5.5 Preliminary Design of Sewerage System

The Core Area of the North Dhaka East Sewerage Zone (feasibility study area) is divided into three sub-zones by nature of sewerage system design and administrative jurisdiction, as shown below.

Core Area of North Dhaka East Sewerage Zone	Area
Existing Sewerage Service Area	654 ha
New Sewerage Service Area	214 ha
Cantonment Security Zone	1,090 ha
Total	1,958 ha

Domestic sewage discharged from the residential areas in the Cantonment Security Zone is planned to be accepted into the main sewer at two designated locations upon consideration of the topography, the alignment of the main roads and railways, and the results of a field inspection. These two locations are planned so as to compress the capital requirements to be borne by the Cantonment and designated at the existing sewerage service area and the new sewerage service area. At these connecting points, flow meters are planned to be installed by DWASA to measure the sewage flow from the Cantonment area for the purpose of sewerage service charge calculation.

Various fundamental figures of the transitional area in 2020 (Master Plan target year) and 2005 (Feasibility Study target year), which are necessary for facility planning, are illustrated in Figures 5.5.1 and 5.5.2, respectively.

5.5.1 Evaluation of Existing Sewer System

The existing service areas within the feasibility Study Area are located in Gulshan and Banani areas and Cantonment Security Zone (65 ha) with a total coverage of 719 ha. All of the domestic sewage discharged in these existing service areas is carried to the Tejgaon Lift Station via 600 mm (maximum) sewer main and pumped to the Asad Gate Trunk Main going to the Pagla STP.

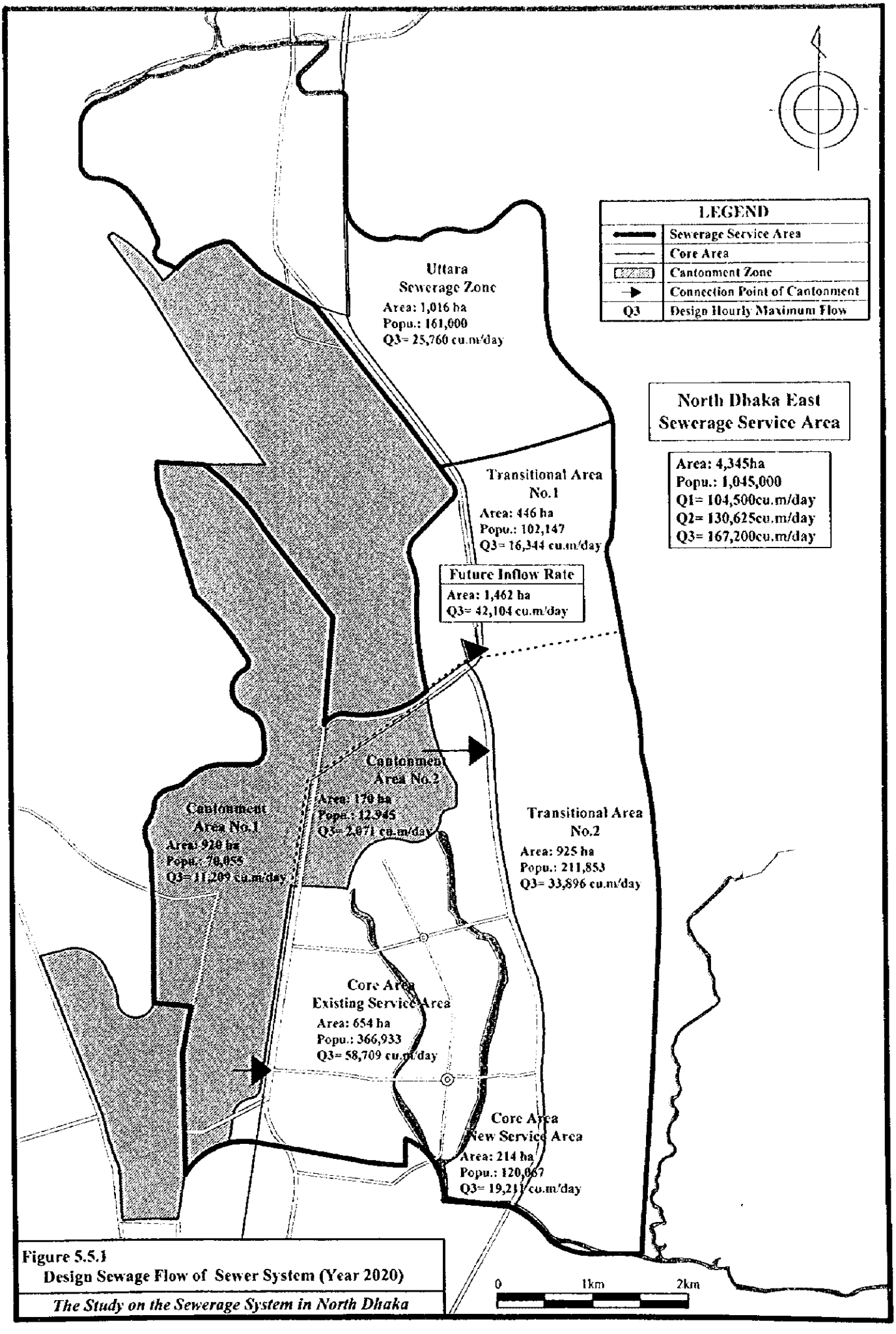


Figure 5.5.1
Design Sewage Flow of Sewer System (Year 2020)

The Study on the Sewerage System in North Dhaka

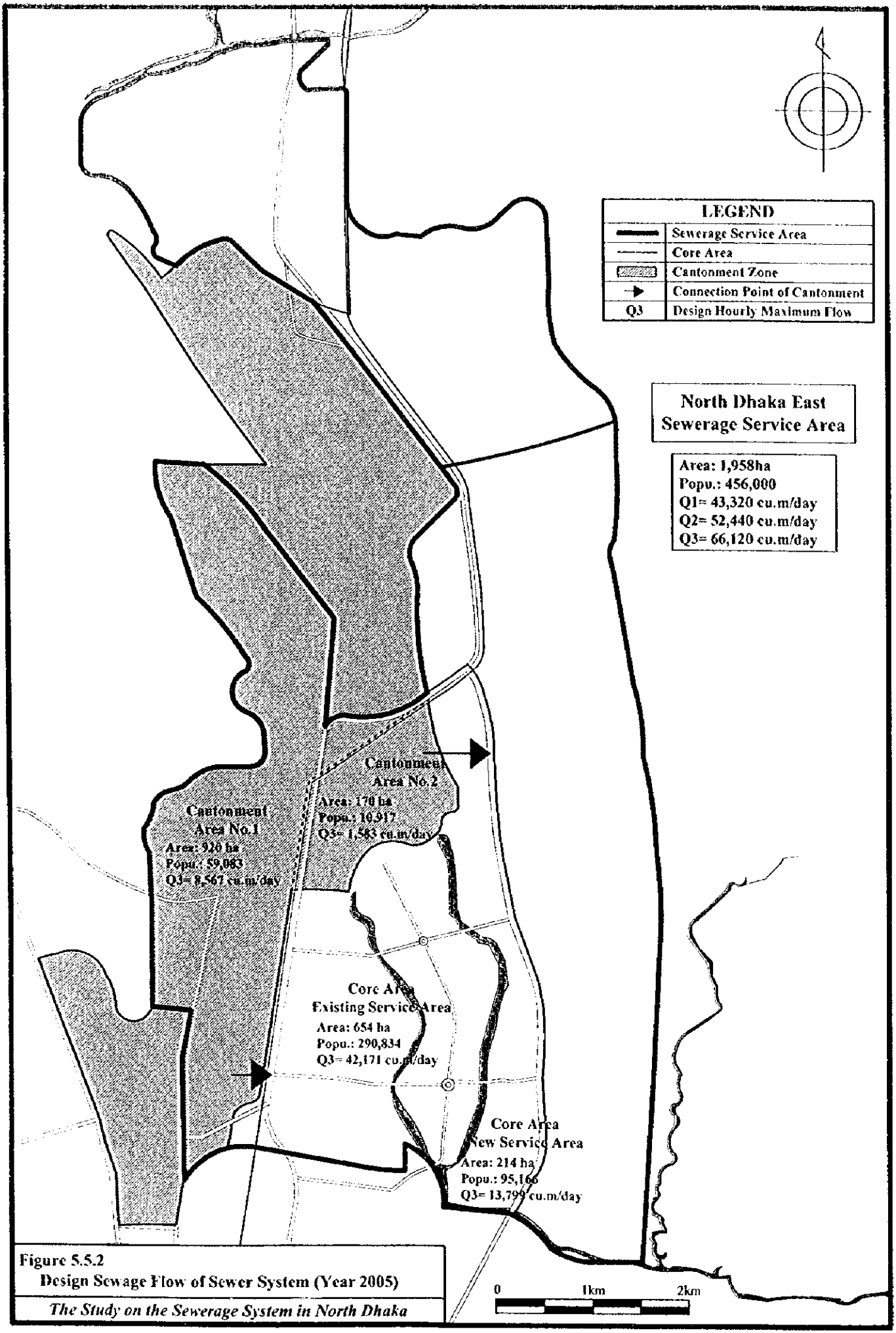


Figure 5.5.2
Design Sewage Flow of Sewer System (Year 2005)

The Study on the Sewerage System in North Dhaka

The technical data held by DWASA on these existing sewer networks was limited to the alignment and diameter of sewer pipes; the ground elevation and gradient of the sewer pipes was not available. Although the ground elevation was confirmed by a topographic survey, the gradient of the sewer pipes could not be surveyed due to the following reasons:

- Throughout the service area of existing sewer network in Gulshan and Banani areas, manholes were filled with sewage and scum near to the manhole cover because of clogging, and visual inspection was not possible to confirm the flow conditions and the invert level the of sewer pipes.
- A huge number of manholes would have to have been disabled to conduct the necessary survey within the limited time of the field activities.

Owing to the above reasons, a hydraulic simulation of the existing sewer network was carried out by the following procedures:

- Gradient of installed sewer pipes was firstly assumed by diameter.
- Trial hydraulic simulations were repeatedly carried out until the calculation result (invert level of sewer pipes) met the actual invert level of the main sewer at the entrance of the Tejgaon Lift Station.
- Through the above hydraulic simulation, the installed gradient of the sewer pipes by diameter was estimated as shown in Table 5.5.1.

Resultant from the above hydraulic simulation, it was concluded that the existing sewer network reaches the entrance of the Tejgaon Lift Station at an average flow velocity of about 0.60 m/sec. The hydraulic simulation result of invert level is presented in Appendix 5.5.1. Structural design of the Tejgaon Lift Station shall be referred to Figures 2.2.1 and 2.2.2 in Chapter 2.

Table 5.5.1 Diameter-Gradient Table for Existing Sewer Network

Material	Roughness Coefficient	Diameter (mm)	Gradient	Velocity (m/sec)	Flow Rate (cu.m/sec)
PVC	0.010	200	0.0020	0.6070	0.019
PVC	0.010	250	0.0015	0.6100	0.030
PVC	0.010	300	0.0012	0.6161	0.044
PVC	0.010	350	0.0010	0.6233	0.060
PVC	0.010	400	0.0008	0.6094	0.077
PVC	0.010	450	0.0007	0.6166	0.098
RC	0.013	500	0.0010	0.6081	0.119
RC	0.013	600	0.0008	0.6142	0.174

Note: PVC = Polyvinyl Chloride Pipe, RC = Reinforced Concrete Pipe

A hydraulic evaluation of the existing sewer network was conducted for main sewer lines having diameters of 300 mm or larger under the conditions of the design hourly maximum sewage flow. In this hydraulic evaluation, the existing sewer network in the Cantonment Security Zone was excluded based on the previously mentioned reason that their domestic sewage will be accepted at two designated locations.

The evaluation results are summarised in Table 5.5.2, while detailed calculation sheets are contained in Appendix 5.5.2. It is obvious that about 70% of the total length of the existing main sewer lines will encounter a shortage of hydraulic capacity in the Master Plan target year.

Table 5.5.2 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

5.5.2 Sewer 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 as 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 sections of the trunk main from the service area up to the STP do not receive any 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 existing sewer network,

based on the aforementioned hydraulic evaluation results. In addition, sewage discharged within the existing sewerage service area shall be collected and carried by the existing sewers with supplementary pipes up to the most downstream point and pumped to the new trunk main in the new sewerage service area.

The configuration of sewer the system, which was designed based on the above-mentioned conditions, is shown in Table 5.5.3, while a general layout plan of sewerage system is shown in Figure 5.5.3. The design data of the new sewerage service area and the existing sewerage service area are contained in Appendices 5.5.3 and 5.5.4, respectively.

Table 5.5.3 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

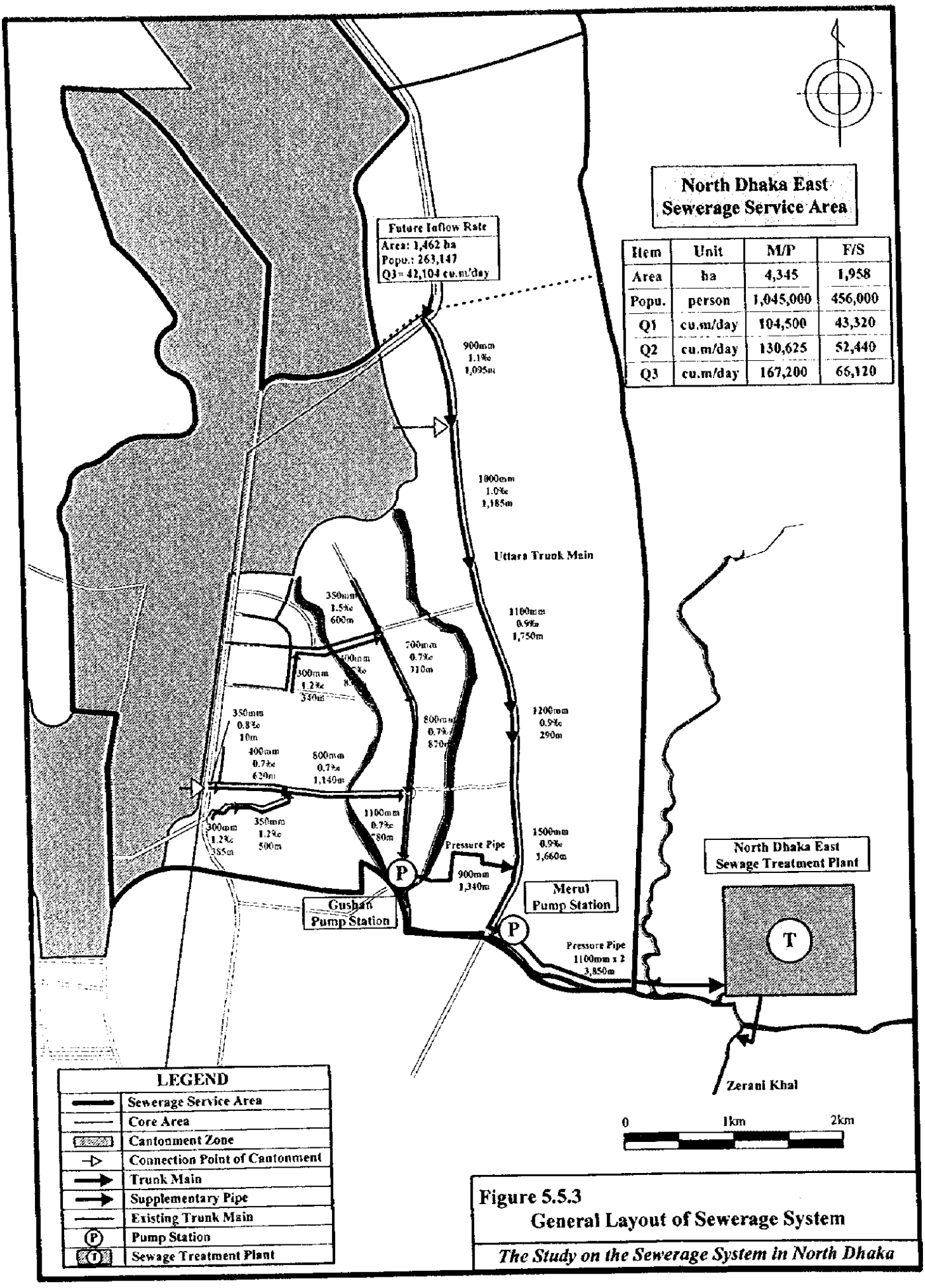


Figure 5.5.3
General Layout of Sewerage System

The Study on the Sewerage System in North Dhaka

5.5.3 Pump Station

The Merul Pump Station and the Gulshan Pump Station are designed in this feasibility study. The design sewage flow of each pump station is shown in Table 5.5.4.

Table 5.5.4 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

(1) Design concept of pump station

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, the civil and architectural facilities of the Merul Pump Station were designed to handle half of the whole capacity, while the Gulshan Pump Station was designed to handle the whole scale of the Master Plan. Thus, the remaining half of the required facilities of the Merul Pump Station will be implemented after the completion of the priority project.

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

The mechanical and electrical equipment and their appurtenances are selected and designed from the view points of:

- Ease of O&M, and
- Operability and sustainability to prevent any interference of the operation of the pump station.

(2) Civil and architectural work

1) Flow chart of pump station

The design maximum hourly sewage flow of the Merul and Gulshan Pump Stations in the Master Plan target year is 167,200 cu.m/day and 69,918 cu.m/day, respectively. These pump stations are therefore regarded as a large-scale pump stations and are classified as the Standard Type 1 category as described in the design criteria of pump station (refer to Section 8.3.2, Chapter 8 of the Master Plan).

Considering the above-mentioned capacity scale of pump station and the ease in O&M through the provision of the symmetrical design, these pump stations are designed to have the same flow chart as shown in Figure 5.5.4.

