**MINISTRY OF FINANCE**
**MINISTRY OF LOCAL GOVERNMENT, RURAL DEVELOPMENT AND CO-OPERATIVES**
**CHITTAGONG WATER SUPPLY AND SEWERAGE AUTHORITY (CWASA)**
**THE PEOPLE'S REPUBLIC OF BANGLADESH**

# PREPARATORY SURVEY
# ON
# CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT
# IN
# THE PEOPLE'S REPUBLIC OF BANGLADESH

## FINAL REPORT

## VOLUME I

## MAIN REPORT

**MARCH 2013**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**NJS CONSULTANTS CO., LTD.**

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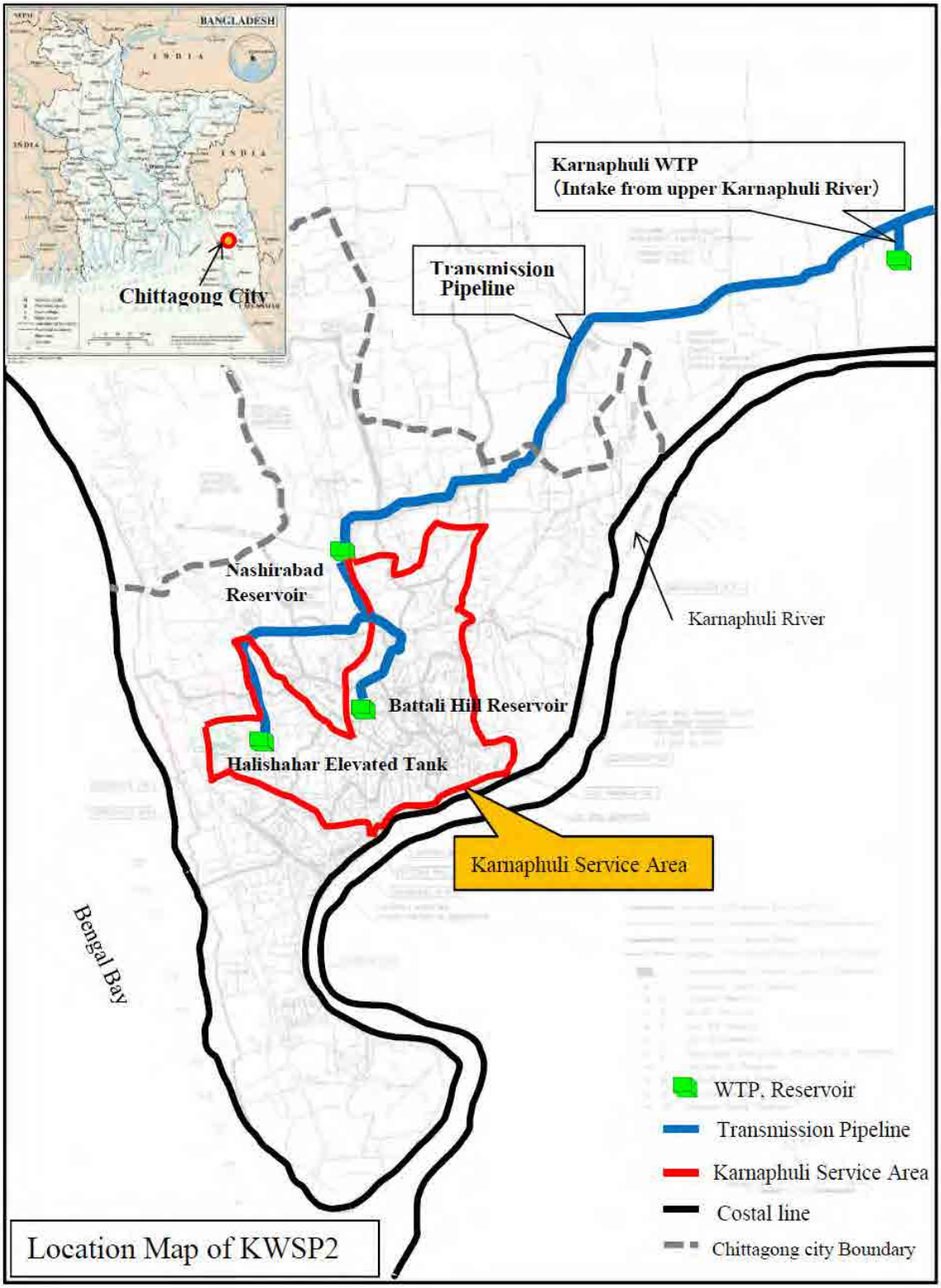
| CR (5) |
| 13-034 |

The cost estimate is based on the price level and exchange rate of December 2012.

The exchange rate is: Bangladesh Taka 1.00 = Japanese Yen 0.966


BANGLADESH
INDIA
Chittagong City
Karnaphuli WTP
(Intake from upper Karnaphuli River)
Transmission
Pipeline
Nashirabad
Reservoir
Karnaphuli River
Battali Hill Reservoir
Halishahar Elevated Tank
Karnaphuli Service Area
Bengal Bay
WTP, Reservoir
Transmission Pipeline
Karnaphuli Service Area
Costal line
Chittagong city Boundary
Location Map of KWSP2

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**MAIN REPORT**

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## ACRONYMS

| | |
|---|---|
| ADB | Asian Development Bank |
| ARIPO | Acquisition & Requisition Property Ordinance |
| BOD | Biological Oxygen Demand |
| BDT | Bangladeshi Taka |
| BWDB | Bangladesh Water Development Board |
| CCL | Cash Compensation under the Law |
| CCC | Chittagong City Corporation |
| CDA | Chittagong Development Authority |
| CDIA | City Development Initiative for Asia |
| COD | Chemical Oxygen Demand |
| CWASA | Chittagong Water Supply and Sewerage Authority |
| DF/R | Draft Final Report |
| DMA | District Metered Area |
| DMD | Deputy Managing Director |
| DOE | Department of Environment |
| DPHE | Department of Public Health Engineering, MLGRD&C |
| DWASA | Dhaka Water and Sewerage Authority |
| EA | Environmental Assessment |
| ECC | Environmental Clearance Certificate |
| ECCo | Environmental Clearance Committee |
| EIA | Environmental Impact Analysis |
| EIRR | Economic Internal Rate of Return |
| EMP | Environmental Management Plan |
| ENPV | Economic Net Present Value |
| EOCC | Economic Opportunity Cost of Capital |
| EQS | Environmental Quality Standard |
| ERD | Economic Relations Division, Ministry of Finance |
| FCD/I | Flood Control Drainage and Irrigation |
| FGD | Focus Group Discussion |
| FIRR | Financial Internal Rate of Return |
| FNPV | Financial Net Present Value |
| FOCC | Financial Opportunity Cost of Capital |

| | |
|---|---|
| F/R | Final Report |
| F/S | Feasibility Study |
| GI | Galvanized Iron |
| GDP | Gross Domestic Product |
| GOB | Government of Bangladesh |
| GOJ | Government of Japan |
| GRC | Grievance Redress Committee |
| HR | Human Resource |
| HRD | Human Resource Development |
| IC/R | Inception Report |
| IEE | Initial Environmental Examination |
| IIP | Interim Improvement Project |
| IT/R | Interim Report |
| IUCN | International Union for Conservation of Nature & Natural Resources |
| JBIC | Japan Bank of International Cooperation |
| JICA | Japan International Cooperation Agency |
| JTU | Jackson Turbidity Unit |
| JVIT | Joint Inventory Verification Team |
| LAP | Land acquisition Plan |
| LGD | Local Government Division, MLGRD&C |
| MARV | Maximum Allowable Replacement Value |
| MBBR | Moving Bed Bio-Reactor |
| MBR | Madaripur Beel Route |
| MD | Managing Director |
| MDG | Millennium Development Goal |
| MLGRD&C | Ministry of Local Government, Rural Development and Co-operatives |
| MoEF | Ministry of Environment and Forest |
| NCS | National Conservation Strategy |
| NEMP | National Environmental Management Plan |
| NOC | No Objection Certificate |
| NRW | Non-Revenue Water |
| NWMP | National Water Management Plan |
| NWP | National Water Policy |
| NWRC | National Water Resources Council |
| O&M | Operation and Maintenance |

| | |
|---|---|
| PAP | Project Affected People |
| PCU | Project Coordination Unit |
| PMO | Project Management Officer |
| PMU | Project Management Unit |
| PPTA | Project Preparatory Technical Assistance |
| PTW | Production Tube Well |
| P/R | Progress Report |
| RAP | Resettlement Action Plan |
| RO | Reverse Osmosis |
| RU | Resettlement Unit |
| SAPROF | Special Assistance for Project Formation |
| SCC | Site Clearance Certificate |
| S/C | Steering Committee |
| SIA | Social Impact Assessment |
| SPS | Safeguard Policy Statement |
| SPT | Standard Penetration Test |
| SRDI | Soil Resources Development Institute |
| S/W | Scope of Work |
| SWTP | Surface Water Treatment Plant |
| TA | Technical Assistance |
| TOR | Terms of Reference |
| UFW | Unaccounted for Water |
| USD | United States Dollar |
| WASA | Water and Sewerage Authority |
| WARPO | Water Resource Planning Organization |
| WTP | Water Treatment Plant |
| WUG | Water User Group |

# EXECUTIVE SUMMARY

# EXECUTIVE SUMMARY

## 1. Background and Outline of the Survey

Chittagong city is the second largest city in Bangladesh, and the country's biggest industrial and port city. Provision of water supply, sewerage and drainage services in the city is the responsibility of Chittagong Water Supply and Sewerage Authority (CWASA). The gap between the demand for and supply of water in the city has increased rapidly due to population growth and expansion of industrial and commercial activities. In addition, the reported Non- Revenue Water (NRW) percentage is higher than a possible level with more than 30%, mainly caused by deteriorated distribution pipes.

The Government of Japan (GOJ) extended loan assistance through the Japan International Cooperation Agency (JICA) for the "Karnaphuli Water Supply Project (hereinafter referred to as the "Phase 1 Project")" to augment water supply capacity. The World Bank (WB) also has a plan to assist CWASA in the improvement of water supply (Chittagong Water Supply Improvement and Sanitation Projects). JICA is also providing technical assistance to CWASA for the reduction of NRW, through the "Project for Advancing NRW Reduction Initiative (PANI) of CWASA". Assistance for institutional development of CWASA is also in progress in the Phase 1 Project.

There are several key issues to be resolved for the improvement of water supply facilities to reduce NRW percentage and to meet future demand beyond the provision by Phase 1 Project (KWSP 1). In order to address these key issues, the Bangladesh and Japanese sides agreed to conduct the Preparatory Survey on the "Chittagong Water Supply Improvement Project（hereinafter referred to as the "Phase 2 Project" and/or KWSP 2）

The objective of the Phase 2 Project (target year 2030) is to increase sustainable access to safe water for the people in Chittagong city, by constructing water supply facilities and strengthening the capacity of CWASA, thereby contributing to the improvement of the living environment of the citizens. The main objective of the Preparatory Survey (which covers the jurisdiction area of Chittagong City Corporation (CCC) and its surrounding areas, as necessary for planning of some facilities) is to provide information necessary for the evaluation of the feasibility of the proposed Phase 2 Project as a Japanese Government loan project.

## 2. General Description of the Survey Area

Natural Conditions - The city is located in the south-eastern part of Bangladesh, and facing the Bay of Bengal. It is bordered to the south and east with the Karnaphuli River, the source of water for the project. Kaptai Lake which is located about 50 km north-east of the city was formed with the construction of the Kaptai Hydropower Dam and discharges water to the Karnaphuli River (water source of Karnaphuli Water Supply Project) at a controlled but variable rate. In recent years there have been several months when the average discharge from the dam in a month or part of a month was low; however, the average discharge is significantly in excess of the capacity of the intake for Phases 1 and 2 of the Karnaphuli Water Supply Project.

Legislative Conditions - The Government of Bangladesh (GOB) has adopted the following policies, which are relevant to the water supply sector:

- National Policy for Safe Water Supply and Sanitation (1998),
- National Water Policy (NWP) (1999),
- National Water Management Plan (NWMP) (2004),
- Sector Development Plan (SDP) (2011-2015)

- Partnership Framework among the Government of Bangladesh and Asian Development Bank (ADB), DANIDA, the Government of Japan (GOJ), the Government of the Republic of Korea (ROK), and World Bank (WD)
- National Policy for Arsenic Mitigation (2004)

Furthermore, the Environmental Conservation Act was promulgated in 1995 and the Environment Conservation Rules (ECR), which include standards for drinking water were stipulated in 1997.

Socioeconomic Conditions - There are several industrial estates in the city, including Chittagong Export Processing Zone (EPZ), Karnaphuli EPZ and a Korean Export Processing Zone. As of October 2012, about US $940 million has been invested in Chittagong EPZ since 1983-1984, with total exports from the EPZ up to the same date being US$ 14,867 million, with a maximum of about US$ 1,690 million in the current year up to the same date. Exports from Karnaphuli EPZ were about US$ 220 million in the current year (up to May 2012 only). Chittagong port handles about 92 % of the country's imports and exports.

In the Household Income and Expenditure Survey (HIES) 2010 urban poverty in Chittagong division was estimated at 11.8% using the upper poverty line, compared to the national average of 21.3% and 18.0% in Dhaka. Using the lower poverty line urban poverty in Chittagong division in the same year was estimated at 4.0%, second only to Dhaka at 3.8% and a significant reduction from 8.1% in 2005. There are essentially no sanitary sewerage systems in Chittagong and a significant portion of wastewater is discharged untreated to ponds, channels and drains and then to the sea via the Karnaphuli River. Solid Waste Management (SWM) in Chittagong is hampered by the absence of adequate national or local legislation relating to municipal SWM and the treatment and disposal of hazardous waste. CCC is responsible for collection and disposal of household waste and more than 95% of such waste is collected and dumped.

In Chittagong, there are two electricity boards which are REB (Rural Electrification Board) and PDB (Power Development Board). REB is responsible for rural areas and PDB mainly covers the city area. Power supply interruption is chronic problem in the city.

**3. Existing Water Supply and On-going Water Supply Projects**

(1) Existing Water Supply System and Facilities

The area covered by the CCC is about 155 square kilometres and consists of 41 wards, which are under the jurisdiction of CWASA for water supply services according to the city's ordinances. The current water sources are surface water, which is used at Mohara Water Treatment Plant (WTP) (approximately 91,000 $m^3$/d capacity) and ground water, which is treated at Kalurghat Iron Removal Plant (68,000 $m^3$/d capacity), supplemented by many tube wells (60,000 $m^3$/d capacity). The existing water supply network comprises 564 kilometres of transmission and distribution pipelines consisting of various materials (more than 20% of distribution pipelines are installed with asbestos cement pipes) and most of the networks were constructed prior to 1990. The networks directly serve about 45,000 households out of an estimated number of households of more than 600,000 in the CCC area, as well as hydrants.

(2) On-going and Planned Water Supply Studies and Projects

Karnaphuli Water Supply Project Phase 1 – includes intake from Karnaphuli River, WTP (production capacity 143,000 $m^3$/d), conveyance, transmission and distribution pipelines and reservoirs/tanks. Construction is in progress with contractual completion date of May 2014 for the last contract to be completed among 3 packages (construction of pipelines). The project also included an institutional development component.

PANI - the purpose of this on-going project is to provide CWASA staff with technology transfer for the improvement of capacity building for reduction of NRW. The area covered by the project is limited to four pilot areas/zones.

Chittagong Water Supply and Sanitation Project (financed by World Bank) – this project, which is at early stage of implementation, includes construction of a new WTP at Madunaghat (production capacity of 90,000 $m^3$/d), transmission pipelines and rehabilitation of existing facilities.

Emergency Water Supply Project financed by GOB - CWASA has been undertaking Emergency Water Supply Project financed by GOB from January, 2010 to complete in June, 2013. The project was designed to construct 30 deep wells in CCC area to produce a total of 20,000$m^3$/d.

(3) Organization and Activities of CWASA

CWASA has been vested to reorganize towards an autonomous corporate with the Gazette issued in May 2008. Under the WASA Act, the CWASA's equity is fully owned by the Government, and the CWASA's Management Board is organized with the Board Members appointed by the Government. 13 Board Members were officially appointed by LGRD&C on 31st July 2012, and the first Board Meeting was held on 1st Septe**m**ber 2012. The first Board Meeting determined to keep the present Managing Director and three Deputy Managing Directors in office, and the Government is in process of approval of the appointed Managing Director and Deputy Managing Directors. As such, CWASA's management has started a new era.

The current organization broadly comprises three departments, namely Engineering, Finance and Administration, and each department has a Deputy Managing Director in charge. There are 610 personnel in the organization, including the Managing Director, compared to 825 sanctioned. The number of billing staff per 1,000 connections is 1.2 persons (54 persons/ 45 thousand connections). The number of engineers who have experience of operation and maintenance of WTPs, water transmission and distribution systems is very limited.

Foreseeing that CWASA's business activities will substantially expand with the completion of the on-going Karnaphuli Water Supply Project and the implementation of the Phase 2 Project, the following issues are urgent tasks for CWASA:

1) Establish an appropriate organization and adequate staffing for the operation and maintenance of the Water supply facilities, which will be constructed under the Phase 1 and Phase 2 Projects, including the adoption of efficient operation and maintenance systems, recruiting experienced key engineers, and training of engineers, operators and technicians.
2) Reorganization of CWASA's overall organizational structures, administrative procedures and management systems

CWASA concluded the Performance Agreement with the GOB (LGRD&C) in early 2011 , setting the target for water service coverage to be attained up to the year 2015 (as shown in Table ES.1) and also for the improvement of its business operation. However, CWASA faces difficulty in achieving the targets due to various constraints including limited availability of adequate human resources. The table shows updated information on the concerned items in 2011. The figures in planned and actual ones in 2011 are within a certain range of accuracy.

**Table ES.1 Performance Agreement up to year 2015**

| Item | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Population in Chittagong city (mil.) | 3.975 | 4.050 (4.000) | 4.125 | 4.200 | 4.275 | 4.350 |
| Population in CCC area (mil.) | 2.98 | 3.00 (2.60) | 3.10 | 3.20 | 3.40 | 3.60 |
| Population served with piped water (mil.) | 1.190 | 1.230 (1.222) | 1.302 | 1.376 | 2.72 | 2.88 |
| Service Coverage (%) | 40% | 41% (47%) | 42% | 43% | 80% | 80% |
| No. of Service Connections | 49,000 | 51,000 (45,000) | 54,000 | 56,500 | 61,500 | 66,500 |
| NRW (%) | 30% | 29% (33%) | 28% | 27% | 26% | 25% |

*Note: Figures in parenthesis in 2011 show updated information*

Institutional Development Consultants (IDC) employed under the on-going Phase 1 Project formulated the CWASA's Business Plan for five years from FY2011/12 to FY2015/16. CWASA has approved the proposed Business Plan with some amendments and submitted it to LGRD&C for their approval. IDC has started investigation of the CWASA's overall organization and will complete it by the end of November 2012. Restructuring of CWASA's organization will be implemented after IDC's recommendation for the restructuring. In addition, the following has been provided for CWASA.

- Legal and Regulation

- Water Supply for Slum Dwellers

- Computerization of Accounting System

(4) Financial Status of CWASA

Based on the audited financial statements for FY 2006/07, FY 2007/08 and FY 2008/09, water revenue increased by 14.0% in FY 2007/08 and 5.3% in FY 2008/09, and a net profit was recorded in each year. CWASA's financial position has remained in positive profit with contribution by operating revenue other than Water Revenue and non-operating income, even though the Water Revenue has been inadequate to recover the CWASA's overall costs and expenses with the Water Revenue not covering the overall costs and expenses. Furthermore CWASA's financial management has been heavily dependent on the financial subsidy provided by GOB in the form of grant or equity participation.

There are three factors affecting CWASA's financial structure, 1) Current tariff structure that is marginal to recover the operating and financial expenses, 2) Comparatively high NRW as reported at 33%, constraining the water revenue while increasing unit water cost and 3) Long tariff collection period recorded as 200 days, which affects cash flow and liquidity. It is essential that CWASA takes appropriate measures to improve the above.

The water revenue is the main source of CWASA's income, accounting for about 70% of annual revenue. The numbers of service connections increased from 48,146 in June 2010 to 53,152 in May 2012. Although this indicates progress in providing additional connections, in particular metered connections, acceleration in the rate will be required in order to utilize the substantial additional quantity of water that will be produced after the completion of the on-going Phase 1 project and after implementation of the Phase 2 Project.

The water tariff rates were set with an annual upward adjustment of 5%, which was the maximum range of increase allowed under the WASA Act 1996. CWASA's tariff rates in 2011 were BDT 6.26/$m^3$ BDT 17.73/$m^3$ for domestic and non-domestic customers, respectively. The tariff rates of Dhaka WASA are higher than those of CWASA by 6% and 25% for domestic and non-domestic, respectively. According to the HIES survey report in 2010 published by the Bangladesh Bureau of Statistics, the Average Monthly Household Nominal Income in Chittagong was BDT14,092, higher by 6.5% compared to BDT13,226 in Dhaka. The tariff of Dhaka WASA is much higher than the tariff of CWASA when the household income level is taken into account.

According to IDC's assessment of affordability and the socio-economic survey in this project, domestic customers seem to be able to pay at least four times the current tariff, considering that consumers may be affordable to pay water charges up to 3% of incomes.

Service connection fees are relatively high with those set on different connection sizes ranging from BDT7,225 for 20mm to BDT212,000 for 150mm. Foreseeing the needs for a significant increase in the number of service connections in order to meet the future water production volume, it would be prudent to review the current connection charges in order to ensure that the applied connection charges do not cause constraints in the planned increase in the number of service connections.

**4. Water Demand Projection in the Survey Area**

In order to determine the extent of the area to be served by the Karnaphuli WTP (hereinafter referred to as the "Karnaphuli Service Area"), the water demand in the CCC area was projected ward by ward up to the target year 2030. Water demand at this year is forecast to be more than double that in the Year 2011, as shown in Table ES.2, which also shows the main criteria in calculating the demand. The NRW/ leakage percentage at the Year 2030, as well as in intermediate years, is based upon the experience gained in the PANI.

**Table ES.2 Summary of Water Demand in CCC Area at Year 2030**

| Criteria | Unit | Quantity | |
|---|---|---|---|
| | | Year 2011 | Year 2030 |
| Population | No | 2,900,000 | 4,600,000 |
| % of population served | % | 47 | 95 |
| Per capita water consumption | Lpcd | 105 | 120 |
| public hydrants/communal faucets demand | No | 14,400 | 0 |
| Domestic water demand | $m^3$/d | 192,300 | 522,700 |
| Non-domestic water demand | $m^3$/d | 100,300 | 269,800 |
| NRW | % | 33 | 15 |
| Leakage | % | 25 | 10 |
| Daily average water demand | $m^3$/d | 408,900 | 880,800 |
| Daily maximum water demand (as % of daily average water demand) | | 1.15 | 1.15 |
| Daily maximum water demand | $m^3$/d | 470,400 | 1,012,900 |
| Peak hour water demand (as % of daily maximum water demand) | | - | 1.5 |

**5. Establishment of Karnaphuli Service Area**

(1) Justification of KSA

1) Major issues and problems on the existing water supply

Currently the water supply in the CCC area is provided by water from two WTPs (Mohara and Kalurghat). Under the present arrangements of water supply, CWASA has no option but to supply customers on a case by case basis without effective control of water supply from the WTPs to and throughout the distribution system.

The time required to address the above issues as well as to develop a functional and realistic hydraulic model of the existing system, which could then be used to develop an optimized and efficient water supply and distribution system for the long term, is likely to be several years. On completion of the above works several years would be required to implement the first phase of measures, allowing for arranging finance, design, procurement, construction, etc.

2) The reason for the establishment of KSA

The comprehensive and up to date Master Plan for water supply, including a construction plan for the distribution network to cover the entire Chittagong city does not exist up to now. However, operation of water supply facilities planned in the Phase 1 Project is scheduled to start in 2014. Once existing network receives water from KWSP 1, it is obvious to arise the following:

- Leakage will be more serious as existing network consists of old AC pipes, and
- Customers still cannot receive sufficient water as capacity of existing network is too small.

Therefore, it is urgent to construct distribution network to deliver water through the main/ sub-main distribution pipelines to be constructed by the Phase 1Project.

KWSP 1 and 2 cannot satisfy water demand in entire CCC area. In this case, CWASA has two choices as follows:

- Enough pressure and continuous supply with minimum water losses in the limited area. At the same time, CWASA has to consider countermeasures outside KSA.
- Low pressure and intermittent supply with considerable water losses in whole CCC area.

The water supply for KSA is planned to provide the customers with sustainable access to safe water with appropriate water pressure on a 24/7 basis in consideration of the water supply capacity of the Karnaphuli WTP (286,000$m^3$/d). The KSA should be independent from other water supply systems as a self-contained system, in order to ensure that the above mentioned service levels are met. There are a lot of cases of water supply system operated independently (except for in emergency cases) by dividing the overall system in the city into several sub-systems, which are supplied by different water sources/WTPs in order to achieve effective O&M of water supply facilities.

3) Manner of selection of the KSA and the establishment of Sectors and DMAs

KSA is selected to cover high priority area (PANI area) in consideration of the balance between water supply capacity from Karnaphuli WTPs and water demand in 2030 in the priority area. KSA boundary doesn't have to follow ward boundary and not based on any hydraulic considerations.

The provisions of sectors and DMAs will allow for the monitoring and effective control of water supply in terms of water quality, flow rate and water pressure. In addition, information required to manage NRW will be easily collected through measurement of the flow rates in the system.

Each Sector will have only one inlet with a flow meter, a pressure gauge and a pressure regulating valve. This arrangement will allow for the adjustment of water pressure at the inlet chamber resulting in the promotion of equitable water distribution to all sectors. Flow and pressure measurement data will be

transmitted on a continuous basis through a SCADA system to the Central Control Room located at Karnaphuli WTP. Instructions will be made, as required for the adjustment of the water pressure at the inlet pipe to each sector.

For the effective control of NRW, each sector will be further divided into a number of small DMAs. This arrangement will allow for the collection of accurate data on leakage and NRW in each DMA. For example, the quantity of leakage in a DMA can be estimated through measuring minimum night flow by using a vehicle on-board electro-magnetic flow meter.

4) The reason of new construction of distribution pipes in KSA instead of rehabilitation of existing pipes

As of today, the exact locations, material types and conditions of the existing distribution pipes as well as the interconnection details and location have not yet been determined. Therefore it is a pre-requisite for evaluation of the possibility for reusing existing pipelines to conduct extensive field investigations, including trial excavations. However, based on the difficulties encountered in the trial excavations carried out under the PANI (limited to a central part of the city), investigation covering a large service area is not realistic in terms of both time and cost requirements, aside from the huge magnitude of disturbances to the residents and traffic in the built up area. Even if existing pipes are found, reuse of deteriorated AC pipes in the areas with a high population density area may be difficult. In addition, the diameters of the existing pipes are not sufficient for the present demand because those pipes were thought to be installed more than 20 years ago. Furthermore, frequent and long interruptions to water supply in a large area would occur if rehabilitation of existing pipes is implemented. On the other hand, the time period for interruption of water supply can be minimized under construction of new distribution pipes up to the service connections because cut off of the water supply is necessary only when new service connection is connected to existing service pipes in the premises of each customer.

Accordingly, new construction of pipelines is advantageous in order to provide effective water supply facilities in terms of reduction of leakage from the start of operation of the system and without causing major problems during the construction period. The construction cost and period required are also reduced considerably as extensive trial excavations for existing pipes will not be required. However, existing distribution mains, which run through KSA and deliver water outside KSA, remain as they are (e.g. Mohara WTP –Patenga B.P).

(2) FAQs regarding KSA

1) Change of service area in the water supply plan from SAPROF/Phase 1 to Phase 2

Water supply improvement plan for two phases was prepared by SAPROF in 2005 and Detailed Design of Phase 1 facilities in 2008. After the previous study/design, preparatory survey for Phase 2 was conducted in 2012. According to the comparison of the planned service area between SAPROF and Phase 2, the following are identified.

KSA must be smaller than that in SAPROF, as

- CCC's water demand in 2030 is 1.65 times as much as that in 2020, however,

- Production volume of KWSP 1& 2 is almost same.

It is not likely that WTPs are materialized as scheduled in SAPROF report except for KWSP 1&2. Current situation is different from what was planned in SAPROF

In addition, two reservoirs (Nashirabad and Battali Hill) are included in Karnaphuli water supply system

in SAPROF. The capacity of the two reservoir isn't still sufficient for KSA, even though KSA doesn't receive Madunaghat WTP water. As for priority area to be covered, in KSA, it is considered to include priority areas where water demand is high and urgent measures are needed, while, in SAPROF, no consideration is given to priority area (Its service area is simply set at hillside area).

2) Needs of accurate GIS data and maps for hydraulic simulation and rehabilitation work

WB recognizes that existing GIS data and maps are not accurate in terms of location. Besides location, following data and information are required;

- Materials (AC pipes must be replaced, no matter how fine they look.)

- Diameter (which hydraulic model depends on, but there are no accurate data)

- Conditions (Leakage occurs everywhere in unreliable network, but only limited information is available)

We must recognize that all data and information necessary for hydraulic simulation and rehabilitation work aren't available at present. There are two options to solve this problems follows:

- Conduct trial excavation along all the pipelines laid in CCC area, then hydraulic simulation and rehabilitation work, or

- Abandon all existing network, then design completely brand-new network.

3) Expansion of water supply toward outside of KSA

It will take a longer time for CWASA to construct water supply systems required to cover the entire Chittagong city. Therefore, it is reasonable for CWASA to apply a staged construction of water supply systems with priority for different areas. If the planned quantity of water for the KSA (286,000$m^3$/d) is used for the entire city area, some improvements such as a longer supply time (than presently practiced) may be expected. However, such arrangement will mean that the service levels for the KSA in terms of drinking water quality, adequate water pressure on a 24/7 basis will never be met. It is an obligation of CWASA to provide customers with safe and sufficient water supply services.

It should be noted that the water currently supplied from Mohara and Kalurghat WTPs to planned KSA (more than half of the quantity of water, i.e. more than 100,000$m^3$/d) will be used in the future in the areas outside of the KSA due to the change in the water source and supply. This shall contribute to the improvement of water supply service in terms of the quality and quantity of water supplied to areas around KSA. Figure ES.1 shows projected expansion of water supply services in provision of KWSP 1 and 2 from present to year 2020.

On the other hand, before effective design and construction such as KSA are achieved in the areas around KSA, careful and effective operation should be basically kept to avoid the deterioration of water supply service in KSA because sudden reduction in water pressure as well as the outflow of a large amount of water without flow control would occur if water supply to the surrounding area of KSA would be made by opening the valve(s) installed to stop the outflow to neighboring distribution systems (in the target year 2030). Except for emergency cases, water supply systems between KSA and neighboring distribution areas should be kept independent to maintain the control of the service level for KSA and surrounding areas.

All water supply systems to be constructed in the city shall be managed independently and at the same time operated comprehensively, supplementing each other and in consideration of countermeasures in emergency cases for each water supply system.

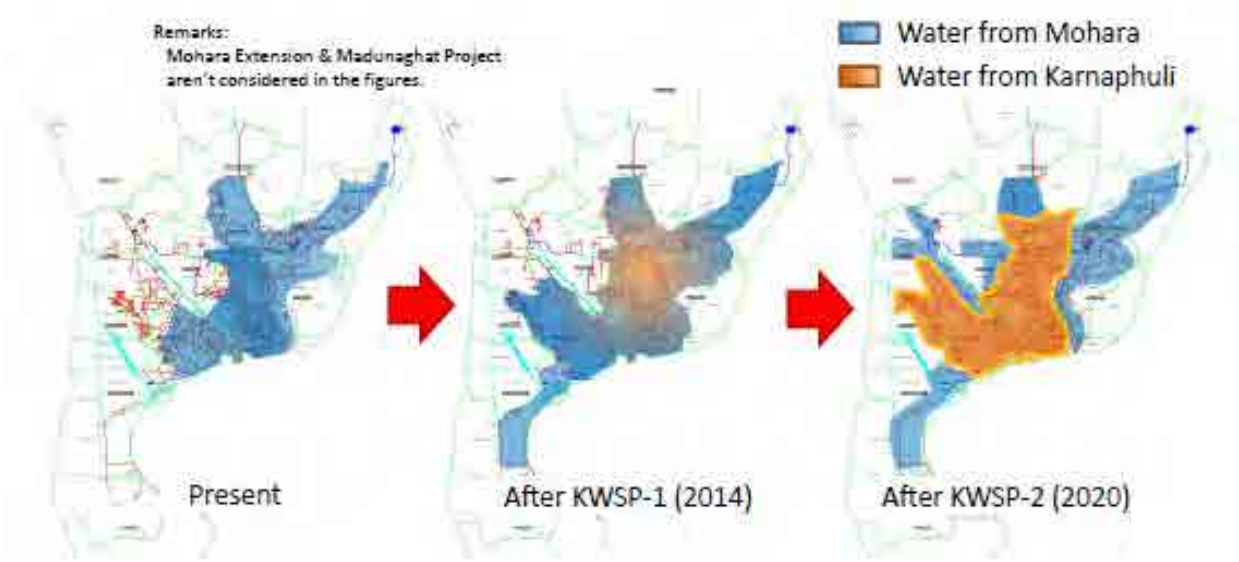



**Figure ES.1 Contribution of KWSP 1 & 2 to the areas outside of KSA**

4) Huge social impact of different water supply quality inside and outside of KSA

Service boundary shall be established anyway both in JICA study and WB study unless supply capacity can satisfy the entire water demand of whole CCC area. CWASA shall make efforts to establish the appropriate water supply areas outside KSA with support from GOB and/or donors.

Water supply service will be significantly improved even outside KSA after completion of KWSP 1 and 2. The supply conditions outside KSA can be further improved if additional supply from the Madunaghat WTP is materialized.

5) Combination of new network and existing not abandoned in KSA

The new pipes in KSA are planned to be connected to existing pipes in some locations. However, the two areas; the KSA and the areas served by the existing pipes (outside of the KSA) will be under different and independent water supply systems separated by valves.

If water supply in surrounding areas of the KSA is highly necessary, CWASA may conduct water supply to such areas as a temporary measure until the year 2030.

Figure ES.2 shows the manner of switching of service connection from old pipe to new pipe.

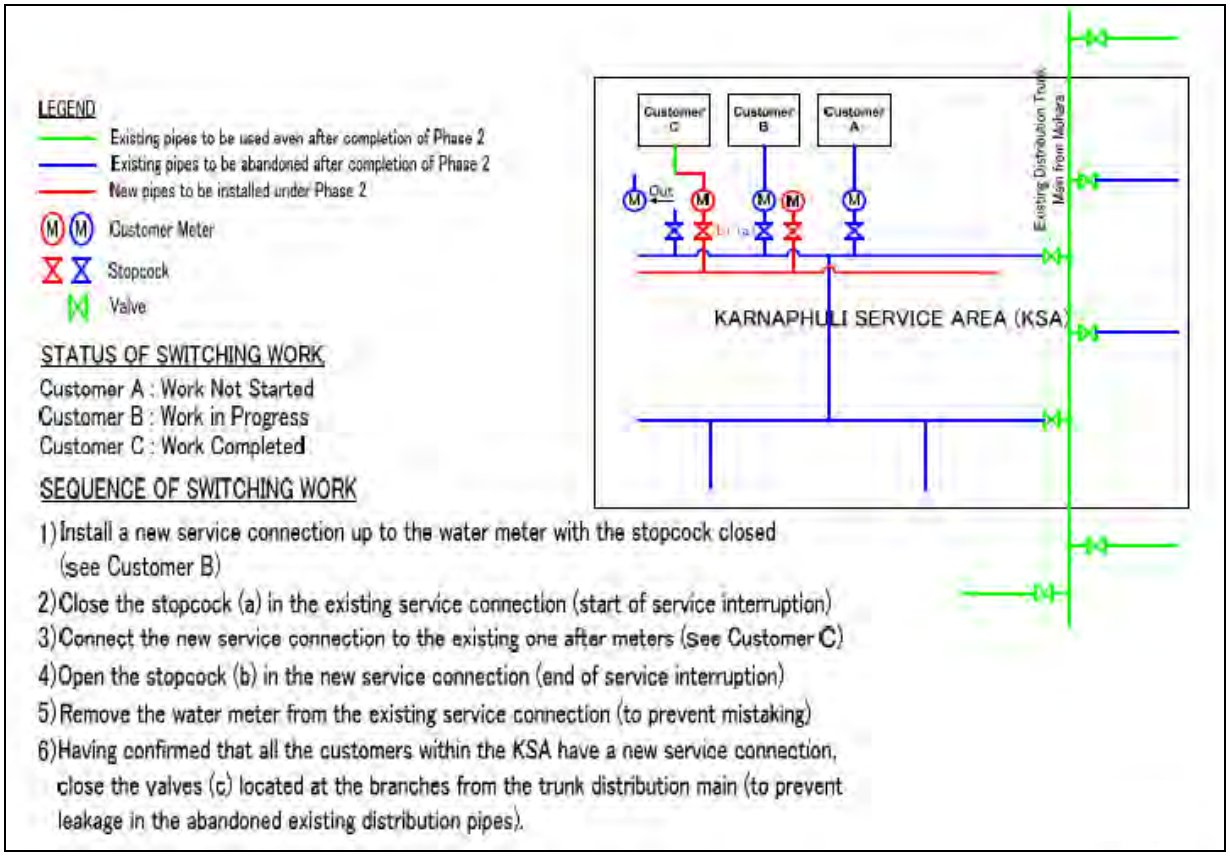



**Figure ES.2 Service connection**

6) Countermeasures to reduce leakage in KSA in early stage

KWSP 2 will give a construction priority to the priority sectors in PANI to commence normal water supply starting from year 2016, as shown in FigureES.3.

