CHAPTER 10 Feasibility Study of Priority Project

10.1 Present Conditions of Existing Sewerage Facilities

There is the existing sewer network in the Core Area of North Dhaka East Sewerage Zone, which is selected as the target area of feasibility study and is connected to the South Dhaka Sewerage System. This sewer network is mainly serving for Gulshan and Banani areas with the following composition.

Pipe Diameter	Total Length
600 mm	1,430 m
450 mm	5,160 m
300 mm	3,805 m
200 mm	48,055 m
Total	58,450 m

PVC pipe is applied for sewers having diameters of smaller than 600 mm and RC pipe is used for diameters of larger than 600 mm. This entire sewer network is finally connected to the Tejgaon L/S and sewage is sent to the Pagla STP via the Asad Gate Trunk Main.

However, most of the existing sewer network in the North Dhaka area is not functioning properly that collected sewage is leaked to Gulshan Lake and Banani Lake. The results of field survey on the existing sewer network is shown in Figure 10.1 with photographs.

Photo ②

Right after crossing Banani Lake, the sewer pipe is broken and almost all sewage collected in Banani area leaks into Banani Lake. The green coloured water was marked using a fluorescent tracer, which was applied at the manhole (Photo ①) upstream.

Photo ③

Scum is raised nearly to the ground surface of the manhole in the northern part of the Gulshan area, which was caused by the clogging of sewer pipes. Sewage overflows from manholes during the rainy season.

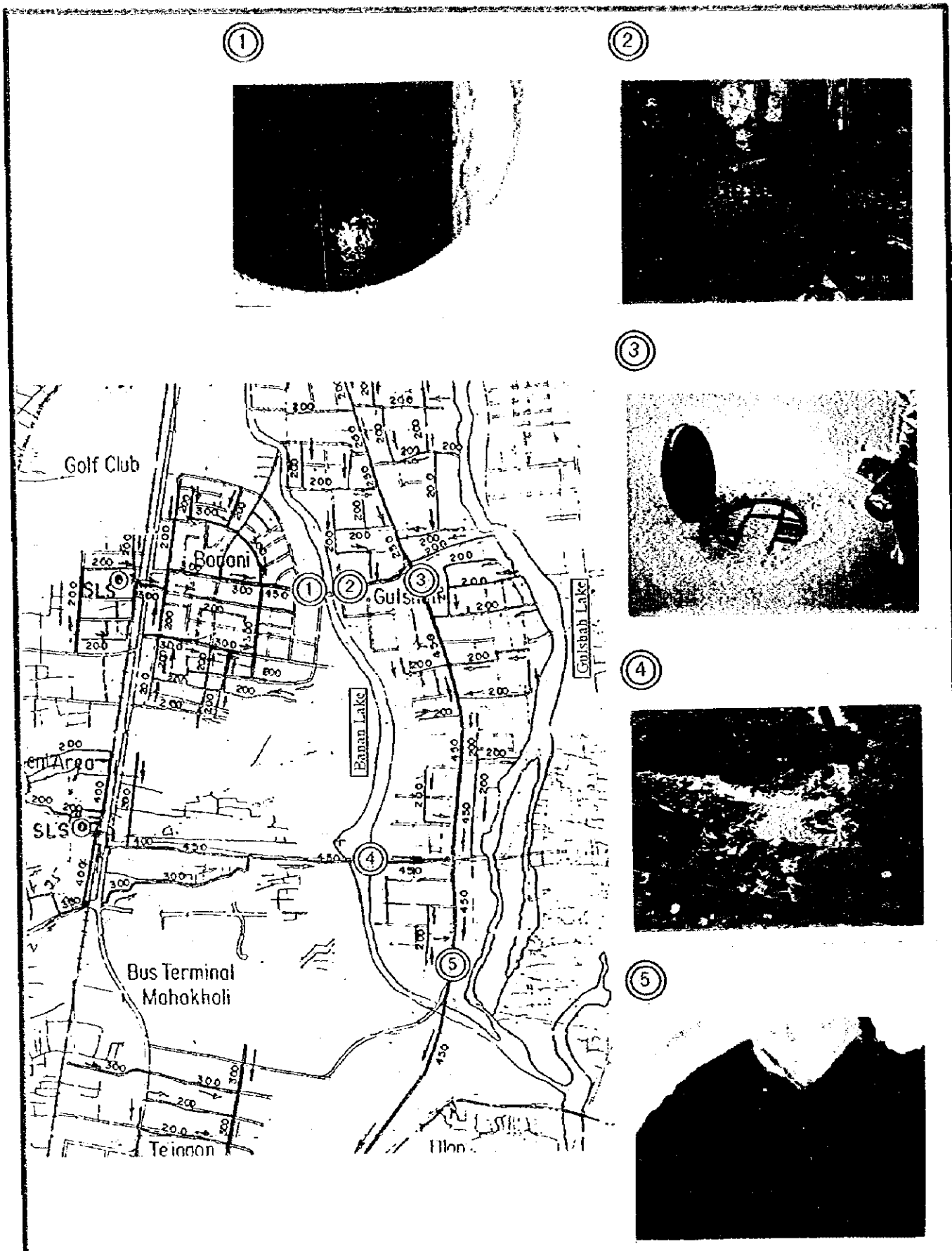


Figure 10.1
Results of Existing Sewer Investigation

The Study on the Sewerage System in North Dhaka

Photo ④

Similar to Photo ②, the sewer pipe is broken at the entrance to the Gulshan area after crossing Banani Lake from the Mohakali area and sewage is leaking into Banani Lake. The sewage is coloured by tracer.

Photo ⑤

This photo shows the flow conditions downstream of the Gulshan area. Sewage is not reaching to this point due to leakage in the network.

In addition to the above, effluent from septic tanks and grey water are discharged into Gulshan Lake through street gutters due to the absence of a sewerage system in Baridhara and other areas at the east bank of Gulshan Lake. The leakage of sewage is likewise deteriorating the aquatic environment in public water bodies, i.e. Gulshan Lake and Banani Lake, and such polluted water is finally flowing down to the Balu River. Just downstream from confluence point of the Balu River and the Lakhya River is the surface water intake facility for the Saidabad Water Treatment Plant, which is under construction. In this respect, a water pollution problem concerning this drinking water source will surface in very near future, unless a sewerage system is implemented in the North Dhaka East Sewerage Zone.

10.2 Facility Planning

10.2.1 Design Fundamentals

(1) Target area and year

The target area of the feasibility study is shown in Figure 10.2. The Core Area of the North Dhaka East Sewerage Zone with an area of 1,958 ha is selected as the target area, of which 868 ha is the built-up area. The remaining 1,090 ha belongs to the residential area of the Cantonment Security Zone. Land use in the Uttara and Gulshan areas in the North Dhaka East Sewerage Service Zone is shown in Table 10.1.

Target year of feasibility study is set forth in 2005.

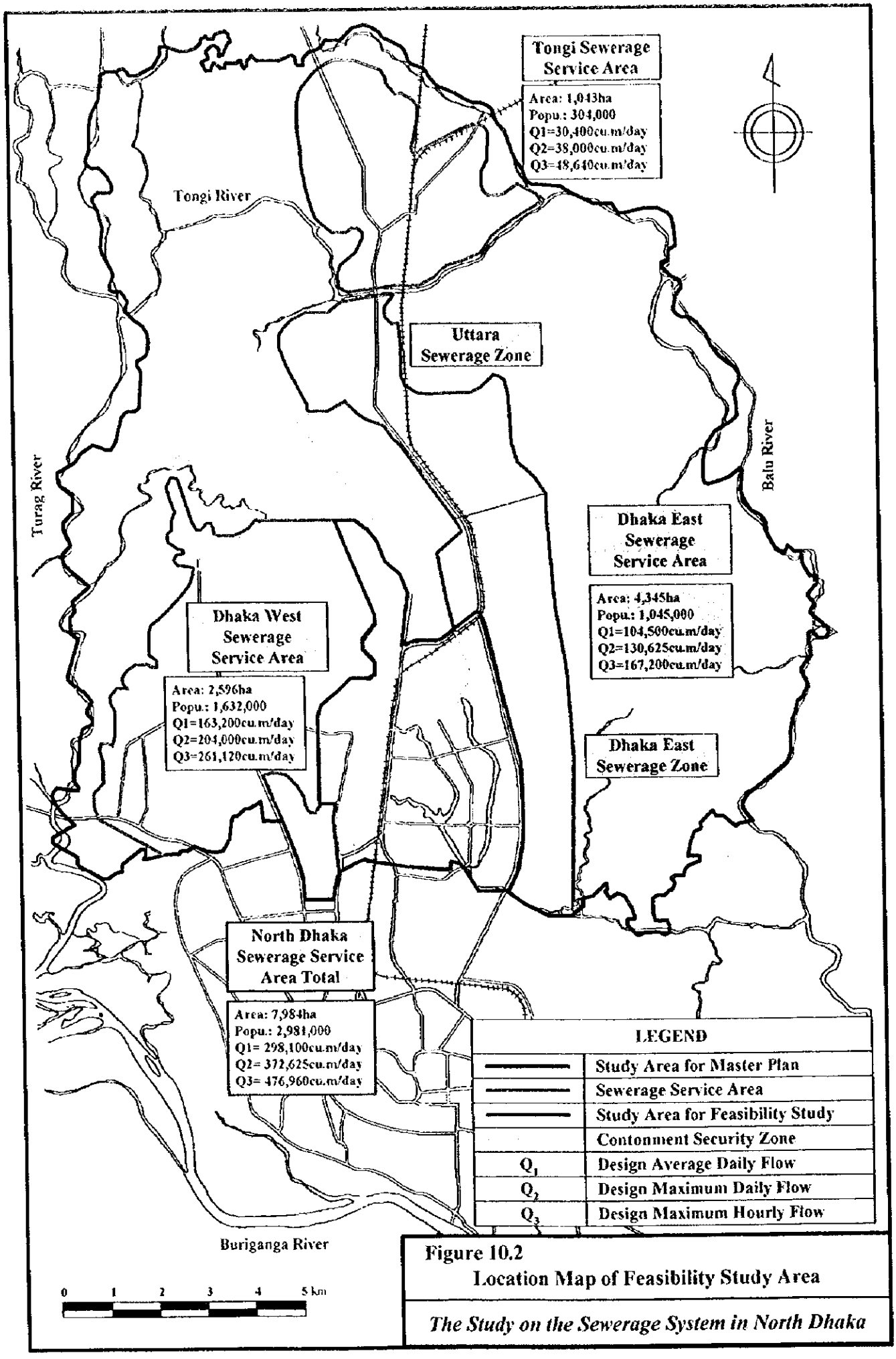


Figure 10.2
Location Map of Feasibility Study Area

The Study on the Sewerage System in North Dhaka

Table 10.1 Land Use in North Dhaka East Sewerage Zone

Unit: ha

Sewerage Zone	Core Area			Transitional Area	Total
	Urban Area	Cantonment	Sub-Total		
Uttara	504	0	504	512	1,016
North Dhaka East	868	1,090	1,958	1,371	3,329
Total	1,372	1,090	2,462	1,883	4,345

(2) Design population

Design population is shown in Table 10.2.

Table 10.2 Design Population of Feasibility Study

Target Year	Sewerage Zone	Item	Core Area			Transitional Area	Total
			Urban Area	Cantonment	Sub-Total		
M/P 2020	Uttara	Area	504	0	504	512	1,016
		Population	86,000	0	86,000	75,000	161,000
	North Dhaka East	Area	868	1,090	1,958	1,371	3,329
		Population	487,000	83,000	570,000	314,000	884,000
	Total	Area	1,372	1,090	2,462	1,883	4,345
		Population	573,000	83,000	656,000	389,000	1,045,000
F/S 2005	Uttara	Area	504	0	504	512	1,016
		Population	80,000	0	80,000	65,000	145,000
	North Dhaka East	Area	868	1,090	1,958	1,371	3,329
		Population	386,000	70,000	456,000	236,000	692,000
	Total	Area	1,372	1,090	2,462	1,883	4,345
		Population	466,000	70,000	536,000	301,000	837,000

(3) Design sewage flow

Based on the per capita design sewage flow as shown in Table 10.3, design sewage flow was estimated as shown in Table 10.4 and Figure 10.3.

Table 10.3 Per Capita Design Sewage Flow

Unit: lpcd

Item	2000	F/S 2005	2010	2015	M/P 2020
Design Average Daily Flow	85	95	100	100	100
Design Maximum Daily Flow	105	115	125	125	125
Design Maximum Hourly Flow	135	145	160	160	160

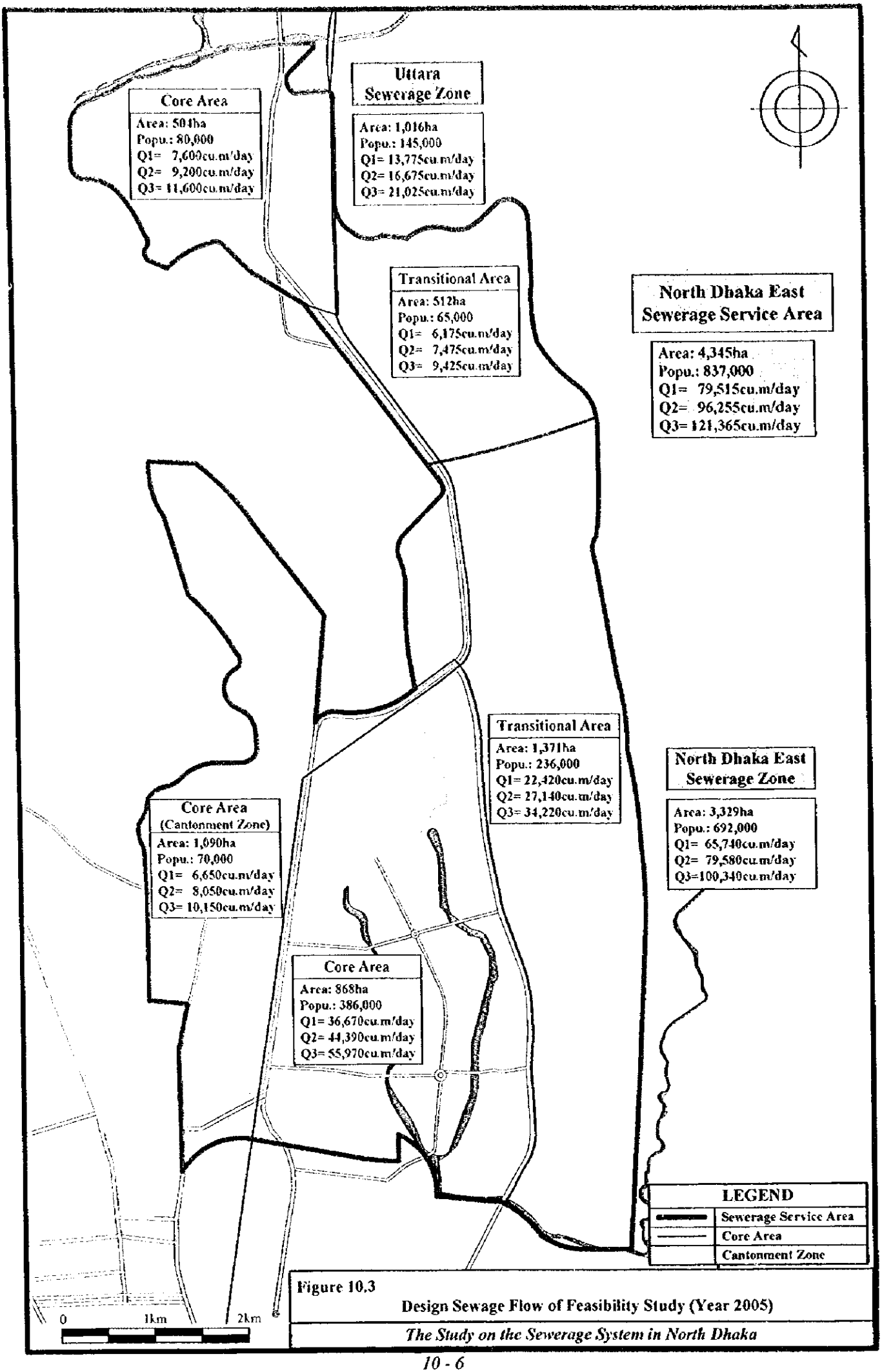


Figure 10.3

Design Sewage Flow of Feasibility Study (Year 2005)

The Study on the Sewerage System in North Dhaka

Table 10.4 Design Sewage Flow of Feasibility Study

Phase	Target Year	Sewerage Zone	Item	Unit	Core Area	Cantonment	Sub-Total	Transitional Area	Total
M/P	2020	Uttara	Area	ha	504	0	504	512	1,016
			Population	person	86,000	0	86,000	75,000	161,000
			Q1	cu.m/day	8,600	0	8,600	7,500	16,100
			Q2	cu.m/day	10,750	0	10,750	9,375	20,125
			Q3	cu.m/day	13,760	0	13,760	12,000	25,760
		North Dhaka East	Area	ha	868	1,090	1,958	1,371	3,329
			Population	person	487,000	83,000	570,000	314,000	884,000
			Q1	cu.m/day	48,700	8,300	57,000	31,400	88,400
			Q2	cu.m/day	60,875	10,375	71,250	39,250	110,500
			Q3	cu.m/day	77,920	13,280	91,200	50,240	141,440
		Total	Area	ha	1,372	1,090	2,462	1,883	4,345
			Population	person	573,000	83,000	656,000	389,000	1,045,000
			Q1	cu.m/day	57,300	8,300	65,600	38,900	104,500
			Q2	cu.m/day	71,625	10,375	82,000	48,625	130,625
			Q3	cu.m/day	91,680	13,280	104,960	62,240	167,200
F/S	2005	Uttara	Area	ha	504	0	504	512	1,016
			Population	person	80,000	0	80,000	65,000	145,000
			Q1	cu.m/day	7,600	0	7,600	6,175	13,775
			Q2	cu.m/day	9,200	0	9,200	7,475	16,675
			Q3	cu.m/day	11,600	0	11,600	9,425	21,025
		North Dhaka East	Area	ha	868	1,090	1,958	1,371	3,329
			Population	person	386,000	70,000	456,000	236,000	692,000
			Q1	cu.m/day	36,670	6,650	43,320	22,420	65,740
			Q2	cu.m/day	44,390	8,050	52,440	27,140	79,580
			Q3	cu.m/day	55,970	10,150	66,120	34,220	100,340
		Total	Area	ha	1,372	1,090	2,462	1,883	4,345
			Population	person	466,000	70,000	536,000	301,000	837,000
			Q1	cu.m/day	44,270	6,650	50,920	28,595	79,515
			Q2	cu.m/day	53,590	8,050	61,640	34,615	96,255
			Q3	cu.m/day	67,570	10,150	77,720	43,645	121,365

Note: Q1-Average Daily Sewage Flow, Q2-Maximum Daily Sewage Flow
Q3-Maximum Hourly Sewage Flow

(4) Design conditions

Prior to proceeding with sewerage facility planning, the following conditions were predetermined as planning fundamentals in the feasibility study:

1) Feasibility Study shall be limited within the Study Area of Master Plan as determined in the Scope of Work for the Study. Relevant matters with the South Dhaka Sewerage System, such as the effective utilisation of the existing sewerage system, shall be therefore taken up in "Chapter 14 Emergency Project for North Dhaka East."