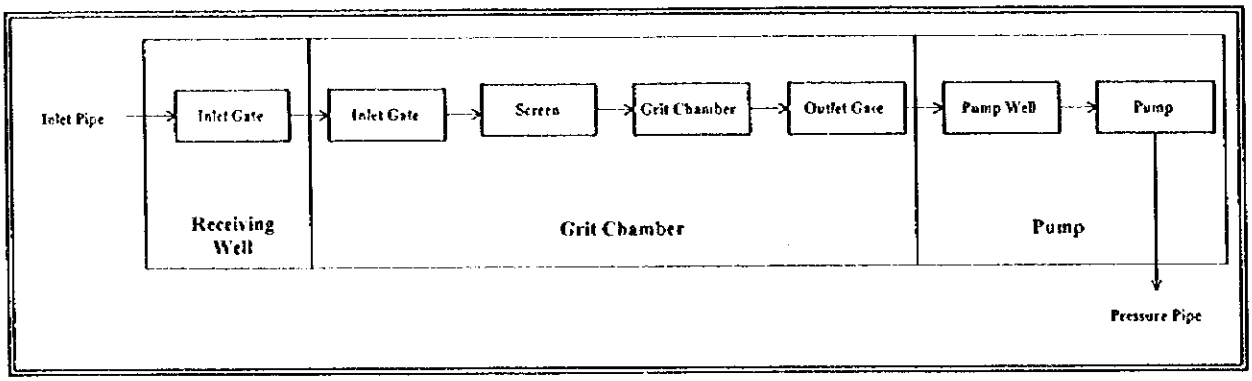


Figure 5.5.4 Flow Chart of Pump Station

2) Trunk main (pressure pipe)

The trunk main from each pump station has a long delivery length with high hydraulic head loss. The optimum diameter of the trunk main was determined by setting up the minimum flow velocity at 1.0 m/sec (within the economical and applicable range) in order to meet with the standard specifications of the total dynamic head and the discharge capacity of pumps.

The number of pipelines was determined as follows:

- The trunk main from the Gulshan Pump Station to the Merul Pump Station shall be a single line since the design maximum hourly flow in the feasibility study is about three-fourths of the whole flow of the Master Plan.
- The trunk main from the Merul Pump Station to the North Dhaka East STP shall use parallel lines; first line is to be constructed in the priority project and the second line to be constructed at a later stage.

(3) Mechanical and electrical facility and equipment

1) Composition of major facilities and equipment

Mechanical and electrical facilities, such as gates, screen, pumps, power receiving and distribution facilities, and operating panels are provided to meet with the design sewage flow in the feasibility study as mentioned before.

Standby generator

A standby generator is also included to cope with frequently occurring power failure and its load capacity is considered to be capable to support all the electric power demand at the pump station.

Pumping equipment

Pumping equipment is considered to have one additional unit as standby to cope with breakdown and suspension of operation for regular maintenance. Settled sand and mud which will accumulate in the trunk main is planned to be removed by the flushing out of such sediments at a faster velocity than the regular flow (1.0 m/sec) by the operation of all pumps, including the standby pump(s).

Screen

Type of screen is determined to be hand raked bar screen. To insure easy removal of captured screenings by manpower, grit chamber is designed to be compact enough with smaller width and shallower depth and catwalk is provided at intermediate level to allow smooth removal of settled screenings on the bottom. Removed screenings stored in the container will be transferred to hauling trucks by the use of motorised hoist.

Settled sand and mud in the grit chamber is designed to be removed by a sand pump and filtered by a mesh bucket to separate it from the sewage. The removed sand and mud stored in the container will be transferred outside of the pump pit by means of a motorised hoist for final disposal by trucks, etc.

The major reasons on the selection and design of screen facility are:

- A complicated and large-scale grit removal facility requires considerable time to recover from a breakdown,
- The removal of grit screenings and sand/mud can be done intermittently, while continuous operation of a submergible grit removal facility is costly, both in construction and O&M.

Gate

Manually operated cast iron type gate is designed for pump station. The inflow gate was designed to be operated both manually and by a motorised/engine driven system, since it requires considerable torque when the inlet side faces the high hydraulic pressure of inflowing sewage because of its deep installation position. Gates are provided for both the inlet and outlet of every line of grit chamber. Both inlet and outlet gates are closed to prevent the inflow of sewage during cleaning work.

Electrical facility/equipment

Both the Gulshan and Merul Pump Stations were designed to receive 11kV of an extra-high-tension primary power supply. The transformer capacities of these pump stations are as follows:

Gulshan Pump Station: 250 kVA x 1 bank

Total power demand: F/S 149.7 kW M/P 194.9 kW

Merul Pump Station: 500 kVA x 2 banks

Total power demand: F/S 344.7 kW M/P 675.3 kW

2) Selection criteria and comparative evaluation of mechanical and electrical equipment

a. Gate

A Manually operated cast iron type was selected through comparative evaluation. Details are referred to Subsection 5.5.4 for the STP.

b. Screen

Comparative evaluation was made among hand raked bar screen, shredder, automatic trash rakes, and rotating screw automatic screen, as shown in Table 5.5.5 and the hand raked bar screen was finally selected for the proposed facility with following advantages:

- Less risk of trouble against excessive inflow of trashes.
- Cheap and easy for O&M.
- Many existing pump stations have adopted this type of screen.

c. Lift pump

A vertical centrifugal mixed flow pump was selected through a comparative evaluation between a centrifugal pump, a centrifugal mixed flow pump and an axial flow pump, as shown in Table 5.5.6.

The major reasons in selecting the said pump are as follows:

- Both the Gulshan and Merul Pump Stations require high pumping heads, at 13 mH and 22 mH, respectively.
- The pumps should have high durability against clogging that could be caused by materials floating in the raw sewage.
- Ease of O&M is desired for pumping equipment.

In addition to the above reasons, pumps have a high risk to encounter flooding under emergency conditions, since the pumps are to be installed at the deepest position of the pump stations. Therefore, vertical-type pumps were selected because of the high position of their motor, at so as to avoid flood hazards.

An outline of the Merul and Gulshan Pump Stations is shown in Table 5.5.7 and their capacity calculation is contained in Appendices 5.5.5 and 5.5.6, respectively. Lists of the mechanical and electrical facility and equipment of Gulshan and Merul Pump Stations are contained in Appendices 5.5.7 and 5.5.8, while single line diagrams of these pump stations are contained in Appendices 5.5.9 and 5.5.10, respectively.

Table 5.5.5 Comprison of Screening Method (1/2)

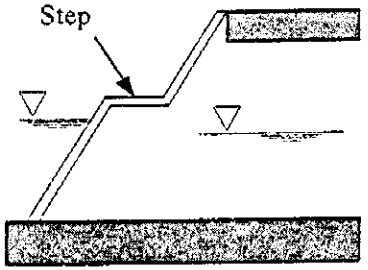
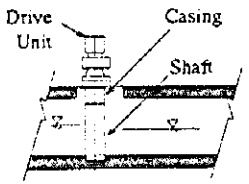
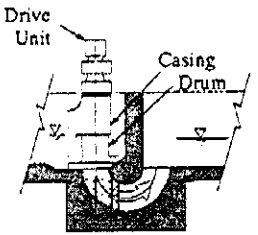
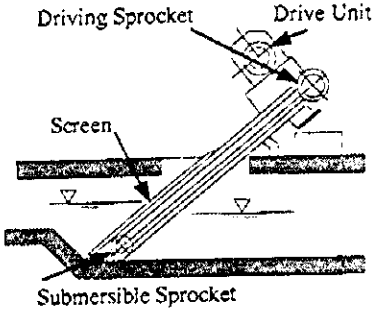
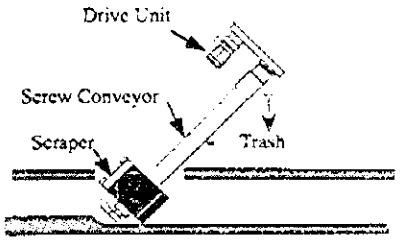
Item \ Type	Hand Raked Bar Screen	Shredder	Automatic Trash Rakes	Rotating Screw Automatic Screen
Contruction		· 2Axes Rotary Type  · Drum Rotary Type 		
Operation	o Remove screenings/trashes by hand rake.	o To be installed at inlet channel and crush all incoming trashes and discharge to outlet channel.	o Rakes attached to chains are moved by driving sprocket and submergible sprocket. o Trashes/screenings are removed from water by rakes.	o Trashes/screenings are captured in submerged circular scraper. o Captured trashes/screenings are carried out by screw conveyor.
Advantage	o No electric power required. o Low cost for installation o Easy to install.	o Require to remove large size screenings/trashes, since solid materials are crushed into small particles and discharged to pump pit.	o Automatic removal of trashes/ screenings is available by setting up of timer or other controlling device. o Can remove relatively large size trashes/screenings.	o Dehydration of screenings can be done automatically and final disposal becomes easy. o Easy to install.

Table 5.5.5 Comprison of Screening Method (2/2)

Item \ Type	Hand Raked Bar Screen	Shredder	Automatic Trash Rakes	Rotating Screw Automatic Screen
Disadvantage	o Considerably poor working environment occurs due to odour caused by hand raked nightsoil and other trashes/ screenings.	o Scum occurs in pump pit owing to finely crushed trashes/screenings. o Cutter blades require periodical replacement.	o Rather complicated maintenance is required for submerged part of equipment. o Periodical replacement of bearings are required.	o Regular operating water depth is shallow at about 50% of the diameter of drum. o There are cases to require coarse screen at upper part of drum screen, when inlet water level exceeds the emergency water level (about 60% of diameter of drum).
Applicability to the Project	o This hand rake method is suitable to meet with various sizes and types of trashes/ screenings in sewage. o Continuously stationing O&M staff can cope with excessive inflow of trashes/screenings and emergency situation.	o This system is not suitable to the project since large size trashes/screenings can not be treated.	o Requires considerable manpower for maintenance. o Breakdown/malfunctioning may occur depending on types of trashes/screenings. o This system is not suitable for the project in view of above reasons and its high installation cost.	o Very high cost equipment. o Not suitable to large scale sewerage facilities owing to less performance in actual application.

Table 5.5.6 Comparison of Lift Pump

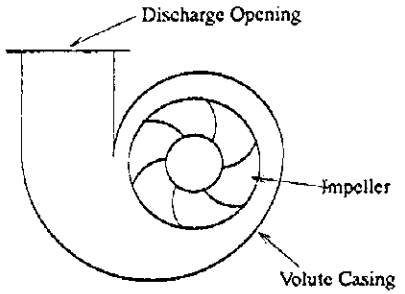
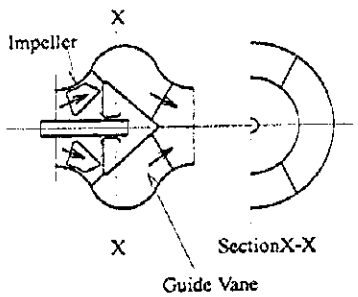
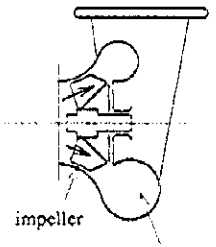
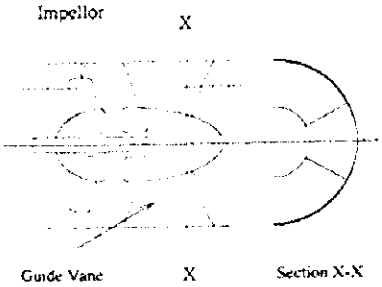
Item \ Type	Centrifugal Pump	Mixed Flow Pump	Centrifugal Mixed Flow Pump	Axial Flow Pump
Construction				
Performance	1. Wide range of high efficiency 2. Superior suction performance and safe against cabitation. 3. Easy to maintain owing to absence of submergible bearing. 4. Suitable to more than 5 m of suction head. 5. Installation area is larger than mixed f low pump	1. Stable discharge against variation of suction water level. 2. Applicable for no-discharge operation in general. 3. Pump body is smaller than centrifugal pump in general. 4. Suction performance is poorer than cen trifugal pump, but superior than axial flow pump. 5. Suitable for stormwater pumping. 6. Suitable for suction water level of 3 to 8 m depth. 7. Installation area requirement is interme diate between centrifugal pump and axial flow pump.	1. Wide range of high efficiency 2. Superior suction performance and safe against cabitation. 3. Easy to maintain owing to absence of submergible bearing. 4. Less risk of clogging by foreign materials owing to the use of open type impeller in comparison to mixed flow pump. 5. Less erosion and easier maintenance than vertical mixed flow pump beings ubmerged in water. 6. Suitable to more than 5 m of suction head. 7. Installation area requirement is larger than mixed flow pump.	1. Smaller pump body than mixed flow pump is available by means of higher revolution speed. 2. Superior than other types when the total pumping head is always less than 4 m. 3. Rapidly increase axial power demand and become overloading with noise an dvibration, when pump discharge exceeds 130% of rated capacity. 4. Applicable for no-discharge operation. 5. Poor suction capacity and narrow range of high performance. 6. Suitable for suction head of 1 to 5 m. 7. Installation area requirement is smaller than mixed flow pump.
Applicability to the Project	There is a risk of clogging by foreign materials, though pump performance satisfies requirements of the Project.	Insufficient suction head and poorer serviceability.	Pump performance satisfies requirements of the Project and superior serviceability.	Insufficient suction head and poor capability to follow-up load variation.

Table 5.5.7 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.

5.5.4 Sewage Treatment Plant

(1) Outline of STP

A preliminary engineering design of the STP with a design sewage flow shown in Table 5.5.8 was prepared handle the sewage collected from the North Dhaka East Sewerage Zone.

The design capacity of the STP was considered to be a half of the whole capacity required in the Master Plan since the design sewage flow during priority project period has about 41% of the total flow in the Master Plan period. In this respect, the number of units for the respective treatment facilities is considered to be an even number and half of them are designed to be implemented in the priority project period.

The sludge lagoon is also designed to treat septage to be collected from the on-site treatment area.

Table 5.5.8 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

The flow diagram and flow chart of the North Dhaka East STP are shown in Figures 5.5.5 and 5.5.6, respectively and the design conditions of sewage treatment facilities are summarised in Table 5.5.9.

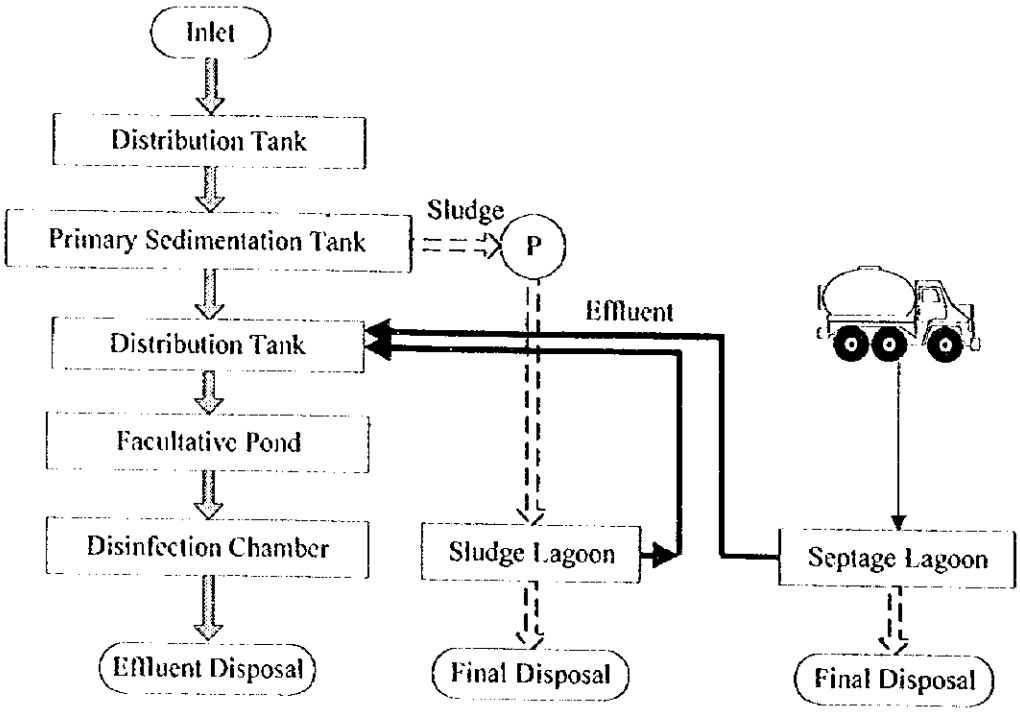


Figure 5.5.5 Flow Diagram of North Dhaka East Sewage Treatment Plant

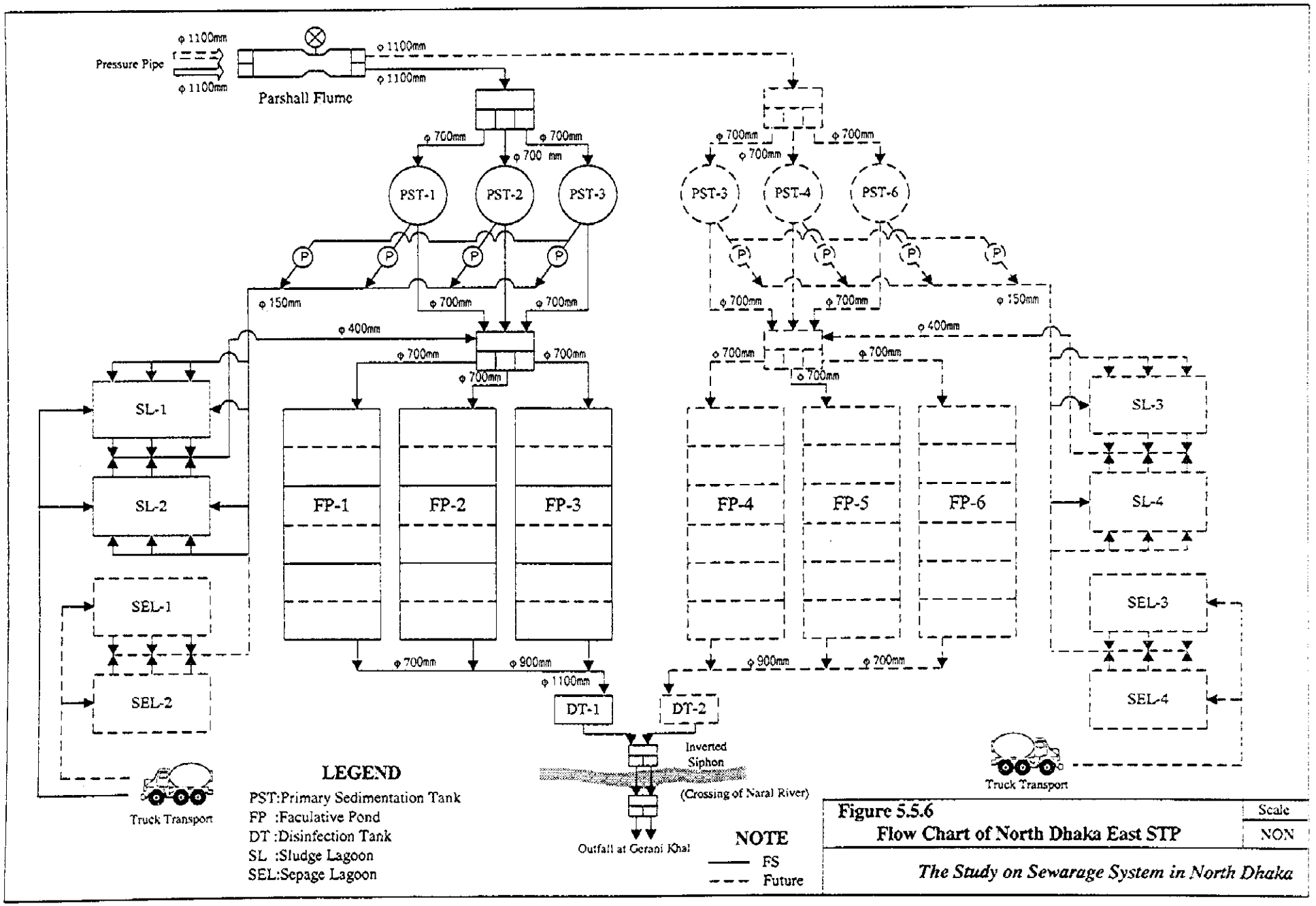


Figure 5.5.6
Flow Chart of North Dhaka East STP

Scale: NON

The Study on Sewarage System in North Dhaka

Table 5.5.9 Design Conditions of Sewage Treatment Plant

Item	Design Conditions
Elevation	+0.47 m
Inlet Pipe Level	+10.800 m
Inlet Pipe Diameter	SP 1,100mm × 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

(2) Civil Work

1) Facility design

The treatment facilities listed in Table 5.5.10 are designed as described below and their capacity calculation are contained in Appendix 5.5.11.

a. Grit chamber

No grit chamber is provided at the STP, since the Merul Pump Station is designed to have a grit chamber.

b. Primary Sedimentation Tank

i. Structural design

The structural design of sedimentation tank is usually rectangular or circular in shape and in large-scale facilities it is commonly designed to be rectangular in shape.

