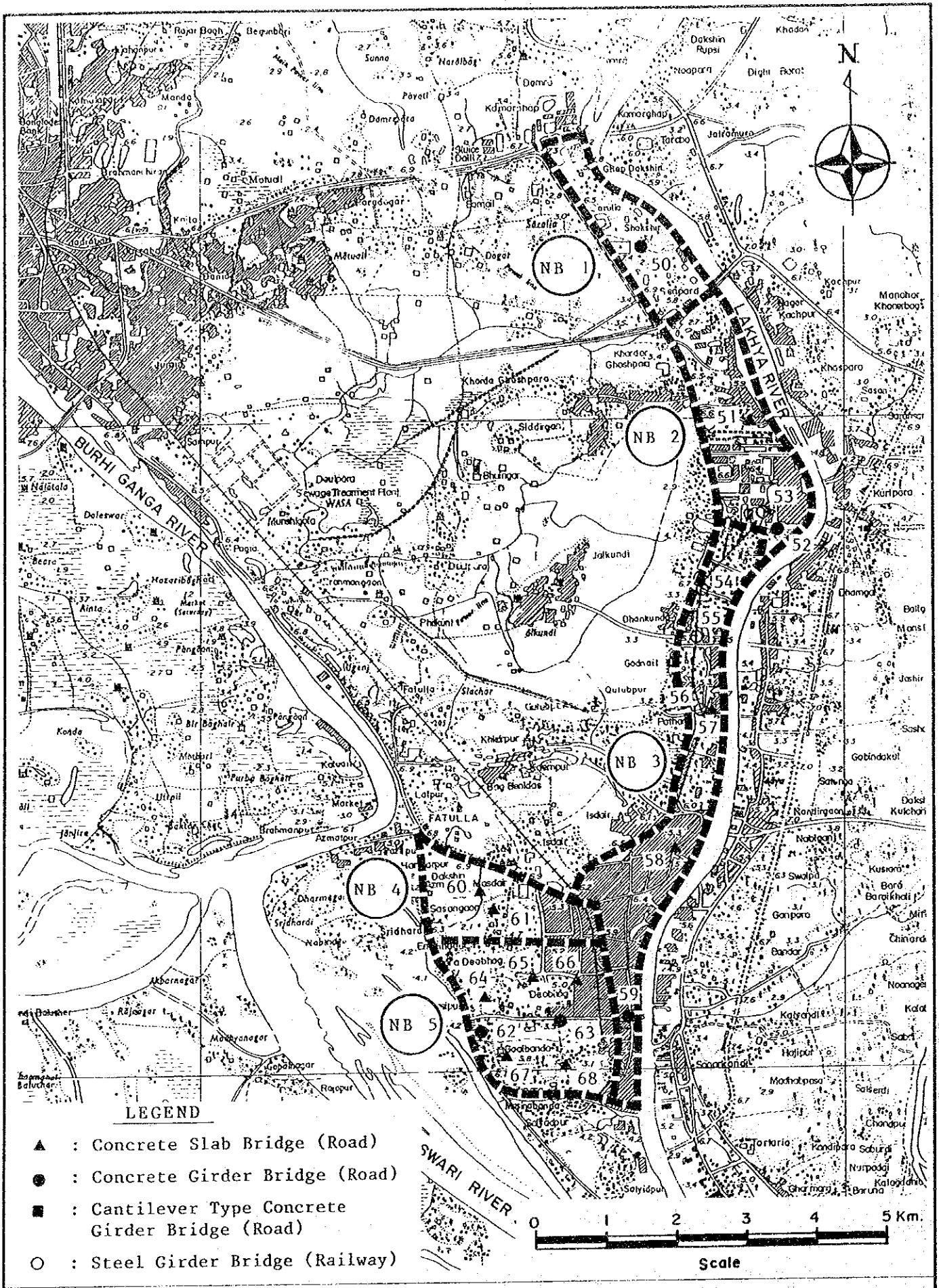

FIG. 6.3.11 LOCATION OF PROPOSED BRIDGES : NARAYANGANJ WEST

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

JICA

CHAPTER 7
ENVIRONMENTAL IMPACT

Chapter 7 : Environmental Impact

7.1 General

The environmental study in the feasibility study (FS) stage is principally targeted at the anticipated major environmental consequences, both of direct and indirect nature, by the implementation of the proposed flood control and drainage works. Though urbanization itself would lead to much direct environmental impacts, living environmental issue with specific concern to sanitation is only selected as the priority element for detailed consideration in this flood control and drainage project. The other major direct environmental issues of urbanization shall be addressed by future studies of direct concern. Nevertheless, major environmental effects, both of direct and indirect, are still identified along with their significance. The possible mitigatory measures are also recommended.

7.2 Ecology

A comprehensive ecological survey, based on available secondary data in combination with judicious field verification, was carried out for establishing the base line conditions of existing ecological resources in the priority area of Greater Dhaka and Narayanganj (ref. Fig. 7.1), and hence to identify the impacts on such resources by the project implementation, on a preliminary basis. The ecological resources targeted by the survey are flora and fauna, termed as general ecological resources, and agriculture and aquaculture, termed as productive ecological resources in consideration to their direct economic value.

The survey was conducted during the six (6) month period from October 1991 to February 1992, to encompass both the flood season and dry season conditions. This is in due consideration to the distinct environmental conditions in the flood plains that predominates in Greater Dhaka East.

The impacts by the project on ecology, both due to the direct dry up effect of embankments and the subsequent change in land use due to urbanization, is evaluated to be insignificant when assessed from a broad perspective on a national basis.

7.2.1 General Ecology

Flora and fauna are the defined general economical elements. Fauna elements of an ecosystem could be grouped into four (4) categories. They are, in the sequential order of their evolutionary status, amphibian, reptiles, birds and mammals. Such a simple classification is impossible for flora due to their complex evolutionary status and varieties. Nevertheless floral elements in the priority area falls into two (2) broad categories of aquatic and terrestrial species. The aquatic species are classified into four (4) groups, namely, floating, completely submerged, partly submerged and marsh plants, while the terrestrial plant species are also grouped to four (4) categories of trees, shrubs, climbers and herbaceous weeds.

The total number of identified floral species and fauna species are 112 and 177 respectively. The surveyed fauna species is limited to that of wild origin.

Among the identified floral species, 81 are terrestrial belonging predominantly to the high lands, and 31 being aquatic of low lands and flood plains. Of the fauna species, 47 are aquatic, 122 are terrestrial and the remaining eight (8), that includes all amphibian, are both aquatic and terrestrial of origin.

However, all the fauna and floral species identified in the priority area are also distributed elsewhere in the country, and no species is confirmed as peculiar to the priority area.

The change expected to the general ecological elements due to embankment and the subsequent dry-up is the dominance of terrestrial species against the aquatic ones. Moreover, with the progressing residential development, even among the terrestrial species, those "domestic" species with direct economic significance to human welfare, like the planted floral species of jack fruit, mango and others, and the domestic fauna species like dog, cat, goat and others will become predominant.

7.2.2 Productive Ecology

The representative productive ecological elements are agricultural crops and aquacultural species of both natural (generally known as fishery) and artificially cultured (generally known as aquaculture).

During flood season, the lowland areas are encompassed by open water bodies. Such open water bodies are vast in the Greater Dhaka East. These open water bodies of

potential aquaculture during flood season becomes agricultural lands during dry season. This is a very typical phenomenon in most lowlands of the whole country.

1) Agriculture

The environmental study area covers about 34,000 ha (ref. Fig.7.1). Under the existing conditions of land use, agriculture accounts for 44% of the total land use covering about 14,800 ha, which is very significant.

The land use distinguished between agriculture and others in Greater Dhaka and Narayanganj is summarized below.

Agricultural Land Use in 1990

Land Use	Greater Dhaka		Narayanganj		Priority Area (Total)	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Agriculture	11,181	42.5	3,637	48.2	14,818	44
Others	15,126	57.5	3,905	51.8	19,031	56
Total	26,307	100	7,542	100	33,849	100

The farming practice comprises three annual seasons, namely Karif - I (March - June), Karif - II (July - October) and Rabi (November - February), which is practiced to suit the climatic and the related land and flood water area changes. Karif-I is the major crop production season, though Rabi the major planting season. Rice and wheat are the major crops cultivated. Their varieties are itemized below. The other products include oil seeds, potatoes, vegetables and pulses.

Rice (Boro)
HYV : Br-3, Br-8, Br-9, Br-12 and IR-8
Local : Amboro, Khaiyaboro, Chiniboro
Improved : Pyzam

Rice (Aman)
HYV : Br-3, Br-4, Br-10, Br-11and IR-20
Improved : Pyzam

Rice (Aus)
HYV : Br-12, Br-15, Br-16 and IR-8

Wheat

HYV : Sonalika, Balaka, Kanchan, Barkat ,Akbar and Ananda

Single cropping, which is confined to Rabi and Karif-I season, is predominant that covers 58% of the total agricultural lands which are mostly flood plains. While double cropping encompassing two seasons accounts for about 33% and triple cropping covering all three (3) seasons accounts for the remaining 9% of agricultural lands, being confined mostly to flood protected DND area.

Accordingly, the average cropping intensity in the whole objective area (priority area) becomes 152%, which is much less than the cropping intensity of Dhaka district with 171%. Hence, it could be concluded that this priority area that encompasses both the existing and the prioritized future urban area is more suited for urban land use than that of agriculture, based on the existing conditions. Nevertheless, it is to be admitted that flood mitigation and drainage would increase the potential cropping intensity of the protected agricultural land, which is predicted to increase up to 160%, but still less than 171% of Dhaka district. Breakdown of existing cropping pattern along with the respective areas is tabulated below.

Existing Cropping Pattern in Priority Area

Pattern	Location	Cultivated Area		Cropped Area	Cropping Intensity
		ha	%	ha	%
Single Cropping	Balu River Flood Plains - East Dhaka Buriganga - Turag River Flood Plains - West Dhaka	8,523	57.5	8,523	57.5
Double Cropping	DND Area Buriganga - Turag Drainage Basin - West Dhaka	4,945	33.4	9,890	66.8
Triple Cropping	DND Area	1,350	9.1	4,050	27.3
Total :		14,818	100	22,463	151.6

The corresponding cropped area, yield and annual production of major agricultural crops are estimated as given below :

Crop	Cropped Area (ha)	Yield (ton/ha)	Annual Production (ton/annum)
Rice	19,863	3.24	64,342
Wheat	130	0.80	104
Potato	185	12.40	2,294
Oil Seeds	850	0.50	425
Pulses	290	0.69	200
Vegetables	1,085	19.20	20,832
Fruits	60	27.00	1,620
Total	22,463		89,817

The total existing annual net value added of agricultural production, is estimated at about Tk. 389 million.

The future agricultural land use in 2010 will occupy only a limited area, even if a portion of retarding areas which could be used for agriculture during dry season is included. Intensive agriculture practice in the remaining flood protected agricultural lands is recommended.

2) Aquaculture

Most low lands and flood plains of single cropped agriculture are the potential open water capture fishery areas of rainy/flood season. Balu river flood plain of Greater Dhaka East is the predominant spawning grounds of open water capture fishery. The low land of DND is also of considerable importance.

A total of 86 aquacultural species comprising 74 fish species, 10 freshwater prawn species, and two (2) crab species is identified in the priority area. In addition five (5) exotic species also exist. All cultured species are also found naturally in open waters. Of these 86 species 25 species are identified to be commercially important. Among both the commercially important and exotic species, eight (8), five (5) of commercial and three (3) of exotic, are noted as highly profitable for culturing (aquaculture).

There exist four major fishery/aquaculture systems in the priority area. They are :

- River / Khal fishery
- Flood plain fishery
- Beel and reservoir fishery
- Culture fishery or aquaculture

Of the above four (4) fishery systems, both the flood plains and beel and reservoir open water fishery will be directly affected by the project, with the embankment and the subsequent dry-up of flood plains. As in the case of agriculture, the change in land use to urban will still critically limit even culture fishery (aquaculture) in these former flood plains, even though its potential will be enhanced with flood protection measure.

The ongoing urbanization will lead to increased pollution load generation. If urbanization proceeded with inadequate pollution control measures, then the resultant water quality deterioration of internal rivers and khals due to increased pollution load discharge would affect even the river/khal open water fishery, indirectly.

Hence pollution control measures with progressing urban, industrial and other developments are necessary for rendering the water bodies suited to a variety of beneficial use, including aquaculture/fishery.

7.2.3 Impact and Mitigation

1) Ecological Impact

Irreversible ecological change in the existing flood plains, predominantly in Greater Dhaka East, would result in consequent to the project implementation and the progressing change in land use to urban and others.

(1) General Ecology

The aquatic flora and fauna that is dominant in the existing low lands and flood plains will be replaced with terrestrial ones, other than in the proposed retarding areas and other water bodies. Moreover, with residential developments, even among the terrestrial species, those species of direct significance to human welfare will tend to predominate. The flood protected DND area depicts this state of ecological change, at present.

(2) Productive Ecology

Potential loss to open water capture fishery in flood plains and beels is inevitable as a direct consequence of their dry-up by embankments. Though, the project will be beneficial to agriculture and culture fishery, the subsequent change in land use to urban will limit their development, other than in the reserved and retarding areas, and water bodies, an indirect effect.

2) Mitigatory Measures

The proposed mitigatory measures encompass both within and beyond the project area, the priority area (ref. Fig. 7.1). This is in consideration to the fact that Bangladesh as a whole is a delta with vast flood plains. Hence it is rational to undertake the mitigatory measures flexibly to suit the local conditions, as environment has no easily defined boundary.

(1) Measures within the priority area

(i) Establishment of an aquatic and terrestrial wild life sanctuary in Dhaka East, similar to the Mirpur botanical garden and zoo of Dhaka West shall be considered. Kaskara area adjacent to the proposed northern most retarding area (ref. Fig. 4.2), where the indicative land use in the year 2010 is agriculture, is a potential location recommended for detailed investigation.

(ii) Intensive agriculture and aquaculture in the reserved agricultural lands, retarding areas and other closed water bodies shall be practiced. Fish culturing and management technology, which is at a primitive level in comparison to agriculture, is in need of improvement in order to enhance the harvest biomass.

The above measures would compensate the inevitable ecological change imposed by the project to some extent.