2) The feasibility study area, the Core Area of the North Dhaka East Sewerage Zone, includes the Cantonment Security Zone (1,090 ha). Owing to the nature of this restricted military establishment, it is assumed that the sewerage facility plan and its implementation be undertaken by the military authority and be excluded from the public invest-

ments. Acceptance of domestic sewage from residential area in the Cantonment Security Zone is, however, considered at two (2) connection points of main sewers in the course of feasibility study.

3) The Core Area of the North Dhaka Sewerage Zone has the existing sewer network (654 ha). A facility plan of this particular area shall be prepared on the basis to provide supplementary pipes to augment existing main sewers to cope with the planned sewage flow in the year 2020 (Master Plan target year).

4) The facility plan in the feasibility study will be carried out in due consideration of the overall plan presented in the Master Plan:
   - to accommodate the design sewage flow of the Master Plan for sewer lines
   - to meet with the design sewage flow of the feasibility study for pump stations and sewage treatment plant.

5) Secondary main sewers in the feasibility study shall be defined to be sanitary sewers under gravity flow having diameters of 300 mm or larger and indicated their layout in the facility plan.

6) Pump stations will also be planned at such locations to be connected with main sewers (diameter of 300 mm or larger).

10.2.2 Design Criteria

(1) Sewer pipe

Same as the master plan.

(2) Pump station

Same as the master plan.

(3) Sewage treatment plant

1) Treatment method

The optimum sewage treatment method was identified to be the stabilisation pond method during the course of Master Plan preparation. A commonly applied sequence of this treatment method is illustrated below.

Anaerobic Pond → Facultative Pond → Maturation Pond

In application of the stabilisation pond method to the feasibility study, the common sequence of treatment process was modified upon evaluation of the actual performance at the Pagla Sewage Treatment Plant as follows:

- The anaerobic pond for sedimentation and anaerobic treatment was replaced with the primary sedimentation tank
- The use of the maturation pond for disinfection was taken over by the application of chlorine disinfection tank

The following treatment process was then introduced for the North Dhaka East Sewage Treatment Plant:

Primary Sedimentation Tank → Facultative Pond → Chlorine Disinfection Chamber

2) Design criteria

The design criteria of the sewage treatment plant is shown in Table 10.5, while the flow sheet is shown in Figure 10.4.

Table 10.5 Design Criteria for Sewerage Treatment Plant

Items	Unit	Value	Remark
1) Primary Sedimentation Tank			
Overflow Rate	cu.m/sq.m/day	35.0	for Daily Max.
Effective Water Depth	M	3.0	Ditto
Weir Load	cu.m/m/day	250	Ditto
BOD Removal Rate	%	40.0	Ditto
SS Removal Rate	%	60.0	Ditto
2) Facultative Pond			
BOD Arear Load	kg/ha/day	60.3×1.0993^{T}	for Daily Average
Safety Factor	--	1.5	--
Water Depth	M	1.5 - 2.0	--
BOD Removal Rate	%	33.3	Ditto
SS Removal Rate	%	37.5	Ditto
3) Disinfection Tank			
Retention Time	Min	15	for Daily Average
Depth	M	2.0	--
4) Sludge Lagoon			
SS Arear Load	kg/sq.m/year	35	for Daily Average
Retention Day	day	90	Ditto

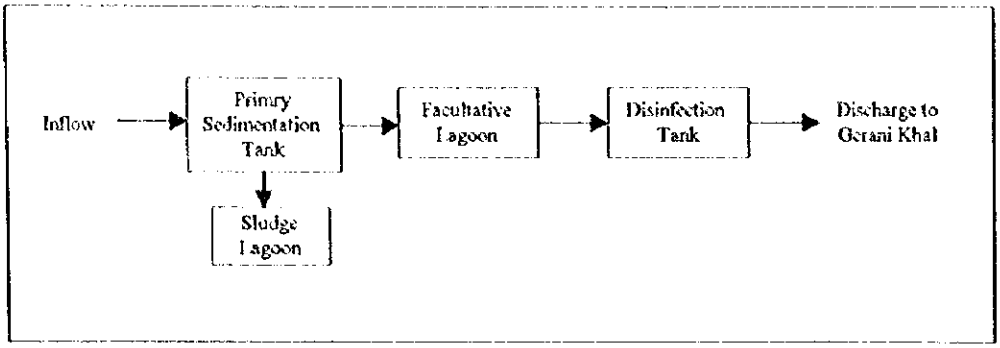


Figure 10.4 Flow Sheet of Stabilisation Pond Treatment Method

10.2.3 Selection of Receiving Water Body for Effluent

(1) Alternatives receiving water bodies

Three rivers were identified as potential receiving water bodies for the effluent as shown in Figure 10.5. The present conditions of these water bodies and construction cost for effluent disposal facility are shown in Tables 10.6 and 10.7, respectively.

Table 10.6 Situation of Receiving Water Body by Alternatives

Alternative No.	Alternative 1	Alternative 2	Alternative 3
Name of Receiving Water Body	Naral River	Zerani Khal	Buriganga River
Type of Receiving Water Body	River	Drainage Canal	River
Administrative Agency	MWR[1)]	DCC[2)]	MWR
Flow Route	Naral River → Balu River → Lakhya River (→ Buriganga River)	Zerani Khal → Dholai Khal → Buriganga River	→ Buriganga River
Water Quality[3)]	Balu River: BOD - 26 mg/l SS - 150 mg/l COD - 100 mg/l Lakhya River: BOD - 26 mg/l SS - 170 mg/l COD - 33 mg/l	Buriganga River: BOD - 18 mg/l SS - 60 mg/l COD - 54 mg/l	Buriganga River: BOD - 18 mg/l SS - 60 mg/l COD - 54 mg/l
Water Use of Receiving Water Body	None	None	None
Water Use in Downstream	Lakhya River: Water Supply Source (Saidabad WTP)	Buriganga River: Water Supply Source (Friendship Bridge WTP)	None

Note: 1) MWR: Ministry of Water Resources (Bangladesh Water Development Board)
2) DCC: Dhaka City Corporation
Source: JICA Study Team for the Sewerage System in North Dhaka

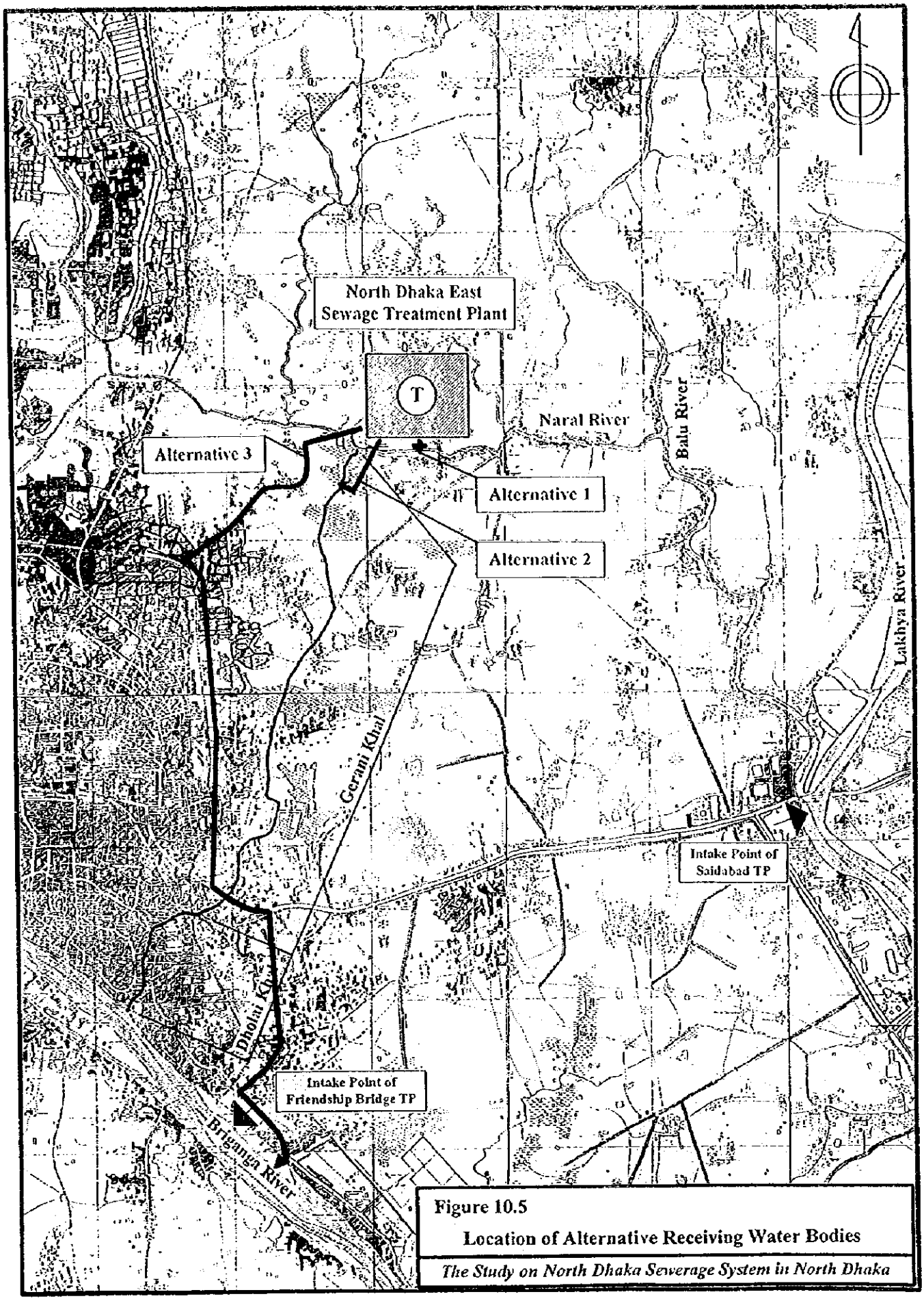


Figure 10.5

Location of Alternative Receiving Water Bodies

The Study on North Dhaka Sewerage System in North Dhaka

Table 10.7 Construction Cost of Additional Facility for Sewage Effluent by Alternatives

Alternative No.	Alternative 1	Alternative 2	Alternative 3
Conveyance System	By Gravity	By Gravity	By Pumping
Required Facility to Discharge Treated Effluent	None	Inverted Siphon to cross Naral River L=20m	Discharge Pump Discharge Pipe (Pressure Pipe) 1,100mm×2 lines L=10km
Construction Cost	0 Tk	8,445,000 Tk	1,158,506,000Tk

(2) Selection of Optimum Receiving Water Body

Although Alternative 1 (Nara River) is the most economical option in terms of construction cost, it has the potential risk of polluting a drinking water source (the surface water intake facility for the Saidabad Water Treatment Plant, which is under construction downstream of the Balu River) to which the Nara River is connected. In this respect, Alternative 2 (Zerani Khal) was selected as the optimum receiving water body. At the confluence point of the Zerani Khal with the Buriganga River, a stormwater pump station is discharging stormwater for flood control. It is deemed that disposal of effluent from the proposed sewage treatment plant into the Zerani Khal does not pose any interference to this pump station since the design sewage flow is only about 5% of the planned stormwater flow of the Zerani Khal.

10.2.4 Preliminary Design of Sewerage System

The composition of design sewage flow in the target year 2005 is shown in Figure 10.6.

(1) Evaluation of existing sewer network

The existing sewer network covers a total 719 ha in the Gulshan and Banani areas and the residential area (65 ha) of Cantonment Security Zone.

The hydraulic simulation result of this sewer network, as shown in Table 10.8, revealed that about 70% of the total length of sewer network would encounter shortage of flow capacity in the master plan target year of 2020.

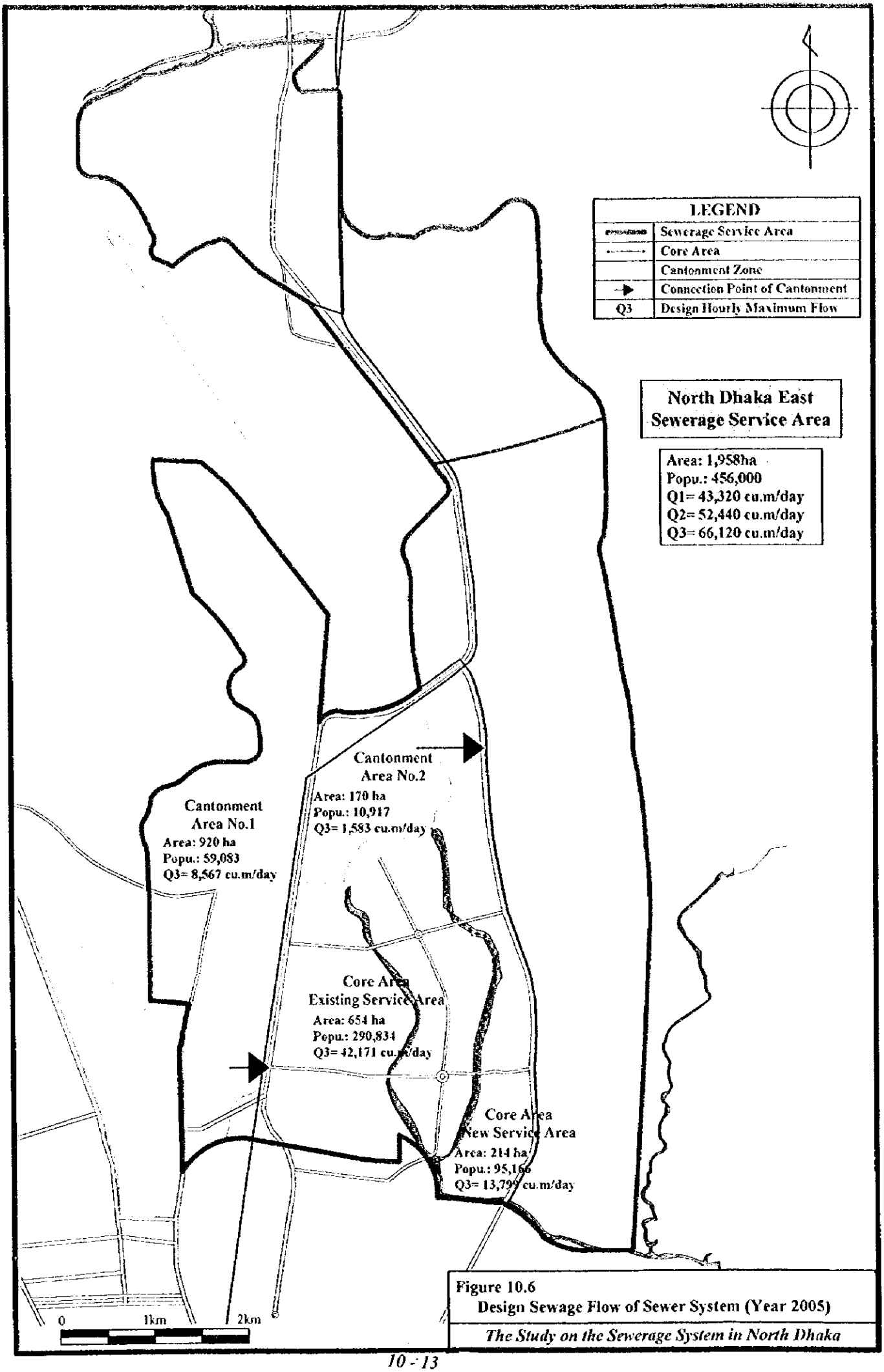


Figure 10.6
Design Sewage Flow of Sewer System (Year 2005)

The Study on the Sewerage System in North Dhaka

Table 10.8 Hydraulic Capacity of Existing Main Sewers to Accept Planned Sewage Flow

Unit: m

Diameter (mm)	Hydraulic Capacity of Existing Main Sewers		
	Acceptable	Insufficient	Total
300	2,580	1,225	3,805
450	620	4,540	5,160
600	0	1,430	1,430
Total	3,200	7,195	10,395

(2) Design of sewage collection system

The sewer system plan in the feasibility study area was carried out based on the design maximum hourly flow of the Master Plan target year. In principle, the sewer system plan for the new sewerage service area was prepared as follows:

- The main sewers shall be designed to be a gravity flow system.
- The maximum depth of earth cover shall be limited to about 8.0 m in consideration of construction difficulty and cost.
- When the main sewer reaches the said maximum depth, a lift station shall be provided.
- Pump stations shall be provided to utilise a pressurised sewer in cases where the local conditions require the opposite direction of sewage flow against the flow direction of the main sewers, and where the section of trunk main from the service area up to the sewage treatment plant will not receive any sewage inflow from the branch sewers.

