No. 52

JAPAN INTERNATIONAL COOPERATION AGENCY

DHAKA WATER SUPPLY AND
SEWERAGE AUTHORITY
THE PEOPLE'S REPUBLIC OF BANGLADESH

THE STUDY
ON
THE SEWERAGE SYSTEM
IN
NORTH DHAKA
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

FINAL REPORT

MAIN REPORT

JULY 1998

NIPPON JOGESUIDO SEKKEI CO., LTD.

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PREFACE

In response to a request from the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a study on the Sewerage System in North Dhaka and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team composed of individuals from Nippon Jogesuido Sekkei Co., Ltd and headed by Mr. Ikuo Miwa. The team visited Bangladesh three times between May 1997 and June 1998.

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

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

I wish to express my sincere appreciation to the officials concerned of the Government of Bangladesh for the close cooperation that they extended to the team.

July 1998

Kimio Fujita, President
Japan International Cooperation Agency

July 1998

Mr. Kimio Fujita, President
Japan International Cooperation Agency
Japan

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit herewith the Final Report for the Study on the Sewerage System in North Dhaka.

The Study was completed through discussions with the officials of the Government of Bangladesh and field investigations during three visits from May 1997 and June 1998 and the homework thereafter.

The Final Report consists of three volumes: 1) the Summary Report, which succinctly describes the study and its recommendations; 2) the Main Report, which covers the findings of the Master Plan and the Feasibility Study, as well as the proposed Emergency Project; and 3) the Supporting Report, which contains data upon which the Master Plan and the Feasibility Study are based.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Construction. We also would like to show our appreciation to the officials of the Dhaka Water Supply and Sewerage Authority, the JICA Bangladesh Office, and the Embassy of Japan in Bangladesh for their kind assistance throughout this Study.

Very truly yours,

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Ikuo Miwa, Team Leader
The Study on the
Sewerage System in North Dhaka

FINAL REPORT

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Abbreviations

1. Unit

capita/day	per capita per day
cm	centimeter
cu.m/day	cubic meter per day
cu.m/sec	cubic meter per second
ha	hectare (1 ha = 10,000 square meter)
ft.	foot
g	gallon
gpcd	gallon per capita per day
H.W.L.	High Water Level
IMGD	Imperial million gallon per day
km	kilo meter
kW	kilowatt
kWh	kilowatt hour
kV	kilovolt
lpcd	liter per capita per day
l	liter
l/sec	liter per second
l/day	liter per day
L.W.L	Low Water Level
m	meter
m3 or m^3	cubic meter
m^3/min	cubic meter per minute
MGY	million gallons per year
MLD	million liters per hour
mm	millimeter
mg/l	milligram per liter
m/s	meters per second
ppm	parts per million
sq.km	square kilometer
sq.m	square meter
sq.mile	square mile

2. Water Quality

BOD_5	Biochemical Oxygen Demand (5 days)
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EC	
PCB	
pH	Hydrogen ion potential
SS	Suspended Solids
TS	Total Solids

3. Organizations

BBS	Bangladesh Bureau of Statistics
BEPZA	Bangladesh Export Processing Zone Authority
BNBD	Bangladesh National Building Code of 1993
BWDB	Bangladesh Water Development Board
DCC	Dhaka City Corporation
DOE	Department of Environment (Government of Bangladesh)
DPHE	Department of Public Health and Engineering (Government of Bangladesh)
DWASA	Dhaka Water Supply and Sewerage Authority
IBRD	International Bank for Reconstruction and Development (World Bank)
IDA	International Development Association (soft loan facility of IBRD)
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency (Japan)
MLGRD	Ministry of Local Government, Rural Development and Co-operatives (Government of Bangladesh)
MODS	Maintenance-Operation-Distribution-Service, operating unit of DWASA
MOF	Ministry of Finance (Government of Bangladesh)
OECF	Overseas Economic Cooperation Fund (Japan)
RAJUK	Rajidhani Unnayan Kartripakha (Capital Development Authority, Government of Bangladesh)
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WHO	World Health Organization

4. Others

ADP	Annual Development Plan (Government of Bangladesh)
BNBC	Bangladesh National Building Code of 1993
BOT	Build - Operate - Transfer
CPI	Consumer Price Index
DITS	Greater Dhaka Metropolitan Area Integrated Transport Study
DMAIUDP	Dhaka Metropolitan Area Integrated Urban Development Plan
DMDP	Dhaka Metropolitan Development Planning
DND Triangle	Dhaka-Narayanganj-Demra Triangle
DTW	Deep Tube Well
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPZ	Export Processing Zone (Government of Bangladesh)
FIRR	Financial Internal Rate of Return
FY	Fiscal Year
GDP	Gross Domestic Product
GL	Ground Level
GNP	Gross National Product
HH	Household
L/S	Lift Station
MIR	Management Information Report, DWASA's official report
NGO	Non-Governmental Organization
ODA	Official Development Assistance
PIP	Public Investment Program (Government of Bangladesh)
P/S	Pump Station
SMA	Statistical Metropolitan Area (Government of Bangladesh)
SPZ	Strategic Planning Zone (Dhaka Metropolitan Development Plan)
STP	Sewage Treatment Plant
T.A	Technical Assistance
TAPP	Technical Assistance Project Proforma (Government of Bangladesh)
UFW	Unaccounted-For-Water
VAT	Value Added Tax
WID	Women in Development

Definition of Terms

1. Definitions Employed by the Bangladesh Bureau of Statistics

Smaller geographic area or community level area:

Union- Smallest electoral unit of rural area which is comprised of mauzas and villages is known as "Union." A Union has a Union Parishad (Council).

Mauza- A revenue village with a jurisdiction list number and defined area is called "mauza." It may be populated or depopulated.

Village- Smallest geographical area of rural area which is known to the people as "village." A village may be same as mauza or there may be more than one village in a mauza.

Ward- Smallest electoral unit of urban area is called a "Ward." Ward has a Ward Parishad.

Mahallah- Smallest identifiable area of municipalities which is known to the inhabitants as "mahallah." For statistical purposes, mahallahs are delineated within Ward.

2. Definitions of different types of urban areas:

Urban Area- Developed areas around (i) an identifiable central place where (ii) amenities like metalled roads, communication facilities, electricity, gas, water supply, sewerage, sanitation, etc. usually exist, (iii) which are densely populated and a majority of the population are non-agricultural and (iv) where community sense is well developed. Three different types of urban areas have been defined for the Census by map;

i) Statistical Metropolitan Area (SMA)
ii) Municipality Area (M)
iii) Other Urban Area (U)

i) Statistical Metropolitan Areas are defined to include Municipal/City Corporations and the adjacent areas having urban characteristics.

ii) Municipalities are incorporated and administered by the government as urban areas under the Paurashava Ordinance, 1977.

