BASIC DESIGN STUDY REPORT
ON THE
SEWERAGE CONSTRUCTION AND REHABILITATION PROJECT
FOR DHAKA CITY
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

FEBRUARY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the People's Republic of Bangladesh, the Government of Japan has decided to conduct a basic design study on the Sewerage Construction and Rehabilitation Project for Dhaka City and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Bangladesh a study team headed by Mr. Shinji Omori, Research and Technology Development Division, Japan Sewage Works Agency from September 3 to October 2, 1987.

The Team had discussions on the Project with the officials concerned of the Government of Bangladesh and conducted a field survey in the Project area. After the team returned to Japan, further studies were made, a draft report was prepared and, for the explanation and discussion of it, a mission headed by Mr. Yasuo Nishiguchi, Deputy Director, Sewerage Planning Division, Sewerage and Purification Department, Ministry of Construction was sent to Bangladesh from January 6 to 16, 1988. As a result, the present report has been prepared.

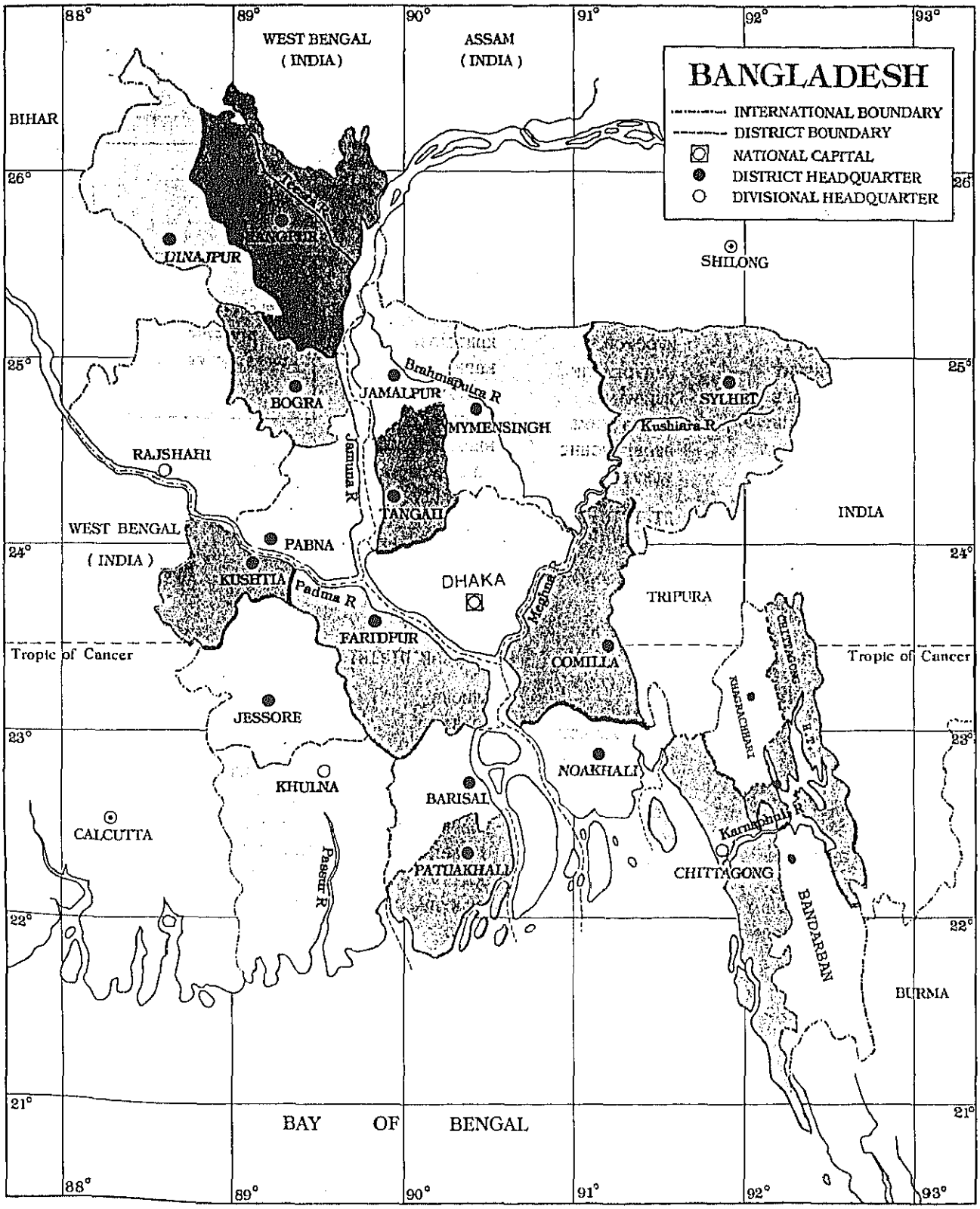
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

February 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency


BANGLADESH
INTERNATIONAL BOUNDARY
DISTRICT BOUNDARY
NATIONAL CAPITAL
DISTRICT HEADQUARTER
DIVISIONAL HEADQUARTER
WEST BENGAL (INDIA)
ASSAM (INDIA)
BIHAR
SHILONG
DINAJPUR
BOGRA
JAMALPUR
MYMENSINGH
SYLHET
Kushiara R.
Brahmaputra R.
Jamuna R.
RAJSHAHI
TANGAIL
INDIA
WEST BENGAL (INDIA)
PABNA
KUSHTIA
Padma R.
DHAKA
Meghna R.
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CALCUTTA
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PATUAKHALI
Pasur R.
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Basic Design Study Report

on

The Sewerage Construction and Rehabilitation Project

for Dhaka City

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SUMMARY

SUMMARY

The Dhaka City Sewerage System commissioned in 1923 has been expanded at several stages with the growth of the city. However the system has become superannuated having sewage leaks and influx of rain water everywhere due to poor maintenance. In spite of the expansion of the sewer network, the improvement of the final treatment plant has been so delayed that they are able to cope with only one-third of the inflow. Due to this overload the treatment plant discharges insufficiently treated effluent into the receiving river, causing serious pollution and social problems threatening public hygiene and health of the people living along the river.

Under these circumstances the Government of Bangladesh prepared an emergency project for the improvement of the existing system and requested the Government of Japan to extend the grant aid and cooperation for the implementation of the project.

In response to the request, the Japanese Government dispatched a preliminary study mission to Bangladesh through the Japan International Cooperation Agency for 13 days from June 1 to 13, 1987. Based on the results of the study by the delegation, a basic design study team was sent for 30 days from September 3 to October 2, 1987.

The team confirmed the contents of the request and the background of the project through field surveys and discussions with the Bangladesh government agencies concerned, reviewed the validity of the project, and exchanged minutes with Bangladesh officials regarding the basic policy of the facilities plan, the scale and contents of facilities, etc. needed for the project.

This report was compiled as a basic design through technical and economic studies of the Sewerage Construction and Rehabilitation Project for Dhaka City, based on the results of the said field surveys.

The contents of this project and its effects are as shown in the following.

1. Scale of the Project

The current population of Dhaka City is approximately 4,320,000. Among these people, approximately 1,150,000 are serviced by the sewerage system. The current volume of sewage is estimated at 96,000 m^3/day in the dry season, and 116,000 m^3/day in the rainy season.

On the other hand, the carrying capacity of the trunk sewer leading from the lifting pump station at the lowest part of the sewer line to Pagla Sewage Treatment Plant is 120,000 m^3/day. Based on these data, a master plan for the sewage treatment system will be made for a planned water volume of 40 IMGD (183,000 m^3/day) as is proposed in the request, but the planned water volume for this project will be 26.4 IMGD (120,000 m^3/day), which is the capacity of the existing sewer.

2. Outline of the Project

(1) Sewage treatment system

The main facilities planned under this project include lift pumps (37 kw x 3), primary sedimentation tanks (33 m diameter x 3 m deep x 4), a facultative lagoon (approximately 42 ha, 27.2 ha of which is already built), a disinfection facility and an outfall pipe (diameter 1.5 m x length 1.24 km).

(2) Pump stations

Of the total of 14 pump stations, four, including Hazaribag Lifting Pump Station, Nawabganj Lifting Pump Station, Faridabad Lifting Pump Station, and Old Narinda Pump Station, need their pumps replaced. In order to maintain safe operation of the pumps, a screen facility and sump-well water gauge (with automatic start and stop) will be installed at each station. Other incidental facilities will be improved as needed.

(3) Sewers

Of the existing trunk sewers, those out of order or seriously damaged and urgently requiring repair will be improved or repaired.

Those in this category are the discharge sides of Hazaribag Lifting Pump Station and Faridabad Lifting Pump Station, a part of the sewer between Tejgaon and Swaminbag, and the piping around the pumps of Old and New Narinda Pump Stations. Furthermore, a complete set of sewer cleaning facilities will be provided to the regional offices of five zones.

Construction of this facility will take 27 months including the test run period.

The project area has a fast growing population due to migration adding to the already overcrowded city population. This increasing population and the delays of the improvement in the existing sewerage system are accelerating aggravation of the living environment and therefor countermeasures are urgently needed. This project proposes to improve the system by rehabilitating the existing lift-pump stations at places where normal operating are not possible, and establishing proper operation of pumps and hence the environment of the communities around these facilities will be greatly improved its implementation.

Furtheremore, as the sewage treatment plant will become capable of treating the present total volume of sewage and steady hygienic treatment can be expected. This project is not only beneficial to the people residing within the project area, but also to the people depending on the Burhiganga River for their daily water demand, to which the effluent of the treatment plant is discharged.

For expansion of sewerage facilities, prerequisite accurate basic data such as current volume of sewage and the capacity of existing facilities have been collected. As such this project has great significancy as a source of accurate facts which for any further consideration of future expansions.

The Dhaka WASA will be in charge of the management, operations and maintenance of the facilities after completion and commissioning of the project. Even though the operational cost of the system can be managed with the present revenues, it is not sufficient to make loan repayments and their interests. In addition, the improvement of the system will increase the costs of operation and maintenance, but not the revenues, and therefore it is necessary to study and review the revenues.

The Government of Bangladesh regards this project as the most urgent on the improvement of existing facilities and plans to review the existing master plan for whole of Dhaka City in the near future. The implementation of this project is very meaningful to the Japanese Government extending its economic cooperation through grant aid which will meet the very basic need of Bangladesh people living within the project area.

1. Introduction

1. Introduction

Dhaka City, the capital of Bangladesh, is located approximately at the center of the country, and has flourished as a political, economic, educational and cultural center as well as a strategic point for domestic and international transportation utilizing her network of roads, railways, water- and airways. In the midst of nation-wide urbanization, concentration of the population into Dhaka is proceeding at a rapid pace. At the time of the 1973 Census, the population of Dhaka was approximately 1,300,000. But the current population is estimated at about 4,320,000, and the annual rate of population increase has reached as high as approximately 10%.

Such a steep population increase has given the city numerous problems with regard to maintenance of basic urban facilities. With regard to the sewerage system, one such urban facility, it is quite obsolete, and only a quarter of the population or about 1,100,000 people can currently enjoy sewerage service.

The history of sewerage in Dhaka is long, dating back to 1923. Narinda pump station and the Imhoff-tank-type sewage treatment plant were built in that year by the British Government, the ruling government at that time. But this project was limited to only Old Dhaka until the early 1940s. The system has expanded since then adding little by little as the population of the city grew rapidly, and in 1977 the Pagla Sewage Treatment Plant with a planned capacity for half a million people was built. This plant is still in operation now.

Current problems for the sewerage system of Dhaka City can be classified into two categories. One is a basic need for expansion and improvement of sewerage facilities in order to cope with the fast growing population in the city and in newly developed surrounding areas. The other is the urgent need for improvement and repairs of existing facilities which have become obsolete.

As for the current condition of the existing sewerage system, there are problems of maintenance and management such as obsolete facilities, blocked or broken sewers, and the lack of sewer cleaning. Sewage leaking out of manholes on streets and from sewers as well as the influx of rainwater can be seen everywhere. Some pump stations cannot be operated satisfactorily due to careless mistakes in designing and construction. A glance at Pagla Sewage Treatment Plant, for example, reveals insufficient treating capacity for the volume of influent sewage, and unsatisfactory quality of treated sewage, which are causes of pollution of the river. Unless measures for improvement of these problems are taken urgently, direct influx of untreated sewage into rivers will increase. It is feared that such situation will cause seious social problem risking hygiene of the people of this area who are depending on these rivers for their drinking and other daily water.

With such a situation as a background, the Dhaka Water Supply and Sewerage Authority (Dhaka WASA) carried out a feasibility study in 1981 with aid from the International Development Association, which is generally known as the Second World Bank, with a view to planning the expansion and improvement of the existing sewerage network. Dhaka WASA sent a request to the Japanese government through their government in September 1986 for grant aid cooperation in order to quickly solve the most urgent problems in their plan for improving the existing facilities.

In response to the request, the Japanese Government dispatched to Bangladesh a preliminary study mission led by Mr. Yasuo Nishiguchi, Assistant Section Chief, Sewerage Planning Section, Sewerage Department, City Administration Bureau, Ministry of Construction, for 13 days from June 1 to 13, 1987, through the Japan International Cooperation Agency. The mission confirmed the contents of the request and the background of the project through meetings with officials of Bangladesh government agencies and Dhaka WASA, and further confirmed the feasibility of the project planned for the aid, while grasping the actual condition of the plan for the renovation and improvement of sewerage facilities for which the aid was requested.

The extent of the improvement plan agreed upon by the two governments through these meetings is shown in the following:

a) Rehabilitation of existing lifting pump stations and related facilities;

b) Rehabilitation of Narinda Pump Station (old and new);

c) Rehabilitation of outfall facilities of Pagla Sewage Treatment Plant; and

d) Renovation of Pagla Sewage Treatment Plant.

On the basis of the results of this preliminary study, the Japanese Government decided to carry out a basic design study and sent to Bangladesh a basic design study team led by Mr. Shinji Ohmori of the Technical Development Section, Technical Development Department, Japan Sewerage Works Agency, for 30 days from September 3 to October 2, 1987, through the Japan International Cooperation Agency. The team further reviewed the contents of the plan through meetings with officials of the concerned Bangladesh government agencies, and carried out field surveys needed for mapping out a basic design.

As a result of these studies, basic items of agreement were compiled in minutes dated September 10, and signed by the leader of the team and the president of Dhaka WASA. The team made further studies on detailed technical items on the basis of the minutes.

This report was compiled to include the results of these discussions and studies, as well as the contents of the basic design plan. Organization, itinerary and minutes of the team are shown in the attached data.

2. Background of the Project

2. Background of the Project

2.1 Outline of the Country

2.1.1 Country and Population

Bangladesh is located on the delta region between world's renowned rivers of the Ganges (lower reaches are generally called the Ganges-Padma) and the Burahmaputra (lower reaches are generally called the Jamuna) which join together and flow into the Bay of Bengal. Most of its national borders come in contact with India, except for the southeastern part which borders on Burma. The country is approximately 144,000 km^2 in area, which is the size about 40% of Japan.

The country is divided roughly into three parts by the aforesaid Ganges, Brahmaputra and Ganges-Padma. These rivers running through the country do not have fixed routes of flow, and flow in a network with a width of 10 to 20 km, causing scour and deposition on river beds, erosion of banks, and movement of sandbars. There are many other rivers, all of which considerably meander creating typical crescent-shaped lakes, ponds and swamps left over from previous routes of flow everywhere. Consequently, flat lands of Bangladesh are divided like a network by these rivers, streams, lakes, ponds and swamps.

Bangladesh is situated in latitude from 20 degrees 54 minutes to 26 degrees 38 minutes north and longitude from 88 degrees 01 minute to 92 degrees 41 minutes east and its climate is tropical. It has three seasons: winter (November to February), summer (March to May) and monsoon or rainy season (June to October). Temperature is between 10°C in winter and 35°C in summer. Annual average rainfall is between 1,500 and 5,500 mm, with particularly heavy rainfall in the northeastern part and coastal region. Approximately 90% of annual rainfall is concentrated in a period from May to October with 56% concentrated in the three months from June through August.

The present population of Bangladesh is approximately 105,000,000, which is estimated to reach 140,000,000 by 2000. The following chart shows future population estimated by B.B.S.

Table 2-1 : Estimated Future Population of Bangladesh

(Unit: 1,000)

Year	Male	Female	Total
1980	45,582	42,925	88,507
1985	51,754	48,714	100,468
1990	58,213	54,792	113,005
1995	65,063	61,278	126,341
2000	71,916	67,777	139,693

(Source: B.B.S., 1986)

2.1.2 Administrative Organization

Territorial structure of administration is divided into four Divisions of Chittagong, Dhaka, Kulna and Rajishahi. As shown in the following chart, each Division is divided into a number of Districts, the total number of which is 20. Each Sub-division is divided into many thana and villages. Figure 2-1 shows territorial division of administration.

Territorial Structure of Administration

Country				1
Division				4
District				20
Sub-Division				62
Regional Center (Thana) and Village	Thana	Urban Center	122	422
		Agrarian Center	300	
	Village			680,020

(Source: Ministry of Public Works and Urban Development)

Major Administrative Organizations

1. Ministry of Industries
2. Ministry of Power, Water Resources and Flood Control
3. Ministry of Food
4. Ministry of Finance
5. Ministry of Health and Population Control
6. Ministry of Civil Aviation and Tourism
7. Ministry of Local Government, Rural Development and Cooperatives
8. Ministry of Home Affairs
9. Ministry of Commerce
10. Ministry of Ports, Shipping and Inland Water Transport
11. Ministry of Railways, Roads, Highways and Road Transport
12. Ministry of Agriculture and Forest
13. Ministry of Fisheries and Livestock
14. Ministry of Public Works and Urban Development
15. Ministry of Petroleum and Mineral Resources
16. Ministry of Planning
17. Ministry of Land Administration and Land Reforms
18. Ministry of Foreign Affairs
19. 11 other ministries

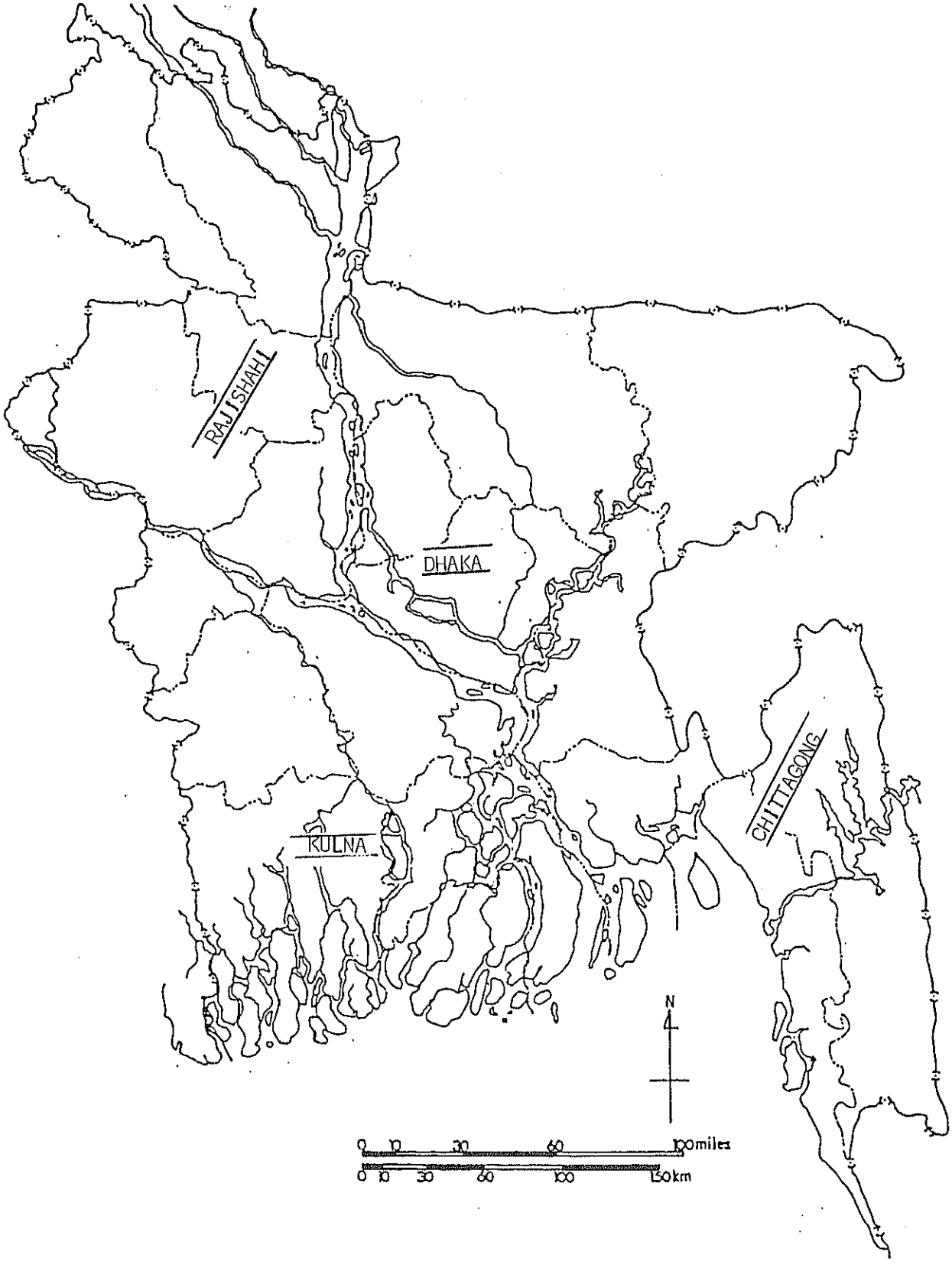


Figure 2-1 : Zoning Map of Bangladesh

2.1.3 Economic Condition

(1) Outline

Bangladesh is an agricultural country with approximately 74% of its labor force engaged in agriculture and with about 51% of its Gross Domestic Product (GDP) depending on agricultural production. Consequently, export industry also has high rate of dependency on primary products and their processed products. In 1984-85 fiscal year, jute and its products occupied about 58% of the total export.