(2) Measures beyond the priority area

It is emphasized that of the master plan area of 850 km^2, the low land flood plains demarcated for flood protection and subsequent urban development is confined principally to the Balu River flood plains of Dhaka East only. An area of about 328 km^2 in Keraniganj and Savar is proposed to remain as flood plain

management area with no urban development. Moreover, a high land rural area of about 43 km^2 in Savar also proposed to remain rural (ref. Fig. 10.1 of Chapter 10, Main Report, Master Plan), though there still remain vast flood plains even around the master plan area.

It is recommended that these rural master plan areas be targeted for conservation and development of ecology by future study programmes.

Finally in consideration to the availability of vast flood plains around the project area, and their potential to conservation and development of both the general and productive ecology, the limited irreversible environmental change that would occur in the future urban area is assessed to be insignificant, from a national view point.

7.3 Environmental Monitoring

7.3.1 Significance of Retarding Area

The proposed retarding areas of internal drainage and subsequent pumping are identified to be the most comprehensive future environmental monitoring stations of water quality. This is due to the fact that a retarding area would be temporary storage location of the whole surface run-off from the drainage basin concerned. Such surface run-off include the pollution load run-off due to all human and other related concerns such as domestic, institutional, industrial, agricultural and other activities.

Accordingly, the base line water quality under the existing conditions in the proposed retarding areas were monitored both during flood season (October 1991) and dry season (February 1992) at fifteen (15) locations. The sampling locations are shown in Fig.7.1. The water quality parameters measured respectively in field and in laboratory are the same as those of master plan study and 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 flood season and dry season are summarized respectively in Tables 7.1 and 7.2.

7.3.2 Water Quality Evaluation

The baseline water quality conditions as measured both during flood and dry seasons in the proposed retarding areas were evaluated based on the important beneficial uses of aquaculture, irrigation and other water contact activities.

It is to be noted that though most proposed retarding areas are just low lands and yet to serve their purpose, still three (3) sampling location in the Greater Dhaka West of FAP-8B project area, namely, location No. 12, 13, 14, already function as de facto retarding area to some extent due to the existing DFPP embankment constructed by GOB after the 1988 floods.

As expected, in an overall sense critical condition in water quality occurred under dry weather flow conditions, in dry season, during which the major composition of run-off is wastewater discharge. However, in some specific instances rainy season water quality may be deteriorated than that of dry season, in low-lying areas. This is because pollutants, that would otherwise be retained in or near the point of their generating source during dry season, are get washed off due to the availability of large quantity of rain-fall run-off.

The dry season water quality of Kesdanga bil and Trimohani khal (No. 7 and No. 8 in Fig. 7.1), which receive their run-off respectively via Segunbagicha cum Gerani khal from Motigheel commercial area, and Begunbari cum Gerani khal from almost the whole commercial and industrial area (Tejgaon) of Dhaka West, is extremely poor and sufficient to justify the necessity of urban pollution control measures.

The baseline water quality of the following eight (8) sampling locations are assessed to be suited for all major beneficial use, including aquaculture, on a year round basis, based on both the analysis results of rainy/flood and dry seasons.

No.	Location No.	Name
(1)	2	Nayamati bil in DND
(2)	3	Kadamtoli pond in DND
(3)	4	Shimrail pond in Narayanganj West
(4)	5	Matuail khal in DND
(5)	6	Pagla pond in DND
(6)	9	Gazaria bil in Dhaka East
(7)	10	Baraid Bazar pond in Dhaka East
(8)	11	Dhamaahl bil in Dhaka East.

7.3.3 Recommendation on Monitoring

Institution of stream water quality monitoring station in the retarding areas, in the internal drainage channels (Khals) leading to those retarding areas and in the Balu-Lakya River, would become necessary with the implementation of this project. This will assist in formulating and implementing the necessary pollution control measures abreast the change in land use.

The parameters of monitoring shall be decided based on the inventory data of the existing sources of pollution load generation due to human living environment, industry and agriculture. However, it is strongly recommended to monitor at least all those living environment related water quality parameters, as measured by the Study Team. Additional parameters may be decided depending on the type of other industrial and agricultural activities in the drainage basin concerned. Begumbari khal at Rampura, the run-off of which includes the Tejgaon industrial area as well, is one such location for monitoring both the living environment and industrial pollutant.

The frequency of monitoring will depend on the degree of time series variation in water quality, but a minimum frequency of two (2) times a year, once each during dry season (December ~ February) and rainy season (July ~ September) is recommended in order to account for the maximum annual deviation in water quality.

Finally, it is to be emphasized that monitoring in itself is just a data collection process. Unless the derived data are translated into action programmes by the agency concerned, DOE, to identify and regulate the polluters, it has the danger of manifesting as a worthless effort of resource wastage.

Urban and industrial pollution control measures are the only means to render the internal drainage channels (khals) and retarding areas to be suited to a variety of beneficial use. Otherwise, they would simply serve as pollution transport, storage and discharge locations.

7.4 Living Environment

7.4.1 General

An inventory study covering the whole study area of master plan of 850 sq. km, which incorporated this priority area of 340 sq. km, concerning water supply, sewerage and sanitation and solid waste management, the prime living environment aspects, has already been presented in the master plan study (FAP-8A).

Most of the existing piped water service area, sewered area and solid waste service area (ref. Figs. 7.1, 7.2 of Master Plan), is encompassed within the priority area of this study. Hence, a supplemental living environment study targeting the on-site sanitation condition and its socio-economic aspects in the priority area was conducted.

7.4.2 Sanitation in Priority Area

1) Sewerage

The existing sewered area of DWASA, that covers about 33% of Dhaka City Corporation (DCC) area of 226 sq.km, is entirely encompassed by the Greater Dhaka area portion of the priority area of this study. This sewerage system is dealt with in details in Chapter 3 of Supporting Report F, Master Plan.

The sewerage system is estimated to serve only a 15% of the population even within its service area. Hence the whole objective area is principally dependent on some form of on-site sanitation system for human waste disposal.

2) Sanitation System

The population in the objective area are presently using various alternative methods or ways of human waste disposal such as septic tank, pit latrine/leaching pit, bucket latrine, katcha latrines (make-shift latrine) and public toilets and open defecation. There are no exact data available about sanitation system as no specific recent studies in the priority area was conducted.

3) Socio-Economic Aspects of Sanitation

In the absence of no specific recent studies on sanitation, a sanitation survey conducted in Manikganj, a district town adjacent to Dhaka during August 1989, under the 18 District water supply and sanitation project in combination with information obtained from local authorities were used to determine the status of sanitation in relation to housing and income level. This is termed as socio economic aspects of sanitation.

It is determined that in Dhaka about 65% of population of high and medium income group with permanent and semi-permanent housings have adequate sanitation systems, being either sewered or having septic tanks. While, low income population of 30% with temporary housing have poor sanitation facilities like bucket latrine, makeshift latrine or no latrine.

This demonstrates the limitation of treating sanitation improvement measures as independent of overall socio economic community development, but still the priority to target low income communities for sanitation enhancement.

4) Operation and Maintenance

DWASA is responsible only for operation and maintenance of sewer system while DCC is responsible for all other sanitary facilities in Dhaka. In Narayanganj as there is no sewerage, municipality is the sole responsible organ for operation and maintenance of sanitary facilities. Due to improper operation and maintenance sewer line is blocked and broken in various places. There are even sewage disposal points towards low lands other than the designated Pagla Treatment Plant and are not at all maintained.

It is understood that at least 50% of the septic tanks and pit latrine are never desludged. Mostly hired cleaners do the desludging job. The average amount people pay to get their latrine or septic tank desludged/emptied is in the range of Tk. 300/= and Tk. 400/.

Operation and maintenance of sewerage and sanitation facilities require urgent attention of the concerned municipal authorities and DWASA.

5) On-going Sanitation Improvement Projects

A feasibility study of sanitation improvement was undertaken by ADB / UNDP under a sub-contract to the Housing Development Project (HDP) in 1985. The study comprised two study components namely Subcontract A and Subcontract B. Location of these study areas are as follows:

- Subcontract A, the old Dhaka project, involves the upgrading and development of sections of the oldest part of the city. The project is expected to be completed by 1997.

- Subcontract B, the Mirpur project, concentrates on the development/improvement of new urban areas in Mirpur, a relatively modern part of the city. The project is targeted for completion by 1994.

6) Sanitation Improvements Measures

The existing sanitary conditions and the available facilities and their operation and maintenance are very unsatisfactory.

The priority actions necessary for the improvement of sanitation are itemized below. They are elaborated in details under the FAP 8B comprehensive environmental management plan :

1. Organizing a public sector based scheme by the local authority like DCC/DWASA specifically on desludging of septic tanks.

2. Provision of twin leading pit toilets for low income population with makeshift or no toilet facilities.

3. Conversion of bucket latrines that remain into twin leaching pit type toilets and prohibition of construction of bucket latrines for new housings by the local authority concerned.

4. Education and campaign to increase the awareness of general population on the importance, means, and benefit of mitigating fecal-oral transmission of disease by adopting sanitary practice and customs.

7) Impact on Living Environment

The project in itself has only beneficial effects on living environment as flood mitigation and drainage measures contribute to public health improvements.

However the necessary means to meet the basic living environmental demands shall be taken up with progressing urbanization in the form of future water supply, sewerage and sanitation and solid waste management development programs.

7.5 Environmental Impacts and Remedial Measures

7.5.1 General

Environmental effects by the project will be predominantly beneficial though adverse to some extent. Specifically adverse effects would be social in nature that is felt by the immediate concerns in the vicinity of project implementation, such as those population displaced in making way for the project facilities and others.

These effects would be both of short term and long term and caused directly and indirectly by the project. Such effects are delineated below.

Both the significant direct and indirect environmental impacts by the project due to flood control and drainage and subsequent change in land use to urban and others are evaluated qualitatively in Table 7.3. An impact integer range from -3 to +3 is employed to represent respectively the maximum adverse and maximum beneficial effects. The necessity of future urban environmental improvement measures to realize a long term net benefit could be visualized from the above qualitative evaluation. Still, the project forms the basis of such measures.

It is emphasized that the direct benefits expected by the project implementation is overwhelming, for both the existing and future urban area of Dhaka, and the anticipated adverse effects in no way could justify the vice-versa.

7.5.2 Beneficial Effects

Major beneficial effects of short and long term realized by the project are summarized below.

1) Short Term Effect

(1) Employment opportunity

Employment opportunities will be generated for construction works. In order to maximize such employment opportunities labour intensive methods will be adopted as far as possible. Also technical training opportunities are availed of for engineers/ technocrats.

2) Long Term Effect

(1) Flood damage mitigation

Mitigation of flood damage to properties, facilities and other economic activities will be realized, the basic reason for this project formulation. Also psychological stress and flood induced displacement of people will be eliminated.

(2) Enhanced land use potential

Enhanced land use potential of flood free lands for urban, institutional, industrial and agricultural uses would be realized. This will be reflected by increased land valve.

(3) Public health improvement

Public health improvement by mitigation of cross contamination of water resources inherent to flooding, and the resultant waterborne epidemics is very significant. Flood mitigation would also facilitate the applicability of on-site sanitation/human waste disposal means such as pit latrine/leaching pit.

(4) Generation of employment

Permanent employment along with technical training opportunities for operation and maintenance of the flood control and drainage facilities will be generated.

7.5.3 Adverse Effects

Significant adverse effects of short and long term are given below.

1) Short Term Effect

(1) Severance

Severance in general implies inconvenience or difficulties which may be physical or psychological in nature experienced by those who are well adapted to the way of living under the conditions without project and are forced to re-adapt to the change in way of living imposed by the project. Such effects are interference to accessibility by embankments and flood walls.

(2) Navigation

Passenger and material transportation by boats is widely prevalent in the Greater Dhaka East during flood season, in the absence of any all weather land based road link between the Balu River and the Rampura-Biswa road.

However a compartmentalized development of the area would facilitate a gradual change over from water based to land based transportation with both functioning concurrently during the initial development stages. This would provide a time frame for those boatmen to switch over to alternative employment, thereby moderating the social impact.

(3) Construction effects

The construction activities involves earthen embankment by filling and compaction, khal improvements such as excavation and widening and pump stations.

The significant effect will be vibration and noise pollution and to some extent air pollution due to dust by the construction activities. However, embankment construction is widely practiced in Bangladesh, and the major embankment sites along Balu river and the retarding areas of pump stations are rural areas which means these effects will not be very significant.

2) Long Term Effect

(1) Resettlement

Resettlement of population displaced by land acquisition for the project, such as embankments and khals is an important negative social impact of the project. This is

considered to be relatively long term in consideration to the movement and the subsequent adaptation involved by those moved. The cost of resettlement and compensation is incorporated as a negative benefit of the project.

(2) Living environment

This is a major indirect consequence by the project, due to subsequent urbanization and the resultant potable water, pollution load and solid waste generation by the increased population. The mitigatory measures are the provision of such basic public health amenities in future. In this regard, the water quality monitoring of retarding areas would help in assessing the change in condition and the required action with progressing urbanization.

(3) Change in land use on ecology

The existing agricultural and open water capture fishery lands, other than those retarding areas, would be changed to urban use in principle, another indirect consequence. Nevertheless, agricultural productivity and culture fishery will be enhanced in the flood protected lands, provided land is reserved for such uses. The retarding areas are suited for such uses at least during dry season.

Moreover, with progressing residential development, terrestrial homestead floral species and terrestrial domestic fauna species will become predominant in place of both the aquatic floral and fauna species and terrestrial fauna species of wild origin.

In consideration to the availability of vast flood plains around the priority area and their high cropping intensity in comparison to the priority area, effects of change in land use to urban in the priority area is assessed to be not very significant, with respect to both the general and productive ecological elements of flora, fauna, agriculture and aquaculture.

