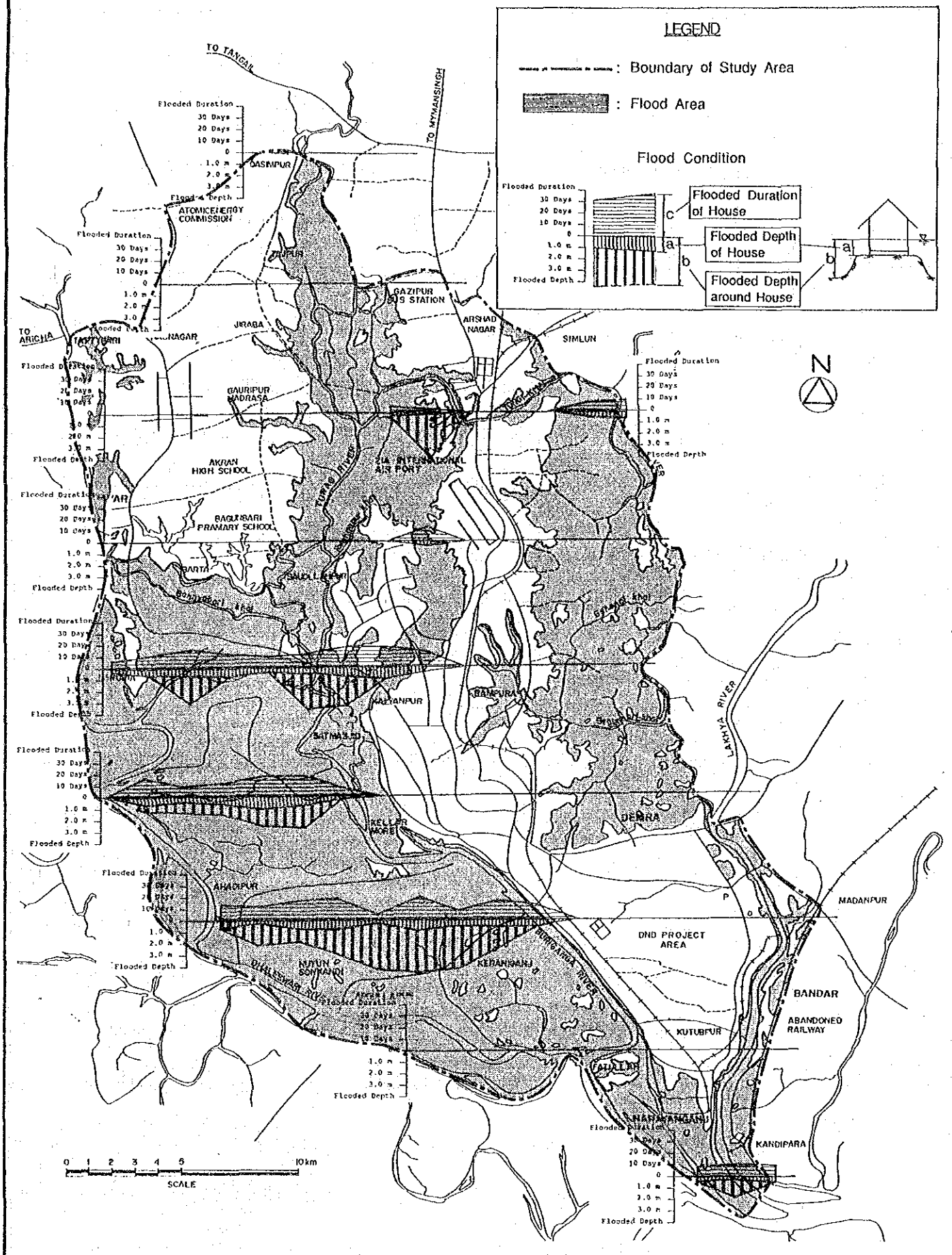

FIG. 5.2 EXTERNAL FLOOD MAP - 1987 FLOOD

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

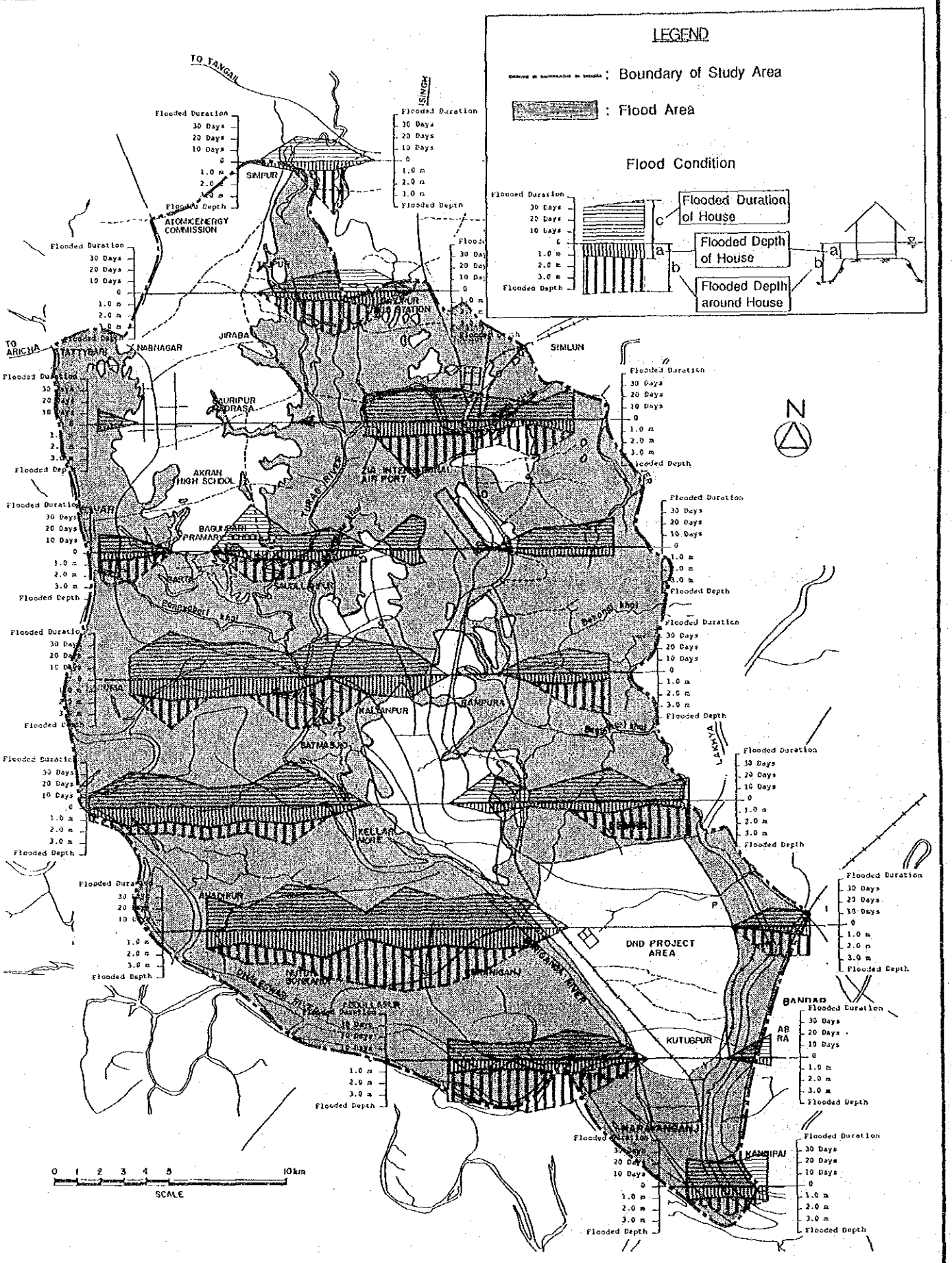

FIG. 5.3 EXTERNAL FLOOD MAP - 1988 FLOOD

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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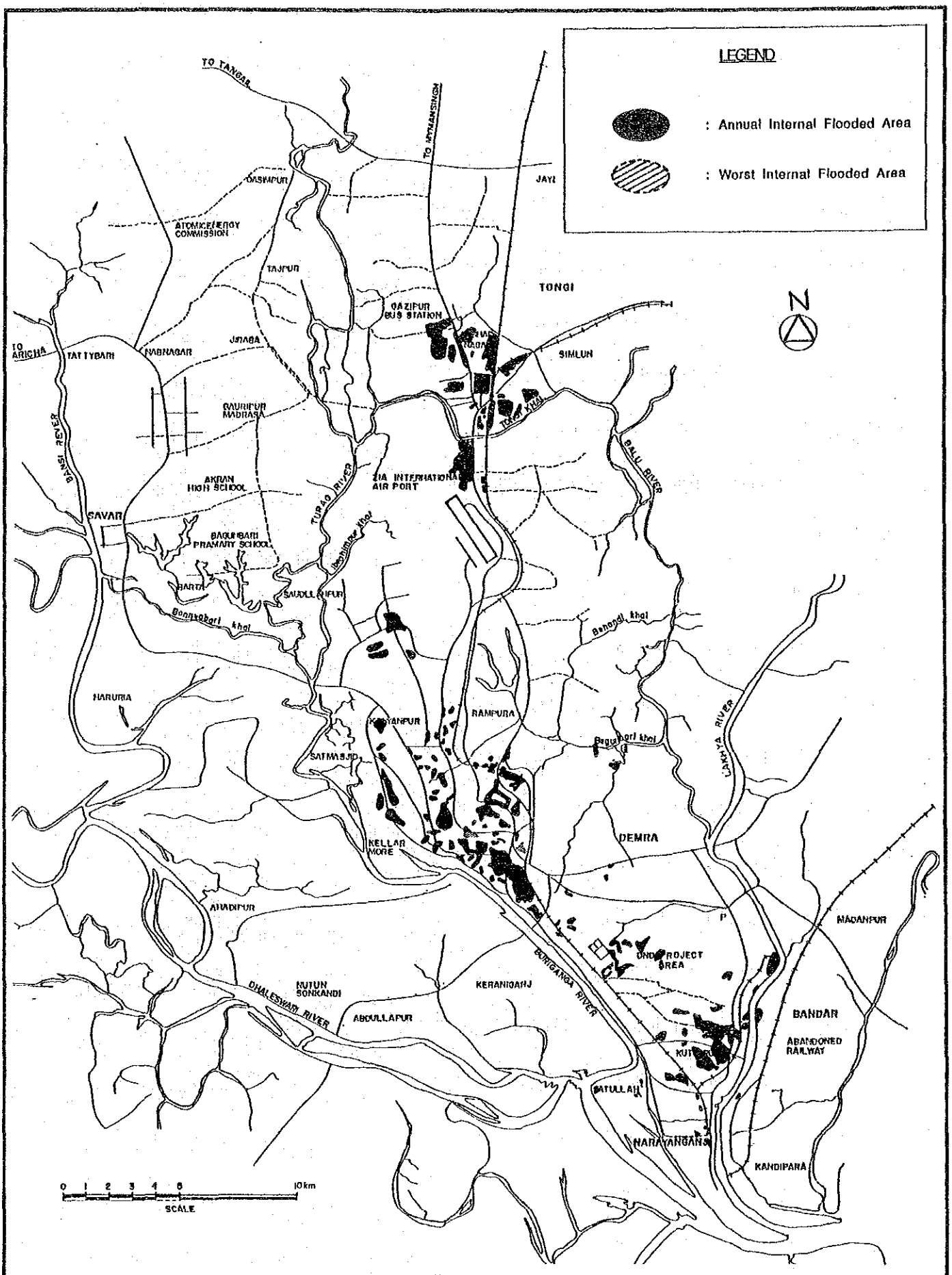
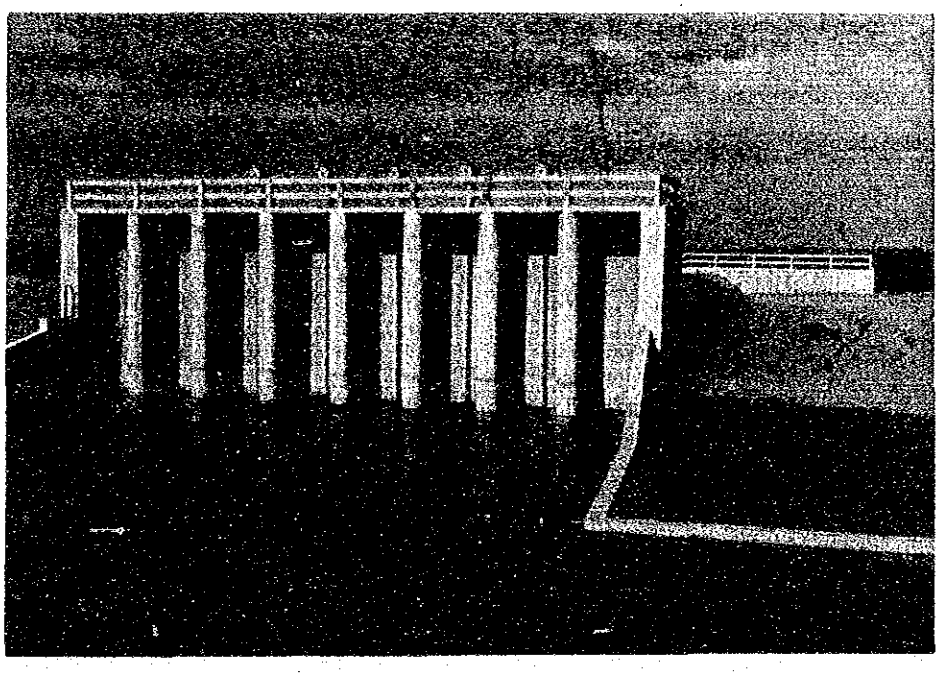


FIG. 5.4 INTERNAL FLOOD MAP

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

Slope Failure Section of Embankment Nearby National Zoo



Sluice Gate of Ibrahimpur Khal Constructed in Phase I Program of GDFCD Project

CHAPTER 6

REVIEW OF EXISTING MEASURES

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6.1 Structural Measures

6.1.1 Existing Flood Control Plans

1) General

Several flood control and storm water drainage plans for Greater Dhaka have been prepared by the GOB with cooperation and assistance from various international agencies. However most of the major existing flood control facilities have been constructed after the 1988 flood (they are shown on Table 6.1 and Fig. 6.1).