In the existing sewerage service area, supplementary pipes shall be provided to meet with the required hydraulic capacity in view of the maximum utilisation of the existing sewer network, based on the aforementioned hydraulic evaluation results. In addition, discharged sewage within the existing sewerage service area shall be collected and carried by the existing sewers with supplementary pipes up to the utmost downstream point and pumped to the new trunk main in the new sewerage service area.

Sewage collection system is shown in Table 10.9 and Figure 10.7, respectively.

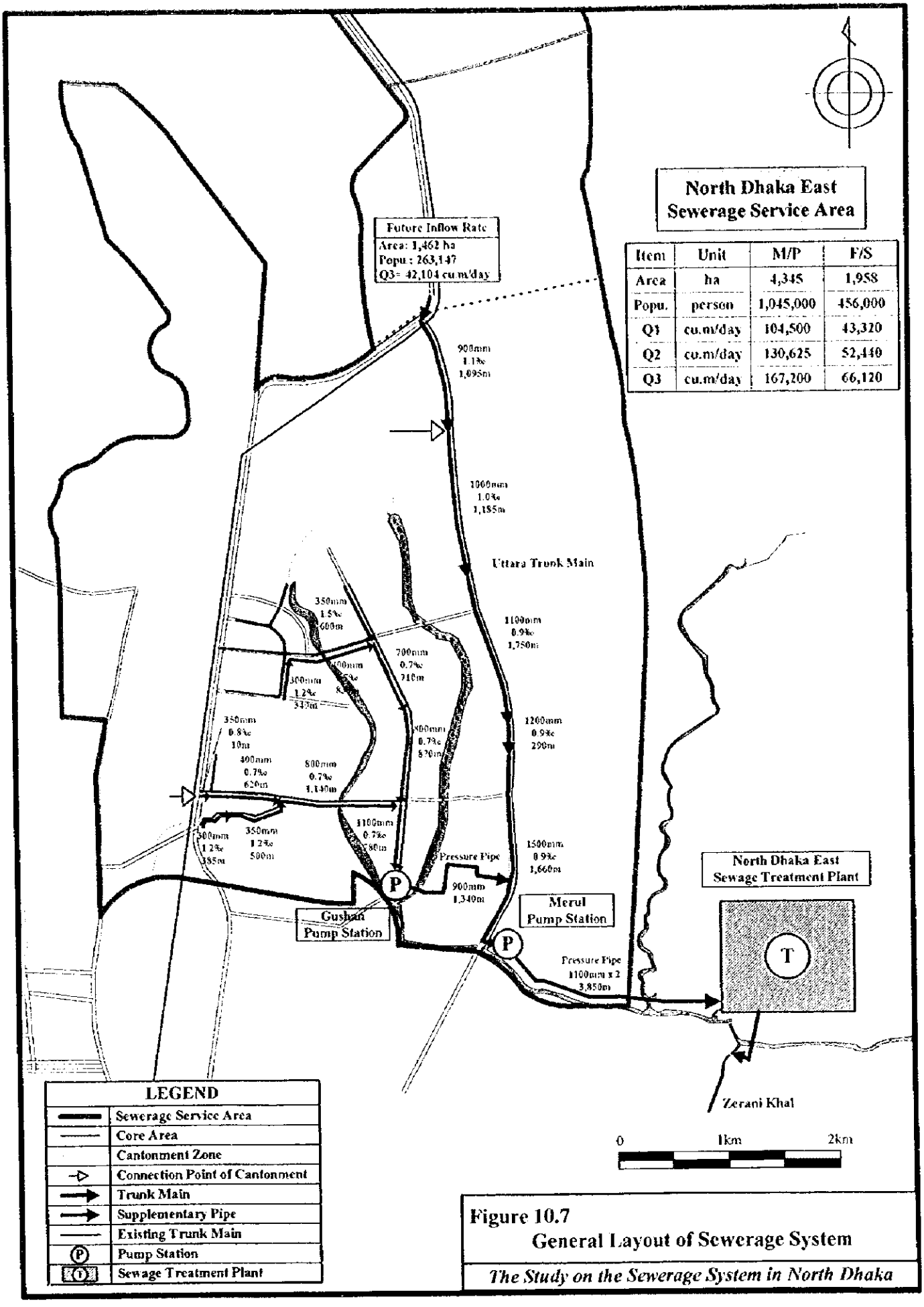


Figure 10.7
General Layout of Sewerage System

The Study on the Sewerage System in North Dhaka

Table 10.9 Configuration of Sewer System

Area	Type of Flow	Material	Diameter (mm)	Length (m)
New Service Area	Gravity Flow	PVC	200	34,500
			250	445
		RC	900	1,095
			1,000	1,185
			1,100	1,750
			1,200	290
			1,500	1,660
		Sub-Total		40,925
	Pressurised Flow	Steel Pipe	1,100	4,400
	Total			45,325
Existing Service Area	Gravity Flow	PVC	300	725
			350	1,110
			400	1,455
		RC	700	710
			800	2,010
			1,100	800
		Sub-Total		6,810
	Pressurised Flow	Steel Pipe	900	1,340
	Total			8,150
Grand Total				53,475

(3) Pump station

The Merul Pump Station and Gulshan Pump Station were planned in this feasibility study as shown in Table 10.10.

Table 10.10 Design Sewage Flow of Pump Stations

Unit: cu.m/day

Name of Pump Station	Sewage Flow	M/P	F/S
Merul Pump Station	Q_1	104,500	43,320
	Q_2	130,625	52,440
	Q_3	167,200	66,120
Gulshan Pump Station	Q_1	43,699	33,242
	Q_2	54,624	40,240
	Q_3	69,918	50,738

Note: 1) Q_1: Design Average Daily Flow
2) Q_2: Design Maximum Daily Flow
3) Q_3: Design Maximum Hourly Flow

In the feasibility study period, the Merul Pump Station and the Gulshan Pump Station will have about 40% and 73% of the design maximum hourly sewage flow of the Master Plan, respectively.

In this regard, civil and architectural facilities of the Merul Pump Station are designed to be a half of the whole capacity, while the Gulshan Pump Station is designed to have the whole scale of the Master Plan. Thus, the remaining half of the required facilities of the Merul Pump Station will be implemented after completion of the priority project.

Similarly, the number of pipelines of the trunk main is also determined taking into account the balance of sewage flow in the priority project and the master plan and the trunk main is designed to be constructed using a staged implementation.

Considering the above-mentioned capacity scale of the pump station and the ease of O&M by provision of symmetrical design, these pump stations are designed to have the same flow chart as shown in Figure 10.8. Outline of pump stations is shown in Table 10.11.

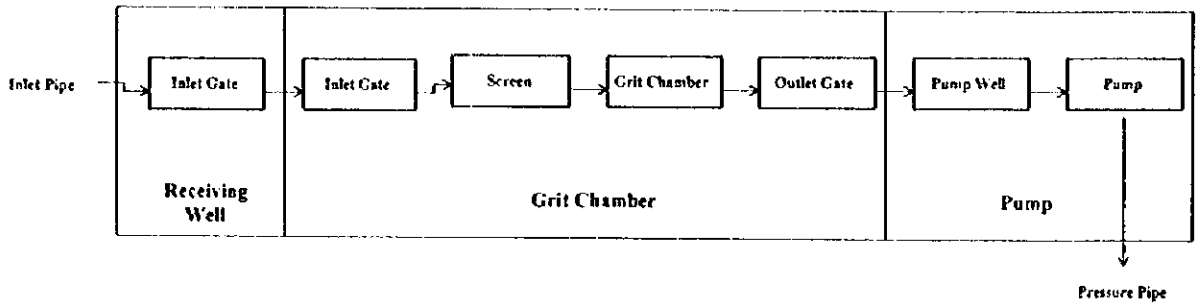


Figure 10.8 Flow Chart of Pump Station

Table 10.11 Outline of Major Facility of Pump Stations

Name of Pump Station	Facility & Equipment	Dimension/Specification	No. of Facility/Equipment	
			M/P	F/S
Gulshan	Inlet Pipe	Diameter: RC 1,100mm Gradient: 0.9‰ Inlet Level: +0.104	1	1
	Grit Chamber	Parallel Flow Type W 1.0m×L 10.0m×D 0.7m	4	3
	Pump	Mixed Flow Pump, Vertical Shaft, Centrifugal Type 350mm×12.5cu.m/min×13.5m×45kw	5 (1)*1	4 (1)*1
	Pressure Pipe	SP 900mm, L=1,340m	1	1
	Land Acquisition	43.7m×23.5m	1,027ha	1,027ha
Merul	Inlet Pipe	Diameter: RC 1,500mm Gradient: 0.9‰ Inlet Level: -1.966	1	1
	Grit Chamber	Parallel Flow Type W 1.7m×L 14.0m×D 1.0m	4	2
	Pump	Mixed Flow Pump, Vertical Shaft, Centrifugal Type 450mm×20.0cu.m/min×22.0m×110kw	7 (1)*	4 (1)*
	Pressure Pipe	SP 1,100mm×2 set, L=3,850m	2	1
	Land Acquisition	M/P: 47.8m×30.5m, F/S: 47.8m×21.5m	1,458ha	1,028ha

Note: *: (1) shows number of standby pump.

(4) Sewage treatment plant

1) Facility design

The design sewage flow is shown in Table 10.12, while the sewage treatment flow is shown in Figure 10.9.

Table 10.12 Design Sewage Flow of North Dhaka East Sewage Treatment Plant

Unit: cu.m/day

Design Sewage Flow		M/P	F/S
North Dhaka East Sewerage Treatment Plant	Daily Average	104,500	43,320
	Daily Maximum	130,625	52,440
	Hourly Maximum	167,200	66,120

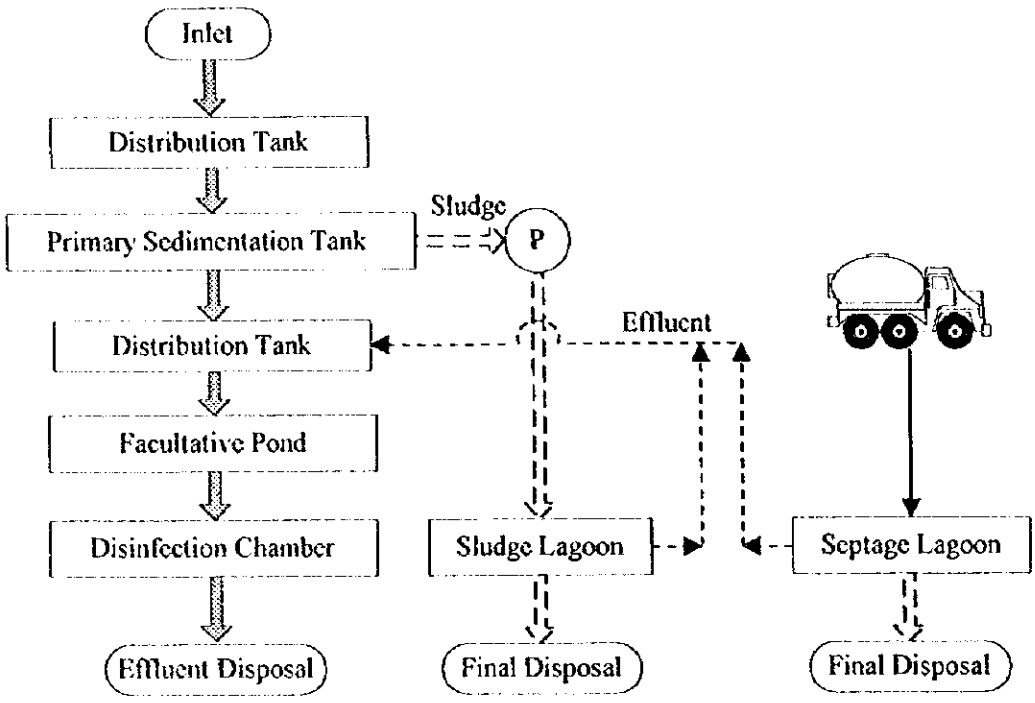


Figure 10.9 Flow Diagram of North Dhaka East Sewage Treatment Plant

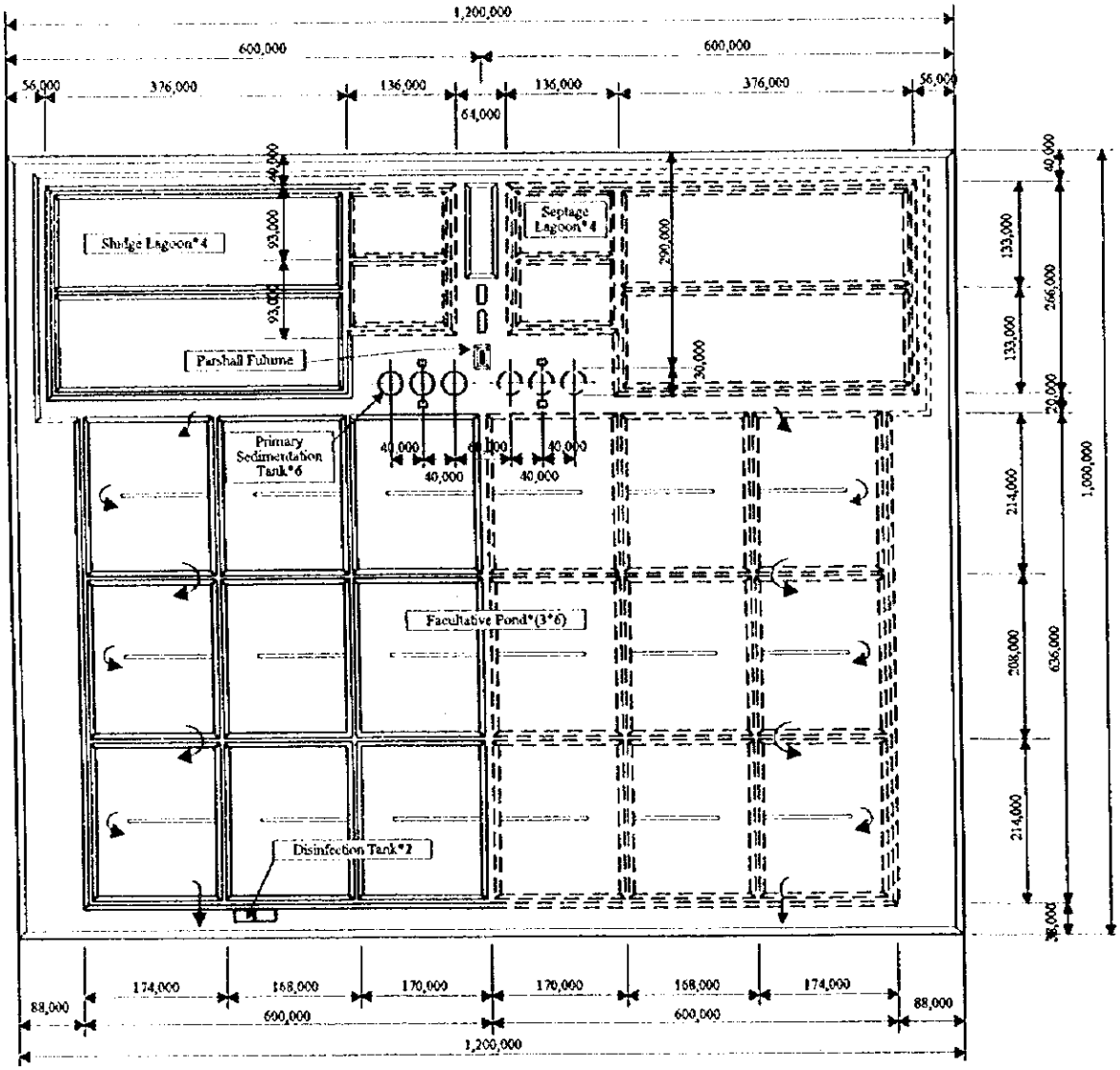
The design conditions of the North Dhaka East Sewage Treatment Plant is shown in Table 10.13 and the composition of sewage treatment facilities is shown in Table 10.14. The general layout of the sewage treatment plant is shown in Figure 10.10, while the hydraulic profile is shown in Figure 10.11.