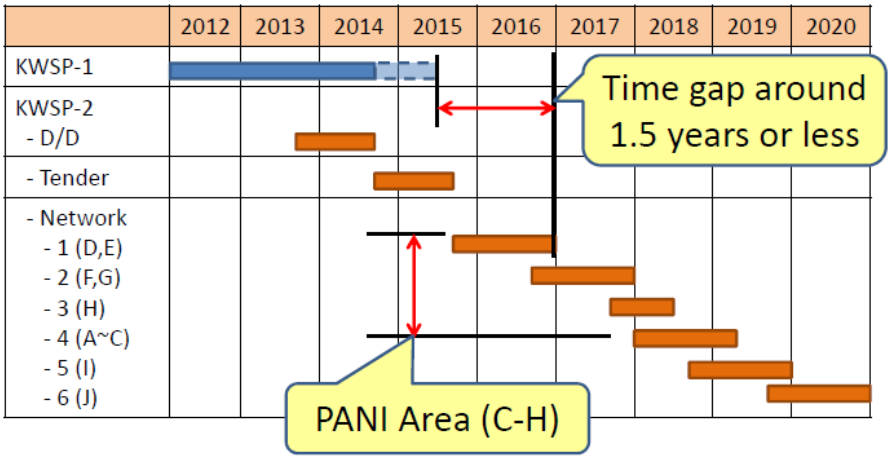



**Figure ES.3 Construction Schedule of Distribution Network to expedite Water Delivery to Priority Areas**

The area (wards) to be included in the KSA is based on giving priority to the following areas: PANI Area, (2) planned area to be covered with main/sub-main pipelines by the Phase 1 Project and (3) wards with a high demand (more than 100m$^3$/d/ha), which are geographically continuous from the PANI Area. A total

of 21 wards with an area of 3,063 ha and a served population of 1,504,200 (more than 95% of the population in KSA) at the year 2030 were selected to be included in the KSA, based on the above criteria, with the locations shown in Figure ES.4.

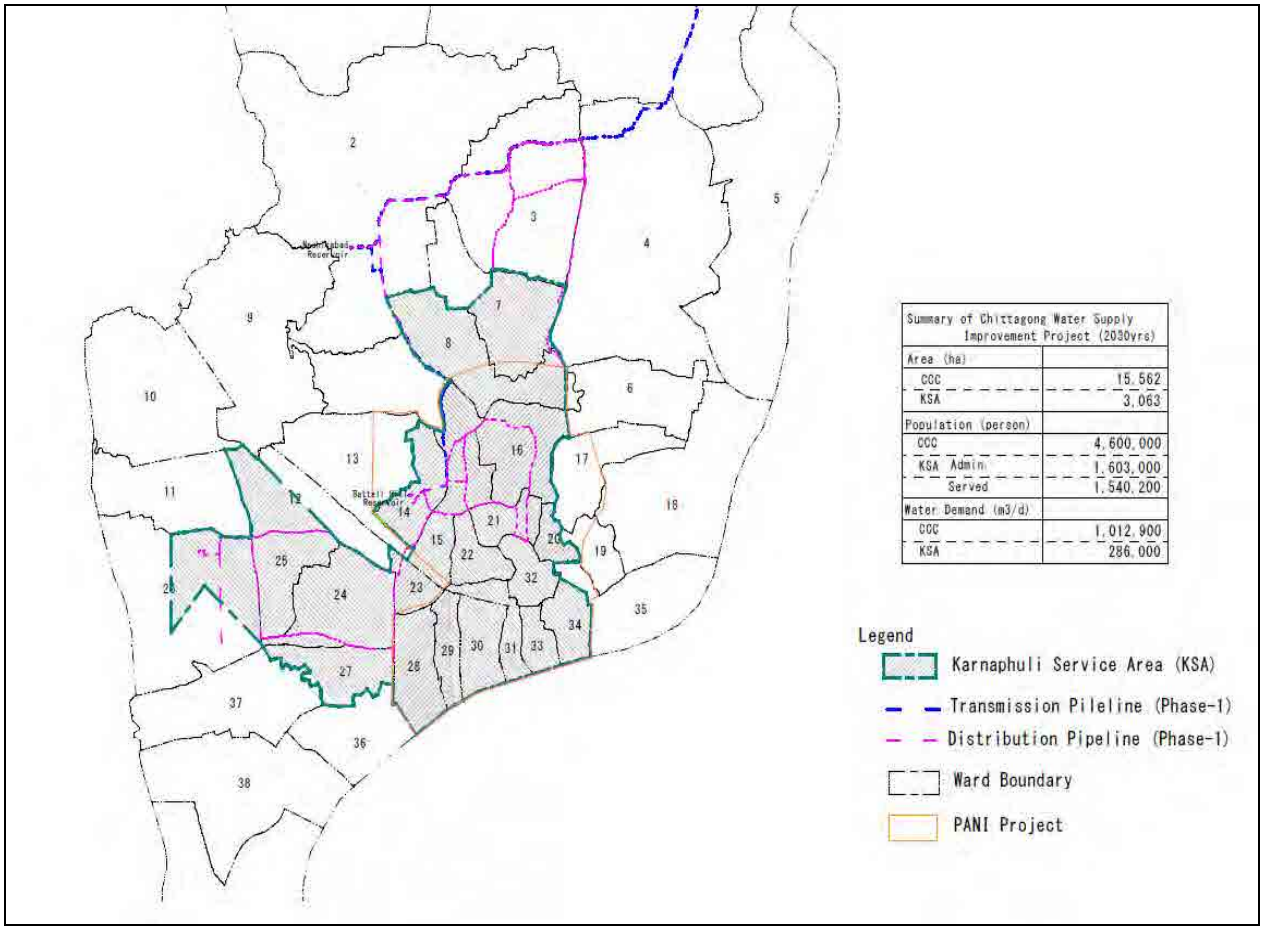



**Figure ES.4 Locations of Wards included in KSA**

## 6. Distribution System

The main objectives to be followed in the planning of the distribution network within the KSA are "equitable distribution" and "control of non-revenue water". In order to achieve this the area is divided into hydraulically independent 'Sectors', with each Sector further sub-divided into a number of small District Metered Areas (DMAs) for the effective control of NRW. Furthermore based on an assessment of the investigation results from the PANI, an entirely new distribution network is proposed, as this is more effective than rehabilitating the existing network.

The KSA is divided into 10 sectors (A to J) in consideration of the following factors: (a) locations of wards, (b) topographical conditions, (c) locations of major infrastructure, (d) distribution main pipeline routes planned in the Phase 1 Project and (e) the daily maximum water demand per sector should generally be in the range from 20,000$m^3$/d to 50,000$m^3$/d. Geographically the KSA consists of the Northern (A to C), Central (D to G) and Western (H to J) areas.

Two alternative distribution systems were studied in consideration of (a) effective use of the facilities in the Phase 1 project, (b) limited space in the road for construction of pipelines and (c) service areas to be covered for areas with a higher ground elevation. The selected system allows gravity flow to all areas, with the three areas above served by respective reservoir/elevated tanks; the Northern area by Nashirabad

Elevated Tank, the Central area by Battali Hill Reservoir and the Western area by Halishahar Elevated Tank. Figure ES.5 shows schematic configuration of main pipelines with inlets to sectors.

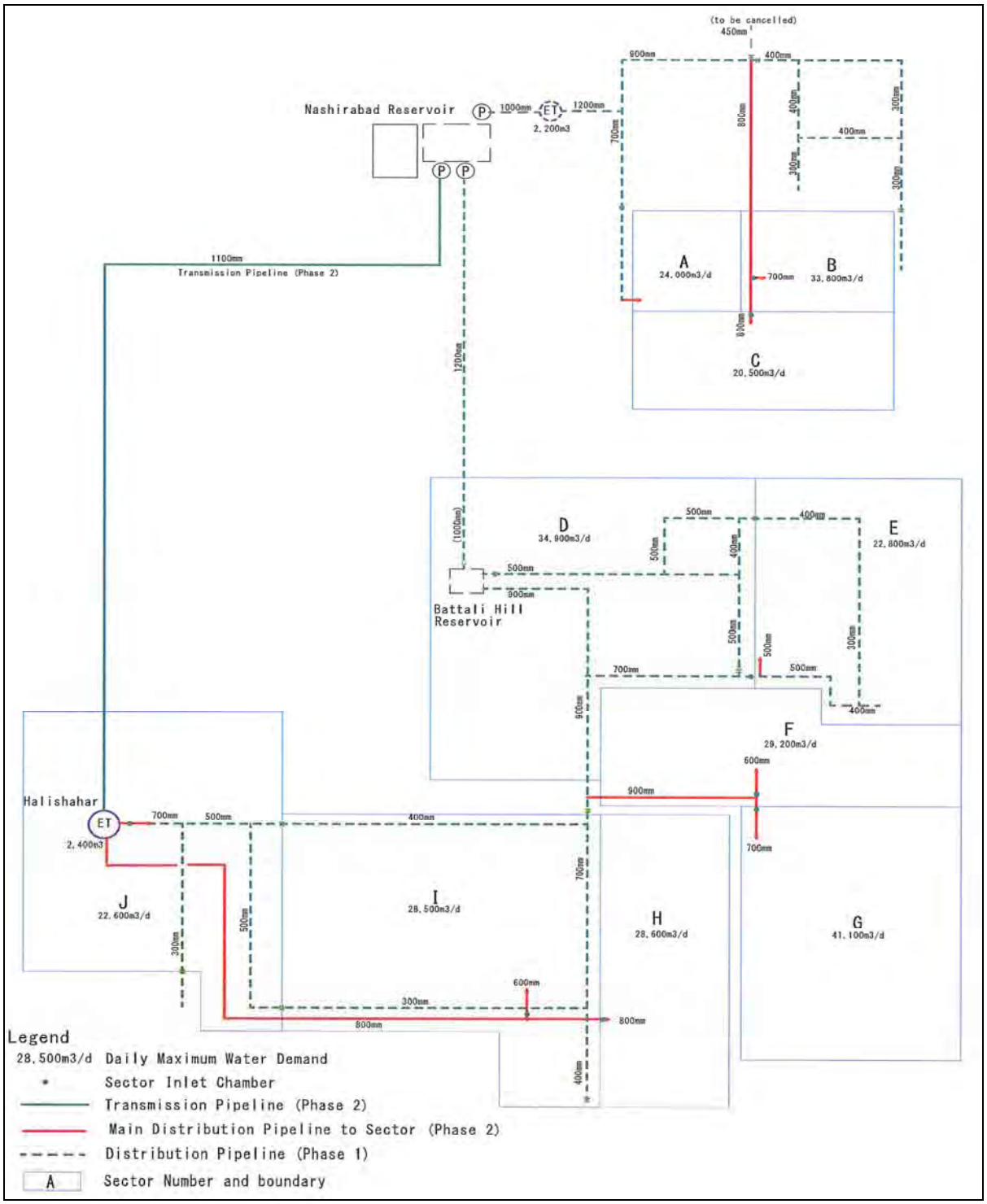



**Figure ES.5 Schematic Configuration of Main Pipelines with Inlets to Sectors**

## 7. Preliminary Design of the Water Supply Facilities

Problems with the existing system to be solved through the implementation of planned projects are as follows:

1) Limited Service Coverage with 47% of the water demand in CCC area,
2) Dilapidated and Inadequate Distribution pipes in the significant parts of the existing networks that are in need of replacement and
3) Considerable Non-Revenue Water (NRW) as reported by CWASA at 33%, but survey results by PANI in 2012 concluded with more than 50%

The Phase 2 Project is the expansion of the Phase 1 Project except for the arrangements of the distribution system. Table ES.3 summarizes the facilities in each phase and Figure ES.6 presents location of major facilities for the both phases.

**Table ES.3 Outline of Karnaphuli Water Supply Project by Phase**

| Facilities | | Phase 1 | Phase 2 |
|---|---|---|---|
| 1 | Intake | C/A: 300,000$m^3$/d<br>M/E: 150,000$m^3$/d | C/A: -<br>M/E: 150,000$m^3$/d |
| 2 | Conveyance Pipeline | DN1200mm, L=3.6 km<br>(including surge tank ) | DN1200mm, L=3.6 km<br>(including surge tank) |
| 3 | WTP | Production Capacity<br>= 143,000$m^3$/d | Production Capacity<br>=143,000$m^3$/d |
| 4 | Transmission Pipeline 1 | DN1200mm, 24.4km<br>(including surge tank) | DN1200mm, 24.4km<br>(including surge tank) |
| 5 | Nashirabad Reservoir | Reservoir:26,300$m^3$<br>Elevated Tank: 2,200$m^3$ | Reservoir:24,800$m^3$ |
| 6 | Transmission Pipeline 2 | Nashirabad – Battali Hill:<br>L=5.2km<br>DN1200/1000mm | Nashirabad – Halishahar:<br>L=10km<br>DN1100mm |
| 7 | Halishahar<br>Elevated tank | - | 2,400$m^3$ |
| 8 | Optical Fiber Cable | L=37km | L=20km |
| 9 | Primary and Secondary Distribution Pipeline | Northern, Central & Southern areas,<br>DN300-DN1200mm<br>L= 42.8km | Distribution Reservoir/ Elevated Tank to the ten (10) Sectors Primary Distribution (Upstream from Sector Valve to Reservoir);<br>L= 7.9km<br>Secondary Distribution (Downstream from Sector Valve to DMA; L=107.5km |
| 10 | Tertiary distribution pipeline | - | 3,063ha<br>(L=367.6km) |
| 11 | Service connection with water meter | - | About 51,360 connections |

Land acquisition is not required. Details of important parts of the facilities are as follows.

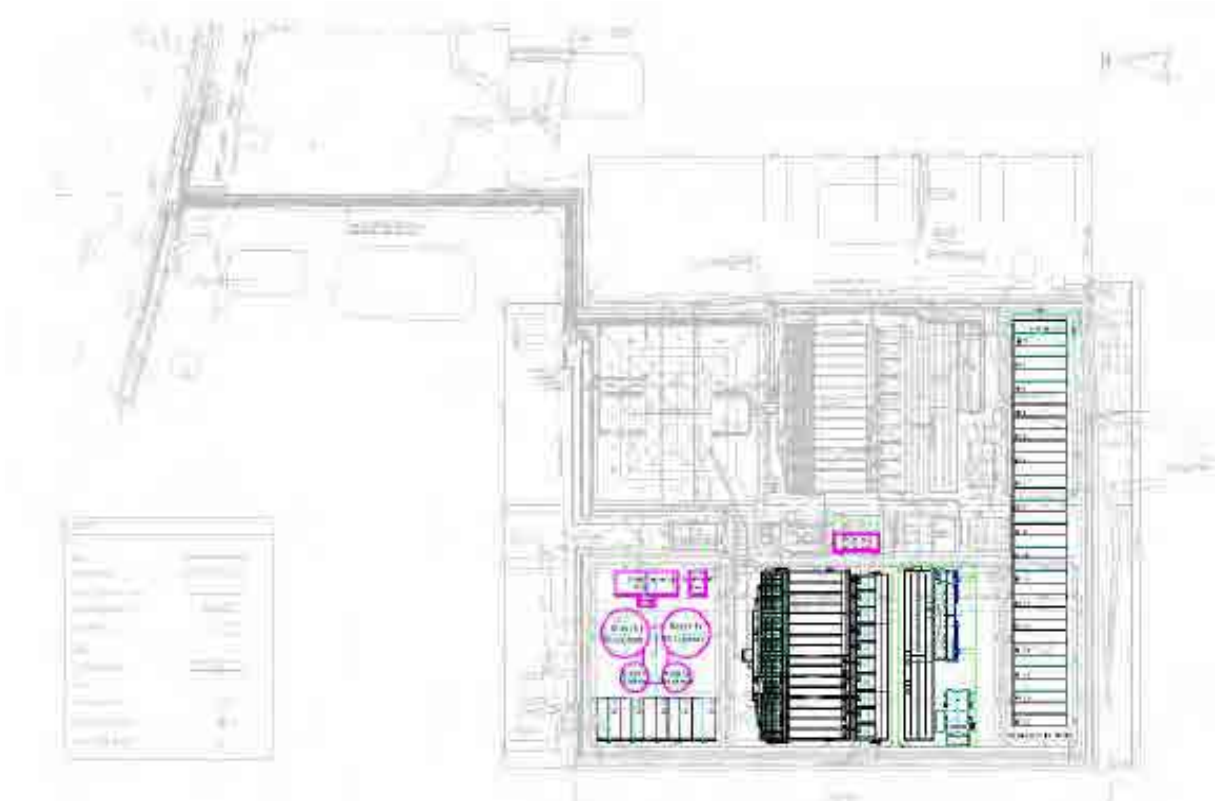


**Figure ES.6 Location of Major Facilities of Phase 1 & 2 Projects**

(1) Water Treatment Plant

The water treatment process for Phase 2 is basically the same as that for Phase 1 in application of rapid sand filter method (flocculation/coagulation-sedimentation- filtration).

The Pre-Sedimentation basin planned in the Phase 1 project will be commonly used for both Phases 1 and 2 in the case where the inflow has a high turbidity. For sludge treatment the process; Sedimentation Basin - Gravity type Sludge Thickener - Sludge Drying Beds – Disposal will be used, as this can be accommodated on the available land and the capital and O&M costs of this solution are lower than for the alternative technical solution considered.

(2) Transmission Pipeline

Transmission pipelines are planned along Kaptai Road for both Phase 1 and 2 Projects between the WTP and Nashirabad Reservoir, and Nashirabad reservoir to service reservoirs (Nashirabad Elevated Tank and Battali Hill Reservoir). A transmission pipeline from the Nashirabad Reservoir to Halishahar Elevated Tank is also planned for Phase 2 Project to supply the western area of the KSA.

Some faucet systems along the transmission pipeline along Kaptai Road shall be provided for the residents to mitigate complaints. City Government shall also extend assistance for the water supply in the area, such as construction of deep wells, which is practiced by the City Government.

(3) Distribution facilities

The distribution system consists of ten (10) Sectors and is divided into three (3) sub-systems, the northern, central and western areas. These areas are served by the Elevated Tank at Nashirabad site, Battali Hill Reservoir, and Halishahar Elevated Tank, respectively.

(4) Distribution Pipelines

Water from the three (3) main distribution facilities, namely the Elevated Tank at Nashirabad site, Battali Hill Reservoir and Halishahar Elevated Tank, is distributed to ten (10) sectors. Furthermore, water is supplied to District Meter Areas (DMAs).

The approximate lengths of distribution pipelines are summarized in table ES. 4 from the distribution reservoir/elevated tank to the sector valves, from the sector valves to the DMAs, and within the DMAs in the KSA. New distribution pipes in DMAs should be laid in the road near housing and the length of the service connection pipes should be minimized.

**Table ES.4 Length of distribution pipeline in KSA**

Unit: m

| | Upstream to Sector Valve | | | | | Downstream of Sector Valve to DMA | | | | | | | DMA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dia.(mm) | 600 | 700 | 800 | 900 | 1000 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 100 |
| Length | 44 | 91 | 2,428 | 2 | 5,367 | 74,883 | 18,055 | 5,056 | 2,968 | 4,776 | 668 | 1,058 | 367,560 |

New distribution pipes in DMAs should be laid in the road near to house, business establishments, etc. and the length of the service connection pipes should be minimized.

(5) Water Distribution Control System

For the purpose of enhancing equitable distribution, the KSA is divided into 10 numbers of hydraulically independent 'Sectors'. Each Sector will have only one inlet which is provided with a flow meter, a pressure gauge and a pressure regulating valve. Flow and pressure measurement data will be transmitted through SCADA system to the Central Control Room located at the Karnaphuli water treatment plant for monitoring and recording purposes on a 24/7 basis. Pressure regulating valves will automatically adjust the pressure at the outlet to match a set point, which can be changed by operators in the Central Control Room.

For the effective control of non-revenue water, each Sector will be further divided into a number of District Metered Areas (DMAs). DMAs will be designed so that whenever it is necessary they can be hydraulically isolated from the rest of the distribution network by closing 3 to 4 valves of known location.

Treated water at Karnaphuli WTP is transmitted to Nashirabad Reservoir at first and reserved, then transmitted to the service reservoirs by transmission pumps. Water in the service reservoirs is distributed to each distribution sector by gravity. The number of sector is ten and pipe size is about 600mm to 700mm, so a valve chamber will be relatively large due to installation of an electromagnetic flow meter and control valve. A valve chamber at the inlet of sector and a control panel will be required on the ground near the valve chamber.

**8. Construction Plan of Water Supply Facilities**

The construction plan has been developed considering environmental and social impacts, and security problems during the construction work. Important points are as follows.

(1) Intake/Conveyance Facilities - At the Intake connections to the Phase 1 facilities shall be carried out such that the facilities operate continuously (except for short term interruptions to the power supply), when the Phase 1 standby generator shall be utilized. The conveyance pipeline from the Intake to the WTP will be installed in Kaptai Road using open-cut method of construction and laid in the opposite side of the road to the Phase 1 pipeline with appropriate traffic control during pipe laying.

(2) WTP - Construction of the facilities shall be planned such that adequate sludge treatment is provided at all times during the change in the method of sludge treatment. Connections to the Phase 1 facilities (for example pre-sedimentation basin, sludge treatment, electrical works), shall be carried out such that the Phase 1 WTP operates continuously (except for short term interruptions to the power supply) and without adversely affecting the treated water quality. In the case when the power supply has to be interrupted the standby generator which is provided under Phase 1 shall be utilized, such that interruptions are short.

(3) Transmission Facilities -The transmission pipeline from the WTP will be laid in Kaptai Road, in the opposite side of the road to the Phase 1 pipeline. Appropriate traffic control shall be provided for this and other pipelines.

(4) Distribution Facilities – measures to mitigate environmental impacts and prevent public nuisance, such as noise and vibration shall be taken. These shall include traffic control and diversions, where necessary. For the construction of tertiary distribution pipelines and service connections with meters, all customers should be informed sufficiently in advance of the timing of works to change the connection pipe, such that they can make arrangements for the storage of water and the works required to be undertaken by the customer. The construction method for pipe laying with the diameter less than 400mm may be determined in consideration of alternatives; open-cut or trench less methods, during detailed design stage. Works should be carried out timely such that disturbance to customers and the duration of the cut off in supply are minimized.

(5) Distribution Pipeline – Nearly 9,000m$^2$ of stock yard for pipe materials are assured in the CWASA property near Bayazid Bostami Road. During construction, the contractor may encounter AC pipes, for which removal and disposal shall be properly and safely carried out. If construction machine break AC pipes, broken pieces shall be treated carefully so that direct contact with the pipes does not occur and exposure to airborne asbestos fibers is in accordance with the prevailing standards and legislation with regard to Permissible Exposure Levels. Broken pieces of pipe shall be packed safely and collected to storage areas, prior to final disposal from the site. Workers shall be equipped with eye-protection glasses, masks and rubber/leather gloves.

About 52,000 connections are planned in the Phase 2 project. After water pressure test of tertiary distribution main pipe, service connections will be installed as the last work in the series of pipe laying process before backfilling.

When new connections are installed, some problems may occur. Joint planning and work among concerned parties, including CWASA staff is indispensable. Before the installation of service connections, CWASA staff shall prepare a map showing the exact location of the water meter for each consumer. The contractor (for package 3: construction of distribution pipelines) will install the service connection up to the construction boundary (i.e. up to a short distance inside the private land from the boundary between public and private land; refer to Figure ES.2).

The project cost includes installation cost of service connections; however, connection fee to be collected from customers later will be utilized for the maintenance of service connections by CWASA. CWASA may reduce some connection fee considering the cost required to connect between CWASA pipe and private pipe in switching work from old connection pipe to new one.

**9. Operation and Maintenance of Water Supply Facilities**

The organization for O&M of the Karnaphuli Water Supply System is recommended from functional view point as a total system for Phases 1 and 2, taking into account the changes required as a result of the Phase 2 project (such as use of SCADA system and leakage monitoring and control in DMAs). The requirements for administrative, engineering (planning and design), commercial/ marketing and public relations are regarded to be managed by CWASA head office, as common services to all water supply sys-

tems in the city. Therefore, the Karnaphuli Water Supply System Office has an independent function for O&M of the facilities.

The organization for O&M consists of two divisions (broken down into two groups among the major facility components), one for the Intake, WTP, Conveyance and Transmission pipelines, and the other for the Distribution Facilities. System management from Intake to the entrances to the sectors of the distribution main pipelines will be undertaken by monitoring and control staff under the Assistant KWS System Manager, who will report to the KWS System General Manager. A total of 164 staff is required for O&M of the system, not including support staff.

The Deputy Manager of O&M for the Distribution Facilities will manage concerned sections consisting of (1) reservoir/elevated tank and (2) main & sub-main Pipelines with Sector Inlet chambers, DMA networks with DMA chambers.

Main pipe/Section Inlet chamber & DMA Section includes (1) 10 Sector offices, (2) Leakage Detection Teams for the three sub- distribution systems which cover 10 sectors and (3) Water Meter Maintenance Center, which will be commonly used for all established Water Supply System in Chittagong City. The Water Meter Center is engaged in the water meter accuracy test, periodical on-site meter calibration and replacement of broken meters.

The field office of each sector shall be established before completion of respective DMAs to manage the water supply business in their territories including marketing, water tariff collection, and monitoring/control of water use and repair of facilities (leakages). For the establishment of comprehensive management for the water supply in the KSA, incentives to staff members and appropriate compensation shall be provided through the competition on the performance of the sectors.

**10. Environmental and Social Considerations**

The Karnaphuli Water Supply Project was classified during Phase 1 as a “Red” category project and this is still the case in accordance with the prevailing legislation. An IEE report and an EIA report were prepared for the Karnaphuli Water Supply Project and both were submitted to the Department of Environment (DOE) to obtain the necessary approvals. The descriptions in both reports cover Phases 1 and 2 of the project.

Approvals by DOE include various conditions, such as requirements for proper mitigation countermeasures and monitoring for site preparation, construction and operation stages. In addition “the Project Proponent (CWASA) shall apply for Environmental Clearance Certificate after installation of the plant as well as other pollution control facilities and equipment”.

With reference to the Phase 2 Project, CWASA sent a letter to DOE Chittagong to obtain “Environmental Site Clearance (ESC)” on September 20, 2012. DOE Chittagong replied to CWASA on September 20, 2012 about the need for the site clearance certificate for Phase 2 of KWSP with requisite fees. After submission of the requirements by CWASA, DOE Chittagong issued the ESC for Phase 2 Project on November 13, 2012.

(1) Environmental and Social Aspects in the Project Sites

There is no need for additional land and resettlement for the construction of water supply facilities for Phase 2 project. The land required for Phase 2 will be managed within the area obtained during the project preparation stage for Phase 1 and/or owned by CWASA. However, before commencement of the Phase 1 Project, six households (about 40 persons) resided at the south-eastern edge of the WTP site, were relocated.

Public consultation as a means of integration of local people's concerns into the Environmental Assessment process was conducted during the preparation stage of Phase 1 Project.

In general, the local people's response to the Karnaphuli Water Supply Project was positive and they were interested to receive the benefits of the project. Most of the people who live close to the treatment plant had no objection towards the implementation of the project, but they expressed concern about the loss of agricultural and productive land. The people in the city area welcomed the project with great interest as it is likely to alleviate the problems of acute shortage of water from which they are suffering.

In the recent survey all of the respondents requested CWASA to provide improved water supply services in terms of 24/7 service, sufficient water pressure and water quality for drinking purposes.

During construction work for the Project inconvenience to the people's lives may occur. Disruption to traffic and congestion, mainly caused by pipe laying in and beside roads is potentially the reason for the highest number of complaints. In order to minimize complaints traffic management measures in major roads, such as Kaptai Road will be provided, with working areas limited to 100 meters long in order to minimize disturbance to traffic flow. Inconvenience to residents may also occur during the construction of the distribution network in built up areas.

To mitigate inconvenience, residents' complaints and opinions should be collected at timely public meetings in the concerned areas. Public meetings can be opportunities for building mutual understanding between residents and the Contractor/ CWASA, and people's participation in the project as well.

Residents along the conveyance and transmission pipelines (outside the CWASA service area) are not served by this Project, although they may be inconvenienced by construction work along Kaptai Road. For their benefit, community faucet systems are planned to be installed along the transmission pipeline route. Assistance by the City Government shall also be sought.

According to the public consultation, residents were concerned that assembly of people during project activities may adversely influence the local environment. The problem can be negligible in the case where local residents are employed in the Project. Public meetings shall be timely conducted before and during construction work to concerned people.

The following items/issues should be carefully considered to avoid, minimize and/or mitigate possible negative impacts due to the project in terms of physical environment (natural environment and items related to environmental pollution).

- Location of Project Sites in and Vicinity of the Protected Areas and Environmentally Sensitive Area
- Vegetation, Animals and Valuable and Endangered Species
- Rich Fish Resources and Fishery Activity
- Specific Hydrological Conditions of Karnaphuli River and its Tributaries due to Coastal and tidal Effect
- Air Pollution
- Surface Water Quality
- Ambient Noise
- Solid Waste Disposal

(2) Identification of Possible Environmental Impacts and Necessary Measures

The following are studied.

- Identify possible negative and positive impacts caused by the project
- Study possible mitigation methods and prepare Environmental Management Plan (EMP) and environmental monitoring plan.

As a result of identification of possible impacts shown, the major possible negative impacts are as follows:

- Pre-Construction Stage

1) Change in land use and utilization of local resources

- Construction Stage

1) Nuisance and/or disturbance of business activities and living conditions affected by the construction work. In particular work for laying pipelines along existing roads may cause traffic congestion, resulting in nuisance and/or disturbance to business activities and living conditions in the project area.
2) Public health condition
3) Working condition
4) Accidents
5) Surface soil erosion
6) Hydrological condition
7) Air pollution
8) Water pollution
9) Noise and vibration
10) Solid waste disposal

- Operation Stage

1) Air pollution
2) Water pollution caused by sludge treatment at WTP
3) Noise and vibration caused by pump operation
4) Chlorine leakage from chlorine storage and injection facilities
5) Sewage volume increase according to the increase of water uses

- All Stages

1) Acceptability by people and local communities
2) Occurrence of conflict and discord within community due to worker's staying in the area and unfairness of benefits
3) Impact to Habitat of flora, fauna and endangered species
4) Impact to fishery resources

(3) Environmental management Plan

The following items are considered.

1) Institutional arrangement with staffing
2) Compliance with Bangladesh Laws, Standards and Regulations as well as the JICA Guidelines
3) People's Participation
4) Preparation of Implementation Plan

(4) Environmental Monitoring Plan

In the terms and conditions, which accompanied the Issuance of ESC and Approval of EIA Report on Karnaphuli Water Supply Project by DOE, following matters are required for environmental monitoring.

1) Record of monitoring
2) Monitoring items and timing
3) Reporting
4) Notification of Environmental Harm

Environmental Checklist both in Bangladesh and JICA was prepared.

**11. Implementation Plan and Construction Cost Estimates**

The implementation Plan is established referring to the lessons from the Phase 1 Project, which is scheduled to be completed in 2015. The Phase 1 project does not include pipeline systems in the DMAs and these pipes up to the service connections in the DMAs are included in the Phase 2 Project, covering the entire Karnaphuli service area.

Construction of pipelines in the DMAs shall be given priority for the PANI area where population density is high with high water demand, while, there are a lot of dilapidated pipes and AC pipes in the area, which requires providing urgent countermeasures. On the other hand, accurate information/data on the existing underground facilities in the area has been accumulated through the implementation of the PANI and this information is useful for the design of the distribution network. This arrangement will provide not only effective water supply service in the KSA, but also help in increasing the income of CWASA.

(1) Contract Packaging and Procurement Method

Four packages are proposed as follows.

Package 1: Intake Facilities, WTP and Distribution Reservoir/ Elevated Tank

Package 2: Conveyance and Transmission Pipelines, and Optical fiber cable (from Nashirabad Reservoir to Halishahar E.T)

Package 3: Primary, Secondary and Tertiary Distribution Pipelines, Lateral/ Service Connections in DMAs; and Optical fiber cable (from several manholes planned in Phase 1 to Sectors A to G, and from Halishahar E.T to Sector inlet chambers of Sectors H, I and J)

Package 4: Procurement of equipment and vehicles (divided into several lots)

Package 3 is a very urgent component in the overall Karnaphuli Water Supply Project in order to provide water supply at an early stage in a cost effective manner. The period for D/D will be reduced to a minimum in recognition of this.

The following is the procurement method for both Consultants and Contractors.

| **Procurement** | **Scope of Work** | **Manner of Procurement with required process/ events** |
|---|---|---|
| Consultants | One consultancy package: D/D & C/S for all packages of work | ICB (PQ, Bid, Approval) |

| **Procurement** | **Scope of Work** | **Manner of Procurement with required process/ events** |
|---|---|---|
| Contractors | Construction of facilities<br>(Package 1, 2, 3 and 4, respectively) | ICB (PQ, Bid, Approval) |

(2) Implementation Schedule

A temporary Implementation Schedule is shown in Table ES.5, based on assumed loan agreement schedule as shown below.

| | |
|---|---|
| Appraisal of the Project | December, 2012 |
| Pledge of JICA Loan | February 2013 |
| Exchange of Note between GOB and GOJ | March 2013 |
| Signing of Loan Agreement | March 2013 |

**Table ES.5 Temporary Implementation Schedule**

| Item | Date |
|---|---|
| Expected Completion of Phase 1 Project | May 2015 |
| Project Appraisal/Loan Agreement | December 2012/ March 2013 |
| Selection of Consultant | 9 months, December 2012 to August 2013 |
| Detailed Design | 13 months,<br>September 2013 to September 2014 |
| Selection of Contractor | |
| Package 1 | August 2014 to November 2015 |
| Package 2 | Ditto |
| Package 3 | Ditto |
| Package 4 | February 2014 to September 2014 |
| Construction stage | |
| Package 1 | 36 months<br>December 2015 to November 2018 |
| Package 2 | 36 months<br>December 2015 to November 2018 |
| Package 3 | 62 months<br>December 2015 to January 2021 |
| Completion of Project including defects liability period | January 2022 |

*Note: Package 4, Procurement of equipment and vehicles, is included in the part of consulting services.*

During the consulting services major investigations (a long period is required to conduct excavation at about 1,200 locations) to finalize pipeline design are trial excavations along planed primary and secondary pipeline routes, since there are no data available as of today. In consideration of this and the large amount of work for Package 3 requiring many engineers and construction working teams, timely completion of the consulting services with absolute conditions (dry season period for trial excavation), careful preparation and arrangements are indispensable.

(3) Project Implementation Unit (PIU)

CWASA will be the primary agency responsible for executing and supervising the Project and a Project Implementing Unit (PIU) in CWASA shall be established. In the PIU under the Project Director and Deputy Project Director, there shall be four sections, which are Procurement, Accounting, Environment and Public Relations. In addition, three groups (excepting for environmental specialist), one for each construction package shall be organized and each group should be vested with a formation from Executive Engineer to Site Engineers. The PIU will consist of 18 core staff from Project Director to Assistant Engineer level, supported by about 80 staff members, all of whom shall be full-time on the assignment.