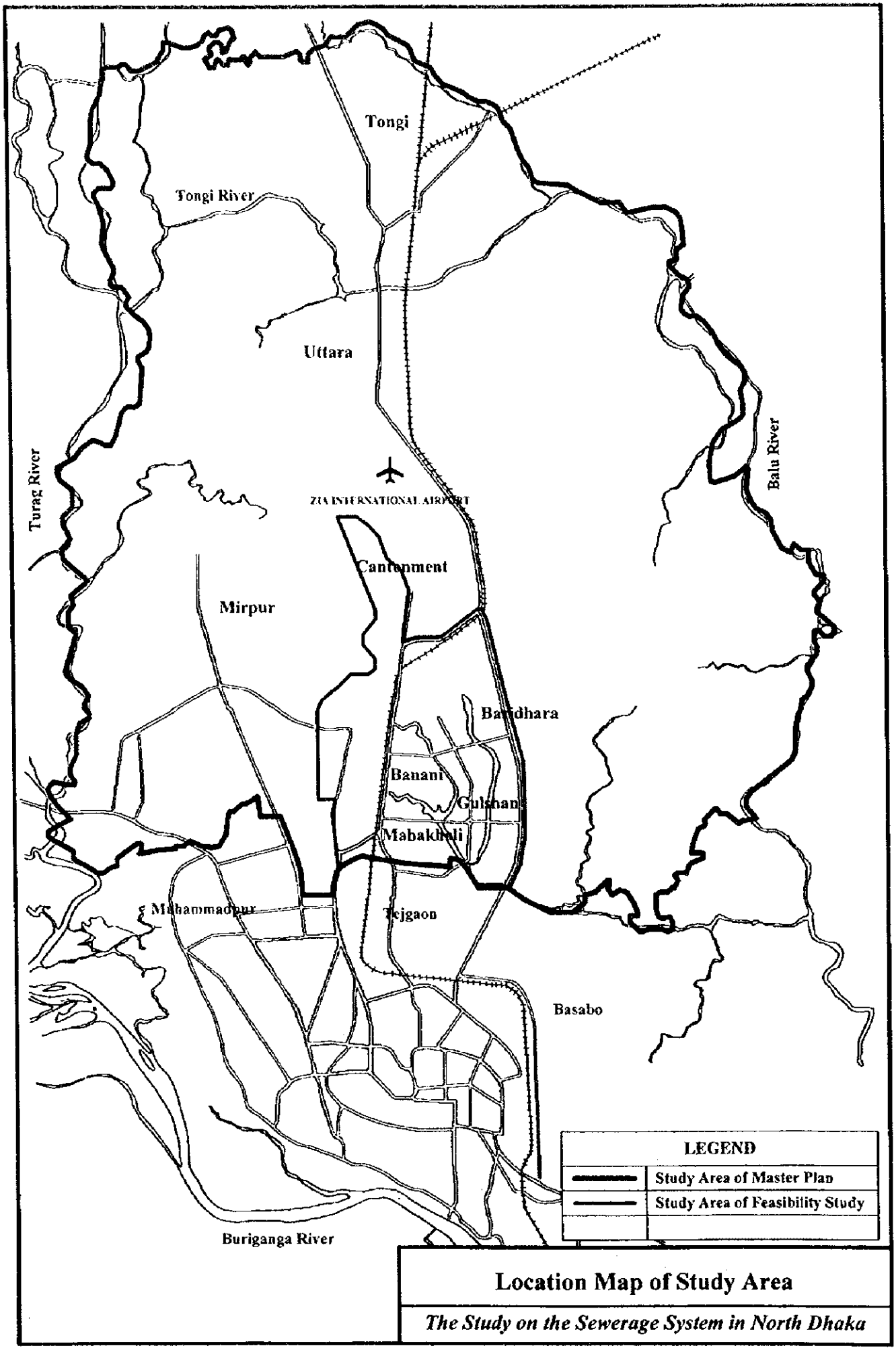
iii) Other Urban Areas are Thana headquarters and the development centers which have urban chanracteristics. Following international practices, urban areas have been classified by size of population as Town (T), City (C), Statistical Metropolitan Area (SMA) and Megacity (MC).

- Towns are urban areas which have less than 100,000 population are classified as towns.

- Cities are urban areas with population of 100,000 to 499,000.

- Statistical Metropolitan Area are urban areas with population of 500,000 to 4,999,000.

- Megacities are urban areas with population of 5,000,000 or more.



Location Map of Study Area

The Study on the Sewerage System in North Dhaka

PART 1

MASTER PLAN

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

A water supply master plan covering Dhaka was formulated in 1950 and DWASA was established in 1963 as the exclusive implementing agency for these public works. However, the project's implementation was limited, mainly due to financial restrictions and thus, the scope of the master plan was reduced by the World Bank; this resulted in the DWASA-I, II and III Projects focusing on water supply. In the DWASA-IV plan, formulated in June 1995, the sewerage development plan for North Dhaka was planned anew and forms the background of the Study.

In North Dhaka, which has less flooding damage due to its higher elevation in comparison with South Dhaka, there has been rapid population growth fueled by migration from rural areas. Most of the existing sewerage system is concentrated in South Dhaka, the old town, while there is no sewage treatment plant in North Dhaka (although sewer pipes have been partially installed).

In some residential areas, sewage is treated by septic tanks, but the majority of sewage and/or domestic wastewater is directly discharged into the existing stormwater drainage canals, open channels, etc. without any treatment. The sewage is finally discharged into nearby ponds, lakes, or rivers. This situation creates health hazards, offensive odor and the contamination of groundwater and public water bodies.

Consequently, sewerage development in these residential areas should be accelerated as an urgent and effective countermeasure to combat the numerous health and environmental hazards posed by raw sewage. To cope with these circumstances, the Government of Bangladesh requested the Government of Japan for the execution of the development study under the Japanese Technical Cooperation Program.

In response to this request, the Government of Japan has decided to conduct the Study in accordance with the relevant laws and regulations in force in Japan.

Accordingly, JICA, the official agency responsible for the implementation of the technical

cooperation programs of the Government of Japan, dispatched the Preparatory Study Team from November 15 to December 1, 1996 to discuss the Scope of Work for the Study. The Scope of Work was then agreed upon between the JICA Preparatory Study Team and the Ministry of Finance on November 25, 1996.

Based on the agreed Scope of Work, DWASA is officially designated as the counterpart agency to the Study Team to be dispatched by JICA and also as a coordinating body in relation with other governmental and non-governmental organizations for the smooth implementation of the Study.

The Study commenced in the middle of March 1997 with preparation of the Inception Report, and is scheduled to be completed by the end of June 1998 with the submission of the Final Report. During fifteen and a half (15.5) months, the Study Team will effectively proceed the Study in close cooperation with its counterpart engineers and specialists, paying special attention to the issue of technology transfer.

1.2 Objectives and Area of the Study

The objectives of the Study are: (1) to formulate a sewerage master plan in North Dhaka for the target year 2020, after a review of the existing plans, (2) to conduct a feasibility study for the priority project(s) identified in the master plan, and (3) to transfer technology relating to planning methods and skills to the Study Team's counterpart personnel in the course of the Study.

1.3 Study Area

The Study Area covers North Dhaka including Tongi, Uttara, a part of Mirpur and Mohammadpur, Banani, Gulshan, Badda, Baridhara, the Cantonment, and adjoining areas.

1.4 Scope of Work

The major elements of the Study are delineated as follows:

(1) Understanding of the present conditions of the Study Area through review and evaluation

of the existing data, interviews and field observations on:

1) Physical conditions
2) Socio-economic conditions and trends
3) Development plans and policies
4) Environmental conditions
5) Wastewater management conditions

(2) Review of previously prepared studies/plans related to the sewerage system

(3) Field survey on actual conditions of the Study Area, such as:

1) Quality and quantity of wastewater
2) Quality of water body
3) Residents' awareness on environmental sanitation and their willingness and affordability to pay
4) Topographic survey and soil investigation

(4) Evaluation of present conditions of wastewater management and identification of issues and problems with emphasis on:

1) Physical aspects
2) Operational aspects
3) Financial aspects
4) Socio-economic aspects
5) Environmental aspects

(5) Forecasts of the changes in quantity of wastewater in the year 2020 through projections of:

1) Population growth and urbanization
2) Economic growth and changes in living conditions
3) Industrial growth
4) Trends in meteo-hydrology

(6) Establishment of basic policies, goals and strategies on:

1) Target level of health and hygiene improvement of the local residents
2) Target level for improvement and conservation of water body
3) Reuse of treated wastewater
4) Choice of appropriate technology
5) Institutional and operational efficiency

(7) Examination of planning requirement for the project

(8) In-depth survey and supplementary data collection such as topography, geology, hydrology, meteorology, and environment

(9) Preparation of alternative plans on such aspects as:

1) Method of collection system
2) Method and level of sewage treatment
3) Zoning and location of the sewerage system
4) Phased implementation

(10) Selection of the optimum sewerage system through comparison of:

1) Technical soundness
2) Financial cost
3) Economic cost and benefits
4) Environmental impacts

(11) Preliminary design of facilities

(12) Equipment plan

(13) Construction plan

(14) Operation and maintenance plan including:

1) Guidelines for proper operation
2) Preventive maintenance
3) Rehabilitative maintenance

(15) Plan for strengthening institutional capacity for the implementation of the project with emphasis on:

1) Managerial capability
2) organizational structure
3) Staffing and manpower development
4) Public education

(16) Cost estimation and financial management plan including:

1) Cost stream
2) Target level of cost recovery
3) Policy on mobilizing financial resources for investment
4) Tariff policy
5) Privatization

(17) Conduct of Environmental Impact Assessment (EIA)

(18) Comprehensive project evaluation including:

1) Technical aspects (appropriate technology)
2) legislative and institutional aspects
3) Financial aspects
4) Social aspects
5) Economic aspects
6) Environmental aspects

(19) Implementation plan

1.5 Implementation of the Study

The Study is being carried out in accordance with the Scope of Work agreed upon between the Ministry of Finance and JICA. DWASA has organized a steering committee and counterpart team, and is keeping close cooperation with the Study Team to ensure the smooth implementation of the Study. The overall set-up for the implementation of the Study is shown below.