Table 10.13 Design Conditions of Sewage Treatment Plant

Item	Design Conditions
Elevation	+0.47 m
Inlet Pipe Level	+10.800 m
Inlet Pipe Diameter	1,100 mm×2 unit
Land Use	Low-lying Swamp Area
Sewage Collection System	Separate System
Treatment Method	Sewage Treatment: Stabilisation Pond
	Sludge Treatment: Sludge Lagoon
Discharge Point	Zerani Khal
Water Level at Discharge Point	+6.5 m
Lowest Monthly Temperature	18°C

Table 10.14 Configuration of North Dhaka East Sewage Treatment Plant

Name of Facility	Quantity		Description
	F/S	M/P	
Parshall Flume	1 unit	1 unit	International Standard No.10 Structure: Reinforced Concrete Size: 2.28 m^W×3.47 m^L×0.68 m^H
Distribution Tank	1 unit	2 units	Structure: Reinforced Concrete Size: 2.5 m^W×4.0 m^L×2.5 m^H
Distribution Tank for Primary Sedimentation Tank	1 unit	2 units	Structure: Reinforced Concrete Size: 3.75 m^W×5.0 m^L×3.8 m^H
Primary Sedimentation Tank	3 units	6 units	Type: Circular, Structure: Reinforced Concrete Size: 28.0 mϕ×3.0 m^H, 615 sq.m Sludge Pump:150 mm×1.1 cu.m, 20 m/min×20 m^H×11 kW (F/S: 4 units, M/P: 8 units)
Distribution Tank for Facultative Pond	1 unit	2 units	Structure: Reinforced Concrete Size: 3.75 m^W×5.0 m^L×2.7 m^H
Facultative Pond	3 units	6 units	Type: Embanked Rectangular Pond Size: 160 m^W×200 m^L×1.5 m^H
Sludge Lagoon	2 units	4 units	Type: Embanked Rectangular Pond Size: 120 m^W×360 m^L×1.0 m^H
Septage Lagoon	-	2 units	Type: Embanked Rectangular Pond Size: 80 m^W×120 m^L×1.0 m^H
Effluent Discharge Pipe	1 unit	2 units	R.C Pipe 1,100 mmϕ
In-plant Pipe(Sewer)	1set	1set	R.C Pipe 700~1,100 mmϕ
In-Plant Pipe(Sludge)	1set	1set	R.C Pipe 400 mmϕ, Steel Pipe150 mm$^{\phi}$
Admin. & Electric. Bldg.	1 unit	1 unit	Structure: R.C & Brick, 1Floor Size: 8.0 m^W×28.0 m^L, 224 sq.m
Garage	1 unit	1 unit	Structure: R.C & Brick, 1Floor Size: 24.0 m^W×100 m^L, 240 sq.m
Disinfection Bldg.	1 unit	1 unit	Structure: R.C & Bric,1Floor Size: 8.0 m^W×28.0 m^L ,224 sq.m, 123 sq.m
Naral River Crossing	1 unit	1 unit	Type: Inverted Siphon Size: R.C Pipe 1,000 mmϕ×20 m^L
In-plant Road	1 lot	1 lot	Surface: Gravel Width: 5 m
Electrical Equipment	1set	1set	Transformer: 150 kVA
Land Acquisition	-	-	(For F/S) STP Site: 65 ha, Road for Access: 20,060 sq.m, Road for Discharge: 11,380 sq.m (For M/P) STP Site: 120 ha, Road for Access: 20,060 sq.m, Road for Discharge: 11,380 sq.m



——: F/S

– – – :Future

Figure 10.10

General Layout of Sewage Treatment Plant

The Study on the Sewerage System in North Dhaka

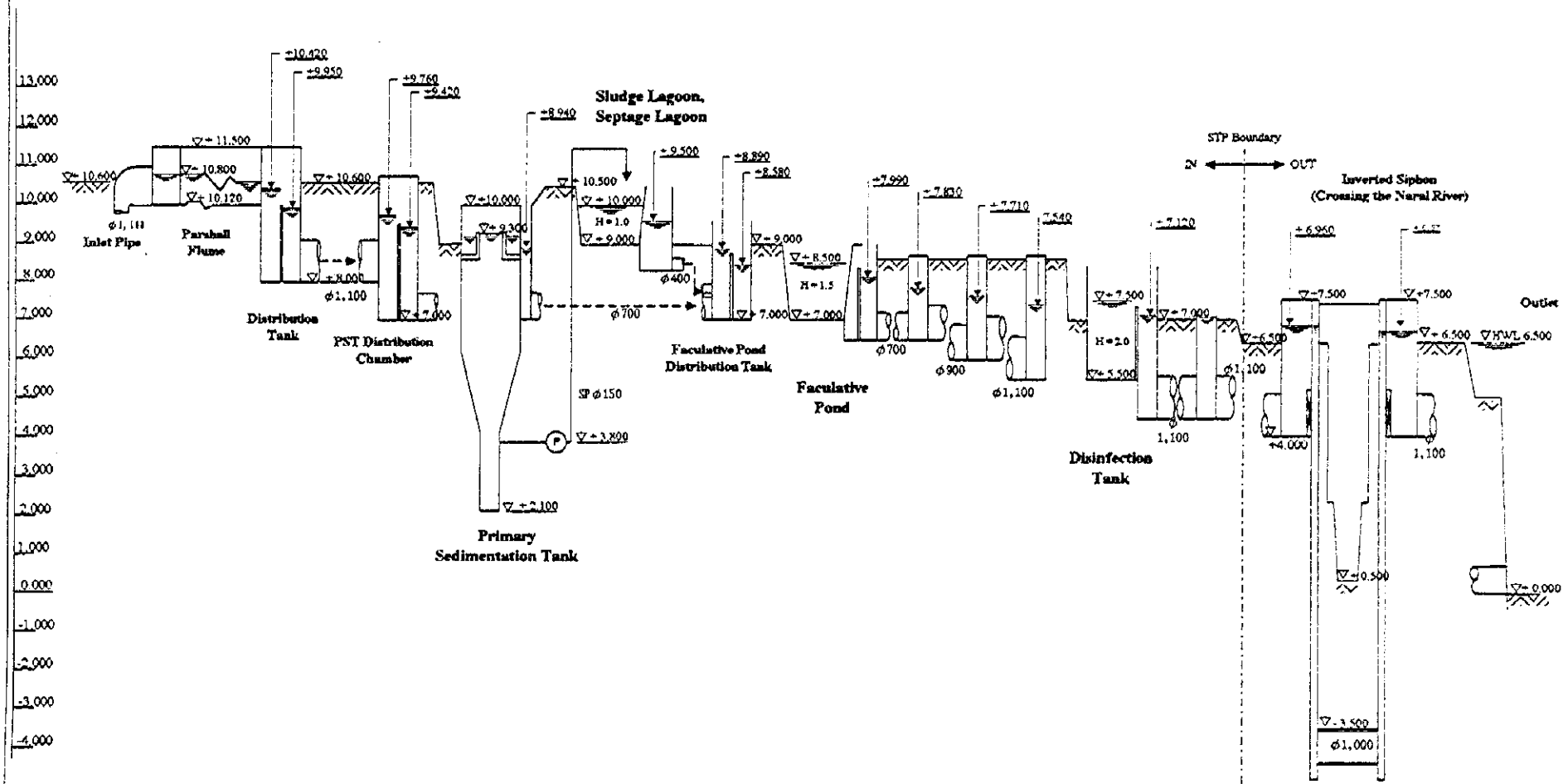


Figure 10.11 Hydraulic Profile

Scale: NON

The Study on Sewerage System in North Dhaka

2) Operation and maintenance equipment

Among the operation and maintenance equipment, water quality analysis equipment and apparatus were selected as shown in Table 10.15.

Table 10.15 Outline of Water Quality Examination Equipment

Name of Equipment	Quantity	Specification	Purpose
pH Meter	1 unit	Glass electrode type, DC	On-site measurement
pH Meter	1 unit	Glass electrode type, AC	Laboratory use
DO Meter	1 unit	Portable type, DC	DO
DO Meter	1 unit	Laboratory use, AC	BOD, COD
Thermometer	5 pcs.	Alcohol type	Water Temperature
Thermometer	1 pc.	Alcohol type	Air Temperature
Transparency Meter	1 unit	0.5m, plastic	Transparency
Electronic Digital Balance	1 unit	Max. 50 g., Min. 0.01 g.	Weighing
Electric Drying Oven	1 unit	100℃、30L	SS
Autoclave	1 unit	Electric heating	Coliform Group Bacteria
Water bath	1 unit	8 holes, electric type	COD
Electric Incubator	1 unit	Desktop type, 50 liter	Coliform Group Bacteria
Electric BOD Incubator	1 unit	Air circulation type,	BOD
Pure Water Generator	1 unit	Ion-exchange-Distillation type, more than 1 liter/hr	
Vacuum Pump	1 unit	Electric type	SS
Refrigerator	1 unit	200 liters	Reagent and sample preservation
Glass-wares	1 set		
Chemical Reagent	1 set		Chemical storage
Centre Table	1 unit	240 cm×120 cm	
Balance Table	1 unit	90 cm×75 cm	
Side Table	1 unit	240 cm×75 cm	
Reagent Shelf	1 unit	90 cm×40 cm	
Steel Shelf	2 units	180 cm×40 cm	

The hauling of dried sludge and screenings is planned to be carried out using the equipment shown in Table 10.16.

Table 10.16 O&M Equipment

Name of Equipment	Required Quantity		Specification
	F/S	M/P	
Dump Truck	2	4	8 ton
Bulldozer	2	4	40 ps
Power Shovel	2	4	0.6 cu.m
Small Boat	1	2	FRP work boat
Portable Engine Pump	1	2	0.5 cu.m/min

10.2.5 Operation and Maintenance Plan

(1) Sewer network

the damage and clogging of the existing sewer network owe to the absence of appropriate and periodical O&M activities. In this respect, work items for the O&M of sewer network were identified in this feasibility study as shown in Table 10.17.

Table 10.17 Work Items by Type of O&M of Sewers

O&M Type	Work Item
Site Investigation	- Location, diameter, material of investigated sewers - Identification of location/cause of damaged/blocked sewers - Identification of location/cause of groundwater intrusion - Investigation of manhole overflow point and its cause - Measurement of the volume of sediments at the sewer bottom
Pipe Cleaning	- Removal of sediments
Rehabilitation	- Replacement/repair of damaged sewer

(2) Pump stations

Work items for pump stations are shown in Table 10.18.

Table 10.18 Work Items of Lift Station by O&M Type

O&M Type	Work Item
Daily Work	- Manual operation of pump facility - Removal of screenings - Record the daily O&M activities and relevant data (pump operation time, receiving voltage, ampere, major breakdown, etc.) on Log Book - Report to MODS Zone Office in case of breakdown
Periodical Work	- Removal/cleaning of scum, sediments in pump pit in every 6 months - Overhaul of pump facility every 5 to 10 years

(3) Sewage Treatment Plant

Although the selected sewage treatment method is simple enough for operation and maintenance, it still requires the minimum labour forces for O&M of the primary sedimentation tank, chlorine disinfection tank, etc. Water quality monitoring and control are also important daily activities. For O&M of the sewage treatment plant, work items were identified and formulated as shown in Tables 10.19 and 10.20, respectively.

Table 10.19 Work Items of Sewage Treatment Plant by O&M Type

O&M Type	Work Item
Daily Work	- Measurement of inflow sewage volume - Removal of screenings - Inspection of mechanical/electrical facilities - Water quality analysis - Record of daily O&M activities
Periodical Work	- Removal of grit and sediments at grit chamber (monthly) - Removal of sludge at stabilisation pond and sludge Lagoon (annually) - Inspection/repair of mechanical/electrical equipments (annually) - Overhaul of mechanical/electrical equipments (every 5 to 10 years)

Table 10.20 Proposed Items and Frequency for Water Quality Analysis

Items	Regulations	O&M
(Sewage)		
Air temperature		●
Water temperature	◎	●
Colour		●
Odour		●
Transparency by cylinder test		●
pH		●
DO		●
BOD	◎	○
COD		●
SS	◎	●
Settleable solids		●
Chloride		◇
Total solids		◇
Ignition Loss		◇
Volatile solids		◇
Dissolved solids		◇
Total nitrogen		◇
Ammonia (Free)		◇
Ammonia nitrogen		◇
Nitrate	◎	◇
Nitrite		◇

Table 10.20 Proposed Items and Frequency for Water Quality Analysis (Continued)

Items	Regulations	O&M
Organic nitrogen		◇
Phosphorus (total as P)	◎	◇
Coliform count	◎	●
Total colonies		●
(Sludge)		
Temperature		●
pH		◎
Moisture content		●
Hazardous substances		◇

Note: Examination frequency

● : More than once a day ○ : More than once a week

◎ : More than twice a week ◇ : As required

As to manpower requirements, staffing plan was prepared as shown in Table 10.21 and their job descriptions were developed.

Table 10.21 Required Staff for Sewage Treatment Plant

Position	No.	Position	No.
Executive Engineer	1	Operator	6
Subdivision Engineer	1	Worker	9 (F/S), 18 (M/P)
Foreman	3	Microbiologist	1
		Total	21 (F/S), 30 (M/P)

10.3 Environmental Impact Assessment (EIA)

An Environmental Impact Assessment (hereinafter referred to as "EIA") was carried out for the sewerage system development plan of the priority project. The EIA concluded that significant improvement of urban environmental conditions would be expected through the implementation of the proposed project. In addition, negative impact to the water use in the receiving water body is determined to be minimal since the effluent is planned to be discharged into stormwater drainage channel.

On the contrary to the above EIA conclusions, several comments/recommendations, which require appropriate attentions and countermeasures during and after construction work, are raised as described below.

(1) Relocation of local residents

Through land acquisition of the proposed sewage treatment plant site, certain number of local residents will have to relocate to substituted places. Appropriate compensation to these local residents shall take place for smooth land acquisition.

(2) Traffic jam

During the construction work of sewerage facilities, construction equipment, such as dump trucks will run about Dhaka City and considerable traffic jam may occur. Even under present conditions, built-up area has serious traffic jam due to increase of vehicles and economic activities. In this regard, DWASA shall co-ordinate with agencies concerned, i.e. DCC and police offices, to re-route such traffics to minimise anticipated traffic jam, together with public campaign to obtain active participation and co-operation of local residents to the project.

(3) Restriction to toxic/hazardous industrial/commercial wastewater

Although the master plan and feasibility study for the North Dhaka Sewerage System Development has preconditions that industrial wastewater is not considered to accept in the public sewerage system, appropriate legislative restriction is required to factories, which are discharging their industrial wastewater into the existing sewer network.

For the long-term scheme of sewerage system implementation, it will be inevitable to accept industrial wastewater into the public sewerage system. In this regard, an installation of pre-treatment facilities at respective factories to reduce toxic/hazardous substances and pollution load of industrial wastewater will be required and pertinent legislative arrangement to promote application of pre-treatment facilities together with public financial assistance will also be required.

CHAPTER 11 Project Cost of Priority Project

11.1 Composition of Project Cost

Project cost was estimated based on the following cost composition.

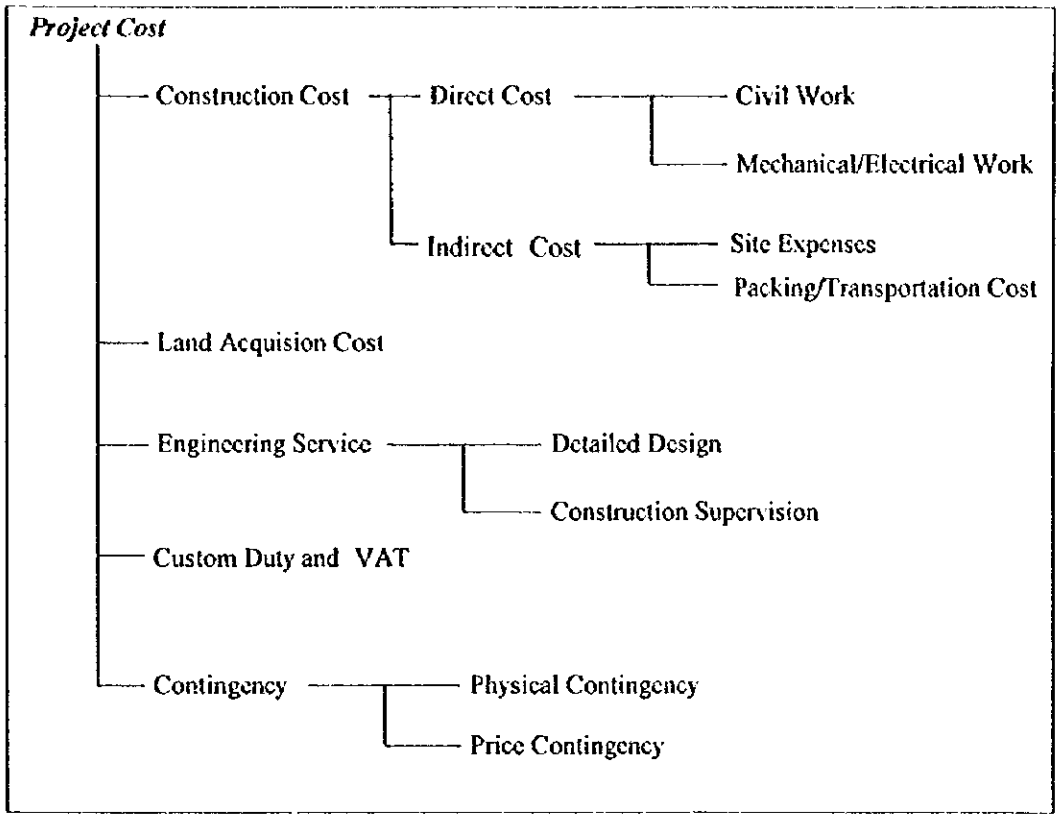


Figure 11.1 Composition of Project Cost

11.2 Selection of Resource Country for Procurement of Equipment and Materials

Resource countries were identified based on the market research as shown in Table 11.1.