TABLE 7.1 FLOOD SEASON WATER QUALITY SAMPLING RESULTS IN RETARDING AREA (OCT. 1991)

Location		PH	EC	TDS	SS	DO	BOD	COD	Org - N	NH_4-N	FC
No.	Description		(Umho/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(No./100ml)
1	Shasongaon Kashipur	7.7	397	156	52	0.6	37	84	1.3	1.2	1.4×10^4
2	Nayamati Bil	7.0	260	134	34	4.9	0.8	16	0.7	1.0	7.1×10^3
3	Kadamtoli Pond	7.0	220	112	28	5.8	2.9	20	1.1	1.1	3.5×10^2
4	Shimrail Pond	7.2	190	97	26	2.9	4.0	8	1.4	1.3	1.0×10^4
5	Matuail Khal	7.0	120	64	32	3.1	5.7	12	0.7	1.4	9.0×10^4
6	Pagla Pond	7.0	380	193	42	2.3	8.5	20	1.1	1.1	1.3×10^3
7	Keodanga Bil Manda	7.0	167	84	26	7.4	4.2	24	1.8	0.2	9.0×10^3
8	Trimohani Khal	7.6	113	57	23	7.9	4.0	14	0.8	1.0	4.4×10^3
9	Gazaria Bil Mad	7.0	71	30	18	4.3	3.9	16	1.0	0.2	$<1.0 \times 10^2$
10	Baraid Bazar Pond	7.0	51	26	20	7.5	2.0	20	1.7	0.9	2.0×10^4
11	Dhamaahl Bil	7.3	49	25	15	7.1	2.0	12	1.2	0.1	8.0×10^3
12	Alakdi Khal Mirpur-12	7.1	166	83	32	5.1	0.7	16	1.6	0.5	2.5×10^3
13	Agunda Bil Mirpur-1	7.0	94	47	18	4.9	2.0	8	1.7	0.2	7.0×10^2
14	Gabtoli Bus Station Pond	6.9	218	109	32	5.8	4.0	12	2.0	1.5	5.7×10^3
15	Kamrangir Char	7.0	91	48	33	5.8	1.3	12	1.5	2.3	2.0×10^4

TABLE 7.2 DRY SEASON WATER QUALITY SAMPLING RESULTS IN RETARDING AREA (FEB. 1992)

Location		PH	EC	TDS	SS	DO	BOD	COD	Org - N	NH_4-N	FC
No.	Description		(Umho/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(No./100ml)
1	Shasongaon Kashipur	7.0	406	203	42	4.4	1.0	12	1.1	0.4	2.2×10^2
2	Nayamati Bil	7.4	107	536	92	2.3	15	36	1.1	1.0	8.0×10^2
3	Kadamtoli Pond	7.3	480	239	52	6.0	2.9	12	1.1	1.5	7.0×10^4
4	Shimrail Pond	6.8	751	375	53	5.0	2.0	8	0.9	0.3	3.0×10^4
5	Matuail Khal	7.2	777	389	95	3.6	12	27	0.6	1.8	1.0×10^2
6	Pagla Pond	7.6	543	272	42	6.1	1.4	16	0.7	0.4	1.4×10^3
7	Keodanga Bil Manda	7.2	328	263	110	0	50	125	1.0	24.0	$1.8\ 10^6$
8	Trimohani Khal	7.6	261	230	105	0	55	175	1.9	18.5	2.7×10^6
9	Gazaria Bil Mad	7.0	394	197	88	4.6	2.4	12	0.5	0.2	8.0×10^2
10	Baraid Bazar Pond	7.0	382	191	45	6.1	0.7	8	0.6	1.5	1.2×10^3
11	Dhamaahl Bil	7.2	133	64	49	5.9	0.3	4	0.6	1.0	6.0×10^2
12	Alakdi Khal Mirpur-12	7.3	265	132	100	1.4	15	42	1.2	0.7	3.5×10^4
13	Agunda Bil Mirpur-1	6.9	785	392	24	7.1	1.6	8	0.4	4.3	1.4×10^3
14	Gabtoli Bus Station Pond	7.3	851	425	43	3.4	12	45	1.4	6.0	4.0×10^2
15	Kamrangir Char	7.4	558	279	22	2.7	7.7	10	0.4	15.5	3.0×10^4

TABLE 7.3 DIRECT AND INDIRECT ENVIRONMENTAL EFFECTS BY THE PROJECT

a) Direct Effect by Flood Control and Drainage

Item	Degree of Environmental Impact				Remarks
	Beneficial (+)		Adverse (-)		
	Short term	Long term	Short term	Long term	
1. Flood damage	-	+3	-	-	Major reason for project formulation
2. Landuse potential	-	+3	-	-	The principal benefit in future urban area
3. Employment	+3	+1	-	-	Construction employment benefit is short term while O/M is long term
4. Navigation	-	-	-1	-	Phased development of Greater Dhaka East will moderate the impact
5. Resettlement	-	-	-2	-1	Resettlement compensation is incorporated as a negative project benefit
6. Construction activity	-	-	-1	-	Better construction management will reduce even the short term impact
7. Aquatic wild flora and fauna	-	-	-	-1	Aquatic wildlife sanctuary/conservation is recommended
8. Terrestrial wild flora and fauna *	+2	-	-	-	Change in landuse to urban will exert long term effect
9. Agriculture *	+2	-	-	-	Change in landuse to urban will exert long term effect
10. Aquaculture/fishery *	-	-	-	-2	Effect due to dry up of flood plains of open water capture fishery
11. Public health *	+2	+1	-	-	Future urbanization and population increase will exert additional living environmental improvement demand.

b) Indirect Long Term Effect by Change in Landuse

Item	Degree of Environmental Impact (Long term)		Remarks
	Beneficial (+)	Adverse (-)	
8. Terrestrial wild flora and fauna •	-	-1	Terrestrial wildlife sanctuary/conservation is recommended
9. Agriculture •	-	-2	Effect due to change in agricultural landuse to urban and others
10. Aquaculture/fishery •	-	-1	Potential effect on culture fishery (aquaculture) due to change in landuse
11. Public health*•	(+2)	(-2)	Effect due to increased living environmental demand
12. Surface water quality*	(+3)	(-3)	Effect due to increased pollution load generation
13. Domestic flora of fauna	+2	-	Effect due to increased homestead plants and domestic animals with progressing residential development

Note : Evaluation point of impact is assigned qualitatively as an integer within the range of ±3

• An item encountered twice under both direct and indirect effects is treated as a single element

* The public health and surface water quality items are interrelated, and could be dealt with integrally as future living environmental and water quality improvement projects of water supply, sewerage and sanitation and solid waste management. Such measures are conditional in order to realize a long term urban environmental benefit.

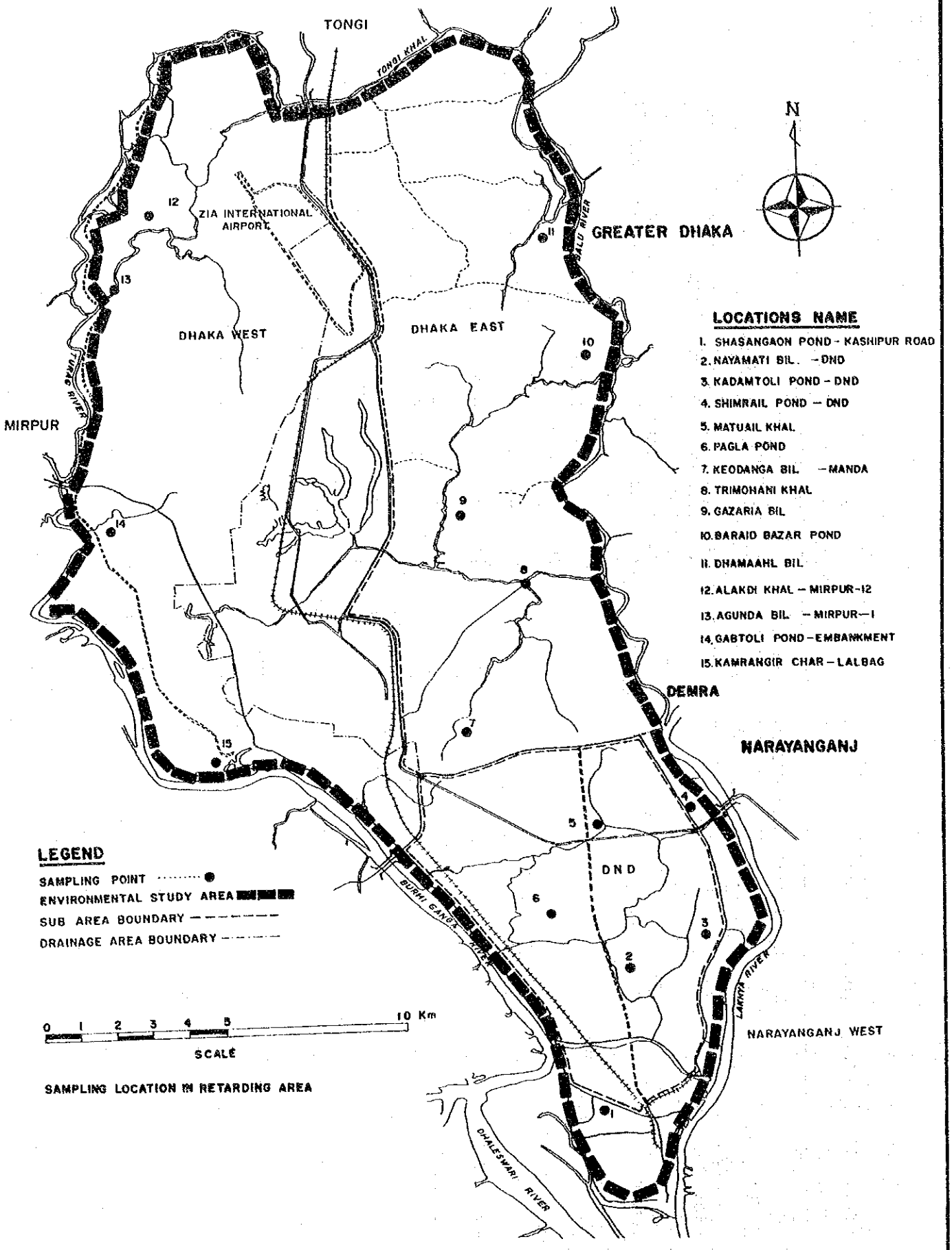

FIG. 7.1 WATER QUALITY SAMPLING LOCATION IN PRIORITY AREA

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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CHAPTER 8
OPERATION AND MAINTENANCE

Chapter 8 : Operation and Maintenance

8.1 General

The operation and maintenance (O & M) measures of the project are routine activities to get the expected benefits with the project. The flood mitigation and drainage improvement facilities, once completed, will encourage people to settle in areas where formerly they would not have settled because of a high risk of flooding. Accordingly inadequate O & M activities could lead to even a high risk of greater damage to life and property than without the project. The proper O & M activities will be indispensable for achievement of the project goals.

Although poor O&M activities widely pronounced and also budget constrictions are the most frequently sited constraint on O&M reported by the GOB.

The poor quality of O&M likely results partly from lack of finance, partly from lack of proper O&M programs.

An optimum O & M program should be prepared by BWDB / DWASA, before implementation of the project.

8.2 Basic Concept

Basic O & M demands for the flood mitigation and drainage improvement facilities are summarized as follows :

(1) The tasks and responsibilities of the O & M divisions of BWDB, DWASA and Narayanganj Municipality which are in charge of the O & M activities of the project, should be defined clearly.

(2) An active local participation should be considered in field level O & M activities or routine maintenance works. It will likely enhance a sense of public duty among local people and also increase employment opportunities for low income or landless people.

(3) Practical O & M manuals and routine programs should be prepared by the BWDB engineers concerned for the project before implementation of the project.

(4) Periodical training programs should be prepared for the GOB staff in supervision of the construction works of flood mitigation facilities and their O & M.

(5) Collaboration and coordination among the operating and the implementing agencies and other government agencies, should be improved in order to minimize adverse impacts and avoid operational conflicts.

(6) The budget constraints should be solved before implementation of the project. Everyone in Dhaka Metropolitan area would get benefit from flood protection measures. Everyone should in principle contribute towards cost.

8.3 O & M Demands for Major Facilities

8.3.1 Greater Dhaka East

1) Responsibilities for O & M

The responsible agencies for O & M activities are :

Facility	Responsible Agency	Assisting group
Flood Embankment / Flood wall	BWDB	Local participants
Drainage Pump / Sluice	BWDB	Local participants
Khal / Drainage channel	DWASA	Local participants

The O & M divisions of BWDB should be fully responsible to required O & M activities for flood mitigation facilities including drainage pumps, sluices and retarding areas. Similarly the O & M divisions of DWASA have full responsibility to O & M to drainage channels and pipes. Local people who live in unions or wards wherein facilities are located, had better be involved in routine O & M activities as assisting groups.

In general, people who share a common interest in O & M activities of flood mitigation facilities would participate in the creation of associations which will enable them to better deal with their water related problems at the bottom level.

Their responsibilities would cover both operation of the sluices and routine maintenance of the embankments / khals serving them.

2) Tasks and Responsibilities

Tasks and Responsibilities of BWDB and DWASA are as follows :

- to employ and organize O & M assisting groups of local people through the unions or wards wherein facilities are located,
- to prepare an optimum O & M manual and a routine O & M program,
- to provide local participants with proper training and guidance,
- to carry out major actions including repairing where necessary, according to the field surveys,
- to operate pumps and sluices according to an operation manual which should be prepared during the detailed study stage.

Tasks and Responsibilities of Assisting Groups are :

- to carry out year - round maintenance of embankments and their O & M roads including repair patching of surface, side slopes and wheel cuts created by vehicles under the guidance of BWDB's field staff.
- to operate and maintain sluices according to the guideline prepared by BWDB,
- to report conditions of embankments, damages, erosion, sliding, failures etc.

3) Routine O & M Activities

The routine O & M demands of the major facilities are as follows :

- Embankment
- Flood Wall
- Sluice
- Drainage Channel / pipe
- Pump Station
- Retarding Area

4) Guidelines for Operation of Pumps and Sluices

For flood mitigation purposes, the pumps and sluices are planned to be operated according to the following concepts :

(1) The sluices along the Balu River, i.e. G. 16, G. 17, G. 18A and B, are planned to be closed for approximately five (5) months from June through October, when the river stage is higher than 3.00 m (PWD).

The river stage normally starts to rise in March, 3.00 m (PWD) around May to June, 5.00 m to 6.00 m in August to September, starts to fall in September, 3.00 m in approximately in November, and becomes the lowest stage in February.

(2) The pumps along the Balu River, i.e. P. 5, P. 6, P. 7A and B, are planned to control the water levels in land side between 3.00 m and 4.00 m (PWD) during the flood season. The pumps are designed to have a capacity to meet the flood stage of a 100-year flood frequency.

The pumps are planned to start operation when the water levels in land side start to rise due to the flood runoff from their own catchment areas.