Implementation Set-up of the Japanese Side

The implementation set-up of the Japanese side consists of the Study Team and the Advisory Committee under the general supervision of JICA headquarters.

The composition of the JICA Advisory Committee and the Study Team are as follows:

Member of the Advisory Committee

Name	Organization/Authority
Mr. Eijiro TAKASHIMA (Leader/Sewerage Planning)	Housing and Urban Development Corporation

Members of the Study Team

Name	Assignment
Mr. Ikuo Miwa	Team Leader
Mr. Masuomi Hiroyama	Sewerage Planner
Mr. Hiroshi Terayama	Facilities Planner
Mr. Atsushi Hinata	Equipment Planner
Mr. Akira Yamaguchi	Implementation Planner/Cost Estimator
Mr. Takashi Watanabe	O&M Planner
Mr. Kenji Kozuka	Water Quality & Environment Specialist
Mr. Hiromitsu Endo	Sanitation & Social Specialist
Mr. Robert L. Keener	Economic & Financial Analyst
Mr. Wilfrido C. Barreiro	Organization & Institution Specialist

Implementation Set-up of Bangladesh Side

The implementation set-up of Bangladesh side consists of the MOF as the executing agency, the DWASA as the counterpart agency to the Study Team with its counterpart personnel, and the Steering Committee for the Study composed by representatives from authorities concerned. Overall coordination of the Steering Committee is being handled by the MOF. The Steering Committee has been organized by following representatives of relevant authorities.

Composition of the Steering Committee

Organization	Name of Representative
Ministry of Finance,	Mr. M.Azizul Islam, Deputy Secretary, Economic Relations Div.
Planning Commission	Mr. Rafidul Islam Khan, Division Chief
Ministry of Local Gov't, Rural Dev't and Co-operatives	
	Mr. Serajul Islam, Deputy Chief, Local Gov't Div.
DWASA	Mr. S. A. Malek, Deputy Chief, Planning and Development

1.6 Study Phase and Reporting Schedule

The Study is subdivided into three (3) phases according to the scope and progress of the work. The Study reports in each phase are scheduled as follows:

Study Phase		Study Report
Phase 1 Master Plan Preparation		
Field Work in Dhaka	May 7 - Aug. 2	Inception Report (beginning of May 1997)
		Progress Report 1 (end of July 1997)
Home Work in Japan	Aug. 4 - Sep. 15	Interim Report (by Sep. 15, 1997)
Phase 2 Feasibility Study		
Field Work in Dhaka	Nov. 6 - Feb. 18	Technical Seminar 1 with Interim Report (beginning of Nov. 1997)
		Progress Report 2 (beginning of Feb. 1998)
Home Work in Japan	Feb. 19 - Mar. 31	Draft Final Report (by Mar. 31, 1998)
Phase 3 Finalization of Study		
Field Work in Dhaka	May 16 - May 31	Technical Seminar 2 with Draft Final Report (end of May 1998)
Home Work in Japan	Jun. 16 - Jun. 30	Final Report (to be delivered to Bangladesh in July to August 1998)

CHAPTER 2

PHYSICAL AND SOCIO-ECONOMIC CONDITIONS

CHAPTER 2 PHYSICAL AND SOCIO-ECONOMIC CONDITIONS

2.1 Physical Conditions

2.1.1 General

Bangladesh is located at the eastern end of the Indo Gangetic plain in southern Asia with a geographical position between 20°34' and 203°8' north latitude and 88°01' and 92°41' east longitude. It extends 767 km (477 miles) SSE to NNW and 429 km (267 miles) ENE to WSW. It has a total land area of 147,570 sq.km wherein most land is within 30 m of sea level.

Bangladesh has a total land boundary of 2,816 km (1,750 miles) and it is shared with two countries. India (2,583 km or 1,605 miles) and Myanmar (233 km or 145 miles). The India-Bangladesh boundary line was determined by the Radcliffe Award at the time of the partition of British colonial India into India and Pakistan in 1947. The border was ratified by the Bangladeshi legislature in 1974. The Bangladesh-Myanmar border was fixed in 1937 at the time of the separation of Myanmar from India. Dhaka City, the national capital, spreads northward from the west bank of the Buriganga River, is located nearly at the geographical center of the country.

Bangladesh has a tropical climate governed by monsoons. Although Bangladesh is comparatively temperate and equable, there are marked seasonal variations. The three main seasons are a hot, summer season from March to June, a cooler but still warm and humid monsoon season from June through September and a cool, dry, winter season from October to February. April and May are the hottest months.

The average temperatures range from 70°C (45° F) in January to 31°C (88° F) in August and 32°C (90°F) in May. Temperatures up to 40.6°C (105°F) have been occasionally recorded. Daily temperature changes are moderate.

Nearly 80% of the annual rainfall occurs from June through September when the moisture-laden monsoons blow in from the south and south-east. The average annual rainfall varies from 1,430 mm to 4,340 mm. The Sylhet district, in the north-east, is believed to receive the highest amount of rainfall in the world.

2.1.2 Meteorology

The monthly meteorological data at Dhaka in 1994 and the annual total rainfall at Dhaka and Chittagong, monitored by the Bangladesh Meteorological Department, is summarized in Tables 2.1.1 and 2.1.2, respectively.

Table 2.1.1 Monthly Meteorological Data at Dhaka in 1994

Month	Monthly Average Maximum Temperature (°C)	Monthly Average Minimum Temperature (°C)	Monthly Average Relative Humidity (%)	Monthly Rainfall (mm)
Jan.	26.1	13.1	78	13
Feb.	26.5	14.3	68	54
Mar.	31.9	21.0	67	115
Apr.	33.2	22.8	70	201
May	33.6	25.1	76	254
Jun.	31.9	26.4	82	266
Jul.	32.1	26.6	80	153
Aug.	31.9	26.3	82	246
Sep.	32.8	25.8	78	169
Oct.	32.7	23.3	76	55
Nov.	30.2	18.8	75	14
Dec.	27.7	12.5	71	00
Range/Total	26.1-33.6	12.5-26.6	67-82 Avg. 75	Total 1,540

Source: "1995 Statistical Yearbook of Bangladesh", BBS, Dec. 1996

Table 2.1.2 Annual Total Rainfall at Dhaka and Chittagong from 1985-1994

Unit: mm

Year	Dhaka	Chittagong
1985	2,053	3,111
1986	2,479	2,784
1987	2,186	3,310
1988	2,478	3,126
1989	1,627	2,584
1990	2,153	2,985
1991	2,850	2,698
1992	1,169	2,274
1993	2,819	3,360
1994	1,540	2,260
Average	2,135	2,849

Source: "1995 Bangladesh Statistical Yearbook", BBS, Dec. 1996

Most months show a maximum temperature of higher than 30°C and relative humidity usually exceeds 70% throughout the year. Although rainfall in the winter season is negligible, relative humidity is still as high as about 70%. In this respect, the Study Area is considered to have generally hot and humid climatic conditions.

In view of the annual total rainfall in Dhaka, the 1994 record is considered to be "the dry year" in the past 10 year's records. When Dhaka and Chittagong, which is located in the southeastern coastal area of the country, are compared in terms of annual total rainfall, Dhaka receives about 75% of the rainfall observed in Chittagong. Thus, the influence of the monsoons in Dhaka is relatively mild compared to the coastal area.

It shall be noted that the annual fluctuation of total rainfall varies about 2.4 times between the smallest year and the largest year, which is caused by the annual difference of monsoon strength represented by the frequency of cyclone hits.

2.1.3 Topography and Geology

(1) Topography

Topographically, Bangladesh may be divided into a vast alluvial plain comprising most of the country and the small Chittagong Hill Tracts in the extreme south-east. The Chittagong Hill Tracts constitute roughly one-sixth of the country. They form a minor hill system with its greatest elevation at Keokradong (1,229 m or 4,034 ft.). Toward the east they form a series of parallel hill chains, while towards the west they slope gradually into a small, coastal plain. The Study Area lies on flat alluvial deposits with difference of ground elevation of less than 10 m.

(2) Geology

Bangladesh has few proven mineral resources but has enormous deposits of natural gas. So far, 17 gas fields have been discovered from which natural gas is available for power generation, industrial and other uses. These gas fields are estimated to hold reserves of about 2,900,000 cu.m.

