

CHAPTER 12
FINANCIAL ASPECTS

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12.1 Past and Current Financial Conditions

12.1.1 Past Financial Conditions

DWASA is a public service organization, with its primary purpose of providing water and sewerage to its customers; in as such, it should not be primarily focused earning profits. DWASA's past operations have been characterized by a lack of commercial orientation, governmental interference and organizational inefficiency.

The accounting system within DWASA, plagued by out-dated manual accounting and record keeping practices, also contributed to the woes of the agency as it could not produce reliable data or give an accurate picture of the fiscal operation of the agency. Only records audited by outside sources could be relied upon to provide generally reliable data.

Over the years, DWASA's fiscal situation, while never strong, has become increasingly tenuous, prompting the World Bank, hereinafter referred to as "the WB", to propose a wide-ranging series of projects aimed at improving the organizational, institutional and fiscal capabilities of DWASA.

12.1.2 Current Conditions

The current financial conditions of DWASA are a picture of gradual improvement over the last year and the collection rate, metering rate, computerization of accounts and other items have been increasing the revenues of DWASA. However, there are some problems, a number of which are outlined below.

(1) Existing problems

Inefficient Operations

DWASA has a staff of some 3,264 employees (December 1996) which amounts to nearly 24 employees per 1,000 connections. In comparison, the Delhi (India) water supply authority has 8.9 employees per 1,000 connections, and the Karachi (Pakistan) water authority has 11.7.

It should, however, be pointed out that in countries like Bangladesh, labor tends to be substituted for capital due to its low cost and relative efficiency. Also, a large number of people live in apartment complexes that are treated as one connection, thereby affecting the personnel to service ratio connection.

Moreover, the high tariffs charged consumers bears little relation to the level of service provided to DWASA's customers and the public's image of DWASA is a negative one. The latest tariff for a residential user is Tk 16.55 per 1,000 gallons (Imperial) (equivalent to US\$0.37 per 1,000 gallons or US\$.10 per cu.m at a rate of US\$1 = 44 Taka).

Moreover, DWASA only provides water supply service to 50% of the population and water-borne sewage to 15% of the population. In addition, there are problems within the service area with regards to water pressure, water supply and customer service.

Unaccounted-For-Water (UFW)

The current estimate for the amount of water unaccounted for is officially 47% but this figure is actually much higher. The DWASA MIR of April 1997 shows a water production/water connection ratio of 4.6 cu.m/day/connection. This is an extremely high amount per connection and it strongly suggests large numbers of illegal connections existing. Further, the same MIR (page 4) comments "Total no. of connections will not tally with the no. of accounts due to regularization of illegal connections and also connection given but account not yet opened." As such, DWASA is losing large amounts of potential income.

On a positive note, DWASA has embarked on a program for leak detection and a crash meter installation program in an effort to bring down its UFW. As part of the performance agreement between DWASA and the Government of Bangladesh, the target level for UFW is to be a maximum of 39% by December 1998.

Low Collection Ratios

The collection efficiency of DWASA is not satisfactory. This is exacerbated by the fact that many connections are billed on the basis of property values rather than actual usage and the fact that water/sewage fee collectors 1) are known to engage in illicit billing/collection activities to supplement their own incomes, 2) have no established route maps or collection procedures and 3) make their own billings.

However, according to DWASA, the 1996/97 period (June 30 to June 30) tallied the highest collection ratio on record at nearly 78%. DWASA is also planning to take steps towards improving this situation through increasing computerization and, possibly, privatization.

Another related issue is the fact that a significant portion of the uncollected water bills are from government agencies. According to the April 1997 MIR, the amount owed by governmental agencies was equivalent to 8.95 months (down from April 1996, which was 10.12 months) billing. This is not acceptable.

Accounting System

DWASA uses a double-entry accrual based commercial accounting system. This system is still primarily a manual operation and financial statements are prepared only yearly. The value of these yearly statements for management information/accounting are minimal as they contain inaccuracies and only the statements audited by outside sources are considered useful but even these audits fail to comply with internationally accepted accounting standards.

(2) Improvement programs

DWASA is now in the process of attempting to bring about changes with the assistance of the World Bank, including privatization measures, water meter installation, improved accounting and management schemes, etc. but up to this point, the financial conditions of the agency in have been less than satisfactory overall.

One of the main reasons for this improvement has been the result of the appraisal done by the World Bank and the subsequent recommendations and projects that have come about.

These projects include the following:

- **Crash Metering Program**

This program is intended to significantly increase the number of metered connections, thereby allowing DWASA to improve its billing efficiency and to better track its water production/distribution.

- **Dhaka Water Resources Management Study**

Currently, 98% of DWASA's water supply is provided by deep tubewells, which are

1) costly to operate and maintain, and 2) endanger the groundwater resource due to overdrawing. This program is intended to help DWASA assess the alternative sources available and to develop a surface water source to help augment the groundwater sources.

- **Leak Detection and Loss Reduction Program**

The goals of this program are to prepare and implement a comprehensive reform of the DWASA Leak Detection Division, improve worker training, update by-laws, reduce UFW by 12% and prepare a sustainable long-term operation and maintenance program for DWASA. Also, the program will assist DWASA to rehabilitate the water distribution system to handle the increased pressures expected when the Saidabad WTP becomes operational in 1998.

- **Management and Operational Support Program (Twinning)**

In a partnership between Thames Water International Consultancy Ltd. and Sir William Halcrow & Partners of the UK and DWASA, the key objectives of this project are the provision of:

1. sustained technical and managerial support aimed at building up DWASA's capability to the point where, within four years, it can operate independently and efficiently all aspects of its operations
2. assistance in the development and implementation of organizational structures, systems, procedures and practices required by a commercial water utility
3. back-up support in carrying out day-to-day operations

The program has just completed its Diagnostic Report containing the results of its review of DWASA's organization and operations. In terms of financial matters, the report cites the lack of an effective management information system, poor meter reading performance, and a will to improve within the DWASA Finance Department.

- **Performance Agreement between DWASA and the Government of Bangladesh**

This is a covenant that establishes a number of numerical targets within a set time period. In the financial sector, DWASA has pledged to strengthen its financial performance, accounting systems, audits and control and to improve its management and operational efficiency.

As part of this program, a new accounting manual has been ordered developed, and

the computerization of accounting and inventory processes is underway.

DWASA has also agreed to revise its tariff structure, the first stage of which was completed in June 1997 (as can be seen in Section 12.3 Current Tariff Structure). The tariff structure will be adjusted periodically to enable DWASA to meet its financial obligations, including debt service.

The performance agreement sets out, among others, the following financial and operational benchmarks to be achieved by no later than December 1998:

Operational Targets & Indicators

1. achievement of a meter coverage of about 95%
2. reduction of UFW to at most 39%
3. increase the number of connections to at least 187,000
4. enhance the staff productivity level to about 17 staff per 1,000 connections
5. improve the average well productivity to about 4.0 million liters per day

Financial Ratios and Leverage Indicators

1. a working ratio and operating ratio of 0.6 and 0.8 respectively
2. a receivables to monthly billing ratio of about 3 months
3. a contribution to investment of about 27%
4. a revenue collection efficiency of above 100%
5. debt service coverage of about 0.8
6. a debt to equity ratio of about 32%
7. a current ratio of no more than 6.6

Each of these programs, if implemented successfully, will have a marked and positive impact on the future of DWASA's ability to sustain itself financially over the long-term.

12.2 Balance Sheet and Assets

The balance sheet and assets of DWASA were prepared using information from the Audit Report and Statement of Accounts from the years 1992 to 1996. These documents were prepared by an outside accounting firm in accordance with government regulations.

The DWASA assets and income statement in Tables 12.2.1 and 12.2.2 for the years 1992 to 1996 reflect a number of interesting factors, which are listed below.

- DWASA incurred an overall earnings loss for the 1992-1996 period of Tk -43,310,000 (US\$ 9,843,318 at \$1 = Tk 44).
- Income increased significantly between 1992 and 1995 but so did expenses and interest payments. This was because DWASA started to make loan payments on existing loans as can be seen by the fact that long-term liabilities did not increase significantly. The impact of this is clearly shown in 1996, where the income dropped and the overall profit of DWASA fell seriously into the red.

Also of note, was that DWASA was able to accumulate large cash balances because:

- DWASA did not pay its debt servicing and thereby surplus due to improper records at the Ministry of Finance, hereinafter referred to as "the MOF". For example, in FY '92, only Tk 15 million was paid when Tk 35 million should have been paid.
- Funding for various projects was dispersed without consideration for the actual work schedule, allowing DWASA to carry forward large cash balances.

Table 12.2.1 DWASA Assets

	1992	1993	1994	1995	(Tk '000) 1996
Fixed Assets	3,605,428	3,871,815	4,531,619	4,534,524	4,653,054
Depreciation	1,159,665	1,243,169	1,356,980	1,473,129	1,591,339
Net Fixed Assets	2,445,763	2,628,646	3,174,639	3,061,395	3,061,715
Intangible Assets	2,384,916	3,024,518	3,058,498	3,064,024	3,082,158
Works In Progress	64,133	434,479	786,674	1,184,663	2,218,180
Deferred Expenses	283,813	304,271	292,172	280,380	427,809
Investments	-	-	-	-	-
TOTAL LONG-TERM ASSETS	5,178,625	6,391,914	7,311,983	7,590,462	8,789,862
CURRENT ASSETS					
Accounts Receivable	278,414	379,643	582,463	678,968	824,392
Stores and Inventories	424,604	225,043	246,436	301,253	218,081
Advances for Materials	136,570	152,501	150,216	179,877	26,035
Other Current Assets	30,787	46,893	62,441	78,293	89,241
Cash Balance	974,968	932,165	743,787	776,300	785,202
Total Current Assets	1,845,343	1,736,245	1,785,343	2,014,691	1,942,951
TOTAL ASSETS	7,023,968	8,128,159	9,097,326	9,605,153	10,732,813

Table 12.2.2 Income Statement

	1992	1993	1994	1995	(Tk '000) 1996
WATER					
Actual Production (ML)	219,363	245,985	260,174	275,326	292,920
Water Billed (ML)	96,624	115,110	133,892	152,563	161,106
System Loss (ML)	122,739	130,875	126,282	122,763	131,814
UFW	56.0%	53.2%	48.5%	44.6%	45.0%
REVENUE (x 1,000)					
Water Revenue	310,343	395,329	528,872	558,403	537,050
Sewerage Revenue	153,061	222,256	263,557	252,060	251,942
Water Connection	7,621	12,701	9,576	9,304	8,365
Sewer Connection	612	723	549	787	808
Street Hydrant	-	-	-	2,968	23,813
Direct Water Sales	641	1,156	1,423	1,273	1,064
Meter Sales	6,752	16,102	3,816	14,527	12,652
TOTAL OPERATING REVENUE	479,030	648,267	807,793	839,322	835,694
DIRECT EXPENSES (x 1,000)					
Power	195,114	250,672	298,668	258,592	287,262
Chemicals	10,416	11,944	14,228	17,376	9,855
Repair and Maintenance	31,262	25,981	30,298	75,707	36,553
Direct Salaries and Wages	44,016	48,111	72,540	67,057	78,015
Other Expenses	50,059	58,646	76,118	72,993	93,234
Total Direct Expenses	330,867	395,354	491,852	491,725	504,919
ADMINISTRATION EXPENSES					
Salaries	32,297	49,214	70,987	66,198	80,717
Other Expenses	11,174	14,780	12,763	17,598	19,439
Insurance	95	96	126	128	501
Provision for Doubtful Debt	23,170	30,879	79,243	81,046	78,899
Total Administration Expenses	66,736	94,969	163,119	164,970	179,556
Total Working Expenses	397,603	490,323	654,971	656,695	684,475
Income Before Depreciation	81,427	157,944	152,822	182,627	151,219
Depreciation	115,701	115,701	117,984	127,936	134,876
Operating Profit	(34,274)	42,243	34,838	54,691	16,343
Add Other Income	74,464	78,305	74,390	53,254	61,304
Income Before Interest	40,190	120,548	109,228	107,945	77,647
Interest	35,706	107,794	108,015	128,087	119,266
Net Profit	4,484	12,754	1,213	(20,142)	(41,619)
Payment to the Exchequer	-	-	1,000	1,000	1,000
Net Earnings	4,484	12,754	213	(21,142)	(42,619)

The most current information from DWASA (MIR of April, 1997), which hasn't been audited (note: there are often difference between the normal account books, the audited books, and the MIRs; the audited books take precedence in this Study), shows that DWASA's revenues and expenses are as follows:

Table 12.2.3 DWASA Revenue/Expenditure 1995-1996 & 1996-1997

(Unit = Tk x 1,000)

Revenue Income	1995-1996 % of Total		1996-1997 % of Total	
Water & sewer rates	457,368	89.86	578,890	92.43
Service Conn. Fee	17,597	3.46	13,787	2.20
Meter sales	14,670	2.88	13,198	2.11
Rent	8,845	1.74	3,239	0.52
Miscellaneous	3,225	0.63	3,105	0.50
DTW License/Royalty	6,505	1.28	12,623	2.02
Water sales (direct)	743	0.15	1,432	0.23
TOTAL	508,953	100	626,274	100
Revenue Expditures	1995-1996 % of Total		1996-1997 % of Total	
Power	239,771	46.40	262,667	47.95
Chemical	4,248	0.82	17,790	3.25
Maintenance	33,679	6.52	35,615	6.50
Salaries & wages	129,858	25.13	129,976	23.73
Overtime	35,161	6.80	36,251	6.62
Others	43,425	8.40	45,131	8.24
Purchase of stores	30,595	5.92	20,374	3.72
TOTAL	516,737	100	547,804	100
Depreciation	0		0	
IDA Loan Interest	50,000		100,000	
Bad Debt	0		0	
Total Expenditure	566,737		647,804	
BALANCE	(57,784)		(21,530)	

The above information points to the following:

- Electric power, required to operate the 190-odd tubewells of DWASA, accounts for a huge proportion of DWASA's budget. Any significant increases in the cost of electricity or power shortfalls could be disastrous for DWASA.
- The failure to note depreciation is not acceptable in terms of maintaining an accurate set of accounts.
- The figures for income, ending balance, chemicals and others do not match with the figures shown in the audited accounts.

DWASA has a high debt to equity ratio, which was 11.8 to 1 in FY1992, and fell to 7.3 to 1 in 1995. However this reflects the following situations:

- unused/left over materials and consumables from past projects which have been carried over in the inventory
- uncollected water bills from government agencies, some of which have been unpaid for years
- low amount of accounts payable due to the inadequate billing process of DWASA
- high amount of advances to contractors for materials that haven't been reconciled

Overall, DWASA is low-leveraged, with most of its financing coming from either the Government of Bangladesh in the form of grants or equities, or from loans from the International Bank of Reconstruction and Development (IBRD) or the International Development Agency (IDA). The Japanese Grant, and other similar funds are transferred to DWASA by the Government of Bangladesh. The Government of Bangladesh also transferred the assets of the stormwater drainage from the Department of Public Health and Engineering (DPHE) to DWASA in 1989. These assets are treated as equity of DWASA.

Over 80% of DWASA's outstanding loans are from the IDA. This soft money has not been reflected in the performance level of DWASA in that the performance of DWASA for being so low-leveraged is quite low compared to other countries. However, the ability of DWASA to obtain local financing is limited due to the structural and economic conditions in Bangladesh.

12.2.1 Tongi Income/Expenses

When compared to DWASA, the Tongi Pourshava's finances are on a much lower scale both in terms of income/expenditure and also in managerial/institutional terms. The current accounting system of the Tongi municipal government is a simple, single line cash-in/cash-out system that relies solely on manual methods (no computers are present in the government offices). There is no managerial accounting, but without a computerized accounting system or a developed institutional structure, that is understandable.

The income of the Tongi pourshava is heavily subsidized by the GOB as its inherent income collection system is unable to garner adequate levels of revenue from the residents/businesses of pourshava. The planned turn-over of the DPHB-run water system in the pourshava has yet to materialize due to a number of factors and the ability of the pourshava to administer the system is open to question. Although there are a substantial number of industries in Tongi, the records available on these industries are minimal and revenue collection from the business sector is hindered by a lack of information and cooperation on the part of the businesses.

As can be seen in the below summary of Tongi's income/expense records for the period of 1994-1997, the overall financial situation of Tongi is not a stable one. Discussions with the Tongi accounting section indicated that no forecasting is undertaken and that the prime determinant of the pourshava's financial health is the level of government.