When the operation of the sludge scraper is stopped by a malfunction or for any other reason, sludge removal will be almost impossible since the sludge draining pit is located at one side of the rectangular sedimentation tank. In the case of a circular sedimentation tank, sludge removal can still continue (at lower efficiency), since the sludge will settle and gather at the centre of the sedimentation tank.

In consideration of the above advantages, the primary sedimentation tank is designed to be circular in shape.

Table 5.5.10 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:150mm × 1.1cu.m, 20m/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^{ϕ}
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: 8.0m^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	-	-	F/S- STP Site: 65ha, Road for Access: 20,060 sq.m, Road for Discharge: 11,380 sq.m M/S- STP Site: 120ha, Road for Access: 20,060 sq.m, Road for Discharge: 11,380 sq.m

ii. Number of tanks

When periodical cleaning, repair and replacement works are taken into account, plural units are indispensable to maintain the continuous operation of a treatment system.

The ideal capacity of sedimentation tank is determined at about 20,000 cu.m/day from the viewpoints of the Water Surface Area Load and the Weir Load.

Judging from the above conditions, the total number of primary sedimentation tanks for the Master Plan sewage flow is determined at 6 units and 3 units of them are considered appropriate for the priority project.

c. Facultative pond

i. Capacity

The required surface area of stabilisation pond is determined based on the BOD Area Load as given in the design criteria and the average monthly minimum atmospheric temperature at 18 ℃ in the past five years (refer to Appendix 5.5.11), as shown below:

$Ls = 60.3 \times 1.0993^{T}$

Where, Safety Factor: 1.5

Ls : BOD Area Load (kg-BOD/ha/day)

T : Average Monthly Minimum Atmospheric Temperature (℃)

$Ls = 60.3 \times 1.0993^{18} / 1.5 = 331.4 / 1.5$

$= 221$ kg-BOD/ha/day

ii. Number of series

Although plural number of units are indispensable for effective treatment including periodical maintenance, an excessive number of units is, on the other hand, uneconomical due to the increase in construction cost.

Under regular operating conditions, stored sewage in facultative ponds will have to be drained at an interval of once every five years to remove accumulated sludge after sun drying. Since the sun drying of sludge will take a period of approximately one month, it shall be scheduled to be carried out during the dry season with a relatively high atmospheric temperature, such as the month of October, and sewage treatment shall be shouldered by remaining ponds. The average monthly minimum atmospheric temperature in October 1994 was 23.3 ℃. Applying this data, the BOD Area Load was estimated at

365 kg-BOD/ha/day.

$$Ls = 60.3 \times 1.0993^{23.3} / 1.5 = 547.4 / 1.5$$
$$= 365 \text{ kg-BOD/ha/day}$$

This estimate is approximately 1.7 times larger than the Design BOD Area Load of 221 kg-BOD/ha/day. In other words, the required surface area during this period is about 60% (221/365 = 0.61) of the Design BOD Area Load. Therefore, the number of series was determined to be six (6) for the Master Plan and three (3) for the priority project (when one series of ponds is used for sludge drying, the remaining two series will be used for sewage treatment at about 67% (2/3) of the Design BOD Area Load).

This number of series well corresponds to the number of the primary sedimentation tanks. For the smooth O&M of the primary sedimentation tanks and facultative ponds, a distribution tank was considered to be located between these two facilities.

iii. Shape

Facultative ponds have generally rectangular or square shape. For this particular project, a rectangular shape is adopted.

From the viewpoint of smooth O&M, one series of ponds is designed to consist of 3 ponds and each pond is divided into two parts by provision of a guide wall to avoid a short cut flow.

Configuration of facultative pond is as follows.

No. of pond: 3 ponds/series (M/P - 6 series, F/S - 3 series)

Dimension: 200 $m^{L} \times 160\ m^{W}$

iv. Structure

The slope of embankment on the inside of the pond is designed to have gradient of 1:3 to avoid erosion by waves to be caused by wind, while that of the outside was designed at gradient of 1:1.5.

The bottom and inside of the embankment of each pond are covered with lean concrete to prevent the seepage of sewage into the ground.

The top of embankment was designed to have a 5 m width to allow the passage of trucks for hauling dried sludge and periodical monitoring. An access slope was provided for each sludge lagoon to allow for the operation of a bulldozer and trucks for hauling dried sludge.

d. Disinfection tank

i. Shape

The rectangular shaped disinfection tank, with 4 channels of horizontally baffled flow, was designed to attain sufficient contact of the chlorine with the treated effluent.

ii. Number of units

The number of disinfection tanks was determined to be two (2) units for the Master Plan and one (1) unit for the priority project, since no particular suspension of usage was foreseen for this facility.

iii. Structure

The disinfection tank was designed to be made of reinforced concrete equipped with a movable weir to drain water from facultative pond. (When the weir is lowered 1.5 m from the normal position to drain water of facultative pond, the contact time of chlorine will decrease to 5 minutes. However, the required contact time for disinfection can be maintained since the flowing period of effluent in discharge pipe from disinfection tank to the discharge point will have about 18 minutes and no negative influence is foreseen to the receiving water body).

e. Sludge lagoon

i. Capacity

The required surface area and depth were determined based on the design criteria.

ii. Number of units

As it is considered for facultative ponds, multiple units are necessary in due consideration of smooth O&M and construction cost.

The sun drying of sludge will require about a one year period, taking into account the atmospheric temperature and rainfall as described in Appendix 5.5.12; a minimum of one series with two lagoons is necessary for sun drying and storage.

Resultant from the above consideration, two (2) series with four (4) lagoons for the Master Plan and one (1) series with two (2) lagoons were adapted in the design.

The sequence of the sludge lagoon operation (storage/digestion and sun drying) is shown in Figure 5.5.7.

Year				1		2	
Season				Rainy	Dry	Rainy	Dry
M/P	F/S	FP-1	Storage & Digestion	■	■		
			Digestion			▒	
			Sun Drying & Removal				▒
		FP-2	Storage & Digestion			■	■
			Digestion	▒			
			Sun Drying & Removal		▒		
		FP-3	Storage & Digestion	■	■		
			Digestion			▒	
			Sun Drying & Removal				▒
		FP-4	Storage & Digestion			■	■
			Digestion	▒			
			Sun Drying & Removal		▒		

Figure 5.5.7 Sequence of Sludge Lagoon Operation

ii. Shape

In due consideration of the distances and the layout in relation to the sludge conveyance from the primary sedimentation tank and the return of the supernatant, the design of the sludge lagoon was determined to be a rectangular shape.

iii. Number of units and dimensions

No. of lagoon: 2 lagoon/series (M/P - 2 series, F/S - one series)

Dimension: 360 $m^L \times 120\ m^W$

iv. Structure

The slopes of embankment were designed with 1:3 gradients for the inside and 1:1.5 for the outside, as applied for the facultative pond.

The bottom of the lagoon and the inside slope of the embankment were designed to be finished with lean concrete to avoid the seepage of sewage into the ground.

The top of the embankment is designed to have a 5 m width to allow the passage of trucks for hauling dried sludge and periodical monitoring.

In order to avoid unequal distribution of sludge settling, 3 units each of sludge inflow points and supernatant outflow points are provided in the longitudinal direction of lagoon.

An access slope for a bulldozer and trucks is provided for each lagoon to remove dried sludge.

f. Sludge lagoon for septage treatment

The balance of design sewage flow between the North Dhaka East Sewerage Service Area and the North Dhaka West Sewerage Service Area is about 40:60. In determining the acceptance volume of septage to be collected from septic tanks in the transitional area, this sewage flow balance was applied considering the equal loading to sludge lagoon. The design septage volume of sludge lagoon is shown in Table 5.5.11.

Table 5.5.11 Design Septage Volume for North Dhaka East Sewage Treatment Plant

Item		M/P	F/S	Remarks
Design Population (person)		778,000	440,000	Excluding Tongi
Sludge Weight (SS-kg/day)	Total	7,780	4,400	10g/day/capita.
	North Dhaka East STP	3,110	1,760	40% of total
	North Dhaka West STP	4,670	2,640	60% of total
Sludge Volume (cu.m/day)	Total	389	220	As 2% of SS Content
	North Dhaka East STP	156	88	
	North Dhaka West STP	233	132	

The design capacity of the sludge lagoon designed for the priority project is 7,838 kg-SS/day, equivalent to the half of the Master Plan capacity, while the design sludge volume in the priority project is estimated at 6,293 kg-SS/day leaving 1,545 kg-SS/day of an excessive treatment capacity.

When the septage volume to be generated during the priority project period at 1,760 kg-SS/day is compared to the said 1,545 kg-SS/day of acceptable allowance, most of the septage can be treated in the sludge lagoon without additional facility. An additional sludge lagoon will be required in the later stage of the project.

i. Capacity

The required surface area and depth are same as sludge lagoon as shown in the design criteria.

ii. Number of units and dimension

No. of units: 2 series (4 lagoons)

Dimension: $120m^{l} \times 80m^{w}$

iii. Shape

Rectangular

iv. Structure

The slopes of the embankment, the lean concrete protection of the bottom and inside slopes of the embankment, and the access slope are the same as the sludge lagoon.

A dumping pit for vacuum truck is considered for access to the septage sludge lagoon. (the number of vacuum trucks is estimated at about 78 units/day by 2 cu.m capacity and traffic frequency is assumed to be every 5 minutes in day-time.)

h. In-plant Piping

i. Design sewage flow for in-plant piping

The design sewage flow for in-plant piping is shown in Table 5.5.12.

Table 5.5.12 Design Sewage Flow for In-Plant Piping

In-plant Piping	Design Sewage Flow
Parshall Flume→ Primary Sedimentation Tank	Hourly Maximum
Primary Sedimentation Tank → Facultative Pond	Daily Maximum
Facultative Pond → Disinfection Chamber	Daily Average
Disinfection Chamber → Sewer Outlet	Daily Average
Primary Sedimentation Tank → Sludge Lagoon	by Pump Capacity
Sludge Lagoon → Primary Sedimentation Tank	by Pump Capacity

ii. Average flow velocity

In-plant piping is usually designed to have a flow velocity of within 0.6 to 1.0 m/sec. In this feasibility study, the average flow velocity within the section where the sludge settling in pipes is not expected is reduced to depress the hydraulic head loss and the ground elevation of the treatment plant, as shown below:

Parshall flume → Primary sedimentation tank: 1.0 m/sec

Primary sedimentation tank → Effluent disposal: 0.6 m/sec

iii. Pipe material

Sewage: Reinforced concrete pipe

Sludge: Steel pipe (primary sedimentation tank → sludge lagoon)

2) Candidate site of STP

The required area of STP is about 65 ha for the maximum daily sewage flow of 52,440 cu.m/day for the priority project and about 120 ha for 130,625 cu.m/day for the Master Plan.

The proposed location of STP was designated at about 2.5 km away from the Rampura Bridge, east of the Gulshan area, as planned in the Master Plan preparation, as shown in Figure 5.5.3 and its photographs are shown in Appendix 5.5.13.

The proposed site faces the Naral River at the south and has an average elevation of about 0.5 m with sporadically elevated sites of about 2.0 m and khals at a height of about 2.0 m. The west side of the proposed site is under land reclamation for residen-

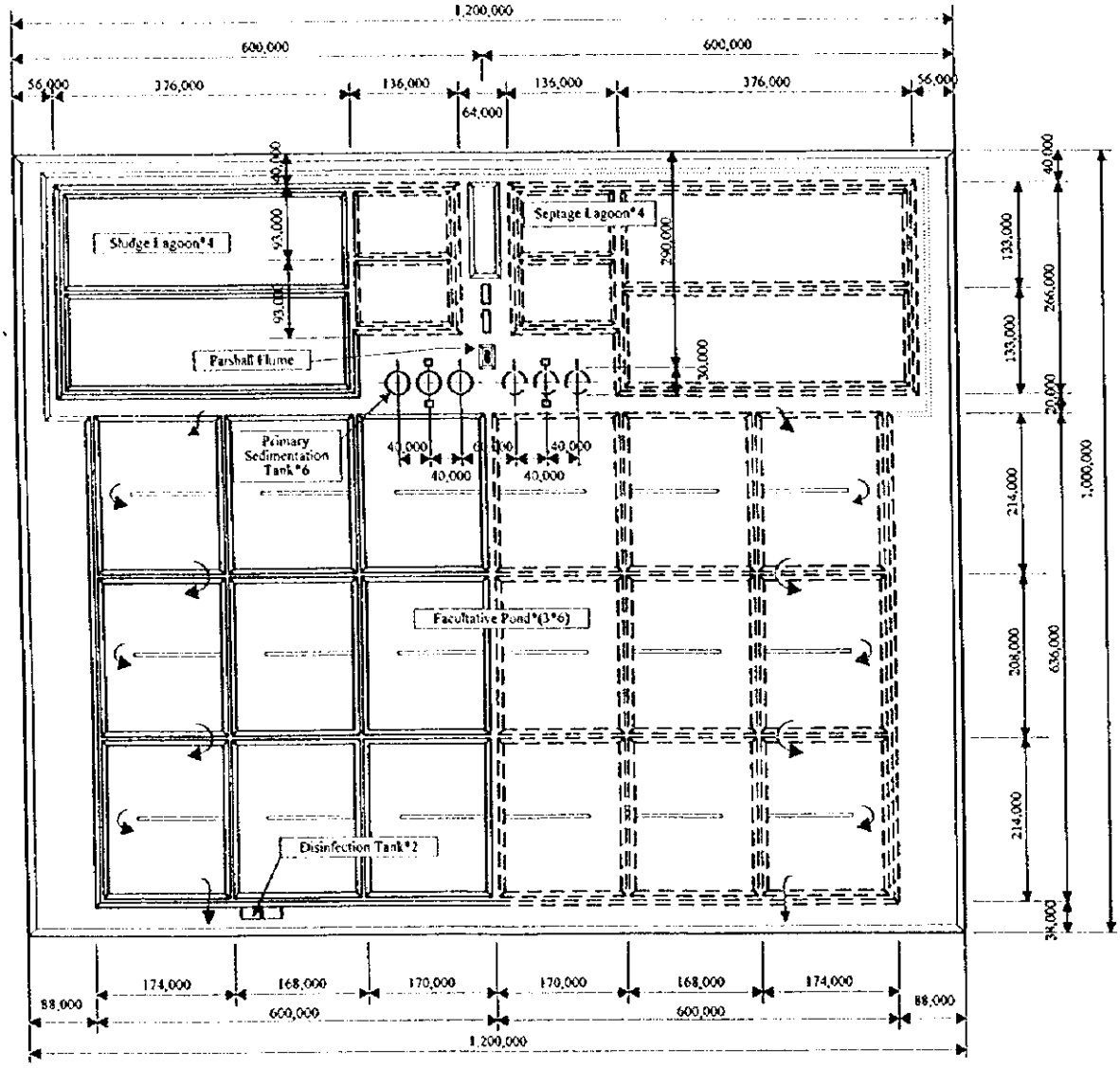
tial use extended from the built-up area. In this connection, a rectangular-shaped site was identified on a less-utilised area of land.

Since there is no existing road, an access road will have to be constructed from the Merul Pump Station to the proposed site where under a trunk main will be laid.

3) Layout plan

The layout plan of the STP is shown in Figure 5.5.8.

Raw sewage will be sent from the Merul Pump Station through the trunk main (pressure pipe) to the west site entrance of the STP.



——— : F/S

– – – :Future

Figure 5.5.8
General Layout of North Dhaka East STP

Scale

The Study on the Sewerage System in North Dhaka

The treated effluent will be discharged into the Gerani Khal after crossing a branch of the Balu River through the inverted siphon. In this regard, the discharge point will be located at south-western end of the treatment plant.