Table 11.1 Procurement Plan for Construction Materials/Equipment

Item	Indigenous Goods (Made in Bangladesh)	Imported Goods	Country of Origin
Construction Materials	Crushed Stone, Gravel, Sand, Cement, Reinforcing Bar, Form-board, Scaffolding, Soil for Banking, Reinforced Concrete Pipe	Polyvinyl Chloride Pipe	Thailand
		Steel Pipe	Indonesia
		Sheet Pile	Indonesia
Construction Machinery	None	Bulldozer, Back-hoe, Clam-shell, Hydraulic Pile Driver, Wheel-crane	Japan
Sewage Treatment Equipment	None	Gate, Screen, Sewage Pump, Sludge Collector, Sludge Pump, Chlorine Injection Equipment	Japan

11.3 Classification of Project Cost by Funding Source

Prior to estimate project cost, cost requirements were classified by source of funding as shown in Table 11.2.

Table 11.2 Cost Classification by Local and Foreign Currency Portion

Item	Sewerage Facility	Foreign Currency Portion	Local Currency Portion
Construction	Sewer	Trunk Main (Larger than dia. 300mm)	Branch Sewer (Dia. 200mm and 250mm)
	Pump Station	Pump Station Facility	Fence, Gate, Inner Road, Water Supply Connect, Telephone Line
	Sewage Treatment Plant	Sewage Treatment Facility	Reclamation, Access Road, Road for Outlet Pipe, Fence, Gate, Inner Road, Water Supply Connect, Electric Power Connect, Gas Connect, Telephone Line
Land Acquisition	-	None	Pump Station, Sewage Treatment Plant, Access Road, Road for Outlet Pipe

11.4 Construction Cost and O&M Cost

Costs for construction work and O&M were separately estimated in terms of sewer network, pump stations and sewage treatment plant, as shown in Tables 11.3 and 11.4, respectively.

Table 11.3 Construction Cost of Sewerage System

Unit: Tk '000

Item	Currency Mode	Ratio (%)	Sewer	Pump Station	Sewage Treatment Plant	Total
Civil Work	Local	-	142,699	712	954,829	1,098,240
	Foreign	-	541,003	91,122	835,893	1,468,018
	Sub-Total	-	683,702	91,834	1,790,722	2,566,258
Mechanical & Electrical Work	Local	-	0	0	0	0
	Foreign	-	0	294,143	187,041	481,184
	Sub-Total	-	0	294,143	187,041	481,184
Direct Construction Cost	Local	-	142,699	712	954,829	1,098,240
	Foreign	-	541,003	385,265	1,022,934	1,949,202
	Total	-	683,702	385,977	1,977,763	3,047,442
Indirect Construction Cost (Overhead & Tax)	Local	15.0	21,404	106	143,224	164,734
	Foreign	20.0	108,200	77,053	204,586	389,839
	Total	-	129,604	77,159	347,810	554,573
Construction Cost	Local	-	164,103	818	1,098,053	1,262,974
	Foreign	-	649,203	462,318	1,227,520	2,339,041
	Grand Total	-	813,306 (US$18,768,744)	463,136 (US$10,687,836)	2,325,573 (US$53,667,482)	3,602,015 (US$83,124,062)

Note: Exchange Rate US$ 1.00 = 43.333 Tk (as of January 1998)

Table 11.4 Operation and Maintenance Cost of Sewerage System

Unit: Tk '000

Item	Sewer	Pump Station	Sewage Treatment Plant	Total
Personnel Expense	1,200	1,855	1,659	4,714
Water Charges	0	7	3	10
Power Consumption	0	10,194	760	10,954
Fuel	2,640	688	54	3,382
Chemical	0	0	6,640	6,640
Repair Expense	0	6,909	3,455	10,364
Total	3,840 (US$88,616)	19,653 (US$453,534)	12,571 (US$290,102)	36,064 (US$832,252)

Note: Exchange Rate US$ 1.00 = 43.333 Tk (as of January 1998)

11.5 Project Cost

Project cost was estimated as shown in Table 11.5 covering construction cost and relevant costs, i.e. engineering service, administration cost and contingencies in accordance with the following procedures:

- Engineering Service: (Construction Cost) x 3%
- Administration Cost: (Construction Cost + Engineering Service) x 5%
- Physical contingency: (Construction Cost + Engineering Service + Land Acquisition Cost) x 10%

Table 11.5 Project Cost of Sewerage System

Unit: Tk'000

Item	Currency Mode	Ratio (%)	Sewer	Pump Station	Sewage Treatment Plant	Total
Construction Cost	Local	-	164,103	818	1,098,053	1,262,974
	Foreign	-	649,203	462,318	1,227,520	2,339,041
	Sub-Total	-	813,306	463,136	2,325,573	3,602,015
Land Acquisition	Local	-	0	18,636	511,078	529,714
	Foreign	-	0	0	0	0
	Sub-Total	-	0	18,636	511,078	529,714
Engineering Service	Local	-	0	0	0	0
	Foreign	3.0	19,476	13,869	36,825	70,170
	Total	-	19,476	13,869	36,825	70,170
Administration Cost	Local	5.0	8,205	40	54,902	63,147
	Foreign	5.0	33,433	23,809	63,217	120,459
	Total	-	41,638	23,849	118,119	183,606
Custom Duty & VAT	Local	100	23,315	0	0	23,315
	Foreign	100	145,211	294,143	244,856	684,210
	Total	-	168,526	294,143	244,856	707,525
Physical Contingency	Local	10.0	17,230	1,949	166,403	185,582
	Foreign	10.0	70,211	49,999	132,756	252,966
	Total	-	87,441	51,948	299,159	438,548
Grand Total	Local	-	212,853	21,443	1,830,436	2,064,732
	Foreign	-	917,534	844,138	1,705,174	3,466,846
	Grand Total	-	1,130,387 (US$26,086,054)	865,581 (US$19,975,099)	3,535,610 (US$81,591,627)	5,531,578 (US$127,652,780)

Note: Exchange Rate - US$ 1.00 = 43.333 Tk (as of January 1998)

CHAPTER 12 FINANCIAL ASPECTS

12.1 FIRR

The bases of the FIRR for the project were 1) the financing of the project, 2) the projected financial performance of DWASA, and 3) the project cost. In this case, the financing of the project was a 30-year, 7% loan with a five-year grace period. The loan repayment schedule is shown below.

Table 12.1 Loan Repayment Schedule

YEARS: 25 RATE: 7.00% GRACE (yrs): 5

Year	Principal	Interest	Payment	Loan
2001	0	0	0 Grace	
2002	0	0	0 Grace	
2003	0	0	0 Grace	
2004	0	0	0 Grace	
2005	0	0	0 Grace	
2006	83,243	368,554	451,797	5,265,053
2007	89,070	362,727	451,797	5,181,810
2008	95,305	356,492	451,797	5,092,740
2009	101,977	349,820	451,797	4,997,434
2010	109,115	342,682	451,797	4,895,458
2011	116,753	335,044	451,797	4,786,343
2012	124,926	326,871	451,797	4,669,590
2013	133,670	318,127	451,797	4,544,664
2014	143,027	308,770	451,797	4,410,994
2015	153,039	298,758	451,797	4,267,967
2016	163,752	288,045	451,797	4,114,928
2017	175,215	276,582	451,797	3,951,176
2018	187,480	264,317	451,797	3,775,961
2019	200,603	251,194	451,797	3,588,481
2020	214,645	237,151	451,797	3,387,878
2021	229,671	222,126	451,797	3,173,233
2022	245,748	206,049	451,797	2,943,562
2023	262,950	188,847	451,797	2,697,814
2024	281,356	170,441	451,797	2,434,864
2025	301,051	150,746	451,797	2,153,508
2026	322,125	129,672	451,797	1,852,457
2027	344,674	107,123	451,797	1,530,332
2028	368,801	82,996	451,797	1,185,658
2029	394,617	57,180	451,797	816,857
2030	422,240	29,557	451,797	422,240
	5,265,053	6,029,870		

The impact on the FIRR of different interest rates was shown calculated and is shown below in Table 12.2. In consideration of the financial status of DWASA, the final financing package for the project should obtain the most advantageous terms possible to minimise DWASA's debt burden.

Table 12.2 Projected Debt Service Burden for Recommended Project

Loan Amount:	5,265,528				
Interest Rate:	10%	8%	6%	4%	2%
Annual Debt Service	580,041	493,244	411,688	337,026	269,268
FIRR (base)	11.26%	12.64%	14.02%	15.38%	16.07%

Note: costs in Tk ('000)

(1) O&M Costs

The O&M costs of the system were considered in terms of the ability of the project's projected income to meet the O&M costs. In this case, it was found that the projected income of the project would be able to meet the O&M costs. The graph below illustrates the O&M costs and the projected project income over time.

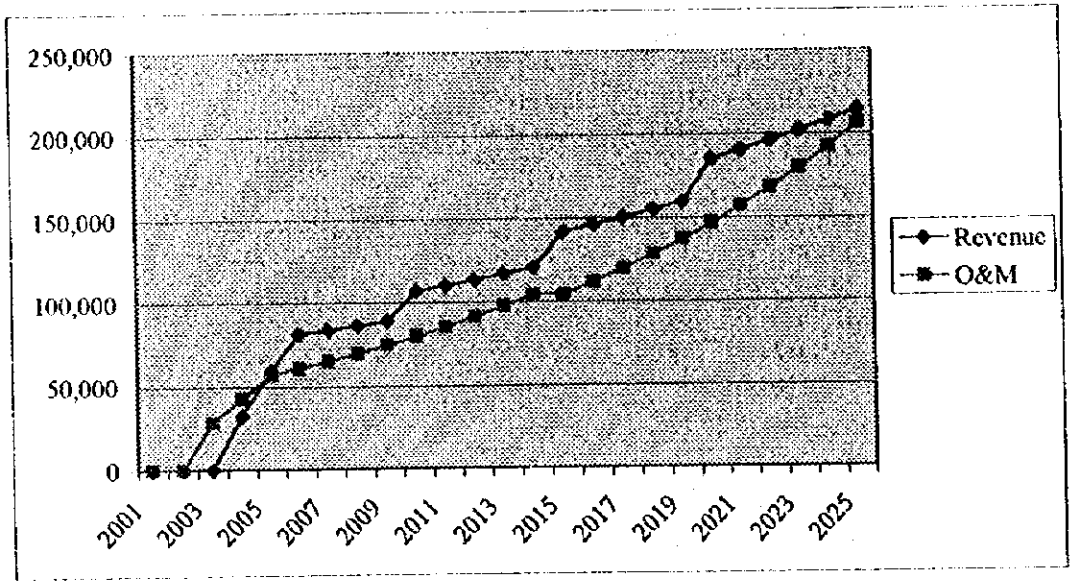


Figure 12.1 O&M Costs vs. Project Income

(2) Conclusion

The FIRR of the project's base scenario was 13.33% and thus viable. For comparative purposes, three additional scenarios were analysed as shown on the following page.

Table 12.3 Sensitibity Analysis

Discount Rate 2.50%

Base Scenario

YEAR	BALANCE	NPV
2001	-1,794,566	-1,750,797
2002	-727,160	-709,424
2003	-656,898	-640,876
2004	-707,150	-689,903
2005	-784,267	-765,139
2006	230,061	224,450
2007	258,123	251,827
2008	285,583	278,618
2009	312,255	304,639
2010	933,111	910,352
2011	1,197,637	1,168,426
2012	1,266,769	1,235,872
2013	1,336,691	1,304,088
2014	1,407,229	1,372,906
2015	1,557,582	1,519,592
2016	1,717,257	1,675,373
2017	1,794,296	1,750,533
2018	1,871,304	1,825,662
2019	1,782,770	1,739,287
2020	1,996,313	1,947,622
2021	2,457,154	2,397,224
2022	2,528,343	2,466,676
2023	2,597,382	2,534,031
2024	2,663,712	2,598,744
2025	2,726,716	2,660,211
	FIRR	14.01%

Sensitivity 1: 10% Increase in O&M Costs

YEAR	BALANCE	NPV
2001	-1,735,972	-1,693,631
2002	-666,807	-650,544
2003	-597,581	-583,006
2004	-679,405	-662,834
2005	-770,174	-751,389
2006	217,272	211,973
2007	236,554	230,764
2008	253,224	247,048
2009	266,708	260,203
2010	871,519	850,263
2011	1,116,602	1,089,368
2012	1,162,251	1,133,903
2013	1,203,894	1,174,531
2014	1,240,464	1,210,208
2015	-180,303	-175,905
2016	541,671	528,459
2017	559,998	546,329
2018	1,175,621	1,146,948
2019	1,019,329	994,467
2020	1,421,510	1,386,839
2021	1,764,908	1,721,861
2022	1,696,767	1,655,383
2023	1,600,638	1,561,598
2024	1,471,307	1,435,422
2025	1,302,672	1,270,899
	FIRR =	10.93%

Sensitivity 2: Lower Tariff Collection Rate

YEAR	BALANCE	NPV
2001	-1,753,550	-1,710,781
2002	-684,913	-668,208
2003	-613,384	-598,424
2004	-694,345	-677,410
2005	-784,267	-765,139
2006	209,683	204,569
2007	237,133	231,350
2008	263,964	257,526
2009	289,987	282,914
2010	910,175	887,976
2011	1,174,013	1,145,379
2012	1,242,436	1,212,133
2013	1,311,628	1,279,637
2014	1,381,415	1,347,722
2015	1,523,669	1,486,506
2016	541,671	528,459
2017	559,998	546,339
2018	1,175,621	1,146,948
2019	1,019,329	994,467
2020	1,421,510	1,386,839
2021	1,764,908	1,721,861
2022	1,696,767	1,655,383
2023	1,600,638	1,561,598
2024	1,471,207	1,435,422
2025	1,302,672	1,270,899
	FIRR =	11.96%

Sensitivity 3: Land Costs +50%

YEAR	BALANCE	NPV
2001	-2,000,460	-1,951,668
2002	-666,807	-650,544
2003	-594,735	-580,229
2004	-675,136	-658,670
2005	-764,482	-745,837
2006	230,061	224,450
2007	258,123	251,827
2008	285,583	278,618
2009	312,255	304,639
2010	933,111	910,352
2011	1,197,637	1,168,426
2012	1,266,769	1,235,872
2013	1,336,691	1,304,088
2014	1,407,229	1,372,906
2015	1,550,258	1,512,446
2016	1,709,420	1,667,727
2017	1,785,910	1,742,351
2018	1,862,331	1,816,908
2019	1,773,169	1,729,921
2020	1,986,040	1,937,600
2021	2,446,162	2,386,499
2022	2,516,582	2,455,202
2023	2,584,797	2,521,753
2024	2,650,246	2,585,606
2025	2,712,308	2,646,154
	FIRR =	13.83%

Note: a discount rate of 2.5% is applied due to the public service nature of the project

12.2 Economic Analysis

While the economic benefits of a sewerage system can be identified to a certain extent, the majority of these benefits cannot be quantified. The value of cleaner air, water, and improved sanitation is readily apparent but attempts to apply numerical values to such benefits is an elusive exercise at best. The costs of a sewerage project are more identifiable, but comparing the costs and benefits of a project such as this aren't useful in real terms.

However, the economic viability of a project can be determined, in terms of the beneficiaries' ability-to-pay (affordability) and willingness-to-pay. In this project, the affordability of the project was demonstrated, as the sewerage tariff's portion of a household's annual budget remains below 2%. The willingness to pay for the sewerage system was measured in the Household Survey on Sanitation conducted in DEVCONsultants Ltd. In this survey, it was found that of the independent and apartment house dwellers, around 95% were willing to pay for sewerage service. Slum dwellers, on the other hand, were only willing to pay 30% of the time.

Table 12.4 Affordability of North Dhaka East STP Sewerage Tariff

Year	Annual HH Income	Sewage Tariff (Tk/cu.gal)	Annual Bill (Tk)	% of Income
2001	186,432	18.98	2,034	1.09
2002	186,432	19.55	2,095	1.12
2003	186,432	20.14	2,158	1.16
2004	186,432	20.74	2,223	1.19
2005	186,432	21.36	2,289	1.23
2006	186,432	22.00	2,358	1.26
2007	186,432	22.66	2,429	1.30
2008	186,432	23.34	2,502	1.34
2009	186,432	24.04	2,577	1.38
2010	186,432	24.76	2,654	1.42
2011	186,432	25.51	2,734	1.47
2012	186,432	26.27	2,816	1.51
2013	186,433	27.06	2,900	1.56
2014	186,434	27.87	2,987	1.60
2015	186,435	28.71	3,077	1.65
2016	186,436	29.57	3,169	1.70
2017	186,437	30.46	3,264	1.75
2018	186,438	31.37	3,362	1.80
2019	186,439	32.31	3,463	1.86
2020	186,440	33.28	3,567	1.91
2021	186,441	34.28	3,674	1.97
2022	186,442	35.31	3,784	2.03
2023	186,443	36.37	3,898	2.09
2024	186,444	37.46	4,014	2.15
2025	186,445	38.58	4,135	2.22

CHAPTER 13 Project Evaluation, Conclusions and Recommendations

13.1 Project Evaluation

The project evaluation on the priority project of North Dhaka Sewerage System was conducted in view of the project's expected benefits and feasibility/appropriateness. The evaluations pertained to such technical, environmental, financial and socio-economic aspects.

13.1.1 Benefits and Feasibility/Appropriateness of Priority Project

The primary objectives of the sewerage system development is to allow for (1) smooth collection of sewage discharged in the sewerage service area and (2) reduce the pollution load going into receiving water bodies through sewage treatment. The project area of the North Dhaka Sewerage System is regarded as one of the most rapidly developing urban areas in Bangladesh this trend will continue for the foreseeable future. Contrary to this movement of urbanisation, the provision of a public sewerage system in North Dhaka is far behind the rising needs of the area. If the current conditions continue, not only the future development of Dhaka City, but also the health and welfare of local residents will be significantly affected.