	<u>1994-1995</u>	<u>1995-1996</u>	<u>1996-1997</u>
TOTAL INCOME	27,771,747.63	29,474,658.05	39,326,211.54
OPENING BALANCE	11,105,839.34	7,197,215.12	16,150,581.46
GRAND TOTAL	38,877,586.97	36,671,873.17	55,476,793.00
Sum, as computed	<u>27,771,746.81</u>	<u>29,474,657.94</u>	<u>39,326,211.59</u>
TOTAL EXPENSES	31,680,371.85	20,521,291.71	39,651,734.92
CLOSING BALANCE	7,197,215.12	N/A	15,825,058.08
GRAND TOTAL	38,877,586.97	N/A	55,476,793.00
Sum, as Computed	<u>31,680,371.85</u>	<u>20,421,291.71</u>	<u>39,647,734.85</u>
Remaining Balance	<u>-3,908,625.04</u>	<u>9,053,366.23</u>	<u>-321,523.26</u>

12.3 Current Water and Sewerage Tariffs

As shown in Table 12.3.1, DWASA charges a separate rate for metered and non-metered customers. The non-metered customers pay a rate assessed on the basis of their property value. The sewage rate is the same as that of the water rate and those customers that are not connected but within 100 feet pay 8.56% of their property value tax. Consumers also pay taxes on their water bill, including valued-added-tax (VAT) of 15%.

The current tariffs set by DWASA on April 27, 1997 to be effective starting from June 30, 1997 for water and sewerage are as follows:

Table 12.3.1 Current DWASA Tariff Schedule

Holding Category	Without Meter	With Meter	
		1,000 Gallons (Tk)	1,000 Liters (Tk)
Residential Bldg. & Comm. Centers	Annual Value Assessment (23.77% yearly)	16.55	3.67
Office, Industries & Comm. Bldg.	Annual Value Assessment (23.77% yearly)	54.09	11.92
Bldg. Under Construction (w/o meter)	a) ¾" pipeline per connection per month	Residential (Tk)	Commercial (Tk)
	b) 1" - as above-	797.43	2,392.28
	c) ½" - as above-	1,594.85	4,784.55
	d) 2" - as above-	3,322.60	9,967.81
Minimum monthly charge per connection (with & without meter) is Tk 19.00			
Holdings having both water & sewer lines shall pay for sewer at the same amount of water charges.			
Holdings having only sewer connection shall pay 23.77% annual valuation assessment of holding.			
Holdings that are not connected to the sewer but are situated w/in 100 feet of DWASA's regular sewage line must pay 8.56% annual valuation assessment tax.			

Source: DWASA

The new water and sewerage tariff rates are significant but more so is the approval of Act No. 6 of 1996 which allows DWASA to raise its tariffs by 5% without approval from the Board of Secretaries of the Government of Bangladesh. Previously, all tariff increases had to be approved by the Board of Secretaries; consequently, many tariff rate decisions were based on political considerations. This legislation was viewed as a key factor in enabling DWASA to become a financially responsible organization.

However, the political realities are such that DWASA will still have to get approval from higher authorities to raise tariffs by any significant amount regardless of the legislation.

12.4 Financial Analysis

12.4.1 Implementation Plan

As the construction of a sewerage system is one of the most important public works projects, the sewerage project shall be carried out in a manner that will benefit the most number of people at the lowest possible cost. As seen in Chapter 9, a number of alternative plans were under this master plan. However, one was recommended based on its merits (please see Chapter 9 for details). A financial analysis was undertaken of the recommended project in order to show the financial impact that such a project would have on DWASA as well as to illustrate the importance of DWASA meeting certain financial goals in order to carry out any future project(s).

Estimated project cost

The estimated project cost has been calculated (as shown in Chapter 9); a summary of the costs is broken down as follows:

Table 12.4.1 Summary of Recommended Project Cost

Total Construction Cost:	11,122,909
Land Acquisition Cost	4,565,630
TOTAL PROJECT COST	15,688,539

Note: costs are Tk ('000)

Operation and Maintenance Costs

In many cases, the O&M burden of a project has a significant impact on the finances of the implementing agency. In this project, however, it is predicted that DWASA will be unfazed, as the project's projected revenues in each year far exceed the O&M costs (Tk 46,953,000). However, this prediction is based on the assumption that DWASA will improve its current operations by the time the project is implemented and that the financial condition of DWASA will also improve.

Projected Cash Flow

Based assumptions regarding the performance of DWASA and economic conditions, the projected cash flow of DWASA from the 2001 to 2025 was done. In addition to the base cash flow assumption, three alternative scenarios were prepared as a sensitivity analysis. The projected cash flow and the sensitivity analyses are shown in Tables 12.4.2 to 12.4.5.

TABLE 12.4.2 DWASA Projected Cash Flow (Base)

All Figures in 1,000 Bangladeshi Taka

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Income														
Water Revenue	875,683	928,591	985,543	1,045,538	1,109,185	1,176,707	1,248,339	1,324,331	1,404,950	1,731,873	1,923,937	2,041,057	2,166,306	2,297,119
Domestic	398,181	411,812	436,861	463,476	491,690	521,622	553,376	587,002	622,800	767,721	862,361	904,779	958,858	1,018,289
Commercial	644,571	683,809	725,436	769,597	816,446	854,746	895,266	937,329	982,150	1,174,152	1,361,576	1,436,278	1,507,448	1,578,830
Sewer Revenue	432,515	468,353	494,745	501,712	523,126	544,935	567,508	590,871	615,051	863,424	963,574	1,024,282	1,084,448	1,144,830
Project Revenue	47,711	50,615	53,667	56,865	60,133	63,467	66,865	70,317	73,822	109,357	121,485	128,860	136,726	145,049
Other Revenue	2,408,642	2,543,380	2,686,302	2,837,288	3,100,880	3,691,312	3,898,333	4,119,433	4,352,327	5,347,071	5,874,527	6,209,016	6,563,057	6,937,813
Sub Total														
Expenses														
Other Loans	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878
Project Loan	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475
Other Costs	583,508	671,034	771,589	887,442	1,020,558	1,091,987	1,168,437	1,250,228	1,337,744	1,431,396	1,531,553	1,638,764	1,753,509	1,876,255
Project O&M	51,309	54,901	58,744	62,860	67,266	71,964	76,901	82,091	87,536	93,330	100,533	107,968	115,558	123,347
Salaries & Wages	277,623	319,287	367,157	422,230	485,565	519,554	555,923	594,478	636,476	681,030	728,702	776,711	824,291	872,091
Other	275,287	284,313	314,711	336,582	365,229	397,627	431,906	468,014	506,976	548,707	594,707	645,469	696,855	748,885
Land Acquisition	750,715	0	0	0	0	0	0	0	0	380,185	360,185	0	1,320	0
Construction/Installation	323,493	739,590	739,590	323,493	327,907	694,893	917,407	694,893	392,317	331,183	537,958	745,909	544,911	309,760
Sub Total	4,182,286	3,899,258	4,172,044	3,952,937	4,787,543	5,167,064	5,001,088	4,860,662	4,731,063	5,287,032	5,698,660	5,738,234	5,754,649	5,749,630
BALANCE:	-1,773,627	-1,455,678	-1,486,742	-1,115,969	-1,666,662	-1,475,752	-1,101,755	-741,230	-378,736	60,038	185,867	470,762	808,408	1,188,214
Income														
Water Revenue	2,436,957	2,622,774	2,782,436	2,951,817	3,059,732	3,301,372	3,502,343	3,715,548	3,941,732	4,181,685	4,436,245			
Domestic	1,090,277	1,162,640	1,253,425	1,308,510	1,356,347	1,403,464	1,452,532	1,501,664	1,551,752	1,602,885	1,654,017			
Commercial	2,037,920	2,539,007	3,011,896	3,195,245	3,312,059	3,573,626	3,791,171	4,021,958	4,266,785	4,520,530	4,802,039			
Sewer Revenue	1,171,974	1,212,983	1,255,448	1,299,388	1,344,867	1,390,930	1,438,737	1,487,463	1,536,174	1,796,840	1,859,533			
Project Revenue	153,878	165,612	175,694	186,396	193,203	208,462	221,152	234,614	248,898	264,049	280,122			
Sub Total	7,481,012	8,003,096	8,456,898	8,941,348	9,266,209	10,112,853	10,687,054	11,266,647	11,940,926	12,622,906	13,344,930			
Expenses														
Other Loans	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000			
Project Loan	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475			
Other Costs	2,007,563	2,148,124	2,298,493	2,459,387	2,631,544	2,815,752	3,012,855	3,223,755	3,449,418	3,690,877	3,949,238			
Project O&M	123,047	132,302	141,563	151,473	162,076	173,421	185,560	198,550	212,448	227,319	243,232			
Salaries & Wages	955,179	1,022,045	1,093,885	1,170,136	1,252,045	1,339,689	1,433,407	1,533,810	1,641,176	1,756,059	1,878,983			
Other	876,527	725,234	780,836	837,336	892,498	946,830	1,003,137	1,112,587	1,193,078	1,260,839	1,374,533			
Land Acquisition	1,198,685	0	0	0	0	0	0	0	0	0	0			
Construction/Installation	376,476	911,566	911,566	626,086	810,628	27,086	0	0	0	0	0			
Sub Total	7,151,502	6,307,744	7,459,903	7,478,282	7,414,294	7,188,953	7,146,495	7,346,176	7,874,185	8,432,569	8,923,481			
BALANCE:	329,510	1,195,352	998,995	1,463,067	1,851,945	2,924,493	3,541,459	3,750,471	3,966,731	4,190,337	4,421,368			

Accumulated Cash Flow = 20,182,155

Table 12.4.3 DWASA Projected Cash Flow--10% Increase in O&M Costs

All Figures in 1,000 Bangladeshi Taka

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Income														
Water Revenue	875,863	928,991	985,543	1,045,538	1,109,185	1,176,707	1,248,339	1,324,331	1,404,950	1,731,873	1,923,937	2,041,057	2,165,306	2,297,119
Domestic	388,181	411,612	436,691	463,476	491,690	521,622	553,376	587,062	622,800	767,721	852,861	904,779	959,858	1,018,289
Commercial	644,571	683,809	725,436	769,597	816,446	867,746	919,206	975,845	1,037,150	1,264,152	1,471,076	1,536,288	1,605,448	1,678,830
Sewer Revenue	452,515	468,353	484,745	501,712	519,126	537,002	555,354	574,209	593,571	613,444	633,824	654,704	676,084	697,964
Project Revenue	47,711	50,615	53,697	56,965	60,433	64,102	68,000	72,144	76,542	81,296	86,404	91,864	97,684	103,864
Other Revenue	2,408,662	2,543,580	2,686,302	2,837,268	3,100,680	3,091,312	3,899,333	4,116,433	4,352,327	5,347,071	5,874,527	6,209,016	6,563,057	6,937,813
Sub Total	4,182,269	4,004,748	4,164,390	3,973,762	4,316,756	5,210,996	5,000,489	4,938,656	4,831,680	5,415,127	5,649,520	5,938,396	6,001,761	6,052,615
Expenses														
Other Loans	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878
Project Loan	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475
O&M Costs	503,508	671,034	771,689	887,442	1,020,553	1,091,907	1,168,437	1,250,228	1,337,744	1,431,366	1,531,583	1,638,784	1,753,509	1,870,235
Project O&M	51,308	60,391	71,000	83,661	98,489	115,698	136,412	160,557	189,975	222,424	261,793	308,130	362,670	426,882
Salaries & Wages	277,623	319,267	367,157	422,230	485,565	519,554	565,923	594,836	636,476	691,030	728,702	770,711	824,201	892,691
Other	275,287	294,313	314,711	336,582	365,229	397,627	431,906	468,576	508,936	548,576	588,936	629,086	669,936	710,586
Land Acquisition	750,715	0	0	0	600,675	600,675	0	0	0	360,195	360,195	0	1,320	0
Construction/Installation	323,493	739,390	739,390	323,493	327,907	624,893	917,467	624,893	332,317	331,163	537,858	745,909	544,911	303,789
Sub Total	4,182,269	4,004,748	4,164,390	3,973,762	4,316,756	5,210,996	5,000,489	4,938,656	4,831,680	5,415,127	5,649,520	5,938,396	6,001,761	6,052,615
BALANCE:	-1,773,627	-1,461,186	-1,498,078	-1,136,474	-1,717,876	-1,519,886	-1,161,166	-818,425	-479,553	-68,056	25,007	270,849	561,296	854,998
Income														
Water Revenue	2,436,957	2,622,774	2,782,436	2,951,817	3,050,732	3,301,372	3,502,343	3,715,549	3,941,732	4,181,605	4,438,245	4,694,732	4,961,245	5,238,732
Domestic	1,080,277	1,162,649	1,233,425	1,300,510	1,356,347	1,463,464	1,552,552	1,647,064	1,747,329	1,853,697	1,965,541	2,078,245	2,191,858	2,306,471
Commercial	2,637,928	2,839,087	3,011,896	3,195,245	3,312,059	3,791,171	4,021,956	4,286,705	4,584,403	4,928,908	5,282,699	5,656,487	6,050,387	6,464,261
Sewer Revenue	1,171,974	1,212,983	1,255,446	1,299,388	1,344,867	1,395,000	1,450,737	1,508,174	1,567,317	1,628,174	1,690,833	1,754,296	1,818,561	1,883,624
Project Revenue	153,879	165,612	175,694	186,369	193,203	208,462	221,152	234,614	248,596	264,048	280,122	296,849	314,211	332,324
Sub Total	7,481,012	8,003,096	8,458,886	8,941,349	9,286,209	10,112,853	10,687,954	11,286,647	11,940,926	12,622,906	13,344,830	14,109,326	14,920,245	15,778,112
Expenses														
Other Loans	368,000	368,000	368,000	368,000	368,000	368,000	368,000	368,000	368,000	368,000	368,000	368,000	368,000	368,000
Project Loan	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475
O&M Costs	2,007,593	2,148,124	2,298,493	2,469,367	2,691,544	2,815,752	3,012,655	3,223,755	3,449,418	3,690,877	3,948,238	4,214,501	4,498,764	4,790,027
Project O&M	502,417	591,344	696,012	819,207	964,206	1,134,871	1,335,743	1,572,169	1,850,443	2,177,972	2,563,472	2,998,972	3,484,512	3,999,992
Salaries & Wages	955,179	1,022,042	1,093,595	1,170,138	1,252,045	1,339,689	1,433,467	1,533,810	1,641,176	1,758,059	1,879,983	1,998,487	2,124,187	2,257,687
Other	676,527	728,234	780,836	837,350	892,498	966,930	1,037,137	1,112,587	1,193,678	1,280,839	1,374,533	1,468,849	1,569,887	1,677,887
Land Acquisition	1,196,665	0	0	0	610,626	610,626	0	0	0	0	0	0	0	0
Construction/Installation	325,416	911,568	911,568	325,416	325,416	624,893	917,467	624,893	332,317	331,163	537,858	745,909	544,911	303,789
Sub Total	7,530,272	7,266,786	8,014,352	8,148,026	8,216,395	8,149,603	8,208,677	8,319,796	8,612,190	10,363,221	11,243,702	12,109,326	13,061,245	14,099,112
BALANCE:	-49,260	736,309	444,534	793,323	1,069,814	1,963,250	2,391,277	2,976,851	3,328,736	2,259,685	2,101,126	2,780,070	3,858,996	5,484,302