The concept is based on flood mitigation and drainage improvement purposes. Then the proposed guideline might be reviewed and revised, if necessary, according to the results of further studies on productive uses of water resources in future.

5) Required O & M Organization

The executive engineer's office and sub-divisional engineer's offices which are planned to be established for implementation of the project, will be shifted to O & M offices after completion of the works.

The required O & M offices are planned to be as follows :

(1) The O & M activities for embankments and related facilities, are conducted under the executive engineer's office of Dhaka II (BWDB), through two new sub-divisional engineer's offices in the field. The field level routine activities are to be conducted by crews of local participants.

(2) The O & M activities for drainage channels, are conducted under the executive engineer's office of DWASA, through a new sub-divisional engineer's office in the field. The field level routine activities are also be conducted by crews of local participants.

(3) For O & M activities of pumps and sluices

It is necessary to establish one superintending engineer's office, executive engineer's office and four new sub-divisional engineer's offices.

The proposed O & M organization for Greater Dhaka East is shown in Fig. 8.1 and required crew of each office are shown in Tables 8. 1 to 4.

8.3.2 DND

1) Responsibilities for O & M

The O & M divisions of BWDB should have a full responsibility for the flood mitigation and drainage improvement facilities, and local people should be involved in routine O & M activities as an assisting group.

2) Tasks and Responsibilities

The tasks and responsibilities of the government agencies and the local assisting groups are the same as those of the Greater Dhaka East.

3) Routine O & M Activities

They are the same as those for the Greater Dhaka East

4) Guidelines for Operation of Pumps and Sluices

For flood mitigation purposes, the pumps and sluices are planned to be operated according the following concepts :

(1) The sluices i.e. G. 19 and G. 20, are planned to be closed when the river stage is higher than 3.00 m (PWD),

(2) The pumps are planned to control the water level in land side between 3.00 and 4.00 m (PWD).

5) Required O & M Organization

The sub-divisional engineer's office for implementation of the project, will be converted to the O & M office.

For O & M activities for the pump drainage system, the existing sub-divisional office is to be reinforced, up to the same scale as that of Table 8.4. O & M activities for embankment and drainage channels are to be done by local participants under the guidance of the sub-divisional engineer's office of Dhaka II, that is planned for the Greater Dhaka East (Fig. 8.1(2)).

8.3.3 Narayanganj West

1) Responsibilities for O & M

The O & M division of BWDB should have a full responsibility for the flood mitigation facilities, including pumps, sluices and stop logs. Narayanganj municipality should have a full responsibility for drainage channels. Local people should be involved in routine O & M activities as assisting groups.

2) Tasks and Responsibilities

The tasks and responsibilities of the government agencies and the local assisting groups are the same as those for the Greater Dhaka East.

3) Routine O & M Activities

They are the same as those for the Greater Dhaka East.

4) Guide line for Operation of Pumps and Sluices

For flood mitigation purposes, the pumps and sluices are planned to be operated according to the following concepts :

(1) The sluice of G. 21 and G. 22 are planned to be closed when the river stage is higher than 3.00 m (PWD), but the sluices of G. 23 ~ G. 32, G. 32A and are to be closed when the river stage is higher than 3.50 m (PWD),

(2) The pumps of P. 12 and P. 13 are planned to control the water level in land side between 3.00 and 4.00 m, but the pumps of P. 14A and B are planned to control the water level between 3.50 m and 4.50 m (PWD).

5) Required O & M Organization

The sub-divisional engineer's office for implementation of the project will be converted to the O & M office.

For O & M activities for pumps and sluices, on sectional office will be required (Table 8.5).

Routine O & M activities for embankments and flood walls are to be conducted by local participants under the guidance of the sub-divisional engineer's office of Dhaka - II.

But O & M activities for drainage channels are to be conducted by local participants under Narayanganj Municipality's office (Table 8. 6 and Fig. 8.1(2)).

Table 8.1 O & M Executive Engineer's Office and Sub-divisional Engineer's Office Drainage Channels (DWASA)

		Executive Engr's Office	Sub-divisional Engr's Office
1.	Executive Engineer	1	-
2.	Sub-divisional Engineer	1	1
3.	Sub-Assistant Engineer	1	2
4.	Head Assistant	1	-
5.	Estimator	1	-
6.	Assistant Accountant	1	-
7.	Draftsman	1	-
8.	Surveyor	-	2
9.	Cashier	1	-
10.	LDA Cum Typist	1	-
11.	Work Assistant	-	6
12.	Line Cleaner	-	6
13.	Driver	-	1
14.	Night guard	1	1
15.	MLSS	1	1
16.	Sweeper	-	1
	Total :	11	21

Note : 1) Annual expense for each Executive engr's office: Tk. 884,200
Sub-divisional engr's office : Tk.1,366,900
(including personnel expenses, office expenditure)

Table 8.2 O & M Executive Engineer's Office and Sub-divisional Engineer's Office for Embankment (BWDB)

		Executive Engr's Office	Sub-divisional Engr's Office
1.	Executive Engineer	1	-
2.	Sub-divisional Engineer	1	1
3.	Sub-Assistant Engineer	1	2
4.	Surveyor	-	2
5.	Draftsman	1	-
6.	Tracer	1	-
7.	LDA Cum Typist	2	1
8.	Senior Accountant	1	-
9.	Accountant Assistant Cum Typist	1	1
10.	Driver	-	1
11.	Guard	-	1
12.	MLSS	1	1
13.	Messenger	-	1
14.	Sweeper	-	1
	Total :	10	12

Note: 1. Executive Engr's office : one
2. Sub-divisional Engr's office : two
3. Annual expense for each Executive Engr's office : Tk. 736,500
Sub-divisional engr's office Tk. 700,100

Table 8.3 O & M Sub-divisional for the Pump drainage System of Pump Station, P5

(BWDB)		Sub-divisional Engineer's
1.	Sub-divisional Engineer	1
2.	Sub-Assistant Engineer (Mech.)	2
3.	Sub-Assistant Engineer (Elect.)	1
4.	Foreman (Mechanical)	1
5.	Mechanic	2
6.	Electrician	2
7.	Helper	2
8.	Sub-divisional Clerk	1
9.	Account Clerk	1
10.	Typist	1
11.	Office Peon	1
12.	Pump Operator	3
13.	Driver	1
14.	Sweeper Cum Mali	1
15.	Security Guard	3
15.	Khalasi / Labour	3
	Total :	26

Note : 1) Annual expenses : Tk. 1,331,700 (not including operation cost)

Table 8.4 O & M Sub-divisional Engineer's Office for the Pump drainage System of Pump Station, P6 (m)

(BWDB)		Sub-divisional Engineer's
1.	Sub-divisional Engineer	1
2.	Sub-Assistant Engineer (Mech.)	2
3.	Sub-Assistant Engineer (Elect.)	2
4.	Foreman (Mechanical)	1
5.	Mechanic	1
6.	Assistant Mechanic	1
7.	Assistant Mechanic	1
8.	Electrician	1
9.	Assistant Electrician	1
10.	Assistant Electrician	1
11.	Pump Operator	4
12.	Helper	4
13.	Khalashi / Labour	6
14.	Security Guard	6
15.	Sub-divisional Clerk	1
16.	Account Clerk	1
17.	Store Keeper	1
18.	Typist	1
19.	Driver	1
20.	Office Peon	1
21.	Sweeper Cum Mali	1
22.	Barkan door	1
	Total :	40

Remark : 1) Apply for pump capacity is 47 to 54 m^3/s
2) This is also applied to pump stations, P.7A and B.
3) Annual expenses : Tk. 1,901,000 (not including operation cost)

Table 8.5 O & M Sectional Officer's Office for Pump Drainage Systems Narayanganj West

Sub-Assistant Engineer (Mech.)	1
Mechanic	1
Electrician	1
Assistant Electrician	1
Pump Operator	3
Helper	2
Khalasi / Labour	3
Sweeper Cum Mali	1
Security Guard	3
Total :	16

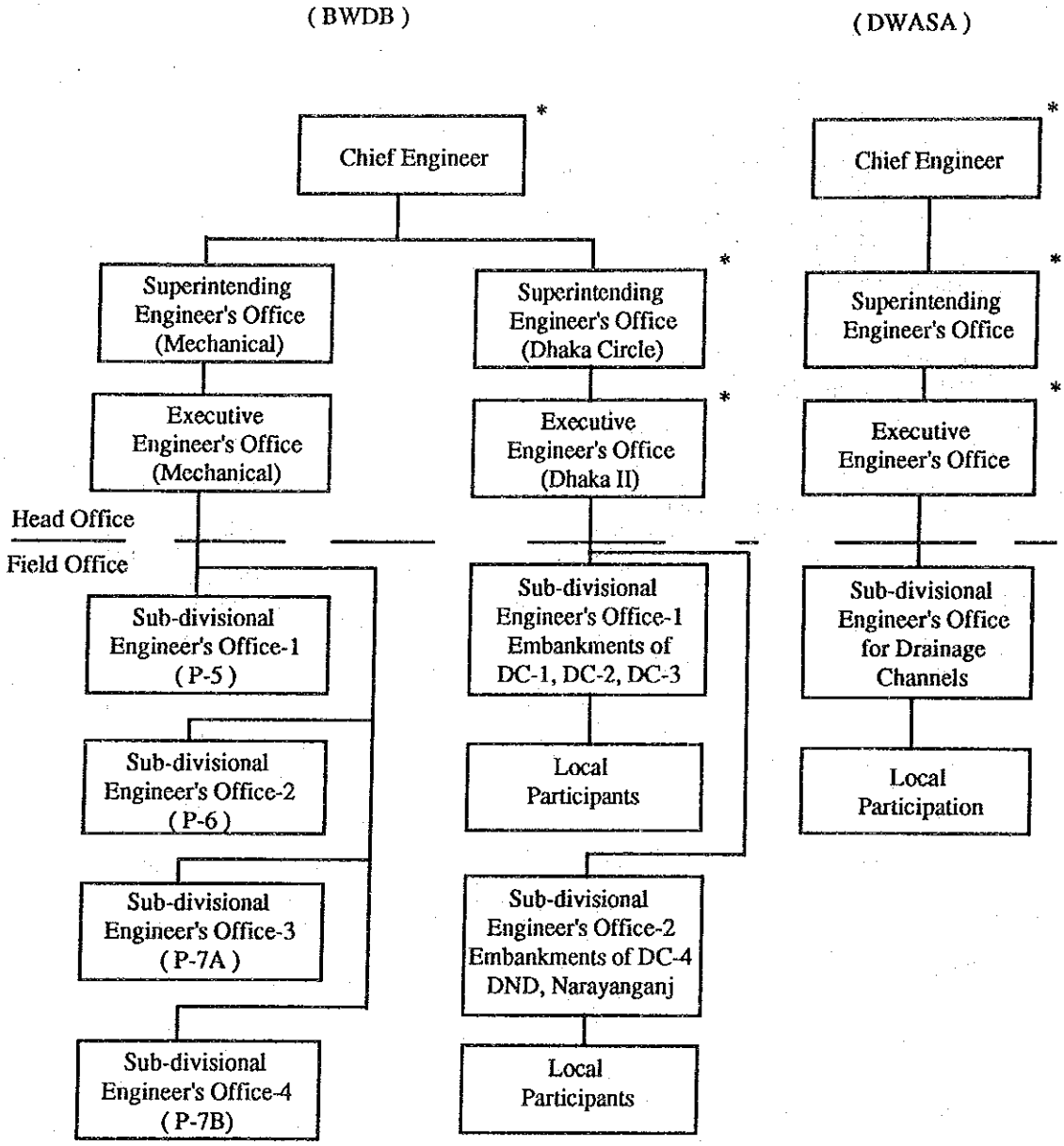
Note : 1) Annual expenses : Tk. 1,331,700 (not including operation cost)

Table 8.6 O & M Executive Engineer's Office and Sub-divisional Engineer's Office Narayanganj Municipality

		Executive Engr's Office	Sub-divisional Engr's Office
1.	Executive Engineer	1	-
2.	Sub-divisional Engineer	1	1
3.	Sub-Assistant Engineer	1	2
4.	Accounts Assistant Cum Clerk	1	1
5.	LDA Cum Typist	1	1
6.	Line Cleaner	-	4
7.	Driver	-	1
8.	Sweeper	-	1
9.	MLSS cum Messenger	1	2
10.	Night Guard	-	1
	Total :	6	14

Note: 1. Annual expenses
Executive engr's office : Tk. 516,800
Sub-divisional engr's office: Tk. 730,000

Required O&M Organization for Greater Dhaka East



Note : * Existing Office

FIG. 8.1(1)	REQUIRED O&M ORGANIZATION FOR GREATER DHAKA EAST

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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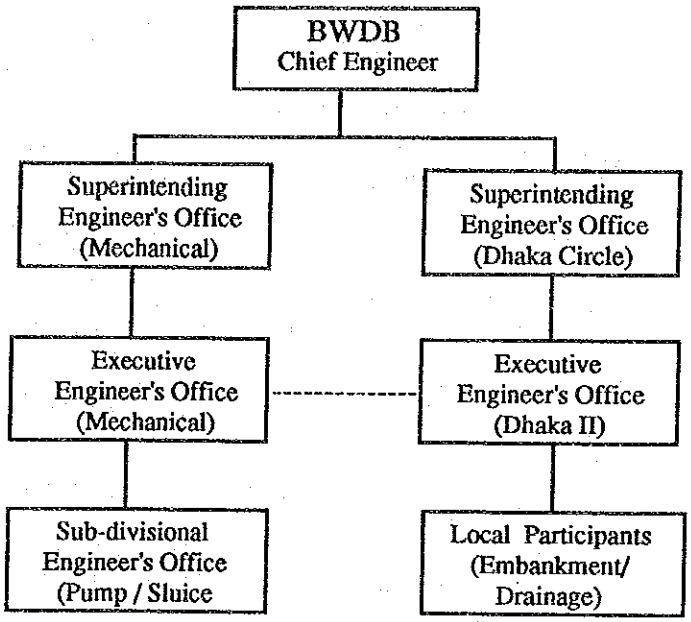
O&M Organization for DND