The leakage of sewage from the existing sewer network is another problem affecting the environmental pollution in public water bodies. The deterioration of the water supply system and the leakage of sewage have a considerable negative influence on the living environment and occurrence of water-borne/related/vector diseases in Dhaka City.

The priority project proposed in this Study was formulated aiming at the improvement of the urban environment and to conserve the aquatic environment in the public water bodies of Dhaka City. This project is deemed to be the initial step towards the provision of a public sewerage system. The priority project will significantly reduce the pollution load to the public water bodies through the collection of discharged sewage and its treatment. Likewise, the feasibility and appropriateness of the priority project are considered self-explanatory.

13.1.2 Project Evaluation

(1) Technical aspects

The technical aspects of the priority project were evaluated as follows:

1) Water quality conservation in public water bodies

Sewage generated in the proposed sewerage service area is planned to be collected through a sewer network and treated at the sewage treatment plant. By this means, the discharge of untreated sewage into public water bodies, i.e. rivers, lakes, will be prevented. Thus, the aquatic environment in Gulshan Lake and Banani Lake, as well as the Gerani Khal, the receiving water body of treated effluent, will be significantly improved.

2) Most economical treatment method

The sewage treatment method adopted for the priority project, as well as the sewerage master plan, is the most economical stabilisation pond method in view of the technical level required for operation and maintenance, construction costs (including land acquisition), and operation and maintenance costs.

3) Design effluent quality of sewage treatment plant

The design effluent quality satisfies the effluent quality standards of Bangladesh and does not require any significant improvement of treatment efficiency through the future. If the inflow sewage volume exceeds the design capacity, an upgrade of the treatment method to the aerated lagoon method is applicable.

4) Rehabilitation/augmentation of existing sewer network

The rehabilitation/augmentation of the existing sewer network is deemed indispensable to attain appropriate sewerage service and to prevent sewage overflow and inundation hazard in the sewerage service area.

Judging from the above-mentioned technical evaluation, the priority project satisfies the needs of the technical aspects of a sewerage service.

(2) Environmental aspects

The environmental aspects were evaluated based on the results of the EIA conducted for the priority project and concluded that the significant improvement of urban environmental conditions could be expected through the implementation of the proposed project. On the contrary, several comments/recommendations, which require appropriate attention and countermeasures during and after construction work, are raised as shown below:

1) Relocation of local residents
2) Traffic jam
3) Restriction of toxic/hazardous industrial/commercial wastewater

The details of these issues are contained in Chapter 10, 10.3 EIA.

(3) Financial aspects

The Financial Internal Rate of Return (FIRR) was adopted in the financial evaluation of the priority project. The result was 13.33%, while that of master plan was 5.10%. Therefore, the priority project is projected to be financially feasible.

However, it shall be noted that DWASA itself shall positively act on the proper O&M of sewerage facilities to prolong service life, saving for depreciation, increase of water supply and sewerage service charge at appropriate rate and timing, in order to realise the said result of the FIRR simulation.

(4) Socio-economic aspects

In contrast to the financial aspect, it is well known that a quantitative evaluation of socio-economic benefits is very difficult for a sewerage sector project. The economic benefits brought about by a sewerage sector project appear as multiplicated effects with relevant measures, i.e. the provision of other urban infrastructures, legislative arrangements, etc. and are therefore difficult to quantity.

A qualitative evaluation was made from the aspects of improved of public hygiene, and from the viewpoint that the project would function as a basic urban infrastructure to support economic development, increase land value, etc.

In view of the beneficiaries' economic burden, the affordable level of water supply and sewerage service charge against family income was inquired in the course of questionnaire survey on the

residents' awareness on environmental sanitation. The projected service charge will be at about 2% of family income, which falls within the affordable level of local residents. In the survey, 95% of house and apartment dwellers indicated their willingness to pay for sewerage service. However, only about 30% of residents in slum areas showed willingness-to-pay for the sewerage service charge. Necessary countermeasures to support these residents will be required.

(5) Overall evaluation

As mentioned above, when a long-term low-interest loan is secured, the priority project is considered financially feasible. The environmental impacts are also deemed within the acceptable limits of negative impact through implementation of necessary countermeasures with agencies concerned and is regarded technically appropriate.

However, considerations of the residents' poverty level, as well as restrictions to prohibit the dumping of solid wastes into the sewer lines, etc., are indispensable. In this respect, co-operation and support from the national government as well as the DCC and local communities are necessary for DWASA to insure successful and smooth implementation of the proposed project.

13.2 Conclusions and Recommendations

The appropriateness and feasibility of the master plan and priority project for North Dhaka Sewerage System have been confirmed in principle. There are, however, several preparatory works which have to be arranged before the realisation of the proposed project, such as land acquisition with the use of local budget, financial negotiation with potential donors, etc.

At this stage of study activities, recommendations, which were not directly concerned with the project evaluation were hereby taken up for furtherance to the project as follows.

(1) Future urban development

The DMDP, prepared by RAJUK, was principally referred to as the basis for master plan preparation of North Dhaka Sewerage System. This DMDP itself requires periodical review and updating and DWASA shall also maintain consistency with its water supply program through the future.

Among others, it is indispensable for Dhaka City to implement various urban infrastructures rationally and economically, since the population of Dhaka City has increased continuously without a long-term development plan. In this regard, close co-operation and co-ordination of DWASA and other relevant agencies are indeed necessary.

(2) Improvement of DWASA's financial conditions

Although appropriate budget and man-power have not been allocated for sewerage sector in DWASA, the appropriation of 500 million Taka for three years from 1998 is considered as the starting point of massive investment in this sector. Not only the promotion of priority project, but also effective utilisation of the said local fund is deemed an urgent requirement for the rehabilitation of damaged sewers and the installation of additional manholes and institutional strengthening of the operation and maintenance set-up.

(3) Fluctuation of foreign exchange rate and inflation

Economic uncertainty in Asian countries and the unstable foreign exchange market are potential risks in securing project financing. These factors could affect the smooth implementation of the project. Rapid urbanisation, fuelled by private sector investments, may also cause an increase in the costs of various construction materials. In this respect, DWASA shall keep maintain close co-ordination with the national government to seek possible measures to hedge the said risks.

(4) Hidden costs

1) Cost for service connection to be shouldered by beneficiaries

Even if sewerage system is completed, actual benefits will not appear unless every beneficiary connects to sewer network. Though such cost for service connection shall be borne by beneficiaries in principle, financial assistance by low interest loan, etc. to beneficiaries shall be considered in order to attain early realisation of project benefits. Such public assistance shall be implemented together with legislative arrangement to mandate usage of sewerage service to beneficiaries.

2) Acceptance of industrial wastewater

For the long-term scheme of sewerage services in Dhaka city, the acceptance of industrial wastewater into sewerage system shall be sought. Installation of pre-treatment facilities requires considerable financial arrangements from the respective factories. To insure proper installation of such facilities, low-interest public loans, etc. shall be taken into account.

CHAPTER 14 Emergency Project for North Dhaka

14.1 Proposal of Emergency Project

When new sewerage system is planned for implementation, complete facilities of sewerage system covering sewer network, pump stations and sewage treatment plant shall be constructed in order to attain the function of sewerage system. It is also acknowledged that considerable period and capital investment are required for project implementation as the inevitable destiny. In this Study, master plan and feasibility study were carried out focusing on the designated study area in North Dhaka. The priority project requires five-year implementation period and capital investment. In other word, the minimum five-year period is required until project benefits appear.

Preparatory stage also requires land acquisition and site preparation for pump stations and sewage treatment plant as well as financial arrangement for construction work, which thoroughly depend on implementation capability of DWASA. And, there is considerable uncertainty in realisation of required arrangement.

On the contrary, as mentioned in Chapter 10, leakage of sewage into Banani Lake from damaged sewers, clogging of sewers, and inflow of untreated sewage from unserved area to Gulshan Lake are causing serious water pollution in Gulshan and Banani Lakes together with deterioration of hygienic conditions in surrounding environment. In the Lakhya River, which is the receiving water body of these lakes, new surface water intake facility is under construction for the Saidabad Water Treatment Plant. Further progress of water pollution in these lakes will hamper conservation of drinking water source. Therefore, urgent countermeasures to prevent further environmental pollution in Gulshan and Banani Lakes are indeed necessary.

Taking into account the above-mentioned situation, an emergency countermeasure is formulated to cater for blank period from 1998 until commencement of sewerage service by the proposed priority project (2005), which intends to utilise surplus capacity of the existing sewerage system in South Dhaka, particularly the treatment capacity of the Pagla Sewage Treatment Plant. If this option is feasible, early commencement of sewerage service in the unserved area of North Dhaka can be realised, prior to the completion of priority project.

At present, an average sewage inflow at about 40,000 cu.m/day to the Pagla Sewage Treatment Plant is less than half of the design treatment capacity of 96,000 cu.m/day (daily average). The emergency project is likewise proposed to temporary utilise remaining treatment capacity of the Pagla Sewage Treatment Plant for sewage to be discharged in the Core Area of North Dhaka Sewerage Service Zone. By this means, an early commencement of sewerage service, an effective utilisation of the existing sewerage facilities, and an early prevention of water pollution in Gulshan and Banani Lakes can be realised.

14.2 Present Conditions of Existing Sewerage Facilities

14.2.1 North Dhaka Area

Please refer to Chapter 10.

14.2.2 South Dhaka Area

Prior to prepare preliminary design of the proposed emergency project, the existing sewerage facilities in South Dhaka, particularly pump stations and Asad Gate Trunk Main, were investigated to verify their functions. Results of the investigations are summarised as follows:

(1) Flow balance of pump stations

The existing sewer network in South Dhaka can be subdivided into three groups by route of trunk main, namely Asad Gate Trunk Main, Hazaribag Trunk Main and Nawabganj Trunk Main. In addition, there are 13 pump stations in the South Dhaka Sewerage System. Sewage flow at each pump stations in both rainy season and dry season was surveyed by means of operation record and interview to pump operators. The survey results were exhibited in Figure 14.1 and summarised as follows:

- Sewage inflow in dry season is less than that in rainy season, which indicates infiltration of rainwater into sewer lines.
- Leakage of sewage from several locations in main sewers is anticipated.

The most serious imbalance of sewage flow in dry season was observed between Bashaboo L.S. (6,350 cu.m/day) and Saidabad L.S. (1,035 cu.m/day) that approximately 5,000 cu.m/day of sewage is considered leaked from Asad Gate Trunk Main.

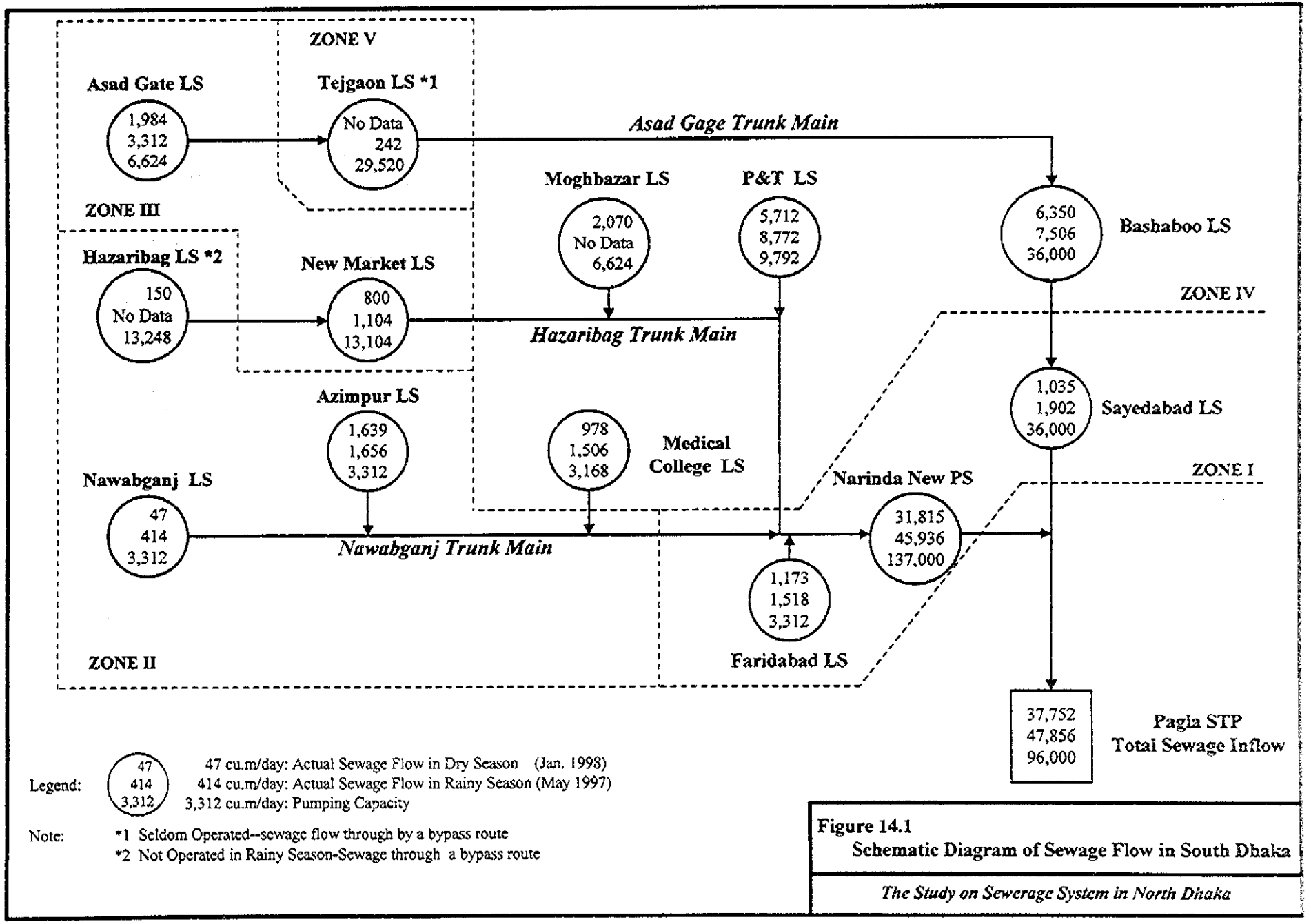


Figure 14.1
Schematic Diagram of Sewage Flow in South Dhaka

The Study on Sewerage System in North Dhaka

(2) Installation conditions of Asad Gate Trunk Main

Following the survey of pump stations, the installation conditions of Asad Gate Trunk Main and its surrounding environment were investigated. This survey result is presented in Figure 14.2 with photographs and colouring of trunk main to distinguish the present conditions. Colouring is as follows:

Red: In this section, trunk main is buried under Gulshan Lake or swamp area and is always submerged in water. Access to trunk main is limited by boat to square manholes protruding above the water.

Yellow: Trunk main in this section is submerged in the water during rainy season. Access to trunk main is limited by small footpath along with pipeline route.

Blue: Trunk main is buried under road in residential or commercial area and is not submerged in the water through the year. Sewer cleaning by means of truck mounted jetting equipment is available.

Massive rehabilitation/improvement of trunk main marked "Red" and "Yellow" is very difficult and even if implemented, it becomes very costly.

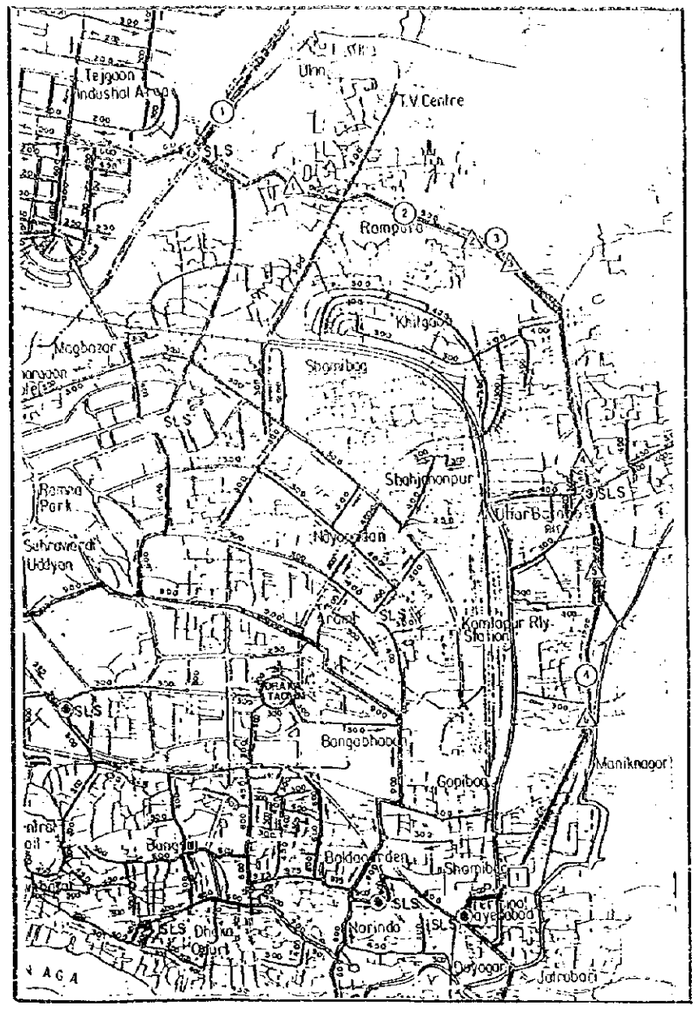
(3) Clogging conditions of main sewers

Clogging conditions of main sewers were also investigated. Survey results are shown in Figure 14.2 and sununarised as follows:

- Large amount of various types of garages is seen at screen of pump stations and manholes.
- Water level in manholes is quite high in relation to installation depth of sewer pipes.
- Considerable length of time is consumed for tracer to reach manholes in downstream.