6,484,302

Accumulated Cash Flow =

Table 12.4.4 DWASA Projected Cash Flow--Reduced Tariff Collection Rate

All Figures in 1,000 Bangladesh Taka

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Income														
Water Revenue	875,683	928,991	985,543	1,045,538	1,109,185	1,176,707	1,248,339	1,324,331	1,404,950	1,731,873	1,923,937	2,041,057	2,165,306	2,297,119
Domestic	388,181	411,812	436,881	463,476	491,690	521,622	553,376	587,002	622,900	767,721	882,661	904,779	930,888	1,018,289
Commercial	644,571	683,809	725,436	769,597	816,446	1,273,746	1,351,286	1,433,545	1,520,812	1,874,695	2,062,599	2,209,377	2,343,673	2,486,556
Sewer Revenue	316,781	327,847	339,322	361,198	467,244	463,701	500,631	518,153	536,288	678,405	720,149	728,724	752,190	778,485
Project O&M	47,711	50,615	53,697	56,965	60,433	74,302	78,825	83,623	88,714	109,357	121,495	128,390	136,726	145,049
Salaries & Wages	2,272,507	2,403,074	2,540,376	2,688,774	2,845,099	3,030,078	3,242,466	3,486,716	4,173,564	5,162,051	6,683,032	6,010,318	6,357,923	6,722,499
Other														
Sub Total	4,182,289	3,999,236	4,172,044	3,952,957	4,787,943	5,167,064	5,007,068	4,860,692	4,731,063	5,287,032	5,683,660	5,738,234	5,754,649	5,749,600
Expenses														
Water Revenue	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878
Domestic	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475
Commercial	563,508	671,034	771,689	887,442	1,020,658	1,091,597	1,168,437	1,250,228	1,337,744	1,431,366	1,531,583	1,638,794	1,750,509	1,876,256
O&M Costs	51,309	54,901	58,744	62,866	67,259	71,964	77,001	82,391	88,158	94,330	100,933	107,998	115,568	123,647
Project O&M	277,623	319,267	367,107	422,230	485,565	519,564	555,923	594,838	636,476	681,030	728,702	779,711	834,291	892,691
Salaries & Wages	275,287	294,313	314,711	336,582	365,229	337,627	361,906	387,969	416,014	468,676	508,536	545,469	584,707	626,855
Other	750,715	0	0	0	602,675	600,675	0	0	0	360,195	360,195	0	1,320	0
Land Acquisition	323,493	739,390	739,390	323,493	327,507	624,850	917,467	674,893	332,317	331,163	537,958	745,309	544,911	309,799
Construction/Installation	4,182,289	3,999,236	4,172,044	3,952,957	4,787,943	5,167,064	5,007,068	4,860,692	4,731,063	5,287,032	5,683,660	5,738,234	5,754,649	5,749,600
Sub Total	-1,909,381	-1,596,193	-1,631,165	-1,206,182	-1,842,444	-1,636,985	-1,268,632	-913,977	-557,499	-124,981	-5,628	272,584	603,274	975,899
BALANCE:														
	2,282,907	2,403,074	2,540,376	2,688,774	2,845,099	3,030,078	3,242,466	3,486,716	4,173,564	5,162,051	6,683,032	6,010,318	6,357,923	6,722,499
Income														
Water Revenue	2,438,967	2,622,774	2,782,436	2,951,817	3,069,732	3,301,372	3,502,343	3,715,548	3,941,732	4,181,685	4,436,245	4,696,541	4,966,541	5,242,541
Domestic	1,080,277	1,162,649	1,233,425	1,308,510	1,356,347	1,463,464	1,565,592	1,647,364	1,747,329	1,863,697	1,993,697	2,138,697	2,288,697	2,448,697
Commercial	2,637,926	2,839,067	3,011,896	3,195,245	3,312,059	3,573,628	3,791,171	4,021,958	4,266,795	4,526,336	4,802,089	5,093,697	5,393,697	5,693,697
Sewer Revenue	952,229	985,587	1,020,051	1,056,753	1,092,704	1,304,941	1,350,614	1,397,896	1,446,812	1,497,450	1,549,661	1,598,661	1,649,661	1,699,661
Project Revenue	153,879	165,632	175,694	185,389	193,203	208,462	221,152	234,614	248,896	264,045	280,122	296,199	312,276	328,353
Other Revenue	7,261,267	7,775,659	8,223,501	8,697,713	9,014,047	9,861,664	10,417,481	11,017,070	11,661,563	12,322,416	13,004,886	13,714,886	14,454,886	15,224,886
Sub Total	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000
Expenses														
Water Revenue	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475
Domestic	2,007,593	2,148,124	2,298,493	2,459,387	2,631,544	2,815,752	3,012,850	3,223,765	3,449,418	3,690,877	3,949,238	4,216,599	4,491,960	4,776,321
Commercial	132,302	141,563	151,473	162,076	173,421	185,560	198,500	212,443	227,319	243,232	260,238	278,244	297,250	317,256
Project O&M	953,179	1,022,042	1,093,585	1,170,136	1,252,045	1,339,659	1,433,467	1,533,810	1,641,176	1,756,059	1,879,593	1,998,661	2,123,353	2,253,645
Salaries & Wages	678,627	728,234	780,836	837,350	892,498	960,930	1,037,137	1,112,587	1,193,678	1,280,839	1,374,533	1,468,886	1,569,886	1,676,886
Other	1,196,665	0	388,385	388,385	0	0	0	0	0	0	0	0	0	0
Land Acquisition	305,416	911,556	911,556	305,416	610,626	27,068	0	0	0	0	0	0	0	0
Construction/Installation	7,160,157	6,817,005	7,469,813	7,469,813	7,425,610	7,200,493	7,159,494	7,560,075	7,969,066	8,440,402	8,940,408	9,440,414	9,940,420	10,440,426
Sub Total	101,110	956,604	753,689	1,208,818	1,558,437	2,661,372	3,258,347	3,456,595	3,662,497	3,874,924	4,094,370	4,314,816	4,535,262	4,755,708
BALANCE:														
	101,110	956,604	753,689	1,208,818	1,558,437	2,661,372	3,258,347	3,456,595	3,662,497	3,874,924	4,094,370	4,314,816	4,535,262	4,755,708

Accumulated Cash Flow =

Note:

14,707,924

Table 12.4.5 DWASA Projected Cash Flow--Increased Land Aquisition Costs

All Figures in 1,000 Bangladeshi Taka

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Income														
Water Revenue	875,683	928,991	995,543	1,045,508	1,109,185	1,176,707	1,248,399	1,324,331	1,404,560	1,731,873	1,923,937	2,041,057	2,185,306	2,297,119
Domestic	388,181	411,912	436,581	463,476	491,690	521,622	553,376	587,062	622,802	767,721	852,861	904,779	956,858	1,018,289
Commercial	644,571	683,309	725,436	759,507	816,446	1,279,748	1,351,236	1,433,545	1,520,810	1,874,686	2,082,599	2,209,377	2,343,873	2,486,556
Sewer Revenue	452,515	468,553	484,745	501,712	523,126	544,935	567,508	590,871	615,051	803,424	893,644	924,922	957,294	990,799
Project Revenue	47,711	50,815	53,667	56,985	60,433	74,302	78,825	83,623	88,714	109,367	121,485	128,880	136,726	145,049
Other Revenue	2,408,662	2,543,500	2,686,322	2,837,288	3,100,890	3,691,312	3,859,333	4,119,433	4,352,327	5,347,071	5,614,527	6,209,016	6,593,057	6,937,815
Sub Total														
Expenses														
Other Loans	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878	442,878
Project Loan	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475
O&M Costs	593,508	671,034	771,609	887,442	1,020,558	1,091,997	1,168,437	1,250,228	1,337,744	1,431,386	1,531,583	1,638,704	1,753,509	1,876,255
Project O&M	51,308	54,901	58,744	62,856	67,256	71,964	77,001	82,591	88,158	94,330	100,933	107,988	115,558	123,647
Salaries & Wages	277,623	319,267	367,157	422,230	485,565	519,554	565,923	594,593	636,476	681,030	728,702	779,711	834,291	892,691
Other	275,287	294,313	314,711	336,582	365,229	337,627	361,906	387,889	416,014	448,576	508,936	545,486	584,707	626,855
Land Acquisition	1,128,073	0	0	0	901,013	901,013	901,013	0	0	540,293	540,293	0	1,900	0
Construction/Installation	323,493	739,390	739,390	921,493	927,907	924,893	917,487	824,893	332,317	331,163	537,856	745,909	544,911	309,799
Sub Total	4,357,646	3,999,258	4,172,044	3,952,267	5,067,860	5,467,401	5,001,083	4,860,692	4,731,003	5,467,130	5,868,757	5,736,234	5,755,309	5,749,600
BALANCE:	-2,148,984	-1,455,878	-1,485,742	-1,115,689	-1,967,000	-1,776,089	-1,101,755	-741,259	-378,736	-130,059	5,770	470,782	807,748	1,188,214
Income														
Water Revenue	2,436,957	2,622,774	2,782,436	2,951,517	3,059,732	3,301,372	3,502,343	3,715,548	3,941,732	4,181,685	4,436,245			
Domestic	1,080,277	1,162,649	1,233,425	1,308,510	1,356,947	1,463,464	1,552,552	1,647,064	1,747,329	1,853,697	1,966,541			
Commercial	2,637,926	2,839,067	3,011,808	3,195,245	3,312,659	3,573,626	3,701,171	4,021,958	4,236,755	4,526,538	4,802,069			
Sewer Revenue	1,171,974	1,212,003	1,255,448	1,299,368	1,344,867	1,389,689	1,433,407	1,476,816	1,519,874	1,786,940	1,859,833			
Project Revenue	153,879	165,812	175,694	186,389	193,203	209,462	221,152	234,614	248,696	294,048	300,122			
Sub Total	7,481,012	8,003,096	8,458,068	8,941,349	9,266,209	10,112,853	10,687,954	11,286,047	11,940,926	12,622,906	13,344,830			
Expenses														
Other Loans	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000	388,000
Project Loan	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475	1,477,475
O&M Costs	132,302	141,563	151,473	162,076	173,421	185,560	198,550	212,448	227,319	243,232	260,250			
Project O&M	955,170	1,022,042	1,080,565	1,170,130	1,252,045	1,339,689	1,433,407	1,533,816	1,641,176	1,756,059	1,876,983			
Salaries & Wages	676,527	726,234	780,836	837,550	892,498	966,000	1,037,137	1,112,587	1,193,678	1,280,639	1,374,533			
Other	1,794,968	0	552,578	552,578	0	0	0	0	0	0	0	0	0	0
Land Acquisition	326,416	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation	7,758,480	6,817,005	7,654,095	7,673,687	7,425,610	7,200,493	7,159,494	7,150,075	7,988,086	8,448,482	8,940,488			
Sub Total	-277,477	1,186,091	804,893	1,268,261	1,840,600	2,912,390	3,528,470	3,736,572	3,951,859	4,174,424	4,404,342			
BALANCE:														

Accumulated Cash Flow = 17,691,338

Assumptions for base cash flow scenario

The base cash flow scenario is based on a number of assumptions. These assumptions are deemed reasonable but it must be remembered that the projections made in this study are for illustrative purposes only.

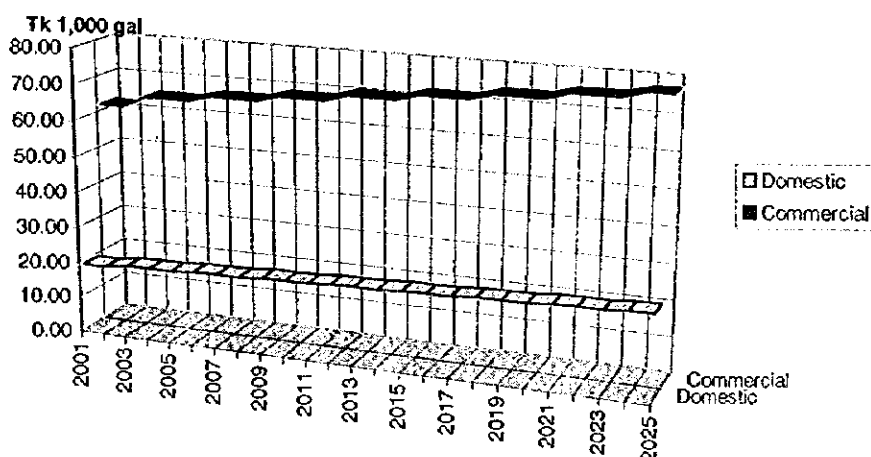
Water Production

As can be seen in Table 12.4.6, Projected Water Sales and Quantities, the water production capacity is assumed to increase by 10% in the year 2006 and 2015. The amount available from actual production is also expected to increase to the point where 100% of the available production capacity is used. Domestic water accounts for 88% of the total, while commercial accounts for the remaining 12%. The ratio of UFW for the year 2001 is set at 35% and declines gradually to 30% by 2016.

Water Tariff

Also shown in Figure 12.4.1, is the assumed tariff rate per 1,000 gallons. The domestic tariff in the year 2001 is set at 18.98 Taka per 1,000 gallons and climbs gradually to 23.69 Taka per 1,000 gallons in 2025. A summary of these assumptions is shown in the graph below.

Figure 12.4.1 Assumed Tariff Rate from 2001 to 2025



Income

Sewer revenue is projected to amount to 51% of water revenues until the year 2006 when it is expected that this will be raised to 75% due to increases in DWASA's efficiency and scope of operations.

Table 12.4.6 Projected Water Production & Sale Quantities

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Production Capacity (MGY)	97,090	97,090	97,090	97,090	97,090	97,090	97,090	97,090	97,090	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890	140,890
Actual Production (MGY)	77,672	79,614	81,604	83,644	85,735	87,879	90,076	92,328	94,636	112,712	118,346	121,306	124,339	127,447	130,634	133,899	137,247	140,678	140,890	140,890	140,890	140,890	140,890	140,890	140,890
UPW	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	31.0%	31.0%	31.0%	31.0%	31.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
Available for Sale	52,429	53,759	55,063	56,460	57,871	59,318	60,801	62,321	63,879	76,081	81,660	83,701	85,794	87,939	90,137	92,380	94,673	96,975	96,623	96,623	96,623	96,623	96,623	96,623	96,623
Domestic Consumption	46,137	47,291	48,473	49,685	50,927	52,200	53,505	54,843	56,214	66,951	71,061	73,657	75,499	77,386	79,321	81,302	83,329	85,404	85,658	85,658	85,658	85,658	85,658	85,658	85,658
Commercial	6,291	6,449	6,610	6,775	6,945	7,118	7,296	7,479	7,665	9,130	9,799	10,444	10,295	10,503	10,816	11,248	11,529	11,817	11,835	12,338	12,646	12,962	13,285	13,618	13,959

Water Tariff (\$/M per 1,000 gal)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Domestic	16.98	19.64	20.33	21.04	21.76	22.54	23.33	24.15	24.99	25.87	26.77	27.71	28.66	29.66	30.72	31.80	32.91	34.06	35.26	36.49	37.77	39.09	40.46	41.87	43.34
Commercial	61.70	63.86	66.09	68.41	70.80	73.28	75.85	78.50	81.25	84.09	87.03	90.08	93.23	96.50	99.87	103.37	106.99	110.73	114.61	118.62	122.77	127.07	131.51	136.12	140.88

Water Tariff (\$/M per 1,000 gal) Yearly increase of 3.5%

Table 12.4.7 Projected Project Income

Assumptions						
Total Target Population	2,981,000					
Person per HH	6.7					
No. of HH	444,925					
Avg. Monthly HH Income	15,536					
Avg. HH Annual Income	186,432					
Avg. Per Capita Water Use	166 lpd					
Avg. HH Annual Water Use	405,953 liters					
	107,172 gallons					
Avg. HH Annual Billing	107.171592	1,000 gal				
	Annual Tariff:	2001	2002	2003	2004	2005
		2,034	2,105	2,179	2,255	2,334
	Collection Rate					
	50%					60%
Base Cash Flow		452,515	468,353	484,745	501,712	623,126
						45%
Sensitivity Cashflow 2	35%	316,761	327,847	339,322	351,198	467,344
	Annual Tariff:	2006	2007	2008	2009	2010
		2,416	2,500	2,588	2,679	2,772
	Collection Rate					
	50%					70%
Base Cash Flow		644,935	667,508	690,871	715,051	863,424
						55%
Sensitivity Cashflow 2	35%	483,701	500,631	518,153	536,288	678,405
	Annual Tariff:	2011	2012	2013	2014	2015
		2,869	2,970	3,074	3,181	3,293
	Collection Rate					
	50%					80%
Base Cash Flow		893,644	924,922	957,294	990,799	1,171,974
						65%
Sensitivity Cashflow 2	35%	702,149	726,724	752,160	778,485	952,229
	Annual Tariff:	2016	2017	2018	2019	2020
		3,408	3,527	3,651	3,778	3,911
	Collection Rate					
	50%					90%
Base Cash Flow		1,212,993	1,255,448	1,299,388	1,344,867	1,565,930
						75%
Sensitivity Cashflow 2	35%	985,557	1,020,051	1,055,753	1,092,704	1,304,941
	Annual Tariff:	2021	2022	2023	2024	2025
		4,047	4,189	4,336	4,487	4,645
	Collection Rate					
	50%					
Base Cash Flow		1,620,737	1,677,463	1,736,174	1,796,940	1,859,833
Sensitivity Cashflow 2	35%	1,350,614	1,397,866	1,446,812	1,497,450	1,549,861

Project revenue is based on the number of households in the project area. The details of the assumptions used for this data are shown in Table 12.4.7 Projected Project Income.

Other revenue is assumed to be 25% of the sum of the other income and accounts for meter sales, service connections, etc.