(4) Consulting Services for Detail Design, Assistance for Bidding, Procurement of equipment and Construction Supervision

CWASA will procure consulting services through ICB, with the consultants' team consisting of international and local professional and supporting staff. A total of 505 man-months of international and 856 man-months of local engineers are proposed, taking into account of the requirements for the design of Package 3, in particular. Consultants will be selected through a short list method to avoid lowering of quality and in accordance with the "Guidelines for the Employment of Consultants under Japanese ODA Loans".

The total cost for the consulting services is estimated at approximately 2,526 million yen (Foreign portion: 1,538 million yen, Local portion: 1,023 million Taka), as shown in Table ES.6.

**Table ES.6 Estimated Cost for Consulting Services**

BDT 1 = JPY 0.966

| | | Unit | Qty. | Foreign Portion | | Local Portion | | Combined Total |
|---|---|---|---|---|---|---|---|---|
| | | | | JPY | | BDT | | JPY |
| | | | | Rate | Amount ('000) | Rate | Amount ('000) | ('000) |
| **A. Remuneration** | | | | | | | | |
| 1 | Professional (A) | M/M | 505 | 2,562,000 | 1,293,810 | 0 | 0 | 1,293,810 |
| 2 | Professional (B) | M/M | 856 | 0 | 0 | 400,000 | 342,400 | 330,758 |
| 3 | Supporting Staffs | M/M | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal of A | | | | 1,293,810 | | 342,400 | 1,624,568 |
| **B. Direct Cost** | | | | | | | | |
| 1 | International Airfare | | 168 | 400,000 | 67,200 | | 0 | 67,200 |
| 2 | Domestic Airfare | | 168 | | 0 | 10,000 | 1,680 | 1,623 |
| 4 | Domestic Travel | | | | 0 | | 0 | 0 |
| 5 | Accommodation Allowance | | | | | | | 0 |
| | Professional (A) | Month | 505 | 350,000 | 176,750 | | 0 | 176,750 |
| | Professional (B) | Month | 0 | 350,000 | 0 | | 0 | 0 |
| | Supporting Staffs | Month | 856 | | 0 | 100,000 | 85,600 | 82,690 |
| 6 | Vehicle Rental | Month | 168 | | 0 | 100,000 | 16,800 | 16,229 |
| 7 | Office Rental | M/M | 1,361 | | 0 | 200,000 | 272,200 | 262,945 |
| 8 | International Communications | M/M | 505 | | 0 | 150,000 | 75,750 | 73,175 |
| 9 | Domestic Communications | M/M | 1,361 | | 0 | 50,000 | 68,050 | 65,736 |
| 10 | Office Supply | M/M | 1,361 | | 0 | 50,000 | 68,050 | 65,736 |
| 11 | Office Furniture and Equipment | Ls | 1 | | 0 | 2,000,000 | 2,000 | 1,932 |
| 12 | Report Preparation | Month | 100 | | | 1,000 | 100 | 97 |
| 13 | Topographic & Soil Survey | Ls | 1 | | | 20,000,000 | 20,000 | 19,320 |
| 14 | Trial Digging | Ls | 1 | | | 70,000,000 | 70,000 | 67,620 |
| | Subtotal of B | | | | 243,950 | | 680,230 | 901,052 |
| | **Total** | | | | 1,537,760 | | 1,022,630 | 2,525,621 |

(5) Preliminary Cost Estimates for the Project

The following are assumptions to estimate the cost requirements according to the implementation schedule.

1) Construction Cost

| | | |
|---|---|---|
| 1) | Base Year | December, 2012 |
| 2) | Exchange Rate | 1 Taka = 0.966 Japanese Yen<br>1 USD = 81.7 Taka<br>1 USD = 79.0 Japanese Yen |
| 3) | Price Escalation Rate per annum | Foreign Currency = 2.1%, Local Currency = 4.9% |
| 4) | Physical Contingency | 5% |

2) Administration Cost and Service Tax

| | | |
|---|---|---|
| 1) | Administration Cost | 5% (of the Eligible Portion) |
| 2) | VAT for local currency | 15% (of the expenditure in local currency of the eligible portion) |
| 3) | VAT for foreign currency | 15% (of the expenditure in foreign currency of the eligible portion for Consulting Service) |
| 4) | Import tax | 30% (of the expenditure in foreign currency of the eligible portion for Procurement/Construction) |

The construction cost (including consulting services) is summarized in Table ES.7

**Table ES.7 Construction Cost** (mil. Yen)

| Item | | Total (million) | | |
|---|---|---|---|---|
| | | FC (JPY) | LC(BDT) | Total(JPY) |
| **A. ELIGIBLE PORTION** | | | | |
| I) Procurement / Construction | | 16,677 | 15,599 | 31,746 |
| 1 | Intake facilities, WTP, reservoirs and elevated tanks | 3,501 | 2,223 | 5,649 |
| 2 | Conveyance and transmission pipeline | 5,942 | 1,310 | 7,207 |
| 3 | Distribution pipeline and service connections | 4,470 | 7,628 | 11,839 |
| 4 | Procurement of goods | 337 | 0 | 337 |
| 5 | Project Implementation Support Unit | 0 | 148 | 143 |
| | Base cost for JICA financing | 14,250 | 11,310 | 25,175 |
| | Price escalation | 1,634 | 3,546 | 5,059 |
| | Physical contingency | 794 | 743 | 1,512 |
| II) Consulting services | | 1,784 | 1,363 | 3,101 |
| | Base cost | 1,538 | 1,023 | 2,526 |
| | Price escalation | 162 | 275 | 428 |
| | Physical contingency | 85 | 65 | 148 |
| Total (I + II) | | **18,462** | **16,962** | **34,847** |
| **B. NON ELIGIBLE PORTION** | | | | |
| a | Procurement / Construction | 0 | 0 | 0 |
| | | | | |
| | Base cost for JICA financing | 0 | 0 | 0 |
| | Price escalation | 0 | 0 | 0 |
| | Physical contingency | 0 | 0 | 0 |
| b | Land Acquisition | 0 | 0 | 0 |
| | Base cost | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| | Price escalation | 0 | 0 | 0 |
| | Physical contingency | 0 | 0 | 0 |
| c | Administration cost | 0 | 1,804 | 1,742 |
| d | VAT | 0 | 2,821 | 2,725 |
| e | Import Tax | 0 | 5,179 | 5,003 |
| f | Banking charge | 0 | 54 | 52 |
| Total (a + b + c + d + e + f) | | **0** | **9,859** | **9,524** |
| **TOTAL (A+B)** | | **18,462** | **26,821** | **44,371** |
| | | | | |
| **C. Interest during Construction** | | 19 | 0 | 19 |
| | Interest during Construction(Const.) | 18 | 0 | 18 |
| | Interest during Construction (Consul.) | 2 | 0 | 2 |
| **D. Commitment Charge** | | 0 | 0 | 0 |
| | | | | |
| **GRAND TOTAL (A+B+C+D)** | | **18,481** | **26,821** | **44,390** |
| | | | | |
| **E. JICA finance portion (A)** | | **18,462** | **16,962** | **34,847** |

3) Performance Indicators

The performance indicators (covering CCC area) to be monitored during project implementation to assess project progress toward project objectives, and for evaluation of project accomplishments after project implementation are shown in Table ES.8 Service coverage is estimated using served population and projected population (Population in 2023 is about 40% higher than that in 2012). Therefore, service coverage in 2023 is 51%, but it is about 70% against the population in 2012

**Table ES.8 Performance Indicators**

| Indicator | 2012 | 2023 (2 years after completion of facility) | |
|---|---|---|---|
| Water Production (Phase 1 + Phase 2) $m^3/d$ | 219,000 | 505,000 | |
| Population Served/to be served (person) | 1,363,000 | 2,008,500 | 90% in KSA<br>Deep well; 343,000 persons |
| Daily maximum water consumption ($m^3/d$) | 146,700 | 388,900 | |
| Service coverage (%) | 47 | 51 | 70% to present population |
| Water Supply per Capita (l/person/day) | 107 | 120 | |
| Percentage of facility utilization (%) | 100 | 100 | |
| NRW | 33% | 23% | |

Note) 1) 2012;
Population in CCC = 2,900,000 person
Population Served =1,363,000person (51,000connection x 20person/connection +343,000person)
Service coverage = 47% (including deep well supply)
2) 2023;
Population in CCC= 3,964,000 person
Population in KSA =1,272,800 person
Population Served = 1,272,800 person x 90% + (51,000connection-25,000connection) x 20person/connection + 343,000person= 2,008,500person
Service coverage = 2,008,500 / 3,964,000 = 51% (70% to present population,
NRW% in 2023= (0.33x.43+0.15x0.57)x 100=23%

## 12. Financial and Economic Considerations

(1) Budgetary Plan

The fund requirements and financing plan for the Phase 2 Project are as follows:

| Particulars | FC Portion (JPY mil.) | LC Portion (BDT mil.) | Combined Total in JPY (mil.) | Combined Total in BDT (mil.) |
|---|---|---|---|---|
| Fund Requirements | 18,481 | 26,820 | 44,390 | 45,952 |
| Financing Plan | | | | |
| JICA Loan | 18,462 | 16,962 | 34,847 | 36,074 |
| GOB Fund | 19 | 9,858 | 9,543 | 9,878 |
| Total | 18,481 | 26,820 | 44,390 | 45,952 |

(2) Forecast of Financial Position of Phase 1 and Phase 2 Projects

The base-line forecast indicates that the annual operating income for the Phase 1 Project (which has also been considered in the financial and economic analysis) will be negative every year during the initial 13 years from FY2016 until FY2028 and the annual operating income for the Phase 2 Project similarly will be negative every year during the initial 18 years from FY2021 until FY2038, since the water revenue income is adequate to recover the O & M costs, but not adequate to recover depreciation.

There are three options for possible measures to be taken for strengthening the sustainable financial structures of the Phase 1 and 2 Projects, as follows:

Option 1: To raise the tariff rates as follows:

1) To raise the tariff rates in FY2016 to BDT30.22 per $m^3$ for domestic consumers and BDT85.61 per $m^3$ for non-domestic consumers (4.6 times of the rates in FY2012) and then rise by 3.0% every year until FY2020.
2) To raise the rates in FY2021 by 1.4 times of the FY2020 rates for domestic and non-domestic consumers, and then rise by 2% every year until FY2025.
3) To raise the rates in FY2026 by 10% of the FY2025 rates for domestic and non-domestic consumers.
4) No need to raise the rates in FY2027 onwards, unless any external conditions change.

Option 2: To relax lending terms of GOB's subsidiary loan as follows:

1) To provide grant and/or equity participation for the whole amount of the funds required for the Phase 1 Project, which is equivalent to about 30% of the total fund requirements for the Phase 1 and 2 Projects.
2) For the Phase 2 Project, relaxing the lending terms as follows:
   a) Repayment of loan with 30 years installments after a 10 years grace period
   b) Interest rate at 1% per annum for both the Foreign and Local Loan Portions
   c) Capitalize interest accrued during the initial 10 years so that annual payment of interest can be released during these years

Option 3: Intermediate arrangement between Option 1 and Option 2

It is recommended to consider taking one of the above measures in order to make the Phase 1 and 2 Projects financially sustainable.

(3) Financial Evaluation of the Phase 2 Project

The financial internal rate of return (FIRR) and financial net present value (FNPV) of the Phase 2 Project are computed for the financial evaluation. The computation is made on the basis of discounted cash-flow taking cash outflow based on initial capital costs, replacement costs and annual O&M costs, while taking cash inflow based on annual water revenue. All inputs are in terms of 2021 constant prices.

The base case indicates an FIRR of 7.07% (negative) and an FNPV of BDT 25,904.14 million (negative). The analysis implies that the water revenue is adequate to recover O&M costs but inadequate to recover the capital investment costs due to the current water tariff rates set comparatively lower.

A sensitivity analysis indicates that an increase in the tariff rates by 170% to BDT26.22/$m^3$ for domestic consumers and BDT74.28/$m^3$ for non-domestic consumers in 2021 constant prices results in a FIRR of 0.79% and FNPV of BDT57.07 million, satisfying the financial opportunity cost of capital (FOCC), which is estimated as 0.78%. However, as such an increase becomes to be higher by 252% than the 2012 rates; it seems difficult to adopt such higher tariff rates. Considering economic benefits that may be brought about by the Project, it is recommended for the Government to consider providing financial support as discussed in 12.2.4 (2) even though gaining adequate financial returns on investment.

(4) Economic Evaluation of Phase 2 Project

The economic internal rate of return (EIRR) and economic net present value (ENPV) of the Phase 2 Project are computed to evaluate the economic effectiveness of the Phase 2 Project. The computation is made on the basis of discounted cash-flow taking cash outflow based on economic capital costs, economic replacement costs and annual economic O&M costs, while taking cash inflow based on two economic benefits, namely, direct benefit in terms of Willing To Pay (WTP) value of water distributed from the Phase 2 Project and indirect benefit in terms of the value of consumers' water cost saving with the supply of water from the Project. All inputs are in terms of 2021 constant prices.

All economic costs are estimated by converting financial cost values with SCF (Standard Conversion Factor) of 0.9. WTP value is deemed to be equivalent to the water revenue used for the financial evaluation, while the value of consumers' water cost saving is estimated assuming that consumers may spend much higher costs for getting water from alternative sources if the Project is not realized.

The base case indicates an EIRR of 11.87% and an ENPV of BDT 3,352.68 million at a 10% discount rate. In light of the economic opportunity cost of capital (EOCC), which is estimated at between 10 and 12%, the Phase 2 Project is evaluated to have a justifiable economic return on investment.

The Phase 2 Project, as well as the Phase 1 Project will contribute significantly in responding to public needs for an improved water supply and also in the improvement of the sanitary environment and public health. In view of the quantitative economic return on investment and these qualitative effects, the Phase 2 Project is strongly justifiable, although the financial position is difficult.

# CHAPTER 1

# BACKGROUND AND OUTLINE OF THE SURVEY

# CHAPTER 1 BACKGROUND AND OUTLINE OF THE SURVEY

## 1.1 Introduction

The water supply in the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh") is not adequate at present in terms of quality, quantity and levels of service. The Government of the Republic of Bangladesh (hereinafter referred to as "GOB") decided to improve water supply using surface water and reduce the use of groundwater, due to arsenic contamination and lowering of the groundwater level.

Chittagong city is the second largest city in Bangladesh, and the county's biggest industrial and port city. The gap between demand for and supply of water in Chittagong city has increased rapidly due to population growth and expansion of industrial and commercial activities. In addition, the reported Non-Revenue Water (NRW) percentage is higher than a possible level with more than 30%, mainly caused by deteriorated distribution pipes. Chittagong Water Supply and Sewerage Authority (hereinafter referred to as "CWASA") presently supplies an average of 219,000$m^3$/day to the served area, while the requirement is estimated at an average of 408,900$m^3$/day.

The Government of Japan (hereinafter referred to as "GOJ") extended loan assistance for "Karnaphuli Water Supply Project (hereinafter referred to as the "Phase 1 Project")" to augment water supply capacity (Production amount of 143,000$m^3$/day). The World Bank also has a plan to assist CWASA in the improvement of water supply in the future (Chittagong Water Supply Improvement and Sanitation Projects). In addition to the countermeasures for physical improvement, Japan International Cooperation Agency (hereinafter referred to as "JICA") has been providing technical assistance to CWASA for the reduction of NRW through the "Project for Advancing NRW Reduction Initiative (PANI) of Chittagong WASA". Assistance for the institutional development of CWASA is also in progress in the Phase 1 Project (refer to the details in 3.3.3 Current Activities for Institutional Improvement of CWASA).

Although a significant increase in water supply capacity is expected in the near future (such as from the construction of Madunaghat WTP and expansion of Mohara WTP including from the Phase 1 Project), there are several key issues to be resolved such as improvement of transmission and distribution systems and future expansion of the Karnaphuli water treatment plant to meet future demand. In order to address these key issues, the Bangladesh and Japanese sides agreed to conduct the Preparatory Survey on the "Chittagong Water Supply Improvement Project（hereinafter referred to as the "Phase 2 Project").

JICA dispatched a mission to Bangladesh from January 14 to January 24, 2012 to develop the scope and implementation arrangements of the Preparatory Survey. After a series of discussions, the Japanese mission and the Bangladesh side (Economic Relations Division: ERD Ministry of Finance, Local Government Division: LGD Ministry of Local Government, Rural Development and Co-operatives, and CWASA) agreed on the scope and implementation arrangements of the Preparatory Survey as shown in the Minutes of Meeting on the Preparatory Survey on the Chittagong Water Supply Improvement Project dated January 22, 2012 (Supporting Report 1.1).

The Preparatory Survey on the Phase 2 Project commenced in May 2012 and the first field work by the Survey Team in Bangladesh was completed in July 20, 2012. Then, the second field work was conducted from August 27, 2012 to October 15, 2012. Final Report was completed in the middle of December with comments from Bangladesh side after the third field work conducted from November 9 to November 20, 2012. The major items covered by the report are as follows;

- Planning framework for the Phase 2 Project
- Selection of the Karnaphuli service area
- Outline design of distribution system,

- Preliminary facility plan,
- O&M Plan of facilities
- Construction plan of Phase 2 facilities
- Environmental and social considerations
- Implementation plan and cost estimates
- Financial analysis

Supporting report 1.2 presents M/Ms on the Preparatory Survey of the Chittagong Water Supply Improvement Project agreed upon between the Government of the Peoples 'Republic of Bangladesh and Preparatory Survey Team at the four times of Steering Committee Meetings.

## 1.2 Objectives of the Preparatory Survey

The main objective of the Preparatory Survey is to provide information necessary for the evaluation of the feasibility of the proposed Phase 2 Project as a Japanese ODA loan project. Such information includes the outline of the project, project cost estimates, economic and financial viability of the project, project implementation schedule, manner of procurement and construction, organization for project implementation, operation and maintenance (O&M) arrangements, social and environmental considerations.

## 1.3 Survey Area and Design Year

The Preparatory Survey covers the jurisdiction area of Chittagong City Corporation (hereinafter referred to as "CCC"), as shown in the Location Map, as well as the surrounding area with regard to planning of the intake, water treatment plant, conveyance and transmission pipelines. The target year for the Project is set as the year 2030.

## 1.4 Scope of Work for the Preparatory Survey

The scope of the work for the Preparatory Survey is enumerated below.

(1) Basic Study

1) Collection and analysis of existing data and information on water supply sector in Bangladesh (including national Policy and Plan, etc.)
2) Collection and analysis of present conditions of the Survey Area through existing data, information and field survey;
   a) Natural Conditions (meteorology, hydrology, hydro-geology, etc.)
   b) Socio-economic conditions and trends (population, industries, land use, social infrastructure, economic conditions, etc.)
   c) Environmental conditions (environmental laws and regulations, public health, etc.)
3) Collection and analysis of present conditions of water supply in the Survey Area through existing data and field survey;
   a) Water demand and supply,
   b) Field survey,
      -Existing water supply facilities
      -Current conditions of non-revenue water
      -Water sources
   c) Water right and water quality,
   d) Willingness to pay and affordability for water supply service,
   e) On-going studies, plans and projects related to the Preparatory Survey (Karnaphuli Water Supply Project, Institutional Development Consultancy Service of CWASA, etc.), and

f) Evaluation of present water supply conditions and identification of problems

(2) Chittagong Water Supply Improvement Project (Phase 2 Project)

1) Planning of the Project

a) Review of existing surveys (population/demand projection)
b) Identification of priority supply area from Karnaphuli water treatment plant
c) Identification of Karnaphuli Service Area
d) Planning of Intake, raw water supply pipe and water treatment plant
e) Planning of transmission mains
f) Planning of primary distribution mains (zoning/ sectorization)
g) Planning of secondary and tertiary distribution mains (District Meter Area)

*Note: Definitions of primary, secondary and tertiary distribution mains are referred to Chapter 6 Distribution System (page 6-17)*

(3) Preliminary design of the Project

1) Topographic and route survey, geotechnical survey, and river cross-section survey, if necessary
2) Project scope and preliminary design of the facilities (intake, water treatment plant, transmission pipelines, service reservoirs, distribution network)
3) Development of operation and maintenance plan related to the facilities to be constructed under the Project
4) Preliminary cost estimation
5) Comparison of the estimated project cost with other similar projects, to verify the appropriateness of the project cost
6) Project implementation schedule and confirmation of necessary procedures for the approval of the project implementation (Environmental Impact Assessment (EIA), Development Project Proposal (DPP), land acquisition, etc.)
7) Procurement plan, method and contract packages of the Project
8) Financing plan of the Project
9) Economic and Financial analysis of the Project
10) Consideration of pro-poor components
11) Environmental and Social Assessment (preparation of Initial Environmental Examination (IEE), EIA, Environmental Monitoring Plan (EMP) and Resettlement Action Plan (RAP)
12) Recommendation on Terms of Reference (TOR) for consulting services (detailed design, construction supervision, etc.)
13) Project evaluation for the project implementation;
-Technical evaluation
-Economic and financial evaluation
-Environmental and social evaluation
-Institutional evaluation
14) Selection of key operation and effect indicators, setting up baseline and target data
15) Preparation of the institutional set-up for the Project implementation
16) Conclusions and recommendations

# CHAPTER 2

# GENERAL DESCRIPTION OF THE CHITTAGONG CITY AREA

# CHAPTER 2 GENERAL DESCRIPTION OF THE CHITTAGONG CITY AREA

## 2.1 Natural Conditions

### 2.1.1 Topography

Chittagong City located in the south-eastern part of Bangladesh and facing the Bay of Bengal, is bordered to the south and east by the Karnaphuli River, the largest river in the south-eastern area of Bangladesh. The Karnaphuli Hydro Power Station is located about 50 km from Chittagong, along the Karnaphuli River.

The centre of the city is located near the river mouth utilized as a port. In the northwest, there are hilly areas with level from 60 m to 90 m. To the east of the hilly areas, flat plain is widely distributed and this is bordered by the Karnaphuli River.

### 2.1.2 Meteorology

Metrological observation in Bangladesh is conducted under the jurisdiction of the Bangladesh Meteorological Department. There is one meteorological observation station in Chittagong, R-306.

Chittagong City is located in the tropical zone. It is characterized by high temperature and heavy rainfall with often excessive humidity. There are three distinct seasons. The hot season lasts from March to May including some wet days. The monsoon season begins in June and usually continues until September, generally starting and ending with cyclones. Between November and February is the cold and dry season.

(1) Rainfall

Annual rainfall in Chittagong in each month in the years from 2002 to 2011 is shown in Table 2.1.1. During this period the annual average rainfall was 2,074 mm, with more than between 67% and 83% of the annual rainfall in each year occurring during the monsoon period between the months of June and September.

**Table 2.1.1 Rainfall in Chittagong**

Unit: mm

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 1 | 0 | 70 | 67 | 453 | 366 | 920 | 456 | 145 | 129 | 128 | 10 | 2745 |
| 2003 | 0 | 0 | 53 | 167 | 198 | 1209 | 372 | 260 | 210 | 234 | 0 | 66 | 2769 |
| 2004 | 0 | 0 | 5 | 145 | 250 | 593 | 902 | 170 | 548 | 206 | 0 | 0 | 2819 |
| 2005 | 0 | 0 | 67 | 158 | 242 | 259 | 129 | 381 | 406 | 101 | 0 | 1 | 1744 |
| 2006 | 0 | 0 | 0 | 0 | 598 | 244 | 637 | 268 | 438 | - | 0 | 0 | 2185 |
| 2007 | | | | | | | | | | | | | 0 |
| 2008 | 63 | 30 | 6 | 4 | 244 | 707 | 859 | 759 | 255 | 175 | 0 | 0 | 3102 |
| 2009 | 0 | 0 | 45 | 74 | 400 | 445 | 1414 | 277 | 300 | 17 | - | 0 | 2972 |
| 2010 | 0 | 9 | 50 | 50 | 282 | 916 | 245 | 392 | 86 | 301 | 52 | 22 | 2405 |
| 2011 | | | | | | | | | | | | | |
| **Average** | 6.4 | 3.9 | 29.6 | 66.5 | 266.7 | 473.9 | 547.8 | 296.3 | 238.8 | 116.3 | 18 | 9.9 | 2074.1 |

*Source: Bangladesh Meteorological Department and previous reports*

In the monsoon season (June to September) during the period from 1980 to 2010, total rainfall ranged from a low of 1,515 mm in 1980 to 3,224 mm in 1987 with an average of 2,578 mm. The total average rainfall in the monsoon season in each of the 10 year periods from 1980 to 1989, 1990 to 1999 and 2,000 to 2009 was 2,490 mm, 2,542 mm and 2,731 mm, respectively.

(2) Temperature

Figure 2.1.1 shows the average maximum and minimum and absolute maximum and minimum temperatures in each month.

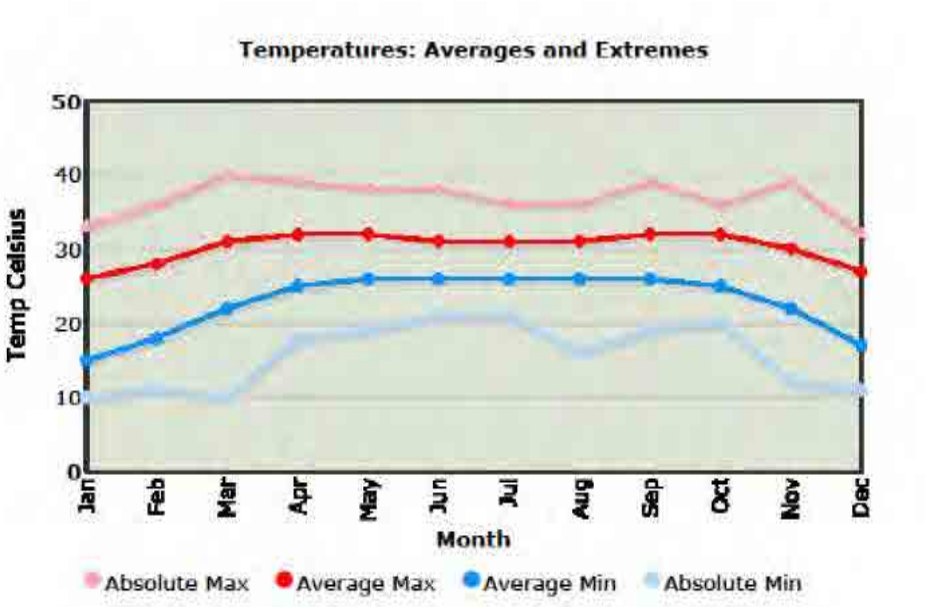



**Figure 2.1.1 Monthly Temperatures in Chittagong – Averages and Extremes**

The monthly average maximum and minimum temperatures in each month in the years from 2008 to 2010 are shown in Table 2.1.2.

**Table 2.1.2 Temperature in Chittagong (2008 to 2010)**

Unit: $^{o}$C

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2008 | Max | 25.1 | 26.0 | 29.9 | 32.2 | 32.2 | 30.7 | 29.8 | 30.1 | 30.9 | 30.7 | 29.7 | 26.7 |
| | Min | 15.2 | 15.7 | 21.9 | 24.2 | 25.1 | 24.7 | 25.2 | 25.4 | 25.3 | 24.0 | 19.6 | 17.7 |
| 2009 | Max | 25.6 | 29.0 | 31.7 | 32.0 | 32.5 | 32.1 | 30.2 | 30.6 | 31.8 | 31.2 | 29.9 | 31.2 |
| | Min | 14.9 | 16.9 | 21.6 | 25.3 | 25.0 | 25.6 | 25.5 | 25.8 | 25.4 | 24.0 | 21.1 | 15.9 |
| 2010 | Max | 26.5 | 29.0 | 31.6 | 32.0 | 32.5 | 32.0 | 30.1 | 30.6 | 31.4 | 31.2 | 29.9 | 26.2 |
| | Min | 14.9 | 16.8 | 21.5 | 25.3 | 24.9 | 25.5 | 25.4 | 25.7 | 25.4 | 24.0 | 21.0 | 15.8 |
| **Average** | **Max** | 25.7 | 28.0 | 31.1 | 32.1 | 32.4 | 31.6 | 30.0 | 30.4 | 31.4 | 31.0 | 29.8 | 28.0 |
| | **Min** | 15.0 | 16.5 | 21.7 | 24.9 | 25.0 | 25.3 | 25.4 | 25.6 | 25.4 | 24.0 | 20.6 | 16.5 |

*Source: Bangladesh Meteorological Department*

(3) Relative Humidity

The monthly average relative humidity in each month in the years from 2008 to 2010 is shown in Table 2.1.3. The maximum humidity occurred during the monsoon season.

**Table 2.1.3 Relative Humidity in Chittagong (2008 to 2010)**

Unit: %

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2008 | 76 | 65 | 78 | 68 | 74 | 82 | 87 | 87 | 82 | 79 | 74 | 79 |
| 2009 | 74 | 65 | 69 | 76 | 75 | 80 | 85 | 78 | 82 | 78 | 72 | 74 |
| 2010 | 70 | 59 | 59 | 76 | 78 | 86 | 82 | 84 | 82 | 83 | 78 | 74 |
| **Average** | 73 | 63 | 69 | 73 | 76 | 83 | 85 | 83 | 82 | 80 | 75 | 76 |

*Source: Bangladesh Meteorological Department*

### 2.1.3 Hydrology

The Karnaphuli River originates from the eastern hilly areas and empties into the Bengal Bay passing the east-south rim of Chittagong City. The river, which is one of the main rivers in the south-

east of Bangladesh, has a total length of about 58 km in main channel, originating from Kaptai Lake. The Halda River is one of the Karnaphuli River's tributaries and the confluence point between the Halda River and the Karnaphuli River is located about 17 km from the Karnaphuli River mouth. This river has a total length of about 98 km and runs from the hilly area near the national border between Bangladesh and India to north of Chittagong City. Kaptai Lake which has an area of 680 $km^2$ is located about 50 km north-east of Chittagong City and is the largest lake in the country. The lake was formed with the construction of the Kaptai Hydropower Dam in 1958, which discharges water to the Karnaphuli River.

Figure 2.1.2 shows the Karnaphuli river basin, including the Halda River and Kaptai Lake. Table 2.1.4 shows the number of days per year when the discharge from Kaptai Dam was low. In May 1995 the discharge from the dam was very low. In recent years there have been several months when the average discharge in the month or part of a month was low, for example in January 2007, December 2008, January 2009, April 2010 and May 2011 (all as shown in the table) and in April 2011, when the average discharge was 3.9 million $m^3$/d in a 20 day period.

**Table 2.1.4 Number of Days per Year with Low Discharge**

| Year | Number of Days less than 5 million $m^3$/d | Number of Days less than 10 $m^3$/s (0.864 million $m^3$/d) | Notes |
|---|---|---|---|
| 1991 | 1 | | |
| 1992 | 1 | | |
| 1993 | 3 | | |
| 1994 | 18 | | |
| 1995 | 32 | | |
| 1996 | 2 | | |
| 1997 | 10 | 5 | |
| 1998 | 4 | 0 | |
| 1999 | 3 | 0 | |
| 2000 | N/A | 0 | |
| 2001 | N/A | 0 | |
| 2002 | N/A | 1 | |
| 2003 | N/A | 0 | |
| 2004 | N/A | 0 | |
| 2005 | N/A | 0 | |
| 2006 | N/A | 0 | |
| 2007 | N/A | 2 | average in month with lowest total 2.33 million $m^3$/d (January) |
| 2008 | N/A | | average in month with lowest total 3.35 million $m^3$/d (December) |
| 2009 | N/A | | average in month with lowest total 3.05 million $m^3$/d (January) |
| 2010 | N/A | | average in month with lowest total 9.42 million $m^3$/d (April) |
| 2011 | 6 | | all days occurred in May 2011, when average in month was 15.3 million m3/d and average in 13 day period when discharge at lowest was 4.9 million $m^3$/d |

*Notes: N/A Not available*
*Source: Kaptai Dam Management Office, except for number of days with discharge less than 10 $m^3$/s (information from KOICA Master Plan for Water Supply)*

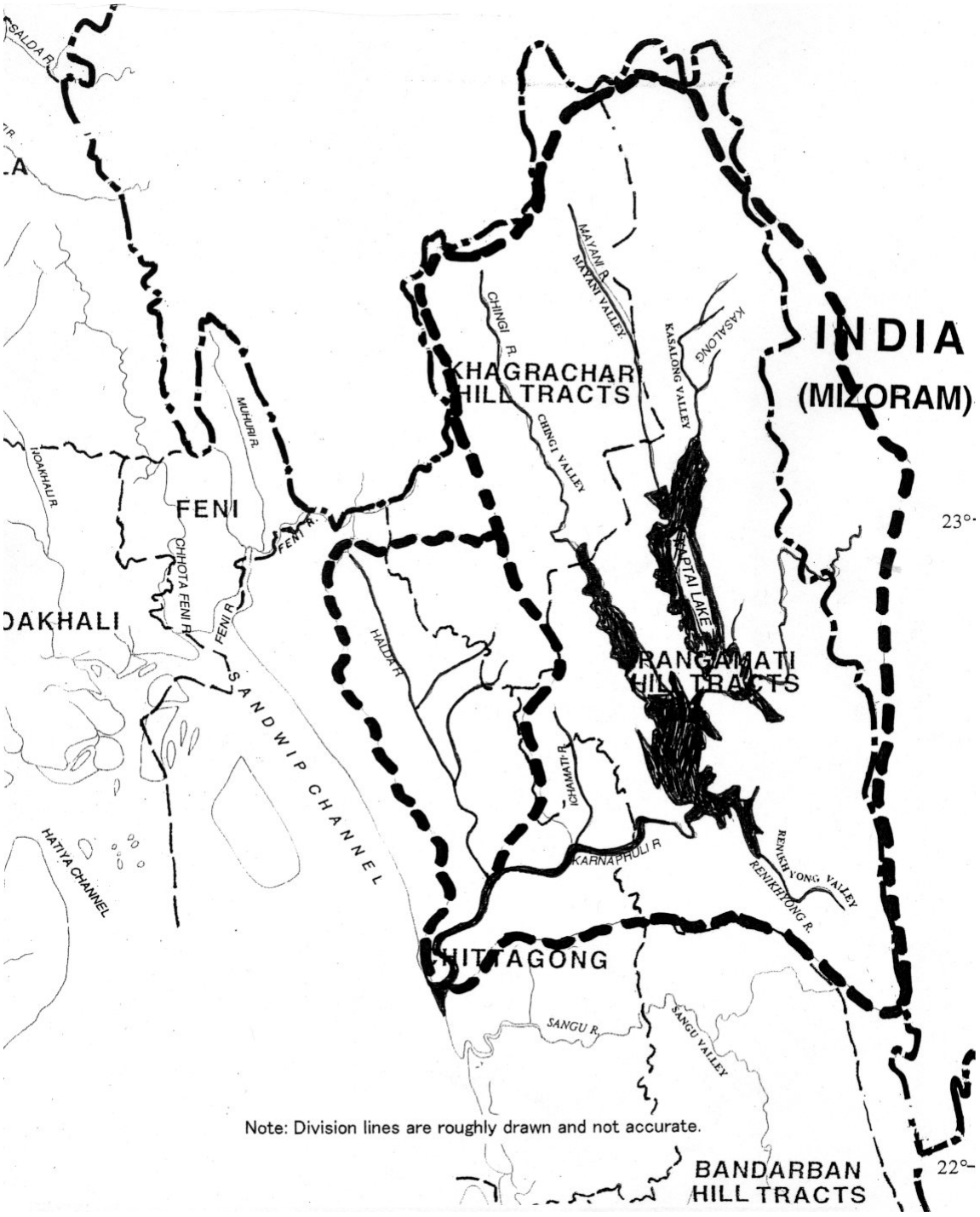



**Figure 2.1.2 General Map of Karnaphuli River Basin**

### 2.1.4 Geology

The hill formations in Chittagong comprise alternating layers of mudstones and sand formations in the Tertiary age. The thickness of both mudstones and sand formations is about 30 m, although it varies in places. The formations have an anticline structure extending from NNW to SSE with a steeper dip in the eastern wing along the eastern boundary between the hilly area and the alluvial area.

The alluvium plain consists of alternating layers of soft clay and sand. Based on the existing deep wells which are owned by CWASA, alluvial sediments have a thickness of more than 130 m.