As for trade balance, imports amount to 3 to 4 times of exports each year because supply of most necessary goods depends on imports from overseas, and trade deficits have to be filled by aids from other countries.

The Ershad administration announced in June 1982 a new industrialization policy placing importance on private industrial sector such as denationalization of jute and other textile plants and aggressive introduction of private investments to vitalize domestic economy. In March 1983, it further announced an 18-item plan aimed at achieving economic independence, and made it a basic policy for promoting domestic economy. Since July 1985, the third five-year plan is under way, aiming at expansion of employment opportunities, achievement of self-sufficiency of foodstuff, reinforcement of private economic sector, development of human resources, etc.

Figure 2-2 shows trends of GDP and its per capita amount:

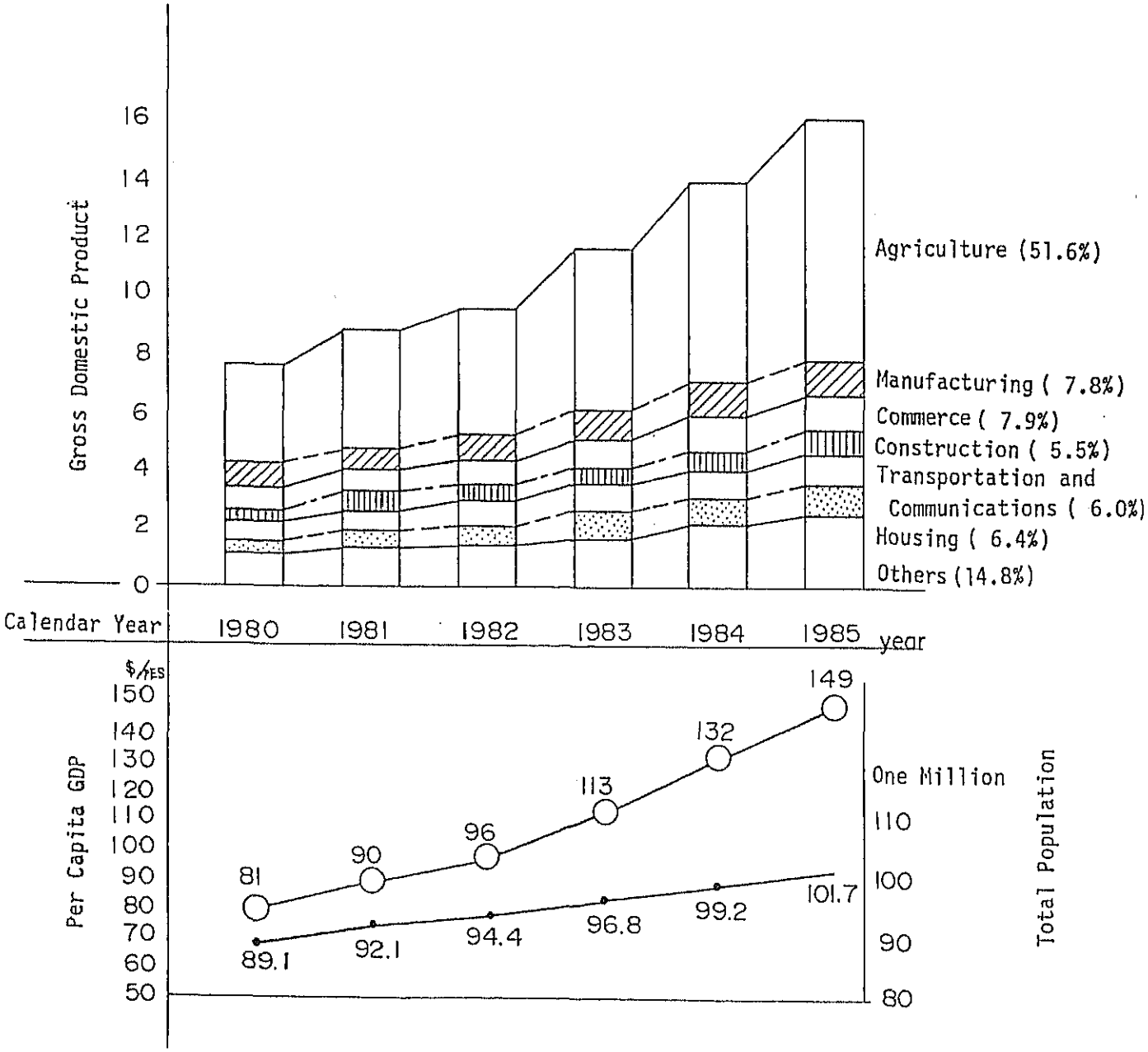


Figure 2-2 : Gross Domestic Product and Per Capita GDP
(Based on 1985 prices)

(Source: B.B.S., 1986)

(2) Agriculture and Industry

In Bangladesh where approximately 74% of the workforce are engaged in agriculture, production of grains and other foodstuff is an important guideline for economic stability. Production of grains and foodstuff in fiscal 1984-85 reportedly reached 16,200,000 tonnes, exceeding the previous year (15,471,000 tonnes), although it failed to achieve the target 16,700,000 tonnes. Although 1984 experienced widespread floods, foodstuff production recorded increase due to quick replacement of crops damaged by floods and increased use of fertilizer and high-crop species.

However, on account of chronicle food shortage resulting from population increase, the government had to import 2,854,000 tonnes (estimate) of grains. As a result, reserve of foodstuff at the end of fiscal 1984-85 was approximately 1,008,000 tonnes.

The present government is pushing forward a new economic policy of placing importance on the private sector by denationalizing 33 jute plants, 24 textile plants in addition to small factories such as plant-oil plants and match plants.

1) Trade

Total Export and Imports

	1979/80	1980/81	1981/82	1982/83	1983/84
Exports	722	711	626	686	822
Imports	2,372	2,533	2,572	2,309	2,353
Balance	-1,650	-1,822	-1,946	-1,623	-1,531

(Source: World Bank, 1985)

2) International Balance of Payments

International Balance of Payments

(Unit: $ million)

	1979/80	1980/81	1981/82	1982/83	1983/84
Exports	722	711	626	686	822
Imports	2,372	2,533	2,572	2,309	2,353
Balance	-1,650	-1,822	-1,946	-1,623	-1,531
Current Balance	-1,436	-1,428	-1,592	-1,107	-1,012
Total Balance	-119	-24	-128	+235	+166

(Source: World Bank, 1985)

2.1.4 Economic Development Programme

Since its independence, Bangladesh has promoted its national economic development programme aiming at land reconstruction and economic revitalization and expansion. The 3rd five-year programme is currently under way, starting from the year 1985. The following table shows the outlined progress of the Programme achieved so far:

Table 2-2 The Scale of the Economic Development Programmes (based on pricing in 1984)

(Unit: Crore TK)

	Planned Amount	Achieve-ment	Achieve-ment Rate	Foreign Aids	
				Aided Amount	Ratio to Achievement
1st 5-Year Programme (1973 - 1978)	4,455	2,074	46.55%	1,491	71.89%
Interim 2-Year Programme (1978 - 1980)	3,861	3,359	87.00%	2,581	76.84%
2nd 5-Year Programme (1980 - 1985)	17,200	15,297	88.94%	9,708	63.46%
3rd 5-Year Programme (1985 - 1990)	38,600	-	-	21,028	-

(Source: B.B.S. 1986)

The outline of the 3rd five-year programme is as follows:

(1) Main Targets

1) Increased opportunities for employment
2) Lowering of the population growth rate
3) Improvement of primary education and fostering of the personnel

4) Technical development for improvement of socioeconomic structure
5) Promotion of self-sufficiency of food
6) Guarantee of basic human needs
7) Further economic growth
8) Promotion of national independence

(2) Investment Programme by Industrial Fields

The investment programme allocated to each industrial field is shown in the following table:

Table 2-3 Sectional Allocation of the 3rd 5-Year Programme
(Based on pricing in 1984)

(Unit: Crore TK)

Field	Government		Private		Total	
	Investment	Rate	Investment	Rate	Investment	Rate
1. Agriculture; water resources; rural development	7,060	28%	4,400	32%	11,460	29%
2. Manufacturing industry	2,600	11%	3,200	23%	5,800	15%
3. Electric power resources	5,675	23%	500	4%	6,175	16%
4. Transportation; communications	3,025	12%	1,500	11%	4,525	12%
5. Housing; water works	550	2%	3,650	27%	4,200	11%
6. Socioeconomic services	6,090	24%	350	3%	6,440	17%
Total	25,00	100%	13,600	100%	38,600	100%

(Source: B.B.S. 1986)

(3) Financial Plan

The financial plan for the 3rd 5-Year Programme is as follows:

Table 2-4 : Financial Plan for the 3rd 5-Year Programme
(Based on pricing in 1984)

(Unit: Crore TK)

Item	Government		Private		Total	
	Treasury Investment & Loan	Rate	Treasury Investment & Loan	Rate	Treasury Investment & Loan	Rate
Domestic Supply	5,960	24%	11,612	85%	17,572	46%
Foreign Aid	19,040	76%	1,988	15%	21,028	54%
Total	25,000	100%	13,600	100%	38,600	100%

(From: B.B.S. 1986)

2.2 The Outline of Water Supply and Sewerage of Bangladesh

2.2.1 Administrative System for Water Supply & Sewerage

In Bangladesh, water supply and sewerage works are controlled by the Ministry of Local Government, Rural Development and Cooperatives. In Dhaka and Chittagong, the Dhaka WASA (Dhaka Water Supply and Sewerage Authority) and the Chittagong WASA are respectively controlling and operating the works.

2.2.2 Present Condition of Water Supply & Sewerage

(1) Dhaka WASA

Dhaka WASA was established in 1963 as a governmental authority for the operation of public works relating to the water supply and sewerage in Dhaka.

Water Supply

The present condition of water supply by Dhaka WASA is outlined as follows:

Population in Administrative District	4,324,000	
Population in Water Service Area	4,000,000 (estimate)	
Populations receiving water service	3,300,000	
Maximum Supply Capacity	480,000 m^3/day	(105.45 IMGD)
Daily Average of Water Consumption	421,300 m^3/day	(92.59 IMGD)
Facilities:-		
Deep Well	119	(99.45 IMGD)
Surface Water Purification Plant	1	(6.00 IMGD)
Water Main	641.36 miles	
Distributing Tank	30	

Sewerage

Utilizing Population	1,151,000	
Flow Rate	116,000 m^3/day (estimate)	
Facilities:-		
Trunk Sewer	300 miles	
Lifting Pump Station	12	
Main Pump Station	1	
Sewage Treatment Plant	1	
Nominal Treatment Capacity	50,000 m^3/day	(11 IMGD)

(2) *Chittagong WASA*

Chittagong WASA is the authority controlling the water supply and sewerage undertakings in Chittagong. However, as the city has no sewerage facilities at present, it is controlling water supply works only.

2.3 Outline of Sewerage in Dhaka City

2.3.1 Organization and Undertakings of Dhaka WASA

Figure 2-3 is the Organization Chart of Dhaka WASA. As shown, Dhaka WASA consists of three departments under the control of the Chairman; the Secretariat (Administration), the Engineering Department and the Commercial Department (for Commerce, Accounts & Revenues). In addition, there is the Training Office under the direct control of the Chairman. A total of 2,610 personnel are working for Dhaka WASA.

DHAKA WATER SUPPLY AND SEWERAGE AUTHORITY [3)]

ORGANISATION CHART.

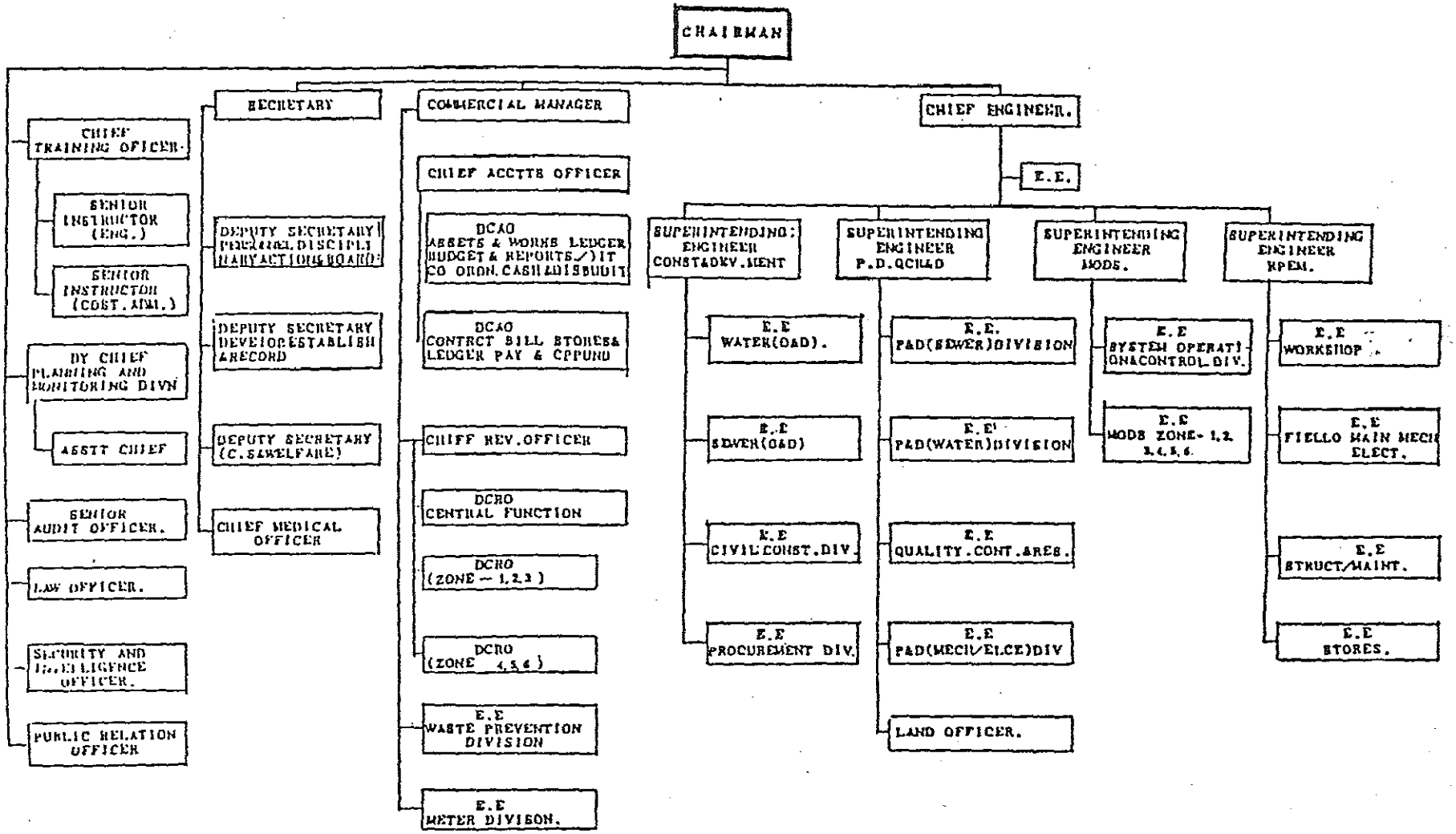


Figure 2-3 WASA Organization chart

Notes:

CONST & DEV: Construction & Development

P.D.QCR & R: Planning, Design, Quality, Control, Research & Record

MODS : Maintenance, Operation, Distribution & Service

RPEM : Resources, Equipment, Plan & Maintenance

2.3.2 Administrative System and Budget

The operation and maintenance of the water supply and sewerage facilities of Dhaka WASA is conducted by MODS Circle. The MODS, dividing the whole City into 6 areas, has set a zone office in each area to take the responsibility of the operation and maintenance of the water supply and sewerage services.

Each office has an Executive Engineer, some other engineers and required number of staff. Most of the staff members are engaged in cleaning of sewers or in operation of the pumps at different locations. For the important facilities such as Pagla Sewage Treatment Plant and Narinda Pump Station, there are special sections respectively with the staff members of 43 and 47 to take charge of those specific jobs.

For the execution of the actual construction work, there are the Sewerage Planning and Design Section with 14 members of staff, the Electric Machinery Planning Section with 12, the Civil Engineering Section in the Construction Department with 13, and the two sections in the Sewerage Works Department with 38 members in total.

The annual achievements of sewer construction and connection to houses was 1.6 kilometers in total for 1,224 cases in 1985, and 2.7 kilometers for 1,176 cases in 1986.

The revenue and expenditure for 1986 are shown in the table below. According to this table, WASA as a whole has a heavy burden of loan payment, resulting in excess expenditure. When the quality of each facility reaches a higher level by the sewerage improvement programme in future, a new problem of 'how to pay the increased cost for the operation and maintenance' will inevitably arise.

Table 2-5 Revenue/Expenditure of Dhaka WASA (in 1986/87)

(Unit: 100,000 TK)

Item	Water Supply	Sewerage	Total
A. Revenue			
1. Rate Income	1,556.15	784.60	2,340.75
2. Installation Fee	22.77	5.24	28.01
3. Others			261.28
Total Revenue			2,630.14
B. Expenditure			
1. Salaries, etc.			484.01
2. Power Cost	646.21	100.27	746.48
3. Repairs/maintenance	117.05	58.20	175.25
4. Chemicals			56.99
5. Others			3.73
6. Reserve & Interest			1,265.10
7. Profit & Loss			△ 101.42
Total Expenditure			2,630.14

2.3.3 *Present Condition of Sewerage Facility*

(1) Background

The first sewerage facilities in Dhaka City were Narinda Pump Station and the Imhoff tank system sewage treatment plant built in 1923 by U.K., the then ruler of the country. Until the beginning of 1940, the sewerage service had been limited only in Old Dhaka, the southern part of Dhaka City.

Since 1947 when Dhaka City became the state capital of East Pakistan, the demand for water supply and sewerage facilities has been on the rise along with the population increase. To meet ever increasing demand, a Master Plan was made out in the 1950's. In 1963, the present Dhaka WASA was established for the purpose of effective execution of the Master Plan.

In 1977, the present Pagla Sewage Treatment Plant was built to serve 500,000 citizens.

The Master Plan, however, was not put into practice as successfully as expected. So, in 1979, "the First Development Project" was made out, with the aid extended by the World Bank and the International Development Association, by reducing the initial Master Plan. But as it needed long time to complete the whole Project, a Feasibility Study was prepared with the aid of the World Bank. At the same time a provisional project was carried out until June, 1985 to meet the urgent demand. This project is called "the Second Development Project."