O&M Organization for Narayanganj West

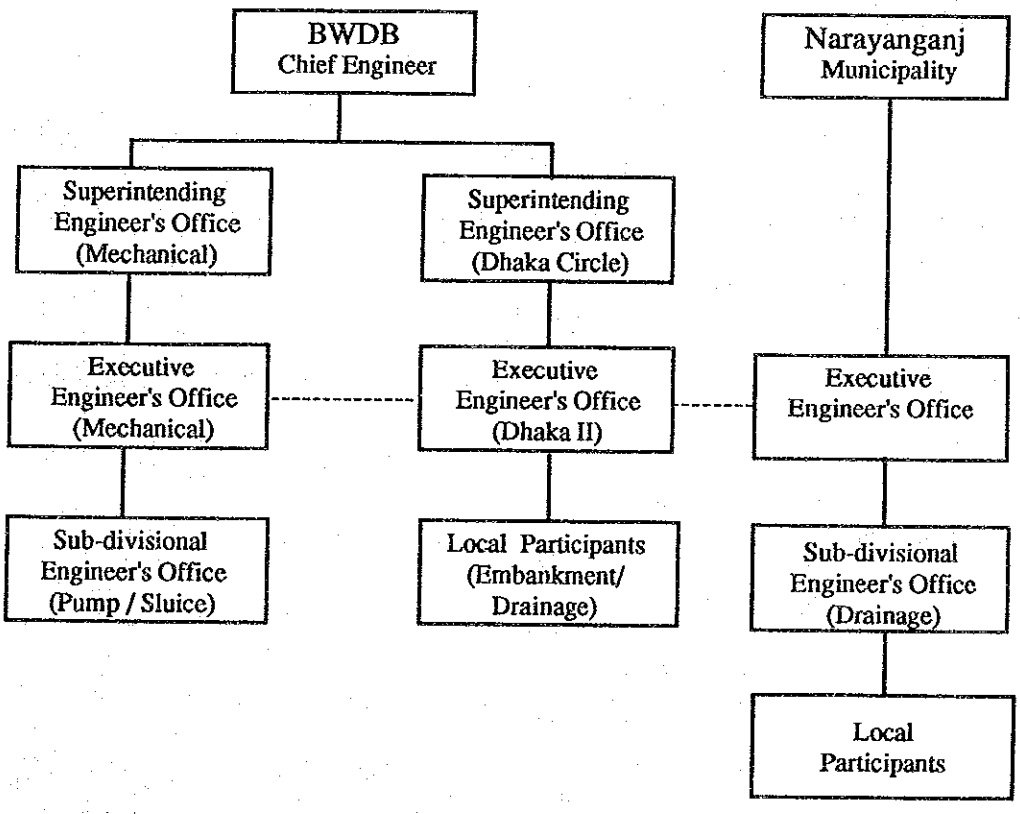


FIG. 8.1(2) REQUIRED O&M ORGANIZATION FOR DND AND NARAYANGANJ WEST

CHAPTER 9
COST ESTIMATE

Chapter 9 : Cost Estimate

9.1 Basic Conditions

The project costs are estimated based on the preliminary designs, the proposed construction schedules and the following considerations.

(1) Component of the project cost

The project cost is composed of "direct costs", "indirect costs" and "contingency". They consist of the followings :

a) Direct Cost :

- Construction costs
- Procurement and installation costs for equipment

b) Indirect cost :

- Land acquisition and compensation costs
- Administration costs,
- Engineering service costs.

c) Contingency :

- Physical contingency.

(2) Price Level

The unit price and cost are estimated based on prevailing market prices in Dhaka in Taka during October, 1991, referring BWDB'S Standard Schedule of Rates.

(3) Mode of Contract

The construction works will be contracted to general contractors through international tenders.

(4) Currency Portion

The costs are divided into foreign currency and local currency portions as follows :

(a) Foreign currency portion (FC)

- Imported equipment and material.
- Overhead for contractors,
- Expense of expatriate personnel

(b) Local currency portion (LC)

- Equipment and material available in the local marked,
- Land acquisition and compensation,
- Expense of local personnel,
- Overhead for local firms,
- Tax and tariff.

(5) Exchange Rate

The exchange rates of foreign currencies applied are :

Tk. 36 = US$ 1.0 = ¥ 137

(6) Indirect Cost

The land acquisition and compensation costs are based on prevailing market price. However the others are estimated on the following assumptions :

(a) Administration cost : 3% of base construction costs,
(b) Engineering service cost : 10% of base construction costs plus physical contingency,

(7) Contingency

Physical contingency : 15% of base construction costs.

(8) Unit Price

The unit prices of labor, material and equipment are estimated based on prevailing market prices referring the data collected from BWDB and other agencies concerned. The unit costs of the construction works are divided into foreign currency portion and local currency portion based on the current data applied to similar projects.

(9) O & M Cost

Routine O & M costs are estimated on a crew-month basis for O & M activities to be established. O & M for minor civil works are estimated at 1.0 ~3.0% of the capital investment costs. Also the operation costs and replacement cost of equipment are estimated.

(10) Customs Duty and Sales Taxes (CDST)

Most of the construction material are available locally, however particular equipment and material such as pump, gate, sheet pile, form steel, geotextile etc., must be imported. It is considered that the CDST for those imported equipment and material will be borne by the GOB and it will be exempted from the contractor's contract as it is being funded by the foreign aid program. The amount for CDST are estimated and shown in the following tables.

9.2 Project Cost

9.2.1 Greater Dhaka East

The total project cost is estimated at Tk. 18,296 million (F/C : Tk. 9,561 million, L/C : Tk. 8,735 million) and summarized as follows :

	Item	F/C	L/C	Total
1.	Construction Cost	7,558	3,358	10,916
	1) Flood Mitigation	(3,732)	(1,964)	(5,696)
	2) Drainage improvement	(3,826)	(1,394)	(5,220)
2.	Indirect Cost			
	1) Land Acquisition/compensation	0	1,487	1,487
	2) Administration	0	328	328
	3) Engineering service	869	387	1,256
3.	Physical contingency	1,134	501	1,635
4.	CDST & Tax	0	2,674	2,674
	Total	9,561	8,735	18,296

The project cost of each compartment is shown in Tables 9.1.1(1) to (4).

9.2.2 DND

The total project cost is estimated at Tk. 4,594 million (F/C : Tk. 2,203 million, L/C : Tk. 2,391 million) and shown as follows:

	Item	F/C	L/C	Total
1.	Construction Cost	1,742	914	2,656
	1) Flood Mitigation	(82)	(32)	(114)
	2) Drainage improvement	(1,660)	(882)	(2,542)
2.	Indirect Cost			
	1) Land Acquisition/compensation	0	400	400
	2) Administration	0	80	80
	3) Engineering service	200	105	305
3.	Physical contingency	261	137	398
4.	CDST & Tax	0	755	755
	Total	2,203	2,391	4,594

Detailed costs are shown in Table 9.2.1

9.2.3 Narayanganj West

The total project cost is estimated at Tk. 4,097 million (F/C : Tk. 1,797 million, LC : Tk. 2,300 million) and shown as follows :

	Item	F/C	L/C	Total
1.	Construction Cost	1,421	633	2,054
	1) Flood Mitigation	(757)	(302)	(1,059)
	2) Drainage improvement	(663)	(331)	(994)
2.	Indirect Cost			
	1) Land Acquisition/compensation	0	1,082	1,082
	2) Administration	0	62	62
	3) Engineering service	163	73	236
3.	Physical contingency	213	94	307
4.	CDST	0	356	356
	Total	1,797	2,300	4,097

The detailed costs are shown in Table 9.3.1.

TABLE 9.1.1(1) PROJECT COST OF DHAKA EAST (DC-1)

Unit : Million TK (1991Price)

Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	2,332	1,127	3,459	
1.Flood Mitigation	1,675	852	2,527	
1).Embankment	1,541	800	2,340	Ref. H.3.13
2). Flood Wall	15	8	22	Ref. H.3.14
3).Sluice Gate	120	45	165	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	657	275	932	
1).Pump Sta.	513	121	634	Ref. H.3.17(1)
2).Khal Improve.	136	144	280	Ref. H.3.18
3).Bridge,Etc	7	10	17	Ref. H.3.19
B.Physical Contingency	349	169	518	Ax15%
C.Engineering	268	130	398	(A+B)x10%
D.Administration	0	104	104	Ax3%
E.Land Aquisition & Compensation	0	565	565	Ref. H.3.11
F. CDST & Tax	0	572	572	Ref. H.3.12
Total	2,949	2,667	5,616	

TABLE 9.1.1(2) PROJECT COST OF DHAKA EAST (DC-2)

Unit : Million TK (1991Price)

Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	1,705	686	2,391	
1.Flood Mitigation	658	362	1,020	
1).Embankment	576	328	905	Ref. H.3.13
2). Flood Wall	16	8	24	Ref. H.3.14
3).Sluice Gate	66	26	92	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	1,047	324	1,371	
1).Pump Sta.	946	218	1,163	Ref. H.3.17(1)
2).Khal Improve.	101	106	208	Ref. H.3.18
3).Bridge,Etc	0	0	0	Ref. H.3.19
B.Physical Contingency	256	102	358	Ax15%
C.Engineering	196	79	275	(A+B)x10%
D.Administration	0	72	72	Ax3%
E.Land Aquisition & Compensation	0	272	272	Ref. H.3.11
F. CDST & Tax	0	706	706	Ref. H.3.12
Total	2,157	1,917	4,074	

TABLE 9.1.1(3) PROJECT COST OF DHAKA EAST (DC-3)

Unit : Million TK (1991Price)

Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	1,667	661	2,328	
1.Flood Mitigation	664	361	1,025	
1).Embankment	594	335	930	Ref. H.3.13
2). Flood Wall	10	5	16	Ref. H.3.14
3).Sluice Gate	60	20	80	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	1,002	300	1,303	
1).Pump Sta.	927	206	1,133	Ref. H.3.17(1)
2).Khal Improve.	76	94	170	Ref. H.3.18
3).Bridge,Etc	0	0	0	Ref. H.3.19
B.Physical Contingency	250	98	348	Ax15%
C.Engineering	192	76	268	(A+B)x10%
D.Administration	0	70	70	Ax3%
E.Land Aquisition & Compensation	0	238	238	Ref. H.3.11
F. CDST & Tax	0	709	709	Ref. H.3.12
Total	2,109	1,852	3,961	

TABLE 9.1.1(4) PROJECT COST OF DHAKA EAST (DC-4)

Unit : Million TK (1991Price)

Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	1,854	884	2,738	
1.Flood Mitigation	735	389	1,124	
1).Embankment	655	359	1,013	Ref. H.3.13
2). Flood Wall	19	10	29	Ref. H.3.14
3).Sluice Gate	61	20	81	Ref. H.3.15
4).Related.Struc.Etc	0	0	0	
2.Storm Water Drainage	1,120	495	1,614	
1).Pump Sta.	914	208	1,121	Ref. H.3.17(1)
2).Khal Improve.	202	282	484	Ref. H.3.18
3).Bridge,Etc	4	5	9	Ref. H.3.19
B.Physical Contingency	279	132	411	Ax15%
C.Engineering	213	102	315	(A+B)x10%
D.Administration	0	82	82	Ax3%
E.Land Aquisition & Compensation	0	412	412	Ref. H.3.11
F. CDST & Tax	0	687	687	Ref. H.3.12
Total	2,347	2,298	4,645	

TABLE 9.2.1. PROJECT COST OF DND

Unit : Million TK (1991Price)

Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	1,742	914	2,656	
1.Flood Mitigation	82	32	114	
1) Flood.Wall Works	32	18	50	Ref. H.3.23
2)Sluice Gate	49	13	62	Ref. H.3.24
3)Related.Struc.Etc	2	1	3	Ref. H.3.25
2.Storm Water Drainage	1,660	882	2,542	
1).Pump Sta.	1,144	219	1,363	Ref. H.3.26
2).Khal Improve.	467	593	1,059	Ref. H.3.27
3).Bridge,Etc	49	70	119	Ref. H.3.28
B.Physical Contingency	261	137	398	Ax15%
C.Engineering	200	105	305	(A+B)x10%
D.Administration	0	80	80	Ax3%
E.Land Aquisition & Compensation	0	400	400	Ref. H.3.21
F. CDST & Tax		755	755	Ref. H.3.22
Total	2,203	2,392	4,594	

TABLE 9.3.1 PROJECT COST OF NARAYANGANJ WEST

Unit : Million TK (1991Price)

Phase	Construction Cost (x10^6)			Remarks
Project Area	F/C	L/C	Total	
A.Construction Cost	1,421	633	2,054	
1.Flood Mitigation	757	302	1,060	
1).Embankment	478	208	686	Ref. H.3.32
2). Flood Wall	159	52	211	Ref. H.3.33
3) .Sluice Gate	120	42	162	Ref. H.3.34
4) .Related.Struc.Etc	1	0	1	Ref. H.3.36
2.Storm Water Drainage	663	331	994	
1).Pump Sta.	440	96	536	Ref. H.3.37
2).Khal Improve.	216	223	439	Ref. H.3.39
3).Bridge,Etc	8	12	19	Ref. H.3.40
B.Physical Contingency	213	94	307	Ax15%
C.Engineering	163	73	236	(A+B)x10%
D.Administration	0	62	62	Ax3%
E.Land Acquisition & Compensation	0	1,082	1,082	Ref. H.3.30
F. CDST & Tax	0	356	356	Ref. H.3.31
Total	1,797	2,299	4,097	

CHAPTER 10
IMPLEMENTATION PROGRAM

Chapter 10 : Implementation Program

10.1 General

The overall coordination for the project will be provided by the Ministry of Irrigation, Water Development and Flood Control (MIWDFC), and the execution of the Project will be the responsibility of the BWDB, which will be the lead Project Executing Agency. The other implementing agencies will be DWASA and Narayanganj Municipality. RAJUK and DOE will be involved in supportive roles such as land use management and environmental monitoring.

The construction works consist of embankment, flood wall, sluice gate, pump station, Khal improvement, box culvert, bridge works etc. for flood mitigation and storm water drainage improvement works. It is assumed that the detailed designs and construction works will be executed by international competitive bidding basis and completed by the target year of 2010.

The urban planning of the priority areas lags behind, as the Metropolitan Development Plan Study for Dhaka was commenced by RAJUK only in April, 1992. Nevertheless the study will prepare an integrated development plan for the area. The results of the study should be referred to before the implementation of storm water drainage improvement facilities.

The implementation program for the project is based on the following :

(1) The proposed flood mitigation and storm water drainage improvement works will be complete by the target year of 2010.

(2) The phased implementation programs proposed in the Master Plan Study, was reviewed from economical efficiency, social and environmental aspects, and modified in order to get a higher economic efficiency and to avoid adverse social impacts as much as possible.