## 2.2 Legislative Condition

### 2.2.1 Key Sector Issue

The water supply in the Bangladesh is not adequate at present in terms of quality, quantity and levels of service. The Government of the Republic of Bangladesh decided to improve water supply using surface water and reduce the use of groundwater, due to arsenic contamination and lowering of groundwater level.

The GOB established "The Sixth National Five-Year Development Plan (2011-2015)" with a special emphasis on providing a safe water supply to all people in an early stage. In the plan, the targets of service coverage for the urban and rural population in the year 2015 are established at 100% and 96.5%, respectively.

(1) National Sector Policies and Strategies

The government has adopted the following policies, which are relevant to the water supply sector:

- National Policy for Safe Water Supply and Sanitation (1998)
- National Water Policy (NWP) (1999)
- National Water Management Plan (NWMP) (2004)
- Sector Development Plan (SDP) (2011-2015)
- Partnership Framework among the Government of Bangladesh and Aisan Development Bank (ADB), DANIDA, the Government of Japan (GOJ), the Government of the Republic of Korea (ROK), and World Bank (WD)
- National Policy for Arsenic Mitigation (2004)

<u>National Policy for Safe Water Supply and Sanitation (1998)</u>

The NPSWSS states "the Government's goal is to ensure that all people have access to safe water and sanitation services at an affordable cost. The objectives of the NPSWSS are to improve the standard of public health and to ensure improved environment. For achieving these objectives, steps will be taken for:

1) facilitating access of all citizens to basic level of services in water supply and sanitation;
2) bringing about behavioural changes regarding use of water and sanitation;
3) reducing incidence of water borne diseases;
4) building capacity in local governments and communities to be effectively with problems relating to water supply and sanitation;
5) promoting sustainable water and sanitation services;
6) ensuring proper storage, management and use of surface water and preventing its contamina-

tion;
7) taking necessary measures for storage and use of rain water;
8) ensuring storm-water drainage in urban areas.

In relation to the institutional roles of WASAs outlined in the policy, the policy states:

a) Water Supply, Sewerage Authorities (WASAs) shall be responsible for sustainable water supply in the metropolitan areas where WASAs exist. In other urban areas the Paurasabhas (City Corporation) with the help of Department of Public Health Engineering (DPHE) shall be responsible for the service.
b) WASAs and the Paurasabhas shall be empowered to set tariffs, bylaws, appointment of staffs, etc. according to their needs and in accordance with the guideline laid down by the government.
c) WASAs and the Paurasabhas shall improve their operational efficiency including financial management. In the near future billing and collection targets will be 90% and 80%, respectively. Paurasabhas and WASAs will take actions to present the wastage of water. In addition they will take necessary steps to increase public awareness to prevent misuse of water. Paurasabhas will take appropriate measures to reduce unaccounted for water from 50% to 30%. Dhaka WASA and Chittagong WASA will also lower their unaccounted for water from the present level.

National Water Policy (1999)

The NWP aims to provide direction to all agencies working with the water sector, and institutions that relate to the water sector in one form or another for achievement of specified objectives, which are broadly:

1) To address issues related to the harnessing and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner
2) To ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children
3) To accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing
4) To bring institutional changes that will help decentralise the management of water resources and enhance the role of women in water management
5) To develop a legal and regulatory environment that will help the process of decentralisation, sound environmental management, and improve the investment climate for the private sector in water development and management
6) To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation.

According to Clause 4.3 of the NWP "in general, the priority for allocating water during critical periods in the water shortage zones will be in the following order: domestic and municipal uses, non-consumptive uses (e.g. navigation, fisheries and wild-life), sustenance of the river regime, and other consumptive and non-consumptive uses such as irrigation, industry, environment, salinity management, and recreation. The above order of priority could however be changed on specific socio-economic criteria of an area by local bodies through local consensus."

For economic and financial management, it is stated in Clause 4.14 of the NWP as an important principle, for the long-term, that public service agencies should be converted into financially

autonomous entities, with effective authority to charge and collect fees.

National Water Management Plan (2004)

The NWMP was approved by the National Water Resources Council (NWRC) in 2004 and aims at implementing the NWMP within 25 years. It is expected to be reviewed and updated every five years.

In 2005, the government included the improvement of water supply and sanitation as part of its agenda for reducing poverty. As of today, there is no information on the updating of the plan.

Sector Development Plan (2011-2025) - Water Supply and Sanitation in Bangladesh

The first SDP-WSSB was prepared by LGD in 2000 to provide a 10-year plan for water supply and sanitation (WSS) sector in Bangladesh. Afterwards, the next SDP for a period of 15 years from 2011 was prepared by the Policy Support Unit of LGD. The objective of the SDP is to provide a framework for planning, implementing, coordinating and monitoring all activities in the WSS sector. As a strategic planning document, it addresses the emerging and the future challenging of the WSS sector and provides a road map for the development of the sector and corresponding sector investment plan.

Partnership Framework among the Government of Bangaldesh (GOB), and Asian Development Bank (ADB), DANIDA, the Government of Japan (GOJ), the Government of the Republic of Korea (ROK), and World Bank (WB)

GOB and major development partners signed a Partnership Framework for a coordinated approach to the existing and planned development partners' support to CWASA and for agreement with GOB on common policy issues. A policy action matrix is included in the framework, focused on, (i) strengthening CWASA's governance and organizational structure, (ii) improved financial management capacity of CWASA, and (iii) improved sustainable service delivery.

National Policy for Arsenic Mitigation (2004)

Complementing the NWP, the government adopted a National Policy for Arsenic Mitigation in 2004. The policy emphasizes public awareness, alternative safe water supply, proper diagnosis and management of patients, and capacity building. In terms of alternative supplies it gives "preference to surface water over groundwater".

In addition to the above, the draft Bangladesh Water Act 2012, which was approved by the cabinet in May 2012, is expected to be placed in parliament in the near future, as of November 2012. According to an article in The Star[1] there are concerns that the Act may limit people's basic right to safe water (under the provision of Clause 16 (2) and there are provisions that may encourage businesses to invest in the distribution of water in rural areas).

(2) Legislative Requirement

Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection.

The national environmental legislation known as the Environmental Conservation Act, 1995, which is currently the main legislative document relating to environmental protection in Bangladesh and

[1] The Star, June 1, 2012 "Limiting the Right to Water"

was promulgated in 1995. In the Environment Conservation Rules, 1997, which are rules for the purposes of carrying out the above Act, standards for inland surface water and drinking are stipulated in Schedule 3, as shown in Tables 2.2.1 and 2.2.2.

**Table 2.2.1 Standard for Inland Surface Water**

| Best Practice based classification | pH | BOD mg/L | DO mg/L | Total Coliform number/100 |
|---|---|---|---|---|
| a. Source of drinking water for supply only after disinfecting | 6.5-8.5 | 2 or less | 6 or above | 50 or less |
| b. Water usable for recreational activity | 6.5–8.5 | 3 or less | 5 or more | 200 or less |
| c. Source of drinking water for supply after conventional treatment | 6.5–8.5 | 6 or less | 6 or more | 5000 or less |
| d. Water usable by fisheries | 6.5–8.5 | 6 or less | 5 or more | --- |
| e. Water usable by various process and cooling industries | 6.5–8.5 | 10 or less | 5 or more | 5000 or less |
| f. Water usable for irrigation | 6.5–8.5 | 10 or less | 5 or more | 1000 or less |

*Notes: 1. In water used for pisiculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.*
*2. Electrical conductivity for irrigation water - 2250 μS/cm (at 25°C); Sodium less than 26%; boron less than 0.2%.*
*Source: Environment Conservation Rules, 1997*

**Table 2.2.2 Standard for Drinking Water**

| Parameter | Unit | Standards | Parameter | Unit | Standards |
|---|---|---|---|---|---|
| 1. Aluminum | mg/L | 0.2 | 26. Hardness (as $CaCO_3$) | mg/L | 200 – 500 |
| 2. Ammonia ($NH_3$) | mg/L | 0.5 | 27. Iron | mg/L | 0.3 – 1.0 |
| 3. Arsenic | mg/L | 0.05 | 28. Kjeldhl Nitrogen (total) | mg/L | 1 |
| 4. Balium | mg/L | 0.01 | 29. Lead | mg/L | 0.05 |
| 5. Benzene | mg/L | 0.01 | 30. Magnesium | mg/L | 30 – 35 |
| 6. $BOD_5$ 20°C | mg/L | 0.2 | 31. Manganese | mg/L | 0.1 |
| 7. Boron | mg/L | 1.0 | 32. Mercury | mg/L | 0.001 |
| 8. Cadmium | mg/L | 0.005 | 31. Manganese | mg/L | 0.1 |
| 9. Calcium | mg/L | 75 | 32. Mercury | mg/L | 0.001 |
| 10. Chloride | mg/L | 150 – 600* | 33. Nickel | mg/L | 0.1 |
| 11. Chlorinated alkanes | | | 34. Nitrate | mg/L | 10 |
| carbontetrachloride | mg/L | 0.01 | 35. Nitrite | mg/L | <1 |
| 1.1 dichloroethylene | mg/L | 0.001 | 36. Odor | mg/L | Odorless |
| 1.2 dichloroethylene | mg/L | 0.03 | 37. Oil and grease | mg/L | 0.01 |
| tetrachloroethylene | mg/L | 0.03 | 38. pH | -- | 6.5 – 8.5 |
| trichloroethylene | mg/L | 0.09 | 39. Phenolic compounds | mg/L | 0.002 |
| 12. Chlorinated phenols | | | 40. Phosphate | | 6 |
| pentachlorophenol | mg/L | 0.03 | 41. Phosphorus | mg/L | 0 |
| 2.4.6 trichlorophenol | mg/L | 0.03 | 42. Potassium | mg/L | 12 |
| 13. Chlorine (residual) | mg/L | 0.2 | 43. Radioactive materials (gross alpha activity) | Bq/L | 0.01 |
| 14. Chloroform | mg/L | 0.09 | 44. Radioactive materials (gross beta activity) | Bq/L | 0.1 |
| 15.Chromium (hexavalent) | mg/L | 0.05 | 45. Selenium | mg/L | 0.01 |
| 16. Chromium (total) | mg/L | 0.05 | 46. Silver | mg/L | 0.02 |
| 17. COD | mg/L | 4.0 | 47. Sodium | mg/L | 200 |
| 18. Coliform (faecal) | n/100mL | 0 | 48. Suspended particulate matters | mg/L | 10 |
| 19. Coliform (total) | n/100 mL | 0 | 49. Sulfide | mg/L | 0 |
| 20. Color | Hazen unit | 15 | 50. Sulfate | mg/L | 400 |
| 21. Copper | mg/L | 1 | 51. Total dissolved solids | mg/L | 1000 |
| 22. Cyanide | mg/L | 0.1 | 52. Temperature | °C | 20-30 |
| 23. Detergents | mg/L | 0.2 | 53. Tin | mg/L | 2 |
| 24. DO | mg/L | 6 | 54. Turbidity | JTU | 10 |
| 25. Fluoride | mg/L | 1 | 55. Zinc | mg/L | 5 |

*Source: Environment Conservation Rules, 1997*

(3) Environmental Requirement

In Bangladesh, the following Policy, Acts and Rules cover and facilitate all the activities regarding environment conservation mainly.

1) Environmental Policy, 1992
2) The Bangladesh Environment Conservation Act, 1995
3) Environment Conservation Rules, 1997

### 2.2.2 Water Resource for Water Supply System

The management of water resources has become a critical need in Bangladesh because of the growing demand for water and increasing conflict over its alternative uses. In Bangladesh water had been considered as a free gift of nature and access to water is recognised as a basic right. However procedural and fiscal measures are enforced to regulate its mobilisation and use. The Government of Bangladesh has formulated a National Water Policy. In accordance with Clause 4.3 of the NWP, "the ownership of water does not vest in an individual but in the State."

Furthermore "The Government reserves the right to allocate water to ensure equitable distribution, efficient development and use, and to address poverty. The Government can redirect its use during periods of droughts, floods, cyclones, and other natural and man-made disasters, such as contamination of groundwater aquifers that threaten public health and the ecological integrity. Allocation rules will be the formal mechanism for deciding who gets water, for what purpose(s), how much, at what time, for how long, and under what circumstances water use may be curtailed. Rules for water allocation will be developed for in-stream needs (ecological, water quality, salinity control, fisheries and navigation) during low flow periods; for off-stream withdrawal (irrigation, municipal and industrial, power), and for groundwater recharge and abstraction. Allocation for non-consumptive use (e.g. navigation) would imply ensuring minimum levels in water bodies used for that purpose."

### 2.2.3 Environmental and Social Considerations

(1) Statute Framework on Environment and Social Aspects

1) Relevant Policy, Strategy and Action Plan

Table 2.2.3 summarize relevant statutes including policy, Strategy and Action Plan on environmental and social aspects in Bangladesh.

**Table 2.2.3 Relevant Policy, Strategy and Action Plan**

| Title | Year | Outline |
|---|---|---|
| National Environmental Policy (NEP) | 1992 | NEP was drawn up in1992 based on the IUCN concept of sustainable development, which was an outcome of the National Conservation Strategy. The objectives of NEP are to:<br>・ Maintain ecological balance and overall development through protection and improvement of the environment<br>・ Protect the country against natural disasters<br>・ Identify and regulate activities which pollute and degrade the environment<br>・ Ensure development that is environmentally sound for all sectors<br>・ Ensure sustainable, long-term, and environmentally sound use of all national resources<br>・ Actively remain associated with all international environmental initiatives to the maximum possible extent.<br>For the water resources, the most relevant Policy clauses for FCD/I EAs are:<br>・ ensure environmentally sound utilization of all water resources.<br>・ ensure that water development activities and irrigation networks do not create adverse environmental impact. |

| Title | Year | Outline |
|---|---|---|
| | | • ensure that all steps taken for flood control be environmentally sound at the local, zonal and national levels.<br>• ensure mitigation measures of adverse environmental impact of completed FCD/I projects<br>• keep the rivers, canals, ponds, lakes, *haors*, and all other water bodies and water resources free from pollution.<br>• ensure sustainable management of underground and surface water resources.<br>• conduct EA before undertaking projects for water resources development and management.<br>The Policy was supported by the 1992 NCS and following widespread and lengthy public consultations, by a recommended implementation strategy as part of the 1995 NEMAP. |
| National Forest Policy (NFP) | 1994 | NFP of 1994 is the amended and revised version of the NFP of 1977 in the light of the National Forestry Master Plan. The major target of the policy is to conserve the existing forest areas and bring about 20% of the country's land area under the forestation Program and increase the reserve forest land by 10% by the year 2015 through coordinated efforts of GO-Non Governmental Organisations (NGOs) and active participation of the people. Amendments of the existing laws (acts, rules and regulations) relating to the forestry sector and creation of new laws for sectoral activities have been recognized as important conditions for achieving the policy goals and objectives. The Forestry Policy also recognizes the importance of fulfilling the responsibilities and commitments under International Conventions, Treaties and Protocols. |
| National Water Policy (NWPo) | 1999 | NWPo of 1999 forms a comprehensive framework for ensuring activities in the water resources sector are fully environment friendly. Its many environmental concerns and specific demands recognize that most of the country's environmental resources are linked to water. Compliance with the Policy will ensure that the development and management of the nation's water resources include protection, restoration, preservation of natural habitats and their dependent bio-diversity, and water quality -with specific provisions for wetlands, mangrove and other forests, and endangered species. NWPo, also prescribes water resource management practices that avoid, or at least minimize environmental degradation. Specific provisions include;<br>• Protection, restoration and enhancement of the water resources<br>• Protection of water quality, including strengthening of the regulations concerning agrochemicals<br>• and industrial effluent monitoring<br>• Facilitation of potable water and sanitation provision<br>• Provisions for fish and fisheries<br>• Participation of local communities is a requirement for all water sector development as a subject to an environmental assessment procedure and for the planning and management process.<br><br>NWPo, however, fails to address issues like consequences of trans-boundary water disputes and watershed management. |
| National Fisheries Policy | 1999 | National Fisheries Policy 1999, highlights the need to conserve fish breeding grounds and habitats, especially in the development of water management infrastructure such as FCD/I projects. It clearly points to a determination to prevent further drainage of standing water bodies for agricultural development, and to promote fisheries development in all water bodies. Beyond conservation, the policy emphasizes the need to expand fisheries areas and integrate rice, fish and shrimp cultivation. The policy proposes banning discharges of industrial waste, agro-chemicals and fish-farm chemicals into water bodies. Measures should be introduced to support shrimp culture, with co-ordination through national, divisional, district and than a level committees. Shrimp and fish culture should not be expanded into areas which damage coastal mangrove forests. Implicit in the Policy is the need to conserve fish migration routes which, in turn, implies the need to assess off-site impacts of interventions in the water resources sector. |
| National Policy for Safe Water Supply & Sanitation | 1998 | The objectives of the "National Policy for Safe Water Supply and Sanitation" are to improve the standard of public health and to ensure improved environment. For achieving these objectives, steps will be taken for:<br>• Facilitating access of all citizens to basic level of services in water supply and sanitation<br>• Bringing about behavioral changes regarding use of water and sanitation<br>• Reducing incidence of water borne diseases<br>• building capacity in local Governments and communities to deal more effectively with problems relating to water supply and sanitation<br>• promoting sustainable water and sanitation services<br>• ensuring proper storage, management and use of surface water and preventing its contamination<br>• taking necessary measures for storage and use of rain water<br>• ensuring storm-water drainage in urban areas |
| National Conservation Strategy (NCS) | 1993 | Bangladesh's endorsement of the World Conservation Strategy in 1980 was followed by its initiatives for developing a National Conservation Strategy. IUCN Bangladesh Country Office had been an active party to the process all through, which culminated in the preparation and subsequent submission of a draft NCS document with the Cabinet of in 1993. After about one decade of the submis- |

| Title | Year | Outline |
|---|---|---|
| | | sion, the IUCN office successfully updated the Draft NCS document and forwarded to the Government for review and approval of the draft. The draft was approved in1993 and it is now to be presented in the National Level Workshop. The Final NCS Document will be modified in the light of feedback and comments to be received from the participants in the workshop. |
| National Environmental Management Action Plan (NEMAP) | 1995 | NEMAP, 1995, based on a nationwide consultation programme, was intended to develop the Environmental Policy and the National Conservation Strategy into an implementable strategy. NEMAP has the broad objectives of:<br>・ Identification of key environmental issues affecting Bangladesh;<br>・ Identification of actions necessary to halt or reduce the rate of environmental degradation;<br>・ Improvement of the natural and built environment;<br>・ Conservation of habitats and biodiversity;<br>・ Promotion of sustainable development; and<br>・ Improvement in the quality of life of the people.<br>In addition, it identified the main national environmental issues, including those related to the water sector which EA (Environmental Assessment) practitioners should note. The main national concerns included flood damage, riverbank erosion, environmental degradation of water bodies, increased water pollution, shortage of irrigation water and drainage congestion; various specific regional concerns were also identified. A surprising omission, however, was specific mention of fisheries issues, but these may have been perceived as 'fish' rather than a 'water resources' concern. Arsenic contamination of groundwater used for potable water supply did not appear as an issue, as the threat had not then been identified. |
| Flood Action Plan (FAP) | 1990 | FAP an initiative to study the causes and nature of flood in Bangladesh and to prepare guidelines for controlling it. FAP included 29 different components of which 11 were regional, with some pilot projects, and the rest were supporting studies on issues like Environment, Fisheries, Geographic Information System, Socio-economic studies, Topographic Mapping, River Survey, Flood Modeling, Flood Proofing, Flood Response, etc. The aim of FAP is to set the foundation of a long-term programme for achieving a permanent and comprehensive solution to the flood problem. |

*Note: IUCN; International Union for Conservation of Nature and Natural Resources, FCD/I; Flood Control Drainage and Irrigation, EA; Environmental Assessment, NEMAP; National Environmental Management Action Plan, NCS; National Conservation Strategy*

*Source: JICA Study Team*

2) Relevant Acts, Ordinance Rules

Table 2.2.4 summarizes relevant Acts, Ordinances and Rules on environmental and social aspects in Bangladesh.

**Table 2.2.4 Relevant Act, Ordinance Rules**

| Title | Year | Outline |
|---|---|---|
| Bangladesh Forest Act | 1927 | The Act of 1927 provides for reserving forests over which the government has an acquired property right. This act has made many types of unauthorized uses or destruction of forest produce punishable. The Government may assign any village community its right to or over any land, which has constituted a reserved forest. |
| The Private Forest Ordinance | 1959 | The Private Forest Ordinance of 1959 provides for the conservation of private forests and for the forestation, in certain cases, of wastelands in Bangladesh. |
| East Bengal Protection and Fish Conservation Act | 1950 | The East-Bengal Protection and Fish Conservation Act of 1950, as amended by the Protection and Conservation of Fish (Amendment) Ordinance of 1982 and the Protection and Conservation of Fish (Amendment) Act of 1995, provides provisions for the protection and conservation of fish in inland waters of Bangladesh. This is relatively unspecific and simply provides a means by which the Government may introduce rules to protect those inland waters not in private ownership. This is framework legislation with rule making powers. Among others, some of these rules may: Prohibit the destruction of, or any attempt to destroy, fish by the poisoning of water or the depletion of fisheries by pollution, by trade effluent or otherwise. |
| The Embankment and Drainage Act | 1952 | An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water |
| Antiquities Act | 1968 | Antiquity act (ACT No. XIV of 1968) was set by the Government in 1968 to the preservation and protection of antiquities in the country |
| Bangladesh Wild- | 1973 | The Bangladesh Wildlife (Preservation) Act of 1973 provides for the preservation, conservation and |

| Title | Year | Outline |
|---|---|---|
| life Act | | management of wildlife in Bangladesh. The earlier laws on wildlife preservation, namely, the Elephant Preservation Act 1879, the Wild Bird and Animals Protection Act 1912, and the Rhinoceros Preservation Act 1932 have been repealed and their provisions have been suitably incorporated in this law. This Act encompasses a range of different activities including hunting and fishing although the provisions of greatest significance relate to the establishment of National Parks, Wildlife Sanctuaries and Game Reserves by MoEF. Such designations have enormous significance for the types of developments that may take place. An executive order issued in June 1998, in relation to the Bangladesh Wildlife Preservation Order of 1973 has imposed a ban for the next five years on hunting of any form of wildlife. |
| Protection and Conservation of Fish Rules | 1985 | These are a set of rules in line with the overall objectives of the Fish Act. Section 5 of the Rules requires that "No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". Section 6 of the Rules states -"No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters". |
| Environmental Conservation Act (ECA 1995) Amended in 2000 & 2002 as well as by a gazette notification in 2009 | 1995 | ECA 1995, the principal legislation for environment protection in Bangladesh, is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. A key provision in the Act is that No industrial unit or project shall be established or undertaken without obtaining an ECC from the DG of DoE in the manner prescribed by the Environmental Rules<br>The main strategies of the Act can be summarized as:<br>・ Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas<br>・ Regulations in respect of vehicles emitting smoke harmful for the environment<br>・ Environmental clearance<br>・ Regulation of the industries and other development activities' discharge permits<br>・ Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes<br>・ Promulgation of a standard limit for discharging and emitting waste; and<br>・ Formulation and declaration of environmental guidelines.<br>The following shows amendments of the Act<br>・ The amendment in 2000 of ECA focuses on: (1) ascertaining responsibility for Compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.<br>・ The amendment in 2002 of ECA elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.<br>・ The amendment in 2010<br>In addition, through a gazette notification date September 1, 2009, the High Court declared the 4 rivers surrounding Dhaka, namely Buriganga, Turag, Balu and Shitolakhkhya, as Ecologically Critical Areas, citing the ECA 1995, Section 5 (Declaration of ecologically critical area). Subsequently pollution creating activities that are detrimental to the water and aquatic life in those rivers has been declared forbidden. |
| Environmental Conservation Rules | 1997 | Promulgated under ECA of 1995, the Environment Conservation Rules of 1997 provides categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects. The rules set ;<br>1) National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc.<br>2) Requirements for and procedures to obtain environmental clearance<br>3) Requirements for IEE /EIA's according to categories of industrial and other development interventions |
| Urban open-fields, Garden and Natural Water-bodies Protection Act | 2000 | Those sites throughout urban areas should preserve their individual characters and should not be leased out or transferred to any other authority. Any encroachment to these areas will be strictly controlled. |
| Environmental Court Act | 2000 | By this act the Government shall establish one or more environment court in each Division and each environment court shall be constituted with one judge and, in consultation with the Supreme Court; the Government shall appoint an officer of the judicial service of the rank of Joint District Judge. An Environment Court shall be competent to impose penalty for offences under section 5A of this Act and under any other environmental law, to confiscate an equipment or part thereof, a transport used in the commission of such offence or an article or other thing involved with the offence, and to pass order or decree for compensation in appropriate cases. |

*Note: MoEF; Ministry of Environment and Forest*

3) Multilateral Environmental Agreements in force in Bangladesh

Relevant international treaties, conventions and so on to which Bangladesh is a party are summarized in Table 2.2.5.

**Table 2.2.5 International Conventions, Protocols and Treaties on Environment**

| No. | Title | Signed | Ratified/Accessed/ Accepted/Adaptation | Being Ratified |
|---|---|---|---|---|
| 1. | International Plant Protection Convention (Rome, 1951) | | 1978 | |
| 2. | International Convention for the Prevention of Pollution of the Sea by Oil (London, 1954 (amended in 1962 and 1969.) | | 1981 (entry into force) | |
| 3. | Plant Protection Agreement for the South East Asia and Pacific Region (as amended) (Rome, 1956) | | 1974 (AC) (entry into force) | |
| 4. | Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water (Moscow, 1963) | 1985 | | |
| 5. | Treaty on Principles governing the Activities of States in the Exploration and use of outer Space Including the Moon and Other Celestial Bodies (London, Moscow, Washington, 1967) | | 1986 (AC) | |
| 6. | International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels, 1969) | | 1982 (entry into force) | |
| 7. | Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) ("Ramsar Convention") | | 1992 (ratified) | |
| 8. | Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxic Weapons, and on their Destruction (London, Moscow, Washington, 1972.) | | 1985 | |
| 9. | Convention Concerning the Protection of the World Cultural and natural Heritage (Paris, 1972) | | 1983 (Accepted), (ratified) | |
| 10. | Convention on International Trade in Endangered Species of Wild Fauna and flora (Washington, 1973) ("CITES Convention") | 1981 | 1982 | |
| 11. | United Nations Convention on the Law of the Sea (Montego Bay, 1982) | | 1982 | |
| 12. | Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985) | | 1990 (AC), (entry into force) | |
| 13. | Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal 1987) | | 1990 (AC), (entry into force) | |
| 13a. | London Amendment to the Montreal Protocol on substances that Deplete the Ozone Layer (London, 1990) | | 1994 (AC), (entry into force) | |
| 13b. | Copenhagen Amendment to the Montreal protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992 | | 2000 (AT), 2001 (Entry into force) | |
| 13c. | Montreal Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1997 | | 2001 (Accepted), (Entry into force) | |
| 14. | Convention on Early Notification of a Nuclear Accident (Vienna, 1986) | | 1988(entry into force) | |
| 15. | Convention on Assistance in Case of a Nuclear Accident of Radiological Emergency (Vienna, 1986) | | 1988(ratified &entry into force) | |
| 16. | Agreement on the Network of Aquaculture Centres in Asia and the Pacific (Bangkok, 1988) | | 1990(ratified) | |
| 17. | Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel, 1989) | | 1993 (AC) | |
| 18. | International Convention on Oil Pollution Preparedness, Response and Cooperation (London,1990) | 1990 | | * |
| 19. | United Nations Framework Convention on Climate Change, (New York, 1992) | 1992 | 1994 | |
| 20. | Convention on Biological Diversity, (Rio De Janeiro,1992) | 1992 | 1994 | |
| 21. | International Convention to Combat Desertification, (Paris 1994) | 1994 | 1996(ratified &entry into force) | |
| 22. | Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, (Geneva, 1976) | | 1979 (AC) (entry into force) | |
| 23. | Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (New York, 1994) | 1996 | | |

| No. | Title | Signed | Ratified/Accessed/ Accepted/Adaptation | Being Ratified |
|---|---|---|---|---|
| 24. | Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (New York, 1995) | 1995 | | |
| 25. | Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Paris, 1993) | 1993 | | |
| 26. | United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Paris, 1994) | 1994 | 1996 | |
| 27. | Convention on Nuclear Safety (Vienna, 1994) | 1995 | 1995 (AT) | |
| 28. | Cartagena protocol on Biosafety to the Convention on Biological Diversity | 2000 | 2004 (AC) | |
| 29. | Convention on persistent Organic Pollutants, Stockholm | 2001 | 2007 (AC) | |
| 30. | Kyoto protocol to the United Nations Framework Convention on Climate Change | | 2001 (AC), 1997 (AD) | |

*Note: AC: Accession/Accessed, AD: Adaptation/Adapted, AT: Accepted, *; In the process of ratification*
*Source: DoE*

(2) Environmental Conservation Rules 1997 and Environmental Clearance System

As specified in Clause 7 of the Environmental Conservation Rules 1997, all new industries and projects must apply for a Site Clearance Certificate (SCC) and/or an Environmental Clearance Certificate (ECC). For the purpose of the issuance of ECC, the industries and projects are classified according to their sites and potential impact on the environment into the four (4) categories as shown in Table 2.2.6. Details can be found in the Rules, especially, Schedule 1 attached in the Rules provides the Category classification of most common industries, in which "Water Distribution Line (Laying /Relaying/Extension) and "Water Treatment Plant" projects are classified as "Red" Category.

**Table 2.2.6 Four Categories of Industries and Issuance of SCC and/or ECC**

| Category | Issuing of SCC and/or ECC | Time Period from receipt of application | |
|---|---|---|---|
| | | SCC | ECC |
| 1. Green | An ECC shall be issued to all existing and proposed industrial units and projects | - | ~ 3 w. days |
| 2. Amber-A | For industrial units and projects firstly a SCC and thereafter an ECC shall be issued | ~ 15 w. days | ~ 7 w. days |
| 3. Amber -B | For industrial units and projects firstly a SCC and thereafter an ECC shall be issued | ~ 30 w. days | ~ 15 w. days |
| 4. Red | For industrial units and projects firstly a SCC and thereafter an ECC shall be issued | ~ 30 w. days | ~ 30 w. days |

*Note: SCC; Site Clearance Certificate, ECC; Environmental Clearance Certificate, ~ ; within, w. days; wording days*
*Source; Environmental Conservation Rules 1997, MoEF, SRO No, 118-Law/2008, Environmental Conservation Law, 1995, 2008, MoEF,*

Provided that the Director General (DG) of DoE may, without issuing a SCC at the first instance, directly issue ECC if he, on the application of an industrial unit or project, considers it appropriate to issue such certificate to the industrial unit or project.

1) Application for SCC and/or ECC

The entrepreneur of the concerned industrial unit or project shall apply to the concerned Divisional Officer of DoE using Form-3 of the ECR, along with appropriate fees as specified in Schedule-13. The necessary documents to be attached with an application for SCC and/or ECC by the each category are summarized in Table 2.2.7.

**Table 2.2.7 Necessary Documents Applied for ECC by Category**

| Category | Necessary Documents |
|---|---|
| 1. Green | i. General information about the industrial unit or project<br>ii. Exact description of the raw materials and the manufactured product an<br>iii. NOC from the local authority |
| 2. Amber -A | i. General information about the industrial unit or project<br>ii. Exact description of the raw materials and the manufactured product<br>iii. NOC from the local authority<br>iv. Process flow diagram<br>v. Layout Plan (showing location of ETP)<br>vi. Effluent discharge arrangement<br>vii. Outlines of the plan for relocation, rehabilitation (if applicable);<br>viii. Other necessary information (if applicable) |
| 3. Amber- B | i. F/S report of the industrial unit or project (applicable only for proposed industrial unit or project)<br>ii. (ii) IEE Report of the industrial unit or project, and also the process flow diagram, Layout Plan (showing location of Effluent Treatment Plant), design of ETP of the unit or project (these are applicable only for a proposed industrial unit or project)<br>iii. EMP report for the industrial unit or project, and also the Process Flow Diagram, Layout Plan (showing location of Effluent Treatment Plant), design of ETP and information about the effectiveness of the ETP of the unit or project, (these are applicable only for an existing industrial unit or project)<br>iv. NOC from the local authority;<br>v. Emergency plan relating adverse environmental impact and plan for mitigation of the effect of pollution<br>vi. Outline of the relocation, rehabilitation plan (where applicable)<br>vii. Other necessary information (where applicable) |
| 4. Red | i. F/S report of the industrial unit or project (applicable only for proposed industrial unit or project)<br>ii. IEE report relating to the industrial unit or project, and also the TOR for the EIA of the unit or the project and its Process Flow Diagram<br>or<br>EIA report prepared on the basis of TOR previously approved by the Department of Environment, along with the Layout Plan (showing location of ETP), Process Flow Diagram, design and time schedule of the Effluent Treatment Plant of the unit or project, (these are applicable only for a proposed industrial unit or project)<br>iii. EMP Report for the industrial unit or project, and also the Process Flow Diagram, Layout Plan (showing location of ETP), design and information about the effectiveness of ETP of the unit or project (these are applicable only for an existing industrial unit or project)<br>iv. NOC from the local authority<br>v. Emergency plan relating adverse environmental impact and plan for mitigation of the effect of pollution;<br>vi. Outline of relocation, rehabilitation plan (where applicable)<br>vii. Other necessary information (where applicable) |

*Note: NOC; No Objection Certificate, ETP; Effluent Treatment Plant, F/S; Feasibility Study, IEE; Initial Environmental Examination, TOR; Terms of Reference, EIA; Environmental Impact Assessment, EMP; Environmental Management Plan*

*Source: Environmental Conservation Rules 1997, MoEF*

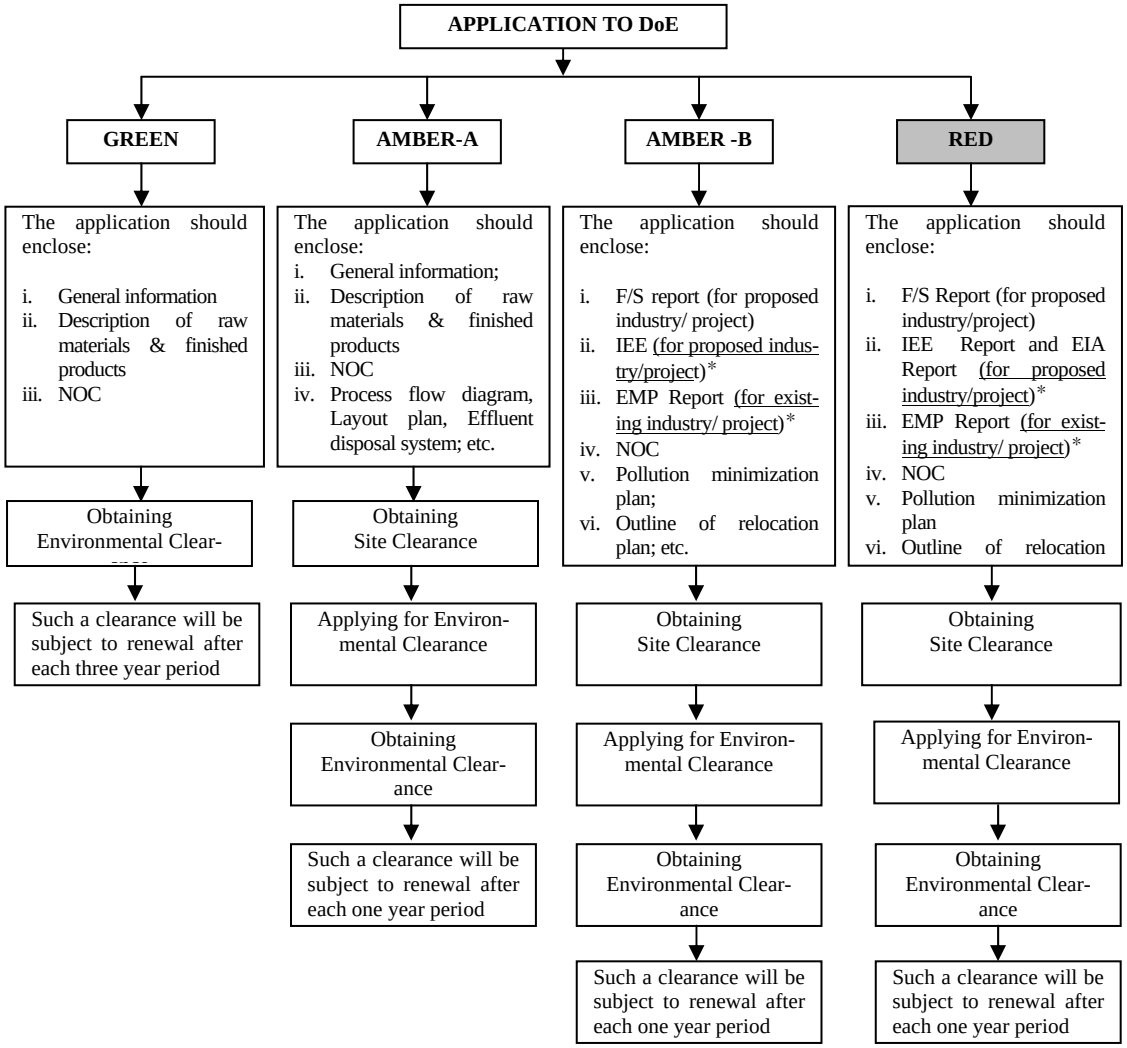
2) Actions may/shall be taken by Applicant after Issuing of SCC

Upon receiving a Site Clearance Certificate (SCC) from DoE, the entrepreneur (applicant):

a) may undertake activities for land and infrastructure developments
b) may install machinery including an Effluent Treatment Plant (ETP) (applicable for industrial units or projects of Amber-A and Amber-B Category only)
c) shall apply for an ECC upon completion of the activities specified in a. and b. above, and without the ECC shall not have gas line connection, and shall not start trial production in the industrial unit, and in other cases shall not operate the project (applicable for Amber-A and Amber-B Category industrial units or projects only)
d) shall submit, for approval of the Department, the EIA report prepared on the basis of program outlined in the IEE Report along with time schedule and the ETP design (applicable only for Red Category industrial units or projects)

3) Flow Chart of Environmental Clearance Procedure

Figure 2.2.1 shows the flow chart of the environmental clearance procedures for industrial projects.