Expenses

Other loans are based on the outstanding loans of DWASA to various international funding organizations and are based on WB estimates. Additional details can be found in Table 12.4.8 Projected DWASA Expenses.

The Project loan is based on a 7% interest rate over a period of 30 years with a grace period of five years. Table 12.4.9 shows the disbursement schedule for this loan.

O&M costs are based on figures drawn from the DWASA balance sheet; O&M costs include power, repairs and maintenance, and chemicals. O&M costs are projected to increase by 15% annually until the year 2006 whereupon they are assume to increase at an annual rate of 7%.

Project O&M includes the wages of the personnel of the facilities and is assumed to increase annually at a rate of 7%.

Salaries and wages are projected from DWASA balance sheets. The annual increase is set at 15% until the year 2006 whereupon it is assumed to drop to 7% per annum.

The Other category is projected from DWASA balance sheets. The annual increase is set at 8%. This category includes insurance costs, provision for doubtful debt etc. as projected from DWASA balance sheets.

Land Acquisition for the recommended project is based on the estimates obtained in Dhaka.

The Construction/Installation costs of the project were taken from Chapter 9.

Table 12.4.8 Projected DWASA Expenses

EXPENSES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Direct Expenses																									
Power	502,423	577,768	664,454	784,123	878,741	940,253	1,008,071	1,078,499	1,161,850	1,232,480	1,318,753	1,411,098	1,509,841	1,615,530	1,728,617	1,849,820	1,970,063	2,117,630	2,285,664	2,424,474	2,594,187	2,775,781	2,270,085	3,177,991	3,400,450
Chemicals	17,153	19,726	22,865	26,048	30,001	32,101	34,348	36,782	39,325	42,078	45,023	48,175	51,547	55,155	59,016	63,147	67,568	72,297	77,358	82,773	88,567	94,787	101,401	108,499	116,094
Repairs & Maintenance	63,931	73,521	84,549	97,232	111,816	119,644	128,019	135,880	146,599	156,828	167,805	179,553	192,122	205,570	219,990	235,387	251,832	269,460	288,323	308,509	330,101	353,204	377,932	404,367	432,094
Direct Salaries & Wages	136,449	154,916	180,453	207,521	238,650	255,355	273,200	292,356	312,821	334,719	358,149	383,219	410,045	438,748	469,490	502,322	537,485	575,109	615,398	658,442	704,533	753,850	806,670	863,083	922,468
Other Expenses	178,844	135,991	147,951	159,787	172,570	186,375	201,265	217,388	234,779	253,681	273,846	295,754	319,414	344,967	372,593	402,370	434,590	469,324	506,870	547,420	591,214	639,511	690,592	744,759	804,340
Direct Expense Total	848,800	964,981	1,100,093	1,264,750	1,431,778	1,533,728	1,642,962	1,758,972	1,885,344	2,019,666	2,163,578	2,317,767	2,482,668	2,659,970	2,849,617	3,052,610	3,270,537	3,503,820	3,753,781	4,021,614	4,308,602	4,616,116	4,945,820	5,298,719	5,677,077
Administration Expenses																									
Salaries	141,175	162,351	186,703	214,709	246,915	284,199	322,693	362,482	403,645	446,311	490,553	536,492	584,249	633,943	685,719	739,720	796,100	855,027	916,879	981,247	1,048,934	1,119,959	1,195,458	1,275,484	
Other Expenses	28,447	28,592	30,847	33,315	35,680	38,859	41,967	45,325	48,951	52,887	57,068	61,684	66,697	71,925	77,079	82,893	89,504	97,853	105,881	114,135	122,296	131,128	140,778	150,280	167,702
Insurance	684	581	686	816	935	1054	1173	1294	1414	1534	1654	1774	1894	2014	2134	2254	2374	2494	2614	2734	2854	2974	3094	3214	3334
Prov. for Depreciat Depr	100,433	177,779	134,315	141,864	155,844	170,739	118,980	123,583	130,570	139,412	148,226	157,020	165,802	174,574	183,336	192,089	200,832	209,565	218,288	227,001	235,704	244,407	253,110	261,813	270,516
Admin. Exp. Total	280,618	316,973	352,464	390,504	438,574	414,451	442,314	472,083	500,890	530,326	560,493	591,376	622,959	654,831	686,884	719,129	751,569	784,204	816,934	849,759	882,579	915,394	948,204	981,019	1,013,839

NOTE: The salaries, etc. for the additional personnel for the project facilities have been included in the above figures.

Table 12.4.9 LOAN DISBURSEMENT SCHEDULE

Figures = Taka x 1,000

YEARS: 25 RATE: 2.50% GRACE (yrs): 5

Year	Principal	Interest	Payment	Loan
2001	0	0	0 Grace	
2002	0	0	0 Grace	
2003	0	0	0 Grace	
2004	0	0	0 Grace	
2005	0	0	0 Grace	
2006	796,936	680,539	1,477,475	27,221,563
2007	816,860	660,616	1,477,475	26,424,627
2008	837,281	640,194	1,477,475	25,607,767
2009	858,213	619,262	1,477,475	24,770,486
2010	879,669	597,807	1,477,475	23,912,272
2011	901,660	575,815	1,477,475	23,032,604
2012	924,202	553,274	1,477,475	22,130,944
2013	947,307	530,169	1,477,475	21,206,742
2014	970,990	506,486	1,477,475	20,259,435
2015	995,264	482,211	1,477,475	19,288,445
2016	1,020,146	457,330	1,477,475	18,293,181
2017	1,045,650	431,826	1,477,475	17,273,035
2018	1,071,791	405,685	1,477,475	16,227,386
2019	1,098,586	378,890	1,477,475	15,155,595
2020	1,126,050	351,425	1,477,475	14,057,009
2021	1,154,201	323,274	1,477,475	12,930,959
2022	1,183,056	294,419	1,477,475	11,776,758
2023	1,212,633	264,843	1,477,475	10,593,701
2024	1,242,949	234,527	1,477,475	9,381,068
2025	1,274,022	203,453	1,477,475	8,138,120
2026	1,305,873	171,602	1,477,475	6,864,097
2027	1,338,520	138,956	1,477,475	5,558,224
2028	1,371,983	105,493	1,477,475	4,219,705
2029	1,406,282	71,193	1,477,475	2,847,722
2030	1,441,439	36,036	1,477,475	1,441,439
	27,221,563	9,715,322		

12.4.2 Funding Scheme/Investment Schedule

Based on the exact components of the project selected to be implemented after the master plan, a series of alternative funding schemes based on the implementation scheme should be prepared in order to maximize the affordability of the project for DWASA. These funding schemes should compare the costs associated with the different funding sources (i.e., bilateral loans, grants, etc.).

The nature of the funding and the implementation schedule used to finance any proposed project will be a key determinant in the financial viability of the any said project. To illustrate this, the table below illustrates the debt service costs for the recommended project resulting from different interest rates along with their associated FIRR returns under the base scenario assumptions.

Table 12.4.10 Projected Debt Service Burden for Recommended Project

Loan Amount:		15,035,991			
Interest Rate:	10%	8%	6%	4%	2%
Annual Debt Service	1,255,389	1,041,981	870,109	711,999	569,720
FIRR (base)	-0.72%	3.17%	7.08%	11.37%	16.52%

Note: costs in Tk ('000)

12.4.3 Financial Analysis

To determine the viability of any proposed project, all costs and benefits will be transformed to represent their values at an appropriate discount rate. This is the rate assumed to represent the pertinent opportunity cost of capital. A low discount rate, however, is considered justified, as this project shall benefit low-income persons.

If the FIRR is above the cost of capital, then it can be assumed that the Project is feasible; i.e. the financial benefits exceed the financial costs at the prevailing opportunity cost of capital. Table 12.4.11 shows the FIRR of the base scenario and the three alternative scenarios. It can be seen that the base FIRR is 5.10%, which while below the cost of the capital (7%), it is above the assumed discount rate of 2.5% and therefore the recommended project is deemed feasible given the assumed conditions.

TABLE 12.4.11 SENSITIVITY ANALYSIS FOR RECOMMENDED PROJECT

Base Scenario				Sensitivity 1: 20% Increase in O&M Costs				Sensitivity 2: Lower Tariff Collection Rate				Sensitivity 3: Land Costs +50%			
YEAR	BALANCE	NPV		YEAR	BALANCE	NPV		YEAR	BALANCE	NPV		YEAR	BALANCE	NPV	
2001	-538,418	-525,286		2001	-538,418	-525,286		2001	-674,172	-657,729		2001	-538,418	-525,286	
2002	-860,988	-839,998		2002	-862,096	-841,070		2002	-996,753	-972,442		2002	-1,041,098	-1,015,703	
2003	-901,673	-879,681		2003	-904,047	-881,997		2003	-1,044,216	-1,018,747		2003	-1,081,771	-1,055,336	
2004	-808,438	-788,720		2004	-812,285	-792,474		2004	-950,980	-927,786		2004	-808,438	-788,720	
2005	-728,152	-710,392		2005	-733,696	-715,801		2005	-870,694	-849,458		2005	-728,152	-710,392	
2006	296,307	289,080		2006	288,817	281,773		2006	150,201	146,538		2006	296,307	289,080	
2007	-437,354	-426,687		2007	-447,069	-436,165		2007	-583,460	-569,229		2007	-736,243	-718,286	
2008	-875,507	-854,153		2008	-887,757	-866,105		2008	-1,021,613	-996,695		2008	-1,174,396	-1,145,752	
2009	-627,825	-612,512		2009	-642,958	-627,276		2009	-777,583	-758,618		2009	-627,825	-612,512	
2010	-413,760	-403,668		2010	-432,163	-421,623		2010	-563,519	-549,774		2010	-413,760	-403,668	
2011	-549,915	-536,502		2011	-572,019	-558,067		2011	-699,673	-682,608		2011	-910,110	-897,912	
2012	78,756	76,835		2012	52,472	51,192		2012	-74,747	-72,924		2012	78,756	76,835	
2013	306,296	298,825		2013	275,298	268,584		2013	152,793	149,067		2013	306,296	298,825	
2014	1,015,951	991,172		2014	979,648	955,754		2014	862,449	841,413		2014	1,015,951	991,172	
2015	1,643,537	1,603,451		2015	1,592,614	1,553,770		2015	1,477,542	1,441,504		2015	1,634,882	1,595,007	
2016	876,912	865,524		2016	818,689	798,721		2016	818,689	798,721		2016	269,874	263,291	
2017	1,217,216	1,187,528		2017	1,150,840	1,122,771		2017	1,150,840	1,122,771		2017	1,207,307	1,177,860	
2018	1,116,129	1,088,906		2018	1,040,657	1,015,275		2018	1,040,657	1,015,275		2018	1,105,526	1,078,562	
2019	723,017	705,383		2019	637,405	621,859		2019	637,405	621,859		2019	528,237	515,353	
2020	495,078	483,003		2020	398,172	388,461		2020	398,172	388,461		2020	299,504	292,199	
2021	1,717,703	1,675,807		2021	1,608,229	1,569,004		2021	1,608,229	1,569,004		2021	1,704,713	1,663,135	
2022	1,336,282	1,303,690		2022	1,212,831	1,183,250		2022	1,212,831	1,183,250		2022	1,322,383	1,290,130	
2023	927,591	904,967		2023	788,608	769,374		2023	788,608	769,374		2023	912,720	890,459	
2024	690,190	673,356		2024	533,958	520,934		2024	533,958	520,934		2024	674,278	657,832	
2025	220,956	215,557	5.10%	2025	45,579	44,467	4.22%	2025	45,579	44,467	2.19%	2025	203,930	198,966	2.92%

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

12.4.4 Recommendations

The financial analysis carried out above assumed that DWASA would be on-track by the year 2001 in terms of its management, finances, revenue collections, etc. It must be stressed that at the present time, DWASA cannot be termed "on-track" and that a number of items must be addressed in order for DWASA to be able to reach the point projected in the financial analysis performed above.

1. Establish a medium-to-long-term comprehensive water and sewerage master plan for the greater Dhaka area. This master plan will enable DWASA to understand what measures will have to be taken in terms of future water resources development, sanitation, etc. In financial terms, it will allow DWASA to work with international, governmental and other organizations to prepare proper funding, assistance programs for water and sewerage.
2. Set up a financial and managerial accounting system that will enable DWASA to accurately assess its current situation (preferably in real time) and to make accurate projections in terms of the expected revenues/expenses it will likely face in the future. If these tools are present within a relatively short time then DWASA will have taken a significant step towards preparing for its future. The benefits of an integrated and well implemented database cannot be understated.
3. Carry out a full-fledged audit using an internationally accepted accounting system that will firmly establish the actual value of the current assets of DWASA, enumerate the contents, conditions, and location of its stores, and give DWASA a clear basis on which to establish a modern accounting system. This is a critical issue in that unless DWASA understands the true state of its fiscal resources, any study performed on tariff levels, income projections, etc. is moot.
4. Many of the items in terms of financial matters that need to be addressed by DWASA are touched upon in the recommendations of the Management and Operational Support Program (Twinning) as well as the other WB programs that are intended to improve the management, finances and efficiency of DWASA as outlined in 12.1.2 of this chapter. DWASA is urged to seriously reflect upon the recommendations made by the WB programs.

5. The UFW status and collections ratio of DWASA has a significant effect on the financial well-being of the organization. DWASA must take immediate and concerted efforts to improve the efficiency in these areas and to eliminate the prevalent illicit activities connected with bill collections.

6. Computerization

At present, the usage of computers in DWASA is minimal. However, if DWASA is to begin to gain control of its finances/operations and move towards a better future it will be forced to adopt increasing levels of computerization. A properly established financial and management database system would literally give DWASA the keys to its own future. The ability to track money, customers, work performed, stores, personnel, etc. would provide the following advantages:

- reduce fraud, waste and abuse
- provide a direct link between finances and operations
- allow management to conduct operational and strategic planning
- increase efficiency of DWASA personnel

Any such database would have to be robust and (very importantly) secure. As mentioned in the Twinning Report, there are numerous off-the-shelf software packages available for DWASA's use.

The associated hardware (computers, printers, etc.) is also readily available world-wide and should not pose a significant problem in terms of acquisition. The most likely difficulties to be encountered will be in terms of management resistance, lack of computer literate personnel, and the associated training. A possible way to address these problems is to use an outside contractor for the computerization scheme and operations. Another possibility is to implement computerization in a logical, phased manner.

CHAPTER 13
ECONOMIC AND SOCIAL ASPECTS



CHAPTER 13 ECONOMIC AND SOCIAL ASPECTS

13.1 Project Benefits

The value of the project will be viewed in terms of economics as well as purely financial terms. A sewerage project provides the community with a wide range of economic benefits that, while sometimes not readily apparent to the average citizen, are nonetheless significant in terms of health, sanitation and overall living conditions. The various benefits expected to be brought about by the project are discussed in the following sections.

13.1.1 Economic Benefits of the Project

(1) Health benefits

Benefits pertaining to health, which are one the main reasons for installing a sewerage system, involves both the community concerned and the individuals in the area. The anticipated benefits concerning health, viewed from the public's and the individual's standpoints, are detailed below.

Public Health Benefits

The health benefits that accrue to the community from the sewerage system have two aspects. Namely, 1) the preventive effect brought about by the sewerage system reduces the burden on the local and central governments concerned with disease prevention and patient treatment activities, and 2) the reduction of opportunities of contact with infected matters reduces the incidence of diseases on the part of the individual.

Regarding the first item above, budgetary and physical provisions of the government will be reduced with respect to the requirements of chemical disinfection for prevention of epidemics, and of hospitals together with the necessary personnel, equipment and materials. Regarding the second item, details are presented in the following subsection.

Individual Health Benefits

The provision of the proposed sewerage system will result in health benefits to individuals in the service area, such as the reduction in the risk and incidence of water-borne diseases, the consequent elongation of people's life spans, reduced expenditure on medical care, reduction in income loss because of absence from work, and others.

The mortality and morbidity rates associated with water-borne diseases in the Dhaka are fairly high—especially among the urban poor/slum dwellers. For example, the incidence of persons suffering from diarrhea by period was as follows:

<u>Period</u>	<u>Incidence (per 1,000)</u>
Mid-Feb. '94 to Mid-Feb. '95	18.08
Mid-Feb. '94 to Mid-May '94	20.71
Mid-Aug. '94 to Mid-Nov. '94	20.23
Mid-Nov. '94 to Mid-Feb. '95	13.19

The available data relating to water-borne diseases is limited but the Study Team will prepare an estimate based on applicable data from various sources. Calculations will be carried out based on the expected savings in medical care costs that will result from the installation of the sewerage system.