(3) The other on-going project or committed projects, if any, will be considered to ensure consistency with the proposed phased implementation programs.

(4) Though three project components of the Greater Dhaka East, the DND and the Narayanganj West, were identified in the Master Plan Study for F/S areas, the Greater Dhaka East is divided into four compartments, considering effectiveness against floods, and easiness for O & M and economic efficiency.

The Greater Dhaka East is divided into the following four compartments :

1. Northern Compartment
2. Central Compartment
3. Southern - 1 Compartment
4. Southern - 2 Compartment

10.2 Basic Conditions

For preparing an optimum implementation program of the project, the following considerations have been taken as the basic concept of project implementation.

(1) Preparation of Detailed Design

The detailed design for major facilities shall be carried out under the management of international consultants according to the design concept.

The Metropolitan Development Plan study for the Greater Dhaka area has already been started by RAJUK in April, 1992. It is recommended to update and modify the proposed measures, if necessary, according to the study results.

(2) Mode of Construction

The construction works shall be carried out by contractors selected through international competitive bidding under supervision of international consultants.

(3) Workable Days and Working Hours

Standard workable days for respective works will be estimated based on river stages, daily rainfall records, Friday, national holidays and experience of similar works in and around the area. The annual workable days for earthwork and concrete work are assumed to be approximately 130 days from November to April, and 160 days from October to June respectively. Daily working hours is set at 9 hours with 1-hour overtime by considering the local working style in the area.

(4) Availability of Construction Plant and Equipment

Heavy construction equipment required for concrete work or earthwork are not available in the local market. However the construction works are planned to be carried out partly by heavy construction equipment with due consideration of the magnitude of work volume, the limited construction period and the quality of works.

(5) Arrangement of Borrow-pit

Borrow-pits for construction of the embankments shall be arranged nearby along the new alignment. While sand for the foundation treatment is to be brought from the places, as designated in the tender documents.

However the method of land fill by dredging should be studied when it become possible to develop a certain large area simultaneously as a result of the Metropolitan Development Plan study, because the method of land fill by dredging is generally feasible in economic terms.

(6) Construction Materials

Concrete materials, round and deformed type of reinforcing steel bars are available in the local market. However the shape steel such as H-steel, T-steel, and geotextile are yet to be available in the local market.

Local materials shall be used as much as possible.

(7) Work Items and Quantities

- Preparatory and Other Temporary Works

  The works will be considered as lump sum basis.

- Major Works of Flood Mitigation

The construction comprises the following major works :

(a) Embankment / Sub-Embankment
(b) Flood Wall
(c) Sluice Gate
(d) Land Lock

- Major Works of Storm water Drainage

(a) Pump Station
(b) Khal Improvement
(c) Box Culvert/Bridge

The above work items include rehabilitation of the existing facilities and temporary works.

10.3 Implementation Schedule

10.3.1 Greater Dhaka East

The implementing agency for flood mitigation and related facilities such as pumps and sluices will be BWDB, while DWASA will be responsible for Khal and drainage improvements.

The Greater Dhaka East is divided into four compartments and planned to be implemented in phases compartment by compartment with progressing urbanization. However the entire projects will be completed by the target year of 2010.

The proposed implementation program is composed of four stages i.e. preparation stage, construction stage, monitoring stage and completion stage.

The proposed construction schedule is arranged to avoid likely adverse effects caused by implementation of the proposed works as much as possible and also to conform the priority sequence. The area, which has a high development pressure and a high economic efficiency, is given a high priority for early implementation.

The construction schedule is based on the following assumptions :

(1) Financial and required arrangements shall be complete by the end of 1993.

(2) Detailed design shall be commenced in 1994 and completed within a period of 18 months.

(3) The construction works of southern compartments-2 shall be commenced in 1996 and completed within a construction period of four years.

(4) The construction works of Northern compartment, southern compartment-1 and central compartment shall be commenced in 2001, 2002 and 2007 respectively. However 60 to 70% of the proposed pump capacity shall be installed in the first stage.

(5) After completion of the first stage construction of each compartment, the drainage system shall be monitored and checked whether there are any gaps between the actual conditions and the assumed conditions.

(6) Before the completion stage of 2007 to 2010, the proposed plans shall be reviewed and modified, if necessary, based on the analyses of monitored data.

The proposed implementation schedule is shown in Fig.10.1.

10.3.2 DND

The implementing agency for the Project will be BWDB.

The construction schedule is based on the following assumptions :

(1) Financial and required arrangements shall be completed by the end of 1995.

(2) Detailed design shall be commenced in 1996 and completed within a period of 12 months.

(3) The construction works shall be commenced in 1997 and completed within three years. however about pump facilities, 60 to 70% of the proposed capacity shall only be installed in this stage.

(4) After completion of the works, the drainage system should be monitored, to check whether there are any gaps between the actual conditions and the assumption.

(5) During the final stage, the proposed facilities shall be reviewed and modified, if necessary, according to the monitored data.

(6) If it is possible for GOB to implement the flood mitigation measures for the Narayanganj West, the flood mitigation works for the DND may be deferred.

The proposed implementation schedule is shown in Fig.10.1.

10.3.3 Narayanganj West

The implementing agency for flood mitigation and related facilities will be BWDB, while that for drainage facilities will be Narayanganj Municipality.

The construction schedule is based on the following assumptions ;

(1) Implementation arrangement shall be completed by the end of 1996

(2) Detailed design shall be commenced in 1999 and completed within a period of 12 months.

(3) The construction works shall be commenced in 2000 and completed within five years.

The proposed implementation schedule is shown in Fig.10.1.

10.4 Disbursement Schedule

The disbursement schedule of each project is shown in Table 10.1.

TABLE 10.1 PROPOSED DISBURSEMENT SCHEDULE

Unit : Million Tk.

Year	'94	'95	'96	'97	'98	'99	2000	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	Total Project Cost
I G. Dhaka East																		
1. DC - 1 (Total)						498	499	900	1,181	1,181	1,179					3	175	5,616
(F/C)						134	134	506	702	703	696						74	2,949
(L/C)						364	365	394	479	478	483					3	101	2,667
2. DC - 2 (Total)												284	285	745	1,141	636	983	4,074
(F/C)												98	98	392	691	362	516	2,157
(L/C)												186	187	353	450	274	467	1,917
3. DC - 3 (Total)							263	263	746	1,118	607	610			6	348		3,961
(F/C)							96	96	395	678	346	348				150		2,109
(L/C)							167	167	351	440	261	262			6	198		1,852
4. DC - 4 (Total)	375	378	620	1,098	1,102	727								5	340			4,645
(F/C)	106	107	314	639	641	395									146			2,348
(L/C)	269	271	306	459	461	332								5	194			2,297
II DND																		
Total			723	1,191	1,192	1,143									5	340		4,594
(F/C)			200	630	631	592										150		2,203
(L/C)			521	533	533	523										87		2,197
III Narayanganj West																		
Total						717	799	1,047	745	389	400							4,097
(F/C)						163	294	459	462	208	211							1,797
(L/C)						554	505	588	283	181	189							2,300

Phase																			Remarks
Year	'92	'93	'94	'95	'96	'97	'98	'99	2000	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	
Preparation Stage by GOB																				
G.Dhaka East																				
1.NORTHERN COMPT.(DC-1)																				
A.Project Preparation																				Including
B.Flood Mitigation																				Sub-Emb.SA
C.Storm Water Drainage																				
2. CENTRAL COMPT.(DC-2)																				
A.Project Preparation																				
B.Flood Mitigation																				
C.Storm Water Drainage																				
3.SOUTHERN COMPT.-1(DC-3)																				
A.Project Preparation																				Including
B.Flood Mitigation																				Sub-Emb.SB
C.Storm Water Drainage																				
4.SOUTHERN COMPT.-2(DC-4)																				
A.Project Preparation																				Including
B.Flood Mitigation																				Sub-Emb.SC
C.Storm Water Drainage																				
Narayanganj																				
1.DND																				
A.Project Preparation																				
B.Flood Mitigation																				
C.Storm Water Drainage																				
2.Narayanganj West																				
A.Project Preparation																				
B.Flood Mitigation																				
C.Storm Water Drainage																				

Note:
1).Preparation stage by GOB :Including development study, etc.
2).Sub-Emb:Sub-Embankment.

FIG. 10.1 PROPOSED IMPLEMENTATION SCHEDULE

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

CHAPTER 11
PROJECT EVALUATION

Chapter 11 : Project Evaluation

11.1 General

Project evaluation was done by comparing the flood damages in the "with" and "without project" situations.

To make an overall evaluation of the project, not only the economic aspect, but also the socio-economic and environmental aspects were taken into account. The socio-economic impacts of the project are expressed in quantitative terms as much as possible. Environmental impacts are usually hard to be quantitatively estimated, therefore qualitative analysis was employed for assessment of environmental aspects.

The period of project life was assumed basically to be 30 years. The opportunity cost of capital (OCC) is assumed as 12%. These are based on the "FAP: Guidelines of Economic (Micro) Analysis".

The estimation of NPVR(2) and the sensitivity analysis using such variables as the increase of capital costs, the increase of O&M costs and the reduction of benefits were done in accordance with the "Guidelines".

Financial analysis were also done, centering on the ways and means to get financial resources for O&M costs.

11.2 Estimation of Benefits and Costs

11.2.1 Estimation of Benefits

In the "with" situation flood damages expected under the "without" situation will be virtually avoided. That is to say, flood damages under the "without" situation just turn into project benefits in the "with" situation.

Economic losses deriving from floods and inundation are manifold and profound. They range from direct damages to houses, establishments, institutions, agricultural crops, infrastructures, etc. to income losses of households, to sales losses of private and public enterprises and to traffic damages in the form of reduced sales, increased operating cost and operating hours.

They have been estimated by project area, by type/scale of floods for 1990 and 2010 in "the Supporting Report B on Flood and Flood Damage". Ultimately they were converted into "average annual flood damages", that is, average flood damages to be expected annually, which were estimated based on probability theory. In the "with" situation they just become project benefits. (Refer to Table 11.1).

Project benefits are summarized as follows :

(Unit : Tk. Million)

Project	1990	2010
DC - 1	43.2	648.4
DC - 2	26.4	176.7
DC - 3	195.1	628.5
DC - 4	293.0	791.3
Greater Dhaka East	557.7	2,244.9
Narayanganj DND	153.4	639.9
Narayanganj West	113.4	395.3
Total	824.5	3,280.1

11.2.2 Estimation of Costs

Costs are divided into capital cost which is required to install/construct necessary equipment/facilities concerned, and operation and maintenance (O&M) cost which is required annually after the implementation of a project. Capital cost is further divided into initial cost and replacement cost. Replacement cost is required to replace pumping equipment.

In performing economic analysis costs were converted into economic costs. To convert capital cost into economic cost, a conversion factor was employed for a specific type of work.

Conversion factors employed are 89.8% for embankment, 85.2% for flood wall, 97.2% for sluice gate, 95.1% for pump station and 88.0% for khal improvement.

Land acquisition cost was valued as a stream of annual net benefits of production foregone.

Replacement cost is assumed to be required in every 15 years.

Economic costs are summarized as follows :

(Unit : Tk. Million)

Project	Costs		
	Capital	NBOPF*	O&M
DC - 1	4,955	2.3	37
DC - 2	2,991	1.1	30
DC - 3	3,457	1.0	29
DC - 4	3,920	1.7	32
Greater Dhaka East	15,323	6.1	128
DND	4,088	1.2	28
Narayanganj West	2,858	1.4	21
Total	22,269	8.7	177

Note : NBOPF : Annual Net Benefits of Production Foregone

In performing economic analysis, a part of the costs of the ADB project now under way under FAP 8B were incorporated into the costs of DC-3 and DC-4 Projects because beneficiary areas of the two projects encompass some of the ADB project areas.

The costs of the JICA drainage project now on-going were also incorporated into the costs of the DC-3 Project. Further, the costs of the raising of roads and the construction of flood walls around the DND were incorporated into the costs of the DND Project. The above table does not take into account these costs.

11.3 Economic Evaluation

Results of economic analysis on the 6 projects are described below. The case where the Narayanganj DND Project and the Narayanganj West Project are integrated is additionally taken up and economically evaluated under Supplementary Study in Supporting Report I. Also, an additional economic analysis applying the standard conversion factor (SCF) to the benefits is performed in the above Supplementary Study.

11.3.1 Calculation of EIRR and Other Decision Criteria

In accordance with the implementation schedule, initial costs were distributed over years for each project. Also, based on the initial cost distribution O&M and replacement costs were determined and allotted over years.

Benefits of each of the intermediate years between 1990 and 2010 and beyond were calculated based on the estimated benefits for 1990 and 2010 employing a simple equation. Benefits during the project implementation period were assumed to be realized in proportion to the extent of project implementation.

In this way cost benefit streams were prepared as shown in Tables 11.4 and 11.5.

Using those cost benefit streams economic internal rate of return (EIRR), net present value (NPV) and benefit cost ratio (B/C) were calculated. In addition, NPVR(2) was calculated. NPVR (2) is defined as NPV divided by the present value of capital and O&M costs. The results are shown under.

Project	EIRR (%)	NPV (Tk. Mln.)	B/C	NPVR(2)
DC - 1	14.8	274	1.22	0.162
DC - 2	8.0	- 98	0.74	- 0.155
DC - 3	13.9	263	1.19	0.147
DC - 4	18.9	1,032	1.55	0.416
Greater Dhaka East	15.8	1,501	1.31	0.228
DND	14.5	371	1.21	0.151
Narayanganj West	14.3	152	1.18	0.110

The DC-4 Project has the highest EIRR of 18.9%. The EIRR's of the DC-1, Narayanganj DND, Narayanganj West and DC-3 Projects are not much different, all being about 14%. All these five projects have EIRR's exceeding the OCC of 12%. The DC-2 Project has the EIRR of 8.0%.

In terms of NPV, the DC-4 Project is the biggest with Tk. 1,032 million. The second place goes to the DND Project with Tk. 371 million, followed by the DC-1 and DC-3 Projects with Tk. 274 million and Tk. 263 million, respectively. The Narayanganj West Project is placed fifth with the NPV of Tk. 152 million. The DC-2 Project has the negative NPV of Tk. -98 million.