Based on the survey results, main sewers and connecting seer network are considered under chronic clogging conditions. Among others, the following critical conditions were confirmed:

- Due to clogging of outlet pipe from Nawabganj L.S., pumped sewage is overflowing to nearby residential areas for past six months.
- Outlet pipe of Medical College L.S. is also clogged and pumped sewage is overflowing to nearby stormwater drainage.



LEGEND

◉	SLS
▭	Submerged Through the Year
▭	Submerged during Rainy Season
▭	Installed under The Road
△	Leakages from Dameged Trunk Main
○	Site Condition of Trunk Main
□	Obstacles Accumulated in Manholes of Trunk Main

Figure 14.2
Present Conditions of Trunk Main

The Study on the Sewerage System in North Dhaka

(4) Sewage leakage conditions

Locations of sewage leakage were confirmed in main sewers with the use of tracing agent. Coloured water marked by tracer was confirmed in swamps areas and leaking at buried pipes was also detected as coloured water appeared to the surface of swamp areas.

(5) Overall conditions

Sewage leaking points and their surrounding area were encountering serious water pollution and offensive odour. Complaints from local residents were sent to DWASA. As a whole, the existing sewer network in Gulshan area and Asad Gate Trunk Main between Tejgaon L.S. and Saidabad L.S. via Bashaboo L.S. need thorough cleaning, but considerable part of the said trunk main situates inaccessible area or difficult area to access.

14.3 Sewerage Facility Plan

Key points in facility planning for temporary treatment of sewage to be collected from the existing served area and new service area, both of which are located in the Core Area of North Dhaka East Sewerage Zone can be defined to the following three subjects:

(1) Selection of new service area in the Core Area and its facility plan
(2) Identification of need and magnitude of improvement/rehabilitation of the existing sewer network in the Core Area.
(3) Replacement and re-routing of the existing trunk main in South Dhaka Sewerage Service Area.

14.3.1 Selection of New Service Area in the Core Area and its Facility Plan

Potential candidate area for sewerage service is 214 ha and can be categorised into three areas in consideration of socio-economic and physical conditions:

(1) Joar Sahara
(2) Baridhara
(3) Badda

Target area of new sewerage service is selected based on the following criteria.

(1) Technical suitability

1) Candidate area shall be served by DWASA's water supply service.
2) Candidate area shall have appropriate road network which allows installation of sewer network.
3) Candidate area shall has reasonable population density in order to realise the maximum benefits of investment.

(2) Socio-economic suitability

Candidate area shall have high potential suitability:

1) Investment effect can be realised as soon as possible.
2) In cost recovery of capital investment and O&M expenses, beneficiaries should have shown willingness-to-pay and should have financial affordability-to-pay for sewerage service.
3) Beneficiaries should have financial affordability to shoulder cost to install service connection to sewer network.
4) Beneficiaries should have shown sufficient willingness-to-participate to the implementation of sewerage project.

Baridhara area has been selected as the target area for new sewerage service in the emergency project based on the above mentioned criteria and is shown in Figure 14.3 and Table 14.1. Due attention was paid to technical suitability and cost recovery in the overall evaluation.

Table 14.1 Selection of New Sewerage Service Area

Selection Criteria	Joar Sahara	Baridhara	Badda
Technical Suitability			
1) Water supply coverage	Good	Good	Good
2) Road network	Poor	Good	Poor
3) Population density	Medium	Medium	Highest
Socio-economic Suitability			
1) Realisation of investment effects	Medium	Highest	Low
2) Cost recovery	Medium	Highest	Low
3) Financial affordability	High	Highest	Medium
4) Motivation	Moderate	Highest	Moderate
Overall Evaluation	2nd	1st	3rd

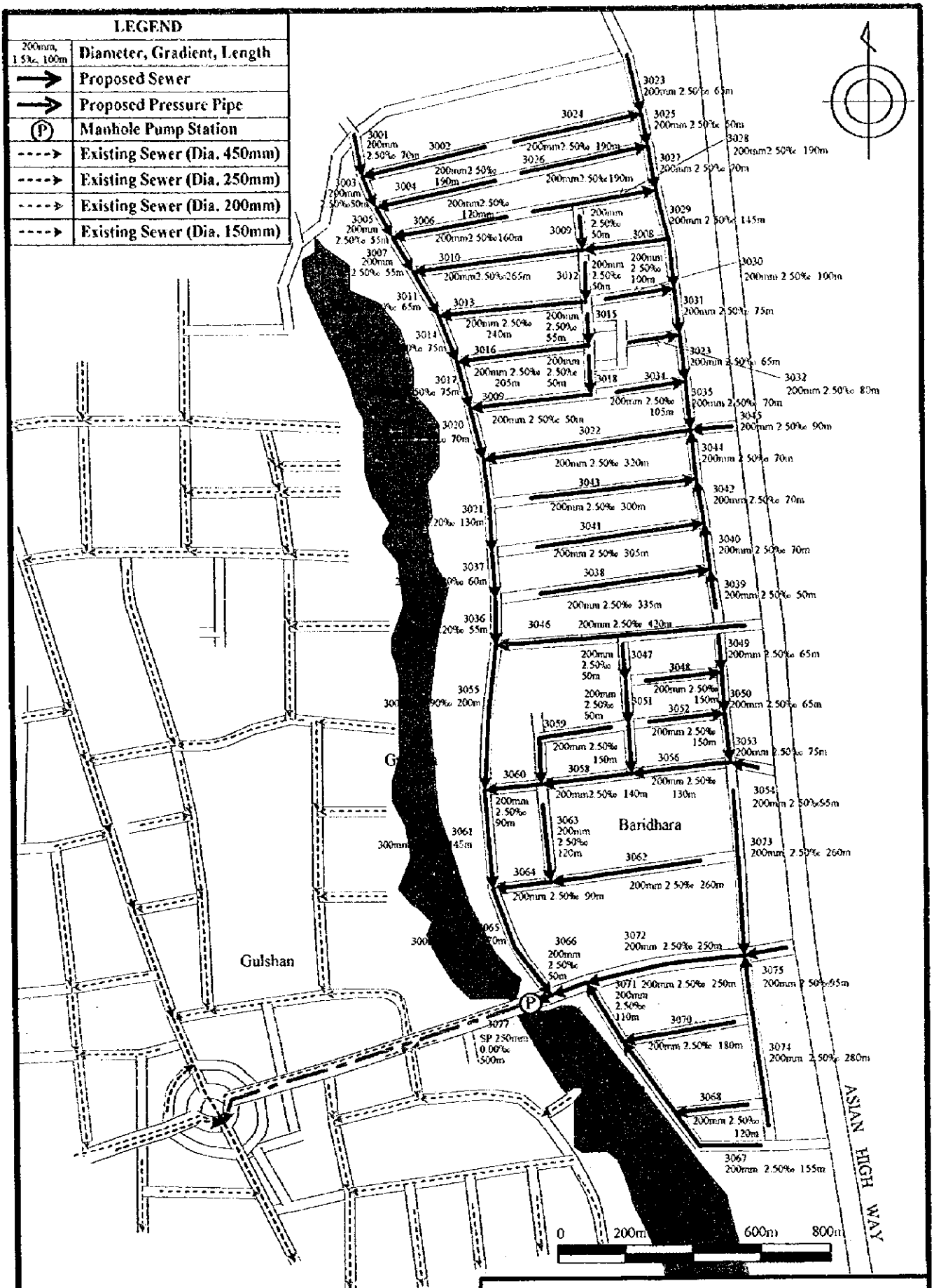


Figure 14.3
Facility Plan of Baridhara Area

The Study on the Sewerage System in North Dhaka

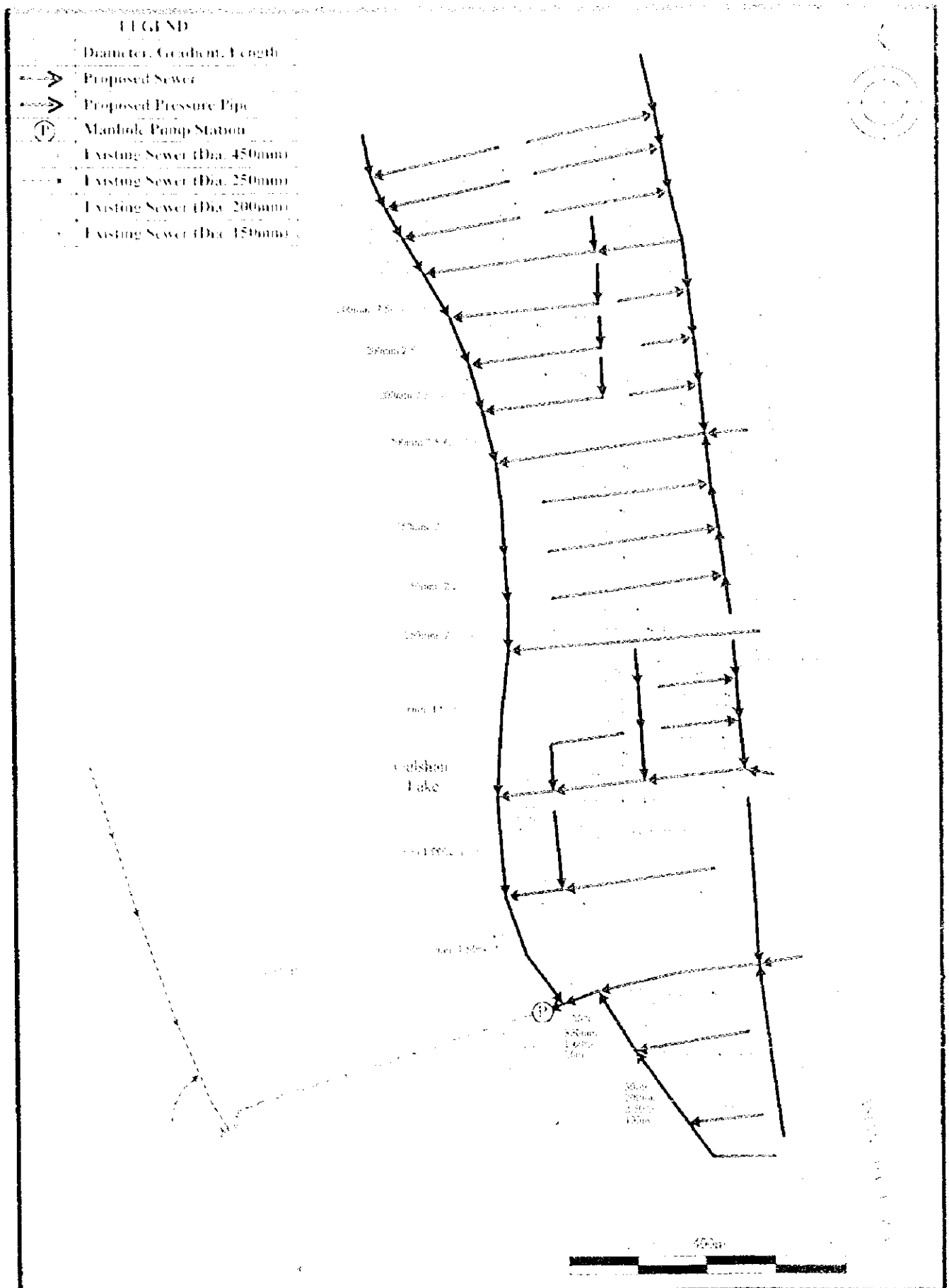


Figure 14.3
Facility Plan of Baridhara Area

The Study on the Sewerage System in North Dhaka

With regard to facility planing, sewage discharged in the new sewerage service area of the emergency project will be collected to one manhole and sent to the existing sewer network in Gulshan area by manhole pump, in order to temporary treat it at the Pagla Sewage Treatment Plant. Thus, this facility plan differs from the facility plan developed for the priority project.

When the said temporary sewage treatment is to be seized, the pressure pipe from the manhole pump shall be re-routed to connect new Uttara Trunk Main which will carry sewage up to the new North Dhaka East Sewage Treatment Plant.

Sewer network plan of Baridhara area is shown in Figure 14.3.

14.3.2 Necessity to Improve Existing Sewer Network in Core Area

For temporary treatment of sewage collected in Baridhara area at the Pagla Sewage Treatment Plant, transmission of collected sewage from Baridhara area to the existing sewer network in Gulshan area is considered the most economical and immediate measure. In this connection, the hydraulic evaluation of the existing sewer network in Gulshan area is required to verify acceptability of sewage from Baridhara area.

Principal conditions for evaluation of the existing sewer network in Gulshan area are as follows:

- Temporary treatment will be seized by 2005.
- Design population and per capita sewage flow in 2005 will be adopted. However, the per capita design maximum daily sewage flow is applied in view of purpose of the hydraulic evaluation.

Adopted conditions are as follows:

- Design population density 444.7 person/ha
- Per capita sewage flow 115 lpcd (design maximum daily sewage flow)

In setting up of realistic sewage flow, sewerage service coverage, which is estimated by ratio of served households by sewerage system and served households by water supply service. Future sewerage service coverage is assumed to be 100% in the master plan target year of 2020. Estimated sewerage service coverage in target years and intermediate years is shown in Table 14.2. Sewerage service coverage of North Dhaka in 2005 is estimated at 44%.

Table 14.2 Present and Future Sewerage Service Coverage

Unit: %

Area	1997	2000	2005	2010	2015	2020
North Dhaka	14.2	25	44	63	81	100
South Dhaka	44.8	52	64	76	88	100

Sewage flow from residential area in Cantonment Security Zone is excluded in this evaluation due to unavailability of required data.

Hydraulic simulation of the existing sewer network revealed that 2 sections of sewer lines showed shortage of flow capacity. These sections will be pressured conditions under over capacity and water level will raise in these sewer lines and connecting sewers in the upstream, as shown in Table 14.3. Increase of water level is estimated at 40 cm, but overflow of sewage will not occur from manholes since average earth cover of sewer lines is about 1.0 m.

Table 14.3 Increase of Water Level in Sewer Lines with Insufficient Flow Capacity

Sewer No.	Length	Sewage Flow	Material	Diameter	Gradient	Velocity	Hydraulic Gradient	Increase of Water Level
	m	cu.m/sec	-	mm	‰	m/sec	‰	m
1025	870	0.1103	VP	450	0.70	0.694	0.89	0.17
1035	780	0.1172	VP	450	0.70	0.737	1.00	0.23
Total								0.40

Resultants from the above simulation, it is concluded that temporary connection of new sewer lines from Baridhara area to the existing sewer network in Gulshan area will not cause significant problem on hydraulic capacity.

14.3.3 Relocation of Existing Trunk Main in South Dhaka Area

(1) Principal approach to relocation

The existing Asad Gate Trunk Main is not functioning properly due to damages and clogging of sewer pipes. For temporary treatment of sewage from the Core Area of North Dhaka Sewerage Service Zone, restoration of damaged sewer lines is indispensable and prerequisite.

Principal approach on this matter is summarised as follows:

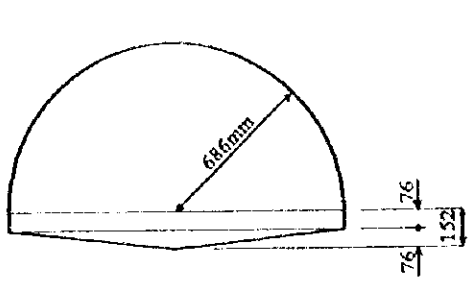
- Target section for restoration work of trunk main is between Tejgaon L.S. and Saidabad L.S., as identified through the field investigation.
- The above mentioned damaged trunk main will be principally relocated under the major road taking into account the following reasons:
  - o The subject trunk main is superannuated since more than 50 years in service.
  - o Damage inspection and restoration work of trunk main being submerged through the year is quite difficult and, even if restored, O&M of trunk main is deemed impossible to due restricted access.
  - o In rehabilitating the damaged trunk main, additional manholes shall be provided for the smooth conduct of O&M work, since the existing trunk main has more than 200 m of manhole intervals which restrict an effective cleaning.
- New trunk main to replace the existing one shall have the same cross-section area to allow hydraulic capacity of the existing one.
- The existing pump stations will be utilised as they are.
- Damaged points of trunk main shall be repaired by DWASA in principle. In this respect, DWASA had secured 500 million Taka of local budget from the national government to disburse the said repair/rehabilitation work in three years starting from 1998.

(2) Determination of cross-section for new trunk main

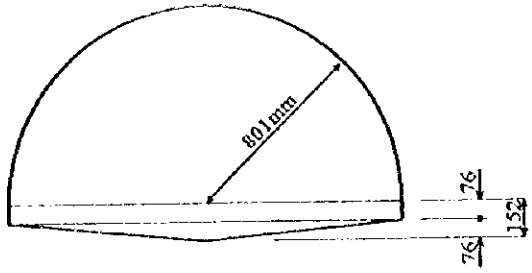
Materials, diameter and gradient of the existing trunk main are as follows:

Section	Material	Diameter	Gradient
Upstream of Tejgaon L.S.	Reinforced Concrete Pipe	600 mm	1.1 ‰
Tejgaon L.S. - Bashaboo L.S.	EQ Brick Arch Pipe	36"	0.48 ‰
Bashaboo L.S. - Saidabad L.S.	EQ Brick Arch Pipe	48"	0 ‰

Vertical cross-section of the existing trunk main is shown in Figure 14.4, while their flow capacity is shown in Table 14.4, respectively.