In order to protect the Greater Dhaka area from flooding, the Greater Dhaka Flood Control Committee, with the Planning Minister as its chairman, was established immediately after the 1988 flood.

The Committee, with the assistance of a Dutch expert, Mr. T.G.H. Jansen, considered various possibilities on the basis of past studies. The Committee's proposal was submitted to the President and approved in March 1989.

For the nearby towns of Savar, Tongi and Narayanganj, flood mitigation facility projects were proposed by the Institute of Diploma Engineers. However no flood mitigation plan for Keraniganj has been prepared.

The Committee's plan with a phasing of activities is summarized as follows:

(Phase I)

(1) Embankment from Tongi Railway Bridge to Sirnir Tek via Satmasjid Road along the Turag River, with five (5) sluice gates;

(2) Road raising and flood wall along the Buriganga River from the Friendship Bridge to Kellar More, and flood wall surrounding the DND project;

(3) Embankment surrounding Dhaka International Airport;

(4) Clearing of khals in the city;

(5) Repair and restoration of the sewerage system, and

(6) Temporary flood control structures.

(Phase II)

(7) Road/embankment from Demra to Tongi Railway Bridge along the Balu River,

(8) Installation of five (5) pumping stations, and

(9) Re-excavation and restoration of twelve (12) khals.

Most of the proposed works for the Phase-I were commenced immediately after their approval, as urgent measures under the supervision of various agencies i.e. BWDB, DMC, RHD, RAJUK, DWASA and CAAB. The works were completed by the end of 1990, except for some works which are still on going or which need rehabilitation.

On completion of the works for Phase-I, the major part of Dhaka City will be enclosed by embankment, flood walls and raised roads and would be free from external floods.

The flood protection plans proposed for Phase II have no implementation program yet, except for the two pump stations in Dhaka City. One of them was committed as a JICA grant project by the Government of Japan and is on going, and the other is to be funded by the World Bank.

The DND project area was developed by BWDB as an irrigation project, protected from floods by polders and drained by pumps. The area, however, will be developed as an urban area and a development plan is being prepared by RAJUK. The area will be safe to the river stage of the 1988 flood, after completion of the flood walls proposed in Phase-I.

For the other urban areas, Tongi, Savar, Narayanganj and Keraniganj, no major flood prevention facility exists.

2) Existing Plan of Greater Dhaka Area

For the embankment along the right bank of the Balu River from Tongi to Demra, for protection of the eastern part of Greater Dhaka against the flood from the Balu River, proposed by the committee for Phase II, BWDB has already commenced the following :

- Survey / Design of the embankment
- Cross-Sections of the embankment
- Longitudinal profile of the embankment (from Tongi to Demra),
- Soil investigations along the proposed alignment of the embankment,
- Typical design sections of the embankment

Land acquisition notices have also been issued to land owners.

The Flood Wall from Mitford Hospital to Kellar More for Phase I, for which the executing agency is DCC (DMC), has not been implemented yet, due to lack of space for construction and some technical problems. The site investigation and some alternative plan has been proposed to the Committee for approval, but yet to be considered.

3) Existing plan for Narayanganj Town

The town of Narayanganj is affected by floods from the Buriganga River, the Dhaleswari River and the Lakhya River. The town is divided into two parts, the West Bank and the East Bank, by the Lakhya River. These two areas are categorized as industrial areas. In order to protect the town area from floods, the following plan was proposed by IDE .

a) West Bank Protection

- construction of 5 km of earthern embankment, and 5 to 6 km of reinforced concrete retaining wall,
- raising the existing road and the provision of 4 regulators.

b) East Bank Protection

- raising the existing abandoned railway embankment as an embankment over 8.70 km

- construction of a flood embankment along both sides of the Lakhya River, some 13.7 km, with the provision of 4 regulators.

The principal purposes of this plan are :

- to protect the area from 1988 scale floods.
- to obtain maximum benefit with minimum investment, only small scale flood protection facilities are to be introduced.

4) Existing Plan for Tongi Town

The flood control facilities proposed by IDE are as follows :

- Raising of the road from the Gazipur Bus Station, west through Shatash and south through Kokil Mouja up to Kathalia Tek, for a distance of 5.50 km.
- Construction of a road/embankment (including land acquisition) from Kathalia Tek to the Tongi Bridge, 2.5 km.
- Construction of a flood protection wall from the road bridge to the Railway Bridge, 1.4 km.
- Construction of an embankment/road (including land acquisition) from Tongi Railway Bridge to Pubail Railway line, a distance of 6 km.
- Construction of an embankment/road (including land acquisition) from Tongi-Mymensingh Railway line north towards Tongi-Joydebpur road, 2.0 km.
- Construction of flood protection wall from Ershadnagar to Gazipur Road, 0.3 km.
- Provision of 2 pump stations and 10 regulators.

5) Existing Plan for Savar Town

During the 1988 flood, Savar was not as much affected as other areas, due to its relatively high ground level compared to flood stages. The flood control facilities proposed by IDE are summarized as follows :

- Construction of an embankment/road from Nayarhat Bridge along the east bank of the Bansi River up to the bridge over the Begunbari Khal on the Dhaka - Aricha road, a distance of approximately 16 km.
- Raising of the road from the north wall of the Atomic Energy Commission up to Sadullapur including construction of 0.21 km of flood protection wall, approximately 3.5 km.
- Raising of the road from Sadullapur up to Barta, approximately 1 km.
- Construction of a road/embankment from Barta village to the bridge over the Bannyabari Khal, approximately 2 km.
- Provision of 2 pump houses and 16 regulators.

6.1.2 Existing Flood Control Facilities

The existing embankment and flood walls were evaluated in terms of crown elevation and stability. The design crown levels were decided by adding a freeboard of 1.2 m for the embankment and 0.6 m for the flood wall. The design crown levels are higher than the river stage of both the 1988 flood and a 100-year flood frequency.

The river stages of the 1988 flood and a 100-year flood are assumed and the design high water levels (H.W.L.) are shown below :

Station		H.W.L	1/100	'88 Flood
Tongi (Sta. No. 299)	:	8.6 m	8.30 m	7.96 m
Mirpur (Sta. No. 302)	:	8.6 m	8.53 m	8.39 m
Mill Barak (Sta. No. 42)	:	7.8 m	7.72 m	7.54 m
Hariharpara (Sta. No. 43)	:	7.2 m	7.10 m	7.17 m
Rakabi Bazar (Sta. No. 71A)	:	6.7 m	6.65 m	6.43 m
Demra (Sta. No. 7.5)	:	7.4 m	7.32 m	7.10 m
Kalagachia (Sta. No. 71)	:	6.4 m	6.40 m	5.97 m
Savar (Sta. No. 69)	:	9.7 m	9.36 m	9.68 m

The stability of the embankment and the flood wall has been evaluated as follows :

1) Greater Dhaka Area

(1) Embankment

The embankment (29.2 km) between Tongi Railway Bridge to Kellar More has been constructed on the basis of the standard cross section (see Fig. 6.2). The crown elevation of the embankment is mostly higher than 10.0 m (PWD) and has sufficient elevation against the design crown level (9.8 m) at Mirpur according to the spot elevation survey last year, however, many parts of the crown is below the design height.

The stability of the embankment will be a problem, because settlement and slope failures of the embankment are observed at some portions, possibly due to poor soil foundation and also poor compaction.

The top at some portion is 1.5 m to 3.0 m lower than design top level, corresponding about 6-year flood frequency.

The ADB consultants reported that "approximately 37 percent of the existing 29.2 km phase I embankment is unstable".

(2) Flood Wall

The flood wall was planned around Sirnir Tek and between Kellar More and Sayedabad via Buriganga Bridge. Most parts of the flood wall have been built on the basis of the proposal prepared by the Committee. However the reach between Kellar More and Mitford Hospital (1.6 km) has not been constructed due to land acquisition problems.

The top elevation of the flood wall near Sirnir Tek is measured at about 8.9 to 9.3 m. The lowest portion is 0.3 m lower than the design top level at Mirpur gauging station. For the reach between Mitford Hospital and Sayedabad, the top elevation is measured between 8.1 m to 8.6 m. The lowest portion is 0.3 m lower than the design top level at Mill Barak gauging station, while the water level in the 1988 flood was at 7.5 m in PWD.

The stability of the flood wall near Sirnir Tek and the reach from Mitford Hospital to Buriganga Bridge is evaluated as satisfactory at present. However, it is recommended that the flood wall should be heightened and its base should be protected or reinforced in order to ensure its stability. The spot elevation of the top of the flood wall is shown in Fig.6.3 (1).

(3) Road-cum-embankment

The road from Tongi bridge to Sayedabad has been raised to the flood stage of the 1988 flood.

The top level of the road ranges from 7.30 m to 8.30 m, while the 1988 flood H.W.L at Tongi and Demra are 7.96 m and 7.10 m respectively. The top level of the road corresponds to about a 50-year flood frequency. The spot elevation of the top of road-cum-embankment is shown in Fig. 6.3 (1).

(4) Regulators

Six regulators have been constructed along the Greater Dhaka Western Bank, but one is not functioning due to lack of a drainage channel. One regulator at Kallayanpur is completed. Early remedial work will be required.

2) Narayanganj Area

The DND project area is protected from floods by the flood wall and the railway-cum-embankment. This flood wall was constructed along the trunk road on the boundary of most of the DND project area.

The top elevation of the flood wall from Buriganga Bridge to Fattulla ranges from 7.6 m to 8.0 m with its road elevation being about 7.0 m, while the design top levels at Mill Barak and Hariharpara gauging station are 8.4 m and 7.8 m respectively. For this section, the height is not sufficient.

In the reach from Sayedabad to Demra, the top elevation of the flood wall ranges from 7.8 m ~ 8.0 m, with the road elevation being about 7.2 m, while the tentative design top level at Demra (Sta No. 7.5) is 8.0 m.

In the reach from Demra to Hajiganj along the Lakhya River, the top of the flood wall ranges from 7.5 m to 8.1 m with the road elevation being about 7.0 m. The design top levels at Demra and Hajiganj are 8.0 m and 7.7 m respectively. The top levels of the flood wall are not sufficient to meet the design criteria.

Furthermore the wall strength is not sufficient to withstand impact of trucks or other heavy weight vehicles. The existing flood wall along the trunk road is evaluated as temporary. The spot elevations of the top are shown on Fig. 6.3 (2).

6.1.3 Existing Drainage Facilities

The existing major drainage facilities are classified into drainage pipes, khals, pumping stations and related structures.

1) Drainage Pipes

The central part of Dhaka City (approximately 60 km^2) is provided with drainage pipes of a total length of more than 110 km, ranging from 0.3 m to 3.0 m in diameter. The diameter of brick drainage pipes is from 1.2 m to 4.0 m and of

reinforced concrete pipes is below 1.2 m. The size and length of the existing drainage pipes are listed in Table 6.2.

The density of drainage pipes is estimated at 2.4 km/km^2 and the location of the trunk drainage pipes is shown in Fig. 6.4.

Existing major drainage pipes and khals located in central Dhaka city were hydraulically evaluated in the report "The Storm Water Drainage System Improvement Project in Dhaka City" by JICA in 1987.

2) Khals

There are a number of khals in Dhaka City totaling approx. 437 km in length, as listed in Table 6.3.

Khals in urbanized areas have the function of stormwater drainage, but in paddy fields or cultivated areas they both drain storm water and supply irrigation water. The existing khal systems are presented in Fig. 6.5.