As "the Second Development Project" was not executed smoothly due to economical difficulties, WASA adopted a more limited, emergency project aiming at completion in 1991. This Project is called "the 3rd Dhaka Water Supply and Sanitation Project."

The new Project includes the construction of new sewers of 37 kilometers in total, the rehabilitation of old sewers totalling 13 kilometers and 8,000 cases of sewer pipe connection to houses.

As described in the above, various efforts have been made to promote the water supply and sewerage programme in Dhaka City to satisfy the remarkable rise in demand caused by the rapid population increase. Due to financial problems, however, the authorities in charge are still at the stage of executing temporary measures.

(2) Outline of Existing Facilities

The outline of existing sewerage facilities in Dhaka City is shown in the figure below. It is reported that the existing sewerage facilities are utilized in 80 to 85% of the Old Dhaka area and in 30 to 40% of the New Dhaka area. The pervasion of sewerage facilities in use is about 27% at present.

According to the data in December, 1984, the major sewerage facilities are as follows:

Sewer	233 miles (= about 375 km)
Lifting Pump Station	12
Pumping Station (New & Old)	1 (Narinda)
Sewage Treatment Plant	1 (Pagla)
Outfall Pump Station & Outfall Sewer	1 (Pagla)

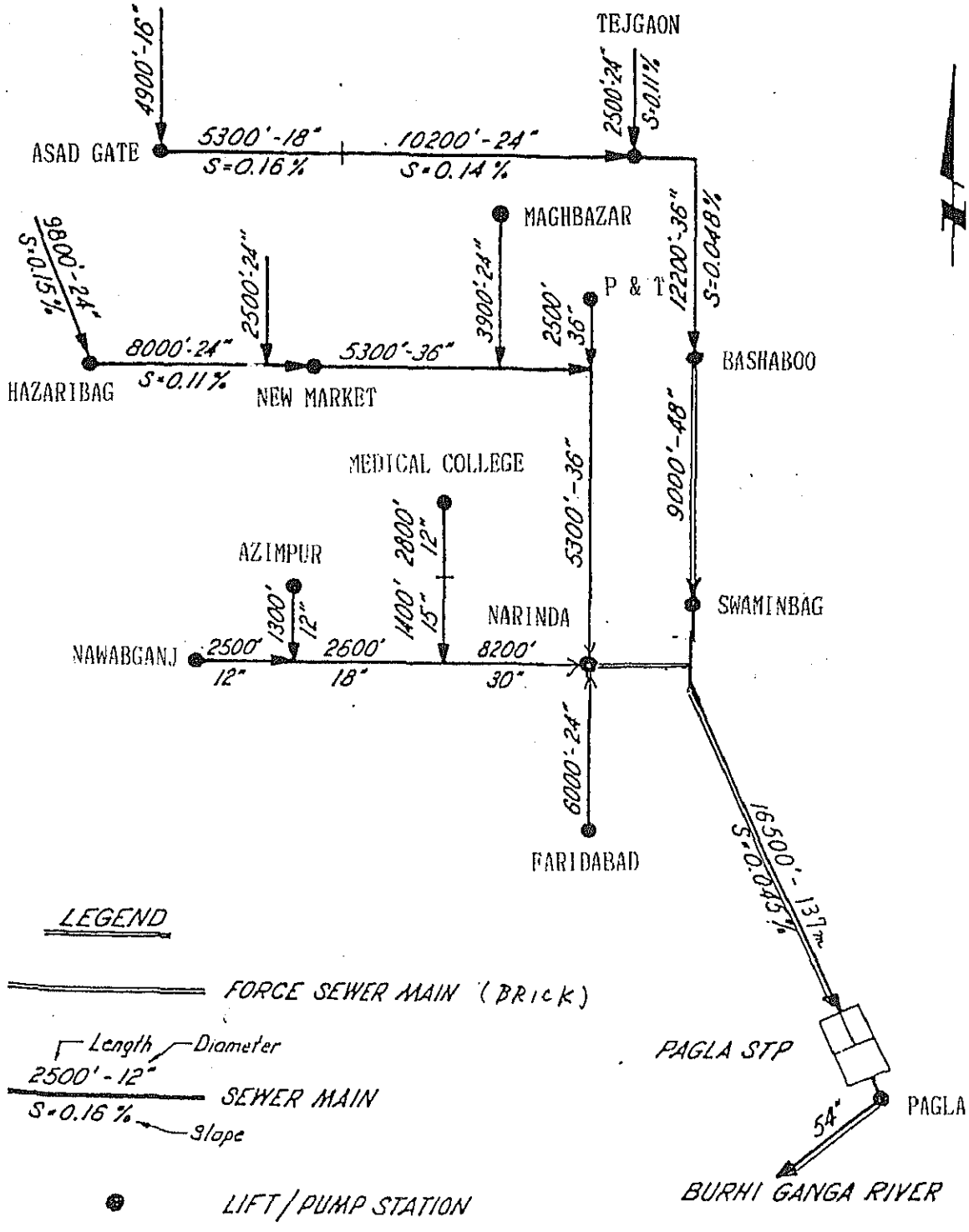


Figure 2-4 Existing Sewage Collection System

The Sewage Treatment Plant in Pagla was constructed with a capacity of serving 500,000 people, but now the capacity has become too small to meet the demand. Consequently the treatment of sewage is insufficient and the quality of the treated water is not alway satisfactory. As a result, the reiver where the treated water is discharged has become contaminated.

To improve such sewerage conditions drastically, not only accurate knowledge of the existing sewer network but also some systematic expansion and improvement plan, based on a new Master Plan, will be required. Problems calling for immediate solution might be cleaning of sewers, functional recovery by repairs, improvement of lifting pump stations and increase in the capacity of Pagla Sewage Treatment Plant. Further, with the limited capacities of the existing sewers, it is also recommended to review the control system of the lift pump operation hours with a view to rationalization.

2.4 Request by the Bangladesh Government

2.4.1 Background of the Request

Dhaka has a population of 4.32 million approximately, showing the tendency of rapid concentration of the population to the capital under urbanization going on a nation-wide scale. In 2000 A.D., the population is expected to reach 8 million. Under such situation, the existing sewerage system in Dhaka cannot satisfy the rapidly increasing demand by the expanding population. As a result, problems such as pollution of rivers/streams, deterioration of environmental and health sanitation have become serious.

If the the population continues to increase at the present rate, direct flow of raw sewage into rivers/streams will cause serious sanitary problems for the daily life of the local inhabitants who depend on these rivers/streams for drinking and other daily water.

The Bangladesh Government carried out a feasibility study in 1981 with an aid of the International Development Association which is generally called the 2nd World Bank for strengthening the water supply and sewerage facilities as a part of the urban infrastructure construction project of Dhaka, the rapidly developing capital. In the feasibility study, the main purpose of the Sewerage Project was to extend the sewage treatment system, including the pervasion of sewerage in the newly developed districts. However, the execution of the project was hampered mainly due to the adverse economic reasons.

Under such circumstances, Dhaka WASA has worked out the Emergency Improvement Programme of the existing facilities and requested the grant aid from the Japanese Government in September, 1986 for the execution of the Programme.

2.4.2 Details of the Request

The details of the request made by Bangladesh are as follows:

(1) The Scope of the Aid

The grant aid is requested to cover the Emergency Improvement Programme mainly aimed at the rehabilitation or replacement of superannuated pumps among the existing ones, as well as the expansion of sewage treatment plant with insufficient treatment capacities. The above plans are described in detail in the following.

1) Lifting Pump Stations

Rehabilitation and renewal of the following pumps and the improvement of related sewers:-

(a)	Tajgaon Lifting Pump Station	30 HP x 2, 20 HP x 2
(b)	Bashaboo Lifting Pump Station	30 HP x 1, 15 HP x 2
(c)	Magbazar Lifting Pump Station	15 HP x 2
(d)	Hazaribag Lifting Pump Station	10 HP x 2, 5 HP x 1
(e)	Faridabad Lifting Pump Station	15 HP x 1
(f)	New Market Lifting Pump Station	10 HP x 1, 5 HP x 1

Rehabilitation of the control panels of the following pumps:

(a) Azimpur Lifting Pump Station
(b) Magbazar Lifting Pump Station
(c) Faridabad Lifting Pump Station
(d) P and T Lifting Pump Station

2) Old Narinda Pump Station

The replacement of the pump, its control panel and the discharge/suction piping will achieve the following capacity:

15 m^3/min x 11 m x 37 kw x 2

3) New Narinda Pump Station

Improvement of the piping at the suction side, and renewal of the vacuum pump.

4) Pagla Sewage Treatment Plant

(a) The replacement of the pumps to achieve the following capacity:

* 32 m^3/min x 10.5 m x 75 kw x 1
* 12 m^3/min x 10.5 m x 37 kw x 1
* 5 m^3/min x 10.5 m x 22 kw x 1

(b) Trickling Filter System

25 mD x 4 m x 6

(c) Final Sedimentation Tank

36 mD x 3 m x 6

(d) Chlorine Disinfection Facility

(e) Sludge Concentration Facility

(f) Sludge Drying Bed

45 m x 70 m x 1 m x 4

5) Outfall Station

(a) Installation of the new pump to achieve the following capacity:

* 25 m^3/min x 8 m x 55 kw x 5

(b) Rehabilitation of existing outfall pipings

(2) The Method of the Sewage Treatment Plant and the Design Flow Rate

The existing Pagla Sewage Treatment Plant is the facultative lagoon process, which needs a large construction space. Therefore, the new treatment plant should adopt trickling filter system plus sedimentation tank system.

The design flow rate is 33.3 IMGD/day on average and 40 IMGD/day at maximum.

3. Outlined Conditions of the Project Site

3. Outlined Conditions of the Project Site

3.1 Natural Conditions

(1) Topographical & Geological Condition

The Dhaka area is an alluvial plain of the Ganges and other rivers, with little undulations, surrounded by rivers and marshes all around, and is quite low and flat. Figure 3.1 shows the rough contour lines of the existing urban area of Dhaka. Dhaka is located at about 150 kilometers up from the estuary, but as seen in this figure, the undeveloped area is only 3 to 6 meters (10 to 20 feet) above the sea level, although most of the urbanized areas are more than 6 meters (20 feet) above the sea. On the other hand, as mentioned later in "Hydrological Condition", the water level of Burhiganga River flowing into the southern part of the site sometimes rises above 6 meters (20 feet) at the peak of the rainy season (August to September). On the average, for the period of 2 to 3 months, the water level rises over 5 meters (16 feet). As known from these facts, all the areas around the City are submerged under shallow water in rainy season.

Dhaka City is located at the southern end of the plateau called "East Balindo Plateau", and is topographically divided into the low level plateaux in the eastern and southern parts of the City, the high level plateau in the north, and the damp low lands around them. On the border between the low lands and the plateau, there are precipices with the relative height of 3 to 5 meters.

Geologically, the low level plateau is made of flood plain deposits such as silt, sand and gravel, and the high level plateau consists of old alluvial deposits (mainly clay), while the damp low lands comprise marshes and delta deposits.

(2) Climate

1) Rainfall

The climate of Bangladesh is the "Subtropical Monsoon" in general classed into three seasons -- summer, winter and monsoon season (rainy season). Winter is from November to February, summer from March to May, and the monsoon season starts in June and continues till October. The maximum monthly rainfall is generally seen in June and July. In addition, Cyclones, originated in Bengal Bay, strikes the land in the rainy season, with heavy rainfalls and strong wind.

The distribution of monthly average rainfall is shown in the table below:

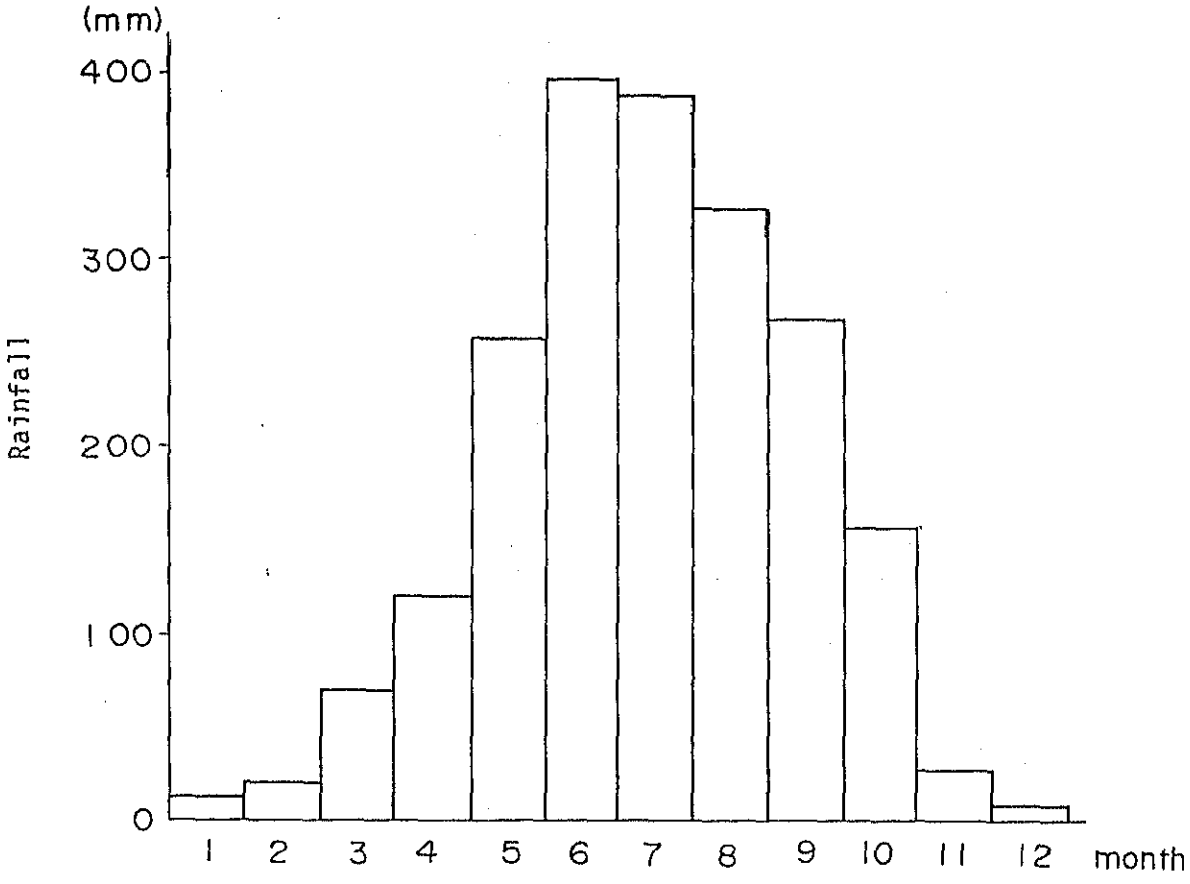


Figure 3-1 : Monthly Rainfall in Dhaka

Source: Bangladesh Meteorological Department
(B.B.S., 1986)

2) Temperature & Humidity

The lowest temperature is recorded in January, and the highest in June all over the land. The average lowest and highest temperatures in dry season are 10°C to 13°C and 24°C to 26°C respectively, while those in rainy season are 25°C to 26°C and 30°C to 32°C respectively.

The average monthly humidity in dry season is 50% to 70%, and in rainy season it exceeds 80%.

An example of annual temperature and humidity is shown in Table 3.1. below:

Table 3.1 Temperature and Humidity in Dhaka.[3)]

Item	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature (℃) Max.	25.5	28.0	32.5	35.0	33.7	31.7	30.7	31.0	31.0	30.9	28.6	26.2
Temperature (℃) Min.	11.7	13.4	18.8	23.4	25.4	25.9	26.0	26.2	30.8	23.7	17.6	12.7
Humidity (%) at 6 a.m.	93	90	88	91	93	95	95	94	95	95	94	95
Humidity (%) at 6 p.m.	61	48	44	54	75	81	82	83	83	79	71	70

3) Hydrological Condition

The water level of Burhiganga River, the major water source of Dahka, is 0.6 m to 1.8 m during the dry season, but when the rainy season is in full swing (August to September), it exceeds 6 meters. The period when the water level exceeds 5 meters lasts for about two months with the surrounding area immersed in water for nearly 2 to 3 months.

Floods last long, but the stream does not seem very strong. Figure 3-2 below shows the water level Hydrograph observed on Burhiganga River (Millbarrak).

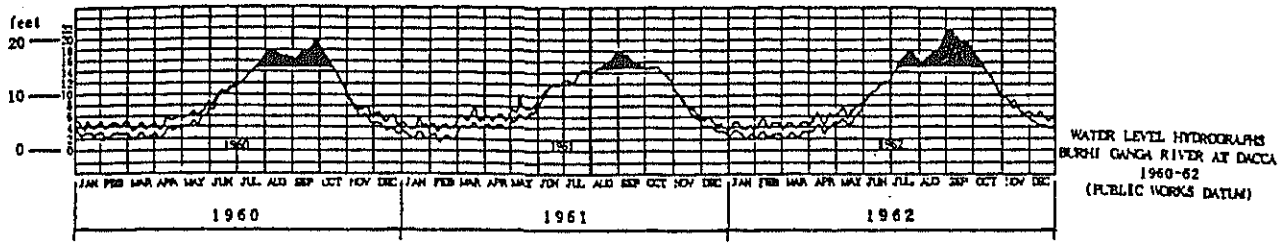


Figure 3-2: Fluctuation of Water Level of Burhiganga River (in Dhaka City)

3.2 Health & Sanitary Condition

The following table compares the change in the incidence and death rates of the diseases caused by worn water in the State of Dhaka with the national averages.

According to this statistical data, we can see that both the incidence and mortality rates in Dhaka are lower than the national averages, except those in the cases of diarrhea and tetanus.

In the above-mentioned data, no statistics on water-caused epidemics are found except for those of dysentery.

The incidence rate of dysentery, when compared with those in other countries, ... with that in the Philippines, for example, where the national average is 54.6 (the average of the three years from 1973 to 1975), is two times higher in Dhaka. Considering the specific climate condition in Bangladesh, that is, the long rainy season and those extensive floods, it is most desirable to take early countermeasures for the improvement of life-environments including the water supply and sewerage facilities in the urban area.

Table 3-2: Diseases in Dhaka State & the Whole Country Caused by Worn Water (Averages of Incidence/Mortality Rates)

Item	1983		1984		1985	
	Dhaka	The whole country	Dhaka	The whole country	Dhaka	The whole country
Incident ratio						
Cholera	-	6.0	-	0.3	-	-
Dysentery	88.7	301.1	81.1	272.0	120.6	628.5
Diarrhea	128.5	98.0	119.3	75.5	260.8	205.5
Malaria	8.3	17.5	4.0	6.6	6.4	12.1
Diphtheria	-	0.6	0.6	0.2	-	24.3
Tetanus	2.5	0.5	-	0.2	0.3	0.2
Polio	-	0.1	0.4	0.1	-	0.8
Mortality ratio						
Cholera	-	0.2	-	0.0	-	-
Dysentery	0.1	5.4	0.5	0.5	0.4	0.9
Diarrhea	4.0	42.4	0.9	2.6	0.9	2.3
Malaria	-	-	-	0.2	-	0.1
Diphtheria	-	0.6	-	0.0	-	0.0
Tetanus	-	0.6	-	0.0	0.0	0.0
Polio	-	0.0	-	0.0	-	-

Source : B.B.S. 1986

Numbers: per 100,000 population

3.4 Status of Infrastructure

(1) Utility

1) Electric Power

The electric power in Dhaka City is generated and supplied to users by PDB (Bangladesh Power Development Board). The power required by this Project is all supplied by PDB. There is no problem of electric power, as it is already supplied fully by PDB, except occasional power failure. Recently, however, the demand for power has increased in Dhaka City, resulting in a voltage drop of power cables. Under such situation, PDB revised the Rules and Rates for the Supply of Electricity which was enacted as of Aug. 1, 1987, to recommend installation of static condensers; in the revisions the installation is obligated especially for motor loads.