The geological characteristics of the Study Area are generally explained by soil types since the subject area is located, in principle, on alluvial deposits. Major soil types and their characteristics are summarized in Table 2.1.3.

2.1.4 Hydrology

In the course of the feasibility study (Interim Report, Sep., 1991) for the "Dhaka City Emergency Water Supply Project" under the French-Bangladesh Protocol, the hydrologic conditions of rivers in the vicinity of Dhaka City were investigated as summarized below.

The Lakhya River, an indirect tributary of the Jamuna River via the Old Brahmaputra and Banar Rivers, meets the Dhalesawari River at about 20 km downstream of Derma. The Buriganga River Flows into the Dhalesawari River in the upstream of confluence of the Dhalesawari River and the Lakhya River.

Table 2.1.3 Major Types of Soil and Their Characteristics in the Study Area

Soil Types	General Characteristics
Flood Plain Soils	
Non-calcareous Alluvium	Raw sandy and silty alluvial deposits, usually stratified either from the surface or below the cultivated topsoil in the active flood plain areas or massive in the older flood plain areas.
Calcareous Alluvium	Calcareous Alluvium is similar in characteristics to the Non-calcareous Alluvium in addition, they are slightly to moderately calcareous due to presence of calcites derived from the Gangetic sources.
Non-calcareous Gray Flood-plain Soils	Prismatic and/or blocky structured gray sandy loams to silty clay loams on young flood-plain ridges and silty clay loams to clays in basins, slightly acid to neutral.
Acid Basin Clays	Very strongly acid, gray to dark gray heavy plastic clays mainly occurring in the Shlhet haor and Chalan beel areas and in deep valleys of the Madhupur Tract. They are usually seasonally deeply flooded and have heavy consistence.
Non-calcareous Dark Gray Flood-plain Soils	Structured dark gray loamy soils on old flood plain ridges and clay in basins. Slightly acid to some what alkaline in reaction. The basin clays have heavy consistence.
Calcareous Dark Gray Flood-plain Soils	Structured dark gray silty clay loams to heavy clays occurring in basins and on low ridges of the old Ganges river flood plain and locally in the Ganges tidal flood plain and old Meghna estuarine flood plain. Soils are calcareous within a depth of 1.2 m below the surface. Clays are highly cracking when dry, drought prone and have heavy consistence.
Calcareous Brown Flood-plain Soils	Calcareous, brown silt loams to light silty clays, occurring in the Ganges river flood plain and locally in the yound and old Meghna estuarine flood plains. Locally they are leached of lime up to a depth of 1 m from the surface.
Terrace Soils	
Shallow Red-Brown Terrace Soils	Brown or red brown usually strongly acid, structured, friable to firm clay loams to clays intergrading into a grayer, compact Madhupur clay substratum within a meter below the surface. They mainly occur on the narrow terraces of the Madhupur Tract and locally in the dessected Barind Tract.
Brown Mottled Terrace Soils	Brown mottled with specks of gray, pale brown and red, slightly acid, structured, friable clay loams to clays intergrading into a mixed red and pale brown, rather friable and weathered Madhupur Clay substratum. They occur in the middle parts of the broadly dissected level terraces of the Madhupur Tract and locally on the edges of the Barind Tract.
Shallow Gray Terrace Soils	Whitish gray slightly to strongly acid, friable, somewhat porous silt loams to silty clays intergrading into a weakly mottled gray, compact and little altered Madhupur clay substratum at a shallow depth. They occur extensively in the level of Barind Tract and locally on the flat areas of narrow terraces of the Madhupur Tract.
Deep Gray Terrace Soils (including Gray Valley Soils)	Whitish gray, speckled with brown or red mottles, slightly to strongly acid, friable and highly porous silt loams to silty clay loams, usually grading into a strongly mottled red and gray, rather friable and permeable Madhupur clay at a deeper depth. They occur extensively in the western parts of Barind Tract and also in smaller extent in the interiors of broad level terrace of the Madhupur Tract and in shallow valleys in both areas.

Source: Soil Resources Development Institute, Bangladesh.

Before the change of course of the Brahmaputra River to the Jamura River, which occurred in the 1850's, the tributary feeding the Lakhya River received substantial flows from it even during the dry season. Since the change of course, these rivers have received decreasing flows due to siltation of the off-take channel. During the dry season, the river essentially receives no flow from upstream. Any flow at these times of the year is derived within the catchment as runoff or drainage.

In common with other rivers around Dhaka, the Lakhya River is tidal during the dry season. The tidal effects show mainly as semi-diural water level fluctuations, with reverse flow occurring at times. The maximum tidal range is about 0.7 m. There is a marked diural inequality and also a monthly cycle of mean level variation. These tidal effects make the measurement of river flow particularly difficult. Measurements done by several methods indicated that the minimum flows in the Lakhya River are essentially zero. During the monsoon season (between June to October), river flows at Demra generally exceeds 1,000 cu.m/sec and is often double. Mean monthly flows and water level for the Lakhya River at Demra are shown in Tables 2.1.4 and 2.1.5, respectively.

Table 2.1.4 Mean Monthly Flows in Lakhya River (1965-1985)

Unit: cu.m/sec

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1965-66	...	...	...	1,605	1,950	1,909	1,046	...	...	...	...	...
1966-67	...	304	1,044	1,657	1,913	2,259	1,106	376	...	...	...	...
1967-68	...	...	...	1,472	1,457	1,140	1,075	...	...	...	...	...
1968-69	...	...	906	1,783	1,933	1,514	1,270	362	...	...	...	...
1969-70	...	...	...	...	...	...	...	...	...	...	...	...
1970-71	...	...	...	...	...	...	...	...	...	...	...	...
1971-72	...	...	...	...	...	...	...	...	...	...	...	...
1972-73	...	...	...	...	...	...	...	...	...	...	...	...
1973-74	...	...	...	...	...	...	...	...	...	...	...	...
1974-75	...	...	...	...	...	...	...	...	...	...	...	...
1975-76	...	...	750	1,324	1,747	1,640	1,200	...	...	...	...	...
1976-77	...	...	1,360	1,811	1,499	1,290	708	...	...	...	...	...
1977-78	...	...	...	1,780	1,840	1,930	1,500	...	...	...	...	...
1978-79	...	...	...	...	...	...	...	...	...	...	...	...
1979-80	...	...	...		1,720	...	...	...	...	...	...	...
1980-81	...	...	...	1,730	2,060	1,700	1,270	...	...	...	...	...
1981-82	...	...	887	1,463	1,787	1,605	...	...	...	...	...	...
1982-83	...	...	1,152	1,769	1,707	1,540	...	...	...	...	...	...
1983-84	...	...	...	1,450	1,630	1,780	...	...	...	...	...	...
1984-85	...	...	...	...	1,810	1,750	1,350	...	...	...	...	...

Note: Empty columns mean no data available.

Source: "Dhaka City Emergency Water Supply Project (Interim Report)", Sep. 1991, DWASA

Table 2.1.5 River Lakhya Water Level (1980-82)