The conveyance capacity of 36 khals situated outside Dhaka city, of 137 km length, are calculated on the basis of the longitudinal and cross sectional survey results of the existing khals. They are summarized below :

Drainage Zone	Khal Width (m)	Discharge Capacity (m^3/s)	Specific Discharge Capacity ($m^3/s/km^2$)
Turag Rive Left Bank (DB)	5.0 ~ 47	1.0 ~ 32	0.1 ~ 2.4
Balu River Right Bank (DC_1)	10 ~ 40	1.5 ~ 60	0.3 ~ 12.8
Balu River Right Bank (DC_2)	12 ~ 44	4 ~ 107	0.2 ~ 20.7
Balu River Right Bank (DC_3)	9 ~ 58	2 ~ 157	0.3 ~ 2.6
DND Project (NA)	-	-	-
Narayanganj West (NB)	5 ~ 46	3 ~ 213	0.2 ~ 51.5
Narayanganj East (NC)	10 ~ 23	3 ~ 17	0.7 ~ 12.7
Keraniganj (K)	14 ~ 32	5 ~ 113	1.1 ~ 20.9

Note : Detailed discharge capacity of each khal is shown in Table 11.4 and Figs. 11.4(1) and (2) in Supporting Report H.

3) Pumping Station

There are two pumping stations: Narinda in Old Dhaka and Demra in the DND project area.

Narinda pumping station drains almost the entire Old Dhaka area of 4.23 km^2. Total design discharge capacity is 9.6 m^3/s.

Demra Pumping Station functions both for stormwater drainage and irrigation water supply for the DND project area of approximately 57 km^2. Total design discharge capacity is 14.52 m^3/sec.

4) Other Related Structures

A number of concrete box culverts and bridges are found where roads and railways cross the khals.

6.1.4 Existing Drainage Improvement Plans

1) Dhaka City

The first master plan study on flood protection and internal drainage of Dhaka city, covering an area of 75 km2, was undertaken by DPHE in 1968. This plan was not accepted by the Government.

As a follow up to the above study, a separate plan for the internal drainage system was prepared by BWDB in 1976. However the plan was not accepted by the Government largely because of financial constrains.

Afterwards, a drainage plan, "Internal Scheme for Removing Water Logging within Dhaka City" was prepared by DPHE with an estimated cost of Tk. 66 million in 1976. This was implemented up to June, 1980.

In 1981, another drainage plan, "Internal Scheme for Removing Water Logging within Dhaka Metropolis" was approved at Tk. 190 million. This project was implemented in June 1983.

In 1985, the "Revised Crash Program for Construction of Storm Water Drainage in Water Logged Area of Dhaka Metropolis" was prepared by DPHE. This project was executed up to 1989.

In 1987, the "Study on Storm Water Drainage System Improvement Project in Dhaka City" was conducted by JICA in collaboration with DPHE. The study area covers the city of Dhaka, with an area of about 137 km2 which will be urbanized by the year 2000.

At the same time, UNDP / UNCHS conducted a feasibility study on the improvement of Dholai Khal as an Old Dhaka area development project (Dholai Khal Rehabilitation and Area Development Project). This project is now on going.

Immediately after the 1988 flood, the Committee proposed various possible alternatives based on the previous studies. The committee's proposals were approved by the President in March,1989.

Among the committee's proposals, some stormwater drainage improvement works were included, as follows :

1) Phase I
   - Clearing of khals in the city
   - Repair and restoration of the sewerage system

2) Phase II
   - Installation of five (5) pumping stations
   - Re-excavation and restoration of twelve (12) khals.

The phase I project was started in 1989 and is still continuing. Phase II is still under preparation, except for two pump stations (JICA and World Bank) which have reached a more advanced stage.

In addition, JICA conducted a re-evaluation and updating of the 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 flooding itself, and proposed an urgent program for improvement of the storm water drainage system in Dhaka City in March 1990.

The drainage zones, and the required drainage facilities with a phased program proposed by JICA, are shown in Fig. 6.6. The proposed urgent program is composed of the works of Phase - I and Phase - II as shown in Fig. 6.7.

After the 1988 flood, WASA also made an improvement plan for cleaning khals in accordance with the Committee's proposal. This is shown in Fig. 6.8.

2) DND Project Area

RAJUK is preparing a detailed plan for this area. When a large agricultural area is changed to urban use, its drainage facilities, such as drainage channels and drainage pumps, have to be reviewed and improved according to the new land use.

3) Other Town Areas

For the town areas of Savar, Tongi and Narayanganj, there are some preliminary drainage plans proposed by the Institute of Diploma Engineers in 1989, but Keraniganj was not considered.

- Savar Town : two pump stations, 16 regulators
- Tongi Town : two pump stations, 10 regulators
- Narayanganj Town : 8 regulators

6.2 Non-Structural Measures

6.2.1 Flood Warning System

1) Existing Condition

(1) Present Project

The activities of flood forecasting and warning were started in 1972. However they have not been carried out continuously due to inadequate project finance.

The present project has been carried out with UNDP Project assistance. This was planned to be executed during the third five year plan period (1985 ~ 1990), but has been delayed.

The project consists of the following sub-projects :

a) Surface Water Survey and Investigation
b) Ground Water Survey and Investigation
c) Flood Forecasting and Warning
d) Investigation of new project

(2) Existing Organization

The flood forecasting and warning project is the responsibility of the Director, Surface Water Hydrology - 2. This project includes :

a) Data Processing Division
b) Flood Forecasting & Warning Center
c) Construction & Instrumentation Division

(3) Flood Information Monitoring Network and Installation

Within Bangladesh, real time water level data from 35 stations and rainfall data from 34 stations are being monitored in the Flood Forecasting and Warning Center. Real time and forecast water levels from 5 stations in India are also monitored through the BMI network of teleprinter circuit. Satellite imagery of cloud formation are monitored in the Flood Forecasting Warning Center at WAPDA Building by SPARRSO for flood information and formulation of forecast. Besides rainfall data, synoptic situations from Bangladesh Meteorological Department are also monitored in the Flood Forecasting and Warning Center.

The flood information monitoring installations are shown in Table 6.4

(4) Flood Information

The Flood Forecasting and Warning Center issues the following information in the form of a daily bulletin. The issuing period is limited to the flood season from May to October.

a) Water levels of each monitoring station

- Recorded Highest Water Level
- Danger Level
- Daily Highest Water Levels of 3 consecutive days
- Daily Highest Water Level of previous year

b) Rainfall amount of each monitoring station

- monthly Maximum Rainfall
- Monthly Normal Rainfall
- Daily (for last 24 hrs) Rainfall of 3 consecutive days
- Cumulative Rainfall Amount of the year and the previous year

Based on the above information, models are run for forecasting. Presently quantitative forecasts are limited to the Ganges, the Brahmaputra-Jamuna River, the Buriganga River, the Lakhya River and the Old Brahmaputra River with lead time varying from 24 hours to 96 hours.

The flood information and flood forecasting and warning is to be made by the Flood Forecasting and Warning Center through the Chief Engineer of Hydrology.

(5) "Emergency Standing Order for Floods"

In order to meet a flood emergency, the Government of Bangladesh issued an emergency standing order for floods, defining the duties and responsibilities of different ministries prior to flood, during the flood and after the flood.

In pursuance to the said order, the BWDB maintains a flood information center during flood time, issues the flood warning and delegates officials to the Ministry of Relief and Rehabilitation or to the President's Flood Monitoring Center.

Table 6.1(1) Flood Control Facilities

A. Existing and On-going Facilities

Executing Agency	Component of Work	Location	Quantity	Elevation/Capacity
Army	Embankment	E1 : Tongi to Diabati	8.00 km	10.0 m +PWD
		E5 : Satmasjid to Kellar More	5.80 km	10.0 m +PWD
BWDB	Embankment	E2 : Diebati to Sirnir Tek	9.69 km	10.0 m+PWD
	Sluice	S1-S6	6 nos.	
	Pump sta.	DND Project	1 No.	14.5 cubic meter/sce.
DMC	Embankment	E3 : Sirnir Tek to Mirpur bridge	1.50 km	10.0 m+PWD
	R.C.C Wall	W1 : - Ditto -	0.75 km	2' above flood mark
	Rising of BWDB Dam			
	Embankment	E4 : Mirpur bridge to Kallyanpur	1.42 km	10.0 m+PWD
	R.C.C Wall	W2 : - Ditto -	0.16 km	10.0 m+PWD
	Embankment	E4 : Kallyanpur to Satmasjid	2.75 km	10.0 m+PWD
	R.C.C Wall	W3 : Mitford Hospital to Buriganga bridge	4.31 km	2' above flood mark
	Rising of road	R1 : Rampura main road	0.98 km	7.9 m+RWD(Approx.)
	* Dholai Khal Project (UNDP/World Bank Project)			
	Improvement of Khal		2.35 km	
	Pump Station	Pmd1:Confluence of Buriganga river	1	80,000 m3/hr
	Reservoir	Narinda,Dayaganji areas	1Nos	205,000 m3
	Removal of Pump Sta.	Existing Narinda Pump Sta.		
CAAB	Embankment	E6 : Surroundings of Zia Airport	10.53 km	9.8 m-10.5 m+PWD
RAJUK	Rising of road	R2 : Joar Sahara to Rampura	6.00 km	7.9 m+PWD(Approx.)
		R3 : Rampura to Syedabad	5.90 km	8.4 m+PWD(Approx.)
		R4 : Sirnir Tek	0.77 km	10.0 m+PWD
RHD	R.C.C Wall	W4 : Surroundings of DND Project area	26.61 km	2' ~ 3' above flood mark
DWASA	Reexcavation of 12 khals	Greater Dhaka Area	---	---
	* Japan's Grant Aid Project			
	Pump station	Pmw 1: Kallyanpur		20(Tentative 10)m3/sec
	Sluice	Smw 1: Kallyanpur		
Railway	Raising of Railway	R5 : Southern part of DND Area	2 km (Approx.)	6.8 m

Note: Contd.

1) * : On-going Project

Table 6.1(2) Flood Control Facilities

B-1. Proposed Flood Control Plans by the Committee

Executing Agency	Component of Work	Location	Quantity	Elevation/Capacity
BWDB	Embankment	Emb 1:Tongi to Demra	29 km (Approx.)	
	Pump Station	Pmb1-Pmb5:	5Nos	
	Suluice	Smb1-Smb5:		
DWASA	Road Culvert			
	Khal Dredging			
DMC	Flood wall/Embankment	Mitford hospital to Kellar More	1.6 km	
Narayanganj town	West and East Bank project			
	Embankment	Emn1:Along the east bank of Lakhya river Emn2:North part &south part of the town		
	R.C.C Wall	Wmn1:Along the West part of Lakhya river Wmn2:Along the old Dhaleswari river		
	Raising Road	Rmn1:Dhaka-Munshiganj road Rmn2:Abandoned railway track embankment		
	Regulators	No detailed indication	8 Nos	

Contd.

Table 6.1(3) Flood Control Facilities

B-2. Proposed Flood Control Plans by the Committee

Executing Agency	Component of Work	Location	Quantity
Tongi Town	West and East of Railway Line		
	Embankment	Emt1:Tongi Railway bridge to Simlun	6.0 km
		Emt2:Ershad Nagar to Railway bridge	2.0 km
	R.C.C Wall	Wm t 1:Railway bridge to Road bridge	1.4 km
		Wmt 2:Simlun to Ershad Nagar	3.5 km
		Wmt 3: Gazipur bus stand to Ershad Nagar	0.3 km
	Road Rising	Rmt 1:Gazipur bus stand to Kathaldiatek	5.5 km
		Rmt 2: Kathaldiatek to Road bridge	2.5 km
	Pump Station	No detailed indication	2Nos
	Regulators	No detailed indication	10Nos
Savar Town			
	Embankment	Ems 1: Bannyabari khal to Nayarhat bridge.	16 km
		Ems 2: Bartaq to Bannyabari khal	2 km
	R.C.C WALL	Wms 1: Nayarhat bridge to Atomic energy commission	10 km
	Road Rising	Rms 1: Atomic energy commission to Sadu	3.5 km
		Rms 2: Barta to Sadullahpur	1.0 km
	Pump Station	No detailed indication	2Nos.
	Regulators	No detailed indication	16 Nos.

Table 6.2 Existing Drainage Pipes in Central Dhaka

Pipe Size	Pipe Length (ft)	Remarks
13' - 3"	430	Brick Pipe
10' - 0"	2,900	"
9' - 0"	2,124	"
8' - 6"	1,000	"
8' - 0"	1,100	"
7' - 6"	1,300	"
7' - 0"	3,800	"
6' - 0"	8,970	"
5' - 6"	9,540	"
5' - 0"	12,660	"
4' - 6"	13,950	"
4' - 0"	26,700	Concrete Pipe
3' - 6"	20,350	"
3' - 0"	44,900	"
2' - 6"	48,860	"
2' - 0"	115,100	"
1' - 6"	38,800	"
1' - 0"	1,600	"
Total	358,884	

Table 6.3 Existing Khal Length by Drainage Zone

Drainage Area	Drainage Zone	Khal Length (km)
Greater Dhaka	Balu River Right Bank (DA)	105.2
	Turag River Left bank (DB)	42.4
	Buriganga River Left Bank (DC)	35.6
Tongi	Tongi East (TB)	5.2
	Tongi West (TA)	16.2
Savar	Savar East (SA)	20.3
	Savar West (SB)	21.5
	Savar South (SC)	14.3
Keraniganj	Keraniganj North (KA)	23.3
	Keraniganj South (KB)	82.3
Narayanganj	DND Project (NA)	50.2
	Narayanganj West (NB)	13.0
	Narayanganj East (NC)	7.5
Total		437.0

Note : The length of existing khals were measured from the National Base Map of Scale 1:50,000.