As a countermeasure against failure, in Narinda Pump Station, an independent power plant of 375 KVA was already installed, while in Pagla Sewage Treatment Plant one each independent power plant of 375 KVA is planned to be newly equipped at the respective sides of the lift pump and outfall pump. No independent power plant is planned particularly for each lifting pump station. But Asadgate Lifting Pump Station has already installed one with 375 KVA, as they have a water supply station in the same site. As for the other lifting pump stations, the generator-loaded trucks belonging to WASA can cope with the power failure any time.

a) Power Source

° Incoming voltage:

Allowable load under 50 KW	:	400V/230V
Allowable load over 50 KW to 2.5 MW:		11 KV

° Working voltage & frequency: 400V/230V, 50 Hz

b) Power Rates

The power rates imposed by PDB are classified into various types depending on the users' application and incoming voltages.

At present, the power rates in Dhaka are rising up by 30% annually. Above all, the rates for street lights and water pumps are provided with the same rating system as those for commercial purpose in general, which is higher almost by 20% than those for private houses and agricultural pumping.

° Under 50 KW:

Power rate (working)	:	TK 2.15 per KWh
Basic Rate	:	TK 35.00 per KW
Service fee	:	TK200.00 per month
Tax	:	TK 0.05 per KWh

° Over 50 KW to 2.5 MW:

Power rate (working)	:	TK 2.10 per KWh
Basic Rate	:	TK 40.00 per KW of max. demand
Service fee	:	TK350.00 per month
Tax	:	TK 0.05 per KWh

Remarks: In either cases, reduction for improvement of power factor is available.

2) Telephone

Telephones are popular all over the central part of Dhaka City. However, due to the shortage of telephone circuits, they are only limited to hotels and other public organizations. Even the sewerage facilities of WASA do not have any telephones at present. Therefore, installation of telephones is desired at least in the major stations for emergency communication with the head office. Study will be made on providing telephone communications with consideration given to various conditions in WASA.

3) Water Supply

The undertaking of water supply in Dhaka City is operated by Dhaka WASA which supplies water to every existing facility.

4) Gas and Other Heat Source

In Dhaka City, city gas supply systems are not provided. Instead, electricity and propane gas are generally used as heat source. Each planned station and plant might need some heat source to serve the personnel, water analysing instruments, etc. For all these purposes, however, electricity will be used as it is simple and easy to use.

5) Chemicals

The only chemicals required for each facility are chlorine agent for disinfection, and lubrication oil and grease for the maintenance of machines.

The unit price of the chlorine agent for disinfection is:
(as of September 1987)

Liquid Chlorine, in 68 kg cylinder: 8.5 TK/kg (¥41/kg)

Liquid Chlorine is available in the local market.

(2) Transportation of Materials & Equipment

The imported materials and equipment will be unloaded at Chittagong Port located in the southeast of Dhaka City, and from the port to the Project Site they will be transported by lorry.

4. Outline of the Project

4. Outline of the Project

4.1 Purpose of the project

This project aims at improving the health and sanitation, and the living environment of the residents of Dhaka City, by rehabilitating its existing sewerage and sewage treatment systems. To achieve the given purpose, superannuated pumping stations and some related sewers will be repaired and the sewage treatment plant will be expanded with the assistance of grant aid of the Government of Japan.

It should be noted that existing sewerage and sewage treatment plant qualitatively and quantitatively fail to meet the rapid urbanization and the increasing population of the city. In order to make a drastic improvement, it is required to make a thorough investigation on the existing sewerage and prepare a new master plan on the basis of estimated future water consumption.

4.2 Study on the Grant Proposal

4.2.1 Study on the Proposed Project

(1) Original Request for Grant Aid

The following have been proposed by the Government of Bangladesh in its request for grant aid.

1) Lifting Pump Station
   a) Replacement of pumps and relevant electrical equipment
   b) Repair of relevant sewers

2) Narinda Pump Station
   a) Replacement of pumps and the relevant electrical equipment
   b) Repair of the influent pipings and the relevant equipment

3) Pagla Sewage Treatment Plant

a) Construction of a treatment plant (40 IMGD)

4) Outfall Station

a) Replacement of pumps

b) Repair of outfall sewer

5) Training for System Operation

At the time of the feasibility study conducted in June, 1987, the following were additionally proposed by the WASA as a part of the rehabilitation plan.

(2) Additional Request

1) Sewer

a) Repair (including replacement) to improve the capacity of trunk sewers

b) Repair (including replacement) to improve the capacity of branch sewers

2) Lifting Pump Station

a) Improvement of lifting capacity

b) Installation of facilities to remove grit and debris

c) Repair of other superannuated equipment (such as gate, pump, building, etc.)

3) Narinda Pump Station

a) Investigation on the levels relating to New Narinda Pump Station and the fundamental modification

b) Installation of facilities to remove grit and debris

c) Repair of other superannuated equipment (such as crane and gate)

4) Pagla Sewage Treatment Plant

a) Works relating to the qualitative improvement of outfall

b) Improvement of other superannuated equipment

5) Outfall Station of Pagla Sewage Treatment Plant
   a) Improvement of Pagla Outfall Pump Station
   b) Installation of new outfall pipings

6) Sewer Cleaning Facility
   a) Vacuum car for cleaning sewers, high-pressure cleaning car
   b) Vehicle for transporting removed grit, debris and foreign materials, and others
   c) Floor drain pump, etc.

(3) Basic Policy of Project Components

Upon the abovementioned request of WASA, the study team obtained an understanding on the following matters after the discussion with WASA with consideration given to the results of the field study.

1) Functional improvement of the sewer should be implemented based on a master plan.
2) A long term study is necessary for preparing such master plan.
3) The time spent for studying this project is short and therefore is not sufficient to carry out the surveys related to the above plan.

After discussion of the above matters, both governments agreed on the following basic policies as regards the project components.

1) Rehabilitation of existing lifting pump stations and the relevant facilities

2) Rehabilitation of Old and New Narinda Pump Stations

3) Improvement of Pagla Sewage Treatment Plant (particularly of the treatment capacity and the quality of treated water)

4) Rehabilitation of the outfall sewer

In particular, the rehabilitation of the relevant facilities mentioned in above 1) will include the urgent rectification of sewers and the supply of machinery and equipment indispensable for proper maintenance and operation of the systems.

(4) Confirmation of Scope of Work

In order to conclude this basic design study on the sewerage construction and rehabilitation project for Dhaka City, further detailed field study and discussion with the WASA were carried out on the basis of the basic policy mentioned above. While the WASA repeatedly indicated the necessity to include the improvement and the repair of the existing sewerage in the scope of this project in order to put their sewarage systems in good service, it was explained for their understanding that such improvement, which should be executed in accordance with the master plan, does not fall into line with the grant aid project being short period of survey.

In regard to the purpose, the scope and the size of the project, the following basic points were mutually confirmed and agreed upon by both countries.

The scope of the work to be covered is as follows:

1) The study will be implemented as an urgent improvement plan of the existing sewerage system of Dhaka city, in which existing reference data on the long term plan will be put in order to more accurately define the purposes of this project.

2) The study and evaluation of the capacity of the existing sewer pipelines and sewage treatment facilities will be performed. However, the rehabilitation and expansion of the trunk sewer and branch sewer are excluded from the subject of this plan except trunk sewers related to Hazaribagh L.S. and Narinda P.S. and few other places which are urgently necessary for recovering the function of the existing trunk sewer.

3) The lift stations and pumping stations facilities will be surveyed for the operation and functioning conditions of the existing facilities, and rehabilitation of the pumps, pumping stations and improvement of the accessory equipment will be implemented as required.

4) The sewage treatment facility will be examined both in terms of quality and quantity to be treated. The planned quantity of sewage to be treated will be determined taking into consideration the result of this study and that of evaluation of the existing sewage quantity and the maximum conveyance capacity of sewer piping from Narinda and Shamibag up to Pagla.

5) The discharge piping of treated water from the Pagla treatment facility of Burhi Ganga River will be examined whether or not the piping has a capacity sufficient for discharging the quantity of treated water as well as resistance against pressure of the highest flood water level of the river at the Pagla treatment facilities. If not, improvement of the piping will be performed.

6) The effect of use and the appropriate capacity of the equipment will be investigated on the cleaning equipment of sewer piping including sludge carrying facilities. The professional training will be provided.

7) From among the above mentioned improvement plans, as stated in items 1, 2, 3, 4, 5 & 6, the feasible plans to be addressed to the basic design will be selected taking into consideration the results of the study and evaluation of urgencies and total project cost including operation and maintenance cost.

These agreements have been reflected in the minutes of meeting, signed by the representatives of both countries on September 9, 1987. Refer to Appendix __ for the details.

4.2.2 Study on the Proposed Facilities

(1) Sewerage Service Area

Dhaka WASA has been managing the water supply and sewerage services in the city area divided into 6 zones. Sewerage and drainage system is planned for densely populated areas in the zones with water supply services available. Approximately 48% of these areas will be covered by the system. Figure4-1 shows the areas where water supply and sewerage services are available. Incidentally, sewerage has not yet been provided for Zone - 4 where water supply services are available.

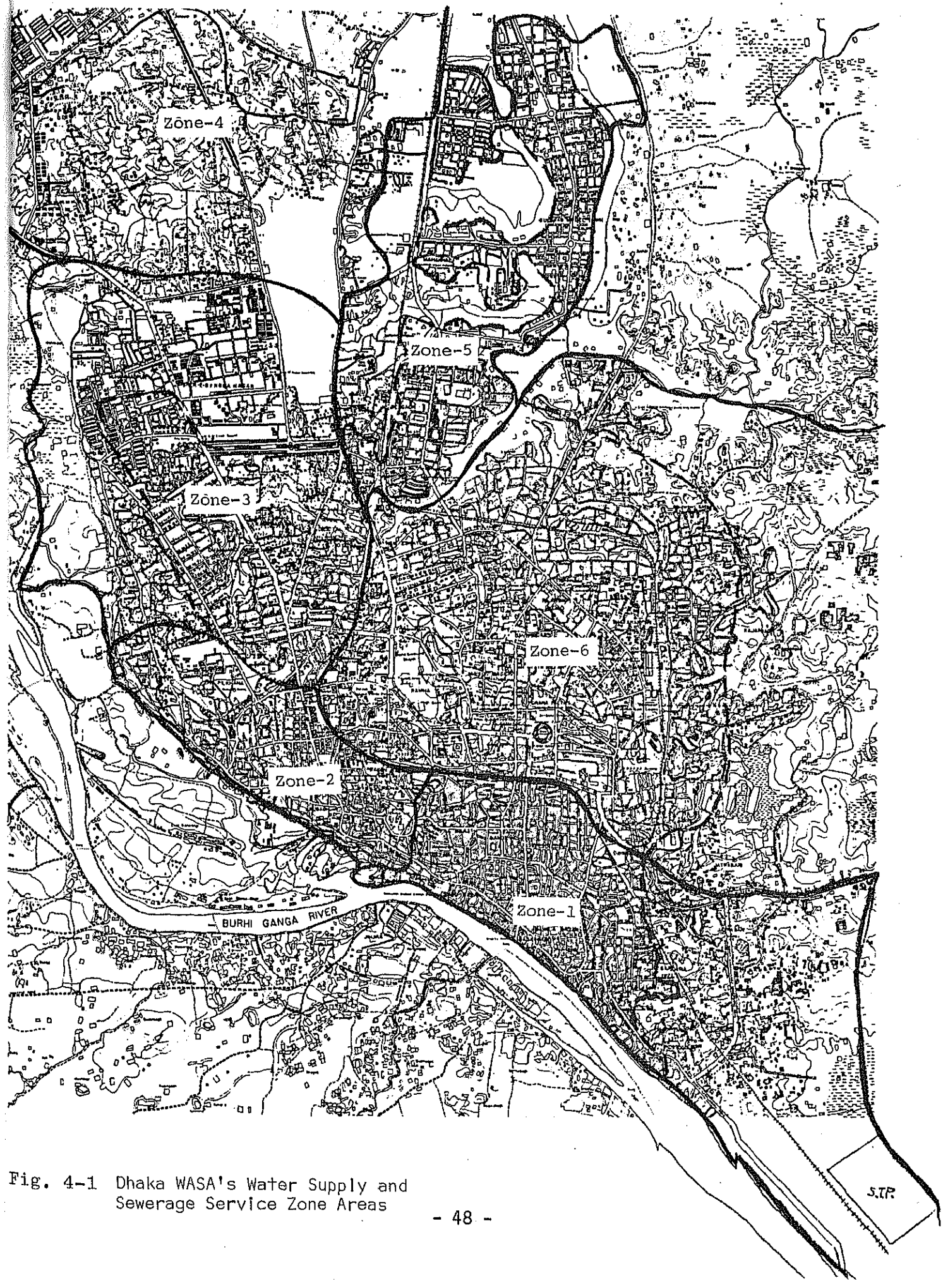


Fig. 4-1 Dhaka WASA's Water Supply and Sewerage Service Zone Areas

(2) Estimated Sewage Flow Rate

Sewage flow rate was estimated on the basis of the results of the preliminary study and the supplementary data obtained from recent field study as well as the meetings with the relevant authorities. Figure 4-2 shows the outline of the study procedure.

Availability of water supply and sewerage services and all the other data used in this study were provided by the WASA, except those with the source mentioned. Major points which have been studied will be introduced in the following.

(1) Current and Future Population of Dhaka City

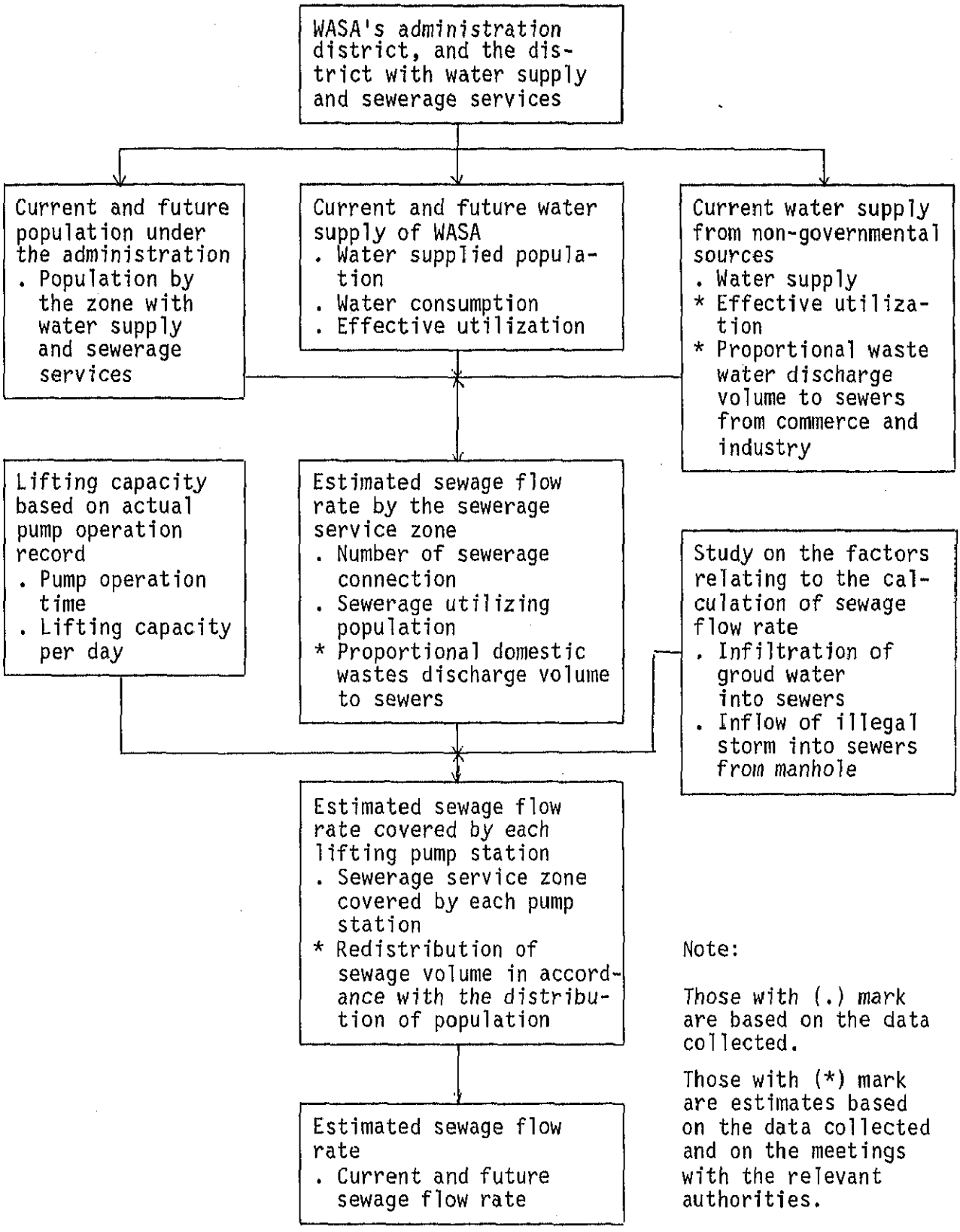
Table 4-1 shows the estimated future population of Dhaka City.

Table 4-1: Estimated Future Population of Dhaka City

Year	Population (unit: 1,000)
1980	2,900
1985	3,500
1990	4,500
1995	5,200
2000	6,000

Source: Dhaka WASA's Present and Future, July, 1986.

Figure 4-2: Flow Chart of the Study on the Future Sewage Flow Rate under Current Tendency



2) Current and Future Water Consumption of Dhaka WASA

As shown below, Dhaka WASA is supplying water to approximately 3,300,000 out of the population of approximately 4,000,000 living in the district, whose water supply volume reaches 421,300 m^3/day (92.50 IMGD). Table4-2 shows the current situation of water supply by zone.

Table 4-2: Dhaka WASA's Water Supply by the Zone

Zone	Total Population (1,000)	Supplied Population (1,000)	Supplied Water Volume (m^3/day)	Supplied Water Volume per Capita (liters/head/day)
I	904	746	93,600	125
II	387	319	53,900	169
III	635	524	73,800	141
IV	764	700	44,100	63
V	317	262	58,400	223
VI	993	819	97,500	119
Total	4,000	3,300	421,300	128 (average)

Source: Dhaka WASA, June, 1987

According to the Dhaka WASA's Management Information Report (June, 1987), the average effective utilization is 65.03%. Thus, the average daily water consumption per capita is,

128 liters/head/day x 0.65 = 83 liters/head/day

Table 4-3 below shows the average daily consumption per capita by housing class in major foreign cities of similar countries. The comparison leads to a conclusion that the abovementioned unit consumption of Dhaka City is within a reasonable range taking current water supply condition into consideration.

Table 4-3 Summary of Measurements of Domestic Per Capita Consumption According to Housing Class

Housing class	Description	Range of per capita consumption[a], l/head/day
High	Detached houses, luxury apartments having 2 or more WCs, and 3 or more taps per household	260—150
Middle	Houses and apartments having at least 1 WC and 2 taps per household	160—110
Lower	Tenements, government rehousing, shared houses, having at least 1 tap per household but sharing WC	70*—55
		*Frequently higher due to wastage

The above figures are based on tests carried out between 1970 and 1978 in the following places: Istanbul (Turkey)[b], Sakaka (S. Arabia), Lesotho (Africa), Cairo (Egypt), Palembang (Indonesia), Hong Kong[c] Alexandria and Port Said (Egypt), also in Camiri, Bolivia in 1981.

References: CONNAL[14]; Twort[16].

Notes:

(a) Exclusive of avoidable consumer wastage.

(b) Figures for the same type of property gave consumptions of 90 l/head/day where there were under 15 persons per meter to 233 l/head/day where over 35 persons were supplied through one meter.