In order to avoid the increase of hydraulic head loss, the main stream line of the sewage treatment facilities is aligned from the north to the west and the length of the effluent discharge pipe by gravity flow was shortened, while the length of the pressure pipe for effluent discharge was extended.

The sludge lagoon was strategically located to realise the shortest length of in-plant piping connecting to the primary sedimentation tank and to the distribution tank of the primary sedimentation tank.

The overall layout of treatment facilities was made symmetrically at east side and west side along with the centre line running from the north to the southward, since the capacity of proposed facilities in the feasibility study is about half of the total in the Master Plan.

4) Hydraulic profile

a. Evaluation of water level in receiving water body

The return period of rainfall and water level in the Buriganga River (the final receiving water body) are shown in Table 5.5.13 in accordance with the "Updating Study on Storm Water Drainage System Improvement Project in Dhaka City" (JICA, 1990).

The Gerani Khal, the primary receiving water body, is connected to the Buriganga River through the Balu River and the Lakhya River and situated at Mill Barrak area in Table 5.5.13.

In the future, when the whole of Dhaka City is encircled by an embankment and the stormwater is pumped out, the water level of the Gerani Khal will decrease. In this feasibility study, the design return period of rainfall is set forth at 20 years and the planned high water level of the Buriganga River is set at 6.5 m. (50 years and 100 years of return period will show the high water level at 6.81 m and 7.10 m, respectively.)

Table 5.5.13 Return Period and Planned High Water Level

Unit: m

Return Period in Year	High Water Level		
	Mill Barrak	Mirpur	Tongi
2	5.36	5.96	6.00
3	5.58	6.18	6.24
5	5.83	6.45	6.51
10	6.13	6.79	6.87
20	6.43	7.12	7.21
30	6.60	7.30	7.40
50	6.81	7.54	7.65
100	7.10	7.85	7.97

Source: Updating Study on Storm Water Drainage System Improvement Project in Dhaka City (JICA, 1990)

b. Design water level of sewage treatment facility

The design water level of the sewage treatment facility is calculated from the downstream side taking into account hydraulic head loss of each facility and in-plant piping.

The design water level of major treatment facilities is shown in Table 5.5.14 and the hydraulic profile is shown in Figure 5.5.9, while the process of hydraulic calculation is shown in Appendix 5.5.14, respectively.

Table 5.5.14 Design Water Level of Major Sewage Treatment Facilities

Facility	Water Level (m)	Bottom Level (m)	Water Depth (m)	Grand Elevation (m)
Parshall Flume	10.800	10.120	0.680	10.600
Primary Sedimentation Tank	9.300	6.300 (Clarifying Zone)	3.000	9.000
Facultative Pond	8.500	7.000	1.500	9.000, 7.000
Disinfection Tank	7.500	5.500	2.000	7.000
Sludge Lagoon	11.000	10.000	1.000	9.000
Septage Lagoon	11.000	10.000	1.000	9.000

The proposed site of the STP is situated in a swampy area and therefore requires land reclamation to construct sewage treatment facilities. However, due to the difficulty in securing quality soil material in the Dhaka City, area land reclamation necessitates a large capital investment on the part of DWASA.

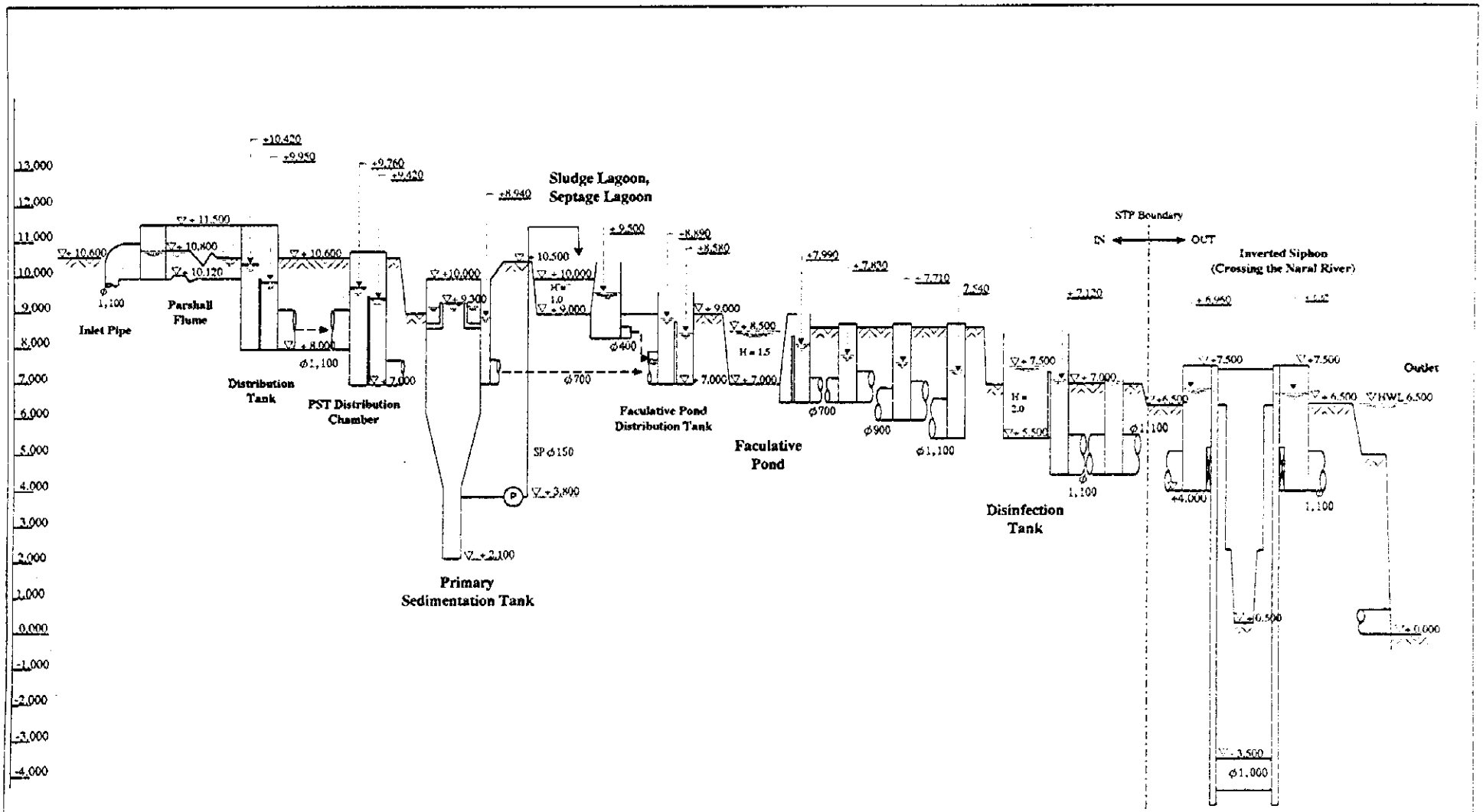


Figure 5.5.9
Hydraulic Profile of North Dhaka East STP

Scale: NON

The Study on Sewerage System in North Dhaka

In order to minimise this capital investment, the flow velocity of in-plant piping was kept as slow as possible to decrease the respective water level of treatment facilities and the draining of water from the facultative pond was designed as follows:

i. Draining from facultative pond

Water shall be drained from facultative pond to dry up the accumulated sludge at rate of once every five years. To carry this out, at least 1.5 m of hydraulic head equivalent to the water depth of facultative pond shall be kept.

In this feasibility study, the water depth of the disinfection tank (2.0 m) was utilised by the provision of a movable weir for draining water from facultative pond, as illustrated in Figure 5.5.10.

5) Design ground elevation

The lowest design ground elevation was set at 7.0 m including allowance over the planned high water level at 6.5 m. Based on this lowest design ground elevation, the design ground elevation of each sewage treatment facility is determined to have the minimum height to avoid unnecessary land reclamation.

With regard to the difference of ground elevation between treatment facilities, slope is designed to have a gradient of 1:2 for easy access of the maintenance staff.

The site preparation plan is shown in Appendix 5.5.15, while the design ground elevation and the design water level of major treatment facilities are shown in Table 5.5.11.

As a result of the above-mentioned set-up of site preparation, the lowest design ground elevation is kept at 7.0 m and the lowest height of treatment facility is designed to be 8.2 m at the disinfection tank. Through this means, no interference is foreseen in the function of treatment facilities even during the high water levels of 7.1 m (100 year of return period) as shown in Table 5.5.13.

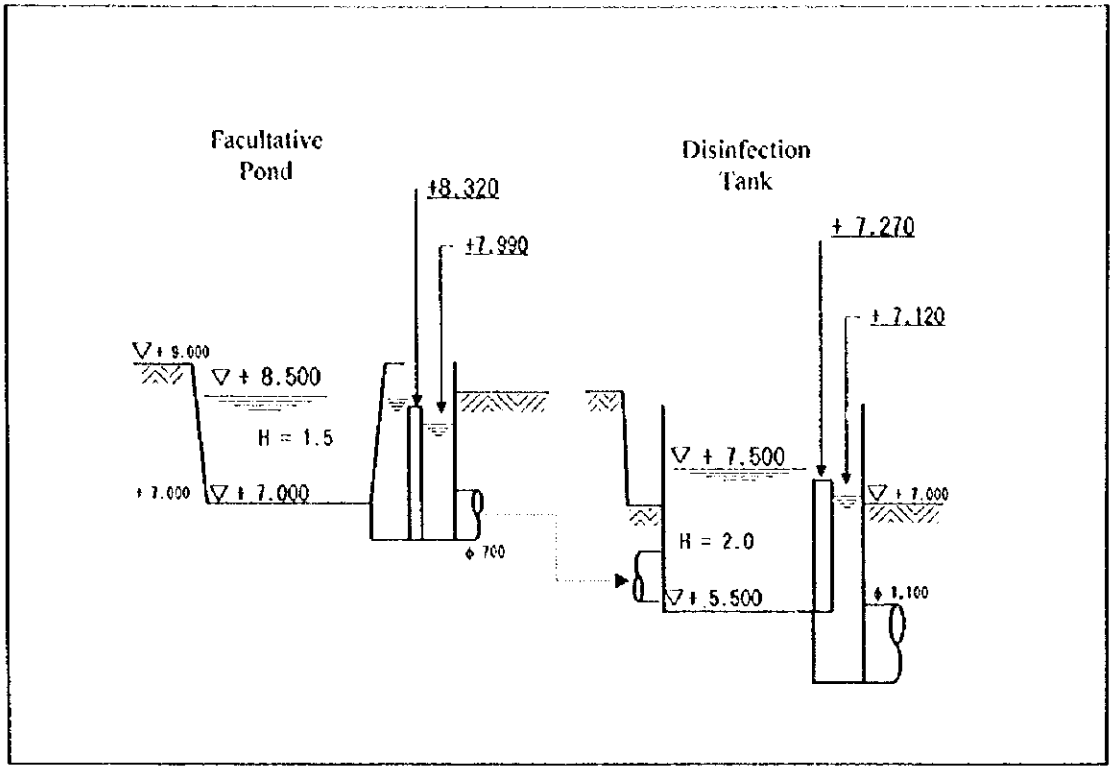


Figure 5.5.10 (1) Water Level in Facultative Pond under Normal Operation

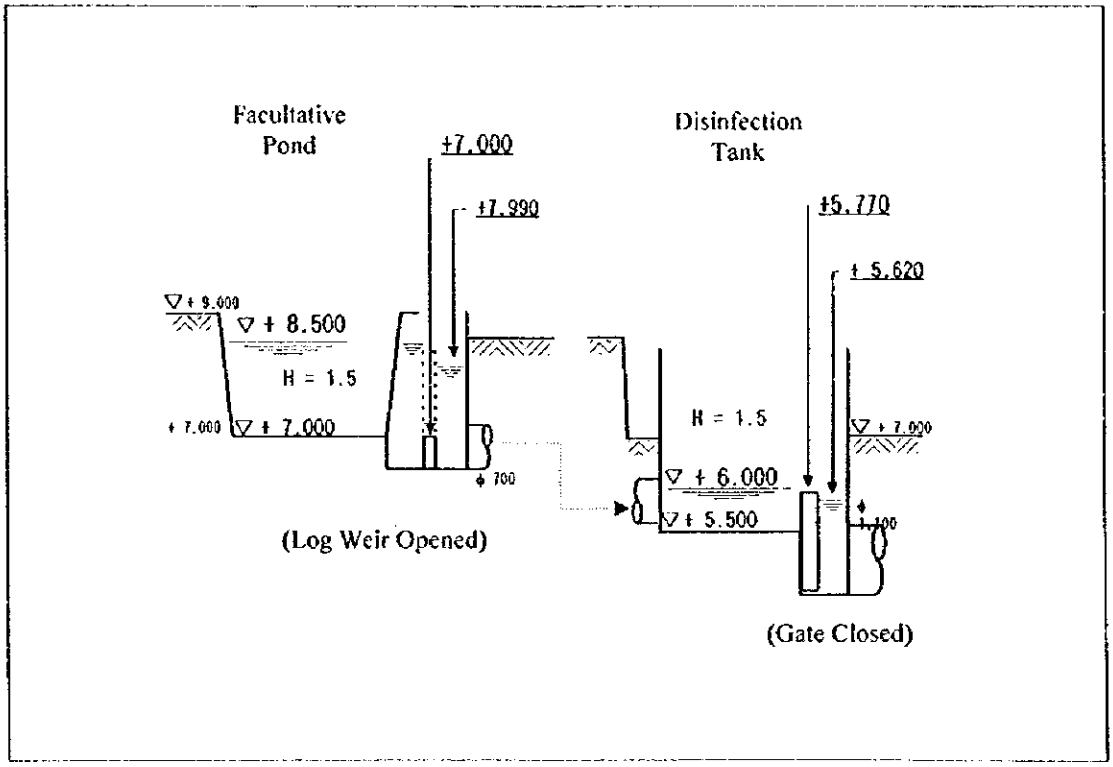


Figure 5.5.10 (2) Water Level in Facultative Pond under Draining Water

6) In-plant landscaping plan

Inside and around the proposed site of STP, maintenance roads, fence and entrance gates are provided. The in-plant landscaping plan is shown in Appendix 5.5.16.

The in-plant roads are designed to be of gravel pavement. The peripheral area of the proposed STP are designed to have a slope with 6.5 m height at a 1:1.5 gradient. For the safety of the proposed site, a perimeter fence is provided on top of this slope.

Although it is not included in the in-plant landscaping plan, the surplus area of the proposed site can be opened to public use, such as a playground for cricket, etc.

7) Administration building

The administration building is designed to be made of reinforced concrete posts with brick walls to accommodate O&M activities, clerical work, water quality examination and the electric control panel.

(3) Mechanical and electrical work

1) Composition of mechanical and electrical facility/equipment

The mechanical and electrical facilities and equipment for the proposed North Dhaka East STP are selected, in principle, to be the same as the existing Pagla STP as it has been operated in the favourable conditions.

The equipment list and single line diagram are contained in Appendices 5.5.17 and 5.5.18, respectively. The descriptions of each mechanical and electrical facility/equipment are presented hereunder.

a. Primary sedimentation tank

The Circular Tank Sludge Screen with Centre Drive Floor Mount Type is applied for sludge collector. Collected sludge at the centre of primary sedimentation tank is drained by means of non-clogging sludge and discharged into sludge lagoon.

Scum is gathered by scum collector and stored in bucket to be placed at the bottom of scum pit. Wastewater in the scum pit is drained and transferred to the primary sedimentation tank by means of scum return pump.

b. Disinfection chamber

The disinfection method is designed to be the same as the Pagla STP in that chlorine gas is ejected from chlorine gas cylinder and injected into chlorine dissolving water to be mixed with treated sewage at disinfection chamber.

This ejector system has superior advantages in terms of safety against possible chlorine gas leaks as the system always maintains its chlorine gas plumbing below atmospheric pressure. In this system design, chlorine gas is not leaked outside of piping network even if crack to pipelines or loosened connection occurs.

Chlorine dissolving water is supplied from disinfection chamber by means of booster pump after passing through strainer. This strainer is located at suction side of booster pump to avoid clogging of ejector by floating debris in treated sewage.

A movable weir to be placed in the facultative pond is provided to drain water for cleaning. This weir is designed for be manual operation considering its low frequency usage, although it has considerable size.

c. Electrical and other equipment

Two units of chain hoist are designed, one for hauling grit and screenings, the other for handling chlorine gas cylinder.

A Parshall flume is provided at the grit chamber for the measurement of the sewage inflow to the treatment plant.

The capacity of the standby generator is determined to be one unit of 50 kVA including power supply to in-plant lighting facilities and booster pumps. Primary reason of this small capacity owes to the gravity flow hydraulic design of treatment system without lift pump. Only the booster pump for chlorine injection requires a continuous power supply for sewage treatment.

From power demand of 115.65 kW for Master Plan and 66.65 kW for Feasibility Study, capacities of transformer are calculated at 75 kVA x 2 banks for Master Plan and 75 kVA x 1 bank for Feasibility Study. However in consideration of economic advantage, one unit of 150 kVA is selected for both Master Plan and Feasibility Study.

2) Selection criteria and comparative evaluation of mechanical and electrical equipment

a. Gate

A manually operated cast iron type is selected upon comparison with steel plate gate as shown in Table 5.5.15. The operating methods are also compared among manual operation, motor driven, motor driven with automatic closure by gravity, and hydraulic operation, as shown in Table 5.5.16.

Major reasons to designate cast iron type gate are as follows:

- Cast iron is commonly used for gate s because of its superior performance in terms of water stopping and durability.
- Manual operation is the most suitable from the viewpoint of recovery from malfunctions, O&M, and installation cost.
- The selected type of gate is widely applied in many pump stations in Dhaka and it advantageous in terms of maintenance and its common practices.

b. Sludge collector

Floor mount type and ceiling mount type sludge collectors are compared to apply for centre drive type circular tank sludge scraper, as shown in Table 5.5.17.

Floor mount type sludge collector was then selected in due consideration of durability and rigidity to install 28 m diameter of circular tank.

c. Disinfection equipment

Three different disinfection methods were compared as shown in Table 5.5.18 and the chlorine gas dosing method is designated based on the following advantages:

- Easy to obtain chlorine gas rather than sodium hypochlorite and calcium hypochlorite.
- Chlorine gas dosing method has been applied for the Pagla STP and good performance has been recognised in chlorine gas supply, O&M and safety control.