The highest B/C of 1.55 is held by the DC-4 Project. The B/C of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are not much different, about 1.2. The DC-2 Project has the B/C of less than one (1) with 0.74.

Turning to NPVR(2), the DC-4 Project has the highest value of 0.416. It is expected that the project will contribute to the increase of national income by the amount corresponding to 41.6% of project costs. The NPVR(2)'s of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are mutually not widely apart, all ranging between 0.1 and 0.2. The DC-2 Project has the negative NPVR(2) with -0.155.

As seen in the above, the five projects, namely the DC-4, DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are judged to be economically feasible, while the DC-2 Project is marginal so far as economic evaluation is concerned. However, in case of social projects such as this one an EIRR of over 7% has proved to be on the high side.

Moreover, if the four Greater Dhaka East projects are combined together and treated as one entity (the Greater Dhaka East Project), which is reasonable because of their geographical, economic and social connections and interrelations, then the project has the EIRR of 15.8, NPV of Tk. 1,501 million, B/C of 1.31 and NPVR(2) of 0.228. These values are the highest among the three projects. Viewed in this way, the implementation of the DC-2 Project is justified.

11.3.2 Sensitivity Analysis

Sensitivity analysis was conducted to see whether the projects can maintain their viability and robustness, when placed under unfavorable circumstances during and after implementation.

In conducting sensitivity analysis, the FPCO Guidelines on Project Assesment was referred to.

In Case A the 15% increase of capital costs compared with the base case was assumed. In Case B the 100% increase of O&M costs was assumed. In Cases C and D the 15% reduction of benefits and one and a half year delay in achieving benefits were respectively assumed.

In Case E the switching values of capital cost increase were estimated. Likewise, in Case F the switching values of benefit reduction were estimated.

The results of sensitivity analysis are shown below. The decision criterion employed is EIRR.

(Unit : %)

Case	Greater Dhaka East					Narayanganj	
	DC-1	DC-2	DC-3	DC-4	Combined	DND	West
Base Case	14.8	8.0	13.9	18.9	15.8	14.5	14.3
Case A	12.9	6.6	12.5	16.6	13.9	12.8	12.4
Case B	14.2	6.7	13.4	18.2	15.1	13.9	13.6
Case C	12.5	6.1	12.2	16.1	13.5	12.4	12.1
Case D	12.7	6.9	12.5	16.2	13.7	12.6	12.4
Case E	22.7	-28.0	20.0	58.6	33.5	22.1	18.7
Case F	17.7	-35.0	15.9	35.4	22.8	17.4	15.1

As the table shows, in all the cases of A, B, C and D all the five above - OCC projects maintain their viability.

When the four Greater Dhaka East projects are combined together and treated as one entity, then this project stay viable in all the cases of A, B, C and D.

In Case E the switching value of the DC-4 Project is calculated at 58.6%, that is to say, it may still stay viable, supposing the capital cost overrun reaches 58.6%. Likewise, the switching values of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects are calculated at 22.7%, 22.1%, 20.0% and 18.7%, respectively.

In Case F the switching value of the DC-4 Project works out at 35.4%, that is, it may still remain viable, supposing the benefits turn out to be less by 35.4%. Similarly, the switching values of the DC-1, Narayanganj DND, DC-3 and Narayanganj West Projects work out at 17.7%, 17.4% , 15.9% and 15.1%, respectively.

The switching value of the combined Greater Dhaka East Project is 33.5% in Case E and 22.8% in Case F.

It follows that all the above five (5) projects will stay above 12% OCC under any conceivable adverse circumstances, which is also true with the combined Greater Dhaka East Project.

As regard the DC-2 Project the 28% reduction of costs or the 35% addition of benefits will be necessary if it is to be feasible. Also it was found out as a result of simulation that the implementation of the project should be started in 2015 (10 years postponement) if we are to make it feasible.

11.4 Socio-Economic Impact Assessment

11.4.1 Negative Impacts

1) Displacement of People

It is estimated that the number of people to be displaced by the construction of embankments and khal improvement will reach 7,053. It is broken down to 1,337 for DC-1, 734 for DC-2, 433 for DC-3, 1,127 for DC-4, 1,783 for the DND and 1,639 for the Narayanganj West. Also, compensation for building demolition accompanying displacement is estimated to amount to Tk. 328.1 million. It is broken down to 34.4, 21.7, 13.6, 31.2, 61.7 and 165.5 in millions of Taka for the areas in the above order, respectively.

The JICA Study Team conducted the sampling questionnaire survey to grasp socio-economic aspects of the people to be displaced, in December 1991, towards people to be affected by the construction of the embankments along the Balu River. The number of sample was 61 houses.

The profile of the sampled subjects is that the average number of household members is 8.3; 62.3% are engaged in agriculture more or less, 11.5% in boating and 4.9% in fisheries; average monthly income is Tk. 6,266; 72.1% got either primary schooling or no schooling whatsoever.

As an overall assessment it can be said that the people concerned have on the whole positive mental attitudes towards resettlement, that proper amount of compensation is the central and crucial issue, and that proper job retraining/ reorientation is a "must". According to the surveys conducted on the people already displaced in such circumstances, the living standard of most of them deteriorated after the displacement. Systematic, detailed and long-term approach to this problem is, therefore, most important and essential.

2) Adverse Effects on Boating and Fishing People

There are many people who are earning their livelihood by boating and inland water fishing in the Greater Dhaka East area. When embankments are constructed along the Balu River and other protective measures are taken, the vast areas which are now under water in the rainy season will be saved from inundation. Then, those people who are making their living by transportation and fisheries will be threatened to lose their trade.

According to the assessment on the survey data by the study team, it can be said that the socio-economic impacts of the construction of the eastern embankment along the Balu River on the boating trade are not so much in comparative terms, because the people and their earnings to be more or less affected by the construction of the embankment account for 0.3 to 1.4% of the total labour force and 0.4 to 1.2% of the total earnings in the Greater Dhaka East.

Moreover, although the boating business is an age-old, traditional occupation that has given employment to a substantial number of people and has benefited millions of customers, it is not an efficient service both for the suppliers and the customers compared with land transport. Although utmost care and measures should be taken so that the people to be directly affected can redirect their occupation or find a new

locations for their trade, the transfer of the transport mode from inland water navigation to land transport is the demand of the modern times. Land transport is bound to be developed where boating was the sole transport means, which is more economic and more contributory to the socio-economic development of the Greater Dhaka East area in long term.

It is said that over 756 households are involved with different intensity in fishing activities in the Study Area. More than 90% of them are occasional fishermen, the balance being constituted essentially by part-time fishermen. Full-time fishermen have proved to be few. Under these circumstances the impacts of the project on fishing people should not be exaggerated.

3) Loss of Farm Land and Occupation as Farmers

To make way for embankments, many people living on the left bank of the Balu River will have to part with their farm land. Or, after the construction of the embankments, the farm land inside the embankments will gradually be changed for residential and other uses.

The agricultural area in the Greater Dhaka East, the DND and the Narayanganj West in 1990 was 8,814 ha, 3,173 ha and 464 ha, respectively. It is forecast that in 2010 agricultural area in the 3 project areas will be reduced to 1,310 ha, 532 ha and 8 ha in the above order, respectively.

Farmers whose land is lost will often fail to reorient their occupation to a higher plane, ending up as squatters and so forth. Systematic long-term approach and programs by the government are sought to avoid or alleviate such a situation. One such approach is the provision of alternative farmlands, that remain unaffected in the surrounding flood plains of the priority area.

11.4.2 Positive Impacts

1) Population to be Saved from Inundation

In the "with" situation people living in the flood prone areas will be no longer affected by inundation.

It is estimated in the "without" situation that supposing the 1988-scale flood hit the feasibility study area in 2010, population to be affected would be 665,996 for DC-1, 261,856 for DC-2, 847,139 for DC-3, 1,218,397 for DC-4, 2,993,388 for the DND and 981,873 for Narayanganj West, totaling 5,326,040. In the "with" situation the same number of people would be saved from inundation.

2) Area to be Saved from Inundation

In the "with" case areas which are habitually or in time of big floods inundated will be free from such influences.

It is estimated in the "without" case that supposing the 1988-scale flood hit the Study area in 2010, built-up area to be affected would be 3,036 ha for DC-1, 1,146 ha for DC-2, 2,977 ha for DC-3, 2,635 ha for DC-4, 4,270 ha for the DND and 1,720 ha for the Narayanganj West, totaling 15,784 ha. In the "with" case the same area would be saved from inundation.

3) Creation of Employment

The implementation of the project will accompany the recruitment of a great number of labour force.

The project will provide employment during construction works to 10,693 people for DC-1, 8,616 people for DC-2, 5968 people for DC-3, 13,637 people for DC-4, 19,974 people for the DND and 7,625 people for the Narayanganj West, totaling 66,513 people on man-year basis.

After project implementation permanent jobs will be created for the operation and maintenance of equipment/facilities.

4) Reduction of Water-Borne Diseases

Water-borne epidemics such as dysentery, diarrhea, malaria, typhoid and cholera tend to break out following the visits of floods, especially, big and protracted ones. According to Statistical Yearbook of Bangladesh 1990, 144,521 more cases of dysentery, 8,930 more cases of diarrhea and 25,533 more cases of malaria were recorded in 1988 compared with 1987 in the Region of Dhaka. Connection with the 1988 flood is suspected for this unusual happening.

The JICA Study Team conducted the field survey to know about the incidence of water-borne diseases as well as medical costs of those diseases in the Study Area.

According to the survey results the incidence of water-borne diseases in the Study Area abruptly went up in the two flood years of 1987 and 1988: in normal years the annual number of cases works out at 17,789 on average, while it was 31,955 and 41,607 in 1987 and 1988, respectively. It means that one witnessed 14,166 more cases in 1987 and 23,818 more cases in 1988. Such cases of water-borne diseases will increase with increasing population in future.

Medical costs of such diseases are calculated at Tk. 3,178 per case on average. It means the additional loss of Tk. 45.0 million and Tk. 75.7 million in 1987 and 1988 respectively to the economy of the Study Area. (Such a loss will increase with increasing population). These amounts correspond to 0.3% and 0.5% of the estimated GDP of the Study Area in 1987 and 1988, respectively.

Supposing the higher incidence of water-borne diseases in 1987 and 1988 was primarily due to floods, such economic losses as estimated above are likely to be avoided in the "with" situation.

5) Removal of Psychological Burden

People of Bangladesh more or less suffer from psychological burden associated with the threats of floods. Once the flood protection and drainage project is realized in the Study Area, people there will be virtually freed from the inner load they are now forced to bear. It will surely affect their attitude toward life. They may get more positive and more active in their socio-economic activities.

6) Elevation of Land Use

After the project the existing low land mainly used for agriculture will be gradually developed and urbanized. It will be gradually converted into built-up areas. That is to say, houses, shops, factories and institutions will make their appearance, grow in number and finally get congested.

In the process more capital will be invested in the land for a higher use of it. It means that the value of the land will gradually go up, which will be reflected in a higher land price. This impact on the value of land can be enormous.

11.5 Environmental Impact Assessment

The project is aimed at protecting from flooding the existing and future urban area of Dhaka and Narayanganj. The population in the Study Area is projected to increase by 2.2 times from 3,068,927 in 1990 to 6,710,661 in 2010. It means increased amount of wastewater, solid waste, etc. more than doubling the present level will be generated in future. (For more details refer to 3.3 of Supporting Report C). Unless proper vigilance and measures are taken most of the water courses crisscrossing the Study Area would become polluted. In order that such things may not happen, regular monitoring of water quality in major water courses in consideration with appropriate mitigatory measures is recommended. (Refer to 4. of Supporting Report C).

As mentioned already, agricultural and open water capture fishery land in the Study Area is bound to be greatly reduced after the construction of embankments. Therefore, possible negative impacts on agriculture and fishery should be viewed against this background. In other words, such impacts should not be inordinately exaggerated.

Environmental factors considered for possible negative impacts on them by a flood protection and drainage project also include general ecological elements of flora and fauna, productive ecological elements of agriculture and aquaculture fishery, public health, surface water quality and others in addition to the social impacts mentioned above. These are dealt with in details in Chapter 7. The anticipated direct and indirect effects of short and long term are also qualitatively evaluated in Table 7.3.

1) Adverse Effect on Water Quality and Its Far-Reaching Implications

Water in canals and ponds will be depleted and its free intercourse with river water outside the embankment will be obstructed after the project. This may lead to the stagnation of surface water. Besides, farmers will be encouraged to grow HYV more as there will be no flooding any more. But, HYV are more prone to pests and farmers will resort to more use of pesticide.

These things along with a more concentration of population are likely to pollute the water of canals and ponds and adversely affect fish and plant concerned. This can cause chain reactions in the overall ecological system in the study area. Future living environmental improvement and water pollution control measures are very essential to realize a long term benefit.

2) Adverse Effects on Soil Quality

Annual flooding in the rainy season in the low land areas bring with them fertile soil made up of organic matters and crops in the dry season are benefited by them. This way of things has continued from the time immemorial. but, once the circumstances are created where there are no more such flooding crops may not grow as before unless farmers take remedial steps.

Farmers will be encouraged to grow HYV because there will be no flooding in the farm land any more. It will lead to a more use of chemical fertilizer as the growing of HYV and the use of fertilizer are inseparable. This situation may contribute to the deterioration of soil quality. However, this effect is expected to be insignificant in consideration to the reduced agricultural land use in future.

3) Possible Change of River Courses

Environmentalists argue about the possible change of river courses as a result of the empoldering of a certain area and its possible adverse effects on the natural and social environments concerned. However such a condition in this case is extremely unlikely as per the backwater curve analysis conducted during the master plan study, in which even the change in river stage due to the embankments is assessed to be very insignificant.

4) Possible Breach of Embankments

Should an embankment fail and the bulged water surge into the erstwhile protected area, the resultant damages to properties, human life and farm land would be enormous. This is a man-made disaster that is not allowed to happen. An effective O&M of the facilities is very essential to minimize such a risk of embankment breach.

11.6 Financial Analysis

The implementation of the flood protection and drainage project will save the vast Study Area from inundation by floods.

Those lands which are now flood plains will be no longer inundated and majority of them will be developed for urban uses. That is to say, they will be raised with additional soil and infrastructures such as roads, bridges, electric lines, telecommunication lines, water supply, gas and sewerage pipes will be constructed there so that they can be used for residential, commercial, industrial and institutional purposes. This land development will be basically public undertakings. The costs of land development will reach an enormous amount.