(c) In government low-cost housing blocks consumption averages 50 l/head/day where households have individual meters, but is about 110 l/head/day where washing facilities are shared.

source :The International Drinking Water Supply and Sanitation Decade Directory (March 1984)

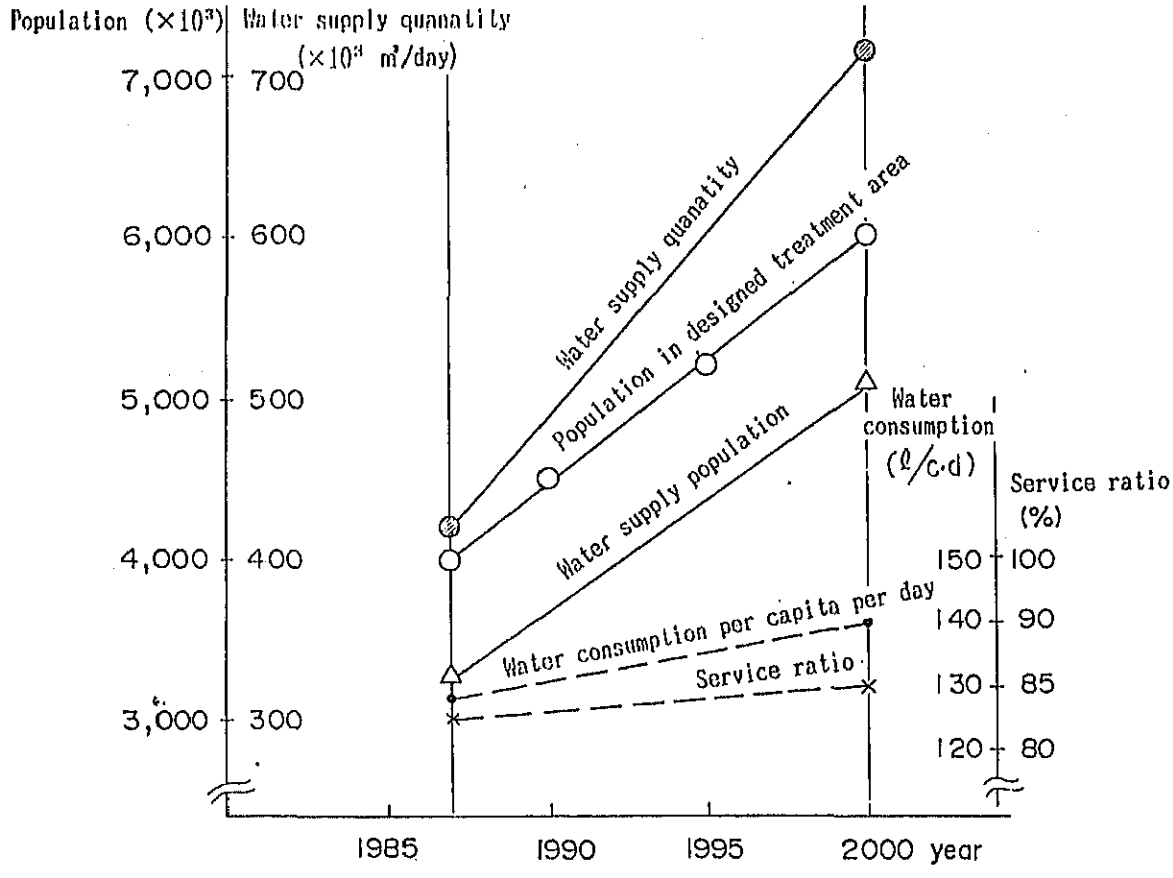
Dhaka WASA currently has a water supply capacity of 480,000 m^3/day (105.45 IMGD). WASA's third-term development project aims to complete construction of a supply plant with a capacity of approximately 90,000 m^3/day (20 IMGD) within coming 4 years, and another plant with a capacity of 455,000 m^3/day (100 IMGD) is also under planning.

As the data on the WASA's water supply plan was not available in the recent field study, the future water consumption is calculated on the basis of the following assumptions. Figure4-3shows the results of the calculation.

Assumed Conditions

	Current Actuals	Estimate at the Year of 2000
Water Supply Pervasion	82.5%	85%
Daily Consumption per capita	128 liters	140 liters

Figure 4-3: Predictable Water Consumption of Dhaka WASA



3) Estimated Sewage Flow Rate

a) Presumed population utilizing the sewerage is approximately 1,151,000. Although the waste water from kitchen, bath room and garage are not permitted in principle to flow into the WASA's sewerage, in many areas it is difficult to separate miscellaneous domestic wastes from the other wastes and there is no data available to show the proportion. It was observed in the field study that miscellaneous domestic wastes were flowing into the drainage. Accordingly, it may be concluded that domestic sewers of wastes other than those miscellaneous wastes have been connected to the rainwater and waste water treatment systems in unexpectedly many cases. In preparing a sewerage construction and rehabilitation plan in the future, it is necessary to conduct a thorough study on the connections to sewerage on the basis of the ratio of domestic wastes to the other waste waters.

Sewage flow rate was calculated on an assumption that 70% of domestic water consumption would be discharged to the sewerage. The calculated flow rate was checked against the one obtained from the operating time of each pump station, which will be discussed later.

Table 4-4: Estimated Sewage Flow Rate of Dhaka WASA

Zone	Supplied Population 1) (a) (1,000)	Sewerage Utilizing Population 1) (b) (1,000)	Unit Actual Consumption 2) (c) (l/head/day)	Consumption of Sewerage Utilizing Population (d)=(b)x(c) m^3/day	Sewage Flow Rate m^3/day (e)=(d)x0.7
I	746	357	81	28,900	20,000
II	319	153	110	16,800	11,800
III	524	188	92	17,300	12,100
IV	700	-	-	-	-
V	262	110	145	16,000	11,200
VI	819	343	77	26,400	18,500
Total	3,300	1,151	92	105,400	73,800

Note 1): Source: Data provided by Dhaka WASA

2): Unit actual consumption = Unit consumption x Effective utilization (65%)

b) Presumed water supply from non-governmental sources reaches 6.14 IMGD (28,000 m^3/day). The water from those sources is used as industrial water and commercial water. Although as a rule industrial sewer is not to be connected to the WASA's sewerage, many industrial sewers have been reportedly connected to it. The ratio, however, has not been clarified.

On an assumption that the effective utilization of the water supplied from non-governmental sources is 80%, and half of which is flowing into the sewerage, the sewage flow rate will be as follows.

$$28,000\ m^3/day \times 0.8 \times 0.5 = 11,200\ m^3/day$$

c) For the infiltration of ground water (amount unknown), by applying the figure (8,000 IGPD/mile) used in the Feasibility Report (RMP and J. M. Montgomery), the flow rate will be as follows:

$$300 \text{ miles} \times 8{,}000 \text{ IGPD/mile} = 2{,}400{,}000 \text{ IGPD}$$
$$= 11{,}000 \text{ m}^3\text{/day}$$

d) The Feasibility Report presents illegal storm/Infiltration = 65/35 as the figure for the penetrating rainwater volume from the results of pumping test at Narinda Pump Station. Using this figure in the calculation, the illegal storm volume will be as follows:

$$11{,}000 \text{ m}^3\text{/day} \times 65/35 = 20{,}000 \text{ m}^3\text{/day}$$

Table 4-5 shows the sewage volume flowing into the sewerage calculated from the given conditions from in the above a) to d).

Table 4-5: Estimated Sewage Flow Rate of Dhaka WASA

Type	Flow Rate	Remarks
a) Sewage relating to WASA's water supply	73,800 m^3/day	
b) Sewage relating to non-governmental water supply	11,200 m^3/day	
c) Infiltration of ground water	11,000 m^3/day	
a) + b) + c) (Subtotal)	96,000 m^3/day	in dry season
d) Illegal storm	20,000 m^3/day	
a) + b) + c) + d) (Grand total)	116,000 m^3/day	in rainy season

The following table shows the sewage flow rate by the zone where sewerage services are available, on the basis of the above calculated flow rate.

However, since the relevant data were not available regarding the wastes generated from non-governmental water supply, the water from non-governmental sources was divided among Zone 2 and Zone 5 as industrial water and among Zone 1 and Zone 6 as commercial water, based on the possible application and the land utilization.

Table 4-6: Estimated Sewage Flow Rate of Dhaka WASA by the Zone with Sewerage Services Available

(Unit: m^3/day)

Zone	WASA Supply (a)	Other Supply (b)	Infiltration Water (c)	Illegal storm (d)	Flow Rate	
					Dry Season (a+b+c)	Rainy Season (a+b+c+d)
I	20,200	2,500	3,000	5,400	25,700	31,100
II	11,800	600	1,700	3,300	14,100	17,400
III	12,100	600	1,800	3,300	14,500	17,800
V	11,200	3,000	1,700	3,000	15,900	18,900
VI	18,500	4,500	2,800	5,000	25,800	30,800
Total	73,800	11,200	11,000	20,000	96,000	116,000

4) Based on the above sewage flow rate by the zone with sewerage services available, Figure __ shows the volume to be treated by each lifting pump station and the flow rate of the trunk sewers connected to Narinda Pump Station.

Although the calculation was made in the following manner, it is unavoidable to make a wild estimate due to the absence of the relevant data. It is expected that more accurate results will be given in the future on the basis of a thorough investigation.

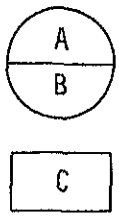
Remarks on the Calculation

1. Sewerage service area covered by each lifting pump station is in accordance with the information provided by WASA.

2. For the sewage flow rate, assuming the ratio of population from the land utilization and the housing density in the zone, the volume was distributed to each lifting pump station in the zone in accordance with the assumed ratio of population in the area covered by a station (Table 4-6).

3. Referring to the daily sewage volume treated by each lifting pump station which was obtained from its actual operation record for the past one year, the assumed sewage flow rate calculated above was adjusted. (Refer to Figure 4-5)

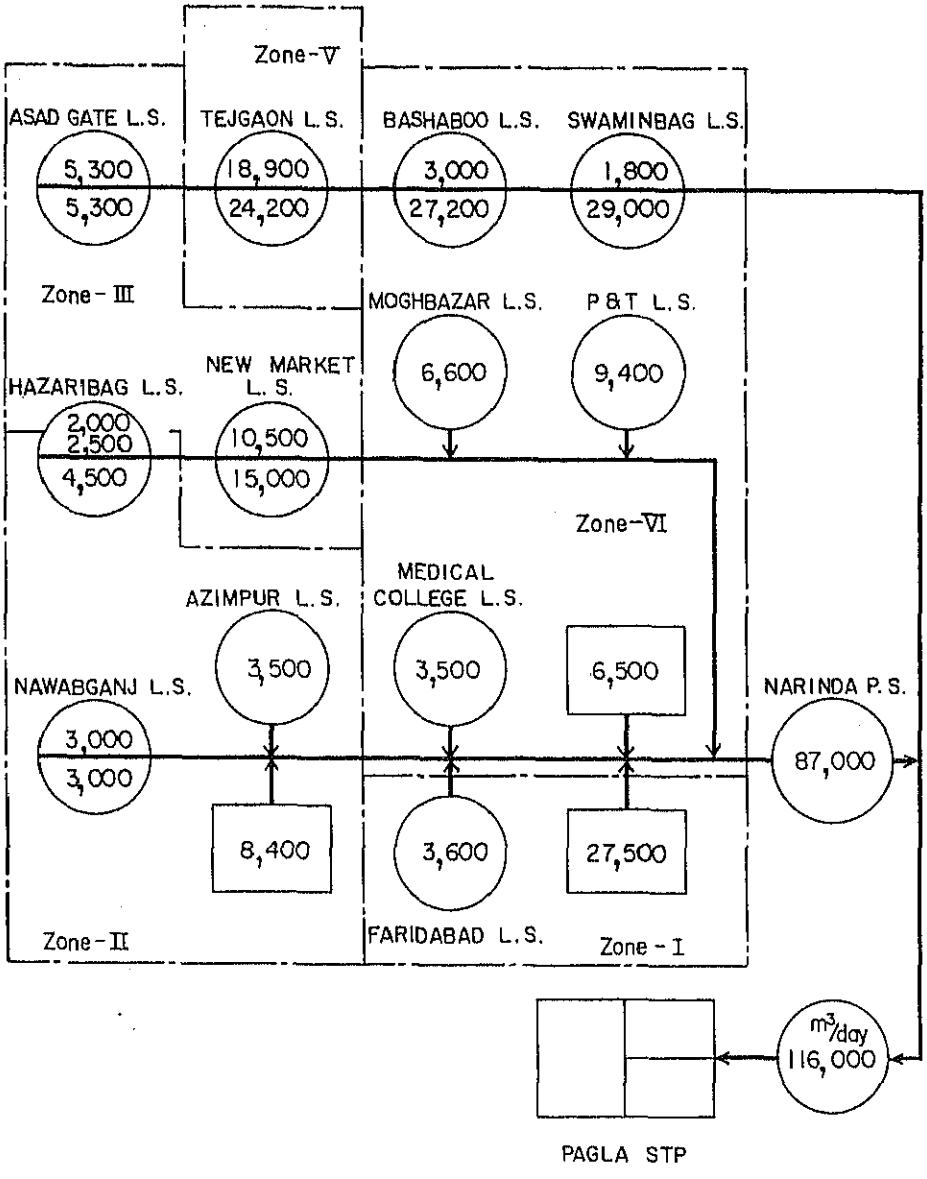
Figure 4-4: Estimated Sewage Flow Rate by the Area with Sewage Services Available



A : Sewage flow rate (m^3/day) of the sewerage service area covered by a lifting pump station.

B : Total sewage flow rate (m^3/day) of the lifting pump station.

C : Sewage flow rate (m^3/day) of trunk sewers connected to Narinda Pump Station.

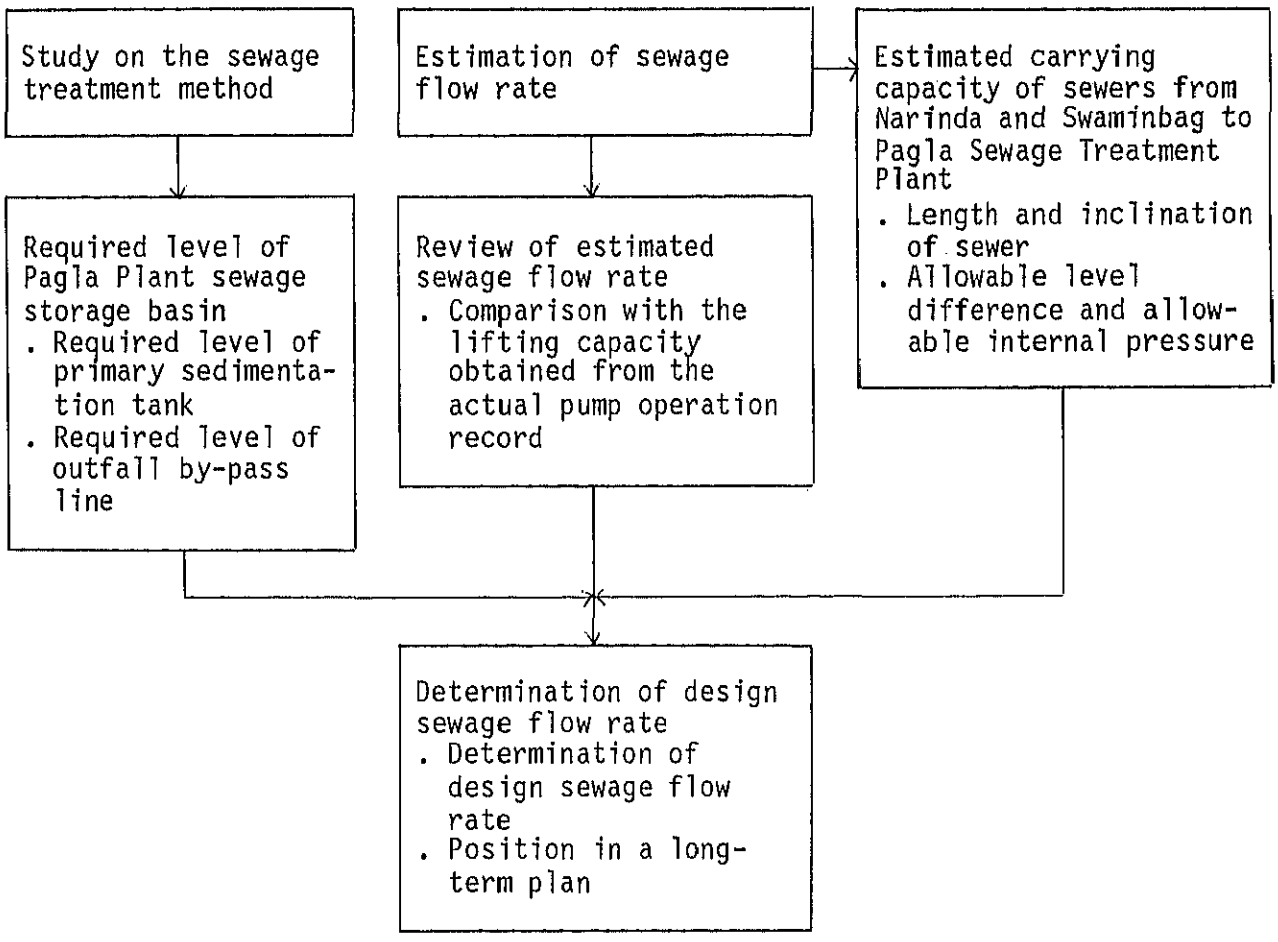


(3) Determination of Design Sewage Flow Rate

On the basis of the results of the feasibility study, the supplementary data obtained from the field study, and the meetings with the relevant authorities, a practical examination was conducted for sewage flow rate to determine the treatment capacity in this project.

Outline of the examination procedure is shown in Figure 4-5. The major points which have been studied will be discussed in the following.

Figure 4-5: Determination of Design Sewage Volume



1) Review of Estimated Sewage Flow Rate

In order to grasp the actual sewage volume flowing in the sewerage, the lifting capacity of each lifting pump station was recalculated in the recent field study in accordance with the pump operation record. The lifting capacity was calculated by multiplying the daily operating time of a pump given by the operation record for the past one year by the rated capacity of the pump. Refer to Section 4.2.2.(5) for details.

The sewerage of Dhaka City is roughly devided into 2 lines; comparatively new Swaminbag line (Asadgate - Tijgaon - Bashaboo - Swaminbag) and the Narinda line covering the other areas. Figure 4-6 shows the lifting capacity of Swaminbag Lifting Station and Narinda Pumping Station, both of which are located at the final destination of abovementioned lines, respectively. For comparison, the lifting capacity of Bashaboo Lifting Pump Station, which is located on the upstream side of the Swaminbag line, is also shown. As the figure shows, the lifting capacity of Swaminbag Lifting Pump Station is smaller than that of Bashaboo Lifting Station in spite of its location on the downstream side of the line. The reason for such arrangement could not be clarified by the field study. As discussed later, however, it is assumed that Swaminbag Station cannot carry out normal pumping operation at any time of the year due to insufficient maintenance of the sewerage, some portions of which being exposed in the low marshland.