*NOC ; No Objection Certificate, usually obtained from local government, F/S; Feasibility Study, IEE; Initial Environmental Examination, TOR; Terms of Reference, EIA; Environmental Impact Assessment, EMP; Environmental Management Plan,*
** ; See 3) Environmental Assessment Process in WARPO Guidelines*
*Source; EIA Guidelines for Industry 1997, DoE, MoEF*

**Figure 2.2.1 Flowchart of Environmental Clearance Procedure**

4) Validity period of ECC

Table 2.2.8 shows the period of validity of an ECC and its renewal period.

**Table 2.2.8 Validity Period of ECC**

| Category | Validity period from ECC issuance Date | Renewal Period (days before expiry of its validity period) |
|---|---|---|
| 1. Green | Three (3) years | at least thirty (30) days |
| 2. Amber-A | One (1) year | at least thirty (30) days |
| 3. Amber -B | One (1) year | at least thirty (30) days |
| 4. Red | One (1) year | at least thirty (30) days |

*Source; Environmental Conservation Rules 1997, MoEF*

(3) Environmental Assessment Procedures in Bangladesh

The Environmental Assessment (EA) system and its procedures are dealt with in the framework of the Environmental Clearance system mentioned in (2) above.

1) Guidelines

Relevant official entities including DoE and local bodies have published a set of environmental guidelines and manuals for conducting environmental assessment and management of different types of projects including water supply and management as shown in Table 2.2.9.

**Table 2.2.9 Environmental Guidelines on Environmental Assessment & Management**

| Title | Year | Outline |
|---|---|---|
| Guidelines for Environmental Assessment of Small-scale Projects | 1994 | The purpose of this guideline is to enable the local level engineers (Thana Engineers) and other technical staff to better appreciate the environmental issues related to small-scale (less than 1000 ha benefited area) selected infrastructure development and equip them to carry out environmental impact assessment and incorporate the environmental protection parameters in the project preparation process. The guidelines are planned to enable the Thana Engineers to analyse the adverse environmental consequences of projects and adopt appropriate measures to eliminate, reduce to acceptable levels or offset such adverse consequences through proper planning and design and thus to optimize overall socio-economic benefits. The ultimate purpose of the guidelines is to strengthen and guide the initiatives of LGED to ensure planned development of physical infrastructure facilities taking environmental and social dimensions into consideration at the local level. The guidelines constitute simple procedures and formats to guide Initial IEE and EIA of proposed projects and draw up plans for environmental management. The guidelines may also be used to conduct IEE and EIA of ongoing and implemented projects to identify potential negative impacts and to design environmental protection measures and appropriate monitoring programmes. |
| Guidelines for Project Assessment (GPA) | 1994 | Developed by FPCO in 1994, GPA aims to ensure that all project components are assessed in a similar manner and to permit MCA techniques to be used when comparing proposed project or component alternatives. |
| Manual on EIA for large-scale projects | 1995 | Under FAP, a manual on EIA was prepared in 1995 (ISPAN, 1995) so that all FAP regional plans and projects are subject to a comprehensive and uniform EIA. The goal of all environmental assessments is to protect the environment by ensuring that only environmentally sound projects are designed and implemented. In EIA, positive and negative impacts are identified and either project designs are altered or mitigation measures are developed to lessen or alleviate negative ones. Public participation is central to the process and should take place at all stages of an EIA. The EIA involves an integrated assessment of the impacts of a project or plan on both natural and human environments. It focuses on linkages among the physical-chemical, biological, social and economic components of the environment. |
| EIA Guidelines for Industries | 1997 | The Guidelines sets out the procedures for environmental clearance of projects by DoE, as required by the Environmental Conservation Rules (DoE, 1997). Although intended primarily for the industrial sector, the procedures also apply to FCD/I projects. Namely, the guidelines covers significant water sector interventions, including flood control embankments, polders, dykes, water supply and sewage treatment, as well as roads and bridges. All these water sector interventions fall under the 'Red' category, with the exception of bridges less than 100 m long, and feeder and local roads. This requires the most stringent EIA process to be followed for proposed project construction, re-construction and extension. The responsibility for following the envi- |

| Title | Year | Outline |
|---|---|---|
| | | ronmental assessment procedure lies with the project proponent or developer. The procedures are different, depending upon the categorization of the proposed intervention. The two most stringent classes, Orange/Amber B and Red, are required to have an IEE, with an EMP. The red classification requires an additional full EIA to be undertaken. Once DoE approves these documents, then a SCC is issued - provided the developer has obtained an NOC from the local authority. |
| EIA Guidelines for the Water Resources Sector | 1992 | The environmental component of the FAP-16, drew up a set of EIA Guidelines, which were approved by the MoEF and DoE for use in the water resources sector; and they were adopted by FPCO and WARPO in 1992. In addition to the water resources EIA Guidelines, FAP 16 drafted a manual in 1995 for carrying out EIA. The manual was intended to assist people not familiar with EIA work, and to give more detail on the use of the Guidelines for a wide range of water sector projects. Under SEMP, the DoE has recently started drafting 18 sets of sectorial EIA Guidelines. In 2003, WARPO in collaboration with DoE modified the guidelines as "Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects (as shown in the following column) |
| Guidelines for People's Participation in Water Management (GPP) | 2000 | GPP was finalized jointly by the Ministry of Water Resources (MOWR) and the Ministry of Local Government Division (LGD) also provide insight into people's participation in small scale water resources development projects (GPP, 2000) . |
| Guidelines on Participatory Water Management | 2001 | The guidelines were prepared by Bangladesh Water Development Board (BWDB) of LGED in 2001 which sets out the procedures for people's participation. |
| Guidelines for Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) Projects | 2003 | These Guidelines for Environmental Assessment are an update of the "EIA Guidelines for the Water Resources Sector" for assessment of FAP projects by FPCO in 1992 under the FAP 16 activities. The "Guidelines for Environmental Assessment of Water Management Projects (FCD/I)" was prepared on December, 2001 and approved by MoEF in 2003. The Guidelines cover EA - a process that covers two key activities of IEE and EIA at the planning level. All agencies involved in the planning, implementation, operation and maintenance and monitoring of FCD/I projects should use these Guidelines to assist in drawing up a TOR for environmental studies, in monitoring the studies and in evaluating the resulting EA reports. |
| Sectorial Guidelines for Environmental Management | | These guidelines covering 18 sectors which have potentially great impacts on the environment (DoE, under the Sustainable Environmental Management Programme (SEMP), in preparation |

*Note: LGED; Local Government Engineering Department, EA; Environmental Assessment, EIA; Environmental Impact Assessment, IEE; Initial Environmental Examination, EMP; Environmental Management Plan, FCD/I; Flood Control Drainage and Irrigation, FAP; Flood Action Plan, FPCO; Flood Plan Co-ordination Organization, MCA; Multi-criteria Assessment, ISPAN; Irrigation Support Project for Asia and the Near East, WARPO; Water Resources Planning Organization, TOR; Terms of Reference*
*Source; State of Environment Bangladesh 2001, MoEF, DoE,*
*Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects 2005 WARPO*
*Integrating Environmental Considerations into the Economic Decision-Making Process, ESCAP*

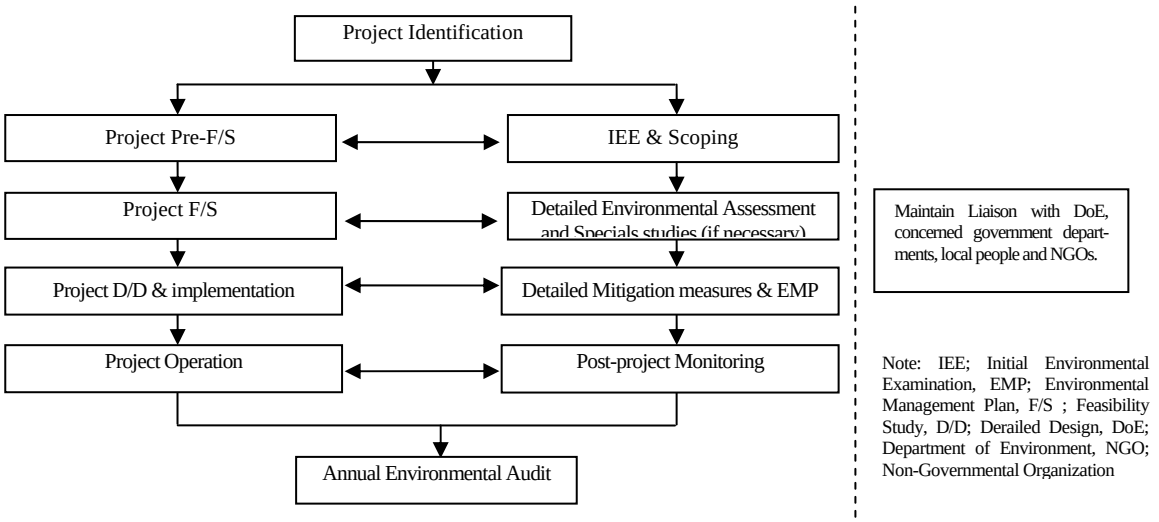
Of the above the "EIA Guidelines for Industries" and "Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects" will initially be made.

2) Environmental Impact Assessment (EIA) Process

In Bangladesh, according to the EIA Guidelines for Industry 1997 DoE, the EIA Process can be summarized as follows;

- The primary responsibility for carrying out an EIA study of any project lies with the project proponent. The proponent may get the study done using in-house expertise, a project consulting agency or an independent environmental consulting agency having requisite qualification to perform the task.
- EIA should be carried out in tiers and as indicated in Figure 2.2.2. It will be seen from this figure that the EIA procedure should be initiated simultaneously with the project planning and the level of efforts required for various tiers of EIA should be commensurate with the project development, throughout the stages of its identification to implementation. Thus the environmental planning should be centered and integrated with the project.

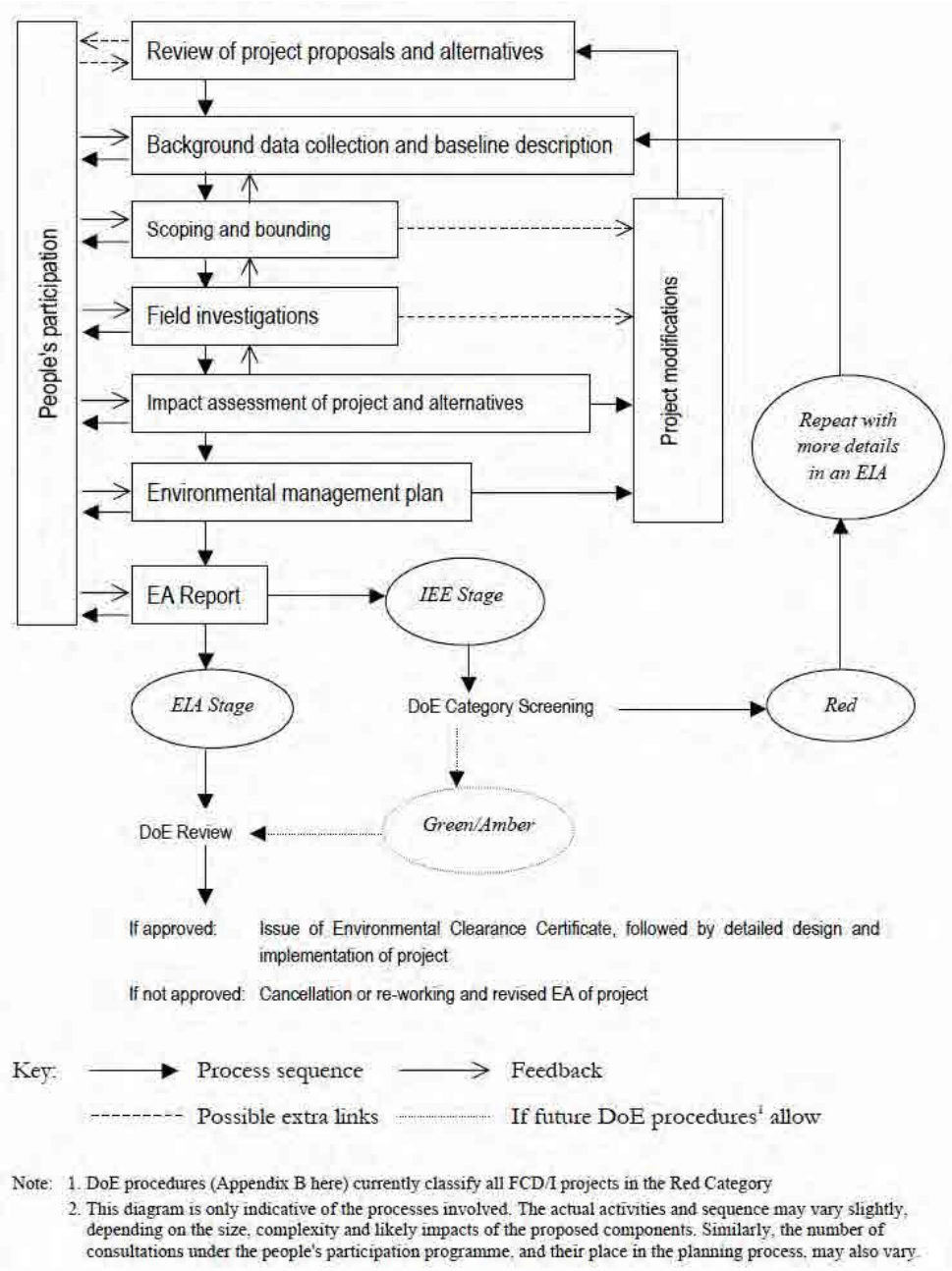
- The TOR for EIA study has been indicated in the form of structures of an IEE report and EIA report, respectively. These will normally be found meeting the study requirement in most of the EIA studies.
- The important stages in the development of an EIA study are:
  - Screening / scoping
  - Identification of significant environmental issues and how these will be resolved
  - Adequacy of imitative measures and an Environmental Management Plan (EMP)
- At this stage, interaction among the DoE, concerned other Governmental Departments/Authorities, NGOs and the people likely to be affected may be establish, in order to formulate views and suggesting and consider them while preparing further proposals for development of the project and environment planning.
- Review of an EIA report in the responsibility of DoE wherein the review exercise will be carried out either through the staff of DoE and /or an Environmental Clearance Committee (ECCo) to be appointed by the Government. Namely the EIA will be reviewed by the respective Divisional office of DoE whereby the review report will be submitted for consideration by DG (Director General) at DoE for the entire industrial project, which require IEE/EIA (Refer to Figure 2.2.2). Then the Environmental Clearance Committee (ECCo) will call the proponent to give presentation about the project objective, strategy, remedial action, findings and etc. The office of the DG will make final decision which will be communicated to respective Divisional office, who in turn, will communicate to the entrepreneur.
- Finally, DoE will issue environmental clearance to a project, or reject it, or call for some more information/studies before clearance in accorded. The environmental clearance may be subject to such conditions as may be considered necessary from the point of view of environmentally should implementation and operations of the project.
- Environmental Assessment (IEE & EIA) Process in WARPO Guidelines




Source; EIA Guidelines for Industries 1997 DoE

**Figure 2.2.2 Project Planning, It's Implementation and EIA Process**

In addition, the Guidelines for Environmental Assessment of Water Management (FCD/I) Projects 2005 WARPO, which basically follows the EIA Guidelines for Industries 1997 DoE, depicts a process for Environmental Assessment (EA) including IEE and EIA that employs a people's participation oriented approach as shown in Figure 2.2.3.



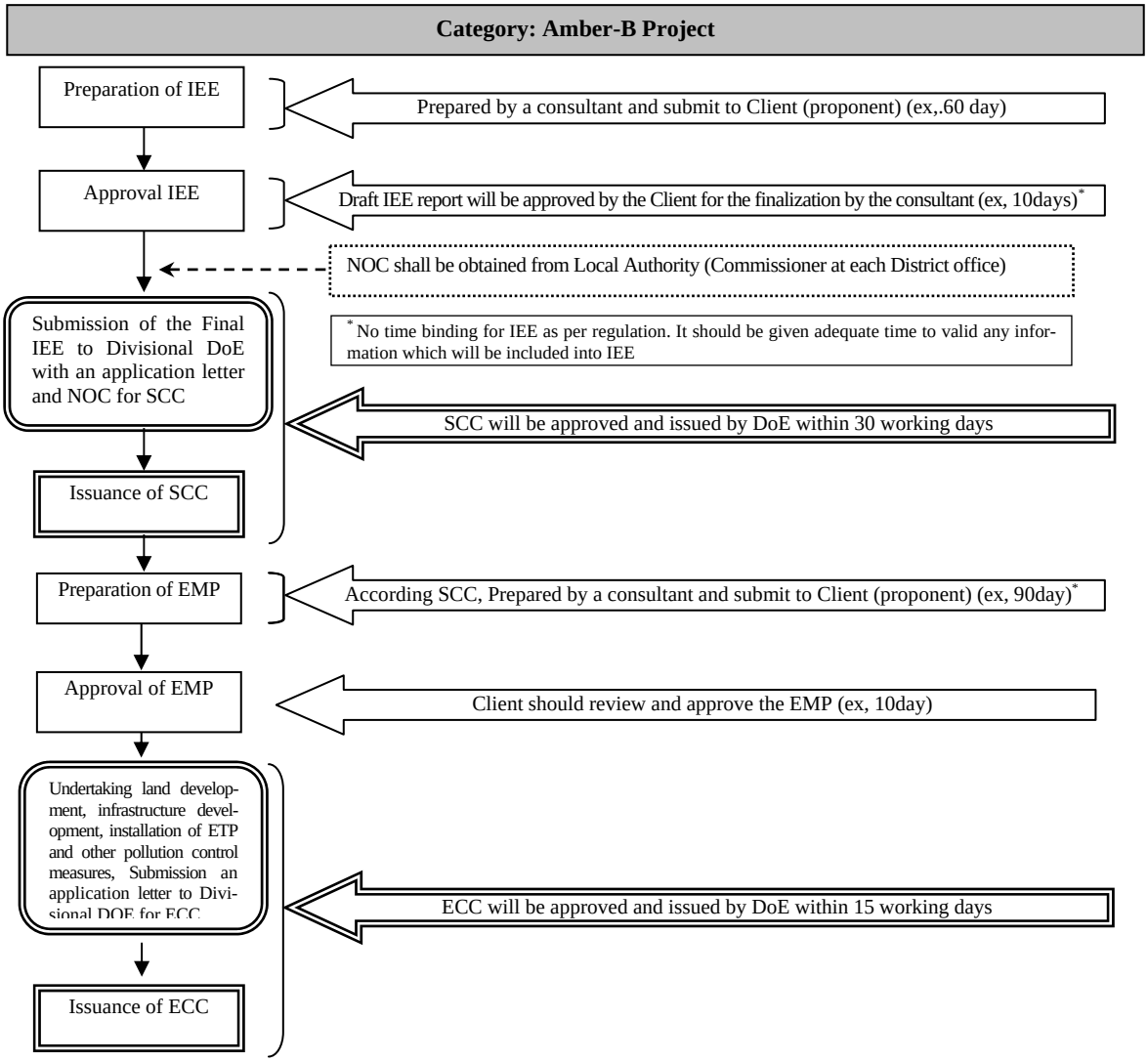

Source; Guidelines for Environmental Assessment of Water Management (FCD/I) Projects 2005 WARPO

**Figure 2.2.3 Key Steps in the Environmental Assessment for FCD/I Projects**

The Guidelines of WARPO mentions that the DoE procedures currently classify all FCD/I projects in the "Red" Category. In addition, the Guidelines of WARPO basically employs the "Flow Chart of Environmental Clearance Procedure" shown in Figure 2.2.1. However, the requirements of WARPO vary from those of the DoE 1997, in requiring an IEE, EIA and EMP for proposed, as well as existing industry/ projects (asterisk and underlined explanation in Figure 2.2.1) which are omitted in the WARPO Guidelines. As well, the "Guidelines" notes that automatic application of the Red Category procedures and regular renewal of the Certificates is not appropriate for all FCD/I projects, especially small interventions with minimal impacts. Unless/until the procedures are formally revised, the DoE should be consulted for guidance on individual projects.

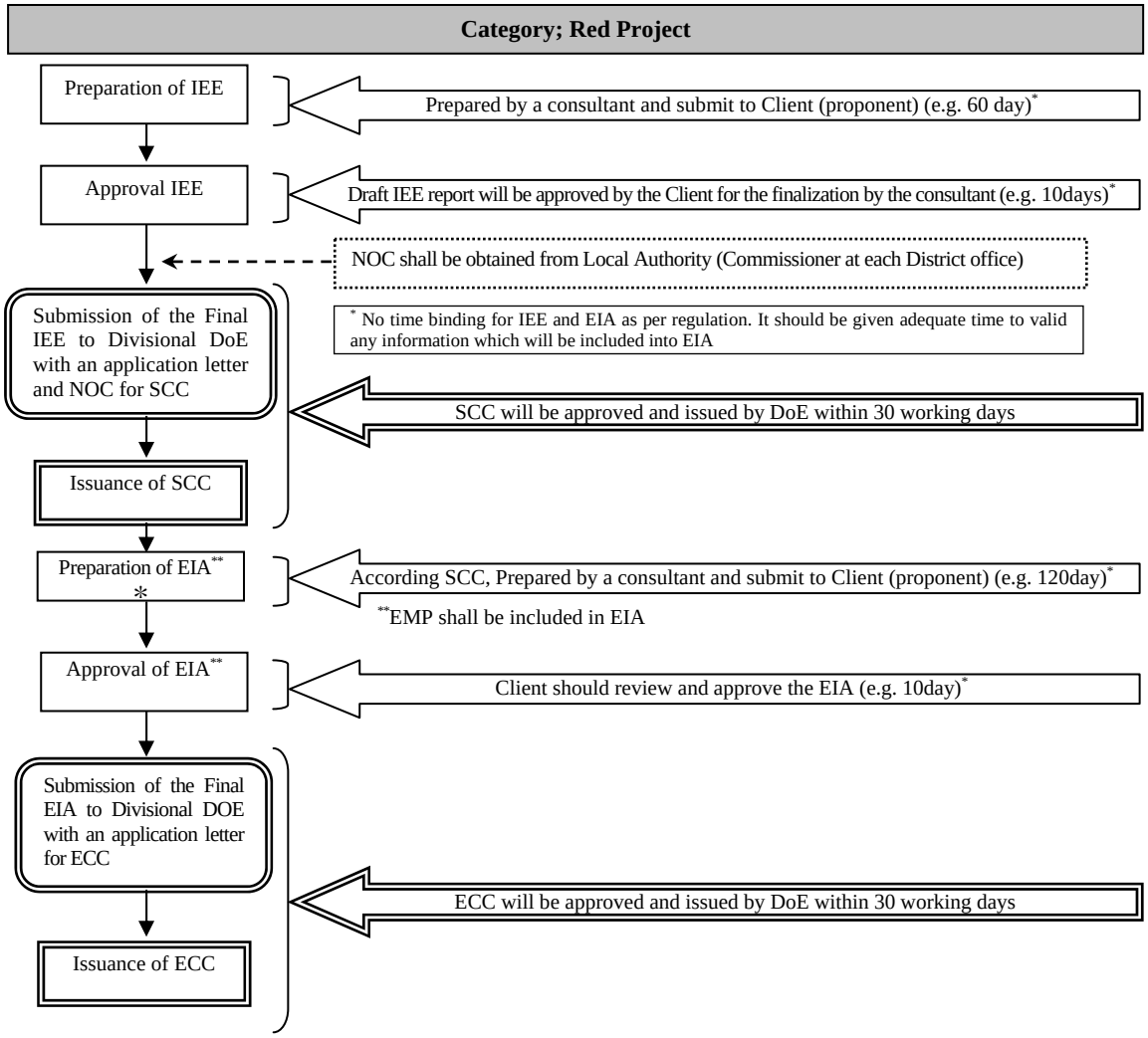
a) Sequence between Environmental Clearance system and Environmental Assessment Procedures

As mentioned above, the Environmental Assessment (EA) system and its procedures are dealt with in the framework of the Environmental Clearance system. Figures 2.2.4 and 2.2.5 show sequence between the "Environmental Clearance system" and "Environmental Assessment Procedures" in case of Amber-B and Red Projects.




IEE; Initial Environmental Examination, NOC; No Objection Certificate, EMP; Environmental Management Plan, SCC; Site Clearance Certificate, ECC; Environmental Clearance Certificate, ETP: Effluent Treatment Plant
*Source: JICA Study Team*

**Figure 2.2.4 Environmental Clearance & Environmental Assessment in Amber-B Category**




IEE; Initial Environmental Examination, EIA; Environmental Impact Assessment, NOC; No Objection Certificate, EMP; Environmental Management Plan, SCC; Site Clearance Certificate, ECC; Environmental Clearance Certificate
*Source: JICA Study Team*

**Figure 2.2.5 Environmental Clearance & Environmental Assessment in Red Category**

b) Public Participation

The "EIA Guidelines for Industries" mentions the public participation as follows;

- ***Public Participation;*** Since the general public is the ultimate recipient of the economic benefits and environmental damages, an EIA study involved in the public as part of the decision making process development. To achieve effective public participation, it is necessary to communicate with as many people as possible, as early as possible, and through as many different ways possible. This requires pre-planning, resources, identification of target groups and a variety of techniques for effective communication. Some of the techniques which could be adopted are:

| | | |
|---|---|---|
| - Radio and Television | - Sample polls | - Public Hearings (consultations) |
| - News releases | - Lobbying | - Information van |
| - News Letters | - Workshops | - Citizens advisory committee |
| - Advertisements | - Public Meetings | |

In addition, "Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects" notes as follows:

- ***People's Participation during IEEs;*** People's participation at the IEE stage involves four steps:

  - Wide and effective dissemination of information on potential interventions
  - Local-level meetings and discussions, identifying problems and developing a problem-solving process
  - Inventory of problems/ constraints and potentials
  - Assessment and reconnaissance of social, agricultural, fishery, livestock and environmental issues

- ***People's Participation during EIAs;*** During EIAs, the participation should be more detailed, involving:

  - Identification of all stakeholders - individuals, communities and government and nongovernmental agencies at all levels from the project site to regional and central agencies
  - Application of field methods to ensure full participation, including social assessment by surveys and participatory rapid rural appraisal
  - Assessment of the capacity of local stakeholder to participate effectively and implementation of measures to ensure the latter (e.g. by involvement of NGOs to help voice local concerns)
  - Identification of support of, and opposition to, the proposed project and enhancement/mitigation measures.

However, "Public Hearing" (to disclose a draft or summary EIA report to public for asking comments upon it, which usually seen in other countries) is not identified in the EIA procedures in Bangladesh.

c) JICA Guidelines for Environmental and Social Considerations (April, 2010)

Based on the JICA's policy on the environmental and social consideration for Japanese loan projects, CWASA shall refer to the JICA Guidelines for Environmental and Social Considerations, dated March 19, 2010.

(4) Environmental Management System in Bangladesh, Chittagong and CWASA

1) Department of Environment

Under the Ministry of Environment and Forest (MoEF), the DoE is the practical official entity for managing the environment and evaluating IEE and EIA reports to be submitted. The headquarters of the DoE is located in Dhaka and organized into nine main functional areas, each of which is headed by a Director, under the overall management of the Director General. The functional areas are: (i) Environmental Clearance, (ii) Law, (iii) Administration and Human Resources Development, (iv) Climate Change (v) Planning, (vi) Air Quality Management (vii) Information Technology, (viii) Monitoring and Enforcement and (ix) Natural Resources Management.

2) Divisional and District Level

There are six Divisional Offices (Barisal, Bogra, Chittagong, Dhaka, Khulna and Sylhet) that carry out enforcement activities including overall management of the environment supported by the laboratory analysis. Twenty newly created District Offices have yet to be started in full operation.

In case of approval of EIA, after submission, it is initially checked and verified at divisional level. Subsequently the EIA report is sent to a committee, called the "Environmental Clearance Committee (ECCo)", which is formed by the Director General (DG) of DoE and which reviews the EIA report in detail and makes a recommendation to the Deputy Director of the DoE for rejection or approval of the EIA. The decision is sent to divisional officials to issue an approval or rejection letter, usually with conditions. Once the mitigation measures are in place as recommended in the EIA report, the proponent applies for ECC to the relevant Divisional DoE office. After field inspection by the DoE officials, the DoE will send an ECC application with their recommendations to ECCo in Dhaka office. ECCo makes a recommendation on the application to the DG for his decision. After the DG's approval, the divisional officer issues ECC. In addition, environmental monitoring in EIA and /or IEE, each Divisional Office including Chittagong follows the direction of the DoE, Head Office.

3) CWASA

In CWASA there is no department, division or section for environmental and social considerations.

## 2.3 Socio-Economy Conditions

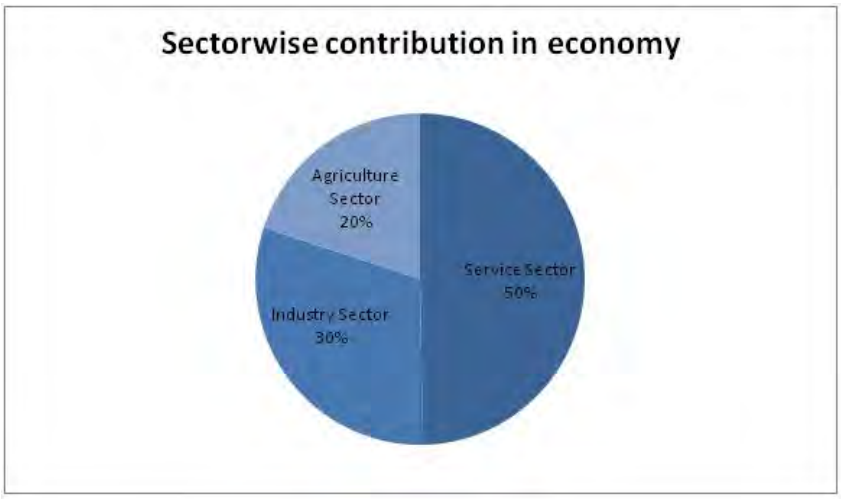
### 2.3.1 General

(1) Bangladesh

Bangladesh's Gross Domestic Product (GDP) at constant prices has grown at a rate of about 6.1 % per year over the past four years (6.43 %, 6.19 %, 5.74 % and 6.07% in each of the years 2006 to 2007, 2007 to 2008, 2008 to 2009 and 2009 to 2010), respectively, with the provisional GDP increase for the year 2010 to 2011 being 6.66 %[2]. GDP per capita was US$ 775 at current prices in 2010-2011.[3]

The sector wise contribution to the economy in 2010-2011 is shown in Figure 2.3.1. In this period the service sector accounts for 50 % of the GDP, which is similar to the years 1980-1981, 1990-1991 and 2000-2001, when the contribution ranged from about 49 % to 50%. In the period from 1980-1981 to 2010-2011 the contribution from agriculture decreased from approximately 33 % to 20 %, with their being a corresponding increase in the contribution from industry in the above period (17 % to 30 %) and a progressive increase in the contribution from industry in each of the above years.[4]

[2] Bangladesh Bureau of Statistics
[3] Board of Investment, Prime Minister's Office
[4] Bangladesh Economic Review 2010




*Source: Bangladesh Economic Review 2010*

**Figure 2.3.1 Sector-wise Contribution in Economy**

Bangladesh produces large quantities of agricultural goods including rice and jute. Although wheat production has increased in recent y ears (from 2004-2005 to 2009-2010); the country is generally self-sufficient in rice production. Bangladesh's growth of its agro industries is due to its rich deltaic fertile land, enabling multiple harvests.

Bangladesh's industrial base remains positive, including its vast human resource base, rich agricultural land, relatively abundant water, and substantial reserves of natural gas, with two natural sea ports in Chittagong and Mongla. In addition Bangladesh is one of eight member countries in an emerging economic hub group, South Asia Association for Regional Cooperation (SAARC) and functions as a geographical linking with the Association of South-East Asian Nations (ASEAN).

The 2011 Human Development Report[5] prepared by the United Nations Development Programme (UNDP) includes information on the Human Development Index (HDI). This index is a composite statistic, which is used to rank countries by level of "human development" and distinguish "very high human development", "high human development", "medium human development", and "low human development" countries. The HDI is a comparative measure of life expectancy, literacy, education and standards of living for countries worldwide.

Bangladesh's HDI value for 2011 is 0.500, which is in the low human development category. Overall Bangladesh was ranked 146th out of 187 countries and territories in 2011, with a lower score than the index for South Asia. Table 2.3.1 shows HDI indicators as well as HDI for selected countries and groups in 2011.

[5] Human Development Report 2011, United Nations Development Programme

**Table 2.3.1 Bangladesh's HDI Indicators 2011 Relative to Selected Countries and Groups**

| Country/Group | HDI Score | HDI Rank | Life expectancy at birth | Expected years of schooling[1] | Mean years of schooling[2] | GNI per capita (2005 PPP$) |
|---|---|---|---|---|---|---|
| Bangladesh | 0.500 | 146 | 68.9 | 8.1 | 4.8 | 1,529 |
| India | 0.547 | 134 | 65.4 | 10.3 | 4.4 | 3,468 |
| Nepal | 0.458 | 157 | 68.8 | 8.8 | 3.2 | 1,160 |
| Pakistan | 0.504 | 145 | 65.4 | 6.9 | 4.9 | 2,550 |
| Sri Lanka | 0.691 | 97 | 74.9 | 12.7 | 8.2 | 4,943 |
| South Asia | 0.548 | - | 65.9 | 9.8 | 4.6 | 3,435 |
| Medium HDI | 0.630 | - | 69.7 | 11.2 | 6.3 | 5,276 |
| Low HDI | 0.456 | - | 58.7 | 8.3 | 4.2 | 1,585 |

*Notes: 1. Total number of years of schooling a child of school-entrance age can expect to receive if prevailing patterns of age-specific enrolment rates stay the same throughout the child's life.*
*2. Average number of years of education received in a life-time by people aged 25 years and over.*
*Source: UNDP Development Report 2011*

Between 1980 and 2011 Bangladesh's HDI value increased from 0.303 to 0.500, an increase of approximately 65%, with an annual average increase of about 1.6%. Table 2.3.2 shows Bangladesh's progress in each of the HDI indicators as well as HDI between 1980 and 2011, compared to that in South Asia and low human development (LHD) groups. In the above period the HDI index in Bangladesh has increased faster than in the LHD group.