Table 5.5.15 Comparison of Quality of Gate Material

Item \ Type	Cast Iron Gate	Steel Plate Made Roller Gate
Construction	o Cast iron is applied for gate sheet and gate itself. Water is stopped by water pressure to gate and compressing force to gate sheet to be caused by the wedge shape.	o Steel plate is applied for gate sheet, gate body and several rollers are equipped at both sides of gate body. Water is stopped by means of watertight rubber.
Water Stop	o High performance of water stop under normal direction of water pressure, while poor performance under reverse direction of water pressure, since one side has metal sheet (BC, SUS)	o Water stop performance is poor owing to insufficient manufacturing accuracy associated with less rigidity of gate sheet.
Manufacturing	o Difficult to manufature span width of larger than 5 m.	o Possible to manufacture larger span width of gate.
Durability	o Superior in durability and anti-corrosion owing to large thickness of cast iron.	o Less durability and anti-corrosion owing to small thickness of gate sheet, submergence of rollers and water stop by watertight rubber.
Installation	o Easy to install owing to high rigidity of gate sheet, though dead weight is heavier than steel roller gate.	o Although dead weight is small, water stop performance owes to installation accuracy which varies by concreting to supplement rigidity of gate sheet.
Maintenance	o Easy O&M owing to superior durability and anti-corrosion.	o Require periodical repainting owing to less durability and anti-corrosion performance.
History of Application	o Applied to many sewerage facilities in the world.	o Applied to flood control and stormwater pumping stations, but less in sewerage facilities.
Applicability to the Project	o Suitable to sewerage facilities owing to its high performance on water stop, high durability and easy O&M.	o Poor in durability, anti-corrosion and rigidity and require periodical repainting. o Not suitable to the proposed project owing to the size of gate.

Table 5.5.16 Comparison of Gate Operation Method (1/2)

Item \ Type	Manually Operated	Motor Operated	Motor Operated with Emergency Closure by Deadweight	Hydraulic Operated
Construction	o Gate is opened/closed by manual operation of handle to rotate rack and pinion gear.	o Gate is opened/closed by motor through rack and pinion gear. o Manual operation is also available.	o Normal operation is same as motor operated type. o Emergency closure is available by lowering gate with its dead-weight.	o Gate is opened/closed by lifting/lowering hydraulic cylinder through hydraulic pump. o Manual operation is also available by means of manual hydraulic pump.
Closing in Emergency	o To be closed by manual operation.	o To be closed by manual operation or by emergency power supply.	o To be closed by operation of an electro-magnetic clutch through manual operation or DC power supply.	o To be closed by means of accumulator, emergency DC power source or manual hydraulic pump.
Applicability	o Suitable to the place where: - Power supply is difficult. - Gate span is small and less operation frequency. - Less occasion of emergency operation - No automatic operation is required.	o Suitable to the place where: - Span width is large and manual operation is difficult. - Gate is frequently operated. - Automatic and remote operation is required.	o Suitable to the place where: - Span width is large and manual operation is difficult. - Gate is frequently operated. - Automatic and remote operation is required. - Emergency operation is required under power failure, etc. (by means of electro-magnetic clutch).	o Suitable to the place where: - Span width is large and manual operation is difficult. - Gate is frequently operated. - Automatic and remote operation is required. - Emergency operation is required under power failure, etc. (by means of accumulator or DC motor).
Installation	o Easy to install since operating mechanism is only required.	o Same as manual type.	o Same as manual type.	o Requires wide space and complicated process for installing hydraulic control unit, hydraulic unit, accumulator.
Operating Speed	o About 10 to 15 kg are required to rotate handle.	o 0.3~0.6 m/min.	o 0.3~0.6 m/min. (2~8 m/min. in emergency)	o 0.3~2.0 m/min.

Table 5.5.16 Comparison of Gate Operation Method (2/2)

Item \ Type	Manually Operated	Motor Operated	Motor Operated with Emergency Closure by Deadweight	Hydraulic Operated
Other	o Full open position can be held firmly. o No risk to pollute water.	o Same as manual type	o Same as manual type.	o Requires continuous use of hydraulic unit to hold full open position. o Risk to pollute water. o Easy to protect hydraulic system owing to presence of pressure limiter.
Maintenance	o Easy O&M owing to simple structural design.	o Requires periodical check-up of operating unit, but easier than hydraulic type.	o Relatively time consuming operation in comparison with motor operated type, but easier than hydraulic type.	o Requires periodical check-uo to prevent deteriortion of hydraulic oil, leakage, clogging of oil filte r. o Complicated O&M practice.
History of Application	o Applied for relatively small size with less operating frequency.	o Applied for relatively large size with frequent operation.	o Applied most commonly to inlet gate of grit chamber for emergency closure.	o Less application in recent years to inlet gate of grit chamber for emergency closure.
Applicability to the Project	o Suitable to the project owing to easy O&M and low cost.	o Less necessity to utilise this type due to less operating frequency.	o Less necessity to utilise emergency close gate due to positioning of O&M staff in the plant. o Not suitable in view of O&M.	o Less necessity to utilise hydraulic type. o Poor serviceability in O&M of hydraulic system.

Table 5.5.17 Comparison of Circular Tank Sludge Scraper Centre Drive Type

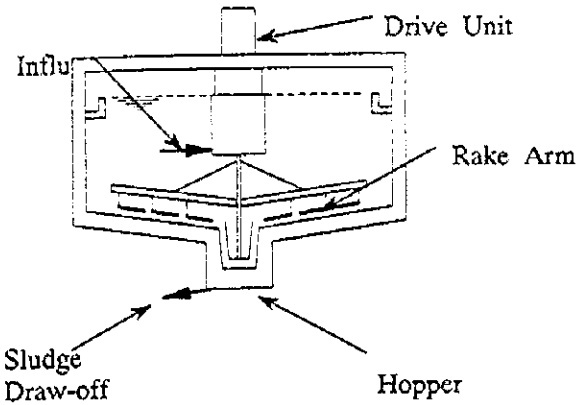
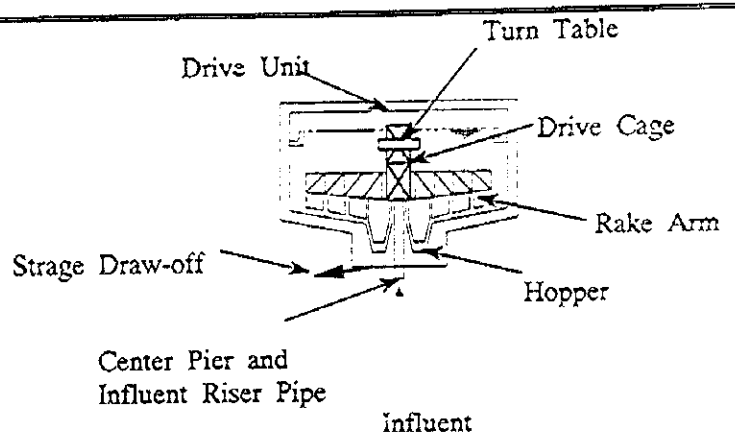
Item \ Type	Ceiling Mount Type	Chlorine Gas Dosing Method
Construction		
Drive Unit	o Hunged rake arm is rotated by drive unit to collect settled sludge to the centre and collected sludge is thickened at hopper.	o Center pier is provided at the centre of circular tank to support drive cage. o Drive cage connected with rake arm is hunged from turn table on top of centre pier. o Rake arm is rotated by drive unit to collect settled sludge at the centre of circular tank and collected sludge is thickened at hopper.
Feature	o Easy to operate without supervising staff. o Easy for O&M o Long service life.	o Same as ceiling mount type.
Applicability to the Project	o Less rigidity to apply for this project having 28 m of diameter of circular tank.	o Generally applied for circular tank with diameters of more than 13 m and suitable for the project.

Table 5.5.18 Comparison of Disinfection Methods (1/2)

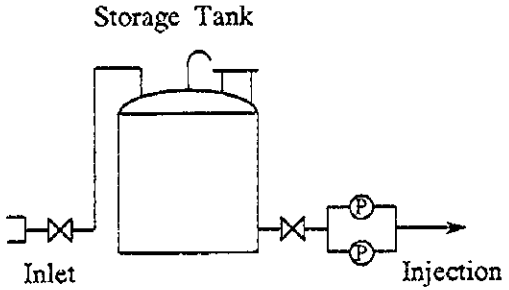
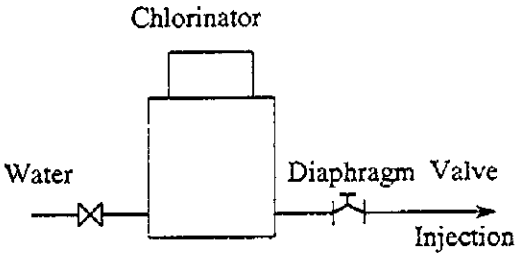
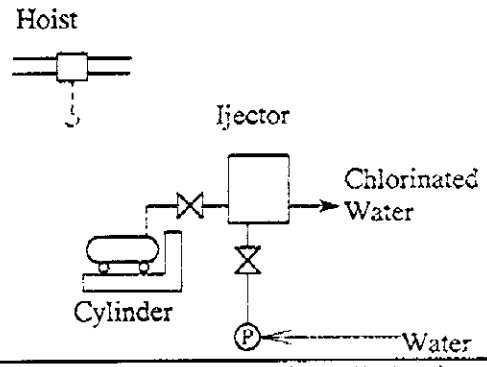
Item \ Type	Sodium Hypochlorite Dosing Method	Wet-Type, Hypochloryte Dissolving Method	Chlorine Gas Dosing Method
Construction			
Structure	o Liquified sodium hypochlorite (12% of effective chlorine content) is received in storge tank from hauling truck. o Stored disinfectant is injected into disinfection tank through metering pump.	o Calcium hypochlorite filled in chlorinator is dissolved by water, and then dosed into disinfection tank. o Dosing rate is conrolled by manual diaphragm valve.	o Chlorine gas contained in cylinder is mixed with water by an ejector. o chlorinated water is then dosed into disinfection tank. o Chlorine dosing rate is controlled as flow in ejector.
Past Application	o Applied to many sewerage facilities.	o Applied to small scale sewerage facilities.	o Applied to many large scale sewerage facilities.
Maintenance	o Easy for disinfection owing to use liquified disinfectant. o Hauling truck is required.	o Requires frequent supply of calcium hypochlorite	o Usage of chlorine gas is regulated by law. o Easy to transport gas cylinder

Table 5.5.18 Comparison of Disinfection Methods (2/2)

Item \ Type	Sodium Hypochlorite Dosing Method	Wet-Type, Hypochloryte Dissolving Method	Chlorine Gas Dosing Method
Safety	o Easy to safely handle liquified sodium hypochlorite rather than chlorine gas, while cautious attention be paid to stimulative effect when evaported.	o Less cautious attention required.	o Requires continuous cautious attention due to toxity of chlorine gas. o To be equipped with leakage protection system.
Others	o Not suitable for long term storage due to short effective storage period of 10 to 20 days. o Applicable to medium to large scale sewerage facilities.	o Can be stored considerably long period under less humidity at indoor place. o Applicable to small scale sewerage facilities.	o Requires appointment of licensed/authorised personnel for operation. o Applicable to medium to large scale sewerage facilities.
Avalability	o Industrial use hypochlorite is not available.	o Same as sodium hypochlorite.	o Chlorine gas is available in Bangladesh.

8) O&M equipment

a. Water quality examination equipment

The water quality examination equipment as listed in Table 5.5.19 were selected taking into account the minimum water quality indices for O&M, such as atmospheric temperature, water temperature, transparency, pH, BOD, COD, SS, DO, and Coliform Group Bacteria.

Chemical reagents and other consumable goods are considered to be readily available in Dhaka City.

Table 5.5.19 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	0.5 m, plastic	Transparency
Electronic Digital Balance	1 unit	Max. 50 g., Min. 0.01 g.	Weighing
Electric Drying Oven	1 unit	100°C、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 l	Coliform Group Bacteria
Electric BOD Incubator	1 unit	Air circulation type,	BOD
Pure Water Generator	1 unit	Ion-exchange-Distillation type, more than 1 l/hr	
Vacuum Pump	1 unit	Electric type	SS
Refrigerator	1 unit	200 l	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	

b. Service vehicle and boats

Upon construction of the STP, periodical removal of dried sludge and removal of aquatic plants will be required as regular maintenance work.

For removal of sludge and hauling, a bulldozer, power shovel and dump truck will be required, while boats will be necessary to remove aquatic plants from the ponds.

To supplement the draining of water from the facultative pond and sludge lagoon and the cleaning of the inverted siphon of the discharge pipe, an engine-driven portable pump will be required.

These O&M equipment are listed in Table 5.5.20.

Table 5.5.20 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

CHAPTER 6

OPERATION AND MAINTENANCE

CHAPTER 6 OPERATION AND MAINTENANCE PLAN

6.1 General

At present, some parts of study area, namely Gulshan, Banani, is served by sewerage system, while the eastern side of the area, to wit, Badda and Baridhara is served by on-site treatment facilities.

Appropriate Operation and Maintenance (O&M) of sewerage facilities are indispensable not only to keep up the function of the public sewerage service, but also to prolong the service life of the overall sewerage system. Based on the findings on present O&M status of existing sewerage facilities in North Dhaka and MODS Zone V Office, responsible for the O&M of sewerage facilities within the service area, proposed maintenance activities are described below.

6.2 Sewer System

There are three procedures of O&M for sewers, namely, site investigation, pipe cleaning and rehabilitation of damaged sewers. The work items by O&M procedures are shown in Table 6.2.1.

Table 6.2.1 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

The O&M work for sewers shall be conducted by the working program as shown below.

(1) Site investigation

The yearly investigation plan shall be prepared covering the entire sewer in the service area and the actual site investigation shall be conducted along with the above-mentioned work items based on the said plan. During the site investigation, all staffs must be careful for the anoxic condition in manhole and the traffic around the working area.

This investigation shall be performed repeatedly and periodically. Further, the daily O&M activities shall be recorded in Log Book.

(2) Sewer cleaning program

The annual sewer cleaning program shall also be prepared and carried out from the priority spots based on the results of site investigation. An example cleaning program is contained in Appendix 6.2.1.

Generally, there are four types of sewer cleaning methods: hydraulic jetting machine, sludge suction machine, bucket machine and manual cleaning. At present, there is one (1) unit of Hydraulic Jetting Machine in MODS Zone V Office, however, most sewers are cleaned by manual using bamboo stick and bucket.

The sewer cleaning shall be conducted repeatedly and periodically and daily O&M activity shall be recorded on Log Book.

(3) Rehabilitation plan

Aside from the existing sewerage system in central area, east side of the study area is left unsewered at present. However, rehabilitation work is indispensable to maintain the proper capacity and to extend the life of both existing and newly installed sewers. The following work shall be conducted.

The annual pipe rehabilitation plan shall be prepared and be carried out from the priority spots in accordance with the results of site investigation, considering their emergency.

Generally, there are two types in pipe rehabilitation, namely the replacement of sewer pipe and repair of damaged portion. The damages are caused by the natural or external factors such as, ground subsidence, adjacent construction works, overweight vehicles and corrosion by hydrogen sulphide etc.

The rehabilitation work shall be basically covered by the O&M team in MODS Zone V office but according to the scale of work, it can be contracted out to the local contractors.

(4) Monthly audit report

Monthly audit report must be prepared. O&M cost shall include all the required cost such as, labour, material, transportation cost, etc. The proposed auditing indicators are as follows:

O&M cost (Tk)/1,000 m of sewer

6.3 Pump Stations

The existing three (3) pump stations, namely, Tejigaon, Banani and Mohakhali, and three (3) proposed pump stations are included in the most optimum project.

The O&M for pump station can be classified into two items namely, daily and periodical work. The work items by O&M types are shown in Table 6.3.1.

Table 6.3.1 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

(1) Daily work program

At present, all the existing pimping stations are operated by manual. Aside from Banani and Mohakhali P/S, without water level indicator, since Tejigaon P/S, the largest and most important pump station for the study area, are equipped with float type indicator, it shall be operated automatically by high/low sewage level control. Proposed two (2) pump stations shall be equipped with automatic operation control system.

Only in case of accident, such as breakdown of the control system, pumps shall be operated manually. Pump shall be operated with close relationship to the sewage level in wet well and high water level (pump starting level) shall be set in lowest that won't interfere the pump operation. However, in most P/Ss not only in North Dhaka but also in South Dhaka, the sewage level in wet well are high. This is because of the breakdown or lack of the water level indicator. The resident pump operators are forced to operate pumps only by their eye measurement of sewage level in wet well and pump starting level of sewage is usually high since they are supposed not to be instructed the safety operational sewage level by DWASA engineer. It might have been hindering the smooth flow of sewer and have caused clogging of sewer and flooding of sewage. Thus, robust and durable water level indicate scheme, such as level float, shall be installed in P/Ss without any sewage level measurement method. Even P/Ss equipped with automatic control system, such simple level measurement device shall be installed as stand-by system.

Removal of screening is also important for the proper operation of L/S and removed screenings shall be hauled by O&M team of Zone Office immediately to avoid the nuisance to the public.

Further, the pump operator must report to the Zone Office in a case of breakdown. Zone Office will call the exclusive O&M team and the team will be dispatched to the site.

(2) Periodical work program

The pump pit needs the periodical cleaning in every 6 months by resident pump operator. The scum and sediments will be removed. The overhaul of pump facility shall be done by 5 to 10 years to expand their durable life and proper operation through the future.

(3) Monthly audit report

Monthly audit report must be prepared. O&M cost shall include all the required cost such as, labour, material, transportation cost, etc. The proposed auditing indicators are as follows:

O&M cost (Tk)/cu.m/day per pumped sewage volume

6.4 Sewage Treatment Plant

The treatment method for the proposed sewage treatment plant is stabilisation pond method which requires simple technology and less manpower, however, proper operation and maintenance is indispensable to extend their durable years and to fulfil their performance.