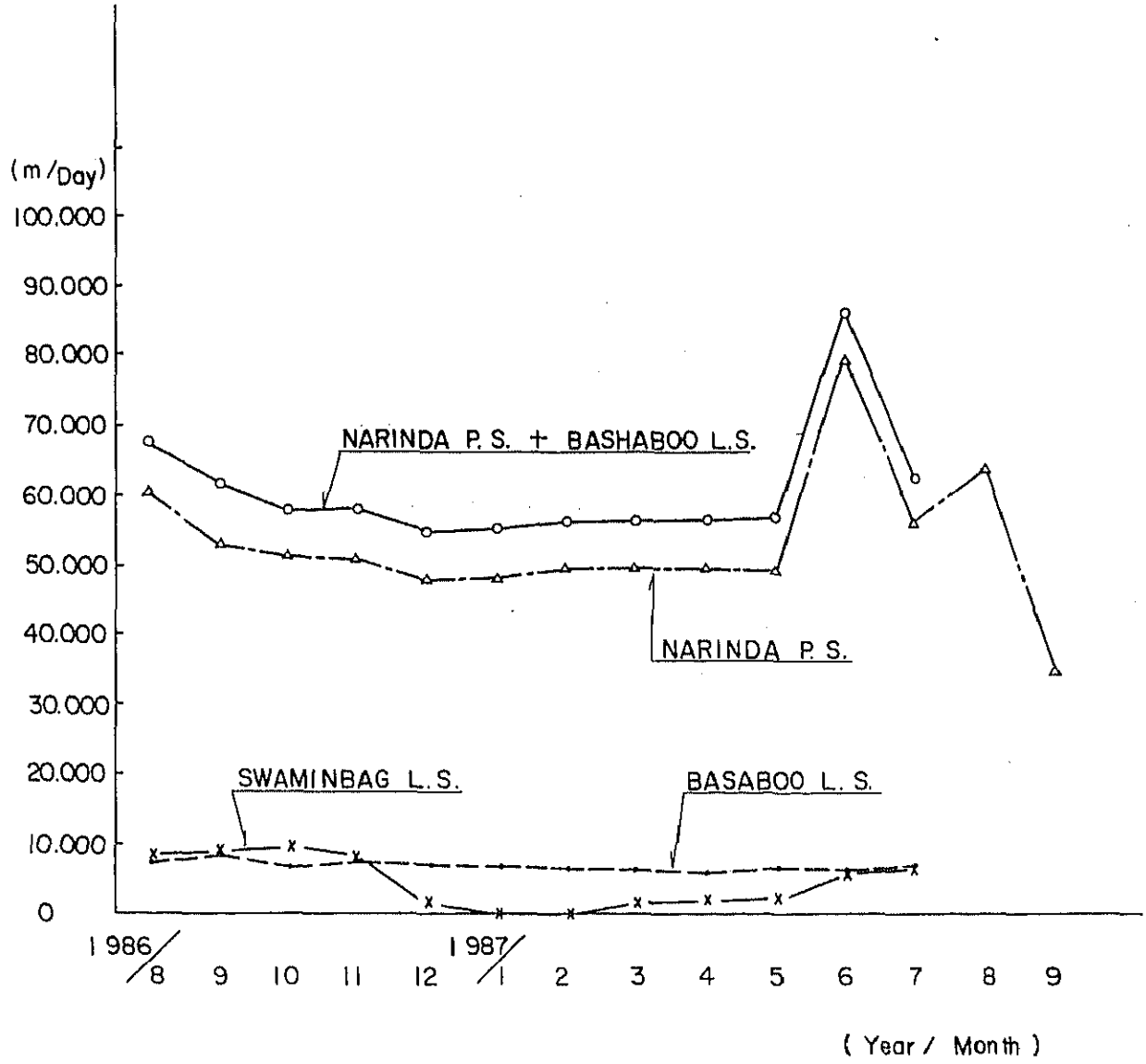


Figure 4-6 : Monthly Lifting Capacity of Narinda and Swaminbag Stations based on the Actual Pump Operation Record

As far as the Narinda line is concerned, the lifting capacity of Narinda Pump Station reaches 50,000 m^3/day at dry season and 79,000 m^3/day at rainy season. Regarding this sewage line, Hazaribag Lifting Pump Station is not in service while Medical College Lifting Pump Station is discharging the sewage to the drainage due to the clogging of its connected sewerage. Accordingly, with the lifting capacity of Narinda Pump Station added to the estimated sewage flow rate of the respective lifting pump stations, the following is obtained.

Pump Station	Dry Season	Rainy Season
Narinda Pump Station	50,000 m^3/day	79,000 m^3/day
Hazaribag Lifting Pump Station	3,700	4,500
Medical College Lifting Pump Station	2,900	3,500
Total	56,600 m^3/day	87,000 m^3/day

If these values are compared with the estimated sewage flow rate calculated from the water consumption, the flow rate at dry season is 56,600/72,000 (79%) and the flow rate at rainy season is 87,000/87,000 (100%). Therefore, it can be concluded that the estimated sewage flow rate of the Narinda line is more or less reasonsable.

Based on the above examination, the estimated sewage flow rate calculated from the water consumption is determined as the current sewage flow rate.

2) Carrying Capacity of 54" Diameter Trunk Sewer

The sewer from the lifting pump stations located at the final destination of each sewage line to Pagla Sewage Treatment Plant is 54 inch diameter brick lining channel with concrete reinforcement, covering the distance of approximately 5.1 km.

The carrying capacity of the sewer is approximately 100,000 m^3/day if it is calculated from its inclination, and approximately 120,000 m^3/day if the sewer is assumed to be a pressure piping allowable upon the location of the piping route. Refer to Appendix-7 for details.

3) Determination of Design Sewage Flow Rate

40 IMGD (183,000 m^3/day) is the design sewage flow rate specified in the request from Bangladesh.

The maximum lifting capacity obtained from the actual pump operation record for the past one year is 88,000 m^3/day. With the addition of approximately 25,000 m^3/day which is apparently a by-pass outfall caused by the failure of the pump or the outfall of some sewage, it will reach 113,000 m^3/day. On the other hand, estimated sewage flow rate calculated from the water consumption is 116,000 m^3/day.

The carrying capacity of the trunk sewers connected to the existing Pagla Sewage Treatment Plant is 120,000 m^3/day at maximum, which is nearly equivalent to the sewage flow rate in rainy season.

As this project aims at urgent improvement and the Government of Bangladesh has agreed that the design sewage flow rate of the treatment plant will be within the range of

the carrying capacity of existing sewers, with the given conditions mentioned above taken into account, the design sewage flow rate is determined to be 120,000 m^3/day. However, a master plan of the plant will be made to meet the capacity of 183,000 m^3/day as requested.

(4) Position of the Project in a Long-Term Plan

1) Predictable Sewage Flow Rate

Although WASA has the Feasibility Report composed in 1980 as a long-term plan, it can hardly meet the present requirements. As a matter of course, they intend to prepare another new master plan for executing drastic improvement.

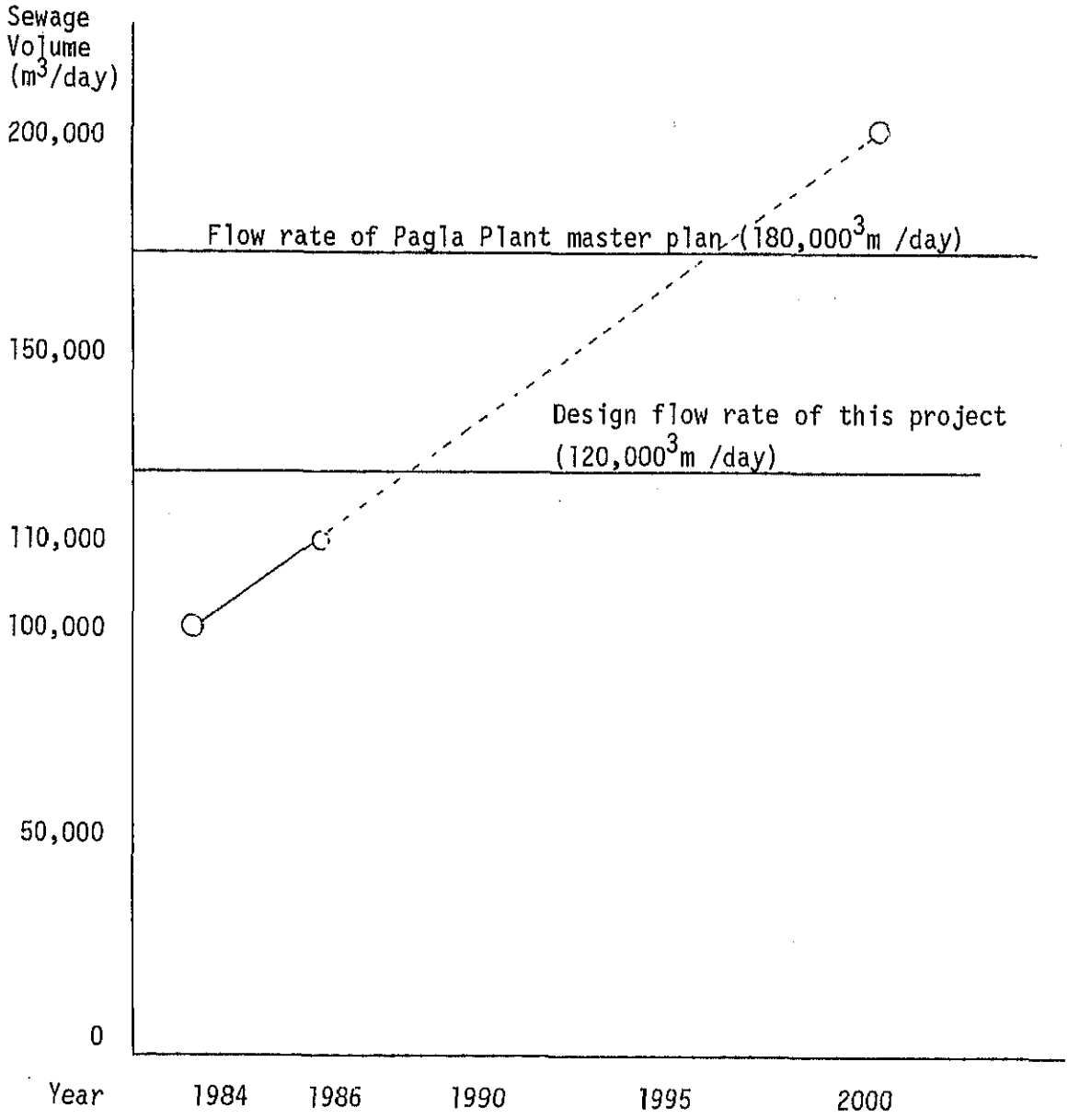
As an annual expansion plan, WASA intends to extend sewers a total of 6 miles and make connections to 1,500 households. If the works are carried out according to this plan, estimated sewage amount in the year 2,000 is as shown in the following table.

Future sewage flow rate shown in the table below was calculated from the population per sewer connection (42.5 heads/connection) and daily sewage volume per capita (101 liters/capita) on the basis of the current number of sewer connections (27,087), sewerage utilizating population (1,151,000) and total sewage flow rate (116,000 m^3/day), allowing for the increment assumed in Figure 4-3 due to the upgrading of the living standard in future.

Table 4-7 : WASA's Sewerage Expansion Plan and Predictable Sewage Flow Rate

Year	WASA's Plan		Prediction	
	Sewer (mile)	Number of Connections	Sewerage Utilizing Population	Sewage Flow Rate (m^3/day)
Actual				
1984	5.46	1,566	985,000	99,000
1985	0.87	1,224	1,037,000	105,000
1986	1.71	1,176	1,087,000	110,000
Planned/Presumed				
1995	6.0/yr.	1,500/yr.	1,663,000	171,000
2000	6.0/yr.	1,500/yr.	1,983,000	210,000

Figure 4-7: Predictable Sewage Flow Rate in Future
(in Rainy Season)



2) Pagla Sewage Treatment Plant

The new Pagla treatment plant which will be constructed by this project will have a capacity of 12,000 m^3/day. If the existing sewerage performs to its normal capacity, the treatment capacity will barely manage the present sewage flow rate. Accordingly, following the possible expansion of sewerage and the increasing connections of household sewer, construction of additional trunk sewers and expansion of the treatment plant will become necessary.

3) Sewerage

Existing sewerage has been expanded by repeating the connection from one after another. Moreover, the lack of the basic data makes it more difficult to evaluate the proper function. However, in order to find the allowance of the existing plant, a bold capacity assessment was made on the basis of the data obtained in the field study.

Figure 4-8 shows the possible allowance of each lifting pump station for the current sewage flow rate of 116,000 m^3/day when the existing sewerage recovers its proper function as a result of this project. The capacity of sewerage was calculated on the basis of the carrying capacity of sewers from the splash box of lifting pump stations to the trunk sewers. Refer to 4.2.(5) for the details.

How to Read the Figure

The origin of coordinates indicates that the capacity of sewer and pump is equivalent to the current sewage flow rate.

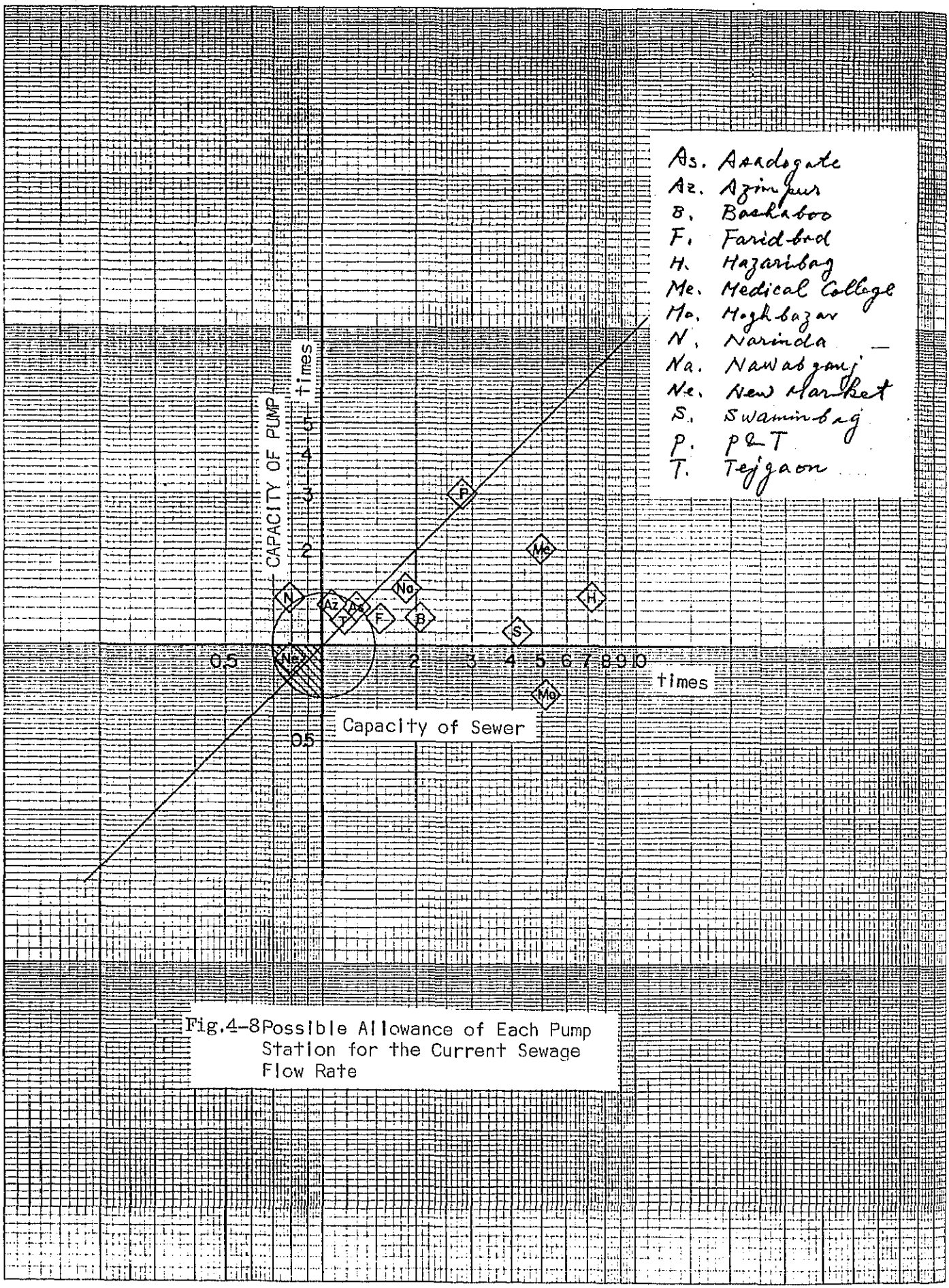


Fig.4-8 Possible Allowance of Each Pump Station for the Current Sewage Flow Rate

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The following points are obtained from the figure.

1. If Hazaribag Lifting Pump Station can be operated properly as a result of this project, the current sewage flow rate will exceed the capacity of both sewerage and pump of New Market Lifting Pump Station so that earlier improvement will be required.

2. Narinda Pump Station, Azimpur Lifting Pump Station, Tejgaon Lifting Pump Station, Asadgate Lifting Pump Station and Faridabad Lifting Pump Station do not have allowance in the sewerage capacity so that improvement will be required in the near future.

(5) Sewer Network and Lifting Pump Station

1) Current Situation of Sewer Network

Although the pervasion of sewerage barely reaches 25% of 4 million population of Dhaka City, the extent of sewer network covers fairly a large area. In the figure, full line indicates the existing sewers while broken line shows those under planning. Separate system has been employed as its displacement method. However, compared with the nominal 50,000 m^3/day treatment capacity of Pagla Sewage Treatment Plant, the expanded network resulted in overload on the treatment plant, which is the background of the request for this project. The sewers have been extended by repeated connection, regardless of the availability of a master plan. As a result, the sewage overflow from manhole is observed in rainy season due to the ingress of rainwater, insufficiency of sewer capacity and sediments in the sewers.

For instance, it was found out at many points that 24" sewers have been combined and connected to another 24" sewer and that 36" sewer and 24" sewer have been combined and connected to another 36" sewer to which another 36" sewer is connected on its downstream side. This is the reason why construction of reinforced trunk sewers is required as early as possible on the basis of a long-term master plan covering the whole city area.

The rainwater displacement system has been managed not by Dhaka WASA but by another agency (DPHE). Feasibility study survey on the rehabilitation project is under way as another cooperation project initiated by the Japan International Cooperation Agency.

Though a separate system is adopted, intentionally or not, drainage is actually connected to the sewers. Furthermore, the structure inevitably discharges sewage from the sewers to the drainage, especially when it is raining, possibly due to the limited capacity of sewerage or improper operation of pumps. (Refer to Picture 4.1.) On the other hand, substantial portion of the trunk sewers are exposed in the low marshland, resulting in the leaching of sewage from the joints and the damaged sections in dry season and the influx of flooding water in rainy season. (Refer to Picture 4.2.)

Existing sewers are made of polychloride vinyl pipe, reinforced concrete pipe and brick-arch-channel. For the trunk sewers, reinforced concrete pipe is used for the sewers up to 24-inch diameter and brick-arch channel for those exceeding 36-inch diameter. Figure 4-9 shows the structure of brick-arch channel with 48-inch diameter.