Year	Month	Ghorasal (A)			Demra (B)			Narayanganj (C)		
		HWL	LWL	Mean	HWL	LWL	Mean	HWL	LWL	Mean
1980		1.81	1.39	1.60	1.81	1.24	1.52	1.71	1.16	1.44
	Apr.	2.20	1.76	1.98	2.28	1.65	1.96	1.89	1.35	1.62
		2.25	2.21	2.23	2.32	1.83	2.07	2.20	1.79	2.00
		3.04	2.78	2.91	2.95	2.61	2.78	2.95	2.54	2.75
	May	3.31	3.16	3.24	3.13	2.83	2.98	3.06	2.66	2.86
		3.30	3.17	3.24	3.01	2.81	2.91	3.01	2.76	2.89
		3.79	3.69	3.74	3.37	3.19	3.28	3.35	3.07	3.21
	Jun.	4.39	4.30	4.35	3.85	3.70	3.77	3.86	3.63	3.75
		4.97	4.94	4.96	4.36	4.30	4.33	4.31	4.19	4.25
		4.93	4.90	4.92	4.43	4.34	4.39	4.38	4.21	4.30
	Jul.	5.01	4.98	5.00	4.55	4.51	4.53	4.50	4.36	4.43
		5.72	5.68	5.70	5.26	5.12	5.19	5.16	5.07	5.12
		5.98	5.97	5.98	5.43	5.40	5.42	5.31	5.31	5.31
	Aug.	6.12	6.10	6.11	5.61	5.59	5.60	5.50	5.50	5.50
		6.57	**6.54**	**6.56**	**6.04**	**5.99**	**6.02**	**5.91**	**5.91**	**5.91**
		6.42	6.40	6.41	5.84	5.81	5.82	5.64	5.59	5.62
	Sep.	5.85	5.81	5.83	5.44	5.41	5.42	5.30	5.24	5.27
		5.40	5.39	5.40	5.00	4.96	4.98	4.90	4.78	4.84
		5.22	5.19	5.21	4.70	4.65	4.67	4.62	4.51	4.57
	Oct.	4.47	4.39	4.43	4.07	4.00	4.03	4.02	3.86	3.94
		4.13	4.06	4.10	3.89	3.73	3.81	3.76	3.67	3.72
		3.24	3.10	3.17	3.17	2.96	3.06	3.20	2.97	3.09
	Nov.	2.60	2.37	2.49	2.74	2.40	2.57	2.74	2.41	2.58
		2.34	2.12	2.23	2.53	2.09	2.31	2.53	2.07	2.30
		2.03	1.68	1.86	2.16	1.72	1.94	2.17	1.73	1.95
	Dec.	2.02	1.66	1.84	2.13	1.65	1.89	2.15	1.71	1.93
		1.92	1.53	1.73	2.01	1.56	1.79	2.04	1.51	1.78
1981		1.72	1.30	1.51	1.80	1.33	1.57	1.75	1.27	1.51
	Jan.	1.58	1.21	1.40	1.67	1.19	1.43	1.49	1.05	1.27
		1.51	1.16	1.34	1.63	1.17	1.40	1.43	1.02	1.23
		1.30	1.08	1.29	1.62	1.10	1.36	1.39	0.94	1.17
	Feb.	1.43	1.01	1.22	1.54	1.07	1.31	1.26	0.79	1.03
		1.35	**0.95**	**1.15**	1.50	1.05	1.27	**1.12**	**0.74**	**0.93**
		1.55	1.08	1.32	1.71	1.18	1.45	1.56	1.01	1.29
	Mar.	1.39	1.06	1.23	1.62	1.09	1.35	1.58	1.17	1.38
		1.50	1.05	1.28	1.66	1.16	1.41	1.43	1.12	1.28
					2.04	1.45	1.75	1.92	1.36	1.64
	Apr.				2.21	1.81	2.01	2.13	1.73	1.93
					2.32	1.98	2.15	2.18	1.77	1.98
					2.48	1.99	2.24	2.37	1.92	2.15
	May				2.37	1.96	2.17	2.29	1.94	2.12
					2.78	2.38	2.58	2.57	2.21	2.39
					3.27	3.03	3.15	3.08	2.74	2.91
	Jun.				3.27	2.97	3.12	2.98	2.67	2.83
					3.46	3.24	3.35	3.13	2.95	3.04
					4.42	4.24	4.33	4.08	3.83	3.96
	Jul.				4.84	4.80	4.82	4.37	4.28	4.33
					5.17	5.13	5.15	4.64	4.52	4.58

Table 2.1.5 River Lakhya Water Level (1980-82) (continued)

Year	Month	Ghorasal			Demra			Narayanganj		
		HWL	LWL	Mean	HWL	LWL	Mean	HWL	LWL	Mean
1981					5.57	5.59	5.58	5.06	4.96	5.01
	Aug.				5.45	5.42	5.44	4.99	4.89	4.94
					5.26	5.24	5.25	4.89	4.74	4.82
					5.32	5.30	5.31	4.93	4.78	4.86
	Sep.				5.24	5.21	5.23	4.74	4.62	4.68
					4.93	4.88	4.91	4.64	4.39	4.52
					4.24	4.19	4.22	3.90	3.34	3.62
	Oct.				3.82	3.68	3.75	3.40	3.11	3.25
					2.94	2.72	2.83	2.43	2.20	2.32
					2.59	2.31	2.45	2.36	2.09	2.22
	Nov.				2.72	2.35	2.53	2.39	2.12	2.26
					2.41	1.96	2.19	2.32	2.03	2.17
					2.01	1.71	1.86	2.19	1.89	2.04
	Dec.				2.21	1.81	2.01	2.09	1.69	1.89
					1.78	1.38	1.58	1.78	1.47	1.62
1982					1.57	1.20	1.39	1.61	1.39	1.50
	Jan.				1.59	1.16	1.37	1.39	1.19	1.29
					1.56	1.09	1.32	1.35	1.11	1.23
					1.78	1.07	1.43	1.48	1.13	1.30
	Feb.				1.35	1.09	1.22	1.38	1.08	1.23
					1.54	1.02	1.28	1.71	1.20	1.45
					1.39	**0.90**	**1.15**	1.59	1.05	1.32
	Mar.				1.44	0.98	1.21	1.51	1.01	1.26
					1.61	1.07	1.34	1.46	1.04	1.25

Note: (1) Water levels are 10 day mean values.
(2) All levels given in meters above PWD.
Figures in bold letter show max./min. data.

Average Differences	(A) - (B)	(B)- (C)
November - March only	0.072	0.060
April - October only	0.399	0.231

Source: "Dhaka City Emergency Water Supply Project (Interim Report)", Sep. 1991, DWASA

2.2 Socioeconomic Conditions

2.2.1 Population

(1) Overview of demographic features in Bangladesh

The third decennial population census conducted by the Bangladesh Bureau of Statistics (BBS) on March 12 to 15, 1991 revealed that:

- The population of the country stood at 111.4 million in 1991.
- The percentage of urban population was 20.1%, while the rural population was 79.9%.
- The inter-censal growth rate of population estimated by using adjusted population of 1991 census was 2.1% per annum. Assuming a medium variant of declining fertility and mortality, the country is expected to reach a population of 129.6 million by the year 2000.
- The population density was approximately 647 persons/sq.km in 1981 and this increased to 755 persons/sq.km in 1991.
- The sex ratio of population was 106 males to 100 females.
- The literacy rate of the country obtained from the 1991 census was 32.4% for the population 7 years old and above.
- The percentage of Muslim population was 88.3%, while that of Hindu, Buddhist and Christian was 10.5%, 0.6% and 0.3%, respectively.
- There were 19.4 million households in the country distributed over 59,990 mauzas (revenue villages).

(2) Demography in the Study Area (Source: Statistical Yearbook of Bangladesh, 1994)

Table 2.2.1 Population and No. of Household by Administrative Level

Administrative Level	No. of Administrative Units				Population	No. of Household
	Thana	Union/ Ward	Mauza/ Mahallah	Village		
Bangladesh	490	4,948	63,277	86,038	106,314,992	19,397,992
Dhaka Division	134	1,393	18,391	25,106	32,665,975	6,103,026
Dhaka Zila	20	163	597		6,163,045	1,077,655
Metro Dhaka					6,950,920	1,258,761
Dhaka City		75	655		3,839,000	659,000
Tongi Paurashava		3	30		181,000	36,000

2.2.2 Industries

The Economic Advisor's Wing at the Finance Division, the Ministry of Finance of the Bangladesh Government, issued the "Bangladesh Economic Review, 1996" in August, 1996. It introduces various economic activities as summarized below.

Industrial activity in Bangladesh involves small, medium to large scale manufacturing and cottage industries. This sector is now contributing about 11.5% of the GDP and employs around 12% of the labor force. Its contribution to GDP has been gradually increasing over the last few years from about 9.9% in 1984/85 to 11.5% in 1995/96. Industrial exports both in intermediate or in finished forms constituted around 75% of the total exports in 1994/95. The sector is regarded to have immense potential for growth and expansion.

The Industrial Policy of 1991 which was formulated in the light of promoting a competitive market economy, which was further revised in 1992, lays out strategies required for rapid industrial development of the country. Notably all industries have now been opened for private investments, both local and foreign, except a selected few related to national security like arms and ammunition, nuclear energy, mint and security, forest plantation and mechanized extraction, air transport and railways. Under the new industrial policy, the government has been pursuing the policy of privatization of selected public sector. A number of public sector units have been privatized or laid-off/downsized and others are in the pipeline.

Table 2.2.2 shows the Industrialization of Bangladesh.

(1) Performance in cottage and small industries

Data on the performance of the Bangladesh Small and cottage Industries Corporation (BSCIC) in promoting entrepreneurial skills and in providing credit facilities to entrepreneurs of small and cottage units show that the number of industrial entrepreneurs covered by the BSCIC marked an increase from 10,920 in 1991/92 to 17,493 in 1994/95. Over the period, a total of 6,812 small industrial and 37,382 cottage industries were provided with credit facilities. During the same year, 10,781 new and 5,690 existing units of cottage industries were provided with credit facilities. In 1994/95, the BSCIC registered units are reported to have generated employment for 76,802 men and women.