Table 6.4 Existing Flood Monitoring Facilities

	Items	No.
1.	SSB Wireless station	51 Nos.
2.	Telemetric station network with Central Station at Moulvi Bazar	6 Nos.
3.	Hydrological Radar with Bangladesh Meteorological Department with microwave link to Flood Forecasting & Warning Centre	1 No.
4.	Calibrating rain gauges at two places with three rain gauges and associated repeater station	2 Sets
5.	Dedicated teleprinter link between Bangladesh meteorological Department (BMD) and FF & W.	1 No.
6.	Telephone	2 Nos.

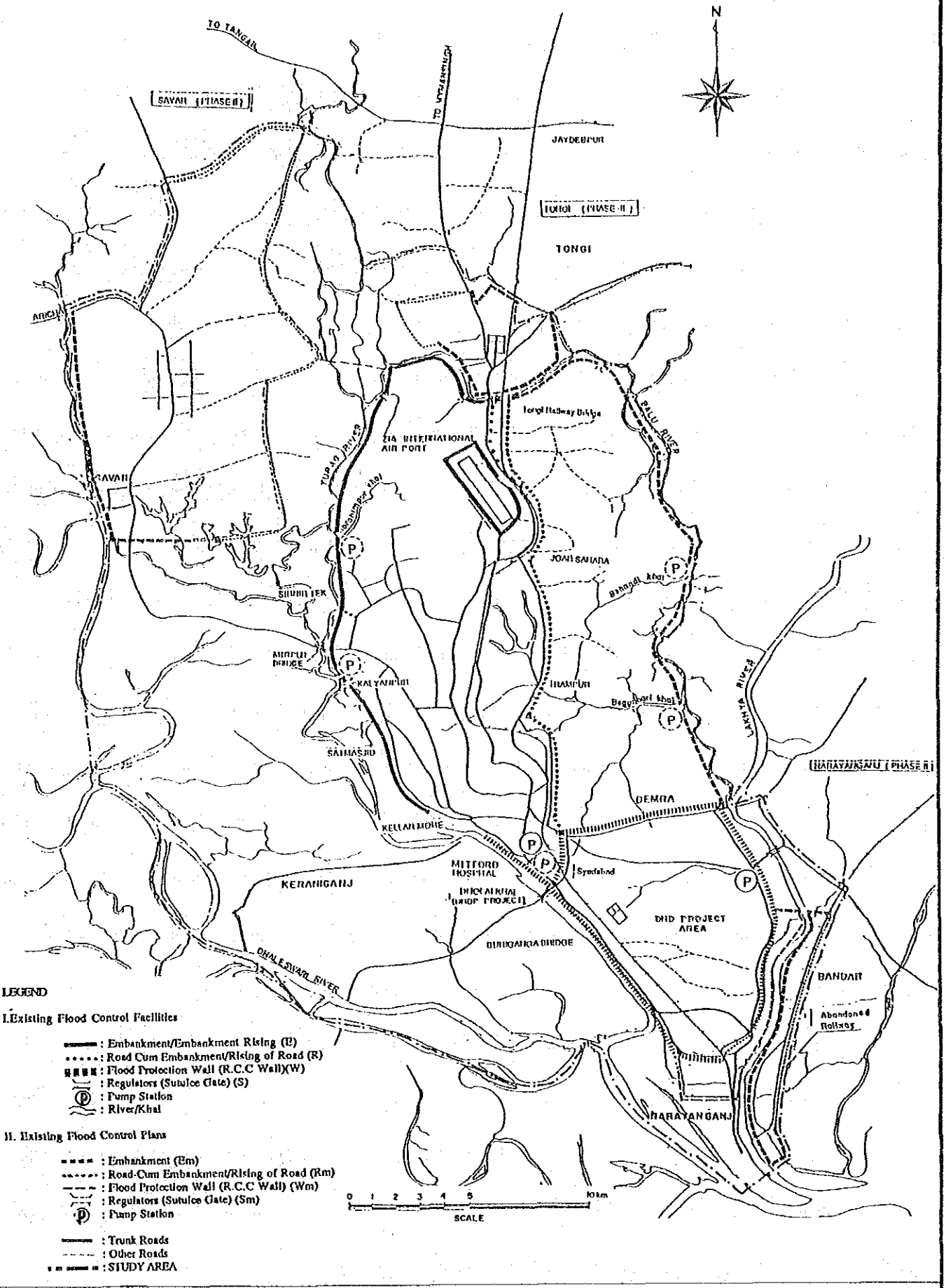
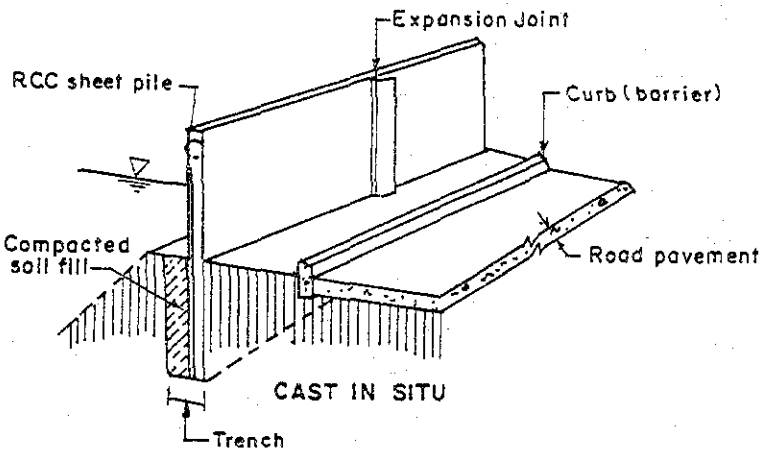


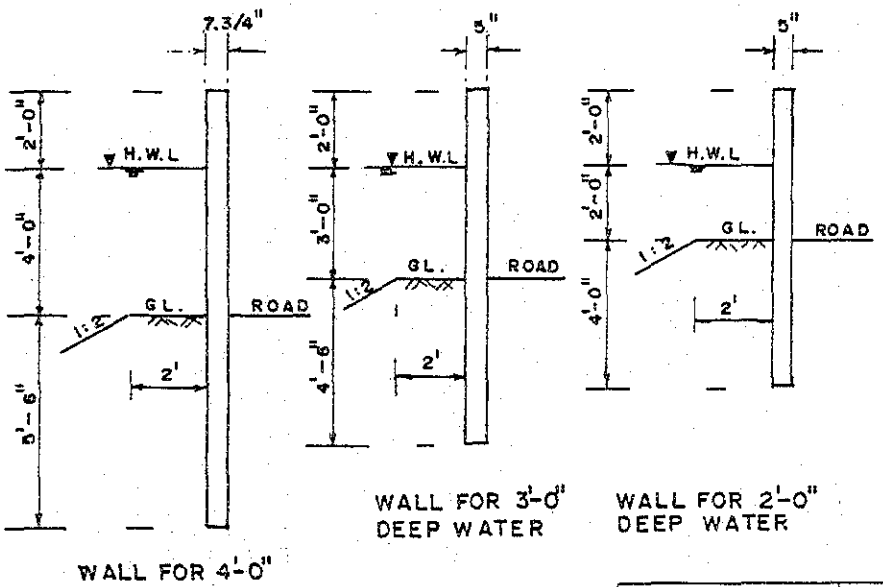
FIG. 6.1 EXISTING (AND ON-GOING) FLOOD CONTROL FACILITIES AND EXISTING FLOOD CONTROL PLANS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA

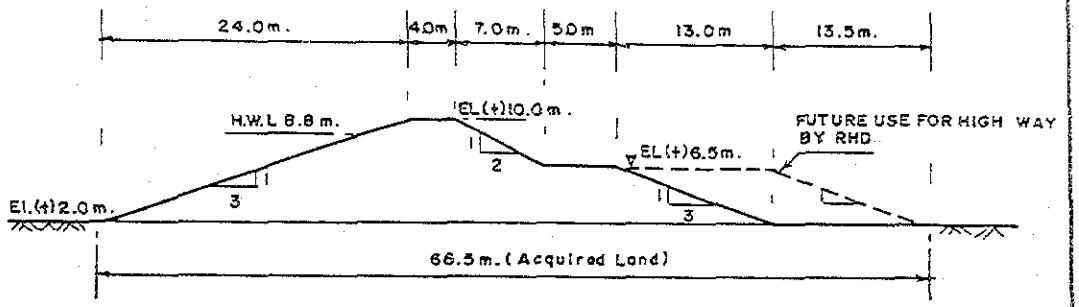
FLOOD PROTECTION WALL (R.C.C WALL)



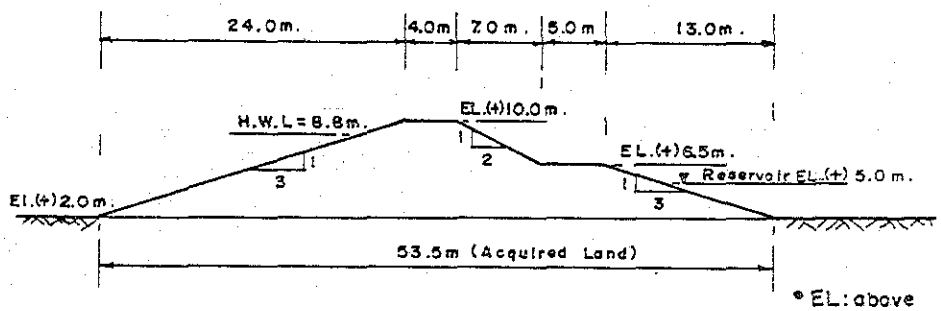


Typical Cross Section
DMC and RHD Construction

FLOOD PROTECTION EMBANKMENT



Typical Cross Section betwee Tongi To Shinir Tek
ARMY & BWDB Construction



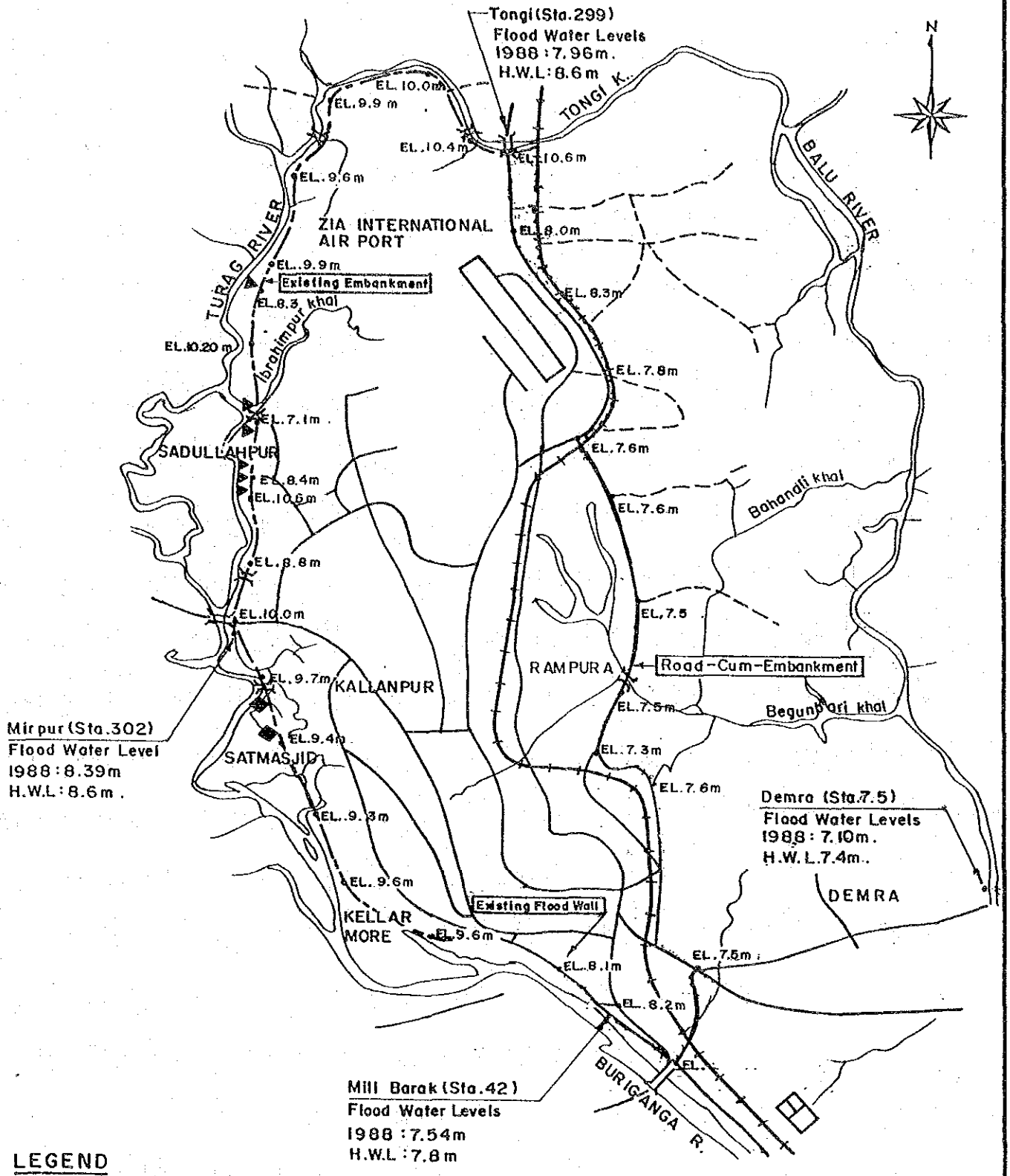
Typical Cross Section between Shinir Tek to Kellar More
DMC and ARMY Construction

Source:
Information from BWDB.DMC.and RHD.