The population in the Dhaka area that is economically active or gainfully employed will be ascertained. The average employment rate in the Study Area, as per the Household Survey on Sanitation was 53%. The final figure for the cost of time lost due to illness will be derived by taking the economically active portion of those afflicted by water-borne diseases multiplied by the minimum daily salary of an average worker in the Study Area; this will be multiplied by the probable number of days that such a person would be incapacitated. The cost of the medical expenses will be derived by multiplying the morbidity rate by the served population and the average expenditure for medical expenses.

(2) Environmental benefits

One of the primary purposes of the Project, as important as health improvement, is the enhancement of the living conditions in areas where water and air pollution have been worsening every year. This will be achieved by the construction of the currently planned sewerage system project, in the following forms:

Improvement of Environment from Aesthetic Standpoint

The unpleasant and filthy conditions of the area will be reduced by some extent by the proposed Project. The offensive smell emitted by the sludge and trash in the area will likewise be reduced. Thus, in areas where human activities are most concentrated, the conditions necessary for relatively pleasant living conditions will be enhanced to a degree.

(3) Local economic benefits

The construction of the sewerage system will contribute substantially to the local economy in several ways. First, the land values in the area will appreciate, and together with such an increase in land value, related properties will also rise in value. Second, the construction of the system will boost the sales of local materials and equipment. Some of the above benefits are quantifiable while others are, unfortunately, not.

Value Added to Land

Investment in sewerage facilities, like other public utilities such as water supply, electricity and road improvement, has the effect of raising the intrinsic value of the parcels of land served by such facilities. The value added per unit of land tends to equal or exceed the pro rata share of the investment involved.

In the Project area, the benefit is considered significant because the project area contains significant portions of land which are in areas destined to be in high-growth areas in the future under the DNDP Urban Development Plan.

Intensified Land Use

When sewerage systems become available, together with other public utilities in general, the land in the area can be more intensively used, as the present Project is implemented. More people can be supported and more activities in industry, commerce and others can be conducted in the Project area. This Project will, therefore, contribute to the development of the area through intensified land use. However, these economic benefits cannot be immediately quantified.

13.1.2 Public Revenue Benefits

Public tax revenue to the local and central governments will be increased in two ways. First, the appreciation in land values will produce an increase in tax revenues. Second, commercial, residential, and other buildings will increase in number and improve in quality; thus, property taxes will increase. This benefit cannot be readily quantified, but it constitutes an important and reliable tax source for the governments concerned.

(1) Employment and local products benefits

During the construction period, the local economy will benefit from the employment of individuals for construction work and through the sale of locally made products and services. The amount of investment for this Project is considerable. The Project, after completion, will also provide permanent employment opportunities for the operation and maintenance of the sewerage system.

These economic benefits will be taken into account in the economic cost analysis by using shadow pricing factors. Some of the economic benefits, presently regarded as unquantifiable, may become quantifiable in the future when the necessary tools for such an evaluation are devised.

13.2 Economic Analysis

13.2.1 Introduction

The evaluation mainly concerned with the economic benefits of the Project, including public health, improvement of the living environment and economic contribution to the community. Regarding the economic valuation of the Project, the most preferable approach would be the quantification of the economic benefits and costs. In many cases, however, there are many unquantifiable factors in infrastructure development projects such as sewerage projects. However, in this Study, all quantifiable benefits are counted for analysis to the greatest extent possible. Intangible factors are also considered.

The first step in economic analysis is to adjust the financial prices to economic values by eliminating direct transfer payments. Direct transfer payments are payments that represent not the use of real sources but only the transfer of claims to real resources from one party in

the same economic society to another. In this Project, the largest transfer payments are direct government subsidies and credit transactions that include loans, receipts, repayments of principal and interest payments and tax. All these entries will be taken out before the financial accounts are adjusted to reflect economic values.

13.2.2 Economic Analysis

To determine the viability of the Project, all economic costs and benefits shall be transformed to their present value at an applicable discount rate. This is the rate assumed to represent the pertinent opportunity cost of capital. A low discount rate, however, is considered justified in light of the prevailing economic and social conditions in the Study Area. The analysis will consist of Benefit/Cost analysis and an EIRR computation.

13.2.3 Social Aspects

The social aspects of the project, in other words how the project will directly affect the lives of the people in the Study Area, will be considered with care. Efforts will be taken to consider unique characteristics of each ward and pourshava in terms of the relative affluence of the people and their requirements/desires in terms of the sanitation and income levels.

13.2.4 Residents' Willingness and Ability to Pay

(1) Willingness-to-pay

The willingness to pay for the sewerage system was measured in the Household Survey on Sanitation conducted in DEVCONsultants Ltd. In this survey, it was found that of the independent and apartment house dwellers, around 95% were willing to pay for sewerage service. Slum dwellers, on the other hand, were only willing to pay 30% of the time.

(2) Ability to Pay

The Household Survey on Sanitation found that the apartment and independent house dweller were willing to pay around Tk 200 per month. This is roughly half of their existing water tariff bill. However, the existing official sewerage tariff is 100% of the existing water bill. The average income in the study area varies greatly from area to area, but a simple average produces an amount of Tk 15,536 per household per month.

In many projects, the ability to pay is commonly expressed as the ratio of the proposed sewerage charge to the total income of potential beneficiary households. The maximum limit of the ratio usually adopted for sewerage charges in developing countries is about 2%. If the proposed sewerage charge is below 2% of household income, the owners of such households are considered capable of paying the sewerage charge.

The ratio of the unit sewerage charge for domestic users to the average monthly income will be calculated as follows:

- Unit Sewerage Charge
- Per Capita Sewage Flow
- Monthly Sewage Flow per Household
- Average number of persons per household is assumed to be 6.7 persons.
- Monthly Sewerage Charge per Household
- Average Monthly Income
- Ratio D/E

13.3 Comments

Some comments regarding the economic and social issues relating to this project are detailed below.

Bangladesh is one of the most densely populated countries in the world and as the migration rural persons to Dhaka City continues, along with the commercial/industrial growth of Dhaka City, the need for sanitation will continue to increase as well. Furthermore, the existing sanitation conditions in the Study Area are already unsatisfactory and will rapidly deteriorate to an even lower level without a sewerage system as the area's population increases.

In order for a substantive economic analysis to be carried out, further data will have to be obtained with regard to health care costs, material costs, import duties, project costs etc. This will be done at a later stage when the details of the proposed project(s) are better known.

CHAPTER 14
ENVIRONMENTAL ASPECTS



CHAPTER 14 ENVIRONMENTAL ASPECTS

14.1 Regulatory Agencies for Water Pollution Control

The Environmental Pollution Control Ordinance of 1977 replaced the earlier Water Pollution Control Ordinance of 1970. A wide range of subjects related to the environment were contained in this law, including air, water, soil, food and shelter for all forms of life. Under this law, the Environmental Pollution Control Board (EPCB) was vested the legal authority to frame the policies for controlling, preventing and abating environmental pollution and to recommend the required implementation procedure through the jurisdiction of the Director.

The Department of Environmental Pollution Control, created in 1977, was renamed as the Department of Environment (hereinafter referred to as "the DOE") in 1989. The DOE is now the sole government agency of the country for environment protection and management.

14.2 Environmental Laws and Regulations

14.2.1 Environmental Protection Act

Until 1995, the existing environmental laws were mutually exclusive. Many of the laws falling in one category were bound to be related to objectives falling in the other categories. This is only natural because of the fact that environment protection is a multi-sectoral phenomenon and not limited to any particular discipline of human activity or any particular aspect of nature.

Through a notification in the Gazette of 16-2-1995, the "Bangladesh Environment Preservation Ordinance" was treated as "the Environmental Protection Act - 1995 (Act No. 1 of 1995)." Through this act, the DOE has the legal authority to perform as per rule against any person or group if he/they do something that will create environmental hazards by any means or activities. Thus, the 1977 Ordinance was replaced by the Environmental Protection Act of 1995, effective from June 1, 1995. (A copy of the Environmental Protection Act and its detailed historical background is contained in Appendix 14.4.1)

14.2.2 Environmental Quality Standards of Bangladesh

The DOE had prepared a draft of the "Environmental Quality Standards" (hereinafter referred to as "the EQS"), as approved by the Technical Expert Committee of the DOE on July 15, 1991, covering such public nuisance on water, air, noise, sewage, industry and soil, under the aforementioned act.

The EQS of Bangladesh, collected during the Stage 1 Field Survey, is summarised below and its standard values are contained in Appendix 14.4.1.

(1) Policy statement in the EQS of Bangladesh

In the Introduction of the EQS, it is stated that:

"Effective programs to control quality of the components of environment depend ideally upon the existence of adequate legislation, supported by regulatory standards and codes that specify the quality of this or that component of environment to be provided to the people. The precise nature of the legislation will, of course, be dictated by national, constitutional, and other considerations, but some features commonly incorporated in such legislation included:

- Specification of the scope of authority,
- Delegation of powers to administer the law to a specified agency or agencies,
- Provision for the establishment and amendment of regulations, and
- Provision for enforcement."

"A standard may be regarded as a quantitative and qualitative statement for the implementation or preservation of some desired grade of product or practice.

Standards can serve as a means to simplifying the design, planning and implementation process or alternatively as a means of control, and are directed towards a variety of objectives, some of which are:

- Uniformity of practice,
- Provision of current, authoritative guidance on good practice,
- Simplification in the manufacture and stocking of materials and components,
- Facilitation of technical communication,
- Dimensional and functional interchangeability,
- Equalisation of the technical capabilities of different enterprises with the technical requirements of the controlling agencies, and

- Proper application of appropriate legislation for better protection of legal, socio-logical, health and economic interests.”

(2) Water pollution

Standard values are set out covering the following category of water uses:

- Drinking water,
- Recreational water,
- Fishing water,
- Industrial water,
- Irrigation water,
- Livestock water, and
- Coastal water.

(3) Air pollution

With regard to the air pollution, the EQS regulates:

- Dust,
- Smoke,
- Mist,
- Fog,
- Fume,
- Sulphurous smog, and
- Photochemical smog.

(4) Noise pollution

Permissible levels of noise pollution are set out by locality, such as residential, commercial, industrial, and institutional areas. Regulations on the motor vehicles are also introduced.

(5) Sewage pollution

Particular regulations on sewage pollution are included in the EQS to prevent pollution in the public water body.

(6) Industrial pollution

Itemised standard values are provided in the EQS for controlling the industrial wastewater categorised by point of discharge, such as inland surface water, sewerage system and on land.

Air pollution and odour to be caused by industrial emission are also regulated by specific pollutant.

(7) Soil pollution

At the time of approval of the EQS, the soil quality criteria were not established yet due to complexity.

14.3 Residents' Awareness on Environmental Sanitation

14.3.1 Objectives of the Questionnaire Survey

The questionnaire survey on the "Residents' Awareness on Environmental Sanitation" was intended to scrutinise the following aspects covering a total of 200 households in the Study Area:

- (1) Awareness on the need and importance of environmental conservation
- (2) Need for the improvement/provision of sewerage system and sanitation facilities
- (3) Health conditions
- (4) Knowledge on hygiene (relationship between water borne/related/vector diseases and hygienic conditions)
- (5) Hygiene and sanitation practices
- (6) Income and expenditure of households
- (7) Willingness and affordability to pay for water supply and sewerage services

The prevailing condition of the recipients' daily life was visualised through statistical analysis and an evaluation of the survey results. The outcome of this particular survey was then reflected in developing alternative measures for the improvement of urban sanitation as well as the institutional and financial aspects.

14.3.2 Questionnaire Survey

(1) Questionnaire form

A set of questionnaire forms covering the aforementioned survey contents was prepared. The answer boxes were intentionally designed to differentiate the responses of each interviewee. (for details, refer to Appendix A.3)

(2) Questionnaire target

The target households were primarily separated into two groups:

- 1) 180 households in the unserved area of the existing sewerage system, and
- 2) 20 households in the served area of the existing sewerage system.

Households belonging to the first group were further subdivided by type of housing facilities and income groups.

Household interviews with the use of questionnaire form were carried out as shown in Table 14.3.1.

Table 14.3.1 Number of Interviewed Households

Study Area		No. of Interviewed Households
Households in Unserved Area	Apartment house	74
	Independent house	126
	Slum area	25
	Sub-Total	180
Households in Served Area		20
Total Number of Interviewed Households		225

Note: Actual survey was carried out including additional 25 households.

14.3.3 Survey Results

The survey results showed that the residents of the Study Area were generally environmentally aware of the dangers of unsafe drinking water and that they dispose of their wastes properly. Most of the people in independent houses and apartment houses use flush toilets. While most maintain their septic tanks regularly, the demand for sewerage services averages around 95%.

The slum households, however, present a different picture. These households generally dispose of their wastes in a nearby street or canal. A large portion of the people were not aware of proper sanitary measures with regard to unsafe drinking water, etc.

14.4 Initial Environmental Examination

The Initial Environmental Examination (hereinafter referred to as "the IEE") was carried out during the Stage 1 Field Work. The outcome of this IEE was further evaluated to draw up the draft Scope of Work and draft Terms of Reference, for the conduct of an Environmental Impact Assessment (hereinafter referred to as "the EIA") on the priority project/s which will be subject to the forthcoming feasibility study.

14.4.1 Objectives

The IEE is planned to be carried out, fully utilising data on the existing sewerage and sanitation conditions as well as existing laws and regulations currently effective in Bangladesh, to preliminary assess the possible and/or review potential environmental impacts which may be brought out through the implementation of the proposed sewerage project.

14.4.2 Target Area of IEE

The Study Area shall cover North Dhaka. These households generally have been included in the Statistical Metropolitan Area (SMA).

The Pagla STP in South Dhaka was also included as one of the alternative sites to treat wastewater to be brought from the North Dhaka area.

The possible location of the main sewer lines and possible area to locate sewage treatment plant/s is indicated in Figure 14.4.1.

Figure 14.4.1 Study Area

14.4.3 Conditions and Requirements of IEE

(1) Project description

The presumed project description is shown in Table 14.4.1.

Table 14.4.1 Project Description

Item		Description
Project Name		Study on the Sewerage System in North Dhaka
Project Background		The Study Area (North Dhaka) have been facing to the rapid urbanisation and population increase at more than 8 % per annum of growth rate. Under these circumstances, living environment of populace in the Study Area is feared by pollution of public water body, emission of offensive odour and growth of unhygienic insects through direct discharge of untreated domestic, commercial and industrial wastewater into nearby water courses due to insufficient provision of the public sewerage system.
Objective of the Project		To develop a sewerage master plan for the target year of 2020 and to carry out the feasibility study of the priority project/s to be identified in the master plan.
Project Location		North Dhaka covering Uttara, Mirpur, Cantonment, Mohammadpur, Banani, Badda, Gulshan and Baridhara, and Tongi Pourashava
Executing Agency		Dhaka Water Supply and Sewerage Authority (DWASA)
Number of Beneficiaries		Projected population in the Study Area in 2015 is estimated at about 5.6 million by RAJUK in the Dhaka Metropolitan Development Plan (DMDP).
Scope of Project	Type of Project	Development of New Sewerage System (sewer lines, pumping stations and sewage treatment plant)
	Project Area	Area: As indicated in Fig.14.4.1 Planned Population: Not yet identified Planned Sewage Flow: Not yet identified
	Sewage Collection Method	Separate Sewer System
	Sewage Treatment Plant	Treatment Method: Not yet determined Treatment Capacity: Not yet determined
	Sludge Treatment/Disposal	Not yet determined
	Sewer Pipeline	Not yet determined
	Effluent Disposal	Discharge Point: Buriganga River, Tongi River, Turag River Lakhya River Effluent Quality: BOD ≤ 40 mg/L; SS ≤ 100 mg/L
Remarks		Intake points of water supply system are located in the downstream of discharge point of treated sewage.

(2) Environmental conditions of the Project

Environmental conditions of the Project are described in terms of social environment, natural environment and public nuisance as shown in Table 14.4.2.