In the plant, there are two substances to be treated namely, sewage and sludge. Sewage will be treated by stabilisation pond and discharged to the receiving water bodies, while sludge will be treated by sludge drying bed and be removed manually then be disposed to the disposal site.

The O&M work for the Sewage Treatment Plant can be categorised into two items, daily and periodical work. The work items by the said category are shown in Table 6.4.1.

Table 6.4.1 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 equipment (annually) - Overhaul of mechanical/electrical equipment (every 5 to 10 years)

(1) Daily work program

Measurement of inflow sewage rate is significant item for proper operation of treatment facilities through the future. The screenings collected at the screen and grit chamber shall be removed everyday to allow the smooth incoming of sewage into the treatment facility. Collected screenings will be conveyed to the waste disposal site. Mechanical/electrical facilities must be inspected during their daily operation to notice any defects and to conduct quick maintenance work. It is very important to extent their life and to maintain proper operation through the future.

These daily O&M activities shall be recorded in Log Book in daily basis. Major breakdown, repair, required man power, time, cost shall be described also. It will be an important data for O&M in the future.

(2) Periodical work program

Two types of maintenance staff are required for periodical work program. The first group is ordinary workers to remove the sediments/sludge in grit chamber, stabilisation pond and sludge drying bed. Removed sludge will be conveyed to disposal site. Whereas the second is technicians for the maintenance of mechanical/electrical facilities.

(3) Laboratory

Since new treatment plant will discharge the treated water into the public water bodies, the treated water must comply with the strict effluent regulation established by the Department of Environment. Thus, a laboratory shall be constructed within the plant to check the effluent quality in everyday basis. Complicated water can be conducted by contract. The examination item and frequency are as follows:

Table 6.4.2 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 6.4.2 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

(4) Monthly audit report

Monthly audit report must be prepared. O&M cost shall include all the required cost such as, labour, material, transportation cost, etc. The proposed auditing indicators are as follows:

O&M cost (Tk)/cu.m/day per treated sewage volume

6.5 Manpower Requirement

6.5.1 Sewer System

Subdivision Engineer for sewerage O&M shall be appointed together with three (3) composed by at least six (6) workers, including sewer inspector and sewer cleaner. All engineers and workers shall be pre-qualified and registered.

Although there are 21 sewer cleaner in Zone V office, only 8 cleaners are working. Through the interview to the executive officer, it was revealed that workers want to work in water supply section, due to the higher health risk and unpleasant working conditions of sewer related works.

Additional incentives can be one option to secure workers, but private sector involvement through service contract can be another option. Actually, Mass Cleaning has been conducted by private contractor in once a year basis in every Zone and the cost of Mass Cleaning in Zone V conducted in last year was 550,000 Tk.

These local contractors shall be properly pre-qualified and registered by Zone office. Septage collection in on-site treatment area can also be contracted out.

6.5.2 Pump Stations

Basically the pump stations shall be operated in 24 hours a day, existing three shift, adopted in South Dhaka, shall be employed as follows:

Shift 1: 6:00 - 14:00
Shift 2: 14:00 - 22:00
Shift 3: 22:00 - 6:00

One (1) resident pump operator shall be assigned in each shift and one (1) stand-by operator shall be employed for emergency case. Thus, in total four (4) pump operators/P/S will be needed.

However, the existing pump operators are seemed to be not properly pre-qualified. Some operators did not know how to record daily activities in Log Book. Such operators shall be replaced or be properly trained. All operators shall be pre-qualified and registered.

6.5.3 Sewage Treatment Plant

Basically the sewage treatment plant will be operated in 24 hours a day, existing three shift, adopted in South Dhaka, shall be employed as follows:

Shift 1: 6:00 - 14:00
Shift 2: 14:00 - 22:00
Shift 3: 22:00 - 6:00

According the optimum project, one (1) STP is proposed in the study area. One (1) foreman and two (2) operators shall be assigned in each shift. The number of workers in each shift will vary according to the design capacity of STP as follows:

Design Capacity (cu.m/day)	Number of workers
43,320 (F/S)	3
104,500 (M/P)	6

Aside from the said O&M staff, one (1) executive engineer and one (1) subdivision engineer will be needed for the management of the plant and one (1) microbiologist shall be employed for laboratory. Thus, in total the following staff will be needed per each STP.

Table 6.5.1 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)

These engineers and workers shall be appointed within the Zone V office by the executive engineer and be trained by On-The Job Training at Pagla STP prior to the arrival to the new North Dhaka East STP. The period shall be six months.

6.5.4 Zone Office

(1) Organisation and budget of MODS Zone Office

For the efficient O&M activities, organisation of MODS Zone Offices shall be separated in water supply and sewerage system together with the necessary authorisation and budget.

At present, most authorisations are concentrated to DWASA Head Office and it seemed that this centralisation are causing stagnant project implementation.

Decentralisation, including devolving of authority and accountability to the MODS Zone offices will be useful for the effective project implementation and for the activation of the offices. Zone V office can be a pilot case for this organisational innovation. Performance of MODS offices shall be monitored be regular audit system.

Detailed recommendation regarding organisational set up are shown in Chapter 9.

(2) Exclusive O&M team and O&M budget for STP and I/S

Exclusive O&M team is indispensable for the proper operation of the sewerage system. They will be dispatched by the request from MODS Zone Offices. Exclusive vehicles and tools shall be prepared also. An independent O&M budget shall be prepared as well.

6.5.5 Project Management Office (PMO)

For the smooth and efficient project implementation, Project Management Office (PMO) shall be established within DWASA. PMO will be headed by the Project Manager and selected DWASA professionals and supporting staff will be detailed. The Project Manager will directly report to the Managing Director on the project related matters.

6.5.6 DWASA Training Institute

There is only one DWASA Training Institute in Lalmatia. Excluding the mechanical and electrical engineers, most DWASA engineers are trained here. However, due to the shortage of budget and resource persons, the Institute has been overloaded. Thus, it is recommended to decentralising the training responsibility to the MODS offices, in order to avoid further stretch the demand on the Institute.

MODS offices shall have training section together with exclusive budget and resource person. Engineers must earn from the basic design skills up to O&M technique of the sewerage facilities.

Institute itself shall be transferred from "training service provider" to "training advisor to MODS offices". For detailed upgrade plan for the Institute, please refer to Chapter 9.

6.6 Others

(1) New workshop

Although there is existing work shop in Mirpur, they mainly repair vehicles. Thus, new

work shop shall be built for water supply and sewerage equipment such as, pumps, motors, generators etc. Periodical rewiring of motor is also effective as preventive maintenance. The spare parts shop shall be constructed also for the efficient repair work. Monthly audit report shall be prepared.

(2) Waste collection system

In some parts of South Dhaka, waste were piled along the road and some were dumped into sewers from open manhole and causing pipe clogging. Waste collection system shall be set up with close relation with Dhaka City Corporation.

(3) Collection and treatment of accumulated sludge in septic tank

Some part of Study Area will be covered by on-site treatment facility such as septic tank. For efficient treatment, settled sludge shall be extracted and treated. Though the collected sludge is dumped to the sludge dumping site at present, considering its impact to the surrounding environment, sludge shall be treated properly. The treatment facility can be planned within the site for new STP. The collection work will be covered by O&M team for sewer reticulation in MODS Zone Office. Thus, the team shall be equipped with the collecting vehicles and tools.

(4) Data Base on sewerage system

Computerised sewerage Data Base System shall be established. Data Base shall be include the following basic information:

1) Information of consumers

Address, phone number, name of the owner, No. of family, diameter of connected sewer.

2) Information of sewer reticulation

Pipe ID No, diameter, length, material of sewer, year of completion, capacity, existing flow rate, repair record.

3) Information of pump stations and sewage treatment plant

Address, list of facilities and equipment, completion year, design criteria, incoming and effluent sewage rate, repair record.

4) O&M activity record

Date, work contents, cost.

(5) Public Information and Education Program

For the sustainability of the service will be offered by sewerage system, information and education program to develop the public awareness toward sewerage system is quite important.

There will be various ways of disseminating the information including benefits and required costs of the project. According to the income level, the following are recommendable:

Media	Income Level
Radio and Television	
Newspaper	
Consumer Newsletters	Higher
School System Activities	↑
Special Events	↓
Handbills and Fliers	Lower
Public Meeting	
Posters and Billboards	

Sample messages will include the following basic but important information for public hygiene:

"Sewer system is not intended to carry garbage !"

"Uncollected wastewater is a serious health risk !"

"Lakes and rivers are polluted due to the uncontrolled wastewater !"

"Shallow tube well can be polluted by wastewater !"

"Septic tanks must be regularly to be effective !"

"How to apply for sewer connection !"

"Sanctions for the system abuse !"

"Benefits of improved sanitation and sewerage !"

CHAPTER 7

PROJECT COST

CHAPTER 7 PROJECT COST

7.1 General

Project cost consists of various cost categories as shown in Figure 7.1.1. The construction cost of the priority project will be estimated based on the unit cost of major construction materials and the required quantity by type of construction work. The unit cost of construction materials will be subdivided into indigenous local materials and imported goods in due consideration of their availability in local markets. In this respect, the project cost will be broken down to a local currency portion and a foreign exchange portion.

It shall be noted that the project cost estimate will have certain limitations regarding its accuracy since it will be based on the preliminary engineering design, not on the detailed engineering design. To cope with the uncertainty of the physical conditions and the future economic situation, physical and price contingencies will be considered in the project cost estimate.

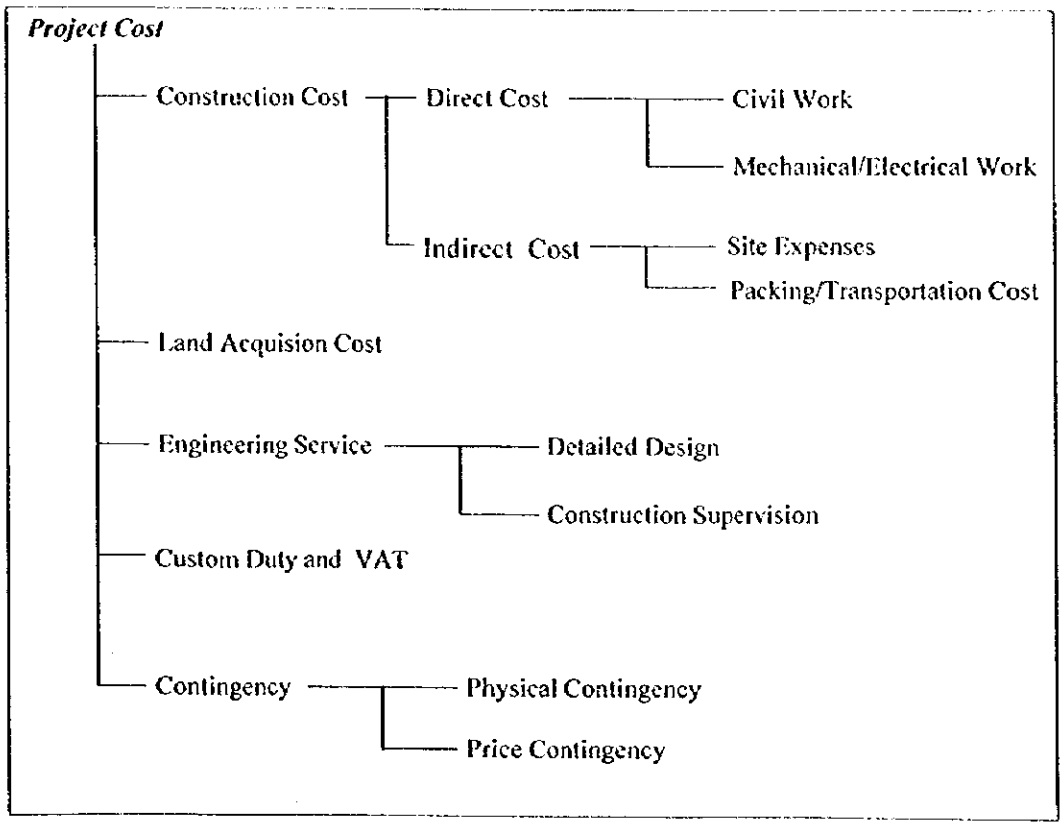


Figure 7.1.1 Composition of Project Cost

7.2 Construction Cost

7.2.1 Availability of Materials and Equipment

A market survey on machinery, construction materials and equipment was continued following the Stage 1 Field Work covering indigenous goods as well as goods imported from other countries. Due attention was paid to the reliability of the manufacturer/supplier for imported goods and the quality of such products from the viewpoint of their practicability in the actual implementation of the project.

As a result of this market survey, the country of origin for some imported goods (sewer pipes and temporary construction materials) was changed from the conclusion of master plan stage. The survey results are shown in Table 7.2.1.

Table 7.2.1 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

7.2.2 Unit Cost

A complete set of unit costs to estimate the project cost and the O&M cost was prepared based on the results of the market survey. Unit cost covers construction materials, mechanical and electrical machinery, and consumable goods (chlorine gas, etc.) as presented in Appendix 7.2.1.

7.2.3 Cost Classification by Local and Foreign Currency Portion

Construction costs were estimated separately by foreign and local currency portions to distinguish the nature of funding as shown in Table 7.2.1.

Table 7.2.2 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

7.2.4 Construction Cost

The direct construction cost of sewerage system was estimated at first by category of facilities, i.e. sewer lines, pump station and sewage treatment plant. The total construction cost was then estimated by adding the indirect cost and Value Added Tax (VAT), etc.

(1) Sewer

Unit construction cost of sewer pipe laying (cost per 1 m length of pipe laying) was established by type of pipe material (Reinforced Concrete Pipe, Polyvinyl Chloride Pipe, Steel Pipe), by diameter, and by depth of backfill, as shown in Appendix 7.2.2.

Accumulated length was also estimated by the above mentioned classification of pipe laying based on the typical standard of vertical profile.

The construction cost of sewer was then estimated by multiplying the unit construction cost and the accumulated length and contained in Appendix 7.2.3.

(2) Pump Station and Sewage Treatment Plant

The direct construction cost of pump station and sewage treatment plant was estimated by category of sewerage facility in accordance with the sewerage system plan.

The direct construction cost of pump station is shown in Appendix 7.2.4, while that of sewage treatment plant is shown in Appendix 7.2.5.

(3) Construction Cost

Construction cost of sewerage system is shown in Table 7.2.3. Indirect cost (overhead and tax) was estimated based on the percentage weights to the direct construction cost at 20 % of foreign currency portion and 15 % of local currency portion, respectively.

Table 7.2.3 Construction 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)

7.3 Operation and Maintenance Cost

The operation and maintenance cost of sewers, pump stations and sewage treatment plant was considered to cover such expenses as personnel salary, water charges, power consumption, fuel, chemical, repair/replacement, and sewer cleaning.

The annual operation and maintenance costs are shown in Table 7.3.1 and the basis of this estimate is shown in Appendix 7.3.1.

Table 7.3.1 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
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Note: Exchange Rate US$ 1.00 = 43.333 Tk (as of January 1998)

7.4 Project Cost

The project cost was finally estimated covering construction cost, land acquisition, engineering service, administration cost and physical contingency based on the following cost percentage:

- Engineering Service: 3% of Construction Cost
- Administration Cost: 5% of Construction Cost + Engineering Service
- Custom Duty and VAT : 100% of Imported Materials and Equipment
- Physical Contingency: 10% of Construction Cost + Engineering Service + Land Acquisition Cost

The project cost is summarised in Table 7.4.1.

Table 7.4.1 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 Tota	-	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 8

IMPLEMENTATION PROGRAM

CHAPTER 8 IMPLEMENTATION PROGRAM

8.1 Implementation Schedule

The implementation schedule of the priority project was established to commence the preparatory work in the year 2000 and to complete by the end of 2005, which is the target year of feasibility study. Thus, the full operation of the North Dhaka Sewerage System will be started from the beginning of 2006. The major annual project activities are listed below:

1999 Project Preparation
2000 Detailed Design, Bidding
2001 Construction
↓
2005 Construction
2006 Commencement of Operation

The schedules of project implementation and annual disbursement of estimated project cost are shown in Figure 8.1.1, while the required project activities are described hereunder.

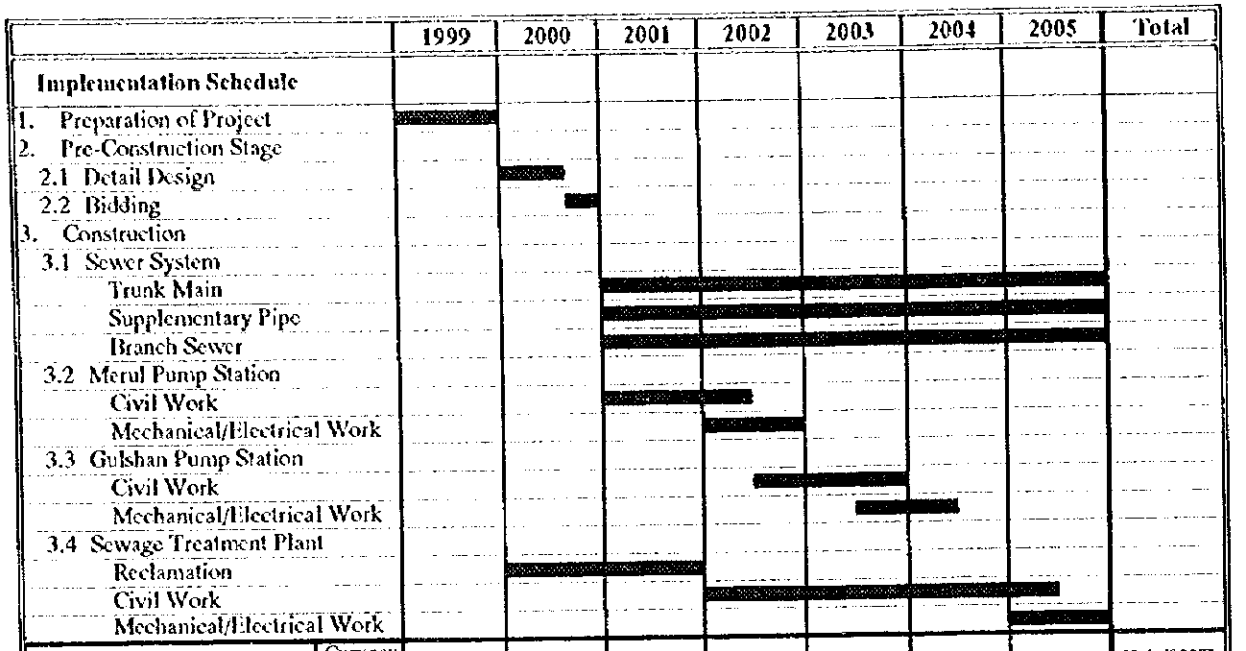
8.2 Activities for Project Implementation

8.2.1 Preparation of Project

The work items programmed for the preparatory work of project implementation are explained below:

- Budgetary arrangements to undertake the local currency component, such as land acquisition for sewage treatment plant and pumping stations, landscaping, access road, and the institutional development of DWASA.
- Negotiation of grant/loan with foreign lending institution(s).
- Selection of consultants in accordance with the agreement executed between the foreign lending institution and DWASA.
- Negotiation with landowners for acquisition of sites for sewage treatment plant and pumping stations.