**Table 2.3.2 Trends in Bangladesh's HDI compared to South Asia and Low Human Development (LHD) (1980-2011)**

| Year | Life expectancy at birth | Expected years of schooling | Mean years of schooling | GNI per capita (2005 PPP$) | HDI Value | | |
|---|---|---|---|---|---|---|---|
| | Bangladesh | | | | | South Asia | LHD |
| 1980 | 55.2 | 4.4 | 2.0 | 584 | 0.303 | 0.356 | 0.316 |
| 1985 | 56.9 | 4.5 | 2.4 | 646 | 0.324 | 0.389 | 0.334 |
| 1990 | 59.5 | 5.0 | 2.9 | 690 | 0.352 | 0.418 | 0.347 |
| 1995 | 62.1 | 6.0 | 3.3 | 784 | 0.388 | 0.444 | 0.363 |
| 2000 | 64.7 | 7.0 | 3.7 | 905 | 0.422 | 0.468 | 0.383 |
| 2005 | 66.9 | 8.0 | 4.2 | 1,120 | 0.462 | 0.510 | 0.422 |
| 2010 | 68.6 | 8.1 | 4.8 | 1,459 | 0.496 | 0.545 | 0.453 |
| 2011 | 68.9 | 8.1 | 4.8 | 1,529 | 0.500 | 0.548 | 0.456 |

*Source: UNDP Development Report 2011*

In the period from 1980 to 2011 per capital GNI increased by about 160%, with life expectancy at birth increasing by 13.7 years, expected years of schooling by 3.7 years and mean years of schooling by 2.8 years.

The Gender Inequality Index (GII), which is included in the UNDP Human Development Report reflects gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activity. GII shows the loss in human development due to inequality between female and male achievements in the three GII dimensions.

Bangladesh has a GII value of 0.550, ranking it 112th out of 146 countries in the 2011 index, with the details of some of the parameters for Bangladesh and selected groups and countries shown in Table 2.3.3. Bangladesh was ranked above both India and Pakistan, but lower than Sri Lanka in 2011, as it was for the HDI. In addition, its score is better than the average scores for South Asia and countries with a low HDI, but significantly worse than the average score for countries with a medium HDI.

**Table 2.3.3 Gender Inequality Index (GII)**

| Country /Group | GII value | GII rank | Maternal mortality ratio[1] | Adolescent fertility rate[2] | Female seats in parliament (%)[3] | Population with at least secondary education (%)[4] | | Labor force participation rate (%)[5] | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Female | Male | Female | Male |
| Bangladesh | 0.550 | 112 | 340 | 78.9 | 18.6 | 30.8 | 39.3 | 58.7 | 82.5 |
| India | 0.617 | 129 | 230 | 86.3 | 10.7 | 26.6 | 50.4 | 32.8 | 81.1 |
| Pakistan | 0.573 | 115 | 260 | 31.6 | 21.0 | 23.5 | 46.8 | 21.7 | 84.9 |
| Nepal | | | | | | | | | |
| Sri Lanka | 0.419 | 74 | 39 | 23.6 | 5.3 | 56.0 | 57.6 | 34.2 | 75.1 |
| South Asia | 0.601 | - | 252 | 77.4 | 12.5 | 27.3 | 49.2 | 34.6 | 81.2 |
| Medium HDI | 0.475 | - | 135 | 50.1 | 17.3 | 41.2 | 57.7 | 51.1 | 80.0 |
| Low HDI | 0.606 | - | 532 | 98.2 | 18.2 | 18.7 | 32.4 | 54.6 | 82.7 |

*Notes: 1. Ratio of number of maternal deaths to the number of live births in a given year, expressed per100,000 live births*
*2. Number of births to women ages 15-19 per 1,000 women ages 15-19.*
*3. Proportion of seats held by women in a lower or single house or senate, expressed as percentage of total seats.*
*4. Percentage of the population ages 25 and older that have reached secondary education.*
*5. Proportion of a country's working-age population that engages in the labor market, either by working or actively looking for work, expressed as a percentage of the working-age population.*
*Source: UNDP Development Report 2011*

According to Bangladesh at a Glance[6] 32% of the population of Bangladesh was below the poverty line in 2010. This is similar to the figure of 31.5% for the incidence of poverty using the upper poverty line, which has been estimated using the Head Count Rate, in the Household Income and Expenditure Survey (HIES) 2010. Using the lower poverty line the incidence of poverty reduces to 17.6% in the above survey.

(2) Chittagong

In the HIES 2010 urban poverty in Chittagong was estimated at 11.8% using the upper poverty line, compared to the national average of 21.3% and 18.0% in Dhaka, with urban poverty in Chittagong being lower than in all other divisions. Urban poverty in Chittagong, based on the upper poverty line, reduced significantly compared to other divisions in the period between 2005 and 2010 (27.8%) and has also reduced significantly since 2000, when it was 55.9%. Using the lower poverty line urban poverty in Chittagong in 2010 was estimated at 4.0%, second only to Dhaka at 3.8% and a significant reduction from 8.1% in 2005.

Rural poverty in Chittagong in the HIES 2010 was estimated at 31.0% using the upper poverty line, compared to the national average of 35.2%, with rural poverty in Chittagong being lower than in all other divisions, except for in Rajshahi (new) and Sylhet where it was 30.0% and 30.5% respectively.

### 2.3.2 Public Hygiene

(1) General

Bangladesh has made significant progress in health outcomes since its independence. Reduction of infant and child mortality rates has been significant. For example the under-five mortality rate declined from 151 deaths per thousand live births in 1991 to 48 in 2010. During the same period the infant mortality rate reduced from 94 deaths per thousand live births to 38, which is lower than the figure of 52 for South Asia.

An overview of the current health profiles of Bangladesh is presented in the Health Bulletin 2011,

[6] World Bank

prepared by the Directorate General of Health Services (DGHS), Ministry of Health & Family Welfare (MOHFW).

Water-borne diseases or diseases associated with unsafe water, poor sanitation, and poor food handling practices include among others, diarrhoea, dysentery, malaria, and dengue. Diarrhoea was the most common cause of admissions to both upazalia health complexes and district and general hospitals, accounting for about 15 % and 9% of admissions respectively. Data of children who attended out-patient and emergency departments of Integrated Management of Childhood Illness (IMCI)[7] facilities shows that diarrhoea is the most common specific cause (excluding very severe disease, which is non-specific) of admissions for children aged 0-28 days and 29-59 days, accounting for between 18 and 19% of admissions. For age groups 2-12 months and 1-5 years the percentage of admissions due to diarrhoea reduced to about 13% for each age group, with pneumonia being the most common cause of admission for both age groups.

National data indicates that for upazalia health complexes diarrhoea was either the most or second most common cause of admission for each age group from 0-28 days to over 50. Where it was the second most common, in the younger age groups pneumonia was the most common, whereas in the older age groups assault was the most common. The situation was similar for district level hospitals, although in some age groups diarrhoea was ranked third, with peptic ulcers being a common cause of admission age groups 25-49 years and over 50.

Bacillary dysentery and dysentery each account for between 2 and 3 % of admissions in upazalia health complexes and district level hospitals, although neither are reported amongst the top ten causes of admissions. This does not appear to be consistent with the summary information on the top ten causes of admissions, which shows that some diseases in the top ten account for less than 2 % of the total. This may be due to categorization used in the summary information.

Diarrhoea/dysentery caused 7% of deaths of children in the age group 5-14 years in upazalia health complexes, but was not in the top causes of mortality in other age groups or for any age groups in district and general hospitals.

(2) Chittagong Division

The reported number of cases and deaths from diarrhoea, as well as the fatality rate in Chittagong Division in recent years is shown in Table 2.3.4.

**Table 2.3.4 Incidence of Diarrhoea in Chittagong Division**

| Year | Number of incidences reported | Number of deaths reported | Fatality rate (No per '1000 people) |
|---|---|---|---|
| 2001 | - | - | 0.05 |
| 2002 | - | - | 0.06 |
| 2003 | 379,276 | 265 | 0.07 |
| 2004 | 432,829 | 277 | 0.06 |
| 2005 | 405,446 | 162 | 0.04 |
| 2006 | 363,710 | 84 | 0.02 |
| 2007 | 446,965 | 148 | 0.03 |
| 2008 | 410,195 | 123 | 0.03 |
| 2009 | 366,092 | 79 | 0.02 |
| 2010 | 367,072 | 95 | 0.026 |

*Source: Director, Disease Control, Directorate General of Health Services (DGHS), as reported in Health Situation of Bangladesh (published November 2011)*

Integrated Management of Childhood Illness (IMCI) is a strategy as well as a program developed in mid-1990s by WHO, UNICEF and other partners to unify existing vertical child health programs (e.g., Control of Diarrheal Diseases and Acute Respiratory Infections). IMCI addresses morbidities which are responsible for almost 75% of under-5 deaths. MOHFW of Bangladesh introduced IMCI in 2002.

The number of reported incidences of diarrhoea has been relatively stable over the period from 2003 to 2010; however the number of deaths generally decreased year on year, although the number of deaths in 2006 was much lower than in the preceding years and the following two years.

The historical trend for the number of deaths per 1000 people is similar in Chittagong to the national trend and that in other divisions.

With regard to children treated at IMCI facilities, Chittagong accounted for 17.1% of diarrhoea cases, but only 14% of all admissions.

There have been no reported incidences of dengue fever in Chittagong Division since 2005, when there were two cases and the last reported death was in 2003.

(3) Chittagong City

Chittagong City has a number of hospitals (including specialist hospitals) and medical institutions which provide health care services. The public and some of the private hospital in the city are shown in Table 2.3.5.

**Table 2.3.5 Hospitals in Chittagong City**

| Type | Name | Number of Functional Beds |
|---|---|---|
| Public | Chittagong Medical College Hospital | 1010 |
| Public | Infectious Diseases Hospital | 20 |
| Public | Chittagong General Hospital | 150 |
| Public | Chest Diseases Hospital | 150 |
| | Diabetic Hospital | |
| | Mother and Children Hospital | |
| | Police Hospital | |
| Private | Chittagong Medical Centre | |
| Private | Royal Hospital | |
| Private | Chittagong Metropolitan Hospital | |
| Private | Chittagong Eye Hospital | |
| Private | Chittagong Poly Clinic | |
| Private | Nebadita Hospital | |
| Private | Agrabad Shishu Hospital | |
| Private | Panasia Hospital | |
| Private | Holy Crescent Hospital | |
| Private | Holy Family Hospital | |
| Private | Surgiscope Hospital | |
| Private | Centre Point Hospital | |
| Private | National Hospital | |

*Source: Health Bulletin 2011 (Government Hospitals)*

### 2.3.3 Sanitation and Sewerage

(1) Drainage System

Urban drainage is a major issue in most cities of Bangladesh due to their low-lying topography, their location next to rivers and the short, but very intensive, monsoon season. Chittagong is no exception in this regard.

There are currently 22 major canals and a network of about 100 secondary and tertiary canals in Chittagong. These are operated and maintained by CCC, who undertook to dredge 145 drains in

2008, including the removal of illegal encroachments, following major floods in 2007.

A Storm water Drainage and Flood Control Master Plan, for which CDA was the Client, was prepared in 1994 to cover the period from 1995 to 2015. The World Bank financed Chittagong Water Supply Improvement and Sanitation Project includes a subcomponent for updating of drainage master plans, identification of priority investments and design of priority investments. It is expected that the assessment activities done under the above will include recommendations for the priority rehabilitation of some existing storm water canals that could provide limited but immediate improvements to the storm water drainage system in Chittagong.[8]

(2) Sewerage

There are essentially no waterborne sewerage systems in Chittagong and a significant portion of wastewater is discharged untreated to ponds, channels and drains and then to the sea via the Karnaphuli River. Storm drains/canals act as combined sewers. According to the Sewerage Master Plan[9], the only sewerage system which was planned and constructed as a sewerage system is a 1.8 km long culvert along Sheikh Mujib Road; however it is not known if this culvert has ever been used for conveyance of sewerage only.

Chittagong City Corporation, which is responsible for sanitation has developed various slum sanitation improvement programs with the support of NGOs and as a result 90% of the open latrines have been converted to septic latrines.[10]

(3) Solid Waste Management (SWM)

SWM in Chittagong, and in many other Bangladeshi cities, is hampered by the absence of adequate national or local legislation relating to municipal SWM and the treatment and disposal of hazardous waste. In particular, there are no mandatory regulations or performance standards for city corporations (e.g. CCC) to establish and manage an effective SWM system; nor are there any sanctions to prevent littering and indiscriminate dumping.

CCC is responsible for collection and disposal of household waste and more than 95% of such waste is collected and dumped.[11]

The Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011 proposes that the two existing landfills are relocated from the southern part of the city to the north due to the wind speed and direction.

### 2.3.4 Commerce and Industry

Chittagong has traditionally been a major centre for trade and commerce and is the second centre of commerce and industry in Bangladesh after Dhaka. The manufacturing industry started to develop in the 1950's when the Nasirabad Industrial Area was constructed. Subsequently industrial areas were developed at Kalurghat and Fouzderhat. The first heavy industrial development in the city was in the 1960's when an oil refinery, cement clinker plant and a steel mill were constructed on the

[8] Project Appraisal Document on a Proposed Credit to the People's Republic of Bangladesh for a Chittagong Water Supply and Sanitation Improvement Project
[9] Part of the 'Preparation of Master Plan for Water Supply and Wastewater Management of the Detailed Planning Area of Chittagong, Bangladesh, financed by Korea International Cooperation Agency
[10] Project Appraisal Document on a Proposed Credit to the People's Republic of Bangladesh for a Chittagong Water Supply and Sanitation Improvement Project
[11] Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011

Patenga Peninsula.

About 30% industrial products of the country come from Chittagong district alone, most of which come from the city area. The major industrial estates developed by the Government including by Chittagong City Corporation (CCC), Chittagong Development Authority (CDA), Bangladesh Small and Cottage Industries Corporation (BSCIC) and the public Works Department (PWD) are shown in Table 2.3.6

Chittagong City owns some very prestigious industrial enterprises, with Chittagong Oil Refinery, Lubricating Grease Industry, Dockyard are the most important ones. Besides these there are jute, textile, leather, cigarette, edible oil, soap, glass, salt, fertilizer, garment and gas industries, etc.

**Table 2.3.6 Major Industrial Estates developed by the Government**

| Name of Estate | Organization | Area (hectares) | No. of plots | Year of Development |
|---|---|---|---|---|
| Kalurghat | CDA | 81 | 58 | 1961-63 |
| Mohra | CDA | 31 | 31 | 1962-63 |
| Fouzderhat/Sagarika | CDA | 132 | 78 | 1961-62<br>1969-70 |
| Sholashahar (light industry) | CDA | 17 | 37 | 1960-61 |
| Nasirabad | PWD | 155 | 396 | 1950-51 |
| Sagarika | CCC | 6 | 10 | - |
| Chandgaon FIDC Road | CCC | 5 | 3 | 1968 |
| Fauzdarhat | BCSIC | 13 | 159 | 1963 |
| Sholashahar | BCSIC | 6 | 66 | 1963 |
| Kalurghat (old) | BCSIC | 5 | 71 | 1963 |
| Kalurghat (extension) | BCSIC | 13 | 255 | 1982-83 |
| Patiya | BCSIC | 4 | 79 | 1981 |
| Patenga | Central Government | | | |
| Fauzdarhat | Central Government | | | |
| Kumira | Central Government | | | |
| CEPZ (Halishahar) | CDA | 183 | 502 | Approx. 1983 |
| Patenga | KEPZ | 90 | 254 | Approx. 2006 |

*Source: Detailed Area Plan for Chittagong Metropolitan Master Plan and Bangladesh Export Processing Zones Authority*

As of May 2012, about US $940 million has been invested in Chittagong EPZ since 1983-1984, with the maximum in any year being US$ 126.46 million in 2007-2008[12]. Investment decreased significantly in the following two years but recovered to about US$ 85 million in 2010-2011 and US$ 83 million in 2011-2012 up to May 2012. Total exports from the EPZ up to May 2012 are US$ 14,867 million, with a maximum of about US$ 1,690 million in the current year (up to May 2012 only). Exports have increased every year (year on year), except for between 1986-1987 and 1987-88 and between 2000-2001 and 2001-2002, when there were small percentage decreases. In 2011-2012 (as of May 2012), approximately 171,000 local people were employed in the EPZ, the maximum in any year.

With regard to Karnaphuli EPZ, about US$ 212 million has been invested since 2006-2007, with a maximum of US $ 76.91 million in the current year (up to May 2012). Investment in the current year is similar to that in the Chittagong EPZ. Total exports from the EPZ up to May 2012 are about US$ 463 million, with a maximum of about US$ 220 million in the current year (up to May 2012 only), which is a significant increase from almost US$ 10 million in 2007-2008. In 2011-2012 (as

[12] Bangladesh Export Processing Zones Authority (BEPZA) – including subsequent information regarding Chittagong and Karnaphuli EPZs

of May 2012), approximately 25,000 local people were employed in the EPZ, the maximum in any year.

In addition, a Korean company, Youngone Corporation, has established a special Korean Export Processing Zone (KEPZ) in the city. This is built on a land area of nearly 1,000 hectares and is expected to attract foreign direct investment worth $1 billion.[13] Permitted industries at the KEPZ are as follows:

- Electrical and Electronics items
- Software development, IT and R&D types industries
- Scientific instruments and precision tools
- Jewellery industries and cutting
- Engineering products and equipment
- Leather products and shoes, bags, jackets etc.
- Sports goods and toy manufacturing, footwear
- Backward linkage industries for textile
- Pharmaceutical products
- Gas based industries, Petrochemical products
- Agro-based industries, organic fertilizer production, garden and farm equipment manufacturing
- Ceramic industries
- Agro construction materials
- Port related services and business, ship chandler items

Hi-Tech projects for electrical/electronic equipment and components, assembly plants for cars and its components, software development, large scale chemical/petrochemical industries are encouraged at the above KEPZ.

Chittagong port which has recently attained international attained international standards in terms of competence indicators handles about 92 % of the country's imports and exports[14]. The main imports at the port include cement clinker, sugar, salt, fertilizer, general cargo, iron materials, chemicals, coal and edible oil, with the main exports including ready-made garments, knitwear, jute and jute products, hides and skins, tea, naphtha, molasses and frozen foods. In 2009-2010 cement clinker amounted to 26% (in terms of tonnes) of total imports, followed by poles in bulk (12%) and foodgrain (10%). In the previous five years cement clinker was the main import in each year.

Table 2.3.7 summarises the cargo handled by the port in the years from 2006 to 2011.

**Table 2.3.7 Cargo Handled at Chittagong Port**

| Year | Imports | Exports | Inland | Inland Container Depot | Total | Import and Export Annual Growth | Total Annual Growth |
|---|---|---|---|---|---|---|---|
| | (Tonnes) | | | | | % | |
| 2006 | 23,936,103 | 3,089,550 | 2,633,565 | 480,349 | 30,139,567 | | 1.93 |
| 2007 | 24,236,261 | 3,392,974 | 2,677,509 | 492,644 | 30,799,388 | 2.23 | 2.19 |
| 2008 | 24,492,707 | 3,704,862 | 2,518,564 | 434,628 | 31,150,761 | 2.06 | 1.14 |
| 2009 | 30,886,680 | 3,957,894 | 2,830,025 | 494,525 | 38,169,124 | 23.57 | 22.53 |
| 2010 | 36,670,356 | 4,512,439 | 3,730,829 | 483,039 | 45,396,663 | 18.19 | 18.94 |
| 2011 | 38,266,480 | 4,873,562 | 5,577,114 | 556,781 | 49,273,937 | 4.75 | 8.54 |

*Source: Chittagong Port Authority*

[13] Export Processing Zone Exclusive for Korea, The Korea Times, 25 March 2009
[14] Budget Speech 2012-2013

There are plans for expansion of the port. However issues that currently constrain expansion include that 500 acres of Chittagong Port Authority land is leased out and the intention of expanding the port downstream of Karnaphuli Fertilizer Company Limited may not be implementable because of the government's plan to construct a 1,300MW coal fired power station in that area.

According to the Statistical Yearbook, 2010 about 57% of the population older than 15 is active in Chittagong, with about 83% of males and 31% of females being economically active, as of 2005-2006, based on a total population of 5.063 million.

There is no recent information on the employment structure in Chittagong. A Census of Non-farm Economic Activities (CNFEA) was published in 1986 (BBS, 1986) from which a detailed breakdown of the employment structure of Chittagong city is presented in Table 2.3.8.

**Table 2.3.8 Employment Structure in Chittagong**

| Sector | No. of Jobs City | No. of Jobs Statistical Metropolitan Area (SMA) | Sources |
|---|---|---|---|
| Manufacturing | 161,000 | 201,000 | CNFEA (1986) |
| Wholesale, retail and trade | 121,000 | 133,000 | CNFEA (1986) |
| Financial, insurance, and business services | 27,000 | 28,000 | CNFEA (1986) |
| Community, social, & personnel services | 48,000 | 56,000 | CNFEA (1986) |
| Public administration, defence & police | 20,000 | | Team |
| Utilities | 3,000 | | Team |
| Agriculture | 8,000 | | Pop. Census (1991) |
| Transport (incl. 80,000 Informal) | 120,000 | | Transport Team (Residual) |
| Rest of informal, floating jobs | 152,000 | | |
| Total | 660,000 | | (Derived) |

*Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011*

The most recent estimate of the breakdown of manufacturing jobs is given in Table 2.3.9

**Table 2.3.9 Estimated Breakdown of Manufacturing Jobs in Chittagong**

| Sector | Manufacturing Jobs (%) | No. of Jobs City | No. of Jobs SMA |
|---|---|---|---|
| Food, beverages, and tobacco | 9 | 20,000 | 17,000 |
| Textiles and garments | 57 | 92,000 | 114,000 |
| Wood and wooden products | 7 | 5,000 | 11,000 |
| Paper, printing, and publishing | 2 | 4,000 | 5,000 |
| Chemical, rubber, and plastics | 4 | 7,000 | 9,000 |
| Metallic mineral products | 4 | 6,000 | 7,000 |
| Basic metallic industries | 5 | 8,000 | 10,000 |
| Metal products, machinery, & equipment | 12 | 19,000 | 24,000 |
| Other manufacturing | 2 | 3,000 | 4,000 |
| Total | 100 | 164,000 | 201,000 |

*Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011*

It should be noted that the information in the above two tables is virtually identical to that included in the SAPROF.

### 2.3.5 The Electricity Power Supply Situation in Bangladesh

(1) Situation

As of May 2012, installed capacity is 8,099 MW, with natural gas being by far the biggest source of power contributing about 67 % of capacity, followed by furnace oil, about 21 %, with diesel, coal and hydropower also being used.[15] The maximum demand to date in 2012 was 6,066 MW.

The above installed capacity is higher than stated in the Budget Speech 2012-2013, as follows "The demand for electricity in the country now stands at 7,518 MW and we are producing 6,066 MW". According to the above speech 3,300 MW has been added to the national grid from January 2009 to April 2012.

(2) Power Supply in Chittagong

In Chittagong, there are two electricity boards which are REB (Rural Electrification Board) and PDB (Power Development Board). REB is responsible for rural areas and PDB mainly covers the city area. Power supply interruption is chronic problem in the city.

(3) Electricity Charges

The electricity tariff applied by PDB varies depending upon the category of user, with their being a minimum charge for most categories, as well as demand and service charges. The tariff for the main categories is shown in Table 2.3.10.

The electricity tariff applied by REB varies depending upon the category of user, with their being a minimum charge for most categories, as well as demand and service charges. The tariff for the main categories is shown in Table 2.3.11.

[15] Bangladesh Power Development Board

**Table 2.3.10 PDB Tariff**

| Consumer Category | Range | Rate /kWh | Charges | | |
|---|---|---|---|---|---|
| | | | Demand | Service | Minimum |
| Domestic Category - A | 000-100 kWh<br>101-400 kWh<br>401 & above for all units in kWh | Tk. 3.05<br>Tk. 4.29<br>Tk. 7.89 | Tk. 12 /kW sanctioned load | Tk. 6 /month for single phase & Tk. 27 /month for 3-phase | Tk. 100 / month |
| Agricultural Pumping Category - B | Flat | Tk. 2.26 | Tk. 35 /kW /month for sanctioned load above 30 kW | 1-phase Tk. 5/ month<br>3-phase Tk.25 / month | Tk. 125 /H. P. /month during season |
| Small Industry Category - C | Flat<br>Off peak<br>Peak | Tk. 6.02<br>Tk.5.16<br>Tk. 7.33 | Tk. 37 /kW per month | Tk. 63.00 /month | Not applicable |
| Non-Residential Category – D | | Tk. 3.92 | Tk. 10 / kW of sanctioned load | 1-phase Tk. 5/ month<br>3-phase Tk.25.00 / month | Tk. 100 |
| Commercial Category - E | Flat<br>Off peak<br>Peak | Tk. 7.79<br>Tk. 6.25<br>Tk. 10.25 | Tk. 22 /kW /month for sanctioned load above 40 kW | Tk. 6 / month for single phase & Tk 27 /month for 3-phase | Tk. 125 /kW of sanctioned load /month |
| Medium Voltage 11 kV General Category - F | Flat<br>Off peak<br>Peak | Tk. 5.90<br>Tk. 5.16<br>Tk. 8.08 | Tk. 45 /kW of sanctioned load per month | Tk. 400.00 /month | Tk. 80 /kW of sanctioned load but not less than Tk. 8000 /month |
| Extra High Voltage Category - G1 | DESA-132kV<br>DESA-33kV | Tk. 2.34<br>Tk. 2.39 | Tk. 40 /kW of sanctioned load | Not applicable | Tk. 80 /kW of sanctioned load |
| Extra High Voltage 132 kV General Category - G2 | Flat<br>Off peak<br>Peak | Tk. 5.33<br>Tk. 4.82<br>Tk. 7.51 | Tk. 35 /kW of sanctioned load | Tk. 80 /kW of sanctioned load | Tk. 60 /kW of connected load |
| High Voltage 33 kV General Category - H | Flat<br>Off peak<br>Peak | Tk. 5.61<br>Tk. 5.08<br>Tk. 7.91 | Tk. 35 /kW of sanctioned load per month | Tk. 400 /month | Tk. 80 /kW of connected load |
| Category - I1 | REB<br>1)132kV<br>2)33kV<br>-Economically unsolvent<br>-Economically Margin<br>-Economically solvent | <br>Tk. 2.34<br><br>Tk. 2.05<br><br>Tk. 2.05<br><br>Tk. 2.39 | Not applicable | Tk. 400 | Not applicable |
| Category - I2 | DESCO<br>-132kV<br>-33kV | <br>Tk. 2.34<br>Tk. 2.39 | Not applicable | Tk. 400 | Not applicable |
| Category - I3 | WZPDCL<br>-132kV<br>-33kV | <br>Tk. 2.34<br>Tk. 2.39 | Not applicable | Tk. 400 | Not applicable |
| Category - I4 | Distribution of BPDB<br>-132kV<br>-33kV | <br><br>Tk. 2.34<br>Tk. 2.39 | Not applicable | Tk. 400 | Not applicable |
| Category - I5 | Distribution Company in Future<br>-132kV<br>-33kV | <br><br><br>Tk. 2.34<br>Tk. 2.39 | Not applicable | Tk. 400 | Not applicable |
| Street lights and pumps Category – J | | Tk. 5.61 | Tk. 37 /kW of sanctioned load | Tk. 205 | Not applicable |

*Note: Category I is High Voltage Bulk Supply for Rural Electrification of Board/ Palli Biddyut Samiti*
*Source: PDB*

**Table 2.3.11 REB Tariff (PBS-2, Chittagong)**

| Consumer Category | Range/Step | Tariff Rate (Tk./kWh) | Demand Charge (Tk/kW/mo.) | Service Charge (Tk/month) | Minimum Charge |
|---|---|---|---|---|---|
| Class-A : Residential (House or Bari) | 0-75 kWh | 3.80 | 15.00 | 10.00 | 65.00 |
| | 76-200 kWh | 4.63 | | | |
| | 201-300 kWh | 4.79 | | | |
| | 301-400 kWh | 7.16 | | | |
| | 401-600 kWh | 7.48 | | | |
| | Above 600 kWh | 9.38 | | | |
| Class-B : Pumps used in Agri-culture | Flat Rate for any consumption (kWh) | 3.60 | 40.00 (Applicable for demand above 30kW) | 30.00 | 10/HP |
| Class-C : Small Industry | Flat Rate | 6.95 | 15.00/kW upto 25kW, 40.00/kW above 25kW | 70.00 | 1-Phase =DC+SC 3-Phase=45.00/ kW |
| | Off-Peak Hour | 5.96 | | | |
| | Peak Hour | 8.47 | | | |
| Class-D : Official/Commercial | Flat Rate | 9.00 | 25.00 | 1-Ph.=10.00 3-Ph.=30.00 | 1-Ph. =95.00/kW 3-Ph.=130.00/k W |
| | Off-Peak Hour | 7.22 | | | |
| | Peak Hour | 11.85 | | | |
| Class-E : Medium Voltage (11KV) -General Use | Flat Rate | 6.81 | 45.00/kW | 400.00 | Tk55.000/kVA |
| | Off-Peak Hour | 5.96 | | | |
| | Peak Hour | 9.33 | | | |
| Class-F : High Voltage-33KV General Use/WTP | Flat Rate | 6.48 | 40.00/kW | 450.00 | 80.00/kW |
| | Off-Peak Hour | 5.87 | | | |
| | Peak Hour | 9.14 | | | |
| Class-G : Street Light | Flat rate for any consumption (kWh) | 6.48 | 15.00 | - | 389.00/light |
| Class-H : Charitable Institution (School, Madrasha, Mosque, Hospital etc | | 4.53 | - | - | - |

*Source: PBS-2 (Polly Bidduth Samity-2, Chittagong)*

## 2.4 Land Use

### 2.4.1 Existing and Future Land Use

The Detailed Area Plan for Chittagong Metropolitan Master Plan (2nd Edition, September 2011) includes existing land use and development plan proposals for the CCC area and areas outside the CCC area, covering a total area of 691 sq.km. In the DAP, the CCC area has been subdivided into six zones, termed as Detailed Planning Zones (DPZs), taking into account the urban, geo physical and development character and ward boundary. There are a further six DPZs outside the CCC area. For each DPZ development proposals, including future land use plans have been prepared. Table2.4.1 shows the reference number and general location of the DPZs. Existing land use in the DPZs 01 to 06 is shown in Table 2.4.2.

**Table 2.4.1 Detailed Planning Zones**

| Type | Name |
|---|---|
| Within CCC Area | |
| DPZ 01 | Patenga – Halishahar |
| DPZ 02 | Agrabad – Kattali |
| DPZ 03 | Sadarghat – Chawk bazaar |
| DPZ 04 | Bakalia- Chandagon |
| DPZ 05 | Lalkhan bazaar – Pahartali |
| DPZ 06 | Panchlaish – Baizid |
| Outside CCC area | |
| DPZ 07 | Silimpur – Kumira |
| DPZ 08 | Hathazari – Raozan |
| DPZ 09 | Kulgaon – Halda |
| DPZ 10 | Madunaghat – CUET |
| DPZ 11 | Boalkhali – Patiya |
| DPZ 12 | Anwara - Karnaphuli |

*Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011*

**Table 2.4.2 Existing Land Use**

Unit: acre

| Type of Use/Area | DPZ01 | DPZ02 | DPZ03 | DPZ04 | DPZ05 | DPZ06 | Total |
|---|---|---|---|---|---|---|---|
| Agriculture & Fisheries | 1,725.36 | 725 | 2 | 925 | 11 | 2,026 | 5,414 |
| Commercial Activity | 42.23 | 52 | 336.61 | 282 | 141 | 72 | 926 |
| Education & Research | 65.36 | 55 | 46.71 | 46 | 48 | 18 | 279 |
| Hilly land | - | - | 595.01 | - | 2,296 | 2,636 | 5,527 |
| Manufacturing & Processing | 1,325.25 | 1,825 | 31.24 | 540 | 344 | 157 | 4,222 |
| Miscellaneous | 42.65 | 43 | 25.24 | 399 | 49 | 68 | 627 |
| Mixed Use | 4.29 | 4 | 251.78 | 676 | 80 | 19 | 1,035 |
| Open/Community Space | 36.60 | 33 | 41.42 | 149 | 48 | 15 | 323 |
| Residential | 3,023.04 | 3,326 | 838.24 | 1,015 | 1,635 | 1,287 | 11,124 |
| Restricted (port, airport, defence) | 1,273.36 | 773 | 41.85 | - | 142 | 1,426 | 3,656 |
| Service Facilities | 13.61 | 14 | 50.21 | 29 | 50 | - | 157 |
| Transport & Community | 625.36 | 725 | 356.08 | 479 | 405 | 358 | 2,948 |
| Vacant Land | 1,645.28 | 945 | 66.85 | 1982 | 393 | 792 | 5,824 |
| Water Body (khals, ponds, marshy land | 1,125.25 | 809 | 629.61 | 1,628 | 255 | 727 | 5,174 |
| Coastal Char | 1,756.36 | 756 | | | | | 2,512 |
| Office Use | | | 13.16 | 44 | 17 | | 74 |
| **Total** | **12,704** | **10,085** | **3,326** | **8,195** | **5,914** | **9,601** | **49,825** |

*Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011, based upon Land use survey 2006-2007*

Residential land accounts for approximately 22% of the total area in DPZ01 to DPZO6, ranging from 12% in DPZO4 to 33% of DPZ02.

## 2.5 Water Supply Sector Institutional Arrangement in Chittagong

### 2.5.1 General

A large number of government entities are in charge of various aspect of the water sector in Bangladesh. The National Water Management Plan (NWMP) lists not less than 14 ministries involves in the sector. Among them the Ministry of Local Government, Rural Development and Cooperatives (LGRD&C) is in charge of water supply in rural areas and cities.

### 2.5.2 Chittagong Water Supply and Sewerage Authority (CWASA)

Chittagong Water Supply and Sewerage Authority (CWASA) is responsible for providing water, sewerage and storm water drainage services in Chittagong.

### 2.5.3 Chittagong City Corporation (CCC)

Chittagong City Corporation (CCC), which is a local government autonomous body under the Ministry of Local Government, Rural Development and Cooperatives (LGRD&C), descended from Chittagong Municipality. Chittagong Municipality was established in 1863 and renamed as Chittagong Paura-Shava in 1977, then upgraded to a Municipal Corporation in 1982 and finally renamed as Chittagong City Corporation in 1990.

### 2.5.4 Chittagong Development Authority (CDA)

Chittagong Development Authority (CDA), which is the statutory planning and development authority for the Chittagong Metropolitan Area (CMA), was created in 1959 under the provisions of the CDA Ordinance 1959, and was established by Bangladesh Government in order to ensure the planned and systematic growth of the city. CDA was established to provide development improvement and expansion of the town of Chittagong and certain areas in its vicinity, with its major roles being development control, promotion and permission.

The major functions of CDA are:

- Preparation of master plan for Chittagong city and the area in the vicinity and its continuous review;
- Preparation of short term and long-term development programs for improvement and expansion of Chittagong city. This includes construction of new roads, widening and improvement of major city roads, construction of shopping complexes, development of industrial and residential estates and commercial plots and other necessary urban developments;
- Exercising planning control over the structure plan as per the provisions of CDA Ordinance and Government approved Master Plan;
- Development control within the preview of Bangladesh Building Construction Acts, 1952 and its subsequent revisions.

### 2.5.5 Department of Public Health Engineering (DPHE)

The Department of Public Health Engineering (DPHE), a national agency under the Ministry of Local Government, Rural Development and Co-operatives (MLGRD&C), is responsible for assisting municipalities and communities in the development and operation of water supply and sanitation infrastructure throughout the country except in Dhaka including Narayanganj, Chittagong, Rajshahi and Khulna where WASAs operate. DPHE's mandate also includes providing advisory services in framing policy and actions plans for water supply and sanitation.

### 2.5.6 Department of Environment (DOE)

Refer to Section 2.2.3.

# CHAPTER 3

# EXISTING WATER SUPPLY AND ON-GOING WATER SUPPLY PROJECT

# CHAPTER 3 EXISTING WATER SUPPLY AND ON-GOING WATER SUPPLY PROJECTS

## 3.1 Existing Water Supply System and Facilities

### 3.1.1 Existing Water Supply Services in Chittagong City

The area covered by the CCC is about 155 square kilometres and consists of 41 wards. The area falls in the jurisdiction of CWASA for water supply services according to the city's ordinances.