Table 14.4.2 Environmental Conditions of the Project

Item		Description
Project Name		Study on the Sewerage System in North Dhaka
Social Environment	Local Residents (Awareness on inhabitants/ aborigines/project)	Majorities of local residents are private and government employees with their dependants and increasing migrants.
	Land Use (City/agriculture/historic ruins/ sightseeing spots/hospitals, etc.)	National capital city, under redevelopment and expansion of urban area with rapid population increase, encounters flooding/inundation in low elevation area during rainy season.
	Economy/Transportation (Commerce/agro-fisheries/ industrial estate/bus terminal)	Unknown since proposed location of sewage treatment plant is not determined yet.
Natural Environment	Topography/Geology (Steep slope/loose foundation/ swamp/faults)	The city has been developed on flood plain and delta area and includes many low lands wherein flooding/inundation occurs during rainy season.
	Conditions of Coastal Area (Erosion, sand deposits, tidal current, etc.)	Not Applicable
	Important Fauna & Flora (Natural park, endangered species, etc.)	Not identified yet.
Public Nuisance	Status of Public Complaints (Noteworthy public nuisance)	Flooding/inundation, deterioration of sanitary conditions, water pollution and offensive odour
	Status of Adopted Counter-measures	Laws and regulations on environmental protection are in force, but not officially acknowledged. Houses in unserved area of sewerage system are obliged to have septic tanks, but their untreated grey water is discharged into nearby water courses.

(3) Scope of IEE activities

1) Results of Scoping

The preliminary environmental examination conducted by the Study Team is shown in Table 14.4.3.

Each evaluation item was preliminarily scored from "A" to "D" in accordance with the anticipated magnitude of the environmental impacts, as follows:

A: Significant impact anticipated

B: Slight impact anticipated

C: Unknown (subject to further verification)

D: Almost no impact anticipated and therefore not subject to IEE and EIA.

Table 14.4.3 Results of Scoping

Item			Score	Description
Social Environment	1	Relocation of Local Residents	C	Depending on location of sewage treatment plant
	2	Economic Activity	C	Same as above
	3	Transportation & Social Facilities	C	Same as above
	4	Separation of Local Society	D	No separation foreseen
	5	Ruins & Cultural Assets	C	No presence identified so far
	6	Water Right & Right of Common	C	Depending on location of effluent discharge point
	7	Public Hygiene	C	Depending on disposal manner of excess sludge
	8	Wastes from Project	B	Same as above
	9	Natural Disaster	C	No significant interference to Flood control is foreseen.
Natural Environment	10	Topography & Geology	D	No significant change planned
	11	Soil Erosion	D	Same as above
	12	Groundwater	C	Depending on disposal manner of excess sludge
	13	River, Lake & Pond	C	Depending on location of effluent discharge point
	14	Coast & Sea	D	No coastal line exists
	15	Flora & Fauna	D	No endangered species identified yet
	16	Climate	D	No large scale facility planned
	17	Scenery	D	Same as above
Public Nuisance	18	Air Pollution	C	Possible, if excess sludge is incinerated
	19	Water Pollution	C	Depending on location of effluent discharge point
	20	Soil Pollution	C	Depending on disposal manner of excess sludge
	21	Noise and Vibration	C	Depending on location conditions of sewage treatment plant/s and pumping station/s
	22	Land Subsidence	D	No groundwater utilisation planned
	23	Odour	B	Possible to emit odour from sewage treatment plant/s and pumping station/s

2) Preliminary overall evaluation

A preliminary overall evaluation on the anticipated environmental impacts was then carried out by the Study Team and summarised as shown in Table 14.4.4.

Table 14.4.4 Preliminary Overall Evaluation on Anticipated Environmental Impacts

Item	Score	Scope of Required Study	Remarks
Wastes from Project	B	Disposal method of excess sludge	
Odour	B	Climate Present conditions of similar facilities	Direction and velocity of wind
Relocation of Local Residents	C	Site conditions of pumping station and treatment plant	
Economic Activity	C	Same as above	
Transportation & Social Facilities	C	Same as above	
Ruins & Cultural Assets	C	No presence identified so far	
Water Right & Right of Common	C	Conditions at effluent discharge point	
Public Hygiene	C	Disposal method of excess sludge	
Groundwater	C	Disposal method of excess sludge Review of possible leachate	
River, Lake & Pond	C	Conditions at effluent discharge point	
Air Pollution	C	To be studied, if sludge is to be incinerated	Direction and velocity of wind
Water Pollution	C	Impact to receiving water body of effluent	
Soil Pollution	C	Disposal method of excess sludge	
Noise and Vibration	C	Site conditions of pumping station and treatment plant	

Note: Scores are to be referred in Table 14.4.3.

3) Scope of IEE

The following work was undertaken by the local consultants hired by the Study Team in the course of the study of the IEE:

- a. Laws and regulations on the EIA, environmental protection and sewerage project
 - Collection and review of the existing laws and regulations pertaining to the EIA, environmental protection and sewerage project to identify the need and field of the EIA.
 - Clarification of legislative requirements on environmental aspects relative to the implementation of sewerage project. This particular item was intended to scrutinise not only the existing laws and regulations, but also such requirements under consideration or proposed for the governmental approval.
- b. Itemised assessment of anticipated environmental impacts

Based on the results of preliminary overall evaluation of anticipated environmental impacts, itemised assessments were performed to identify the need and field of the EIA to be carried out in the feasibility study of the priority project(s).

14.4.4 Results of IEE

(1) Overview of IEE results

The IEE was conducted for the preliminary master plan during the Stage 1 Field Work, while additional master plan alternatives were further considered and evaluated in the course of the Stage 1 Domestic Work. This additional work primarily took into account the inclusion of the domestic sewage to be generated in the Cantonment Security Zone (military installation). However, such additional alternatives did not show any remarkable change on the general configuration of preliminary alternatives in view of potential/anticipated environmental impacts.

As a whole, it was regarded that the implementation of the proposed sewerage system development would bring about improvements in the urban sanitation of the project area. However, the proposed project necessitates a comprehensive environmental study (an EIA), on some of the major potential impacts so that appropriate preventive measures can be taken up during the planning, design and implementation phases to avoid costly environmental restoration afterward.

The IEE report identified some issues regarding the anticipated environmental impacts and the prospective countermeasures to avoid or to mitigate such negative impacts beforehand, as shown in Table 14.4.5.

Table 14.4.5 Summary of Main Negative Impacts and Their Countermeasures Identified in IEE

No.	Project Activity	Possible Negative Impacts	Identified Countermeasures
1	Land acquisition (flood plain, swamp-land, high land)	<ul style="list-style-type: none"> - Ecological loss - Loss of agricultural land - Loss of flood plain fisheries - Resettlement issues 	<ul style="list-style-type: none"> - Careful relocation (alternative sites) - Provision of a nearby compensation
2	Construction of <ul style="list-style-type: none"> - Treatment plant - Pump station - Sewer mains 	<ul style="list-style-type: none"> - Community displacement - Construction hazard - Regional drainage problem - Navigation - Traffic hazard - Health hazard 	<ul style="list-style-type: none"> - Provision of adequate street or c - Careful relocation of site - Employment of displaced persons in project works - Proper planning and management - Navigation facility to regional/local areas - Adequate protection & public relations
3	Operation & Maintenance	<ul style="list-style-type: none"> - Inadequacy in O&M - Downstream water quality problem - Health hazard 	<ul style="list-style-type: none"> - Check anal. A of design - Develop proper O&M guidelines including monitoring - Application of preventive & remedial measures - Monitor health problem - Proper monitoring & develop public relations

Further evaluation on the respective issues was carried out during the course of the Stage 1 Domestic Work as described below.

(2) Individual evaluation of identified environmental issues

1) Ecological loss (wetland ecology)

So far as the IEE covered, endangered species or relevant ecologically/bio-logically important substances were not found in the proposed site(s) of the sewage treatment plants.

In terms of wetland ecology, the proposed sites for the sewage treatment plants are currently used as natural flood retention area. Usage for agricultural production is minimal. The size of these treatment plant sites is not significant when compared

with the total area of similar nature in the Study Area. Thus, any ecological loss was deemed not influential to the overall biomass/ecosystem, at this moment.

2) Loss of agricultural lands

Proposed sites for sewage treatment plants are, as mentioned above, not intensively utilised for agricultural production.

3) Downstream water quality

At present, all of surface water intake facilities for DWASA's water supply are located somewhere downstream of the proposed sites of sewage treatment plants. The ongoing Saidabad Water Supply Project is in the tendering stage for construction of a water intake facility just downstream of the confluence of the Balu and the Lakhya rivers, while the proposed sewage treatment plant is located upstream of this water intake.

Under the given conditions for the Study, the sewerage system development for the North Dhaka area, particularly in western half of the Study Area, has no option to locate its treatment plant and/or effluent discharge point in the upstream of existing surface water intake facilities for water supply.

A comprehensive water supply and sewerage master plan study is deemed indispensable to strategically locate the relevant facilities to avoid interference between the water supply and sewage works.

4) Occupational health and safety

The proposed sewerage systems, particularly the sewage treatment plant, will not utilise potentially hazardous/toxic substances in their construction and the operation and maintenance, except in the case of treated sewage disinfection.

The treated sewage will be most likely be disinfected by the use of liquefied chlorine gas contained in the steel cylinder. Safety devices to detect the leakage of chlorine gas, as well as neutralising chemicals, will be introduced as needed. In this respect, the proposed sewerage system will not cause any human health hazard to either workers or nearby residents.

5) Traffic hazards (particularly during construction)

The main trunk sewers are considered to be laid under the new roads proposed in the DMDP and installation work can coincide with the construction of these new roads. Through such means traffic hazards can be minimised.

Traffic hazards anticipated during the construction of a sewage treatment plant may be the major concern in this respect. The majority of the construction work pertains to the land reclamation of the proposed site and the hauling of construction equipment and materials. However, the proposed location of the treatment plant is on the outskirts of Dhaka City and bypass routes can be considered to minimise anticipated traffic hazards

14.4.5 Prospective Scope of Environmental Impact Assessment

The EIA was scheduled to be carried out during the Stage 2 Field Work from November 1997 to February 1998 for the priority project/s as identified in this master plan study.

The prospective scope of the EIA was be principally based on the anticipated environmental impacts being identified in the IEE and subject to mutual consent with DWASA and the authorities concerned.

CHAPTER 15
IDENTIFICATION OF
PRIORITY PROJECT(S)

CHAPTER 15 IDENTIFICATION OF PRIORITY PROJECT(S)

15.1 Selection Criteria of Priority Project(s)

The feasibility study on the priority project commenced from the Stage 2 Field Work to with the technical feasibility and financial/economic viability. In view of the urgency and importance of the priority project, the target year was set forth in 2005. This coincides with the medium-term target year of the DMDP.

The selection criteria of the priority project were prepared from the viewpoints of two key features; technical suitability and socioeconomic suitability as shown below, in due consideration of the above mentioned nature of the project.

(1) Technical suitability

- 1) The target area shall be fully served by DWASA's existing water supply system.
- 2) The target area shall have a well organized road network to allow for installation of the sewer network.
- 3) The target area shall have a reasonable population density to attain cost effectiveness.

(2) Socio-economic suitability

The priority project shall have high potential for:

- 1) realization of investment effects in the shortest time possible.
- 2) cost recovery of capital investment and O&M cost as demonstrated by prospective beneficiaries in terms of willingness-to-pay and affordability-to-pay for the sewerage services.
- 3) financial affordability of prospective beneficiaries to shoulder the cost to connect with the sewer network.
- 4) sufficient level of motivation to participate in the project.

Project implementation will require preparatory work, such as the institutional strengthening of DWASA, funding arrangements for capital investment, legislative arrangements to provide a clear-cut the cost recovery policies, etc. The target area shall fulfill the above-mentioned selection criteria and allow for the successful achievement of the project objectives. Needless to say, the target area will be chosen from the core areas of the master plan output.

15.2 Selection of Priority Project(s)

(1) Candidate area

The candidate areas (core area of each sewerage zone) in the master plan are as follows:

- Tongi
- Uttara
- North Dhaka East (Badda, Banani, Baridhara & Gulshan)
- North Dhaka West (Mirpur & Mohammadpur)

(2) Comparison of candidate areas

The candidate areas were evaluated based on the selection criteria as shown in Table 15.2.1.

Table 15.2.1 Comparative Evaluation of Candidate Areas

Selection Criteria	Tongi	Uttara	North Dhaka East	North Dhaka West
Technical Suitability				
1) Water supply coverage	Poor (Not served by DWASA)	Good	Good	Good
2) Road network	Poor	Good	Good	Good
3) Population density	High	Low	Medium	Medium
Socio-economic Suitability				
1) Realization of investment effects	High (small area)	Low (large vacant space)	Highest (existing sewers)	Low (large area)
2) Cost recovery	Low	Medium	Highest	Medium
3) Financial affordability	Low	High	Highest	Medium
4) Motivation	Moderate	High	Highest	Moderate
Overall Evaluation	4th	3rd	1st	2nd

Resultant from the above evaluation, the Core Area in North Dhaka East was determined to have the highest priority, both in technical and socioeconomic suitability. The main focus of the overall evaluation was cost recovery, aside from the technical evaluation, since the burden of cost sharing by the prospective beneficiaries was anticipated.

CHAPTER 16
CONCLUSIONS
AND RECOMMENDATIONS



CHAPTER 16 CONCLUSIONS AND RECOMMENDATIONS

16.1 Conclusions

This Master Plan Study recommends the adoption of Alternative 8 as the optimum plan for sewerage system development in North Dhaka. In order to seek the early realization of this Master Plan, together with an improvement of DWASA's services and the attainment of a sound and stable institutional and financial set-up, close cooperation and coordination are deemed indispensable not only among the departments/sections within DWASA, but also between DWASA and the relevant authorities concerned.

The optimum plan for North Dhaka Sewerage System Development has introduced the stabilization pond method of sewage treatment in due consideration of the financial and technical affordability levels of DWASA. Although this system requires a substantial land area, it has an essential advantage in that it will allow for the future expansion of the plant's treatment capacity through the upgrading of its treatment method. When the speed of urbanization in Dhaka City is taken into account, it must be considered that it will become quite difficult to obtain additional space for expansion of treatment plant in the future. Therefore, the land requirements of the stabilization pond method will work to DWASA's advantage in the long run.

For the on-site sanitation area, which is outside of the scope of DWASA's sewerage services, the treatment of septic sludge is considered to be undertaken at the sewage treatment plant of DWASA. Unless the areas' local government establishes a sludge treatment facility, DWASA is the sole agency with the physical capability to handle such waste. To realize this arrangement, appropriate legislative and financial/tariff arrangements (together with inter-agency cooperation) will be required.

The application of on-site treatment facility may be divided into several categories by type of treatment:

- Individual septic tank or similar nature will be applied mostly for individual households with regardless to area category.
- Small-scale domestic sewage treatment facility for nightsoil and gray water will be applied for apartment type housing and public/private facilities having dining and toilet facilities to

be situated in the on-site treatment area.

- Small-scale community sewerage system for a cluster of households with considerable population density in the on-site treatment area.

The treatment of septage to be collected from septic tanks is planned to be carried out at the sewage treatment plants of DWASA to reduce environmental pollution loads. Legislative arrangements among the agencies concerned are a prerequisite for the proper implementation of this technical option.

The institutional design to undertake this master plan needs serious attention, since the areas to be covered are very diverse in terms of their economic activity and income levels. Furthermore, the current arrangements require some clarification and strengthening.

Institutional Arrangements and Capacity at the Central Level

The institutional responsibility for policies and regulations to ensure that all residents of Dhaka have reasonable access to hygienic wastewater management services will have to be identified and agreed upon. At the operational level, these functions are much better defined.

The regulatory functions will also have to be exercised at the central level through mechanisms which ensure the adequacy and fairness of tariffs, compliance with environmental standards, the adequacy of service delivery, etc.

(1) Urban Development Planning and Leadership

While disagreements and obstructions continue to confront the DMDP, it still represents the most comprehensive guide to urban development for Dhaka at this time. It is crucial to develop a constituency for the DMDP from among and within government agencies, local authorities, people's organizations and the donor community and to cultivate strategic partnerships with the Planning Commission and the ERD to influence the flow and direction of capital investments as early as the project identification stage.

(2) Environmental Management

A recent report cites the numerous pollution control legislation, policy statements, and institutional arrangements which have been enacted or adopted with very little enforcement and implementation because of, among others, serious resource and capacity constraints. There have also been serious overlaps and conflicts between the central and local government agencies.

(3) Benefits, Demand and Willingness-to-Pay

The issue of the government's demand for this project will have to be revisited when the O&M costs and the economic and social benefits are clearer. It would not be realistic to expect dramatic water quality improvements in the rivers and lakes at this time because of pollution from other sources. Rather, the key benefit to residents of this sewerage and sanitation project in North Dhaka will be: improved household health; general convenience and the removal of stagnant wastewater from canals and drains. Landowners can expect land values to rise with the availability of wastewater collection facilities in their area.