Figure 8.1.1 Project Implementation and Disbursement Schedule



Disbursement Schedule	Currency Mode								Unit:000Tk
1. Land Acquisition	Local	511,078	10,934	7,702					529,714
2. Construction Work									
2.1 Sewer System				137,062	137,062	137,062	137,062	137,061	685,309
Trunk Main	Foreign			66,924	66,924	66,924	66,924	66,925	334,621
Supplementary Pipe	Foreign			40,798	40,798	40,798	40,798	40,798	203,990
Branch Sewer	Local			29,340	29,340	29,340	29,340	29,338	146,698
2.2 Merul Pump Station				39,337	196,064				235,401
Civil Work	Foreign			39,337	19,668				59,005
Civil Work	Local				368				368
M&E Work	Foreign				176,028				176,028
2.3 Gulshan Pump Station					10,706	80,813	59,057		150,576
Civil Work	Foreign				10,706	21,411			32,117
Civil Work	Local					344			344
M&E Work	Foreign					59,058	59,057		118,115
2.4 Sewage Treatment Plant			462,510	462,510	238,827	238,827	258,700	316,389	1,977,763
Civil Work	Foreign				238,827	238,827	238,827	119,412	835,893
Civil Work (Reclamation)	Local		462,510	462,510					925,020
Civil Work (Others)	Local						19,873	9,936	29,809
M&E Work	Foreign							187,041	187,041
2.5 Direct Construction Cost	Foreign		0	147,059	552,951	427,018	405,606	414,176	1,946,810
	Local		462,510	491,850	29,708	29,684	49,213	39,274	1,102,239
	Total		462,510	638,909	582,659	456,702	454,819	453,450	3,049,049
2.6 Construction Cost	Foreign		0	176,470	663,541	512,421	486,727	497,012	2,336,171
	Local		531,886	565,627	34,164	34,136	56,594	45,166	1,267,573
	Total		531,886	742,097	697,705	546,557	543,321	542,178	3,603,744
3. Engineering Service	Foreign			5,294	19,906	15,372	14,601	14,910	70,083
4. Administration Cost	Foreign		0	9,088	34,172	26,389	25,066	25,597	120,312
	Local		26,594	28,281	1,708	1,706	2,829	2,259	63,377
	Total		26,594	37,369	35,880	28,095	27,895	27,856	183,689
5. Physical Contingency	Foreign		0	19,085	71,761	55,418	52,639	53,752	252,655
	Local	51,107	56,941	60,161	3,587	3,584	5,942	4,743	186,065
	Total	51,107	56,941	79,246	75,348	59,002	58,581	58,495	438,720
6. Total (1+2+3+4+5)	Foreign	0	0	209,937	789,380	609,600	579,033	591,271	2,779,221
	Local	562,185	626,355	661,771	39,459	39,426	65,365	52,166	2,046,727
	Total	562,185	626,355	871,708	828,839	649,026	644,398	643,437	4,825,948
7. Price Contingency	Foreign	0	0	10,496	39,469	30,480	28,951	29,563	138,959
	Local	28,109	31,317	33,088	1,972	1,971	3,268	2,608	102,333
	Total	28,109	31,317	43,584	41,441	32,451	32,219	32,171	241,292
8. Project Cost	Foreign	0	0	220,433	828,849	640,080	607,984	620,834	2,918,180
	Local	590,294	657,672	694,859	41,431	41,397	68,633	54,774	2,149,060
	Total	590,294	657,672	915,292	870,280	681,477	676,617	675,608	5,067,240

This preparatory work will commence from the beginning of 1999 and will be completed within the same year.

It shall be noted that the institutional development of DWASA and staffing required for project implementation is a prerequisite, not only to insure successful achievement of the project objectives, but also to secure the firm commitment of financial assistance from the foreign lending institution(s). An appraisal mission from such financial institutions will pay due attention on the preparedness and maturity of the proposed project as well as implementing capacity of DWASA both financially and institutionally.

8.2.2 Pre-Construction Stage

The majority of the project activities will be undertaken by the consultants hired by DWASA. Activities to be carried out by the consultants include, but are not limited to: detailed field investigations, detailed engineering design, and preparation of tender documents for bidding. These activities will start from early in 2000 to the middle of the same year.

After preparation of the tender documents, an international competitive bidding for construction work of proposed project will be executed by the end of 2000.

Other important subjects, such as the tariff system of the sewerage service for cost recovery, shall be taken up by DWASA as recommended in the preceding chapter of this Study.

8.2.3 Construction Stage

The major activities of the construction work are as follows.

(1) Sewage collection system

- Trunk main (diameters of more than 300 mm)
- Supplementary pipe
- Branch sewer (diameters of less than 250 mm)

(2) Pump station

- Civil work

- Mechanical/electrical work

(3) Sewage treatment plant

- Civil work
- Mechanical/electrical work

Construction periods for major works are estimated as shown below.

(1) Sewer system

Trunk main	60 months
Supplementary pipe	60 months
Branch sewer	60 months

(2) Pump station

Civil work	18 months
Mechanical/electrical work	12 months

(3) Sewage treatment plant

Civil work (reclamation)	24 months
Civil work	42 months
Mechanical/electrical work	12 months

Construction work will be implemented over a five-year period starting from the beginning of 2001 up to the end of 2005.

CHAPTER 9

INSTITUTIONAL ARRANGEMENTS & CAPACITY BUILDING PLAN

CHAPTER 9 INSTITUTIONAL ARRANGEMENTS & CAPACITY BUILDING PLAN

The estimated total capital investments needed for sewerage in the high-priority areas of North Dhaka will be in the order of Taka 5.2 billion. Much institutional preparation is needed at DWASA and other agencies to build capacity to attract and manage such a major financial responsibility. This chapter lays out a practical and feasible plan to strengthen institutional capacity for project implementation and operation and maintenance for the proposed North Dhaka East sewerage facilities.

9.1 Proposed Legislative and Policy Reforms

To the extent possible, this Study has avoided the need for new legislation. However, several policy reforms will have to be enacted by the DWASA Board to ensure the sustainability of the new sewerage facilities. These would include:

(1) ***Influent standards policy for acceptance of wastewater into the sewerage system.*** The treatment plant is intended to handle domestic wastewater only. The introduction of industrial and/or hazardous wastewater reduces the treatment efficiency and increases operating costs. The removal of heavy metals and other toxic substances is most economically done in pre-treatment facilities owned by the "polluting industry" at the source. Through the regular monitoring of wastewater quality, DWASA will be able to assist the DOE in enforcing environmental laws and, at the same time, ensure the efficacy of its sewerage treatment works. Influent standards have been adopted in other major cities and DWASA should take the steps to establish similar standards and provide for its enforcement.

(2) ***Sewer service connection promotion policy.*** Current experience with sewerage projects, local and elsewhere, indicates that the high connection costs have tended to discourage potential customers from applying for the service. The slow build-up of the customer base has been a major obstacle to the proper system function in many projects. Low flows contribute to the frequent fouling of the system. Service connections are treated as operational expense or as a direct

capital development cost borne by the customer. A sewer service connection usually consists of a pipe extending from the sewer line up to a fixed length, say 4 m, to the house.

A policy allowing DWASA to advance a portion (say 50%) of the service connection costs, to be repaid by the customer over 2-3 years, is recommended. Such "special" arrangements may be offered to specific wards during a fixed specific period - after which the "special promotion" is discontinued and offered to another ward. Another "limited promotions" policy which could be considered is to have special periods (or areas) when the service pipe length (say 4 m) is given free. Still another variation is to offer service connection discounts outright for a fixed period (the start-up period).

Such policies would however have an implication on DWASA's cash flow which should be assessed. At current prices, service connection is estimated to cost about Taka 6,000 to 8,000 per connection (including labour, materials and surface restoration).

(3) *Sewer service extension policy.* In the immediate future, a Memo of Agreement between DWASA and the Cantonment Board on policies governing extension of domestic wastewater services will have to be concluded and cleared by the Board [See Sec 9.2.1(5)]. In a more general sense, the arrangements for Cantonment presents a model for possible extension of the system to *other* existing and planned land development or housing projects areas. Where the institutional and technical arrangements are appropriate and the internal sewerage collection systems (possibly, including water supply distribution) are customer-financed, sewerage services may be extended for customer groups with an acceptable agreement on fees to be levied by DWASA to the system owners or beneficiaries.

(4) ***Mandatory sewer connection policy for customers with high consumption.*** To help ensure the financial viability and raise the utilisation rate of the new sewerage system, a policy requiring commercial and high residential water consumers to connect will be needed to make the sewerage system viable. Current policies requiring connection for those who can be served do not carry a sufficient sanction or incentive for those who choose not to connect. The difference with cur-

rent policy is that this mandatory connection is only for high domestic consumers and all commercial consumers.

(5) *Incentives policy for sewerage field staff.* Higher health risks and unpleasant working conditions associated with working on sewerage are sufficient reasons for offering additional incentives. Current preference of field staff is for water supply or drainage assignments which are perceived as "cleaner" and "of higher status".

9.2 Proposed Institutional Arrangements

9.2.1 The North Dhaka East Sewerage Project

The project management arrangements are dependent on whether the capital investment will be provided through external loans or through grants. Since it does not seem likely that a grant at the size needed will be available, the following ***discussion assumes that loan conditions will apply***. In addition, if co-financing, parallel financing or mixed grant-loan financing is done, further modifications, conditionalities and working arrangements may have to be negotiated prior to appraisal.

(1) **Project Co-ordination.** A *Project Management Office (PMO)*, headed by a Project Manager, will be organised to co-ordinate all the activities related to this Project. The Manager will report to the MD directly on matters related to the project. However, he is expected to co-ordinate closely with the concerned DMDs. The PMO will also be expected to co-ordinate implementation of a public information and education program. It is envisaged that consultants will be recruited to guide the activities of the PMO and transfer technology. Selected DWASA professional and support staff will be detailed to the PMO.

In addition, the PMO will take the necessary steps to promote the next phases of the project implementation based on the Master Plan; and ensure that such new developments are co-ordinated with the DCC, RAJUK, ERD, MLGRDC and other units within DWASA itself.

(2) **Facilities Design and Construction.** The DWASA Planning and Development Service will be the lead counterpart for facilities design and construction. It is envisaged that the consultants will supervise the detailed design and construction

of the new facilities; prepare the tender documents and guide the selection of the contractor; and transfer technology on project management and construction inspection skills. DWASA staff from the sewerage-related offices under the Planning and Development Service who are detailed to the PMO are expected to contribute to this effort.

(3) **Training.** The Training Institute will be strengthened to deliver effective training services for sewerage operation, maintenance and management, both directly and through the MODS management. It is envisaged that MODS-V will be piloted as the "centre of excellence" for sewerage operation and maintenance for other zones. This is consistent with the emerging DWASA strategy of developing "centres of excellence" for the various aspects of its operations.

Training services for sludge handling and sewer maintenance will also be opened to the private sector contractors. Steps towards the organisation, training and the professionalisation of the private contractors who provide wastewater-related services should be promoted by DWASA.

(4) **Operation and Maintenance of New Facilities.** DWASA Technical Services, specifically MODS-V, will bear the main responsibility for ensuring that the facilities are properly operated and maintained. Since many of the O&M problems can be traced to design and construction decisions, their involvement, even during the initial stages, will be critical.

The responsibility for ensuring effective and well-organised septage management will be maintained at DWASA. The STP capacity includes septage treatment and disposal. It is rational to have the overall responsibility lodged with DWASA. However, private sector involvement, through service contracts, for septage collection is strongly recommended.

(5) **Public Information and Education.** The Project Management Office, in collaboration with the Public Relations Office and MODS-V, will be responsible for launching a systematic and sustained public information and awareness campaign.

(6) Sewerage Services to Cantonment Area

1) The Cantonment is a special area which may be included if arrangements can be reached between DWASA and the Cantonment Board for acquiring the survey data and for the meeting the conveyance and treatment costs.

2) *Basic scheme for the extension of wastewater services.* Prior to a detailed study, a Memo of Agreement between DWASA and the Cantonment Board laying out the basic principles and policies for the extension of domestic wastewater services by DWASA to the Cantonment area will be needed. It is proposed that the Cantonment Board will continue to be responsible for improving, managing the *internal* wastewater collection system, *including* the sourcing of capital improvement funds. For a fixed fee, DWASA will accept the wastewater at one (or several) "wastewater transfer points", convey, treat and dispose of the wastewater and sludge in a sanitary manner. The fee should be sufficient to cover all the associated operating costs of DWASA and should be re-negotiable every three years. Only domestic wastewater is covered by the Agreement; industrial wastewater and stormwater are not included.

9.2.2 Proposed Structure and Staffing for the North Dhaka East Sewerage Project

(1) *Promoting Decentralisation.* Actual delegation of authority and implementation of a strong performance audit system based on MODS as cost centres should be vigorously pursued. Additionally, this Study proposes that a step-wise scheme to progressively devolve authority and accountability to the MODS, contingent on attainment of specific MODS-level institutional development and performance indicators, be applied. Regular operations audits should be conducted and each MODS and key point installation would receive an efficiency rating. The system should enable an equitable comparison of performance among the various MODS and key point installations.

(2) New MODS-V structure and staffing. It is best to keep the water supply O&M separate from the sewerage O&M. At present, there are only three (3) inspectors and eight (8) sewer cleaners at MODS-V spread throughout the entire zone.

(3) The appointment of an SDE for sewerage O&M will have to be augmented with three (3) teams with a complement of at least [6] sewer cleaners each with adequate equipment, tools and vehicles. Each team will be assigned a specific subzone. The current practice of contracting out sewer cleaning should be strengthened with a view towards ensuring proper pre-qualification of the capability of the contractors and rationalising the use of contractors and use of in-company sewer cleaners.

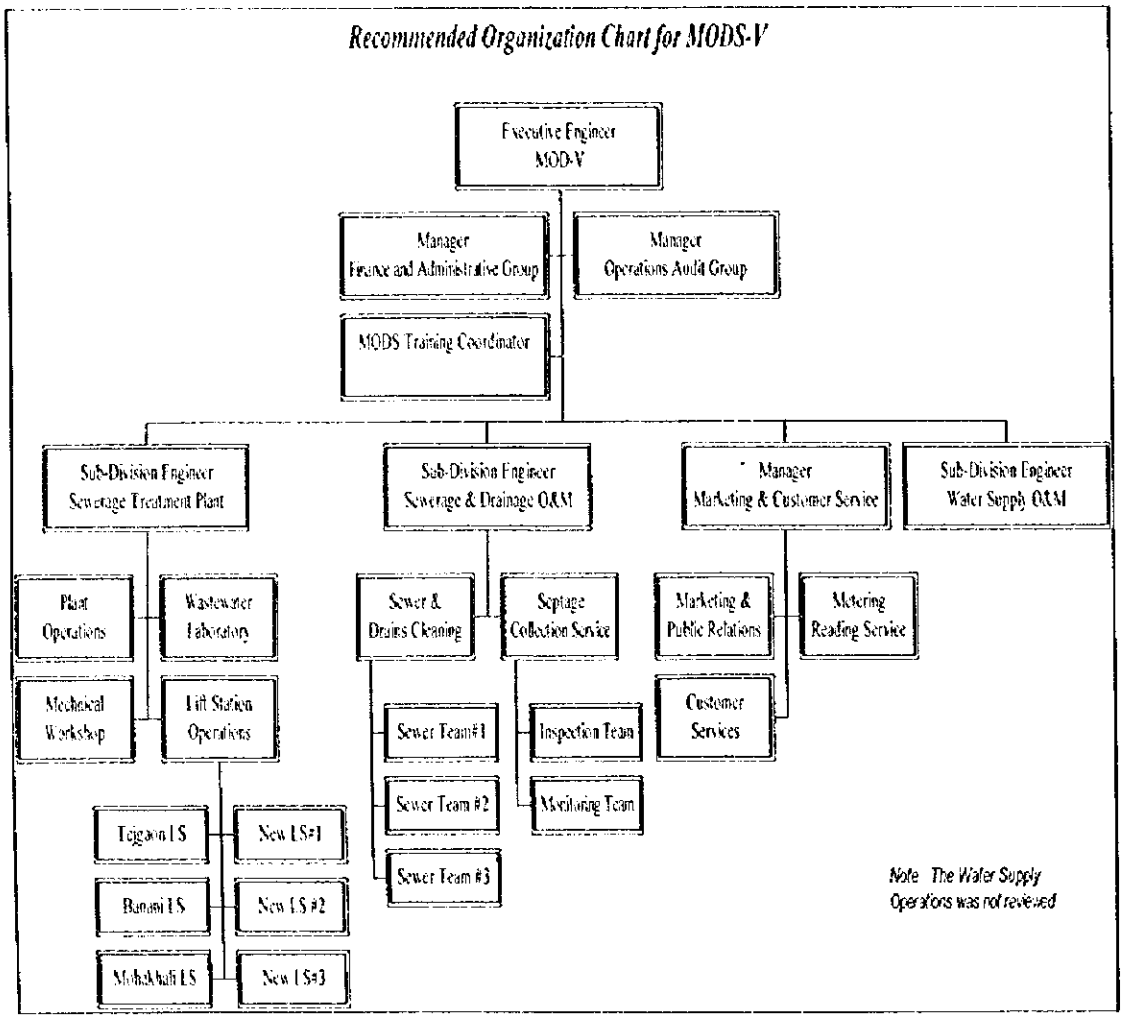


Figure 9.2.1 Proposed MODS-V Organisational Structure

(1) Unlike the existing arrangements in South Dhaka, the operation and maintenance of the new (and old) lift stations and the new treatment plant will be the responsibility of a new unit which reports to the MODS-V Executive Engineer. All fa-

cilities will serve Zone V only; so consistency with the cost centre concept is maintained.