Cross-section of Trunk Main between Tejgaon LS and Bashaboo LS



Cross-section of Trunk Main between Bashaboo LS and Sayedabad LS

Figure 14.4 Vertical Cross-section of Existing Trunk Main

Table 14.4 Flow Capacity of Existing Trunk Main

Section of Existing Trunk Main	Length	Cross-sectional Area	Wetted Perimeter	Hydraulic Mean Depth	Roughness Coefficient	Gradient	Flow Velocity	Flow Rate
	L	*A*	*P*	*R*	*n*	*I*	*V*	*Q*
	m	sq.m	m	m	-	-	m/sec	cu.m/sec
Gulshan Area - Tejgaon LS	1,580	0.283	1.885	0.150	0.013	0.00110	0.720	0.204
Tejgaon LS - Bashaboo LS	3,720	0.896	3.688	0.243	0.015	0.00048	0.569	0.509
Bashaboo LS - Sayedabad LS	2,743	1.190	4.278	0.278	0.015	0.00111	0.947	1.127

Relocation of the existing trunk main will result longer length than the existing trunk main, because the existing three pump stations, namely Tejgaon L.S., Bashaboo L.S. and Saidabad L.S. will be utilised through the future. In this connection, diameter and gradient of new trunk main will be designed to have the same flow capacity of the existing trunk main, since depths of trunk main connected to respective pump stations can not be changed.

Specifications of new trunk main are shown in Table 14.5, general layout of new trunk main is shown in Figure 14.5 and the longitudinal vertical cross-section is shown in Figure 14.6.

Table 14.5 Specifications of New Trunk Main

Section of Existing Trunk Main	Required Flow Rate	Roughness Coefficient	Gradient	Diameter		Flow Velocity	Flow Rate	Length
				Required	Therefore			
	Q	*n*	*I*	*D*		*V*	*Q*	*L*
	cu.m/sec	-	-	mm		m/sec	cu.m/sec	m
Gulshan Area - Tejgaon LS	0.204	0.013	0.000665	659	700	0.621	0.239	2,615
Tejgaon LS - Bashaboo LS	0.509	0.013	0.00044	1005	1000	0.640	0.503	4,015
Bashaboo LS - Sayedabad LS	1.127	0.013	0.00081	1207	1200	0.981	1.110	3,370

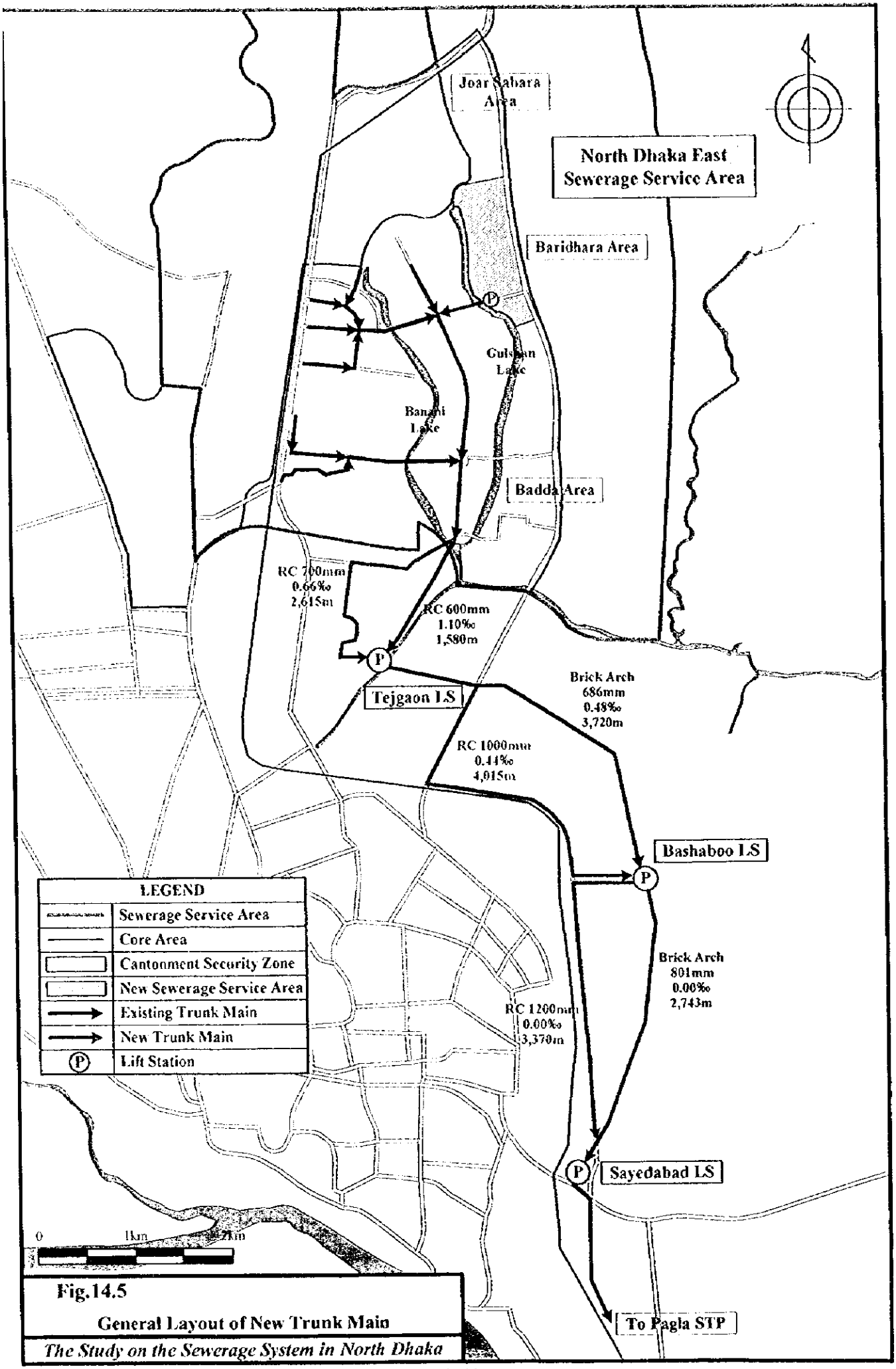
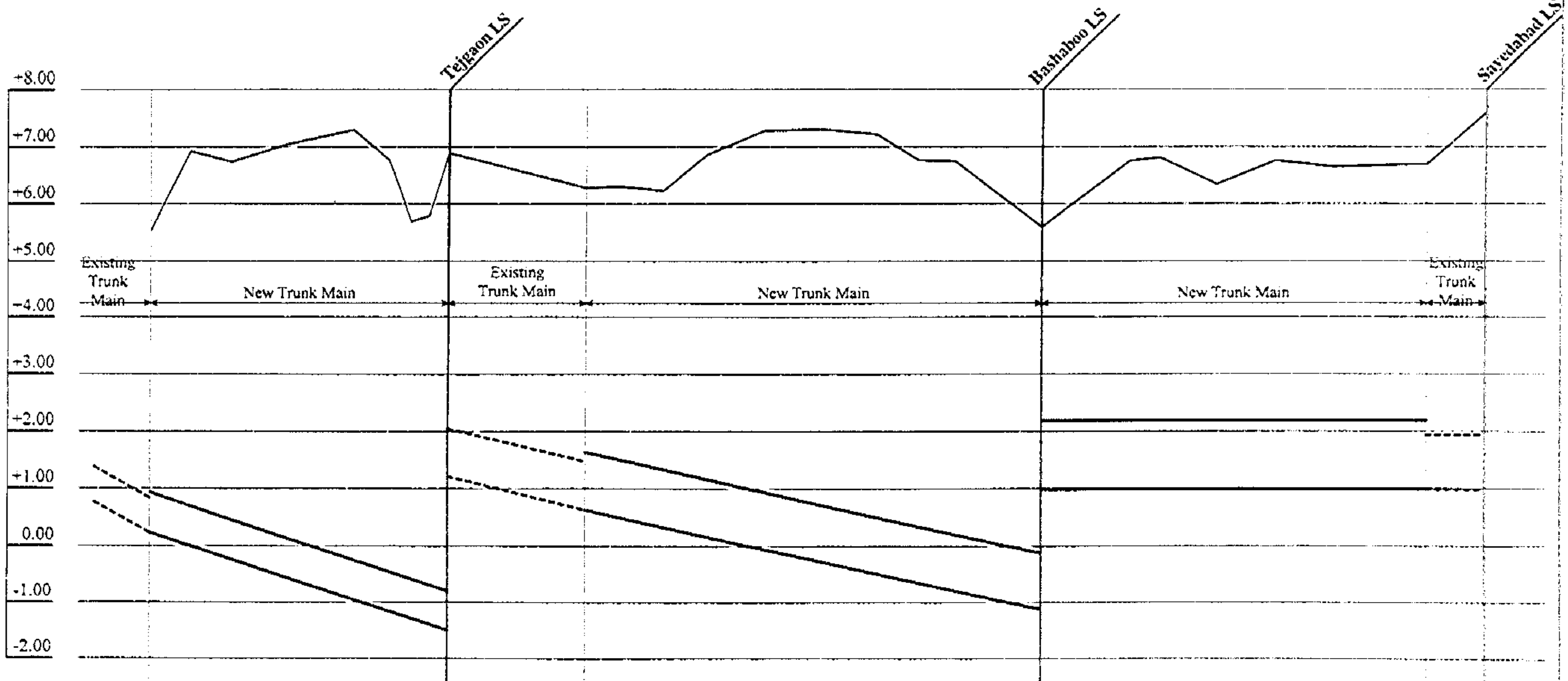


Fig.14.5

General Layout of New Trunk Main

The Study on the Sewerage System in North Dhaka



Diameter	600mm		700mm		686mm		1000mm		1200mm		801mm	
Gradient	1.1‰		0.66‰		0.48‰		0.44‰		0.00‰		0.00‰	
Ground Level		5.54		6.89		6.28		5.60		6.69		7.60
Invert Elevation		0.240		-1.498 / 1.219		0.638		-1.125 / 0.990		0.990 / 0.990		0.990
Distance		0	2,615	2,615	1,210	3,825	4,015	7,840	3,370	11,210	510	11,720

Figure 14.6
New Trunk Main Profile

The Study on the Sewerage System in North Dhaka

14.4 Project Cost

Project cost of the proposed emergency project is estimated as shown in Table 14.6

Table 14.6 Cost of Proposed Emergency Project

Unit: Tk'000

Item	Ratio (%)	Baridhara Area	South Dhaka Area	Total
Direct Construction Cost		56,890	573,364	630,254
Indirect Construction Cost	20	11,378	114,672	126,050
Construction Cost		68,268 US$1,575,427	688,036 US$15,877,875	756,304 US$17,453,302
Engineering Service	10	6,826	68,803	75,629
Administration Cost	5	3,754	37,841	41,595
Physical Contingency	10	7,884	79,468	87,352
Total		86,732 US$2,001,523	874,148 US$20,172,801	960,880 US$22,174,324

Note: Exchange Rate - US$ 1.00 = Tk 43.333 (as of January 1998)

14.5 Project Evaluation

Principal concept of the proposed emergency project is to partial utilisation of the existing sewerage system in South Dhaka, which situates out of the Study Area for North Dhaka Sewerage Development.

It is prerequisite to evaluate technical feasibility of temporary treatment of sewage until 2005 with the existing capacity of the Pagla Sewage Treatment Plant and the concerned pump stations. However, due to absence of the sewerage master plan of South Dhaka Area at the equivalent level of the North Dhaka Sewerage Master Plan, it is difficult to exactly evaluate influence of this emergency project to the existing South Dhaka Sewerage System.

In this regard, planning fundamentals of the South Dhaka Sewerage System was roughly evaluated to verify an influence of the proposed emergency project to the existing South Dhaka Sewerage System.

14.5.1 Design Population

Design population of South Dhaka Sewerage System in the year 2020 was estimated based on the DMDP of RAJUK with the same manner applied for the North Dhaka Sewerage Master Plan, as shown below:

Target year: 2020
Sewerage service area: 4,811 ha
Design population: 3,706,000 persons

14.5.2 Design Sewage Flow

Per capita sewage flow of the North Dhaka Sewerage Master Plan was applied to estimate the design sewage flow at each pump station in South Dhaka Sewerage System.

Ratios of service coverage and sewage leakage from sewer lines were considered to estimate more realistic design sewage flow in 2005. Sewerage service coverage was referred to the percentages shown in Table 14.2, while sewage leakage ratios were separately considered for the service area of Saidabad L.S. showing heavy leakage and other service area covered by Narinda L.S. Leakage ratio was then estimated based on the following formula and shown in Table 14.7.

Sewage Leakage Ratio =

(Design Sewage Flow x Service Coverage - Sewage Flow at Pump Station)/
(Design Sewage flow x Service Coverage)

Table 14.7 Present Sewage Leakage Ratio

Area	Unit	Sayedabad LS	Narinda LS
Design Sewage Flow	cu.m/day	71,240	124,946
Sewerage Service Ratio	%	44.8	44.8
Pumping up Rate	cu m/day	1,469	38,876
Sewerage Leakage Ratio	%	95	31

Future sewage leakage ratio was established assuming it would be reduced to 20 % in 2020 (master plan target year) as shown in Table 14.8.

Table 14.8 Future Sewage Leakage Ratio

Lift Station	1997	2000	2005	2010	2015	2020
Sayedabad LS	95.0	85	69	53	36	20
Narinda LS	31.0	30	27	25	22	20

Design sewage flow at pump stations in 2005 was estimated taking into account sewerage service coverage and sewage leakage ratio and shown in Figure 14.7. This simulation result indicated that New Market L.S. and Nawabganj L.S. would encounter slightly excessive sewage inflow than the pump capacity, Asad Gate Trunk Main between Tejgaon L.S. and Saidabad L.S. would be still capable to the estimated sewage flow. With regard to the Pagla Sewage Treatment Plant, the estimated sewage inflow would exceed approximately 15 % of the treatment capacity. As a whole, the proposed emergency project was concluded to be technically feasible.

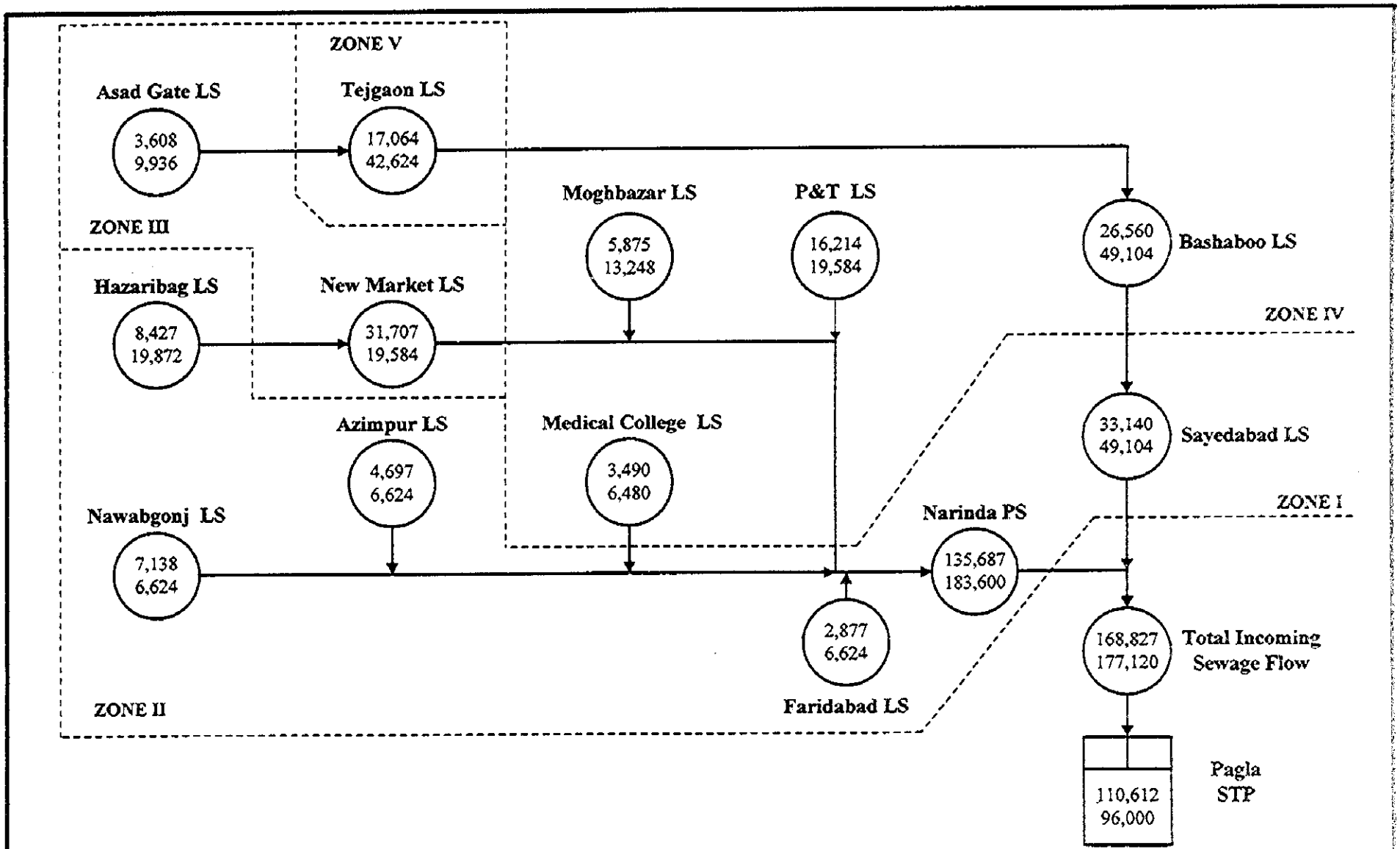


Figure 14.7
Design Incoming Sewage Flow of Existing Lift Station (Year 2005)

The study on the Sewerage System in North Dhaka