(4) Private Sector Participation

As private sector participation is further considered, it is crucial that water supply provision **not** be separated from sewerage operations. The Study supports private sector involvement in water supply and sewerage of Dhaka. However, further studies will be needed to formulate a viable strategy and approach. The opportunity to amalgamate the resources of these private mills to organize, finance, construct and operate a common industrial WWTP can be further studied.

Institutional Arrangements and Capacity for Sewerage Areas

The development of and the operation and maintenance functions for sewerage for Dhaka City is clearly within the current mandate of DWASA. However, management at DWASA is characterized by very little delegation of responsibilities and authority. The MODS concept is fundamentally sound. However, the managerial capacities of the executive engineers in charge of the various MODS have, at best, not been tested since key decisions are still made at the central office. Unless improved soon, the MODS will continue to deteriorate.

Institutional Arrangements and Capacity for On-site Sanitation Areas

The DCC has the mandate for promoting on-site sanitation systems. The DCC has been experiencing difficulties in operation and maintenance and has opted for lease arrangements with private groups from within the user communities to operate the facilities, with much success. The next possible upgrade is to grant concessions, i.e., a private group is given a concession to provide public sanitation facilities, which includes the responsibility to finance, operate and maintain such facilities. Bangladesh has been at the forefront of innovative community management of such facilities. The institutional structures for planning and operations for on-site sanitation tend to be more complicated and sensitive. With the broad

range of technology, financing and institutional arrangements available, some flexibility is needed to be more responsive to users' demand and to take advantage of opportunities.

Furtherance to the Project

It is noteworthy to mention herein that, among others, there are pending, but irrevocable issues on the water supply and sewerage sector development not only for the North Dhaka area, but also for the Metropolitan Dhaka area, as follows:

(1) Conflict on water quality issue

As it has been declared in the DMDP, the Balu and Lakhya river basin is designated as a conservation area for water supply purposes. The construction of a new surface water intake facility just downstream of the confluence point of these rivers is about to be commenced as a part of the on-going Saidabad Water Treatment Plant Project. This pertains directly to the restriction of effluent disposal from the sewage treatment plant to be located upstream of the said intake facility.

This situation does not apply only to the above particular matter; all of the existing and planned surface water intake facilities of DWASA are located downstream in South Dhaka, while a huge amount of sewage can be expected to be discharged in the upstream areas located in North Dhaka. This problem owes to the continued disintegrated planning approach of water supply and sewerage development to date and the sewerage sector alone cannot shoulder the burden of capital investment to avoid such conflict.

The presence of the industrial complex in Tongi is also closely related to this issue, since this complex has been discharging untreated industrial wastewater into the Tongi River which is connected to the Balu River in its upstream.

(2) Effective utilization of the existing Pagla STP

An effective utilization of the existing Pagla STP, including its expansion and/or upgrading, was not taken up as a master plan alternative, since this Study has focused on to the North Dhaka area and therefore the South Dhaka area was excluded from the Study Area.

In view of the complexity and magnitude of these issues, it shall be sought to develop a comprehensive water supply and sewerage development master plan for the Metropolitan Dhaka including the aquatic environmental conservation in the public water body. Only

through such comprehensive planning can an integrated approach for water supply and sewerage sector development be established either economically or technically.

16.2 Recommendations

16.2.1 Technical Aspects

Periodical Review and Update of the Master Plan

This Master Plan is prepared to look into the appropriate sewerage and sanitation provision toward the target year of 2020. As urbanization is dynamic and has been exploding toward the outskirts of Dhaka City (including redevelopment within the built-up areas), a periodical review and update of the Master Plan is indispensable.

In doing so, the relevant authorities, such as RAJUK, the DCC and other local governments, shall be called to cooperate. Reciprocally, DWASA shall closely cooperate with such authorities to reflect the latest urban development of the staged sewerage development plan. The compilation of the Detailed Area Plan being undertaken by RAJUK is one of the key factors which may affect the implementation of the sewerage system.

To properly achieve such a plan, continuous data gathering within DWASA and from the authorities concerned shall be programmed and carried out.

Enhancement of Computerized Operation and Management

DWASA has started to computerize data processing mainly at commercial/financial groups. Computerization in the technical fields shall also be enhanced and accelerated to avail of the following information and activities:

- 1) A sewer network data base which will graphically indicate sewer profile with relevant technical data and will be utilized for periodical cleaning as well as repair/rehabilitation.
- 2) A consumer data base including the connecting point to the sewer network will be periodically updated when application for water supply and sewerage service is accepted by DWASA and will be referred to for various monitoring activities, such as raw sewage quality, assessment of sewer flow capacity, etc.
- 3) Proper O&M scheduling and monitoring
- 4) Inventory control of equipment, materials, consumable goods and their allocation to the needed activities

- 5) Statistical monitoring of water production, water consumption and sewage flow

16.2.2 Legislative and Institutional Aspects

Institutional Arrangements and Capacity Building Recommendations at the Central Level

- (1) Implementing this Master Plan: The operational responsibility for provision of adequate wastewater management in the city is divided between DWASA, the DCC and Tongi Pourashava. Master plan follow-up and implementation will have to be arranged in cooperation with the local officials. The MLGRDC is well-positioned to take up this function as its oversight functions covers DWASA, the DCC and Tongi Pourashava.
- (2) External Cooperation for Capacity Building. The feasibility of establishing management and technical support to develop the competency requirements above through JICA Technical Cooperation can be further assessed.

Institutional Arrangements and Capacity Building Recommendations for the Sewered Areas

- (3) To implement the sewerage facilities in the Study Area, a full-time Project Management Office for North Dhaka Sewerage, reporting to the Deputy Managing Director for Planning and Development, is recommended to coordinate all aspects of project design and execution.
- (4) Operation and maintenance of public toilets in schools and public areas, such as bus terminals, parks, and public markets, will continue to be developed by the DCC even within the sewered areas.
- (5) DWASA should also ensure effective and well-organized septage collection, treatment and disposal. Private sector involvement in septage collection is recommended. Appropriate cost recovery policies, procedures and incentive schemes should be devised to ensure that septage is actually collected effectively; that the sludge is disposed of in the treatment plants and that the fees collected for septage removal and treatment are adequate.
- (6) Health and hygiene promotion can be done through the respective wards and relevant local sector departments, with technical and local financial support. A public awareness and

social marketing program will help in realizing the health benefits associated with improved sanitation and household practices, including proper disposal of solid wastes.

(7) **Financing Training and HRD in DWASA.** The adoption of the following operating policies and guidelines for HRD is recommended:

1) DWASA will allocate an amount initially equivalent to about 3% of its annual staff salary budget for training activities.

2) External loan and grant funds will be utilized for training and social marketing.

3) All DWASA investment projects should have a training and technology transfer component.

(8) **Improving Decision Making at DWASA..** A clearer delineation of the policy-making functions from management functions will improve and streamline board-management relationship, will give more autonomy to DWASA management, and will strengthen its commercial orientation.

(9) **Promoting Decentralization.** Actual delegation of authority and implementation of a strong performance audit system based on MODS as cost centers should be vigorously pursued. Specifically, this Study proposes that a step-wise scheme to devolve powers and authority to the MODS, contingent on attainment of specific MODS-level institutional development and performance parameters, should be set up. Regular operations audits should be conducted and each MODS and key point installation would receive an efficiency rating. The system should enable the comparison of performance among the different MODS and among the various "key point installations".

(10) **Institutional Options to Address Financial Viability Issues.** Because of DWASA's low tariff base and collection performance, it is expected that there will be increased financial deficits when the new sewerage systems are put on-line. There is the possibility of implementing new institutional arrangements so that this shortfall could be addressed.

1) *Sewer service connections and household improvements*, specifically for toilet construction or in-house plumbing are major costs borne by householders. However, it would be useful to look into the viability of extending a lending facility through other banks or NGOs for toilet improvement and plumbing.

- 2) To reduce possible financial deficits and raise the utilization rate of the new (and proposed) sewerage system, the DWASA Board should adopt a regulation requiring commercial and high residential water consumers to connect will be needed to make the sewerage system viable. This can be achieved by a policy decision of the Board.
- 3) *Financing the anticipated O&M shortfall.* One option is for DWASA to ask DCC to adopt new tax revenue measures. Since land and holdings values are expected to rise with the availability of wastewater collection facilities, there will be increased city revenues from tax collection. A part of this increase may be pre-allocated to DWASA for sewerage O&M. This implies that a premium is levied on holdings with access to sewerage, regardless of whether they are connected or not. Another option might be to levy an annual environmental surcharge on top of the holdings tax.

Either of the above options assume a reasonable level of tax compliance and enforcement. These revenue potentials involve new institutional arrangements and legislation, since holdings taxes are within the responsibility of the city government. Significantly, incentive mechanisms can be built in by DCC for DWASA to achieve higher collection performance by indexing actual fund transfers to DWASA based on its actual general collection performance.

(6) Strengthening the DWASA Training Institute for Wastewater Management and Technical Training.

- 1) *Organizational Location.* The most useful location of the training is in the mainstream of planning and operations.
- 2) *Core Trainer Skills.* DWASA trainers should develop expertise in adult learning principles and approaches and use of participative methods. DWASA should build its in-house core staff of trainers and improve the skills of trainers on effective methods.
- 3) *Leadership for developing the internal HRD.* The key is in making the training job attractive enough to interest talented individual/s in the company, with strong communication and management skills, confidence and enthusiasm for the task.
- 4) *Training and information materials.* 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.

- 5) *Linkages with other HRD-support systems.* Cooperation with universities and colleges, vocational training institutes, and continuing education programs of professional organizations will help bolster the capacity of the Training Institute.

(7) Improving Effectiveness of Training Programs

- 1) *Individual Competence vs. Corporate Competence.* It would be fair to state that in all 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.
- 2) *Management's Role.* It is also important that management promotes an environment which will allow a critical self-assessment of internal operations in order that current problems are tackled and further training needs identified.
- 3) *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.

- (8) Improving Management Development Training. Focusing on planning, incentives and performance monitoring, does more for management development, than organizing "management training workshops." Sharing strategic information and current news or suggestions on where they can get more information is more powerful as a motivator for competency development. An external adviser's role here is crucial in helping the managers respond to their information needs (or at least point to other information sources) or sort out the data deluge brought on by the ready access to information. It is fair to say that the desire to learn new management ideas and skills pervades the institution.

Institutional Arrangements and Capacity Building for Onsite Sanitation Areas

- (1) For Master Plan implementation, a "pilot project" approach is recommended to test the various policies and methodologies for determining actual user demand and for involving users in the planning and implementation.
- (2) It is thus best to maintain flexibility in institutional design, i.e., not have too many detailed rules which have to be complied with. The key concerns which have to be met are: that the beneficiaries participate in making the major decisions, including operations

responsibilities and cost recovery, and agree with the steps to be taken; that the beneficiaries have a stake in the success of the project and that they have a hand in monitoring the quality of construction, operation and maintenance. Government agencies take on the role of promoters (social marketing) and technical advisors to enable communities to solve their communal problems; not necessarily be the direct providers of the service.

16.2.3 Financial Aspects

Improving Revenue Flows

A key aspect of any project will be the ability of DWASA to improve and then maintain its revenues. If DWASA cannot demonstrate that it can generate sufficient income to meet its financial obligations, properly maintain its facilities, etc. then many of the efforts in the other sectors will be moot. Therefore, the following recommendations are put forward:

- (1) Implement a computerized accounting system:** this is a key element in improving the billing, collection, and auditing of DWASA. Any such system should be implemented based on the needs of the external and internal clients of DWASA and it should utilize enhanced security features to prevent irregularities and/or criminal abuse. It is recommended that a program be implemented to design an integrated system for DWASA which would be able to use private sector resources as well as expatriate oversight.
- (2) Utilize an internationally accepted accounting system:** the adoption of an internationally accepted accounting system would also greatly enhance the ability of DWASA to track and account for its financial resources. This system should be designed for overall usage throughout DWASA and be spearheaded by upper management of DWASA with appropriate training from experts. These experts could be obtained from international assistance programs.
- (3) Conduct a full audit:** DWASA should work with an outside accounting source to perform a full audit of its operation. This should include the valuation of its current assets, equipment, etc. All the data collected in this full audit should serve as a database (computerized) for a new accounting system.

- (4) **Improve banking relationships:** in order to expedite the billing and collection system, DWASA must work with the banks of Dhaka to develop an efficient and accurate payment system. A possibility is that DWASA could give customers a discount for making their payments through selected financial institutions that are partnered with DWASA. The banks would then make swift and error-free transfers of these funds to DWASA's accounts.
- (5) **Make the financial data of DWASA available to the public:** by allowing the public easy access to non-sensitive information (similar to the practice in the USA and other countries), public awareness would increase as to the costs of supplying water and sewerage. This would also act as a possible "public audit" that would allow DWASA a much needed interface with its external customers.
- (6) **Investigate alternative funding sources:** DWASA should be able to come up with a series of possible methods to diversify/strengthen its funding sources. These alternative sources could take the form of an environmental surtax, cooperative arrangements with other relevant agencies (the DCC for example), other user fees, etc.
- (7) **Undertake a new tariff study:** at present, DWASA has no clear idea of its actual operating costs, assets, expenses, etc. Under these conditions, the required tariff level cannot be ascertained. Therefore, a new tariff study should be carried out once DWASA has a clear picture of its fiscal situation.
- (8) **Combat graft and corruption:** DWASA must inculcate an organizational culture which does not permit graft and corruption. Although this problem is deeply rooted and will not be subject to a "quick-fix" solution, steps must be taken to combat this problem. Possible steps in this direction include improving the pay rate of DWASA employees, utilizing incentive-based compensation, establishing a telephone "hotline" to allow people to safely inform on wrong-doing etc.

16.2.4 Economic and Social Aspects

Ability and Willingness to Pay

The Household Survey on Sanitation, conducted by DEVCONsultants of Dhaka, showed that there is a general willingness of the public to pay for water and sewerage services. However,

the survey also showed that there are a great number of inadequacies in the water and sewerage services provided by DWASA.

It is recommended that DWASA increase its awareness of the ability and willingness of its external clients to pay for its services. Regular, scientifically valid, surveys should be conducted by DWASA and incorporated into its database. Moreover, this information should be shared with the public.

Socially Equitable Water Supply and Sanitation

Dhaka is composed of widely disparate economic groups wherein the difference between the rich and poor is considerable. In order to provide the economically disadvantaged households with adequate water supply and sanitation, DWASA should cooperate with the various NGOs and other groups. Further, such steps should be coordinated to make the best use of the limited resources available.

Public Education/Awareness

Currently the efforts by DWASA in the areas of public education/awareness are lacking. However, if implemented correctly, a public education program could work in many areas for DWASA and the public (if sufficiently motivated with clear incentives and an honest approach) could become a positive vehicle for change in regards to the general public's water consumption, sanitary habits and waste disposal methods. If DWASA could decrease water consumption or illegal disposal of wastes into sewers by 10%, any costs associated with such a program would be negligible.

16.2.5 Environmental Aspects

Periodical Monitoring of Industrial and Commercial Sewage

Aside from legislative set up to restrict discharge of toxic/hazardous substances into the sewerage system, DWASA shall also conduct periodical monitoring of industrial and commercial sewage quality. Discharge of strongly polluted sewage will cause various problems to sewerage facilities.

Close Coordination with DOE and Local Governments for Environmental Conservation

Provision of public sewerage system is closely related to the conservation of aquatic environmental conservation, particularly with utilization of surface water for drinking water

supply. For proper protection of public water body from water pollution, DWASA shall periodically monitor the quality of raw sewage and treated effluent and inform it to relevant authorities.

Illegal disposal of septage and solid wastes into sewerage system shall be strictly prohibited through close cooperation and coordination with local governments and police department.

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PART 2
FEASIBILITY STUDY

CHAPTER 1
DESCRIPTION OF
THE PRIORITY PROJECT AREA

CHAPTER 1 DESCRIPTION OF THE PRIORITY PROJECT AREA

1.1 General

North Dhaka East Sewerage Zone is comprised of the developed residential areas of Banani, Baridhara, the Cantonment, and Gulshan, as well as the developing area of Badda. The area lies within the strategic planning zones 5, 6, 12, 13-1, and 13-2 of the Dhaka Metropolitan Development Plan area. The total area of North Dhaka East Sewerage Zone is approximately 3,329 ha.

Population of North Dhaka East Sewerage Zone is projected under RAJUK planning to become a part of the core area of the future Dhaka City. As such, the development of this area, particularly in regard to its infrastructure is of great importance.