Table 2.2.2 **Industrial Production**

Type of Industry	1989/90	1990/91	1991/92
Jute textiles	528	435	415
-hessian	177	158	136
-sacking	269	203	198
-carpet backing	67	57	63
others	15	17	18
Cotton cloth (million yd)	75	66	64
Cotton yarn (million lb)	112	123	133
News print	46	47	47
Other paper	46	43	41
Cement	337	275	272
Steel ingots	75	58	37
Re-rolled steel product	134	96	67
Petroleum products	984	1,086	1,017
Uria fertilizer	1,472	1,421	1,640
Ammonia sulfate	3	2	5
Chemicals	23	23	19
Refined sugar	184	246	195
Wine and sprits ('000 liters)	3,759	3,888	2,184
Tea(million lb)	91	98	100
Edible oil and vegetable ghee	30	29	30
Cigarettes ('000 million)	12	14	13

(Source: The Europa World Yearbook 1995, Vol. 1)
Selected products ('000 metric tons, unless otherwise indicated; public sector only, year ending June 30).

(2) Reform measures in public manufacturing sector

Capital restructuring has been carried out in several manufacturing units like fertilizer factories under the Bangladesh Chemical Industries Corporation (BCIC) and jute mills under the Bangladesh Jute Mills Corporation (BJMC). The Jute Sector Adjustment Credit (JSAC) program with the World Bank's support is currently underway for purpose of revitalizing the ailing jute industry. Around 39,000 workers were retrenched from the jute sector between June 1990 and June 1995.

Four jute mills have been closed down and one mill has been downsized. Overdue loans of both private and government sector jute mills have been restructured through waiving one-third and rescheduling remaining two-third. Government has made compensation to banks to the tune of Taka 10.75 billion. Moreover, losses incurred by the mills during the years 1992/93 to 1994/95 have been partly financed by government and for the purpose around Taka 8.55 billion has been paid by the government so far.

Non-performing loans of Nationalized Commercial Banks (NCBs) due to public sector manufacturing units like the Bangladesh Textile Mills Corporation (BTMC), the Bangladesh Jute Mills Corporation (BJMC), etc. have been settled and process is under way for settling overdue loans of other public sector manufacturing units.

Collection on account of Debt Service Liabilities (DSL) and settlement of arrears dues among corporations have also been strengthened. The Sale of 21 public manufacturing sector units has so far been finalized (6 from the BCIC, 8 from the BTMC, 3 from the BSEC, and 3 from the BSFIC) for privatization. Among these 12 units have already been handed over (4 from the BCIC, 6 from the BTMC, 1 from the BSFIC and 1 from the BJMC). The manpower of public enterprises remaining with the government is being rationalized and their overhead expense curtailed for purpose of making these more efficient and dynamic.

(3) Industrial investment situation

Investment both foreign and local in the industrial sector has been increasing over the years. Foreign investment has been taking place through the establishment of fully foreign-owned enterprises or participation in joint ventures and through portfolio investments through the country's stock markets. The Board of Investment (BOI) maintains records on investments registered within them.

Table 2.2.3 shows total investment registered with the BOI over the last five years (1991/92 - 1995/96). It is observed that total investment registered with BOI rose from US$ 116 million during 1991/92 to US$ 1,574 million during 1994/95. During the period, foreign investment increased from US$ 25 million to US$ 729 million.

Table 2.2.3 Investment Registered by BOI, 1990/91 - 1994/95

Unit: Million US Dollar

Year	Local	Foreign	Total
1991/92	91	25	116
1992/93	90	53	143
1993/94	457	804	1,261
1994/95	845	729	1,574
1995/96 (Up to Dec. 1995)	775	916	1,691
Cumulative Total	2,258	2,527	4,785

Source: "Bangladesh Economic Review, 1996," Ministry of Finance, Dec. 1996

Table 2.2.4 summarizes foreign direct investment (FDI), either 100 % foreign or joint ventures which have been registered with the BOI in the recent past. It is seen from the table that Malaysia (US$ 962.2 million), Japan (US$ 237.0 million), Hong Kong (US$ 200.4 million), UK (US$ 188.1 million), and India (US$ 133.4 million) are the top five investing countries.

Table 2.2.4 Foreign Direct Investment

Unit: Million US Dollar

Name of Country	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	Cumulative Total
Malaysia	-	-	-	270.0	140.0	552.6	962.6
Japan	2.0	1.0	2.0	50.0	84.0	98.0	237.0
Hong Kong	70.5	2.5	0.5	1.0	110.3	15.6	200.4
UK	0.8	3.0	2.0	72.0	51.5	58.8	188.1
India	0.5	1.0	0.2	10.7	117.0	4.0	133.4
Germany	2.0	1.0	0.4	4.0	56.5	64.0	127.9
USA	-	-	1.5	2.4	13.0	73.4	90.3
Singapore	0.2	2.0	20.0	1.0	53.0	-	76.2
South Korea	1.4	0.4	6.5	20.0	36.0	5.0	69.3
China	0.5	-	1.0	25.0	12.2	0.4	39.1
Greece	7.4	-	-	-	12.0	-	19.4
Switzerland	-	10.0	-	-	0.3	-	10.3
Netherlands	6.0	1.5	-	-	1.2	0.2	8.9
Italy	-	0.8	0.5	0.3	1.5	-	3.1
Canada	-	-	-	-	0.3	-	0.3
Sweden	-	0.5	-	0.3	-	-	0.8
Others	1.0	1.5	18.0	347.5	40.6	4.6	452.2
Total	92.3	25.2	52.6	804.2	729.4	915.6	2,619.3

Source: "Bangladesh Economic Review, 1996," Ministry of finance, Dec. 1996

Table 2.2.5 shows the inflow of foreign direct investment by major industrial sector over the last five years. It is observed that the largest inflow of foreign direct investment has taken place in textile sector (24.2%) followed by service industries (24.1%), chemical industries (20.0%) and engineering industries (15.6%). Table 2.2.6 shows handloom units (establishment) and looms by type of ownership by administrative level.

Table 2.2.5 Foreign Direct Investment by Major Industrial Group, 1990/91-1995/96

Unit: Million US Dollar

Name of Industrial Group	1990 -91	1991 -92	1992 -93	1993 -94	1994 -95	1995 -96	Total
1. Agro Based Industries	1.2	0.7	-	16.7	41.0	40.5	100.1
2. Food & Allied Industries	2.0	11.0	28.0	3.4	13.4	18.5	76.3
3. Textile Industries	6.2	7.1	5.5	360.3	169.0	86.0	634.1
4. Printing & Publishing	-	-	3.0	1.1	5.3	1.0	10.4
5. Tannery, Leather & Rubber	2.0	3.1	-	4.9	22.5	5.3	37.8
6. Chemical Industries	7.2	0.1	0.9	372.0	126.5	18.1	524.8
Non-metallic Mineral Prod.							
7. Glass, Ceramics & Other	16.0	-	-	8.0	120.1	42.0	186.1
8. Engineering Industries	57.7	1.2	7.2	24.1	178.0	139.7	407.9
9. Service Industries	-	-	7.5	9.1	49.5	564.5	630.6
10. Misc.	-	2.0	0.5	4.6	4.1	-	11.2
Total	92.3	25.2	52.2	804.2	729.6	915.6	2,619.3

Source: "Bangladesh Economic Review, 1996," Ministry of Finance, Dec. 1996

Table 2.2.6 Handloom Units and Looms by Type of Ownership by Administrative Level

Administrative Level	Ownership and Number of Handloom Unit							
	Total		Private Family Owner		Partnership		Cooperative	
	No. of Units	No. of Looms	No. of Units	No. of Looms	No. of Units	No. of Looms	No. of Units	No. of Looms
Bangladesh	212,421	514,456	209,848	497,369	2,217	15,429	356	1,658
Dhaka Division	67,864 (31.9%)	183,000 (35.6%)	66,887 (31.9%)	178,076 (35.8%)	870 (39.2%)	4,380 (28.4%)	107 (30.1%)	544 (32.8%)
Dhaka Zila	6,339 (3.0%)	13,340 (2.6%)	6,298 (3.0%)	13,164 (2.6%)	37 (1.7%)	151 (9.8%)	4 (1.1%)	25 (1.5%)

Note: Percentage against the national total.
Source: "1995 Statistical Yearbook of Bangladesh," BBS, December, 1996

2.2.3 Land Use

Bangladesh is a country dominated by its rivers. The rivers and their branches and channels provide natural boundaries for land use. The land use pattern of the country mainly consists of land for agricultural use, land for fisheries, forested areas, land for rural/urban settlements and land for infrastructure.