Figure 4-9 Typical Section of Brick Arch Sewer

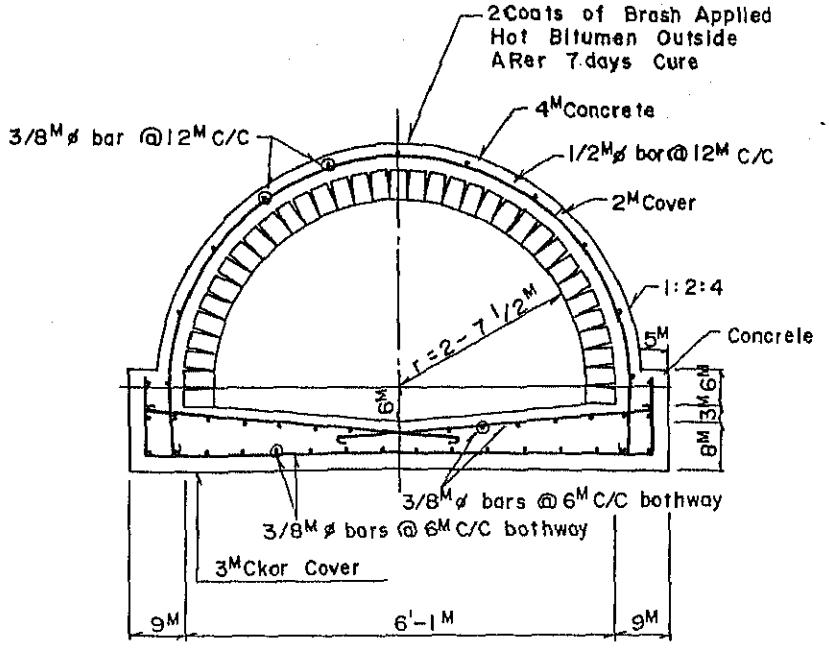


Photo 4.1.(a): From sewer to drainage,
Faridabad Lifting Pump Station

Photo 4.1.(b): From Sewer to drainage,
Medical College Lifting Pump Station

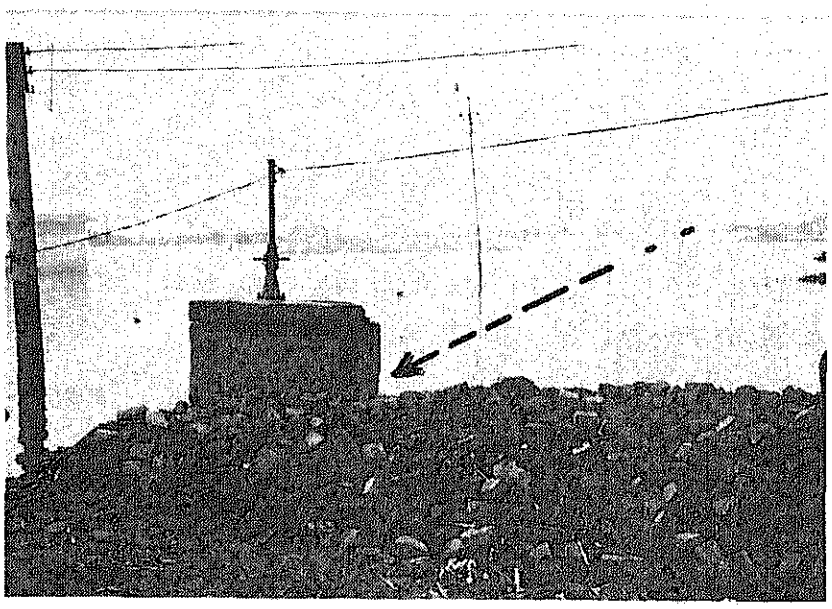


Photo 4.2 (a): Incoming trunk sewer (pointed by arrow), Hazaribad Lifting Pump Station, 10 September, 1987

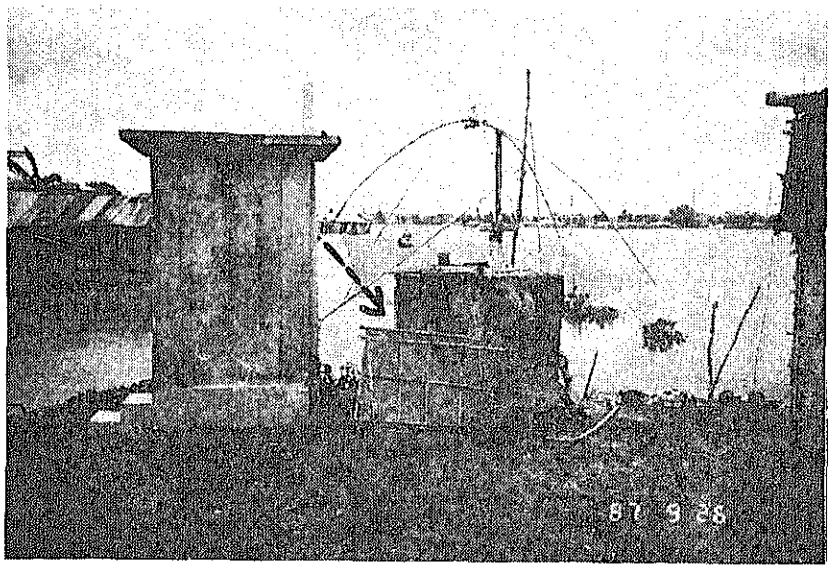


Photo 4.2.(b): Incoming trunk sewer (pointed by arrow), Tejgaon Lifting Pump Station, 26 September, 1987

According to the data of December, 1984, the total length of the existing sewers was approximately 375 km with about 5 km (3 miles) newly constructed at every year, which was managed by 38 personnel of WASA's 2 sewer construction departments. Figure 4-10 shows the location of trunk sewers and lifting pump stations, and the sewerage service area covered by the respective stations.

Line connection of the lifting pump stations is as shown in Figure 4-11.

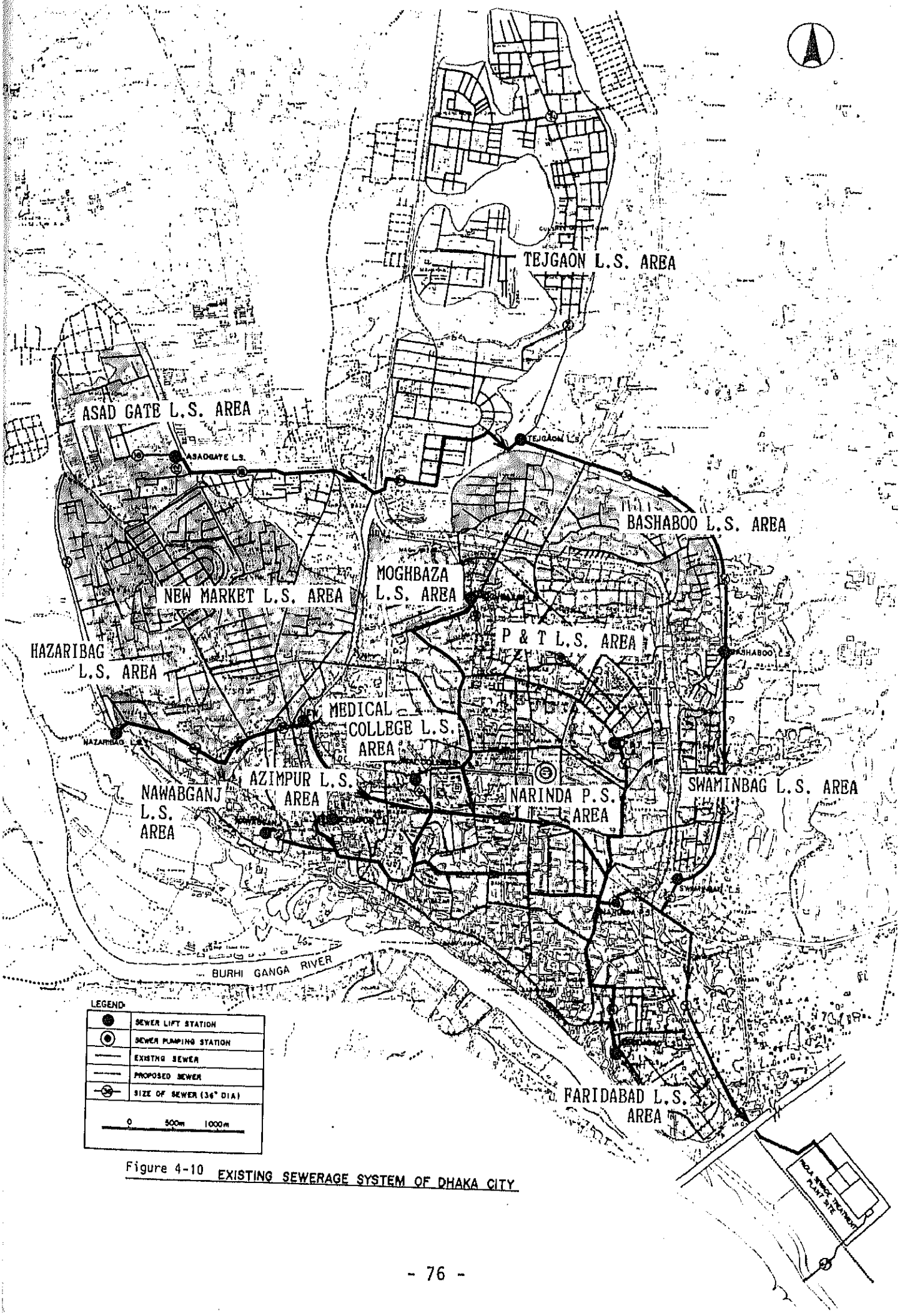


Figure 4-10 EXISTING SEWERAGE SYSTEM OF DHAKA CITY

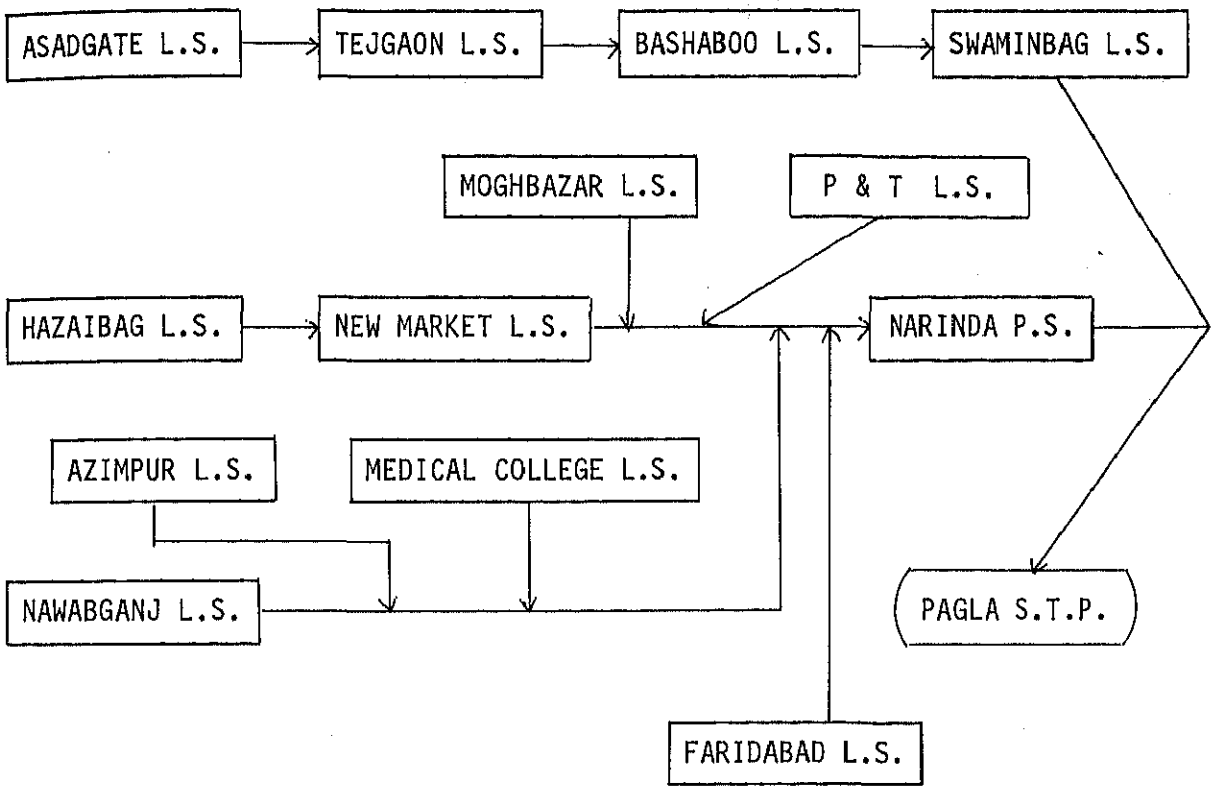
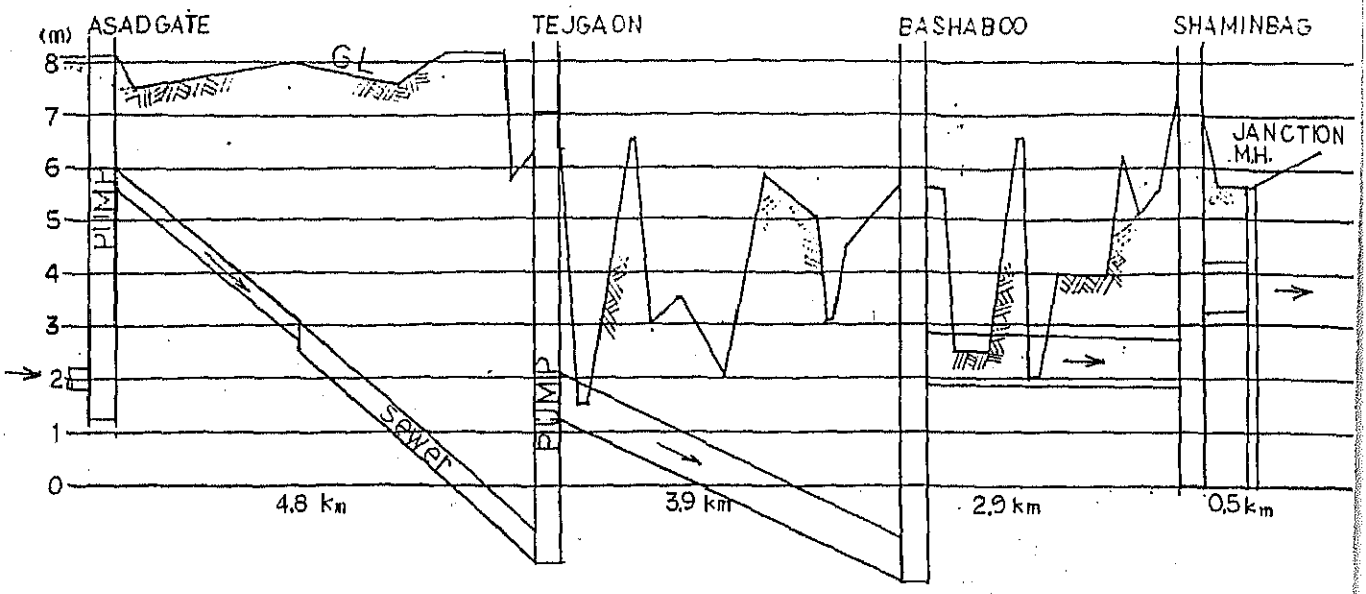
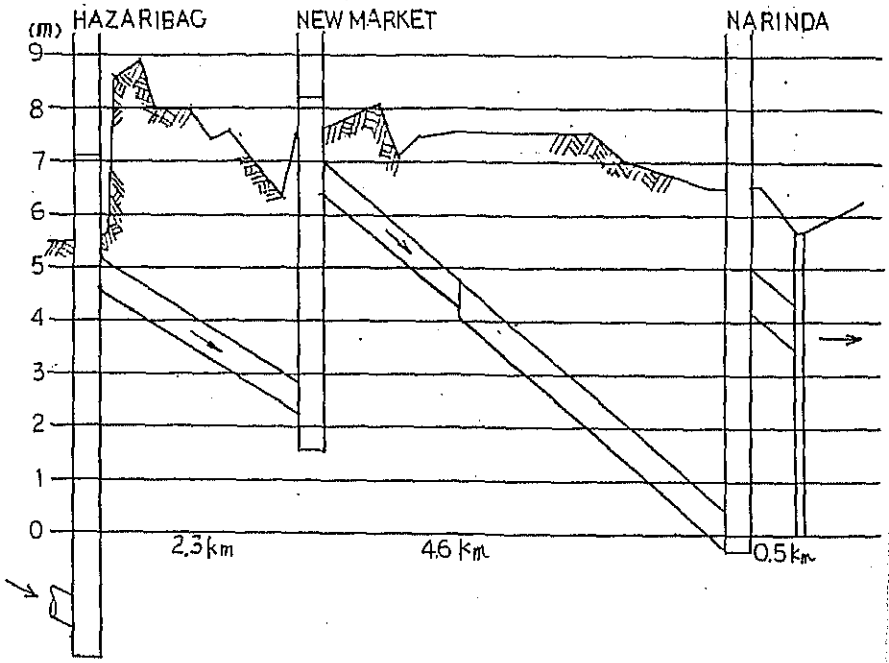


Figure 4-11 : Line Connection

Figure 4-12 shows the difference in level between the pump stations by the line shown in Figure 4.4. All the lifting pump stations, except Narinda Pump Station (Figure 4-13), are small in size and have only pump well without pump protection facilities such as screen and grit chamber. The typical structure is shown in Figure 4-14.





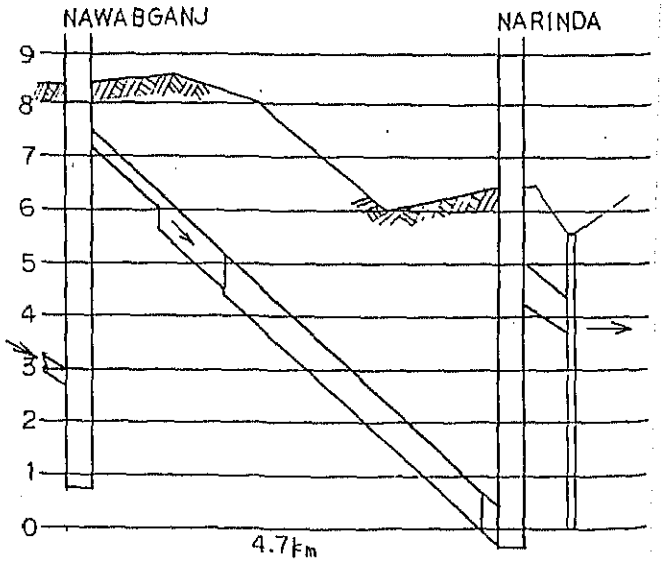
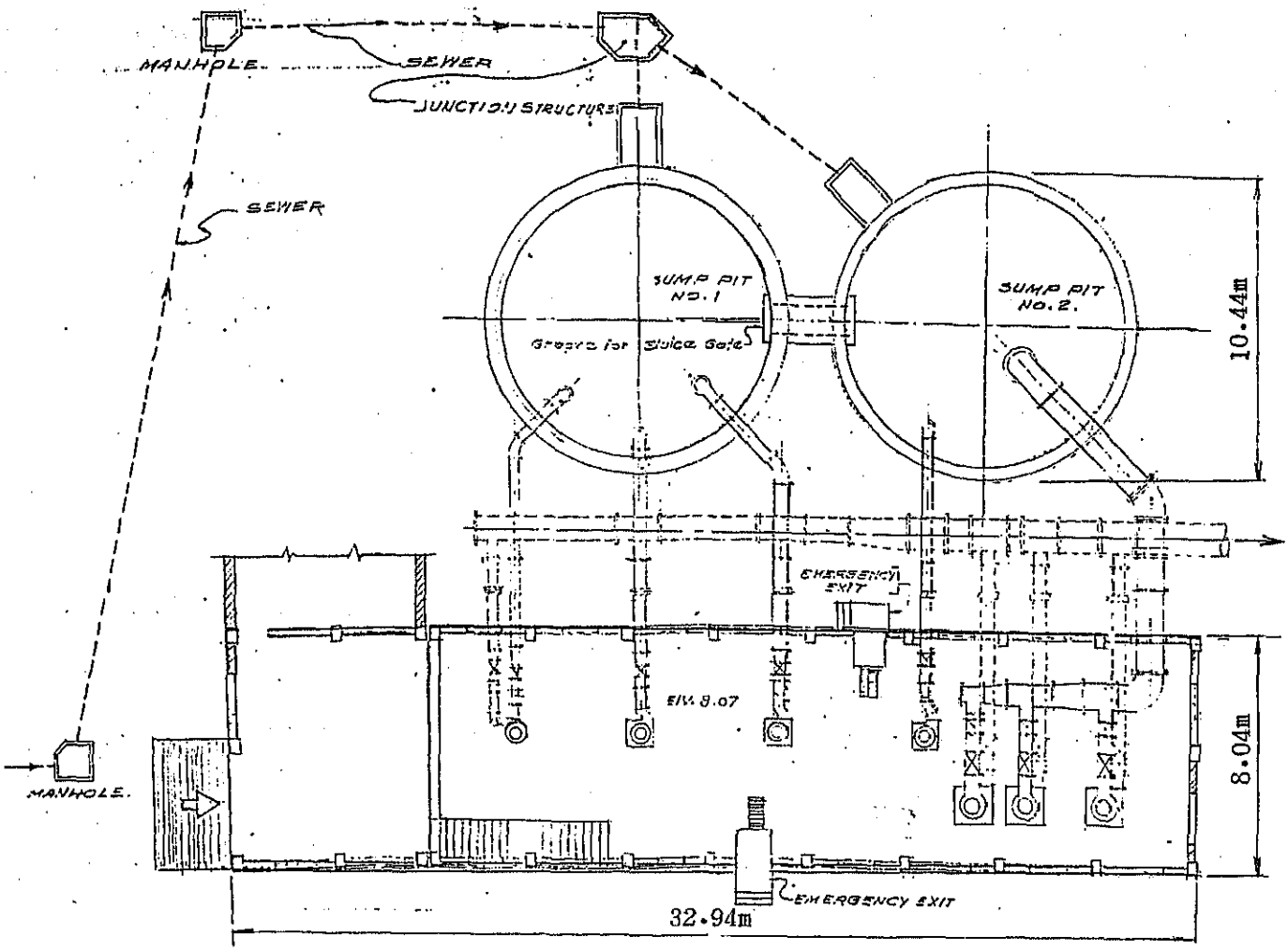
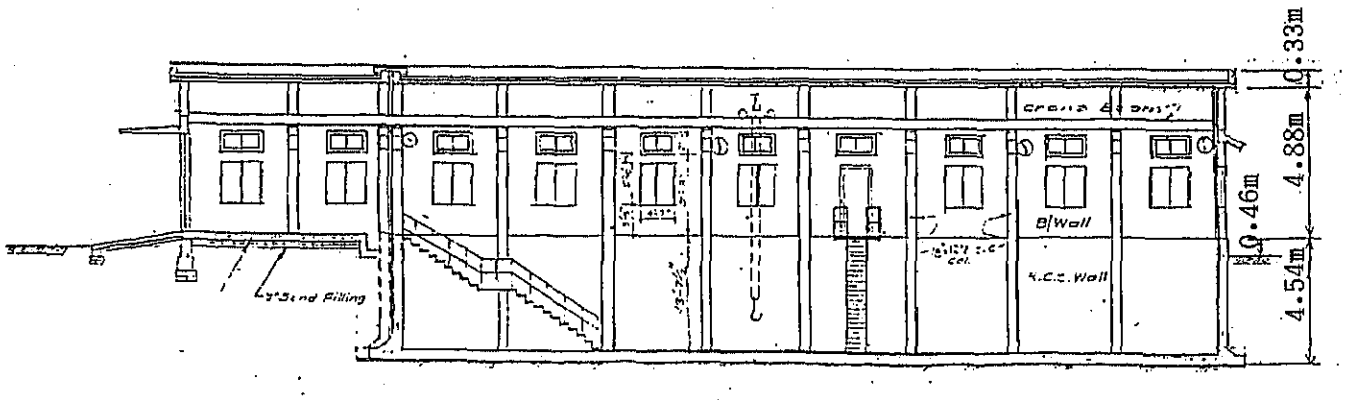