The current water sources of CWASA are surface water, which is used at Mohara Water Treatment Plant (WTP) (approximately 91,000 $m^3$/d capacity) and ground water, which is treated at Kalurghat Iron Removal Plant (68,000 $m^3$/d capacity), supplemented by many tube wells (60,000 $m^3$/d). The total production capacity of 219,000$m^3$/d caters for about 47% of the present demand in the CCC area.

The existing water supply network comprises 564 kilometres of transmission and distribution pipelines consisting of various materials (mainly Ductile Iron (DI), Asbestos Cement (AC) and polyvinyl chloride (PVC)). The network directly serves about 45,000 households out of an estimated number of households of more than 600,000 in the CCC area and hydrants (689 units). The overall service area is managed in two Maintenance and Operation Divisions (MOD), namely MOD-I and MOD-II, which are each further divided into two sub-areas. Figure 3.1.1 shows the existing water supply system and served area.

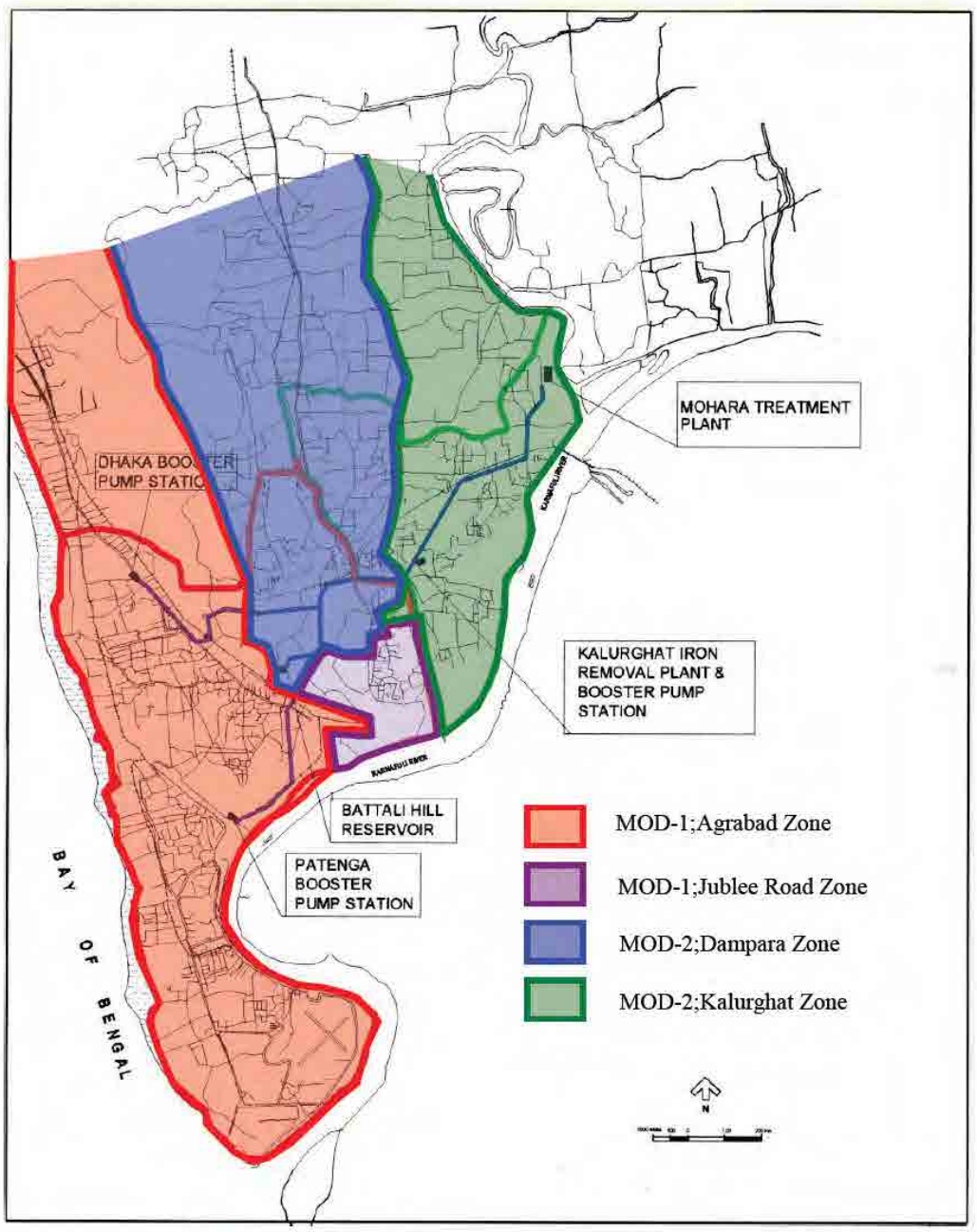



**Figure 3.1.1 Existing Water Supply System and Served Area**

### 3.1.2 Outline of Existing Water Supply Systems in Chittagong City

(1) Kalurghat Water Supply System

The Kalurghat System was constructed in 1977 under the International Development Association (IDA) financed First Chittagong Water Supply and Sanitation Project and subsequently added to in the Second Chittagong Water Supply Project. It was planned to cover the central area of the city by direct pumping from the Kalurghat Iron Removal Plant (IRP) with the provision of Booster Pump Stations (BPSs) and a balancing tank, i.e. old Battali Hill Reservoir. However, water has never been supplied to Battali Hill Reservoir because the reservoir is not watertight, due to structural failure. Therefore, water is directly supplied from the BPSs by pumps.

(2) Mohara Water Supply System

In 1988, the Second Chittagong Water Supply Project was completed with financing by the IDA. In the project, Mohara WTP, ADC Hill Reservoir, Patenga BPS, and Dhaka Trunk Road BPS were constructed, and pipelines connecting those facilities and old Battali Hill Reservoir[1] were also installed. Mohara WTP was constructed to supplement the water from the Kalurghat Water Supply System. In the original plan, the transmission line from Mohara WTP was designed to transmit water to two reservoirs, i.e., old Battali Hill Reservoir and ADC Hill Reservoir, and two booster pump stations, i.e., Dhaka Trunk Road BPS and Patenga BPS. However, water has not been supplied to either reservoir from this source and at present ADC Hill Reservoir is supplied from nearby tube wells. There are two branch pipelines in the Mohara system extending to the Nashirabad Industrial Area, and one pipeline is used as an interconnection pipe with the Kalurghat system.

(3) Operation of the Existing Water Supply System

Four interconnection pipes are installed between the Kalurghat and Mohara system. The valves installed between the two systems are usually open partially in order to relieve water shortages in the Kalurghat system. Consequently, Kalurghat IRP and Mohara WTP jointly serve an integrated water service area. However, the service area has suffered from chronic water supply interruptions due to a shortage of water production capacity.

The interconnections between the two systems force pump operation at lower pressure and larger supply amount from Mohara WTP. At Mohara WTP, two distribution pumps are operated in the daytime, while three pumps are operated during the night-time to supply water to higher elevation and distant areas. However the expected improvement in water supply interruptions has not occurred as of today.

Water pressure is still insufficient to reach both Battali Hill and ADC Hill Reservoirs. As these reservoirs are not used effectively, the whole system cannot cope with the peak water demand in the existing service area. During peak demand hours, water pressure is low in most of the service area and the area where there is disruption to the water supply service increases.

### 3.1.3 Major Water Supply Facilities in Existing Water Supply System

#### 3.1.3.1 Mohara Water Treatment Plant

(1) Treatment Facilities

The existing Mohara WTP (production capacity of 91,000 $m^3$/d) treats surface water from the Halda River and is the first phase out of a planned two phases in the master plan. The High Rate Clarifier – Rapid Sand Filter treatment method is adopted in treatment process. A schematic diagram of the treatment process is shown in Figure 3.1.2.

[1] The pipeline connecting the transmission line with Battali Hill reservoir was also arranged for use as a “floating type reservoir”.

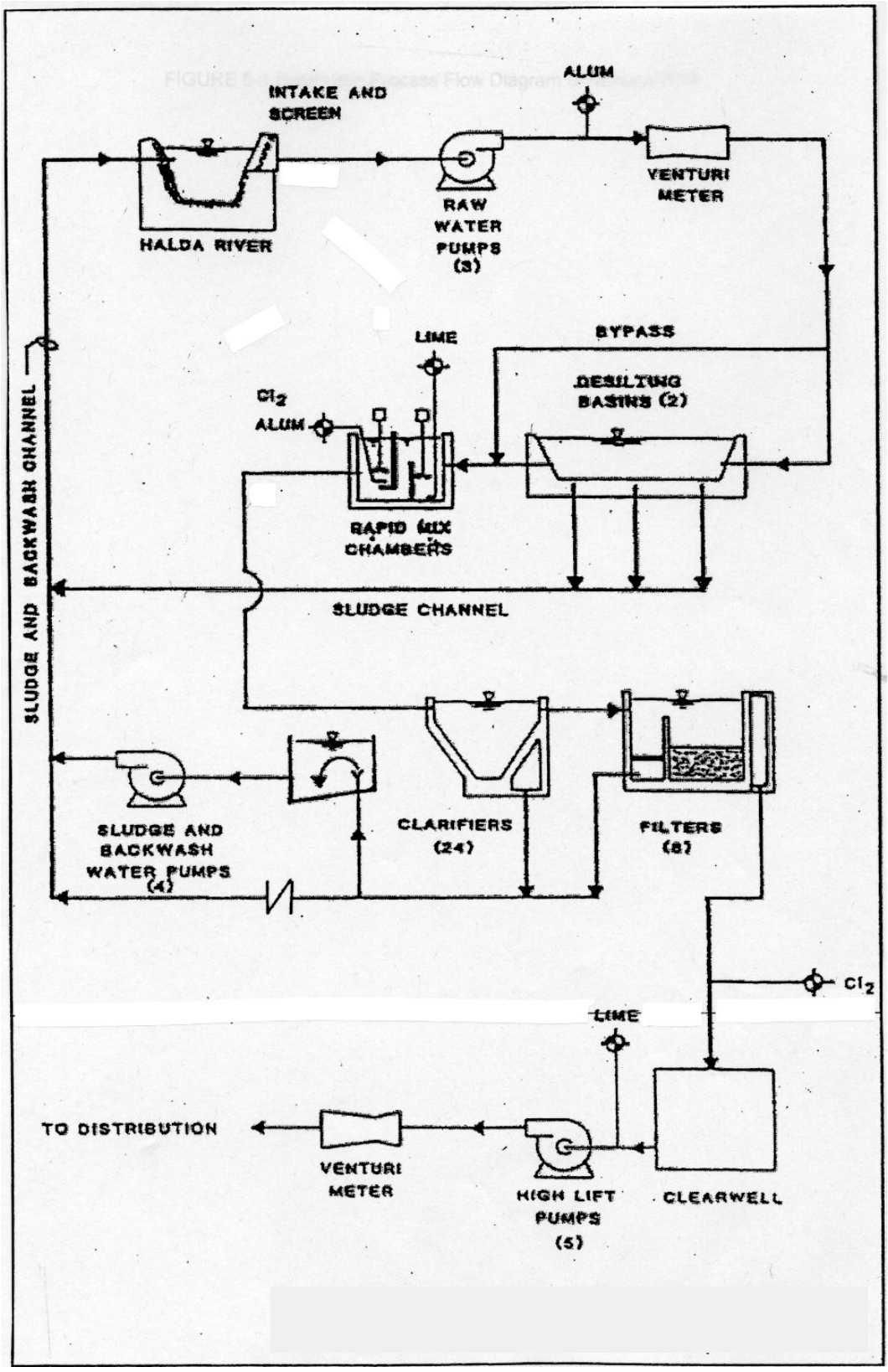



**Figure 3.1.2 Treatment Process of Mohara WTP**

Replacement of some mechanical and electrical equipment at the plant, provision of a standby generator and other works including installation of valves to facilitate operation and maintenance, has recently been completed, with financing by Japanese Government (Mohara and Kalurghat Water Treatment Plants Rehabilitation Project).

The plant consists of intake pumps (raw water pumps), desilting basins, flash mixers, clarifiers, filters, clear water reservoirs, transmission pumps (high-lift Pumps), a wastewater drainage facility, an administration building and a chemical storage building. The design raw water turbidity is 350 NTU. Two desilting basins are installed in order to reduce the load to the clarifiers and filters. All mechanical equipment including intake pumps, flash mixers, transmission pumps and drainage pumps is operated manually.

Land for expansion of the treatment facilities is available within the site area, although the area available is limited. The outline of the facilities is summarized in Table 3.1.1

**Table 3.1.1 Outline of Facilities at Mohara WTP**

| Facilities | Dimension | Capacity/Notes |
|---|---|---|
| Intake Pump | 47 $m^3$/min x 14 m x 160kW x 3 units<br>40$m^3$/min x 12.7m x 132kW x 2 units | new pumps recently installed<br>old pumps; planned to be replaced in the future |
| Desilting Basin | 25.29 m x 134.11 m x 1.98 m x 2 units | 90,900 $m^3$/d |
| Rapid Mixing Chamber | 2.29 m x 2.28 m x 1.45 m x 1 unit | for Lime |
| | 2.29 m x 2.28 m x 1.00 m x 1 unit | for Alum |
| Clarifier | 7.62 m x 7.62 m x 24 units | 90,900 $m^3$/d |
| Filter | (2.44 m x 9.14 m x 2) x 8 units | 90,900 $m^3$/d |
| Clear Water Reservoir | 30.28 m x 39.27 m x Effective Depth 2.88m | Total Depth 4.57m |
| Transmission Pump | 16 $m^3$/min x 83 m x 350 kW x 5 units | 16$m^3$/min x 81 m (Punp recently replaced) |

(2) Treatment Efficiency

The result of water quality analysis in 2010 is summarized in Table 3.1.2. During this year the turbidity of the raw water ranged from 20 NTU to 500 NTU, with the maximum turbidity being lower than the maximum of 830 NTU referred to in the SAPROF report. In the period from May to September turbidity ranged from 80 NTU to 500 NTU, with the maximum turbidity in the months of January, February and December being 70 NTU.

Turbidity of the treated water ranged from 0.5 NTU to 1.20 NTU, meeting the Bangladesh Drinking Water Standard (BDWS: 10 NTU) and WHO guideline (5 NTU). The maximum concentration of manganese in the treated water was 0.12 mg/l. which are slightly higher than the BDWS and WHO guideline of 0.1 mg/l. However, the concentration of the manganese ranged from 0.05 mg/l to 0.12 mg/l, showing an improvement compared to the period between February and August 2000, when it ranged from 0.10 mg/l to 0.16 mg/l.

In 2010 all other parameters complied with the BDWS, with the exception of copper in one month (1.08 mg/l compared to 1.00 mg/l in the BWDS).

**Table 3.1.2 Results of Water Quality Analysis at Mohara WTP**

| No. | Parameter | Unit | Mohara WTP | | | | BDWS | WHO DWG |
|---|---|---|---|---|---|---|---|---|
| | | | Dry Season | | Rainy Season | | | |
| | | | Raw Water* | Treated Water* | Raw Water** | Treated Water** | | |
| 1 | Water Temp. | 0C | 28°C | 25°C | 29°C | 28°C | - | |
| 2 | Conductivity | µS/cm | 246 | 215.60 | 219 | 220.30 | - | - |
| 3 | pH | - | 7.01 | 7.12 | 7.23 | 7.18 | 6.5 ~8.5 | 6.5 ~8.5 |
| 4 | Turbidity | NTU | 70 | 0.96 | 500 | 0.90 | 10 | 5 |
| 5 | T-Alkalinity | mg/litre | 67 | 67 | 63 | 63 | - | |
| 6 | Ca Hardness | mg/litre | | | | | | |
| 7 | T-Hardness | mg/litre | 55 | 50 | 130 | 130 | 500 | 250~500 |
| 8 | $NH_3$-N($NH_3$) | mg/litre | 0.20 | 0.19 | 0.28 | 0.18 | 0.50 | 0.5 |
| 9 | $NO_3$-N($NO_3$) | mg/litre | 3.0 | 3.2 | 2.0 | 1.8 | 44 | 10 |
| 10 | $PO_4$ | mg/litre | 0.32 | 0.58 | 0.32 | - | 6 | 6 |
| 11 | $SO_4$ | mg/litre | 20 | 20 | 17 | 18 | - | 400 |
| 12 | Chloride | mg/litre | 26 | 26 | 28 | 15 | 600 | 600 |
| 13 | Resi. Chlorine | mg/litre | - | | - | - | 0.2 | |
| 14 | T-Fe | mg/litre | 0.28 | 0.32 | 0.60 | 0.55 | 1 | 0.1~1.0 |
| 15 | Mn | mg/litre | | 0.07 | | 0.10 | 0.1 | 0.5 |
| 16 | SS | mg/litre | | | | | 10 | |
| 17 | TDS | mg/litre | 124 | 108 | 210 | 95 | 1,000 | 1,000 |
| 18 | DO | mg/litre | 9.5 | | 7.1 | | 6 | |
| 19 | BOD | mg/litre | 1.3 | | 1.4 | | 0.2 | |
| 20 | COD | mg/litre | 23 | | 20 | | 4 | |
| 21 | Fecal Bacteria | | | | | | | 0 |
| 22 | As | mg/litre | | 0.003 | | 0.004 | 0.05 | 0.01 |
| 23 | Cd | mg/litre | | 0.002 | | 0.003 | 0.005 | 0.005 |
| 24 | Cr | mg/litre | | 0.003 | | 0.002 | 0.05 | 0.05 |
| 25 | Cu | mg/litre | | 0.08 | | 1.08 | 1 | 1 |
| 26 | Pb | mg/litre | | ND | | ND | 0.05 | 0.05 |
| 27 | Hg | mg/litre | | | | | 0.001 | 0.001 |
| 28 | Zn | mg/litre | | 0.15 | | 0.15 | 5 | 5 |
| 29 | Cn | mg/litre | | | | | 0.1 | 0.07 |
| 30 | F | mg/litre | | 0.40 | | 0.53 | 1 | 1.5 |

Sampling Date: * January, 2010 & ** June, 2010
BWDS: Bangladesh Drinking Water Standard (July 1991), ND: not detectable
WHO DWG: Guidelines for Drinking Water Quality (WHO, 2003)

(3) Detail of the Existing Facilities

1) Intake Facility

The intake facility consists of an intake mouth and intake pumps, with the intake mouth constructed at the riverbank and pumps installed in the pump house. River water is pumped after screening to the desilting basins, which are located 300 m from the pump house. During three months of the year from January to March, when turbidity of the raw water is low, water is directly pumped to the rapid mixing chamber to carry out cleaning of the desilting basins

2) Desilting Basin

The two desilting basins are used in order to reduce the load to the clarifiers and filters.

Pre-coagulation by alum is carried out at the inlet to the basins when turbidity exceeds 300 NTU for a period of 3 to 4 months in a year. During operation, sediment is removed every day by opening valves installed on four discharge pipes from the bottom of each basin. During the period from January to March when raw water is directly sent to the rapid mixing chamber settled silt in the basins is dried and removed manually.

3) Rapid Mixing Chamber

The rapid mixing chamber comprises two units of flash mixers installed in series, with lime and alum dosed upstream of each mixer, separately. When raw water is pumped directly to the rapid mixing basins, the water level rises above the designed water level (which is 0.55m below the top of the chamber).

4) Clarifier

Twenty four units of pyramid-type high rate sludge blanket type clarifiers are provided. The inlet pipe to each clarifier is 300 mm diameter at the centre of the clarifier. To retain the slurry interface at a stable level, there is a sludge pocket inside each clarifier and slurry is drained by manually operating a valve. Excess sludge is also drained by manual operation of valves installed on sludge drain pipes. The nature of the floc is basically good and sedimentation occurs even in inlet channel of clarifiers.

5) Filter

There are eight self-backwashing type filters with surface washing equipment. The continuous filtration time ranges from 30 to 40 hours and backwashing is conducted when the filter water depth reaches the critical design depth, 3.66 m at maximum. Currently the backwashing period is eight minutes, with five minutes of surface-washing commencing three minutes after the start of backwashing. Backwashing is carried out manually by judgment of the operators.

6) Clearwater Reservoir

A chlorination channel is installed at the beginning of the clear water reservoir. The reservoir is divided into two tanks, each with a capacity of 3,360 $m^3$, with a total retention time of 1.8 hours. Although the nominal retention time is 3 hours, which would require a capacity of 11,280 $m^3$, the actual retention time is considered to be practicable taking into account of the centre level of the suction pipes of the transmission pumps.

7) Wastewater Discharge Facilities

Wastewater generated at the treatment plant is discharged to the Halda River via a wastewater drain basin. When the water level in the river is low, wastewater can be directly discharged to the river by gravity. If the water level in the river is high, a flap gate which is installed on the effluent pipe is closed and wastewater flows into a wastewater drain basin. Wastewater stored in the basin is drained and discharged to the river by a slurry pump automatically operated by water level switch.

The basin receives wastewater generated in the plant from the following:

- Sludge which is drained from the bottom of the desilting basins
- Slurry which is drained from the slurry blanket and sludge which is drained from the bottom of the clarifiers
- Backwashing wastewater from the filters

8) Chemical Dosage Facilities

Alum as coagulant and lime as pH adjustment agent are dosed to the raw water. The dosing rates are determined based on turbidity, pH and the results of jar tests. Chemical dosing facilities for alum and lime are provided. The design turbidity is 350 NTU.

Post-chlorination is conducted for disinfection and pre-chlorination is also carried out from time to time to remove algae and/or insects.

9) Transmission Pump (High-Lift Pumps)

Five units of transmission pumps including one standby unit are installed in the pump house. The four duty pumps have sufficient capacity when all are operated to transfer the total production capacity to Battali Hill reservoir. However, at present, pumps are operated in low head and large discharge operation to cope with the increased water demand and restrictions caused by the connection with the Kalurghat System.

### 3.1.3.2 Kalurghat Iron Removal Plant (KIRP) and Booster Pump Station

(1) Treatment Facilities

Kalurghat IRP and BPS have nominal capacity of 45,500 $m^3$/d. Ground water containing high concentration of iron is pumped to the IRP from 41 tube wells, the majority of which are scattered in the MOD II area (only two wells are in the MOD I area). Table 3.1.3 summarizes water quality examination results on concerned wells as the sources of KIRP.

Aeration towers, sedimentation basins and filters are installed in the plant for iron removal. Groundwater is aerated by gravity sprinkling aeration towers for oxidization of iron and to disperse the volatile component, such as $CO_2$. Lime is dosed at the inlet of a sedimentation basin to raise pH. Although a chlorine injection facility is provided at the aerators, it is not used at present. Oxidized iron is removed in sedimentation basins and rapid sand filters. Treated water flows into a clear water reservoir and is directly distributed by pumps.

Additional filters with a capacity of 22,000 $m^3$/d located adjacent to the southern edge of the clear water reservoir were constructed in 1987 under the Second Chittagong Water Supply Project. The filters designed to reduce the load on the existing filters as an alternative to increasing the capacity of the IRP treat water without the need for sedimentation. The total treatment capacity of the IRP with the addition of the filters is 68,000 $m^3$/d.

**Table 3.1.3 Results of Water Quality Analysis of Existing Deep Wells for Kalurghat Plant**

| No. | Name of TW | Sampling date | Water Quality | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | pH | Turbid-ity (NTU) | Cl (mg/l) | T-Fe (mg/l) | T-hardn ess (mg/l) | Alkalinity (mg/l) | Mn (mg/l) | No3 (mg/l) | TDS (mg/l) |
| 1 | No.1 TW | Jan,01,2011 | 6.72 | 22 | 20 | 6.7 | 95 | 112 | 0.5 | 1.2 | 135 |
| 2 | No.2 TW | Jan,08,2011 | 6.68 | 18 | 20 | 5.6 | 92 | 110 | 0.4 | 1.0 | 130 |
| 3 | No.3 TW | Jan,15,2011 | 6.92 | 32 | 22 | 7.2 | 90 | 115 | 0.6 | 0.80 | 128 |
| 4 | No.4 TW | Jan,20,2011 | 6.81 | 22 | 18 | 6.9 | 85 | 112 | 0.8 | 0.90 | 137 |
| 5 | No.5 TW | Jan,28,2011 | 6.80 | 26 | 22 | 5.2 | 86 | 140 | 0.5 | 0.8 | 160 |
| 6 | No.6 TW | Feb,02,2011 | 6.84 | 30 | 20 | 5.2 | 65 | 98 | 1.0 | 1.20 | 138 |
| 7 | No.7 TW | Feb,07,2011 | 7.08 | 12 | 18 | 8.2 | 125 | 130 | 1.8 | 1.20 | 112 |
| 8 | No.8 TW | Feb,12,2011 | 7.80 | 16 | 22 | 5.2 | 72 | 112 | 0.8 | 1.0 | 135 |
| 9 | No.9 TW | Feb,18,2011 | 6.84 | 20 | 30 | 1.5 | 78 | 110 | 0.4 | 1.0 | 138 |
| 10 | No.10 TW | Mar,01,2011 | 7.12 | 10 | 32 | 5.4 | 110 | 95 | 0.6 | 1.3 | 158 |
| 11 | No.11 TW | Mar,07,2011 | 7.32 | 12 | 15 | 2.2 | 86 | 92 | 0.4 | 1.2 | 108 |
| 12 | No.12 TW | Mar,13,2011 | 7.48 | 19 | 22 | 6.2 | 62 | 94 | 0.3 | 0.8 | 102 |
| 13 | No.13 TW | Mar,19,2011 | 7.23 | 20 | 25 | 4.2 | 72 | 86 | 0.4 | 2.10 | 132 |
| 14 | No.14 TW | Mar,27,2011 | 6.82 | 12 | 15 | 7.8 | 92 | 140 | 0.9 | 1.50 | 158 |
| 15 | No.15 TW | Apr,03,2011 | 6.68 | 36 | 35 | 15.0 | 110 | 120 | 1.2 | 1.30 | 162 |
| 16 | No.16 TW | Apr,08,2011 | - | - | - | - | - | - | - | - | - |
| 17 | No.17 TW | Apr,13,2011 | 6.68 | 25 | 45 | 6.8 | 92 | 112 | 0.4 | 0.8 | 240 |
| 18 | No.18 TW | Apr,18,2011 | - | - | - | - | - | - | - | - | - |
| 19 | No.19 TW | Apr, 25,2011 | 7.48 | 16 | 23 | 4.1 | 78 | 90 | 0.6 | 0.7 | 145 |
| 20 | No.20 TW | May,01,2011 | 7.68 | 16 | 22 | 9.20 | 95 | 135 | 1.2 | 0.8 | 142 |
| 21 | No.21 TW | May,08,2011 | - | - | - | - | - | - | - | - | - |
| 22 | No.22 TW | May,12,2011 | 6.52 | 22 | 16 | 7.8 | 100 | 120 | 0.8 | 0.5 | 160 |
| 23 | No.23 TW | May,18,2011 | - | - | - | - | - | - | - | - | - |
| 24 | No.24 TW | May,24,2011 | 6.82 | 25 | 15 | 5.80 | 86 | 112 | 0.9 | 0.6 | 142 |
| 25 | No.25 TW | Jun,01,2011 | 7.49 | 17 | 22 | 4.15 | 79 | 93 | 0.65 | 0.68 | 142 |
| 26 | No.26 TW | Jun,08,2011 | 7.70 | 18 | 23 | 9.18 | 93 | 132 | 1.18 | 0.78 | 140 |
| 27 | No.27 TW | | - | - | - | - | - | - | - | - | - |
| 28 | No.28 TW | Jun,18,2011 | 6.55 | 21 | 17 | 7.82 | 101 | 11 | 0.84 | 0.49 | 161 |
| 29 | No.29 TW | | - | - | - | - | - | - | - | - | - |
| 30 | No.30 TW | Jul,23,2011 | 6.85 | 24 | 16 | 5.83 | 84 | 110 | 0.88 | 0.55 | 140 |
| 31 | No.32 TW | | - | - | - | - | - | - | - | - | - |
| 32 | No.33 TW | Jul,30,2011 | 6.84 | 30 | 20 | 5.2 | 65 | 98 | 1.0 | 1.20 | 138 |
| 33 | No.34 TW | Aug,05,2011 | 7.01 | 10 | 16 | 8.1 | 120 | 128 | 1.78 | 1.18 | 110 |
| 34 | No.35TW | Aug,13,2011 | - | - | - | - | - | - | - | - | - |
| 35 | No.36 TW | Aug,19,2011 | 6.98 | 11 | 17 | 8.18 | 118 | 128 | 1.79 | 1.18 | 110 |
| 36 | No.37 TW | Sep,01,2011 | - | - | - | - | - | - | - | - | - |
| 37 | No.38TW | Sep,15,2011 | - | - | - | - | - | - | - | - | - |
| 38 | No.39TW | Oct,15,2011 | - | - | - | - | - | - | - | - | - |
| 39 | Kopolock-2 TW | Nov,01,2011 | 6.78 | 20 | 32 | 6.20 | 90 | 112 | 0.9 | 1.2 | 162 |
| 40 | Fulkoli TW | Nov,15,2011 | - | - | - | - | - | - | - | - | - |
| 41 | Saiyed shah TW | Dec,06,2011 | 6.72 | 28 | 35 | 8.2 | 92 | 135 | 1.5 | 1.2 | 172 |
| Average (Kalurghat No.1-41) | | | | | | 6.52 | | 109.72 | 0.86 | | |
| Max. (Kalurghat No.1-41) | | | | | | 15 | | 140 | 1.80 | | |
| Min. (Kalurghat No.1-41) | | | | | | 1.5 | | 11.0 | 0.3 | | |
| Water Drinking Standard | | | 6.5~8.5 | 10 | <600 | <1.0 | <500 | - | <0.1 | <1.0 | <1,000 |

The newer filters have a blower so as to scour filter media by air during backwashing. The older filters do not have air or surface washing equipment and have been operated with insufficient washing operation resulting in early clogging of filter layers. Table 3.1.4 presents an outline of the IRP.

**Table 3.1.4 Outline of Kalurghat Plant**

| Facilities | Dimensions | Capacity/Notes |
|---|---|---|
| Aeration tower | 3.35 m x13.2 m x 4.44 mH x 2 units | 22,700 $m^3$/d/unit |
| Sedimentation Basin | (46.38～34.16 m) x (79.19～68.52m) x 3.05 mD x 2 units | 22,700 $m^3$/d/unit |
| Old Filter | 4.88 m x 6.71 m x 8 units | 45,500 $m^3$/d |
| New Filter | 8.23 m x 13.30 m x 4 units | 22,700 $m^3$/d |
| Clearwater Reservoir | 29.87 m x 98.45 m x 2.87 m x 1 unit<br>22m x 135m x 6m x 1 unit | Nominal Volume: 9,100 $m^3$<br>Capacity 17,820 $m^3$ |
| Distribution Pump | 18 $m^3$/min x72 m x 315 kW x 4 unit | New pumps recently installed |
| | 14.2 $m^3$/min x 63.4 m x 250 kW x 1 unit | Old pump, planned to be removed |
| | 9.1 $m^3$/min x63.4 m x 200 kW x 1 unit | Old pump, planned to be removed |
| | 12 $m^3$/min x 71.9 m x 200 kW x 2 units | Old pump, planned to be replaced |

(2) Present Status of Iron Removal

In the original design, injection of chlorine and lime into the aeration tower was planned. However, it cannot be used for iron removal efficiently because chlorine is dispersed into the air. At present, only lime dosing is executed at the inlet of the sedimentation basins. Chlorine injection for iron removal purpose is not practiced and oxidization is carried out by the aeration tower only.

Table 3.1.5presents updated water quality examination results (May 26, 2011). The total iron of treated water in the clear water reservoir was 0.87 mg/L, less than WHO standard value of 1 mg/L.

**Table 3.1.5 Iron Removal Status in Kalurghat Iron Removal Plant**

| Sampling No. | Iron (mg/l) | Sampling Point | WHO limit |
|---|---|---|---|
| No. 1 | 6.80 | Aeration tower | 0.1~1.0 |
| No. 2 | 2.90 | Before Aerator | |
| No. 3 | 2.85 | After Aerator | |
| No. 4 | 2.78 | Upstream of Sedimentation Basin | |
| No. 5 | 2.70 | Middle of Sedimentation Basin | |
| No. 6 | 2.73 | Downstream of Sedimentation Basin | |
| No. 7 | 2.73 | Transmission Channel to Filter | |
| No. 8 | 1.18 | After Old Filter | |
| No. 9 | 0.56 | After New Filter | |
| No. 10 | 0.87 | Clear Well | |

*Note: Sampling Date: 26-05-2011*

As chlorine is injected at the inlet channel between the old filter and the clear water reservoir, oxidized iron might be settled in this reservoir. There is only one clear water reservoir and as there is no bypass line to the distribution pumps, the reservoir has never been cleaned. There is a possibility of re-elusion of settled iron to the treated water, which is stored in the reservoir.

(3) Booster Pumps

Pumps which are installed in the booster pump station (BPS) are utilized as distribution pumps. When four pumps are operated, the reservoir becomes empty within five or six hours, so the pumps must be stopped to allow the water level in the reservoir to recover. Because of this the pumps are operated intermittently, five to six hours during daytime and nine hours at night-time.

### 3.1.3.3 Other Water Sources

Thirty two tube wells under MOD-I are operated as of May 2012, as shown in Table 3.1.6. The production capacities of the wells have been gradually decreasing due to clogging of the well screens.

**Table 3.1.6 Production Amount of Tube Wells under MOD-I**

| No. | Pump Name | Pump Type | Horse Power | Production Capacity ($m^3$/hour) |
|---|---|---|---|---|
| 1 | Love lane | Submersible | 60 | 149.82 |
| 2 | Jubilee road | Submersible | 40~55 | 99.88 |
| 3 | Collegiate | Submersible | 75 | 149.82 |
| 4 | Agrabad-1 | Submersible | 10 | 22.70 |
| 5 | Agrabad-2 | Submersible | 12.5 | 49.94 |
| 6 | Agrabad-3 | Submersible | 25 | 49.94 |
| 7 | Halishahar-2 | Submersible | 15 | 36.32 |
| 8 | Firojsha-1 | Submersible | 41 | 99.88 |
| 9 | Firojsha-2 | Submersible | 41 | 49.94 |
| 10 | Firojsha-3 | Submersible | 41 | 99.88 |
| 11 | Halishahar-1 | Submersible | 25 | 49.94 |
| 12 | Goalpara | Submersible | 60 | 99.88 |
| 13 | Policeline | Submersible | 25 | 49.94 |
| 14 | Ice Factory | Submersible | 25 | 49.94 |
| 15 | Jail road | Submersible | 30 | 74.91 |
| 16 | Bakulia | Submersible | 33 | 83.99 |
| 17 | Bahutala | Submersible | 33 | 49.94 |
| 18 | H-L block | Submersible | 25 | 49.94 |
| 19 | CGS colony | Submersible | 25 | 49.94 |
| 20 | MOD-I office | Submersible | 25 | 49.94 |
| 21 | Sadarghat | Submersible | 41 | 99.88 |
| 22 | Haji camp | Submersible | 25 | 49.94 |
| 23 | Dulalabad | Submersible | 25 | 49.94 |
| 24 | Rongipara | Submersible | 13.5 | 29.96 |
| 25 | Uttara | Submersible | 25 | 49.94 |
| 26 | Fire service | Submersible | 25 | 49.94 |
| 27 | Basundara | Submersible | 25 | 49.94 |
| 28 | Hazi para | Submersible | 25 | 49.94 |
| 29 | Al-Nahian | Submersible | 41 | 99.88 |
| 30 | Bisha colony | Submersible | 41 | 99.88 |
| 31 | CSD | Submersible | 41 | 99.88 |
| 32 | Moharipara | Submersible | 25 | 49.94 |

*Note: Data collected from Monthly Performance Report- operation (water) under MOD-I, Reporting month, May, 2012*

There are also two tube wells under MOD-I as of May, 2012, operated to supplement the capacity of the wells supplying Kalurghat IRP (refer to Table 3.1.7).

**Table 3.1.7 Production Amount of Tube Wells for KIRP**

| No. | Pump Name | Pump Type | Horse Power | Production capacity ($m^3$/hour) |
|---|---|---|---|---|
| 1 | Fulkali | Submersible | 62 | 149.82 |
| 2 | Saiyedshah | Submersible | 62 | 149.82 |

*Note: Data collected from Monthly Performance Report- operation (water) under MOD-I, Reporting month, May, 2012*

There are thirty nine tube wells under MOD-II that are operated as of May, 2012, as shown in Table3.1.8. The water from these wells is pumped to Kalurghat IRP. The production capacities of the wells have been gradually decreasing due to clogging of the well screens.