FIG. 6.2 TYPICAL CROSS-SECTION OF EXISTING FLOOD PROTECTION EMBANKMENT AND FLOOD WALL

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

JICA



LEGEND

▶ : Settlement Place of Embankment.

◆ : Below Design Section Portion.

H.W.L : Design High Water Level.

Existing Sluice Gate

FIG. 6.3 (1) SPOT LEVELS OF EXISTING FLOOD PROTECTION FACILITIES/TRUNK ROADS- GREATER DHAKA

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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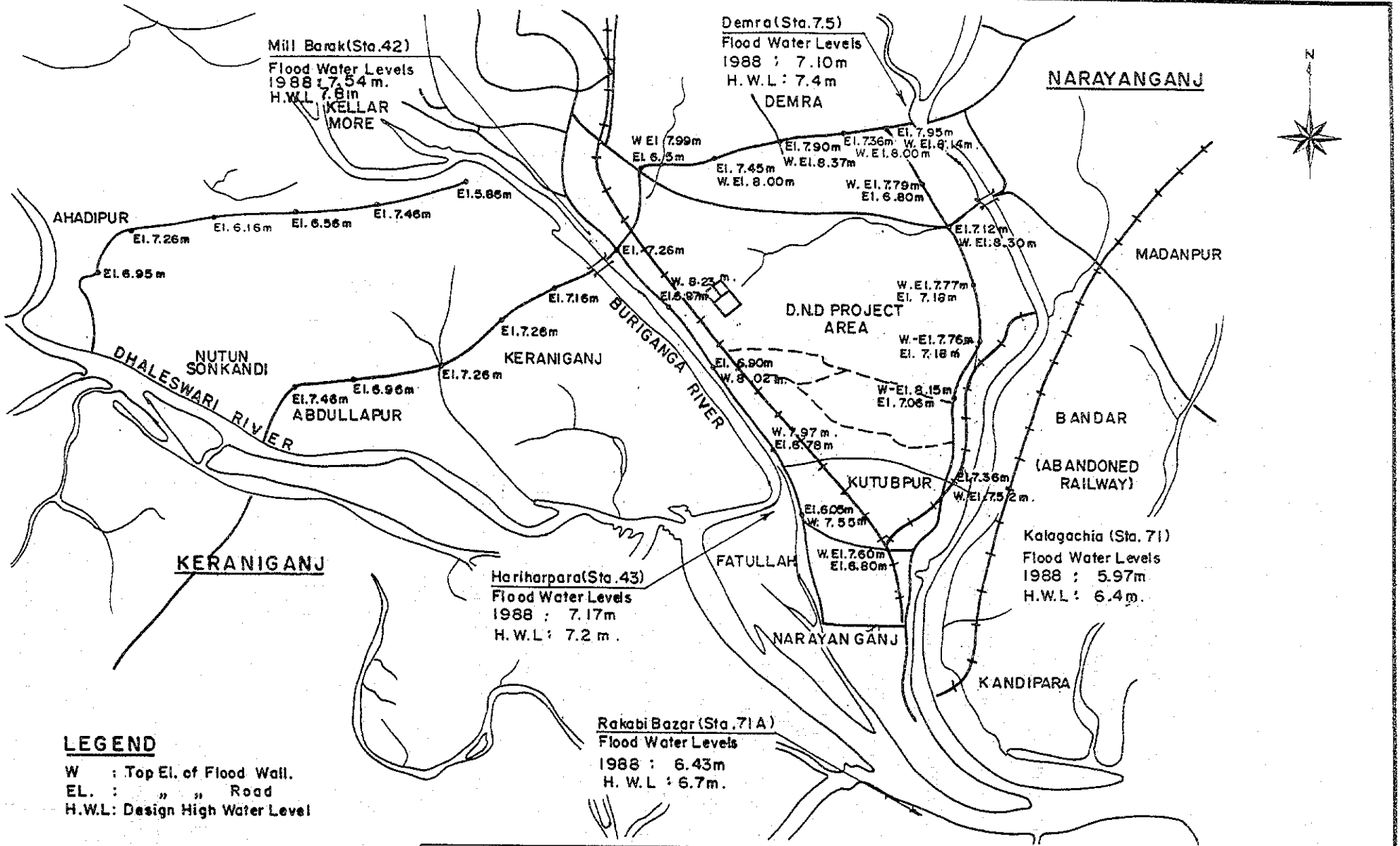

FIG. 6.3 (2) SPOT LEVELS OF EXISTING FLOOD PROTECTION FACILITIES /TRUNK ROADS - NARAYANGANJ AND KERANIGANJ

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

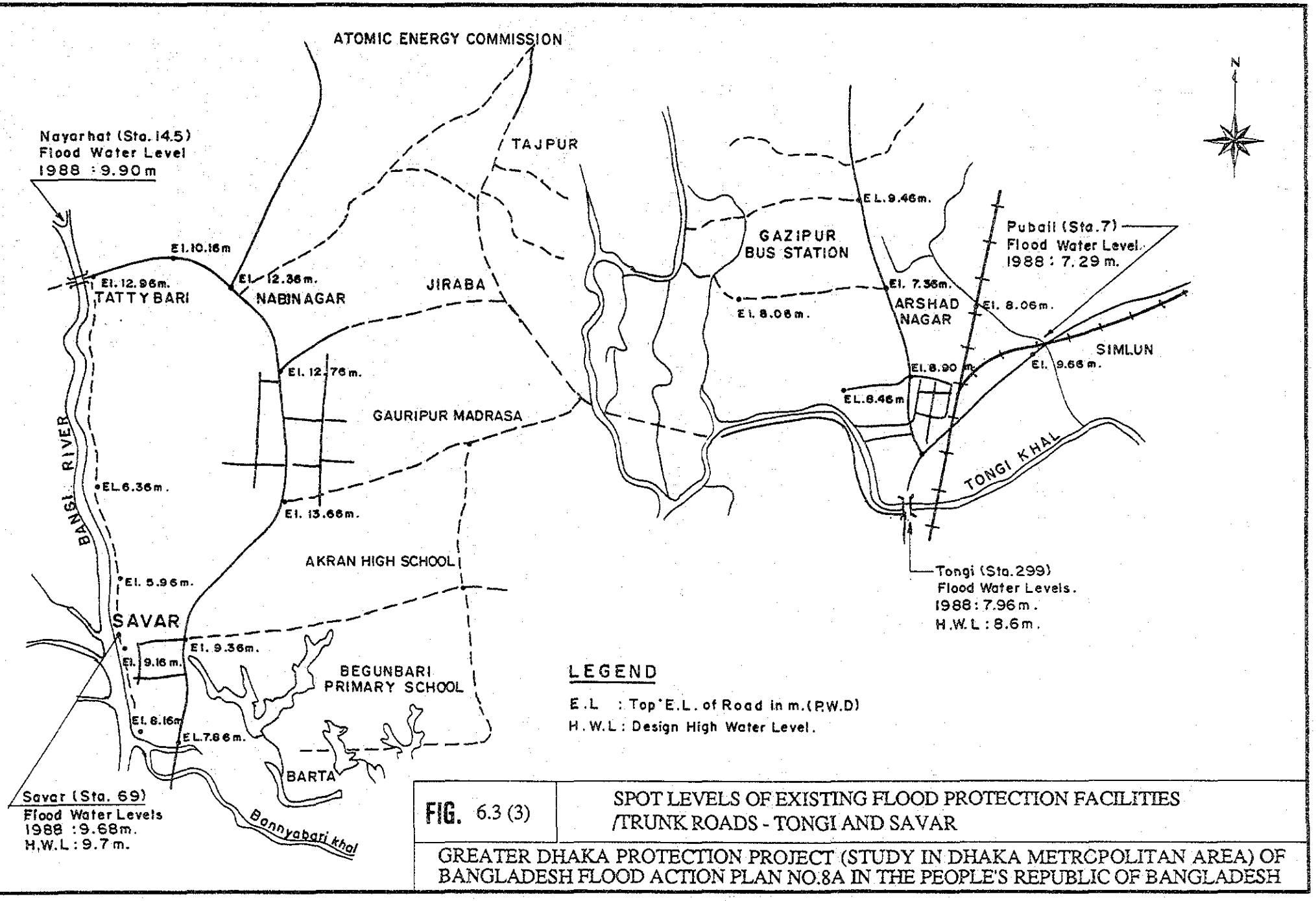

FIG. 6.3 (3) SPOT LEVELS OF EXISTING FLOOD PROTECTION FACILITIES /TRUNK ROADS - TONGI AND SAVAR

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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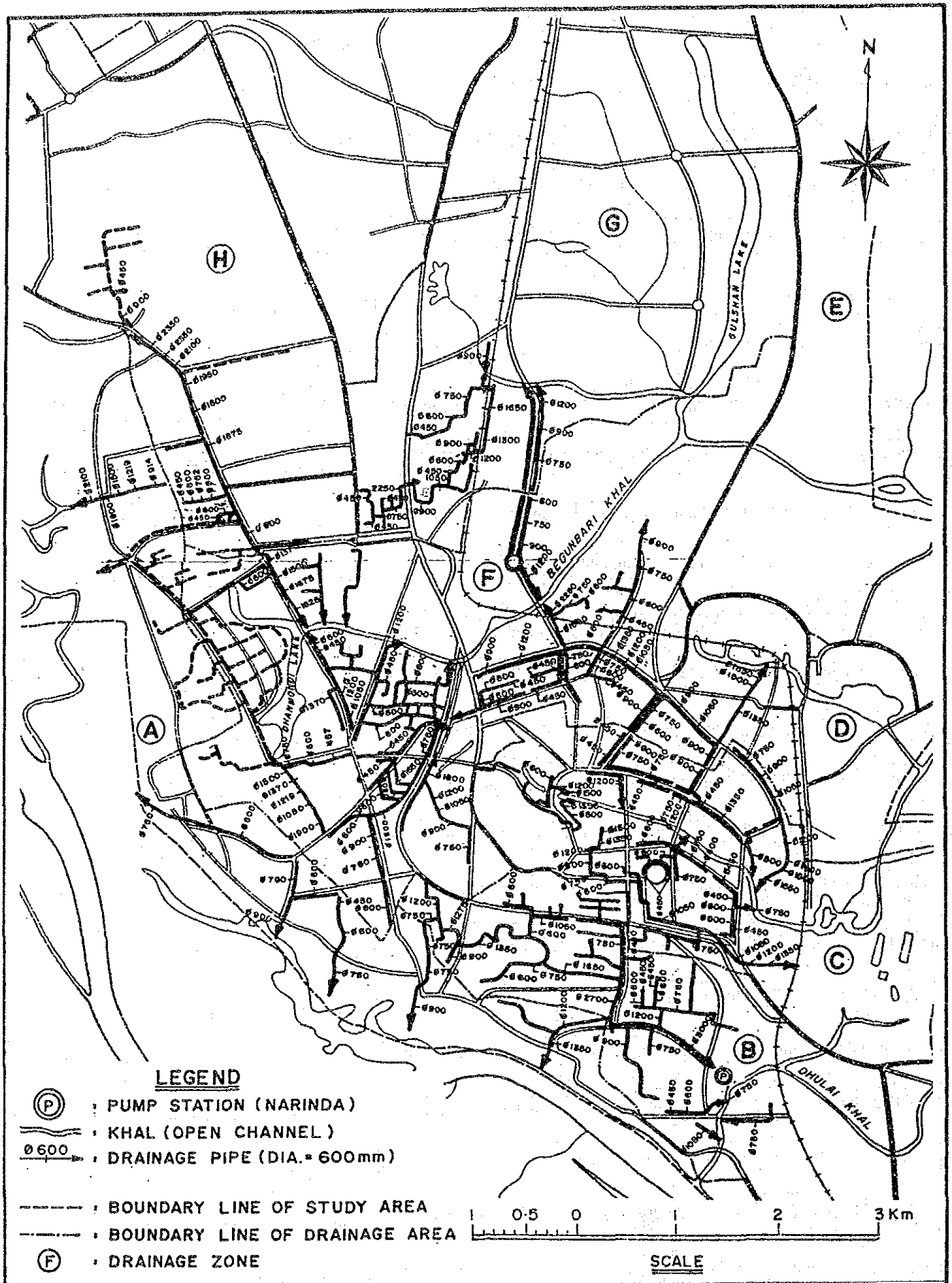