(1) Agricultural/forest land

Agricultural lands in Bangladesh are very fertile and are located throughout the country, including the hilly region in the south-east. The agricultural land can be divided into several groups by type of cultivation and cropping pattern; e.g. land not available for cultivation, cultivable waste (the area suitable for cultivation, but laying fallow for more than one year), current fallow (the area already brought under cultivation but not cultivated during the year), net cropped area, area sown more than once a year. The cropping patterns are single crop, double crop and triple crop. The country's forest areas mainly lie in the south-eastern part of the country in the chittagong hill tracts and the sundorbong areas.

Table 2.2.7 Land Utilization

Unit: '000 ha

Year	Forest	Not Available for Cultivation	Cultural Waste	Current Fallow	Net Cropped	Area Sown More Than Once	Total Cropped Area
1989-90	1,903	3,150	349	1,087	8,350	5,713	14,063
1990-91	1,899	3,221	584	962	8,174	5,861	14,035
1991-92	1,892	3,857	480	633	7,797	4,862	12,659
1992-93	1,892	4,194	444	665	7,646	5,051	12,697

(2) Land area for fisheries

According to the Directorate of Fisheries, the country's total land area for fisheries was 5,275,507 ha (1982). This includes 1,767,128 fish ponds and tanks; 60,097 dighis, beels, haors (water bodies larger ponds) etc.; artificial reservoirs, rivers and canals, flood lands, estuaries and irrigation canals compose the remaining area.

(3) Land for rural/urban settlements and infrastructure

In the rural areas of Bangladesh, there are 71,000 villages, four housing settlements and numerous huts/bazaars/industrial estates located in the rural areas. Urban settlements consist of four city corporations, and 67 towns, which are more or less furnished with all basic infrastructure facilities.

2.2.4 Social Infrastructure

As the national capital of Bangladesh, the Study Area is provided with almost all the social infrastructures available in the country.

(1) Transportation and telecommunication

Transportation facilities cover international and domestic air flights, national roads connecting radially to the country and water transportation mainly for indigenous products and travelers.

Telecommunication facilities are also providing international and domestic communications by telephone, telegram, TELEX, FAX, worldwide Internet services and postal services including privately operated international parcel/courier service.

(2) Education

The education system in Bangladesh is divided into primary, secondary, higher education and university levels.

Education at the primary levels is free and accepts students starting from 5-years of age. After completion of primary school, they may be admitted to a secondary school at the at the age of 10. This schooling lasts for up to seven years, comprising a first cycle of two years and a second cycle of two years further education.

In 1990, an estimated 69% of the children (74% of boys and 64% of girls) in the relevant age groups attended primary schools. The enrolment ratio at the secondary school level was 17% (22% boys and 11% girls) in the relevant age groups.

Secondary schools and colleges in the private sector greatly outnumber government institutions. In 1974, government high schools comprised only about 2% of the total. There are seven state universities, including one of agriculture, one for Islamic Studies and one for engineering. There are two more private universities which began operation in 1993. In addition to governmental institutions, there are many private vocational training centres. The total of education establishments in Bangladesh in 1990/91 is shown below.

Level	Institutions	Students
Primary	48,146	13,035,000
Secondary	9731	3,666,200
Technical/Vocational	141	23,722
University	9	52,620

Educational reform efforts by the government are designed to assist in fulfilling the manpower requirements of the country and primary emphasis is placed on primary, technical and vocational education. The government launched an open university project in 1992 at an estimated cost of US $34.3 million. In 1990, the government launched a primary education sector project, which aimed to help achieve universal primary education and the eradication of illiteracy by the year 2000.

According to UNESCO estimates, the rate of adult literacy averaged 64.7% (males 52.9% and females 78%). Governmental budgetary expenditures on education increased from Tk 11,828 million in 1990/91 to Tk 12,564 million in 1991/92.

(3) Medical services

In Bangladesh, basic health services remain underdeveloped. Although primary health care in rural areas has improved over the last decade, health problems in the country remain severe and are exacerbated by a shortage of medical staff and facilities. Health programs have given particular priority to the popularisation of birth control (5.2% of public sector development expenditure was allocated to population planning in 1990/91).

In 1981, Bangladesh had 504 hospitals with a total of 19,727 beds. This is equivalent to one for every 4,545 persons; one of the lowest ratios in the world. In 1985, there were 14,944 physicians (1.5 per 10,000 persons), 5,333 nursing personnel and 5,664 midwives working in the country. The government budget in the healthcare sector increased from Tk 3,888 million in 1990/91 to Tk 4,035 million in 1991/92.

(4) Housing

The bulk of the people live in over 71,000 villages. The housing structures of the rural areas mainly consists of kutcha and semi-pucca (roofing with CI sheets) housing. Pucca housing in the rural areas holds a very small percent of the total housing. Kutcha houses--material used for this are mainly natural (straw, mud-clay, wood, CI sheets and bamboo etc.). In every household in the rural areas, the majority have (about 80%) their separate kitchen houses/kitchen sheds and in those that don't have, they use an space near their house for their kitchen work.

In the urban areas people historically built their housing with brick construction for individual housing in the form of one/two or multi-storied buildings furnished with all other major facilities. In the old areas of the city/towns, a large portion of housing also exists in semi-pucca modes. Recently, in the capital city Dhaka-in some major residential areas, housing patterns are going to be revised (old individual houses) through co-operative involvement by making multi-storied apartment housing. In Dhaka, people can borrow the money for housing construction from an organisation named the House Building Finance Corporation (HBFC) with the approval of proper planning from the concerned authorities such as RAJUK.

(5) Water supply

Urban water supply - Dhaka and Chittagong water supply and waste disposal service are being regulated by water supply and sewerage authorities (DWASA/CWASA), while the rest of the country's urban centres are being catered by the Department of Public Health Engineering (DPHE) and local municipalities.

Urban water supply is composed of a piped water supply system exists in 63 districts towns (Dhaka and Chittagong not included) and a few major upazila (Thana) centres (7 out of 396 upazila centres). The total amount of ground water used for piped domestic water supply in the urban centres (Dhaka and Chittagong not included) is about 104,403 cu.m/day. Only seven towns are totally or partially dependant on surface water for their domestic water

supply. The total amount of surface water is about 11,000 cu.m/day or about 10% of that of total water production. This shows the importance of ground water in domestic water supply sector. Most important components of piped water supply system in urban centres is shown below in Table 2.2.8.

Table 2.2.8 Piped Water System Components

Item	Unit	District Towns	Upazila Center
Length of pipe	km	1,142	14
House Connection	nos.	16,632	1,137
Public stand point	nos.	3,222	40
Storage reservoir	m	26,431	683
Production wells	nos	267	12
Production of ground water	cu.m/day	104,430	2,000
Average production per well	cu.m/day	577	167
Surface water treatment plant	nos.	7	0
Production of treated surface water	cu.m/day	11,000	0
Total production piped water	cu.m/day	115,130	2,000

Source: DPHE, July 1985

The water supply facilities mentioned above don't the facilities owned by various institutions, private industries and government organisation for their offices and stuff quarters .In the upazila centres, for example public works department has installed small scale water supply system for government offices and staff quarters

Rural Water Supply---Service levels vary quite considerably throughout the country. This is because of the need for different technologies to meet the needs of different areas. Some of which are inexpensive and easy to implement while others are more costly and far more difficult to handle.

Shallow Tube Wells (STW): These are easily sunk, and use the well-known new Handpump No.6. These pumps are relatively inexpensive Tk 3,000 to 3,500 per tubewell but can lift water up to barometric pressure level (about 25 feet after friction loss). In 1980 the areas where water is less than seven meters below ground, throughout the year represented 68% of the country. At present this area is dramatically being reduced due to very large and increasing extraction of ground water for agriculture. A study by the Master Plan Organisation (MPO) and the DPHE, with assistance of DANIDA hydrogeologists, in 1985 revealed that such areas will be amount to 53% in 1990 and 33% by the year 2000. The DPHE had sunk 7,18,201 STW by the end of 1990 in 425 upazilas. Which at that time covered 84

persons per STW or 94 person per running tube well. In these upazilas 60 million out of 89.5 million people are covered by these STWs (68% coverage). This is probably the largest in the world for a rural hand pump program. It is reported that in 1990 during dry months about 100,000 STWs went out of operation due to the lowering of the ground water table.