(2) It should also be pointed out that although the sewerage and drainage functions are located in one work group, the new facilities are not intended to take in stormwater. One key responsibility of this work group is to ensure that the sewerage system is, in fact, kept separate from the drainage system.

(3) At the central level, the following chart shows the recommended modifications to the DWASA organisational structure and the staffing needed

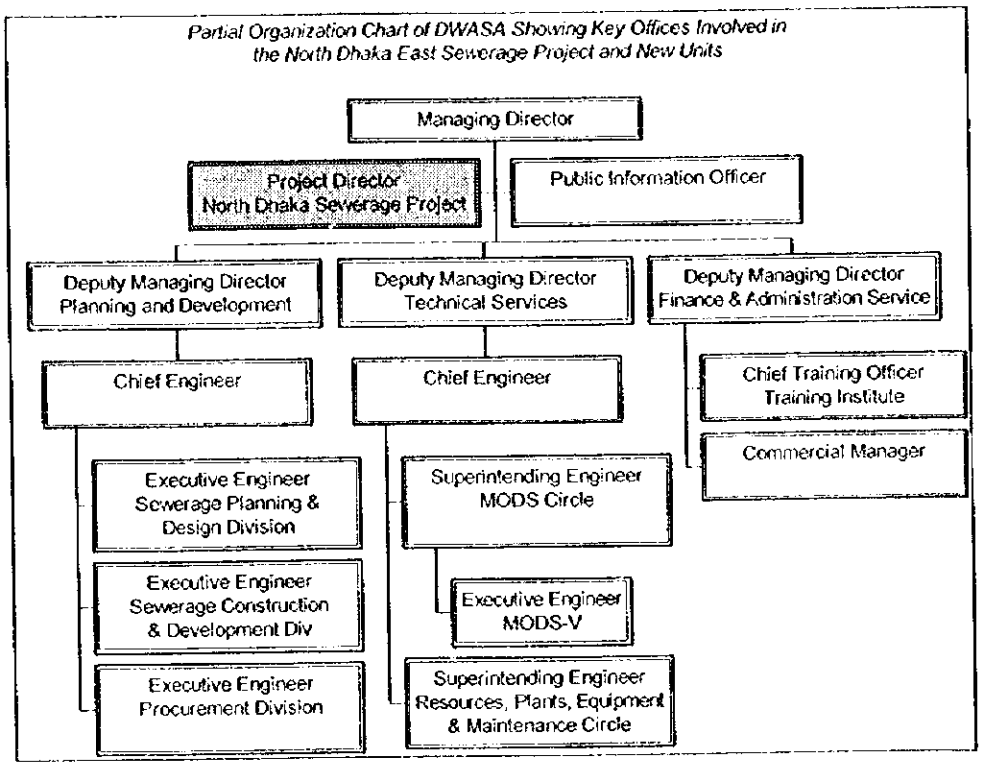


Figure 9.2.2 Proposed DWASA Organisational Structure

9.3 Capacity Building Plan

To make the above institutional arrangements truly functional, current capacity building plans will have to be augmented. DWASA, in co-operation with several external support agencies, have already launched various institutional development programs targeting the entire institution, i.e., both water and sewerage for the entire

service area. These programs include interventions through the introduction of new management planning and control systems (methods, tools and techniques) and human resources development, among others. In designing (and implementing) the institutional arrangements for this project, therefore, close liaison to ensure consistency with other improvement programs should be maintained.

(1) **Linkages with the Management and Operations Support (Twinning) Project under the WB-supported DWASA-IV Project.** This project appears to be the umbrella project under which a host of critical capacity building interventions will be organised. It is useful to briefly mention some of the key institution-wide improvements planned which are of equal importance to the success of this proposed North Dhaka East Sewerage investment. Based on current discussions, the congruence and consistency of the future development findings, directions and concepts between the two projects is clearly emerging. The Twinning Project recently moved to the next phase with a clear and challenging work plan. It consists of five Key Improvement Programs (KIPs) which bear relevance and importance to the North Dhaka East Sewerage Project, as follows:

- ***KIP1: Corporate Development.*** This Sewerage Study promotes the general policy towards the decentralisation of authority and accountability to the MODS. In formulating the O&M structure, the Study follows the restructuring of the MODS by function, i.e., water supply, sewerage, drainage, etc., instead of the current structuring by geographic sub-areas. The Study supports the establishment of MODS-level performance targets as the basis for future corporate planning and evaluation.

- ***KIP2: Customer Relations, Revenue and Accounting Improvement Program.*** This Study supports efforts to make DWASA more marketing-oriented and customer-friendly. In addition, guidelines for a public information and education program are laid out in the next section (9.4). This can augment the "water awareness programme".

  The sewerage study agrees with the need to rationalise and develop a management information system. Similarly, the billing and collection system and customer ledgers should be reviewed.

- ***KIP3: Operations Improvement Program.*** This Study fully supports the introduction of the "technical standards practices" for sewerage. By the time the new facilities are in place, it is anticipated that the Twinning Project shall have completed its TSPs and Preventive Maintenance Program for sewerage facilities. This sewerage project should basically follow the form of the TSP with appropriate content modifications, as required.

- ***KIP4: Employee Improvement Program.*** To avoid overlaps, the project's training programs will focus on the technical training requirements to improve sewerage operation and maintenance in the priority area.

  On the matter of strengthening the DWASA Training Institute, this sewerage project concurs with the basic findings with respect to the capacity of the Institute and the proposed development strategy. Focusing is a key issue at the Institute; and this sewerage project envisages that the Institute's capacity will be further stressed with the sewerage training demand. In lieu of this, an approach may be piloted to decentralise the delivery of sewerage training services to the MOD, can be considered. This approach recognises that training is a function and responsibility of operating managers. The role of the Institute, under this concept, is somewhat modified. Section 9.3.2 further discusses this approach.

  The role of the labour union is central to any staff development program. Its input in the planning and implementation of the programs should be seriously considered.

- ***KIP5: Asset and Maintenance Management Program.*** The project concurs with the findings regarding the stores management system. As with other financial and management system interventions which have to be system-wide in application, it is best that the sewerage project, beyond flagging the issue and participating in future discussions as practicable, abide by the system improvements to be introduced.

(1) The scope, therefore, of the capacity building plan under the North Dhaka project will be limited to the following components:

- Provision of Direct Training on Wastewater Facilities Construction and O&M

- Strengthening of DWASA Training Institute for Wastewater Management and Technical Training

9.3.1 Direct Provision of Training on Sewerage Facilities Construction and O&M

(1) **Training Objective.** To ensure that there will be adequately skilled staff to supervise the planning and construction activities and to operate, maintain and manage the sewerage collection, treatment and disposal facilities during its start-up.

(2) **Assessment of Competency Needs.** A wider-scale training assessment was reported out in Progress Report 1. Current activities to address training needs were also noted. This section focuses on the training needs which are particularly emergent due to the implementation of this Project.

(3) **Training Approaches and Methods.** The next phase will employ several training approaches, including:

- Use of the existing South Dhaka sewerage facilities and other demonstration project sites for field work, demonstration, practice and case study to help improve quality of training.

- To the extent possible, the operating manuals will be adapted and used as the training material. Additional new training materials based on local case studies, field reports, etc. will be developed. On-job training, coaching and group discussions will be organised.

(4) **Target Participants.** It is thus envisaged that the primary target of the training will be DWASA staff and officers directly involved in project implementation

(Planning and Development Services) and field staff performing daily sewerage operation and maintenance (Technical Services, particularly, MODS-V).

(5) **Training Plan for Sewerage and Wastewater Management.** The courses listed in Table 9.3.1 are modular and participants are expected to complete all the individual subject areas listed in the series. To the extent possible, new participatory training methods and techniques will be used. Detailed training designs will be prepared and reviewed prior to implementation. Overseas training also may be organised following the outline below.

Table 9.3.1 Suggested Training Programs

Series	Modules	Recommended Workshop Coverage
Sewerage Operation and Maintenance Series	Sewer Cleaning, Rehabilitation and Maintenance	Sewer Connections; Site Investigation; Sewer Cleaning; Sewer Rehabilitation; Work safety procedures; Emergency procedures; Operations reporting system; Cost efficiency; Testing procedures; Equipment and tools maintenance; Work-organisation
	Operation and Maintenance of Lift Stations	Routine Maintenance (Daily); Periodic Maintenance; Work safety procedures; Emergency procedures; Operations reporting system; Cost efficiency; Testing procedures; Equipment and tools maintenance; Work organisation.
	Operation and Maintenance of Sewerage Treatment Plants	Grit chambers; Primary sedimentation tanks; Facultative ponds; Disinfection chambers; Sludge lagoons; Work safety procedures; Emergency procedures; Operations reporting system; Cost efficiency; Testing procedures; Equipment and tools maintenance; Work organisation
	Engineering and Management of Sewerage Systems	Treatment Efficiency (BOD removal rates); Sludge Management; Wastewater Effluent Standards and Laboratory Methods; Operations Planning and Cost Control Systems; Industrial Wastewater Management
Project Management and Development Series	Preparation of Technical Specifications, Bidding and Tendering Documents	Legal Documentation. Technical specification writing. Bid evaluation and award criteria and procedures.
	Procurement Guidelines	Materials testing and acceptance (various materials to be procured)
	Construction Inspection, Supervision and Monitoring	Role of Construction Inspectors and Working Relationships. Construction Standards, Inspection and Testing Procedures for: Sewer Pipe Laying, Soil Compaction and Surface Restoration, Reinforced Concrete, Equipment Installation and General Civil Works. Safety. Logbooks and Progress Reports. Progress Payment Procedures

(6) Implementation and Monitoring of Training

1) **Training Responsibility.** The promotion and organisation of staff training is the responsibility of the DWASA Training Institute which was established in 1980 and is headed by the Chief Training Officer under the Administrative Service.

2) **Monitoring training results and impact** is one of the more complicated aspects of most projects. Guidelines will be formulated as part of the capacity building to check the impact of training interventions on the performance of DWASA based on key performance. This training plan will be closely linked with the planned establishment of the planning system and management information system under the Twinning Project. The relationship between costs and outputs are not readily apparent. Specifically, the following key indicators may be used to assess the overall contribution of the project:

- Operational indicators, including: % HH connected; Volume and % wastewater treated.
- Efficiency Indicators, including: Treatment cost per cum; Capacity utilisation; Staff/1,000 connections; O&M Cost per km of sewer.

A *second area* to be monitored is the effectiveness of training designs and methods for local application. This will be done through a deliberate and year-round assessment of training methods and techniques.

The *third area* is the monitoring of individual progress in acquiring new skills and knowledge. This will be done through tests and exercises to be conducted during the training programs.

9.3.2 Strengthening DWASA Training Institute

(1) Objectives. This component will equip the Training Institute to provide training advisory and support services to the MODS for effective training programs for sewerage O&M.

(2) Strategies will consist of:

1) *Piloting the decentralisation of training responsibility to the MODS managers.* The most useful location of the training is in the mainstream of planning and operations. In order not to further stretch the demands on DWASA Training Institute, a strategy of decentralising the training responsibility to the MODS may be adopted. This follows on from the premise that staff development is the responsibility of every manager towards his staff. MODS will now have to allocate and spend the budget for training its staff. Training Institute will change itself, *vis a vis sewerage O&M training*, from being a provider of training services into a training adviser to the MODS, a learning resource centre, and possibly, a monitor. In the future, it may handle inter-MOD training demands, such as trainers' training.

2) *Core Trainer Skills.* This approach envisages the use of DWASA central and MODS managers, supervisors and "master operators" as resource persons and coaches. It would be fair to state that in most operating units, a small corps of competent supervisors and technicians has taken root and it is important to keep the momentum going by provision of adequate incentives for further development and application of new knowledge and skills within DWASA. DWASA trainers and "coaches" should develop expertise in adult learning principles and approaches and use of participative methods.

3) *MOD leadership for developing the internal HRD.* The post of MODS Training and Development Co-ordinator to proposed at MODS-V to oversee the training of MODS staff and co-ordinate activities with the Training Institute. The co-ordinator should have strong communication and management skills, confidence and enthusiasm for the task.

4) *Transforming the Training Institute into a Learning Resource Centre.* The facilities, including training and information materials of the Institute will be upgraded.. More operation and maintenance training materials are needed. Setting up a library of audio-visual training and information materials can greatly help build training capacity. These leaning resources may be availed of by the MODS and the Institute itself.

5) *Linkages with other HRD-support systems.* Co-operation with universities and colleges, vocational training institutes, and continuing education programs of professional organisations will help bolster the available resources.

6) *Training Designs.* Training designs, not just a list of topics with a time schedule, are needed. These training designs would clearly describe learning objectives, the relevance to corporate objectives and the process to be used in gaining the competency.

(5) **Technical assistance** should be sought to improve the capacity of DWASA staff to operate and maintain the sewerage system, particularly the sewer network and the wastewater treatment plant through the posting of a **Technical Training Expert.** It is proposed that DWASA secure the services of an expatriate Expert under an international technical assistance program. This could be implemented in tandem with any proposed project(s). The Expert could usefully in a twenty-four-month assignment based in Dhaka. The Expert would assist the Training Institute and MODS-V. DWASA would provide office and use of the Institute's training facilities, including utilities

Preliminary Terms of Reference. The Technical Expert's tasks will include, but will not necessarily be limited to, the following:

- Design of training programs for various O&M skills, including routine and corrective maintenance for sewers, pumping stations, wastewater treatment plants, etc., to be carried out to upon completion of the new facilities in north Dhaka (and also, to improve operation and maintenance in the existing south Dhaka facilities);

- Identification, acquisition and adaptation of training materials based on the technical standards practice manual produced by the twinning project;

- Identification and acquisition of needed audio-visual training materials and some equipment;

- Selection and training of sewerage technical trainers and coaches;

- Develop and test a methodology for preparing an annual training plan for wastewater training, integrated within the Institute's planning system;

- Pilot implementation of the training programs;

- Evaluation of training results and recommendation of additional training in specific areas, as needed.

9.4 Public Information and Education Program

It would be prudent to point out that in order to gain full advantage of the benefits of this project, the demand (which includes a willingness to pay) of householders for these household-level benefits should be ascertained. After all, to achieve the impact of improved environmental sanitation, 1) improvements in the in-house water and toilet facilities may be required and 2) householders have to agree to connect to the system (or improve their on-site facility) and 3) the system will have to be properly operated and maintained. Householders and businesses will have to pay for these costs.

The key benefits if the availability of sewerage to consumers will be improved household health and hygiene, general convenience, removal of stagnant wastewater from canals and drains and improved business prospects. For landowners, the land values should also rise with the availability of wastewater collection facilities.

A thorough understanding of the benefits and costs by the residents of Dhaka City is important to ensure the sustainability of the service.

9.4.1 Objectives and Strategy

(1) Objectives. The public information and education program is envisaged to increase the demand for improved sanitation and wastewater management.

(2) Strategy. Different audiences have different information needs; and some dissemination methods are more effective than others depending on the audience

one is trying to reach. It is therefore useful to first identify who the various audiences are, define their information needs and draw up a strategy to address these needs.

9.4.2 Key Messages, Target Audiences and Media

(1) Based on the data collected and the initial household survey, the following is a summary of some of the recommended key messages targeting specific audiences.

Table 9.4.2(a) Target Audience and Media

Sample Messages	Target Audience					
	Domestic (income level)			Business		Gov't
	High	Middle	Low	Major	Minor	
"Sewerage is different from the stormwater drainage system!"	•	•	•			•
"Sewer system is not intended to carry garbage (solid waste)!"	•	•	•	•	•	•
Uncollected wastewater is a serious health risk.	•	•	•			
Industrial wastewater should not be accepted in a domestic sewerage system.				•	•	•
Lakes and rivers are polluted due to uncontrolled wastewater.	•	•	•	•	•	•
Shallow tube well supplies can be polluted by wastewater.	•	•	•			
Septic tanks have to be cleaned regularly to be effective.	•	•	•	•	•	
How to apply for sewer connection.	•	•	•	•	•	
Sanctions for system abuse.	•	•	•	•	•	•
How and where to pay for service.	•	•	•	•	•	
How and where to report problems and complaints.	•	•	•	•	•	
New sewer connection policies	•	•	•	•	•	
Annual financial and operating highlights of DWASA	•	•	•	•	•	•
Benefits of improved sanitation and sewerage.	•	•	•	•	•	•

Table 9.4.2(b) Information Dissemination Vehicles

Dissemination Media	Target Audience					
	Domestic (Income Level)			Business		Gov't
	High	Middle	Low	Major	Minor	
Radio and Television	•	•		•	•	•
Newspapers	•	•		•	•	•
Handbills and Fliers		•	•			
Public Meetings		•	•			
Posters & Billboards	•	•	•	•	•	
Consumer Newsletters	•	•				
School System Activities	•	•	•			
Sponsored Facilities Tours		•	•			
Special Events	•	•	•	•	•	•

(3) DWASA should not underestimate the importance of an internal staff awareness program, particularly for field workers who are in direct contact daily with customers. All staff should be able to effectively respond to questions and represent the best interests of the company.

9.4.3 Implementation Arrangements

(1) **Responsibility.** DWASA's Public Information Office, under the Managing Director, is responsible for planning and implementation of public information and education programs.

(2) At present, the PIO's activities are more directed towards media relations, almost exclusively. Its capacity to launch direct consumer-targeted information is largely untested. The PIO's budget is very limited and mostly used for the advertisement of tender notices.

(3) **Planning.** A Project Public Information and Education Plan will be formulated even prior to the start of the project and made the basis for the year-end reviews.

(4) **Budget and Resource Requirements.** A reasonable and adequate annual per budget household (for both customers and non-customers) should be determined.