1.1.1 North Dhaka East Sewerage Service Zone

The North Dhaka East Sewerage Service Zone is comprised of the following components:

The Banani-Gulshan area is now the second most desirable (affluent) residential area in Dhaka City. This area is home to large homes as well as various commercial establishments. The current sewer system consists of branch sewers with diameters of 200 mm, 250 mm and 450 mm. The Banani lift station (L.S.) is located in the new Defence Officers Housing Society (D.O.H.S.) and serves this area.

The Baridhara area is located on the eastern bank of Gulshan Lake and is the diplomatic zone of Dhaka City. There is no conventional sewage system in this area. Septic tanks are the standard treatment method.

The Cantonment area is a military reservation that lies near the old airport on the western side of the North Dhaka East Sewerage Service Zone. The sewer system in this area consists of 200 mm, 300 mm and 400 mm pipes and the Mohakhali Old L.S. The pumps in this L.S. have recently been replaced.

The Badda area occupies the south-eastern portion of the North Dhaka East zone. This area has no sewer network and waste treatment is done using septic tanks. Badda is characterised by lower income households.

1.1.2 Priority Project Area (Core Area of North Dhaka East Sewerage Service Zone)

The priority project recommended in this report was identified in the North Dhaka Master Plan. Upon further analysis undertaken as part of this report, it was confirmed that the North Dhaka East project would be the most suitable as the priority project. The basis of this confirmation is outlined below.

1. Water supply coverage:	Good
2. Road network:	Good
3. Population density:	Medium
4. Realisation of investment effects:	Highest
5. Cost recovery:	Highest
6. Financial affordability:	Highest
7. Beneficiary motivation:	Highest

The full details of this system are shown in Chapters 5, 6 and 7.

1.2 Natural Conditions

1.2.1 Topography, Topology, and Hydrogeology

(1) Topography

The topography of the Study Area is largely that of an alluvial plain and is located at the southern end of the East Balindo Plateau. The Study Area is divided topographically into a low-level plateau, comprising the eastern and southern parts of the city, and a high level plateau consisting of the northern area, and damp low land around these areas. On the border between the low land and the plateau there are precipices with a relative height of between three and five meters. The ground elevation of the Study Area is lower than eight meters above mean sea level.

(2) Geology

The Study Area's geological characteristics can generally be determined by the area's plateau formation and soil type. The low-level plateau contains flood plain deposits such as silt, sand and gravel. The high level plateau is composed of old alluvial deposits (mainly clay), while the damp low lands is made up of marshes and delta deposits.

Across the entire Dhaka region, all water-bearing strata are alluvial deposits of the Quaternary Age. Two formations of these deposits form major aquifers; one is located under Dhaka City and the other is east of the Bangshi River. The aquifers are covered by silt and clay deposits belonging to the Deadhupur Clay Residuum and/or the low land alluvium. These fine-grained surface deposits are generally less than 10 m thick in Dhaka but may exceed 40 m north of Tongi.

Quaternary sedimentation has been controlled by a network of deep seated faults that divide the region into a series of tectonic blocks. The Turag, Tongi, Pagla and Balu faults define the block around Dhaka City which has been uplifted relative to the surrounding areas.

Most rivers, which generally follow fault lines, have previously cut channels much deeper than their present level and have often penetrated the main aquifer. The sediments that filled in these channels are of variable composition and may either enhance or retard the recharge of the river water to the underlying aquifer. The base of the Dupi Tile aquifer in Dhaka City is at about 120 to 150 m below ground. There is no evidence of any other major aquifer within the upper 450 m of the geological sequence.

The upper stratum of the Study Area is characterised by the Madhupur jungle terrace and the flood plains of the Buriganga, Turag and Balu rivers. The flood plain of the Buriganga River covers the Kallayanpur Khal area; the Balu River flood plain and the Madhupur jungle terrace area covers the Gulshan area; the flood plain of the Turag River and Madhupur jungle terrace cover the Tongi zone.

The surface soil of the terrace area consists of oxidised red clay containing calcareous modules. The surface soils in the surrounding flood plain is grey in colour. Silt and clay are predominant in the upper layers of the subsoil of the Study Area, with an approximate thickness of 10 to 15 m. Sand occupies the major portion of the lower deposits.

(3) Hydrogeology

In general, the hydrogeology of the Study Area consists of both the Dupitila (which is composed mainly of quartz and some feldspar—often weathered to clay and clay lenses) and the lower Alluvial Sequences from high-yielding semi-confined aquifers. However, the Dupitila formation is weakly cemented by iron oxides and clay; this means that the permeability is significantly lower (15-30 m/day) than the younger lower Alluvial Sequences (55-75 m/day).

Both aquifers are recharged primarily by vertical percolation from rainfall and floodwater, although the rivers are the significant sources of recharge in areas where groundwater extraction is substantial. Outside Dhaka City the aquifer are fully recharged every year by the end of the monsoon season.

Specific yield increases significantly with depth as the water table falls into more sandy strata and determines the rate of decline and rise of the piezometric level in the main aquifer. Specific yield varies in the range of 0.02 to 0.15.

The piezometric levels in the aquifers of Dhaka City have fallen steadily over the past 24 years as the rate of abstraction has increased. The deep-set piezometric level is approximately 22 m below ground in the Motijheel area. The clay that overlies the aquifer has remained saturated even though the piezometric level in the aquifer below the base of the clays.

Groundwater quality in the Study Area, both for domestic and industrial use, is quite good. Chlorination is supposed to be carried out at the well heads. There has been no significant indication of groundwater quality deterioration but it should be noted that continued unrestricted industrial discharge of toxic substances poses a long-term risk to the aquifer.

Rapid urbanisation has had a major but variable impact on the water balance of Dhaka City. Natural recharge has been reduced by the increase in paved areas but increased by on-site sanitation and distribution losses from the water supply and sewerage system.

1.2.2 Rivers, Canals, Lakes and Ponds

(1) Rivers

1) Overview

Rivers are the greatest natural asset of Bangladesh. They drain a total area of 549,000 sq.km (45,000 sq. mi.) and provide a cheap and convenient form of transportation, furnish vast supplies of fish, and bring in or carry away over 2.4 billion tons of sediment load annually.

Bangladesh has one of the most complex river systems in the world, as its many rivers form an interlacing grid covering most of the country. The three principal rivers of this network are: the Ganges (known as the Padma in Bangladesh), the Brahmaputra (known as the Jamuna in Bangladesh) and the Meghna. The Ganges (Padma) flows south-east after it enters Bangladesh and branches into hundreds of tributaries, the largest of which are the Madhumati and the Arial Khan rivers. Known as "the many mouths of the Ganges," these rivers dissect the Ganges Delta before entering the Bay of Bengal. The delta land east of the Padma-Megna estuary is known as the Sunderbans, that to the west between the Indian border and the Modhumoti is known as the Old Delta.

The Brahmaputra-Jamuna, originating in the high Himalayas, receives four tributaries before it joins the Ganges about 72 km (45 mi.) west of Dhaka; these tributaries are the Dharla, Tista, Karatoya and Atrai rivers.

The Meghna is formed of two branches of the Barak River, the Surma and the Kusi-yaraa, which enter the country from India. It is later enlarged by the Baulai River. Before joining the Ganges, the Meghna River receives two tributaries; the Brahmaputra and the Dhaleswari.

The main steam of the river system is formed by the three rivers below Dhaka to the Bay of Bengal. This triangular estuary contains a number of temporary islands, known as chars, as well as permanent islands. The permanent islands consist of the following: Shahbazpur, North Hatia, South Hatia and Sandwip. The tides from the Bay of Bengal felt as far inland as Kalipur, 270 km (168 mi.) away. Tidal waves from the Bay of Bengal, called bores, often cause disastrous floods.

2) Study Area

In the Study Area, there are three rivers, the Turag, the Tongi and the Balu. The Turag River is located on the western side of the Study Area along Muhamedpur, Mirpur, behind the greater Dhaka flood protection embankment, which runs further north and meets with the Tongi River.

The Tongi River is located along the southern border of the Tongi pourashava, which is connected in the west to the Turag River and in the east to the Balu River. This river also dissects Tongi pourashava from the Uttara residential zone.

The Balu River is located along the eastern border of the Study Area, and is populated/inhabited by fringe or rural-type people.

Actually, the total Greater Dhaka area drains through khals (canals) into the Turag River on the east side, the Balu River on the west side, the Buriganga River on the south side. The Tongi Khal connects to the Turag River and flows into the Balu River. The Tongi Khal changes direction depending upon the hydraulic conditions of the Turag and Balu rivers. In the dry season, the Study Area rivers/khals are influenced by the tidal effects from the Bay of Bengal.

Waters of the Turag, Buriganga and Balu rivers are collected by the Dhaleswari River and are finally conveyed to the Bay of Bengal through the Meghna and Ganges (Padma) rivers. The water level of the Turag, Balu and Tongi khals are affected not only by the discharge from upstream rivers (the Dhaleswari, Bangsi, and old Brahmaputra rivers), but also by backwater from the downstream rivers (the Dhaleswari, Lakhya, Meghna and Ganges [Padma] rivers).

The environmental conditions of the rivers in the Study Area are not good due to the fact that they receive drainage consisting of the city's sewage, run-off and industrial effluents, which have deteriorated water quality to a large extent. River water in the Study Area is used extensively for agriculture, urban development, and household/commercial uses such as bathing, washing/cleaning etc. Due to the environmental degradation of the rivers, species diversity has been substantially reduced.

Another major problems regarding these rivers is the excessive siltation of the river beds, mainly caused by run-off and bank erosion, which is gradually reducing the

rivers' volume by increasing their bed levels and by forming new chars (temporary islands), which further leads to navigational problems and thus effects the economy of Bangladesh.

(2) Canals

The local name for the canal is khal. In the Study Area, there are numerous khals connected to the surrounding rivers. Khals of East Dhaka consist of the Badda Khal, the Dhumni Khal, the Begunbari/Mohakhali Khal, the Benpair Khal and the Ujanpur Khal, which drain into the Balu River. West Dhaka contains the Abdullahpur Khal, the Baunia Khal, the Gabtoli Khal and the Kallayanpur Khal, which empty into the Turag River.

In Dhaka City, there are more than 25 khals within the city boundary. There are three major groups of drainage khals. The khals can be grouped as follows:

Digun-Ibrahimpur-Kallyanpur khals

- 1) Gulshan-Banani-Begunbari-Dhanmondhi khals
- 2) Dholai-Gerani-Segubaghicha khals

Approximately five-sixths of the city area is drained through these canals to the surrounding rivers. The catchment area of the khals varies from 6 to 40 sq.km.

Table 1.2.1 Characteristics of the Major Khals in Dhaka City

Name of Khal	Length (km)	Catchment Area (sq.km)
Dholai Khal	4.0	16.8
Gerani Khal	3.4	6.7
Segunbaghicha Khal	3.5	8.3
Begunbari Khal	6.5	37.7
Total	17.4	69.5

Dholai Khal drains an area of 16.8 sq.km. From Jatrabari it stretches approximately 3.0 km from Jatrabari to the confluence with the Buriganga river. The khal is connected to the Genari Khal upstream and flows in the opposite direction (northerly).

The Segunbaghicha Khal originates in Ramna Lake and has a gradient of approximately 1/5,000. The khal has a length of 2.8 km and stretches up to the Bangladesh Railway

crossing where it covers a drainage area of 4.95 sq.km. The khal is provided with retarding ponds in certain places but it is extremely narrow at road and railway crossings where the specific discharge capacities are usually less than 3 m/s/km.

Begunbari Khal starts from the outlet of the Dhanmondi Lake. The main Begunbari Khal runs through the central part of Greater Dhaka to the DIT road crossing. It has a drainage area of 16.02 sq.km. The total length is 5.3 km, of which 2.5 km is upstream from the New Airport crossing and 2.8 km downstream from the same road crossing. The khal sections are wide enough in the downstream reaches. On the other hand, sections in the upstream reaches are narrowed at several places by roads and railway crossings. The specific discharge capacities of the narrow sections are usually less than 5 m/s/km.

Water quality of these khals are of course in a more deteriorated condition compared to the rivers of the Study Area due to the inflow of sewage and the illegal dumping of garbage. Located in highly urbanised areas, a sickly odour characteristically emanates from the khals during the dry season.

The deterioration of water quality in the khals in Dhaka has become a matter of concern in recent years. Although DWASA has taken the initiative in improving the drainage and management of storm water and khal rehabilitation, the situation has not improved significantly.

The flow capacity of the open channels (khals) have been decreasing due to siltation, deposits of garbage, encroachment of squatters, illegal earth filling and so on. This exacerbates flooding problems by increasing the flood duration as well as the flood area along the khals.

During the monsoon period the khals often become flooded by rain water, due to the lack of a proper drainage system. The flooding causes heavy damage to the city. DWASA has completed the cleaning of 13 existing khals under the Khal Improvement Project as a part of the Greater Dhaka Flood Control and Drainage Project. At the same time they have prepared a project for the demarcation of land for acquisition, the elimination of unauthorised houses and structures through resettlement and eviction.

As a result of the prolonged flooding congestion occurs, which is one of the major curses of city life. It disrupts communication, the movement of people/vehicles, hampers trade

and business, recreation, education etc. Above all, the spread of contaminated water from khals, rivers, drains and manholes make the surrounding areas unhealthy and aesthetically unappealing.

(3) Lakes

In the Project Area there are three lakes; Banani Lake, Gulshan Lake and Uttara Lake. The Banani and Gulshan lakes are located within the city and Uttara Lake is located away from the main city in the Uttara residential zone.

Banani Lake is located in between the Gulshan and Banani residential areas, which start from behind the Titumir college grounds and ends at the Banani graveyard.

The “necklace of North Dhaka East,” or Banani Lake, as it was once said to be, has become increasingly a source of concern due to its multiple problems. Maintaining the lake has always been the job of the government but this task has been unfulfilled. It is evident that the local residents have never bothered to look after it either. The lake is treated as a convenient dumping ground. The waste deposited into the lake ranges from polyethylene bags and household waste water to human excrement.

The drainage system, which was thought to be DWASA property, is basically the property of every Banani resident. The drainage has no owner, so consequently everybody points a finger at one another when questions of responsibility arise. There are numerous penetration points, both legal and illegal, which convey sewage and surface water to the lake.

The lake's water is becoming increasingly muddy and brackish. There are many hanging latrines, used by slum dwellers, along the bank of the lake, from where raw faecal matter is directly discharged into the lake. Slum dwellers also use the lake water in their daily activities such as bathing, cooking, washing etc. Part of the lake is covered by aquatic plants, which also can create problems in that such plants can serve as a breeding ground for insects.

Gulshan Lake is located between the Gulshan and Baridhara diplomatic zones. The east embankment of the lake comprises the Baridhara diplomatic zone and the Badda area. The west embankment of the lake comprises the Gulshan residential area. The lake starts from in front of Road No. 12, Baridhara to the north and ends near Road No. 143, in the

south, at Gulshan.

The natural condition of the lake is the same as Banani Lake as mentioned above. The characteristics of Gulshan Lake during the dry season are as follows: Length (m): 3,800; Avg. Depth (m): 2.5; Area (sq.km): 0.480; volume (m³): 1.2×10^4

Uttara Lake is located a little farther from Dhaka City in the Uttara residential zone, which is under the administration of the Dhaka metropolitan area. Compared to the above two lakes, the natural condition of this lake is slightly better.

(4) Ponds

There are many ponds in the Study Area. The natural condition of these water bodies is significantly worse than any other water bodies due to their stagnant conditions, which compound the effects of their receiving city sewage, run-off, garbage etc. Pond water in the Study Area is highly polluted and are nearly lifeless. In fact, pond water cannot be used for cleaning work, because it is too muddy and too polluted. However, some people are using the ponds for the cultivation of African Catfish. Many of the ponds are expected to be filling in as the city continues to develop.

Flood Plain Depression Storage

The Study Area is surrounded by the low lying lands comprised mainly of the flood plains of the surrounding rivers. These depressions serve as flood water storage and work to reduce the flooding resulting from the excessive precipitation of the monsoon season. Unfortunately however, the volume of this depression storage is gradually being reduced. The reason for this is the encroachment of residential areas. The high cost of land in Dhaka has lead people to fill up private depressions for housing purposes. The acquisition of low lying land by RAJUK for model towns has also reduced the depression storage volume. The major depression storage areas of the flood plain during the monsoon season are shown below.

Table 1.2.2 Major Depression Storage

Depression	Area (sq.km)	Average Depth (m)
Northwest Turag Flood plain	20	1.5
Northwest Balu Flood plain	11	2.0
Central Balu Floodplain	20	2.0
Southwest Balu Floodplain	40	2.0
Total	91	