Tube well with Deep-Set Hand Pumps and TARA Tubewell: Wherever ground water levels lies deeper than seven meters below ground level; a so called deep set hand pump will be required to lift water to surface. DANIDA hydrologists in September 1984 estimated that approximately 7.8 million people in rural areas were affected by lowering water table which is likely to increase to 60% in 2000, 75% in 2010, and 80% in 2020 in terms of population. Traditional deepset hand pumps are expensive and require a mobile maintenance crew to keep them operating. Analysis has shown that it will be impossible to cover the rural areas with this type of technology both in terms of finance and manpower. Thus a new, less costly and easier to maintain handpump, called the TARA pumps, have been developed.

At present 123 upazilas fall within this category (lowering of ground water below seven meters during dry months). The total population affected at present is about 20 million. DPHE data (as of the end of 1990) has fielded about 33,234 deep-set/Tara tubewells. The present coverage is one well to 593 persons or one running well to 658 persons.

Deep Tubewell (DTW): There are wells with well shafts of more than 250 ft in depth but use the No 6 type suction hand pumps because the ground water level is less than seven meters bellow ground. They are usually used in saline areas where wells have to go deep to find fresh water aquifers. They are expensive and need about Tk 40,000 per DTW and take much longer to install than STWs. The entire coastal belt, including greater Barisal, Patuakhali, Khulna, Faridpur, Noakhali and Chittangonj falls within the DTW aquifer zone. The total population depending on such deepwell is estimated at 10 million (DPHE) in 84 upazilas. The DPHE has sunk about 32,664 such DTWs so far (end of 1990) and the coverage is 301 person per tubewell or 335 persons per running well.

Very Shallow Shrouded Tube wells (VSST): These are very shallow wells which are appropriate to certain areas in the saline belt. They rely on two very specific conditions for their success: 1) there must be a small pocket of fresh water (2) an aquifer exists within this fresh water zone.

The results published in September 1985 of fresh water resources in coastal belt reveal water famine where surface water disappears completely in the dry season. These area are generally favourable for VSSTs due to their high infiltration rate. In these areas where settlement are dispersed this technology should get due attention. Unfavourable ground water zones are often indicated by a limited fall in water level of the ponds. Therefore, for these areas treatment of fresh pond water may be considered.

Experience has shown that VSSTs can be placed in larger numbers very quickly and at very low costs (Tk 4,000) which is only one-tenth of a DTW but will yield as much water

Sandfilters (SFRS): These have been tested in several upazilas in the coastal belt; mainly in the Khulna region. As a permanent presence of surface water is a prerequisite, they constitute a possible alternative for areas (ponds) with unfavourable conditions (Dacope, Up). The presently tested sand filters are elements placed at the side of the pond. Water from the pond has to be pumped into a raw water reservoir underlain by a sand bed. From the sand bed water pours out freely via a clean water reservoir.

The price of such filters varies between Tk 8,000 and Tk 16,000 depending on the availability and price of the needed materials. This is a low-cost technology suitable for use in medium-sized human settlements. VSSTs and SFRSs are suitable solutions in areas like Satkhira, Sundarbans, Dublarchar and Hironpoint to name a few.

Other Systems: A number of alternative solutions exists such as dugwells, gravity systems for hilly areas, very deep-set well for the Chittangonj hills and barind tracts.

(6) Electricity

The country's only hydropower aggregates are located in the Chittagong hill tracts at Kaptai over the Karnafuli River, which contributes 11% of total electricity generation (884 million kWh) and the remaining 89% (7.2 billion kWh) are generated by several thermal power stations.

(7) Transport

Most transport in Bangladesh is waterborne, although the government's transport policy is now concentrating on developing roads and rail links. A major bridge is currently being built across the Jamuna River, which bisects Bangladesh from north to south. The US$ 700 million project has suffered many delays and now expected to be completed in 1997.

The state-owned rail system consists of 2,883 km (1,791 miles) of track, of which 2,483 km (1,541 miles) are meter gauge and 953 km (592 miles) are broad gauge, 35 km (22 miles) narrow gauge and 290 km (180 miles) double track. In 1983 the rail system carried 5.359 million passenger km and 765 million net ton km of freight. Very recently, the Government of Bangladesh took the initiative to privatise this sector by implementing the Dhaka-Narayangonj, a 15 km rail route on an experimental basis.

River traffic is the most important means of transportation. The total length of navigable inland waterways is 8,430 km (5,238 miles). There are over 300,000 manually operated craft and several thousand motorised boats providing cheap transportation even to remote villages unreachable by any other means. During the flood season, large areas are totally dependent upon water transport. The inland waterways systems, under the jurisdiction of the Bangladesh inland water transport authority, has 1,400 launch landings and five major river ports (Dhaka, Narayangonj, Chandpur, Barisal, and Khulna).

Since independence, Bangladesh has built up a small merchant marine of 237 cargo ships with 514,200 GRT (as of 1983) under the authority of the Bangladesh Shipping Corporation. There are two deep water ports: Chittangonj, on the north bank of the Karnafuli River, and Mongla (also known as Chalna). The two ports handled 7,125,000 metric tons of cargo in 1983.

The terrain and climate of Bangladesh don't favour road transport. There is no national road system as such. Most roads break off at river banks and crossings are made by fording or ferry. Although most of larger towns are connected by road, the highways become submerged during the rainy season. The total length of the road system is 45,633 km (20,338 miles), of which 4,076 km (2,531miles) are paved.

Table 2.2.9 Road Traffic in 1991/92

Type of Traffic Mode	No.
Private motor cars	34,517
Taxis	2,143
Buses and mini-buses	23,796
Trucks	30,994
Jeeps	8,927
Auto-rikshaws	30,162
Motor cycles	6,502
Others	116,689
Total	253,730

Source: Europe World Yearbook, Vol. 1, 1996

The national airline is Bangladesh Biman, which operates a fleet of aircraft on domestic and international flights. A private airline, Aero Bengal, also started its service on domestic routes. There are 24 airfields in the country which of which 17 are useable with permanent surface runways, eight have scheduled flights and three have runways over 2,500 meters (8,000 ft). The major international airports are Dhaka and Chittangonj. A third international airport opened at Kurmitola in 1982.

2.2.5 Economic Conditions

Dhaka City is the capital and the largest metropolitan area in the country. It is the main hub of all business, economic, cultural and government activities in the country. While the national economy continues to retain its agricultural character (38% contribution to GDP; 65% of employment), the urban-based manufacturing and services sector contribution is rapidly growing. Much of this share is contributed by Dhaka City. The pace at which the economy, in Dhaka particularly, is growing is not only straining the adequacy of infrastructure to support the growth, but the capacity of service institutions to keep in step with developments. The per capita GNP of Bangladesh is about US$ 200 - which is below other economies in the region.

(1) Urban Poverty

A Planning Commission Study, assisted by the ADB, on poverty in 10 urban areas, including Dhaka, in 1995, reported that poverty incidence in urban areas at 60.86% (of which 40.2% is hard-core poor). Those taking less than 2,122 k-cal of food per day are considered below the poverty line; those taking less than 1,805 k-cal/day are considered hard-core poor. The poverty study used an index of monthly income of Taka 3,500 and 2,500 (for

poor and hard-core poor, respectively) to support the normative calorie intake and other expenses. Significantly, only about 80% of those classified as poor considered themselves as such. Also, the poor are reported to have good access to safe drinking water (90%) and sanitation facilities (41%).

(2) Employment

The DMDP estimates that there are 523,000 jobs in the manufacturing sector in Dhaka. Sixty percent (60%) of these jobs are in publicly-owned textile mills and garments factories many of which face severe operating problems. As the national capital, Dhaka's next major employer is the Government which accounts for about 200,000 jobs. However, the DMDP points out that the economy is largely informal and it is the informal sector which has created an estimated one million jobs. Official figures also estimate that about 181,000 skilled and unskilled manpower are working overseas and repatriating about US$ 1.2 billion annually.

(3) Inflation

During 1994-95 in Dhaka and based on the Consumer Price Index, inflation was reported at 5.2% with food prices accounting for much of the increase.