Figure 4-12 Level Relation Between Each Pump Stations

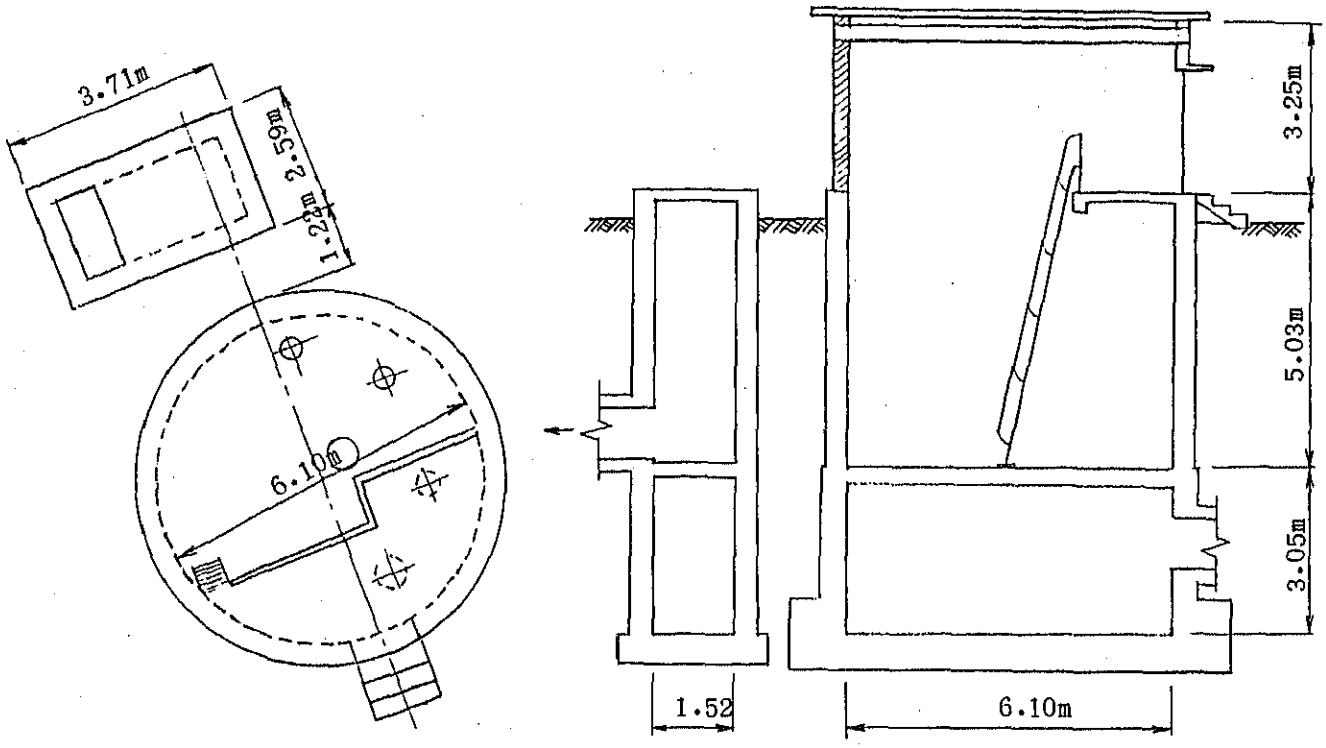


(a) LAYOUT



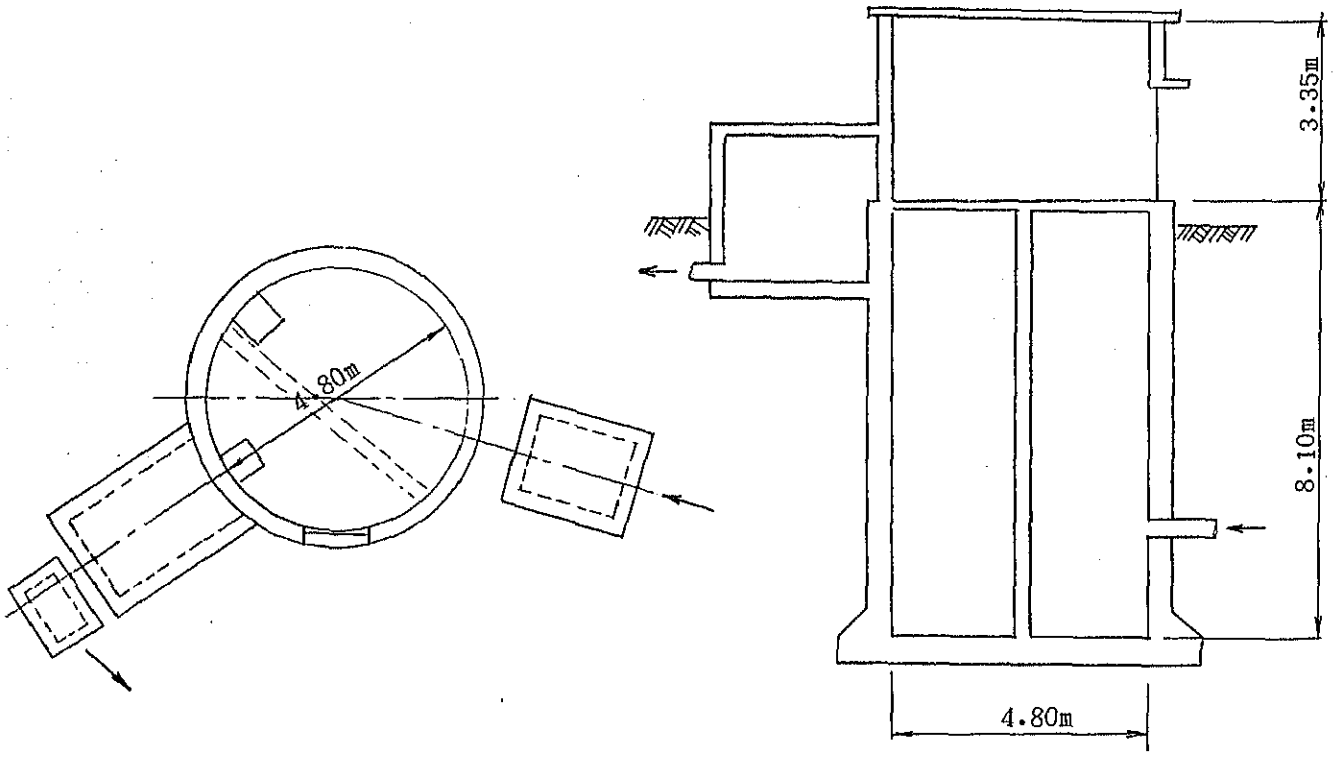
(b) SECTION

Figure 4-13 Existing New Narinda Pumping Station



floor plan section

(a) SWAMINBAG L.S.



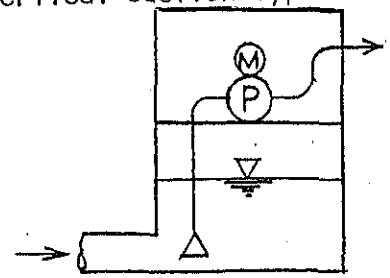
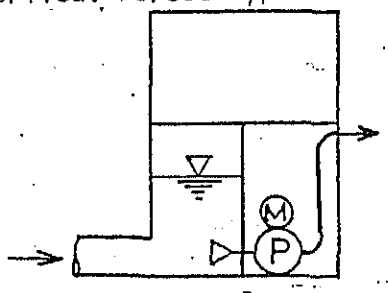
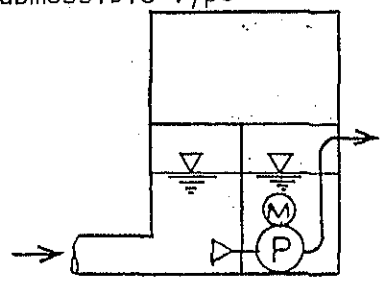
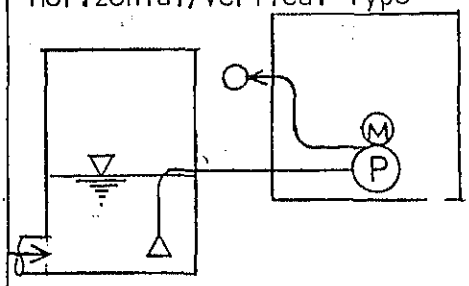
floor plan section

(b) NAWABGANJ L.S.

Figure 4-14 Tipical Types of Lift Stations

The table below shows the classification of the pump stations by the pump type.

Table 4-8 : Classification of Pump Stations by the Pump Type

	TYPE OF PUMP	LIFT STATION
A	Vertical Suction Type 	ASAD GATE L.S. TEJGAON L.S. BASHABOO L.S. SWAMINBAG L.S. HAZARIBAG L.S. NEW MARKET L.S. MEDICAL COLLEGE L.S.
B	Vertical Forced Type 	AZIMPUR L.S. P&T L.S.
C	Submessible Type 	MOGHBAZAR L.S. NAWABGANJ L.S. FARIDABAD L.S.
D	Horizontal/Vertical Type 	(H.) OLD NARINDA P.S. (V.) NEW NARINDA P.S.

Lifting capacity of pumps, including probable auxiliary units, is 127.34 m^3/min for New Narinda Pump Station, 150.08 m^3/min for Old Narinda Pump Station and in the range from 4.55 m^3/min to 13.64 m^3/min for the other small pump stations.

For Hazaribag Lifting Pump Station, pump is yet to be installed. At the time of the feasibility study conducted by the Basic Design Study Team in September, 1987, flooded water reached the top edge of the pump machine room while the route of the incoming trunk sewers was immersed in the water.

For electrical facilities, high-voltage power is supplied to the 3 stations of Tejgaon, Bashaboo and Swaminbag, and low-voltage power to the other lifting pump stations. Asadgate Station is equipped with a diesel generator of 50 KVA capacity as a countermeasure against possible power failure. All the stations have starter panel with the ratio of 1:1 to their respective pumps and are operated by manual mode. However, for Tejgaon, Bashaboo and Swaminbag stations, their starters for 15 KW (20 HP) are not sufficient for the rated capacity. It is possible to start up the system but, after running for several minutes, the safety device is activated to shut down the operation. Furthermore, some starters are equipped with instruments such as voltmeter and ammeter while others are not.

According to the 'Rules and Rates for the Supply of Electricity' dated on 1 August, 1987, published by the Bangladesh Power Development Board (PDB), all the motors installed in WASA's plant are supposed to be equipped with static condenser. This requirement implies that, with consideration of possible power drop of incoming cable during the operation of pumps, improvement is started first

from public facilities in Dhaka where electric power supply is not too stable.

As far as the pump operation control method is concerned, the pumps of every station are manually shut down when inflowing sewage starts overflowing from the vertical pipe provided at the top of sump well, resulting in an operation at high level. It is assumed that this kind of operation control may have caused scaling and sludge sedimentation in the sewers.

2) Rainwater Displacement and Dhaka WASA's Sewerage

a) Current State of Overflow Problem in Dhaka

The level of the Brhiganga River running across Dhaka City from west toward southeast occasionally exceeds 6 m (20 feet) especially at the peak of rainy season (from August to September) and exceeds 5 m (16 feet) normally for about a couple of months in a year. In rainy season, the areas in and around Dhaka City are submerged under shallow water. Most part of Dhaka WASA's trunk sewers is also immersed in water for several months. (Refer to Figure 4-15) Figure4-16 shows the fluctuation of water level measured by Millbarrak Observation Point located at the right bank of the Brhiganga River just below the junction with the Narindakar (Drykar).

Note: According to the PWD, the water level mentioned below has a difference of 0.5 m from BM used by Dhaka WASA. For comparison, therefore, 0.5 m shall be subtracted from the values shown in the figure.

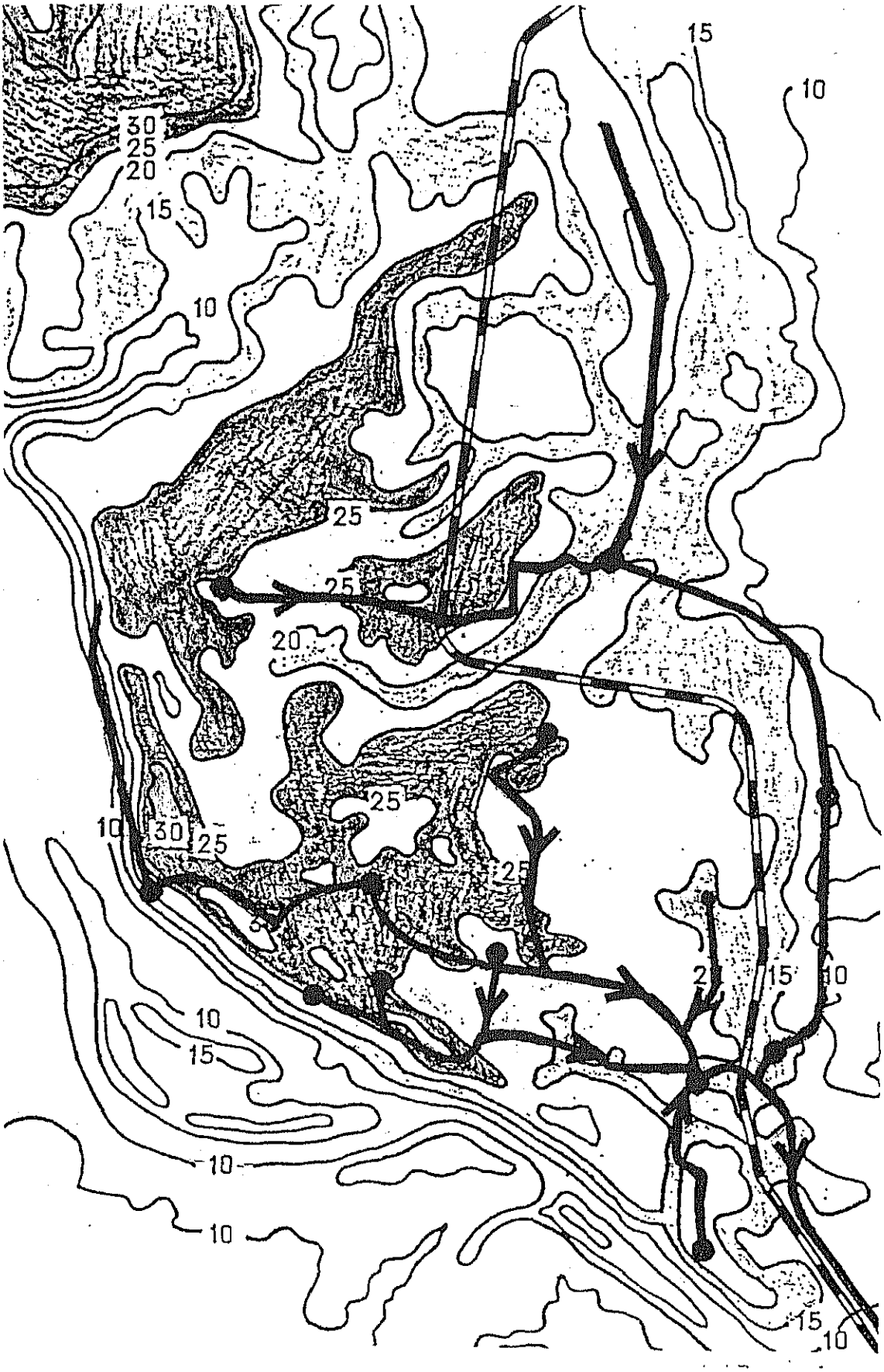


Fig. 4-15 Contour Map in Dhaka City and Trunk Sewer

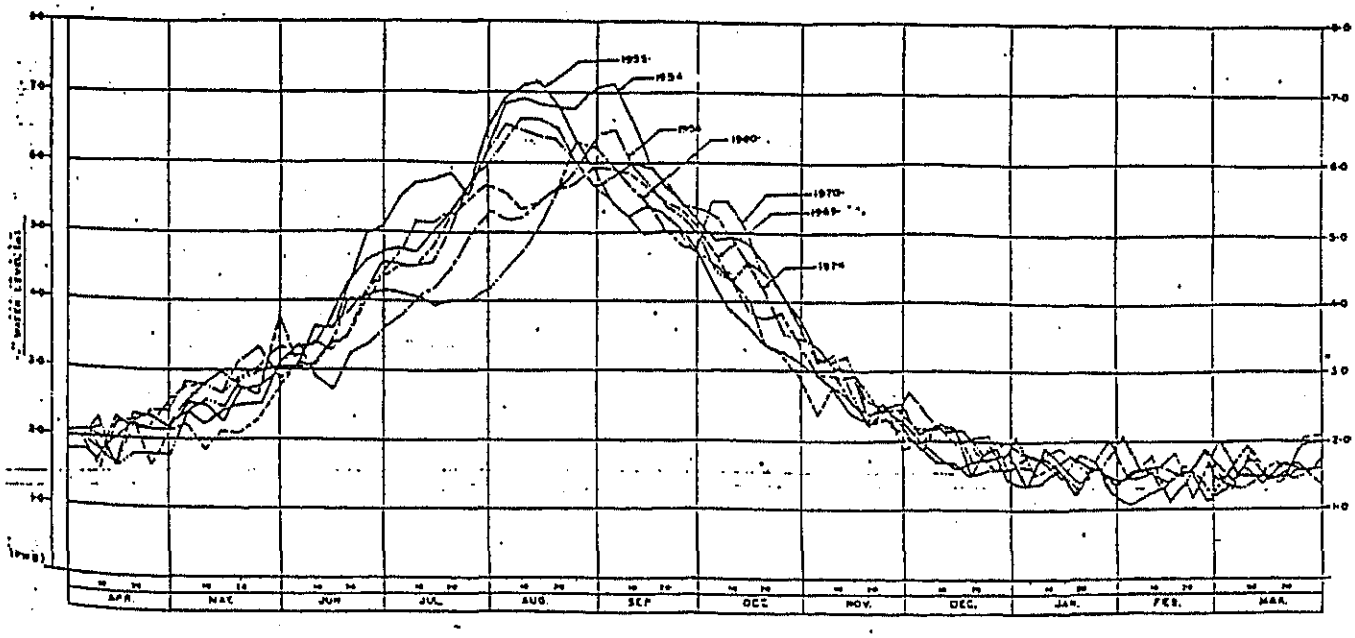


Figure 4-16 SEASONAL VARIATION OF BURHIGANGA RIVER AT MILL BARRACK STA.