FIG. 6.4 LOCATION OF TRUNK DRAINAGE PIPES IN DHAKA CITY

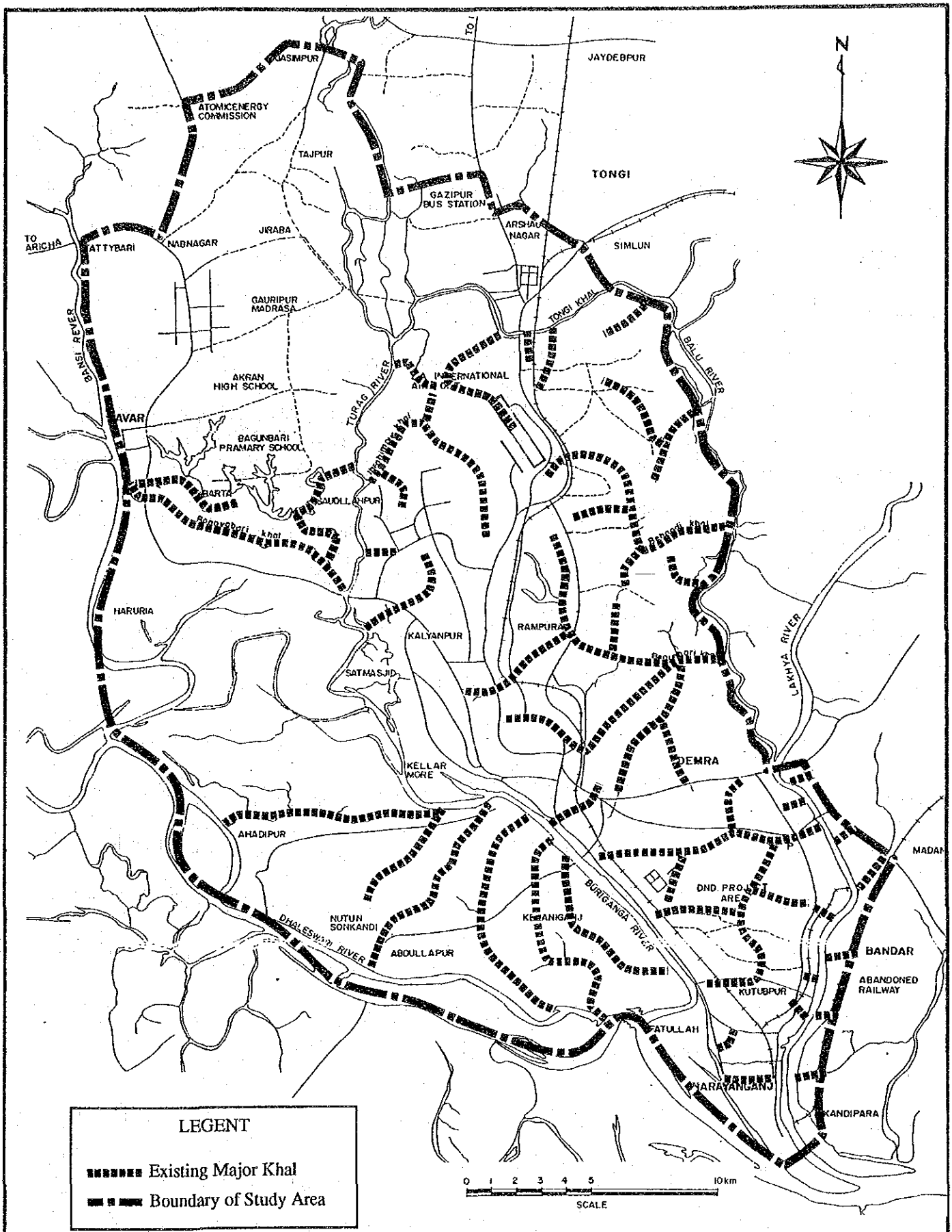

FIG. 6.5 KHAL NETWORK IN DHAKA METROPOLITAN AREA

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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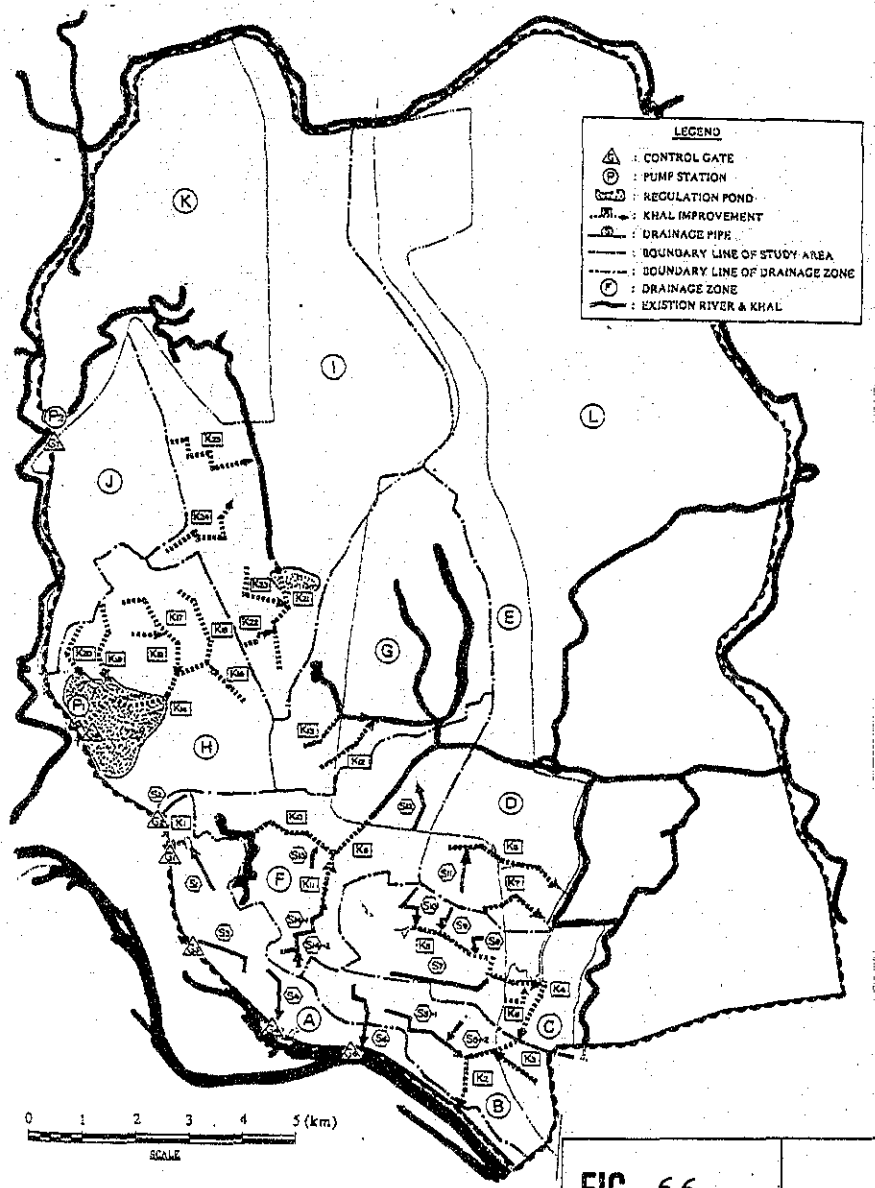

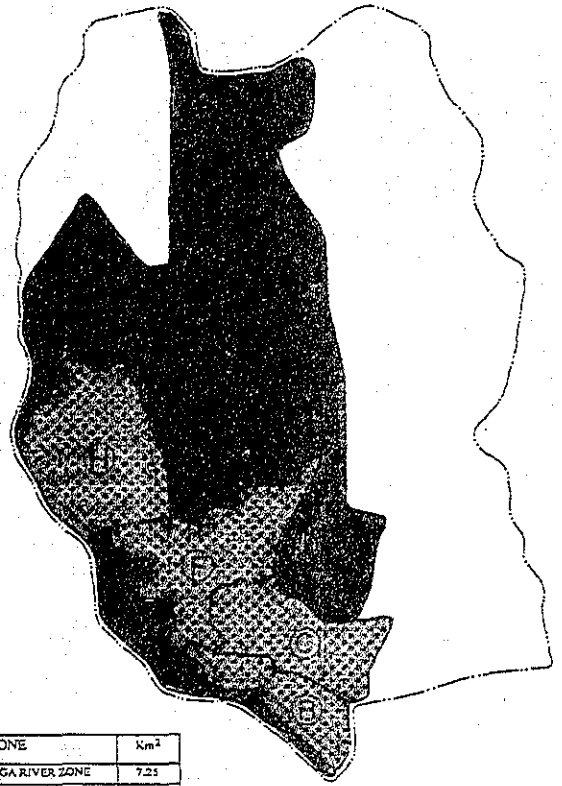

DRAINAGE ZONE		Km²
A	BURIGANGA RIVER ZONE	7.25
B	DHOLAI KHAL ZONE	7.24
C	SEGUNDAGICHA KHAL ZONE	10.92
D	BASHABO ZONE	7.46
E	NORTH EAST EDGE ZONE	13.93
F	BEGUNBARI KHAL ZONE	13.70
G	GULSHAN-BANANI ZONE	17.64
H	KALLYANPUR ZONE	17.60
I	NORTH ZONE	31.42
J	TURAG RIVER BANK ZONE	7.69
	TOTAL DRAINAGE AREA	134.85

LEGEND

: First Priority Area

: Second Priority Area

FIG. 6.6 PROPOSED FACILITIES AND THEIR PHASED PROGRAM BY JICA STUDY

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METRO OLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

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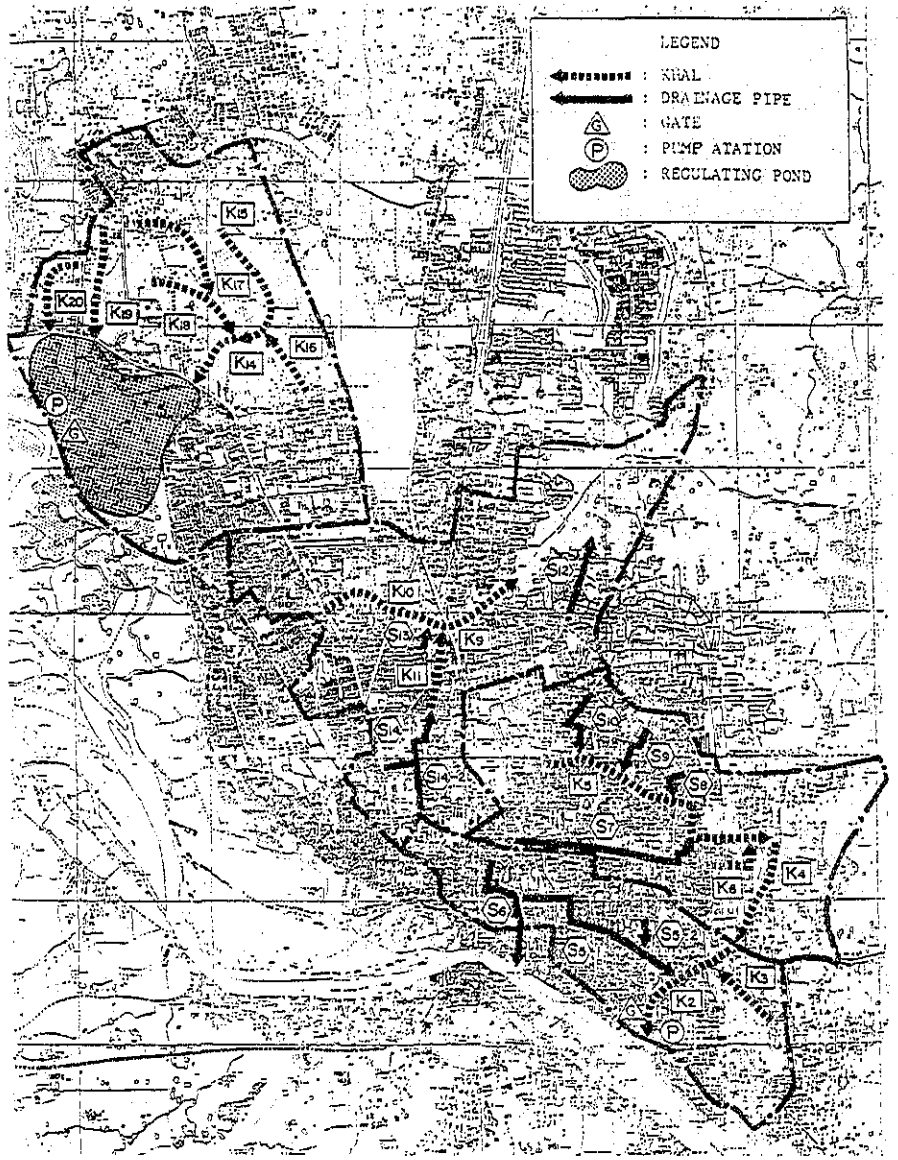