Those areas which are already built up will also be no longer inundated.

The total capital costs of the flood protection and drainage project are estimated at Tk. 26,987 million. In addition, to maintain and operate the flood protection and drainage facilities recurrent costs amounting to Tk. 177 million will be annually required.

Through flood protection, drainage and land development majority of lands in the Study Area will turn into urban areas. In parallel with it the value, that is, price of land will go up to a great extent.

It follows from the above that land owners in the Study Area will be a major beneficiary of the project. However, the degree of benefits they will get will be different between those who now own flood plains and those who own already built-up areas. Also, it will be different between those who own commercial areas with high population density and those who own residential areas with low population density.

The JICA Study Team proposes that the authorities impose Land Development Tax on landowners to recover O&M costs.

The built-up area in Greater Dhaka East is estimated to increase from 6,675 ha in 1990 by 98.4% to 13,245 ha in the target year of 2010. Likewise, the built-up area in Narayanganj is estimated to increase from 3,487 ha in 1990 by 71.8% to 5,990 ha in 2010. In total, the built-up area in the Study Area will go up from 10,162 ha in 1990 by 89.3% to 19,235 ha in 2010.

It is assumed that Dhaka and Narayanganj have their own, separate jurisdictions for the collection of Land Development Tax rates. It implies that the tariff will be different between the two areas.

As mentioned above, the built-up area in Greater Dhaka East and Narayanganj is estimated in 2010 to reach 13,245 ha and 5,990 ha, respectively, while annual O&M costs of the project for the two areas in the same year are estimated at Tk. 128 million and Tk. 49 million, respectively. That is to say, to recover O&M costs annual rates of Tk. 9,664 and Tk. 8,180 per ha will be levied on landowners in Greater Dhaka East and Narayanganj, respectively. Supposing collection efficiency is 70%, their respective annual rates will be Tk. 13,806 and Tk. 11,686 per ha.

Using the local measure, Tk. 39 and Tk. 33 per decimal will be annually levied in Greater Dhaka East and Narayanganj, respectively. Supposing collection efficiency is 70%, their respective annual rates will be Tk. 56 and Tk. 47 per decimal.

As already mentioned, actually the tariff should be structured in such a way that rates will be different depending on various factors. For instance, they will be different between the land which is now agricultural and the land which is now already urban, and also between the highly built-up area and the built-up area with low population density. Rates will be determined partly in accordance with the level/intensity of infrastructure investments per unit area of land and partly in accordance with the convenience/utility of locations. They will all be reflected in the price of land.

11.7 Project Assessment

As already mentioned, the Greater Dhaka East, the DND, and the Narayanganj West Projects with their respective EIRR of 15.8%, 14.5% and 14.3% can be judged to be economically feasible without any reservation (ref. Table 11.4).

The economic efficiencies of the 4 compartments of the Greater Dhaka East area are varied from 8.0% to 18.9%, however the areas are geographically, socially and economically interdependent and inseparable. In case of the project with a strong social nature, the EIRR of over 7% have proved to be on the high side.

Values of other decision criteria and results of sensitivity analysis support the above evaluation.

In terms of socio-economic impacts of the projects, supposing the 1988-scale flood hit the Study Area in 2010, 5,660,700 people or 84.4% of the total population and 15,784 ha or 82.1% of the total built-up area would be saved from inundation. The projects will provide employment opportunities reaching 66,513 man-years.

They will surely reduce the breakout of water-borne diseases by tens of thousands of cases, saving the economic losses running into Tk. fifty to one hundred million. They will remove psychological burden and stresses from people's mind, nurturing positive attitude to life. Most importantly, the enormous and vast area of land will be set free from inundation, enabling it to be developed and used for human habitation and economic activity.

The resettlement and boating trade issues must be treated with the utmost care as the livelihood of people is involved. However, they are transitory in nature and an inescapable friction from the standpoint of overall economic development.

A summary of project evaluation is shown in Table 11.4.

Regarding environmental issues, it is indispensable and essential to concentrate all the human efforts to prevent, stop and lessen the negative environmental impacts of the project. The prime requirement is the urban environmental enhancement measures of living environment and water pollution control.

TABLE 11.1 AVERAGE ANNUAL FLOOD DAMAGES BY AREA BY YEAR

(Unit : Tk. Million)

Area	Average Annual Flood Damages		
	External Flood	Internal Flood	Total
1. 1990			
Dhaka East - 1	40.7	2.5	43.2
Dhaka East - 2	25.4	1.0	26.4
Dhaka East - 3	121.0	74.1	195.1
Dhaka East - 4	195.5	97.5	293.0
Dhaka East (Sub-Total)	382.6	175.1	557.7
Narayanganj DND	116.0	37.4	153.4
Narayanganj West	88.5	24.9	113.4
Total	587.1	237.4	824.5
2. 2010			
Dhaka East - 1	634.5	13.9	648.4
Dhaka East - 2	169.3	7.4	176.7
Dhaka East - 3	480.4	148.1	628.5
Dhaka East - 4	631.9	159.4	791.3
Dhaka East (Sub-Total)	1,916.1	328.8	2,244.9
Narayanganj DND	483.8	156.1	639.9
Narayanganj West	318.8	76.5	395.3
Total	2,718.7	561.4	3,280.1

Source : JICA

TABLE 11.2 (1) ECONOMIC COSTS BY PROJECT

1. Capital Cost

(Unit : Tk. Million)

Item	Greater Dhaka East					Narayanganj		Total
	DC-1	DC-2	DC-3	DC-4	Sub-Total	DND	West	
A. Project Preparation								
1) Administration	85	59	57	67	268	66	51	385
2) Engineering	326	226	220	258	1,030	250	194	1,474
3) Compensation	34	22	14	31	101	62	166	329
Sub-Total	445	307	291	356	1,399	378	411	2,188
B. Flood Mitigation								
1) Embankment	2,101	813	835	910	4,659	0	616	5,275
2) Flood Wall	19	20	14	25	78	43	180	301
3) Sluice Gate	160	89	78	79	406	60	157	623
4) Related Struc.etc.	0	0	0	0	0	3	1	4
Sub-Total	2,280	922	927	1,014	5,143	106	954	6,203
C. Storm Water Drainage								
1) Pump Station	1,156	553	1,077	1,066	3,852	1,296	510	5,658
2) Khal Improvement	246	183	150	426	1,005	932	386	2,323
3) Bridge etc.	14	0	0	8	22	101	16	139
Sub-Total	1,416	736	1,227	1,500	4,879	2,329	912	8,120
D. Physical Contingency	425	294	285	337	1,341	326	253	1,920
E. Replacement	389	732	727	713	2,561	949	328	3,838
Total	4,955	2,991	3,457	3,920	15,323	4,088	2,858	22,269

TABLE 11.2 (2) ECONOMIC COSTS BY PROJECT

2. Annual Net Benefits of Production Foregone

(Unit : Tk. Million)

Item	Greater Dhaka East					Narayanganj		Total
	DC-1	DC-2	DC-3	DC-4	Sub-Total	DND	West	
Land Acquisition (ha)	197.9	96.2	83.1	146.3	523.5	107.1	121.2	751.8
Annual Net Benefits of Production Foregone	2.28	1.11	0.96	1.68	6.02	1.23	1.39	8.65

3. Annual Operating and Maintenance Cost

(Unit : Tk. Million)

Item	Greater Dhaka East					Narayanganj		Total
	DC-1	DC-2	DC-3	DC-4	Sub-Total	DND	West	
O & M Cost	37	30	29	32	128	28	21	177

Source : JICA

Table 11.3(1) Cost Benefit Streams - Greater Dhaka East Project

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits
CF=Cash Flow (=BF - CS)

(Unit:Tk Million)

NO.	YEAR	CC	OM	CS	BF	CF
1	1992	602	0	602	28	-574
2	1993	347	0	347	48	-300
3	1994	90	3	93	54	-39
4	1995	158	7	166	56	-110
5	1996	434	7	441	144	-297
6	1997	877	7	884	287	-597
7	1998	880	7	887	444	-443
8	1999	734	24	758	558	-200
9	2000	323	36	360	584	225
10	2001	820	36	856	684	-172
11	2002	1498	35	1533	964	-569
12	2003	1848	35	1883	1273	-610
13	2004	1382	48	1430	1533	103
14	2005	572	84	656	1684	1027
15	2006	144	96	240	1761	1521
16	2007	723	96	819	1882	1063
17	2008	925	100	1025	2025	1000
18	2009	629	113	742	2134	1392
19	2010	551	119	670	2245	1575
20	2011	6	130	136	2329	2193
21	2012	181	130	311	2414	2103
22	2013	6	135	141	2498	2357
23	2014	540	135	675	2582	1907
24	2015	6	135	141	2667	2526
25	2016	6	135	141	2751	2610
26	2017	6	135	141	2835	2694
27	2018	6	135	141	2920	2779
28	2019	303	135	438	3004	2566
29	2020	550	135	685	3089	2404
30	2021	6	135	141	3173	3032
31	2022	189	135	324	3257	2933
32	2023	6	135	141	3342	3201
33	2024	185	135	320	3426	3106
34	2025	646	135	781	3820	3039
35	2026	4	100	104	2405	2300
36	2027	188	100	288	2464	2176
37	2028	4	100	104	2524	2419
38	2029	4	100	104	2583	2479
39	2030	4	100	104	2783	2679
40	2031	2	63	65	1636	1571
41	2032	2	63	65	1442	1377
42	2033	2	63	65	1471	1406
43	2034	2	63	65	1718	1653
44	2035	1	30	31	365	334
45	2036	1	30	31	592	561

Table 11.3(2) Cost Benefit Streams - Narayanganj DND Project

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits
CF=Cash Flow (=BF - CS)

(Unit:Tk Million)

NO.	YEAR	CC	OM	CS	BF	CF
1	1992	234	0	234	0	-234
2	1993	0	0	0	0	0
3	1994	0	0	0	0	0
4	1995	0	0	0	0	0
5	1996	328	0	328	0	-328
6	1997	895	0	895	110	-786
7	1998	896	0	896	236	-660
8	1999	850	14	864	372	-492
9	2000	1	25	26	397	370
10	2001	1	25	26	421	395
11	2002	1	25	26	445	419
12	2003	1	25	26	470	443
13	2004	1	25	26	494	468
14	2005	1	25	26	518	492
15	2006	1	25	26	543	516
16	2007	1	24	25	567	542
17	2008	5	24	29	591	562
18	2009	171	24	195	616	420
19	2010	1	28	29	640	611
20	2011	1	28	29	664	635
21	2012	1	28	29	689	659
22	2013	1	28	29	713	684
23	2014	1	28	29	737	708
24	2015	771	28	799	762	-38
25	2016	1	28	29	786	757
26	2017	1	28	29	810	781
27	2018	1	28	29	835	805
28	2019	1	28	29	859	830
29	2020	1	28	29	883	854
30	2021	1	28	29	907	878
31	2022	1	28	29	932	903
32	2023	1	28	29	956	927
33	2024	180	28	208	980	772
34	2025	1	28	29	1005	976
35	2026	1	28	29	1390	1360

Table 11.3(3) Cost Benefit Streams - Narayanganj West Project

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits
CF=Cash Flow (=BF - CS)

(Unit:Tk Million)

NO.	YEAR	CC	OM	CS	BF	CF
1	1992	0	0	0	0	0
2	1993	0	0	0	0	0
3	1994	0	0	0	0	0
4	1995	0	0	0	0	0
5	1996	0	0	0	0	0
6	1997	0	0	0	0	0
7	1998	0	0	0	0	0
8	1999	369	0	369	0	-369
9	2000	376	0	376	44	-332
10	2001	603	0	603	121	-482
11	2002	606	0	606	207	-400
12	2003	286	16	302	256	-46
13	2004	295	16	311	311	-1
14	2005	1	21	22	325	302
15	2006	1	21	22	339	317
16	2007	1	21	22	353	331
17	2008	1	21	22	367	345
18	2009	1	21	22	381	359
19	2010	1	21	22	395	373
20	2011	1	21	22	409	387
21	2012	1	21	22	423	401
22	2013	1	21	22	438	415
23	2014	1	21	22	452	429
24	2015	1	21	22	466	443
25	2016	1	21	22	480	457
26	2017	1	21	22	494	472
27	2018	1	21	22	508	486
28	2019	329	21	350	522	172
29	2020	1	21	22	536	514
30	2021	1	21	22	550	528
31	2022	1	21	22	564	542
32	2023	1	21	22	579	556
33	2024	1	21	22	593	570
34	2025	1	21	22	607	584
35	2026	1	21	22	621	598
36	2027	1	21	22	635	613
37	2028	1	21	22	649	627
38	2029	1	21	22	772	750

TABLE 11.4 PROJECT EVALUATION

Item	Greater Dhaka East					Narayanganj		Remarks
	DC-1	DC-2	DC-3	DC-4	Combined	DND	West	
1. Economic Evaluation								
1) EIRR (%)	14.8	8.0	13.9	18.9	15.8	14.5	14.3	
2) NPV (Tk. million)	274	-98	263	1,032	1,501	371	152	
3) B/C	1.22	0.74	1.19	1.55	1.31	1.21	1.18	
4) NPVR(2)	0.162	-0.155	0.147	0.416	0.228	0.151	0.110	
2. Socio - Economic Impacts								
1) Population to be Saved from Inundation by 1988 - Scale Flood in 2010	665,996	261,856	847,139	1,218,397	2,993,388	1,685,439	981,873	
2) Area to be Saved from Inundation by 1988-Scale Flood in 2010 (ha)	3,036	1,146	2,977	2,635	9,794	4,270	1,720	
3) Labour Force to be Employed during Construction (man-years)	10,693	8,616	5,968	13,637	38,914	19,974	7,625	
4) Resettlement								
(1) No. of People to be Displaced	1,337	734	433	1,127	3,631	1,783	1,639	
(2) Compensation (Tk. million)	34.4	21.7	13.6	31.2	100.9	61.7	165.5	
5) Boating Trade to be Affected								
(1) No. of Boatmen to be Affected	853	415	1,207	150	2,625	-	-	
	118	-	305	150	573	-	-	....Seriously
(2) Annual Sales to be Affected (Tk.)	30,675,750	4,727,800	12,513,100	5,355,000	53,268,650			
	3,701,250	-	9,061,150	5,355,000	18,117,400	-	-	....Seriously

Source : JICA