PROPOSED PHASED PROGRAM

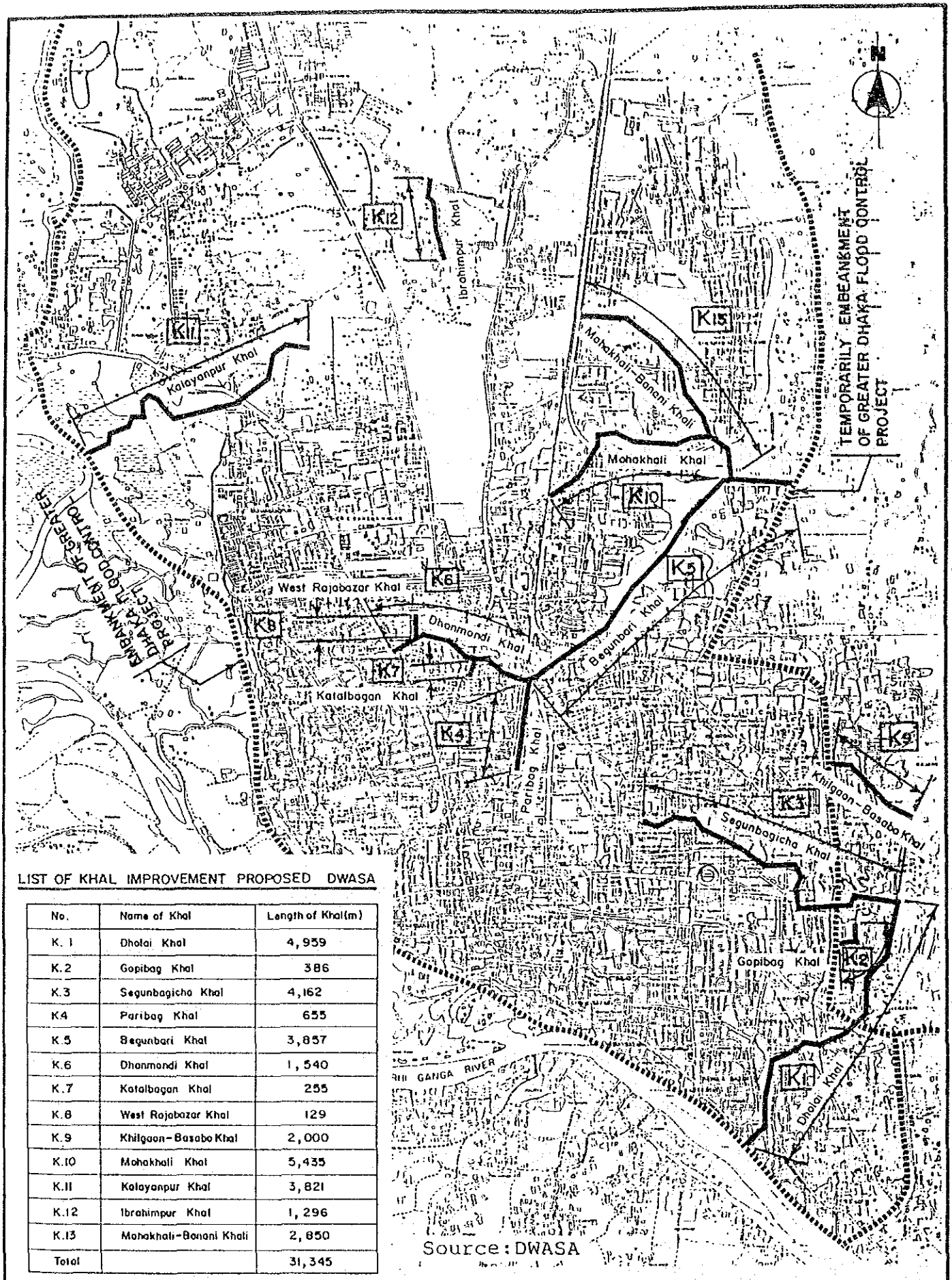
Unit : Million Tk at 1989 price

ZONE	WORKS	PHASE I		PHASE II		REMARKS
A	(1)Drainage Pipe			L=5.80km	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=4.81	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.II=K14
	(2)Pump Station	L=10.0m3/s	226.7	Q=10.0m3/s	226.7	K15.K16.K17
	(3)Sluice Gate	n=1place	30.9			K18.K19.K20
	(4)Land Acquisition	A=5.20ha	68.0	A=3.10ha	46.4	
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.

FIG. 6.7 URGENT PROJECT PROPOSED BY JICA STUDY

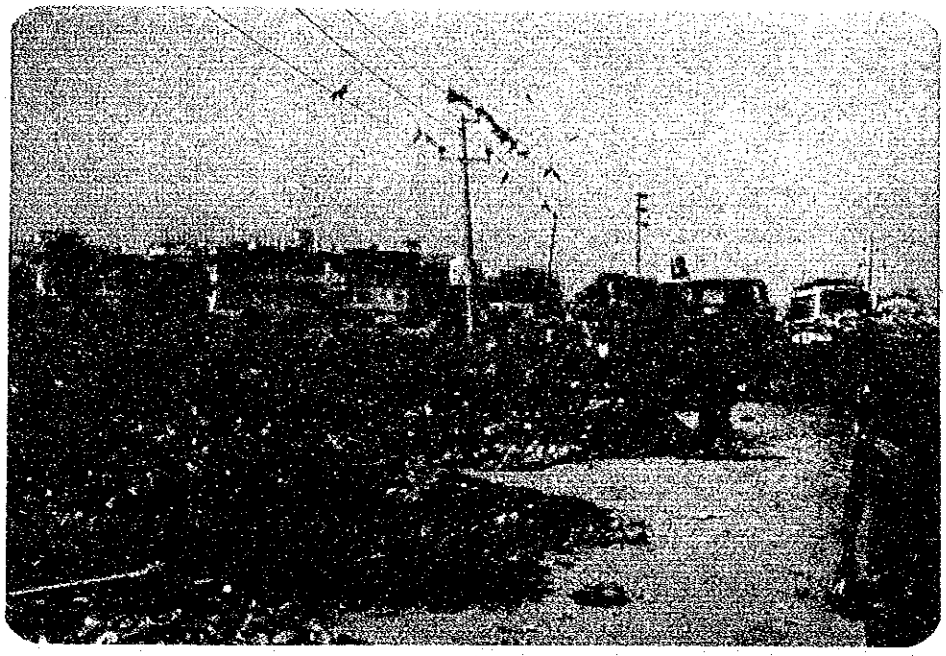
GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METRCPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



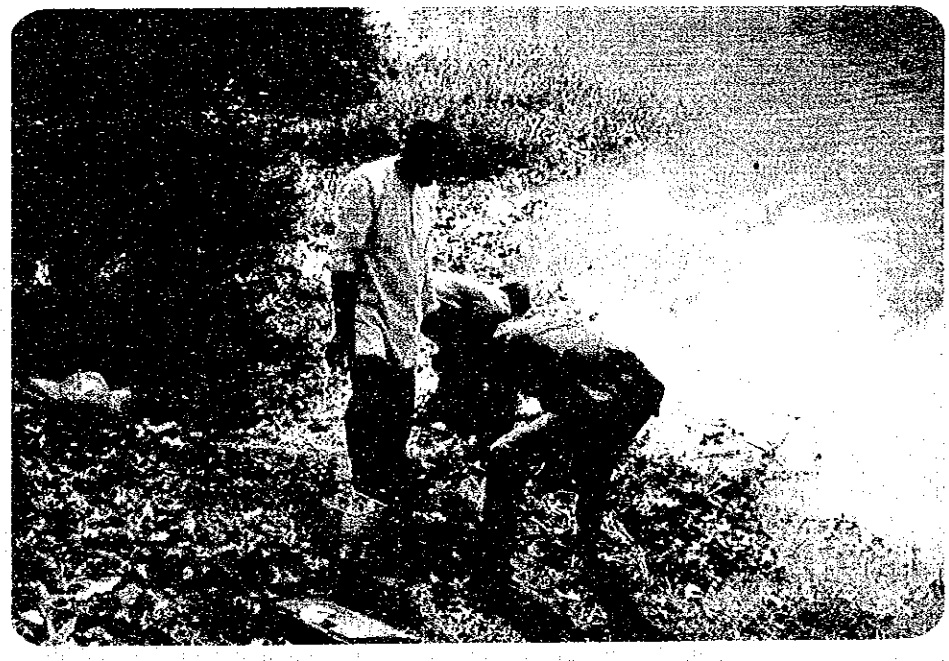
LIST OF KHAL IMPROVEMENT PROPOSED DWASA

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. 6.8 URGENT KHAL CLEANING PROJECT BY DWASA



Insanitary Landfill in Jatrabari



Water Quality Sampling in Gulshan Lake

CHAPTER 7

LIVING ENVIRONMENT

CHAPTER 7 LIVING ENVIRONMENT

7.1 General

This study aims to assess existing environmental conditions principally in the urbanized regions of the study area. The important direct environmental aspects concerned are potable water, sewerage and sanitation, and solid waste management, which are infact basic public health amenities.

Accordingly, an inventory study covering existing water supply, sewerage and sanitation, and solid waste management facilities was conducted in the study area. In addition, surface water quality, which is the prime indicator of pollution, was assessed, based both on available data and on a sampling survey conducted by the study team. Available information on slums and environmental standards was also reviewed.

7.2 Inventory Study

7.2.1 Water Supply Facilities

The study area is broadly classified into two (2) categories based on existing conditions of potable piped water supply used.

They are:

(1) Areas with provision of piped water supply facility
(2) Areas with no provision of piped water

The provision of piped water supply in the study area by Dhaka Water and Sewerage Authority (DWASA) is confined to a portion of the existing urban areas of Dhaka and Narayanganj. The service areas cover portions of the respective municipalities, Dhaka City Corporation (DCC) and Narayanganj Municipality, as shown in Fig. 7.1. The cantonment area of Dhaka has its own private water supply facility.

1) Dhaka Water Supply

The original area served by piped water covered approximately 1,500 ha. on the northern side of the Buriganga River. The capacity of the treatment plant was 13.5 MLD, which is now expanded to 27 MLD.

At present (1990) the piped water service area of Dhaka encompasses about 130 km^2, which represents 58% of the DCC area of 226 km^2.

Existing sources are composed of both surface water and groundwater with independent but virtually interconnected service areas (ref. Fig. 7.1). Despite the number of rivers in and around Dhaka, surface water contributes to only 3% of the total water served of 530 MLD. The remaining 97% (514 MLD) is obtained from 146 deep tubewells.

The groundwater based water supply system was developed by DWASA I and II projects and is being further expanded by the ongoing DWASA III project, scheduled to be completed in 1991 in order to further improve the water supply in DCC area.

There are 33 elevated storage tanks throughout the Dhaka service area at present, of which 30 are operational. In many areas the water pressure is too low to fill the tank, even during low demand periods. Thus, most of the time they are ineffective. Table F.1 of Supporting Report F could be referred for details on existing status of these elevated tanks.

Piped water connections are estimated to serve a population of about 2.7 million. The population served with public stand posts (about 1,200) is about 0.3 million. Hence on average one stand post serves 250 people.

In addition to the DWASA served population of 2.7 million, it is estimated that another 0.5 million people including those in Dhaka cantonment, are provided with privately owned piped water supply. Accordingly, the piped water service covers a potential total population of 3.2 million, which is 78% the total Dhaka population of 4.1 million.

There are numerous old pipes in the DWASA distribution system that are in urgent need of replacement. Leakage in the distribution system is widespread, and is the major cause of low distribution pressure.

DWASA is at present implementing two (2) improvement and expansion schemes to its groundwater based water production and distribution network.

They are :

(1) Urgent Expansion Project (UEP) or WASA III, under financial assistance from IDA.

(2) Crash Program Under GOB finance.

A recent study of Feb. 1991, Dhaka Region Groundwater and Subsidence Model Study, accomplished under IDA finance for DWASA, deals with the effects of increasing groundwater abstraction for potable water and other uses in the Dhaka region.

This IDA study identified a significant decline in pezometric levels in the urban areas of Dhaka due to increasing groundwater abstraction, corresponding to increased urbanization. Especially in the highly urbanized Motijheel area, an annual pezometric level decline of more than 1m has been reported during the period of 1987-1990. No significant land subsidence is observed.

The topmost ground layer of Dhaka is composed of Madphur clay, the compressibility of which is determined to be very low by the subsidence risk assessment of the above Study. This topmost layer serves as an effective barrier in mitigating contamination of groundwater by polluted surface waters.

Moreover, the thick partly unsaturated silty and fine sands underlying the topmost clay layer offers excellent potential for groundwater purification during infiltration. This is confirmed by very low nitrate concentration (NO_3N) of less than 0.7 mg/l measured in all the tubewells, located at 12 different locations, by the above IDA Study. Nevertheless, the protection of groundwater quality is a serious concern and particular attention should be paid to ensure its quality assurance.

2) Narayanganj

Narayanganj has a 70 year history of piped water supply. There are two independent water treatment and distribution systems, on both sides of the Lakhya River. Major expansion and rehabilitation works were accomplished recently, during 1985-1989, with financial assistance from JICA. Accordingly, the water service coverage planned has been enhanced to a level of 94%, from 44%. The water source comprises both surface water from the Lakhya River and groundwater. Though the daily water production capacity is 64 MLD (45 MLD at the West Bank, 19 MLD at the East Bank) at present, the water production is only

16 MLD. This is attributed to low progress in achieving the targeted house connections.

3) Tongi

Tongi Municipality is the only municipality which is not covered by piped public water supply. Tongi is predominantly an industrial center and industries generally have their own water supply facilities. There are about 337 dug wells, 264 shallow tubewells and 29 deep tubewells installed by municipality for public water supply, mainly for potable use. These are located in common public places.

4) The Other Areas

The rest of the area is predominantly rural. In these areas, groundwater by means of deep tubewells and shallow wells is the major source of drinking water.

The Department of Public Health Engineering (DPHE) is responsible for provision of potable water in all non - municipal area.

With the assistance of UNICEF, DPHE is implementing potable water schemes with deep and shallow tube wells at Keraniganj, Savar and other areas, targeting the poor.

Keraniganj has a very low coverage of potable water facilities. In Keraniganj Upazila, the total number of DPHE tubewells is around 2800, serving a population of about 775,000. This results in a coverage of 275 people per tubewell, much lower than the national average of around 135 people per tubewell. This low coverage in Keraniganj is due to its rapid population growth which increased more than two fold during the last 10 years.

7.2.2 Sewerage and Sanitation Facility

Within the study area, a portion of DCC Area has the only sewerage facilities in Bangladesh. This was originally developed to serve Old Dhaka area in 1923, and later expanded with the expansion of the city. Hence this area could be defined as the sewerage area. However, as the sewerage system does not serve the entire population in its service area, and such non-sewered population depends on on-site sanitation facilities in the same way as in areas having no sewerage facility, still the whole study area could be defined as a sanitation area.

1) Sewerage Area

The existing water borne conventional separate sewer covers about 33% of the DCC Area, but connects not more than 50% of residents, making the remainder dependent on on-site sanitation measures. The main sewer lines and existing stabilization pond treatment plant in Pagla, having its final disposal into the Buriganga River, are shown in Fig. 7.1. Dhaka sewerage is under the jurisdiction of DWASA since 1963.

There exist 440 km of sewer lines and 37,522 sewer connections. Assuming one sewer connection serves about 25 persons, the sewered population is estimated at about one (1) million.

At present three (3) improvement schemes are on-going by DWASA. They are:

(1) Urban Expansion Project (UEP) or WASA-III under IDA finance,
(2) Rehabilitation Programme of sewer system by JICA
(3) Sewer construction and rehabilitation project in Mirpur under Dhaka Urban Infrastructure Development Project with ADB finance.

2) Sanitation Area

The sanitation area covers the whole study area including the sewerage area. The study area is composed of urban centers, semi urban centers and the rural area. The urban centers are the three municipalities of Dhaka, Narayanganj and Tongi, covering 277 km^2 of the study area. The remaining areas are predominantly rural with some small semi urban centers.

Provision of on-site sanitation or sanitary disposal of human waste is the responsibility of the municipality in all municipality areas, with DPHE being responsible in all other semi urban and rural areas.

The available on-site sanitation facilities for human waste disposal include pit latrines makeshift latrines (Kutcha latrines), twin pit leaching pits, septic tanks and public toilets. Bucket latrines are also reported to exist in Dhaka and Narayanganj municipalities.

In all on-site sanitation areas generally, household sullage (gray water) is discharged to nearby ditches / drains and is the major cause of water pollution.

The service level of sanitation lacks behind that of sewerage, even in the DCC area, not to mention the other areas.

The common practice of defecation in rural areas is by makeshift or open latrines or defecation in the open field. Coverage by good sanitary latrines including pit latrines, is not more than 4%. DPHE, with assistance from UNICEF, is at present implementing the construction of water sealed leaching pits as low cost sanitary latrines in semi urban and rural areas at a subsidized rate, as an improved means of on-site human waste disposal.

7.2.3 Solid Waste Management

The service area for collection, transport and disposal is confined to the three urban municipal areas as shown in Fig. 7.2. Other major private solid waste management systems in the study area cover the cantonment areas of Dhaka and Savar military zone.

There is no organized solid waste management in semi urban and rural areas.

1) DCC Area

DCC manages the solid waste collection, transport and disposal in the whole area under its jurisdiction, that covers about 226 km^2. The community bin system of collection is used.

Insanitary land fill by dumping of solid waste is the general practice. The major site of dumping is Jatrabari. It seems that solid waste is considered simply as a resource of land filling material, of value in a low-lying area. Accordingly it is transported and disposed off at a variety of locations, overlooking the adverse environmental and public health implications of insanitary land filling.

Under the Environmental Improvement Project funded by IDA, a site covering 25 ha at Matuail along the Dhaka Demra road, 3 km outside the DCC limit, has been proposed as the future sanitary land fill area.

In a developing country municipality like Dhaka, the solid waste collection rate is in the order of 50-60% of generation. Assuming a collection rate of 50% and a population of 4.1 million, the per capita solid waste generation rate is estimated at 375 g/capita/day, which corresponds to a total generation of 1,540 ton/day.

This compares with the per capita solid waste generation rate of 330 g for Jakarta, Indonesia in the year 1985, estimated by the JICA Solid Waste Management Study.

2) Narayanganj

At present, most waste is transported and dumped mainly in a single area in Tanbazar (approx. 1/2 ha) where a land development programme is being undertaken by the Municipality. Other low-lying areas or ditches scattered throughout the town are also filled regularly.

The quantity of solid waste collected by trucks is estimated at 14.0 ton/day. Assuming a collection ratio of 40%, the total quantity of solid waste generation is estimated to be about 35 ton/day.

3) Tongi

No specific area is designated by the municipality for solid waste disposal. The waste is disposed at low lands scattered throughout the municipal area, especially the road side ditches north of the telephone factory. The waste is simply dumped in low lying land without following any specific sanitary procedure or plan. Assuming a collection ratio of 40%, the quantity of solid waste generation is estimated at 12.6 ton/day.

7.2.4 Slum Settlement

The present number of slums and their population has been identified as a crucial problem of urban life. The number of slum dwellers are increasing very rapidly, especially in Dhaka, though there are slums in and around all three municipalities.

There are virtually no slums in the rural areas, such as Keraniganj and Savar, though housing conditions in Jinjira could be considered slum-like because of its high population density, unplanned urbanization and lack of social amenity.

Considerable information on slums and slum dwellers in Dhaka is available from various organizations who have conducted survey and research. However, it is very difficult to get an accurate information on the number of slums and their population, though abundant information is available on the physical condition of the slums.

The location of slums in DCC area as surveyed by the Center for Urban Studies (CUS) of the Geography Department of Dhaka University in 1988 is shown in Fig. 7.2. Slums are found in all the 75 wards of the DCC area, except that of ward No. 54 (Motijheel Colony Area), and even in Banani and Gulshan areas. Slums are also found on areas along railway lines. Slums normally grow nearer to the potential areas for work and trade.

Most of the slum grew in recent years. According to the CUS survey in 1988, 25% of slums were established during the last 7 years and 70% in the last 17 years. Slums which existed for more than 20 years are about 23% out of a total of 1125.

The population density of Dhaka slums is very high, since large number of people live in comparatively small areas. The population density of Dhaka slums can be as high as 2500 ~ 5000 person/ha. Based on the CUS survey of 1125 slums, it is found out that about 70% of the slums have a population not more than 300 person and a total number of families not more than 80, illustrating a high distribution of small sized slums typical to Dhaka.

Community service level is very poor in slums as evident from Table 7.1.

Not much information is available concerning slums in Narayanganj and Tongi. The information obtained from the municipalities on slum dwellers is that there are 3785 families (18400 people) in Narayanganj and 830 families (3212 people) in Tongi.

A few slum improvement schemes have been executed. In 1975, about 200,000 squatters / slum dwellers were evicted and 70,000 were shifted to three sites. Later on, two schemes were taken up to rehabilitate about 50,000 people permanently. The schemes are funded by GOB and international agencies.

The growth of urban slums has very complex sociological aspects. It is not often practicable to use relocation as the sole means of slum improvement. It is more appropriate and economical to utilize the self help potential of the dwellers to the maximum possible extent to improve their living conditions by themselves.

7.3 Environmental Quality

7.3.1 Surface Water Quality

Surface water quality and ambient air quality are the priority elements representative of overall environmental quality of an area. The surface water quality of the study area is evaluated principally by a sampling survey conducted by the study team, while available information was used for assessing ambient air quality.

The Department of Environment (DOE) has at present twenty monitoring stations throughout the whole country. Of these, five surface water monitoring stations fall within the study area. Their locations are shown in Fig. 7.3. All these stations are located in the river reaches of the Buriganga River (3 stations), the Balu River or the Tongi Khal (1 station) and the Lakhya River (1 station).

No significant trend in river water quality variation was noted based on the available data of these five(5) stations.

The JICA study team conducted water quality sampling at 21 selected locations which also included three(3) monitoring stations of DOE (ref. Fig. 7.3) both during dry season of January-February 1991 and rainy season of July~August 1991. The sampling locations were selected to include rivers (5 No.), khals (10 No.), lakes (5 No.) and ponds (1 No.) in the whole study area, with prominence given to urban areas.

The water quality parameters, measured respectively in field and laboratory, are itemized below :

(1) Field measurement : Temperature, Colour, Odour, Turbidity, PH, Electric Conductivity (EC) and Total Dissolved Solids (TDS).

(2) Laboratory measurement : Suspended Solids (SS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Organic Nitrogen (Org-N), Ammonia Nitrogen (NH_4N), and Fecal Coliform Density (FC).

The results of water quality analysis of dry season and rainy season are summarized respectively in Table F.10 and Table F.11 of Supporting Report F.

7.3.2 Water Quality Evaluation

Both the dry season and rainy season water quality as measured by the study team are evaluated with due consideration to typical beneficial use in the Study Area. The important potential beneficial uses considered are aquaculture (fishery), irrigation and other water contact activities. The appropriate criteria recommended for tropical developing countries by Pescod (AIT, 1973) and other available relevant standards/criteria as well as aesthetics were used for purposes of evaluation. In general, if a water body can support aquaculture then it will be suitable for all other important beneficial uses, including potential water supply source. The results of evaluation, distinguished between dry and rainy season water quality, is summarized in Table 7.2.

It is evident from Table 7.2, the dry season water quality results in limited beneficial use, and hence the critical conditions, as expected. Accordingly, the overall beneficial use of the sampled water bodies under critical dry season conditions in summarized below.

All the rivers sampled are relatively unpolluted (BOD less than 10 mg/l) while most khals are polluted (BOD 200 - 400 mg / l). Water quality of all five rivers and three Khals, namely Begunbari Khal in Amin Bazar, Hydrebad Khal in Tongi and Lakya Khal in Narayanganj, are found to be suitable for all beneficial uses including potential water supply source. The three major Khals in the highly urbanized area, Begunbari, Segunbagicha and Dolai Khals, are in fact open sewers with no beneficial use. They are black in colour and emanate an offensive odour.

The stationary bodies of lakes and ponds are moderately polluted and fall between the rivers and khals. Ghognagar Pond in Narayanganj was the worst polluted, while the Nawaberbag Lake in Mirpur meets developed country standards for recreational water use like swimming.

7.3.3 Ambient Air Quality

At present there are no permanent ambient air quality monitoring stations in Bangladesh. However, on a demonstration basis, ambient air quality at three (3) locations in Dhaka city was monitored by the on - going NEMPCP project for ADB during January - October 1990.

The monitored locations are the DOE office premises in Lalmatia, the DOE Laboratory premises in Motijheel, and the Tejgaon industrial area. The parameters monitored are