**Table 3.1.8 Production Amount of Tube Wells under MOD-II (1)**

| No. | Pump Name | Pump Type | Horse Power | Production capacity ( $m^3$/hour) |
|---|---|---|---|---|
| 1 | Kalurghat-1 | Turbine | 60 | 75 |
| 2 | Kalurghat-2 | Turbine | 60 | 60 |
| 3 | Kalurghat-3 | Submersible | 72 | 65 |
| 4 | Kalurghat-4 | Turbine | 80 | 100 |
| 5 | Kalurghat-5 | Turbine | 60 | 85 |
| 6 | Kalurghat-6 | Turbine | 60 | 80 |
| 7 | Kalurghat-7 | Turbine | 80 | 70 |
| 8 | Kalurghat-8 | Submersible | 72 | 100 |
| 9 | Kalurghat-9 | Turbine | 50 | 76 |
| 10 | Kalurghat-10 | Turbine | 80 | 120 |
| 11 | Kalurghat-11 | Submersible | 72 | 90 |
| 12 | Kalurghat-12 | Turbine | 60 | 120 |
| 13 | Kalurghat-13 | Submersible | 72 | 40 |
| 14 | Kalurghat-14 | Submersible | 72 | 154 |
| 15 | Kalurghat-15 | Turbine | 80 | 60 |
| 16 | Kalurghat-16 | Turbine | 75 | 40 |
| 17 | Kalurghat-17 | Submersible | 52 | 50 |
| 18 | Kalurghat-18 | Turbine | 60 | 70 |
| 19 | Kalurghat-19 | Submersible | 25 | 17 |
| 20 | Kalurghat-20 | Turbine | 60 | 70 |
| 21 | Kalurghat-21 | Submersible | 72 | 60 |
| 22 | Kalurghat-22 | Submersible | 52 | 43 |
| 23 | Kalurghat-23 | Turbine | 60 | 90 |
| 24 | Kalurghat-24 | Turbine | 75 | 34 |
| 25 | Kalurghat-25 | Submersible | 52 | 50 |
| 26 | Kalurghat-26 | Submersible | 41 | 80 |
| 27 | Kalurghat-27 | Turbine | 60 | 15 |
| 28 | Kalurghat-28 | Turbine | 75 | 160 |
| 29 | Kalurghat-29 | Submersible | 72 | 154 |
| 30 | Kalurghat-30 | Submersible | 72 | 150 |
| 31 | Kalurghat-32 | Turbine | 75 | 70 |
| 32 | Kalurghat-33 | Turbine | 60 | 76 |
| 33 | Kalurghat-34 | Turbine | 60 | 40 |
| 34 | Kalurghat-35 | Submersible | 72 | 90 |
| 35 | Kalurghat-36 | Submersible | 72 | 70 |
| 36 | Kalurghat-37 | Submersible | 72 | 110 |
| 37 | Kalurghat-38 | Submersible | 52 | 72 |
| 38 | Kalurghat-39 | Submersible | 52 | 120 |
| 39 | Kolphlock-2 | Submersible | 72 | 156 |

*Note: Data collected from Monthly Performance Report- operation (water) under MOD-II, Reporting month, May, 2012*

There are also fourteen tube wells under MOD-II that are operated to provide water directly to the consumers as of May, 2012 (refer to Table 3.1.9).

**Table 3.1.9 Production Amount of Tube Wells under MOD-II (2)**

| No. | Pump Name | Pump Type | Horse Power | Production capacity ($m^3$/hour) |
|---|---|---|---|---|
| 1 | Almas | Submersible | 72 | 50 |
| 2 | Mehedibag | Submersible | 18 | 11 |
| 3 | Ambagan | Submersible | 25 | 13 |

| No. | Pump Name | Pump Type | Horse Power | Production capacity ($m^3$/hour) |
|---|---|---|---|---|
| 4 | Khulshi | Submersible | 25 | 11 |
| 5 | Jalalabad | Submersible | 25 | 21 |
| 6 | Polytechnical | Submersible | 25 | 7 |
| 7 | Hilview | Submersible | 18 | 20 |
| 8 | Momenbag | Submersible | 62 | 66 |
| 9 | Shersha | Submersible | 25 | 44 |
| 10 | Bayzid | Submersible | 25 | 17 |
| 11 | Roufabad | Submersible | 25 | 42 |
| 12 | Garibullah | Submersible | 25 | 32 |
| 13 | MOD-2 pump | Submersible | 41 | 80 |
| 14 | Parsival Hill | Submersible | 25 | 50 |

*Note: Data collected from Monthly Performance Report- operation (water) under MOD-II, Reporting month, May, 2012*

### 3.1.3.4 Existing Water Distribution System

(1) Existing Pipeline

The major transmission and distribution pipelines in the city were installed from 1966 to 1979 under the First Chittagong Water Supply and Sanitation Project. In this project AC pipe were used, with DI pipes being used in the Second Water Supply Project. For smaller size pipes with diameter less than or equal to 300 mm, PVC pipe have been used more recently. The total length of the existing pipelines is estimated at about 564 km, with the pipe length and materials by diameter shown in Table 3.1.10. However, the location of the pipes is difficult to identify due to lack of as-built drawings, as confirmed by the Project for Advancing Non Revenue Water Initiative (PANI).

**Table 3.1.10 Length of Pipelines**

| Diameter (mm) | Length (m) | | | | |
|---|---|---|---|---|---|
| | Ductile Iron (DI) | Asbestos (AC) | PVC | Other (MS pipe) | Total |
| 100 | 0 | 8,720 | 261,526 | 33 | 270,279 |
| 150 | 0 | 18,920 | 64,180 | 0 | 83,100 |
| 200 | 0 | 17,720 | 67,258 | 12 | 84,990 |
| 300 | 5,523 | 46,959 | 6,280 | 0 | 58,762 |
| 450 | 5,123 | 23,894 | 0 | 0 | 29,017 |
| 600 | 11,108 | 13,024 | 0 | 0 | 24.132 |
| 750 | 1,910 | 0 | 0 | 0 | 1,910 |
| 900 | 10,325 | 0 | 0 | 0 | 10,325 |
| 1200 | 1,570 | 0 | 0 | 0 | 1,570 |
| Total | 35,559 | 129,237 | 399,244 | 45 | 564,085 |

*Source: Inventory and Valuation of Fixed Assets CWASA*

Table 3.1.11 shows the existing pipe length by pipe material and installed year (the part of pipes within limited information available).

**Table 3.1.11 Pipe Length by Pipe Materials and Installed Year**

| Pipe Material | Length (m): Installed Year | | | | | |
|---|---|---|---|---|---|---|
| | Total | Before 1970 | 1971-80 | 1981 –90 | 1991 –2000 | 2001 - |
| PVC | 150,600 | 17,500 | 100,900 | 11,700 | 20,500 | |
| AC | 128,000 | 51,200 | 70,100 | 6,700 | 0 | |
| DI | 129,900 | | | 129,900 | | |

*Source: Inventory and Valuation of Fixed Assets CWASA*

(2) Area Served by Existing Distribution System

The location of the main pipelines as well as treatment plants and other major facilities is shown in Figure 3.1.3. The two systems i.e., the Kalurghat system and the Mohara system have an integrated water supply network without division into small service blocks. Even in the case of the existence of a small-scale elevated tank, the distribution volume is controlled by open-close operation of supply valve, without any systematic schedule. At present, under the considerable shortage of water supply capacity, intermittent water supply by valve operation is executed as daily practice or upon end users' request.

In the North Halishahar and Rampur areas, located in south of the Dhaka Trunk Road BPS, people suffer chronic water shortages which has been exacerbated by rapid population growth in the area. As Friday is a non-working day in the CEPZ, which is one of the largest consumers served by Patenga BPS, water is sent to the above two areas from Patenga BPS from Thursday night to Friday night by shifted valve operation. Such "intermittent water supply" is practiced with the provision of ground storage tanks by families, who typically have a storage tank with a capacity of 10 $m^3$ or more each in their premises.

(3) Kalurghat System

The distribution trunk main from Kalurghat IRP, diameter of 600 mm, is connected to Battali Hill reservoir (capacity approximately 13,600 $m^3$), which is the largest reservoir in the water supply system. As this reservoir was designed as a floating tank, a single connection pipe with a diameter of 600 mm was used for both the inlet and outlet pipes. From this distribution trunk main, two semi-trunk mains each with a diameter of 450 mm are extended to Dhaka Trunk Road BPS and Patenga BPS. However, currently treated water at Kalurghat IRP is directly supplied by pumps without utilizing Battali Hill reservoir because of the low working pressure.

A pipe with a diameter of 450 mm from Kalurghat IRP is connected to the transmission pipe from Mohara WTP, which has a diameter of 900 mm. Thus, Mohara system together with Kalurghat system directly distributes water without using existing reservoirs. Interconnection pipes between the two systems were installed without a systematic hydraulic study for the distribution being carried out. Intermittent pump operation has been forced due to insufficient capacity of the existing clear water reservoir (as stated previously) and limited water production by the wells.

(4) Mohara System

The Mohara system was designed to transmit treated water to Battali Hill reservoir, ADC Hill reservoir, Dhaka Trunk Road BPS and Patenga BPS.

Presently, Mohara WTP supplies treated water by high lift pumps without using Battali Hill reservoir. During daytime, two units of pumps are operated while three units are operated in night-time, from 11:00 or 12:00 pm to 8:00 am. To cope with the fluctuation of distribution flow, such irregular plant operation has been forced with continuous monitoring of water level in the clear water reservoir at the WTP. In addition, as distribution is carried out without a reservoir the peak demand cannot be met.

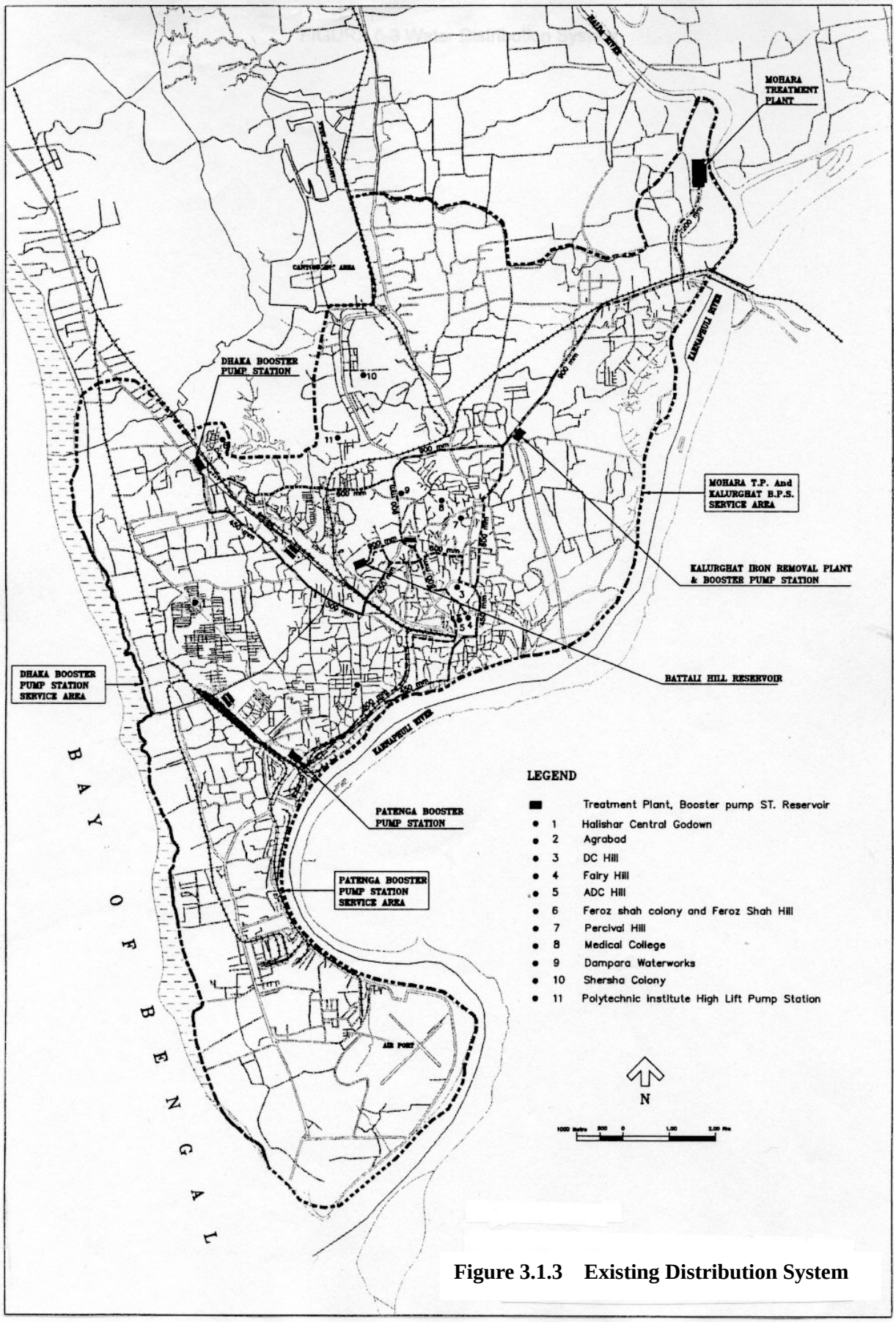



**Figure 3.1.3 Existing Distribution System**

With the exception of some locations, the service area of the Mohara and the Kalurghat systems is generally flat with an elevation of about 5 m. Since water supply capacity is limited, the areas located at the end of distribution pipelines or fringe parts of the service area cannot receive sufficient volume and water supply interruption occurs frequently during the period when areas near the WTP are receiving sufficient water.

(5) Small-scale Water Supply Systems

Besides the Mohara and the Kalurghat systems, several small-scale water supply systems are also utilized. The water source of the systems is groundwater. The typical system consists of a well source and a ground reservoir or an elevated tank and water is delivered by gravity. Most of them were constructed during the age of East Pakistan and no drawings of the facilities are available. Most of the groundwater from the existing wells contains high iron.

(6) Reservoirs and Booster Pump Stations

Among the existing reservoirs (excluding those at WTP and IRP), Battali Hill Reservoir has the largest storage capacity of about 13,600 $m^3$, followed by ADC Hill Reservoir having 4,546 $m^3$. Other reservoirs are small, namely; Agrabad elevated tank with 568 $m^3$, and other elevated tanks and ground reservoirs with a volume of 454 $m^3$ or less. The storage capacity and water level of each reservoir and elevated tank are shown in Table 3.1.12.

**Table 3.1.12 Reservoirs and Elevated Tanks**

| Reservoir / Name | | Capacity $m^3$ | Water Level | | Remarks |
|---|---|---|---|---|---|
| | | | HWL(m) | LWL(m) | |
| 1 | Mohara WTP | 11,364 | 4.9 | 2.75 | in use |
| 2 | Kalurghat IRP & BPS | 9,092 | 3.32 | 0.0 | in use |
| 3 | Halishahar Central Godown | | | | |
| 3-1 | Tank 1 RC Elevated Tank | 455 | 29.3 | 24.7 | in use |
| 3-2 | Tank 2 RC Ground Reservoir | 227 | 10.0 | NA | in use |
| 4 | Agrabad RC Elevated Tank | 568 | 25.3 | 21.9 | in use |
| 5 | DC Hill RC Elevated Tank | 455 | 48.8 | 43.9 | in use |
| 6 | Fairy Hill | | | | |
| 6-1 | Tank 1 RC Elevated Tank | 455 | 40.5 | 36.0 | not in use |
| 6-2 | Tank 2 SS Elevated Tank | 796 | 36.1 | 28.8 | no tank |
| 7 | ADC Hill Ground Tank | 4,546 | 38.1 | 33.5 | in use |
| 8 | Ferojshah Hill | 227 | 46.0 | NA | in use |
| 9 | Ferojshah Colony | 45 | 15.0 | NA | in use |
| 10 | Battali Hill | 13,638 | 51.5 | 42.7 | not in use |
| 11 | Percival Hill | 455 | 42.7 | 38.1 | in use |
| 12 | Medical College | | | | |
| 12-1 | Water Tower RC Elevated Tank | 45 | 25.0 | NA | in use |
| 12-2 | Reservoir RC Ground Reservoir | 455 | 43.6 | 40.2 | in use |
| 13 | Dampara Waterworks RC Round Reservoir | 455 | 15.0 | NA | in use |
| 14 | Sherahah Collony RC Ground Reservoir | 68 | NA | NA | not in use |
| 15 | Parada Comer RC Ground Reservoir | 68 | NA | NA | in use |
| 16 | Polytechnic Institute High Lift Pimp Station | 455 | NA | NA | not in use |
| | **Total** | **46,142** | | | |

There are two existing booster pump stations, namely; Dhaka Trunk Road BPS and Patenga BPS, having in-line boost pumping structure without a receiving tank.

## 3.2 On-going and Planned Water Supply Studies and Projects

Many studies for the improvement of water supply in Chittagong city have conducted through international technical assistance (JICA, JBIC and KOICA). Master plan for Water Supply and Wastewater Management of the Detailed Planned Area of Chittagong was prepared by KOICA in 2009 (utmost recent water supply study covering entire Chittagong city beyond CCC area). The following are on-going projects as of today.

### 3.2.1 Karnaphuli Water Supply Project (Phase 1)

**A. Physical Works**

(1) Purpose of the Project

To improve living standard of urban dwellers and investment climate in Chittagong City by developing water supply facilities and institutional capacity of CWASA.

(2) Scope of the work for the Project and Construction Packages

The water intake is located near the Godown Bridge, Rangunia on the right bank of the Karnaphuli River. The treatment plant will be constructed in Pomra along the Roads and Highways Department (RHD) main road. Treated water will be pumped to the Nashirabad reservoir through a 1,200mm diameter transmission pipeline. It is planned that Nashirabad reservoir would distribute water to Khulshi, Fatehabad, Nashirabad and Salimpur service blocks through an elevated tank with a capacity of 2,200 $m^3$. A part of the water will be pumped further to Battali Hill reservoir. Battali Hill reservoir is planned to distribute water to Kotowari, Halishahar, Agrabad and Madar-Bari service blocks.

The following are three construction packages.

1) Contract No. KWSP-C-1: Intake Facility and Water Treatment Plant

   - Intake Facility: Civil/Architectural Works for 300,000 $m^3$/day
     Mechanical/Electrical Works for 150,000 $m^3$/day
   - Water Treatment Plant: Production Capacity 143,000 $m^3$/day

2) Contract No. KWSP-C-2: Transmission and Distribution Pipelines

   - Conveyance pipeline (1,200mm x 3.6 km)
   - Transmission pipelines (1000/1200mm x 29.9 km) including Bridge crossing of Pipeline over Halda River
   - Distribution pipelines (300-1,200mm x 42.8 km)

3) Contract No. KWSP-C-3: Nashirabad Reservoir(26,300 $m^3$), Battali Hill Reservoir (8,500$m^3$), and transmission/ distribution pumps
   - Nashirabad Elevated Tank: capacity 2,200$m^3$
   - Battali Hill Reservoir: capacity 8,500$m^3$
   - Khulshi Booster Pump Station: rehabilitation work

Table 3.2.1 presents planned schedule for the construction packages. The outline of the Karnaphuli Water Supply System is shown in Figure 3.2.1.

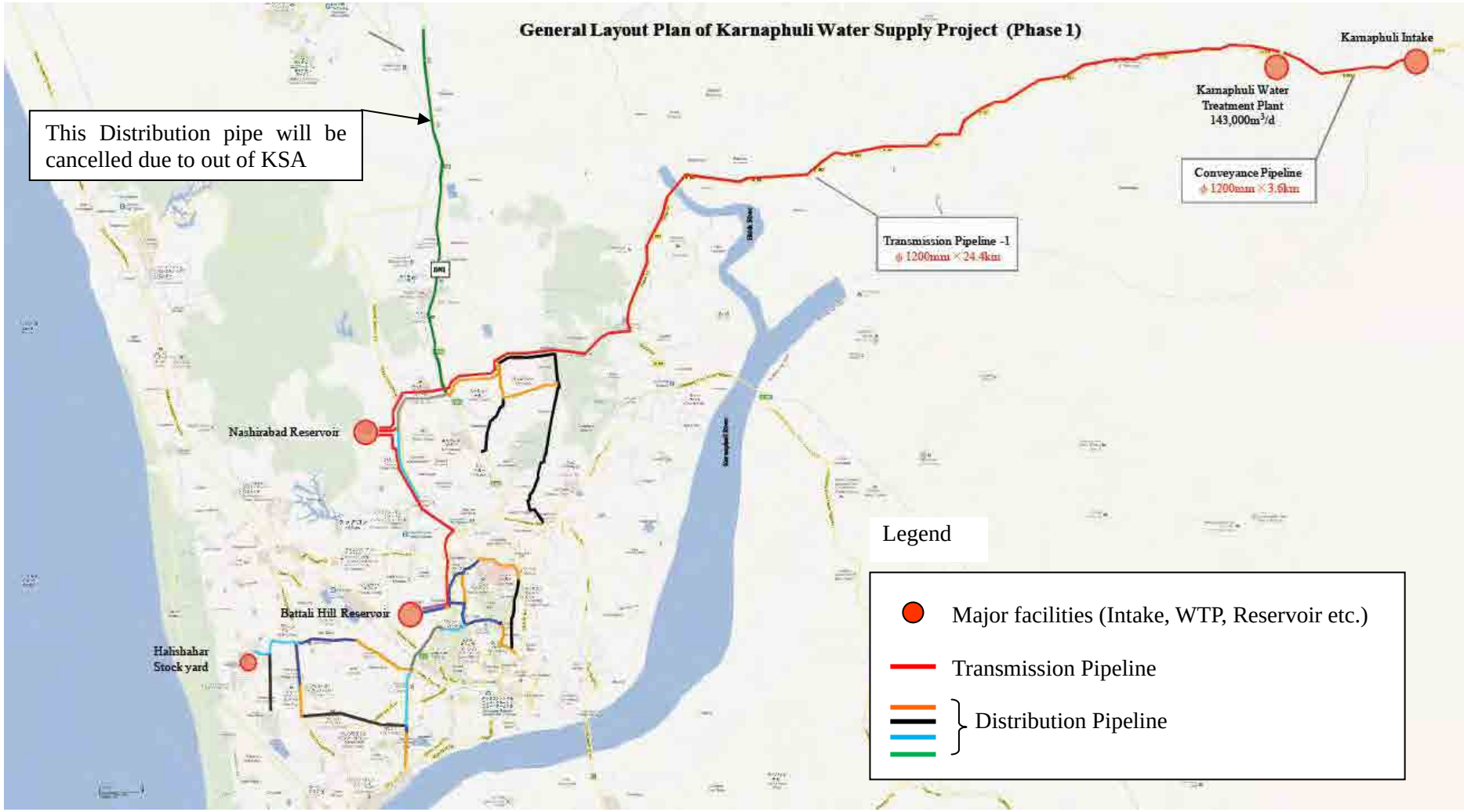



**Figure 3.2.1 Outline of Karnaphuli Water Supply Project**

**Table 3.2.1 Construction Schedule by Package**

| Description | Package 1 (KWSP-C-1) | Package 2 (KWSP-C-2) | Package 3 (KWSP-C-3) |
|---|---|---|---|
| Contractual Commencement Date | 11/20/2011 | 04/18/2012 | 02/09/2011 |
| Contractual Completion Date | 05/19/2014 | 10//04/2014 | 08/08/2013 |

(3) Status of the Project

Present progress status of the three packages is summarized as follows as of end of November 2012:

1) C-1 package: physical progress is reported at 11%
2) C-2 Package: physical progress is reported at 7%.
3) C-3 package: physical progress is reported at 61%.

With reference to the delay of C-2 Package, the following is relevant information.

At present work is on-going only in the CCC area, where trial pits are being carried out and pipe installation was scheduled to start in July, 2012. However, there was an objection from RHD, Ministry of Communication regarding laying 34 km of conveyance and transmission mains along the stretch from Madunaghat to the entrance to Chittagong University of Engineering and Technology and to the intake structure.

The RHD prefers that the Contractor lays the pipes outside the existing road surface. This is different from the original plan (and Contract), which is to install pipes under the road. Various problems will arise if the alignment is changed as per RHD's preference, such as (i) need for survey and design of the pipeline for revised alignment of pipeline, (ii) relocation of households would be required, (iii) the removal of hundreds of old and young trees would be required, (iv) demolition of stores, businesses, etc. Negotiations between CWASA and RHD had been continued for more than 3 months. The permission on the pipe laying was obtained on October 3, 2012. Then, the contractor started construction work in the middle of October, 2012.

**B. Institutional Works**

JICA extended technical assistance for the development of the institutional capacity of CWASA (Institutional Development Consultancy Services (IDCS)) as follows:

(1) Purpose of the IDCS

The purpose of the IDCS is to strategically improve CWASA's medium and long term management capacity to ensure the operational sustainability of CWASA in the post-implementation period of the Karnaphuli Water Supply Project.

(2) Scope of Services in the IDCS

The Consulting services consist of (1) business plan, (2) organizational restructuring, (3) legal and regulation, (4) water supply for slum dwellers, and (5) computerization of accounting system.

1) Business Plan

   a) Assist CWASA to review the existing "Investment Plan" that includes new water production and distribution facilities that may be financed by donors and the GOB.

b) Assist CWASA to prepare an appropriate tariff structure including step tariff. This should take into account of customer's willingness to pay, affordability to pay and cost recovery of capital investment in a reasonable period.
c) Assist CWASA to prepare a "Revenue and Expenditure Plan" that considers tariff setting, water demand, billing and collection, NRW in the revenue, as well as operation and maintenance cost, number of staff, etc.
d) Assist CWASA to prepare a "Loan Repayment Plan" that considers the conditions of Subsidy Loan Agreements between CWASA and GOB, such as interest rate and repayment period.
e) Assist CWASA to prepare an integrated "Financial Model" of CWASA under the new organizational structure. The Investment Plan, the Revenue and Expenditure Plan and the Loan Repayment Plan prepared by the International Consultant (Business Plan) should be incorporated into the Financial Model.
f) Assist CWASA to prepare an initial 5-year Rolling Business Plan that should include the financial viability of CWASA by using the "Financial Model" prepared by the national Specialists (Business Plan) as well as the financial statement of CWASA.
g) Assist CWASA to update the Business Plan on an annual basis by the end of FY. The first two year's updates should take into account the other activities in the long-term action plans

2) Organizational Restructuring

a) Assist CWASA to create a "Transitional Plan" and implement the Plan
b) On- the- job Training

3) Legal and Regulation

a) Assist CWASA to review current acts, ordinances and regulations and propose new acts, ordinances and regulations.

4) Water Supply for Slum Dwellers

a) Assist CWASA to formulate schemes to provide water for the urban poor
b) Review lessons learned from the experience in other organizations

5) Computerization of Accounting System

a) Mobilization of the accounting and billing systems
b) On- the –Job training

(3) Status of the services

The assistance work for the institutional improvement of CWASA is on-schedule as of July, 2012. The Consultants inputs as of October, 2012 are reported at 71% of the scheduled. Supporting Report 3.3 shows the road map for the implementation of the services.

### 3.2.2 Project for Advancing NRW Reduction Initiative (PANI)

(1) Purpose of the project and scope of work

The purpose of the project is to provide CWASA staff with technology transfer for the improvement of capacity building with reference to the reduction of NRW. The area covered by PANI is limited to four pilot areas/zones, as shown in Figure 3.2.2, for which a redeveloped pipeline network MAP using

(Geographical Information Systems) GIS Mapping and high resolution satellite image was prepared, as referred to in the major activities below. Project activities also included house-to-house surveys to verify the functional status of water meters. The following are specific goal of the project.

1) Completion of Baseline Survey, Customer, Water Meter, Water Consumption & Billing
2) Installation of NRW Reduction Task Force, Meter Replacement/Installation, Monitoring
3) Transfer of Ownership of Service Connection & Water Meter
4) Renovation of Water Meter Testing Laboratory & Meter Storage Warehouse.
5) Installation of NRW Reduction Task Force, Meter Replacement/Installation, Monitoring
6) Installation of GIS Operation Group, Development and Operationalize Various Database

To achieve the goal, the major activities are:

a) Organize NRW Reduction Management & Action Teams,
b) Develop NRW reduction long term and annual work plan,
c) Implement pilot project for on the job training of NRW reduction work,
d) Redevelop GIS Map and information on distribution networks.

(2) Present status of the project

1) Redevelopment of distribution network drawings in use of GIS Mapping and high Resolution Satellite image in model area.
2) Field verifications survey to identify pipelines
3) Underground utilities survey (Test excavation)
4) House to House survey to verify functional status of water meter

(3) Issues and Problems on the on-going works

1) Absence of Reliable drawings of distribution net work
2) No updated record of drawings
3) Absence of accurate topographic map in Chittagong City.
4) Inappropriate customer data management due to absence of map

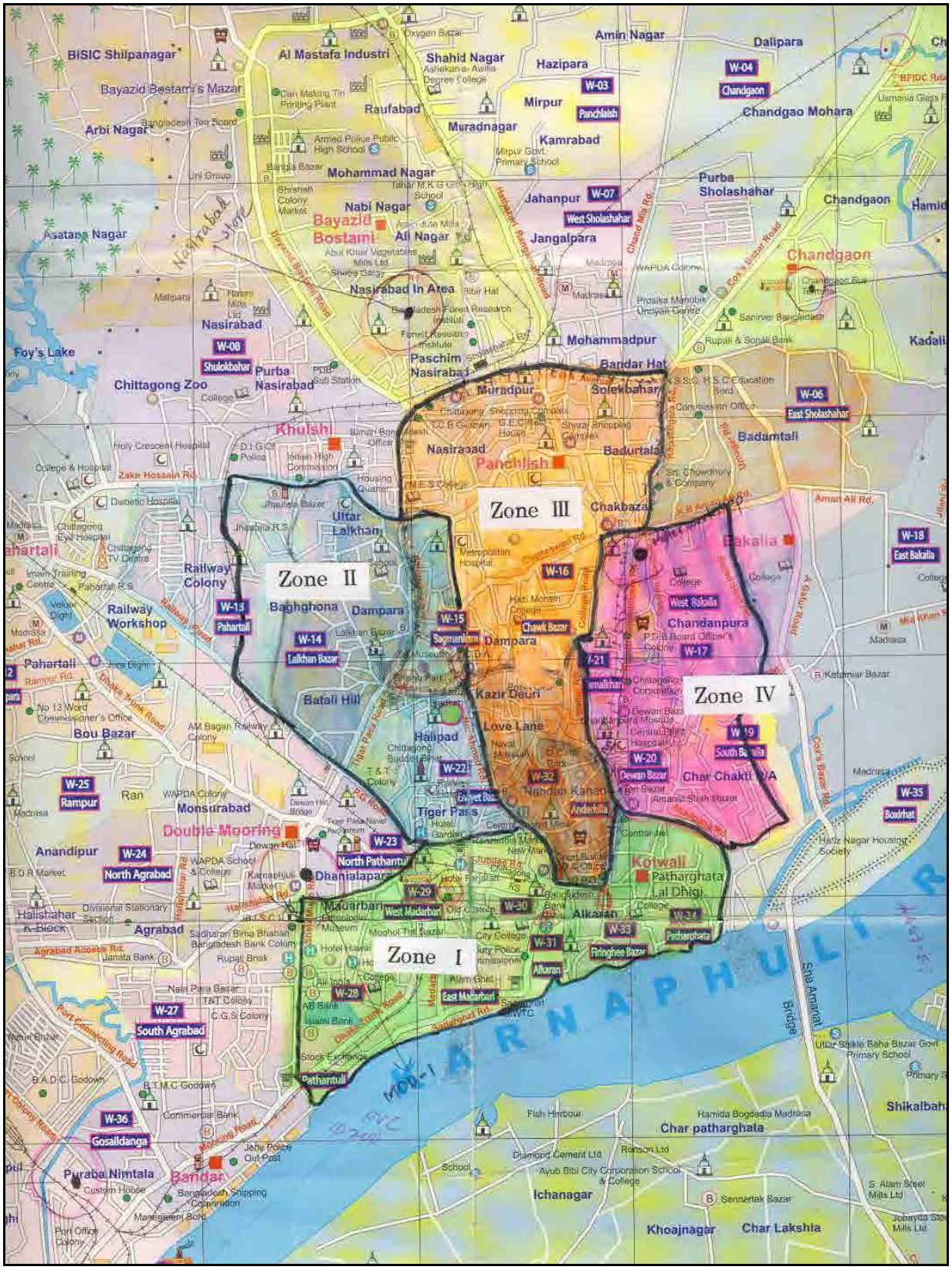



**Figure 3.2.2 Location of PANI Area**

5) No updated information of water meters installed at customers

Table 3.2.2 shows one of the outputs of the study for reduction of NRW in pilot areas.

**Table 3.2.2 Experience on the Reduction of NRW in Provision/Replacement of Water Meter**

| Pilot Area | No of Connec-tions | Served Popula-tion | Survey Date | | No. of Work-ing Meters | (1) Water quantity supplied ($m^3$) | (2) Water Con-sumption ($m^3$) | NRW (%): (2)/(1) |
|---|---|---|---|---|---|---|---|---|
| Khulshi | 172 | 1049 | Before | 2011.1 | 72 | 1474 | 659 | 55% |
| | | | After | 2011.2 | 129 | 1086 | 776 | 29% |
| | | | | 2012.5 | 152 | 2756 | 2230 | 19% |
| Chandgaon-A | 201 | 1226 | After | 2011.10 | 191 | 3957 | 3390 | 14% |
| | | | | 2011.2 | 199 | 1626 | 1403 | 13% |
| Chandgaon-B | 304 | 1854 | After | 2012.2 | 302 | 1951 | 1700 | 12% |
| Agrabad | 234 | 1427 | After | 2012.4 | 229 | 1079 | 891 | 17% |
| Halishahar | 128 | 781 | After | 2012.4 | 84 | N A | N.A | - |

*Note: Data collected from PANI on 03-07-2012*

### 3.2.3 Chittagong Water Supply Improvement and Sanitation Projects (financed by the World Bank)

Financing Agreement between GOB and International Development Association (IDA) was made for the Project on July 26, 2010. Then, the Subsidiary Loan Agreement was made between GOB and CWASA on October 19, 2010.

The project is targeted at infrastructure investments for increasing production of safe water by CWASA, coupled with the rehabilitation and expansion of its water distribution network to increase access to safe water within its service area. The project will also support the comprehensive institutional development of CWASA. In parallel, the clarification of institutional mandates for sewerage and drainage in Chittagong, and identification and design of priority investments will be supported. The Project consists of two major components as follows:

- Water Supply and Sanitation
- Sewerage and Drainage- US$ 9.5 Million including contingencies.

Note: Information source is Project Appraisal Documents, May 27, 2010.

Proposed works include the following:

(1) Construction of Madunaghat Water Treatment Plant, production capacity 90,000 $m^3$/d.

(2) Development of Transmission and Distribution System and Other Works

1) Madunaghat WTP to Nashirabad Reservoir (45,000$m^3$/d); 12.00km long pipeline, 900mm diameter.
2) Madunaghat WTP to Kalurghat Booster Pump station (45,000$m^3$/d); 9.00km long pipeline, 900mm diameter.
3) Kalurghat Booster Pump station to Patenga Booster Pump station (25,000 $m^3$/d); 13.00km long pipeline, 750mm diameter.

4) Rehabilitation of Kalurghat and Patenga BPSs

(3) Development of Drainage and Sanitation System

(4) Rehabilitation of existing CWASA distribution facilities

1) Distribution network in North Mohara Service block (20,000$m^3$/d, 80 km long with 10,000 connections)
2) Distribution network in South Mohara Service block (25,000 $m^3$/d, 50 km long with 15,000 connections)
3) Extension of water supply and sanitation services expanding to urban slums (phase-1)

The Government of Bangladesh agreed to lend to CWASA the amount in Taka equivalent to SDR 112,500,000 (equivalent to US$ 170,010,000). The Government opens a Subsidiary Loan Account on its books in the name of CWASA. CWASA shall pay to the Government interest on Principal of the Subsidiary Loan outstanding from time to time, at the 5% per annum. The execution of the agreement was scheduled to start on June 30, 2011 to complete June 30, 2030.

The EIA report for the project has been approved by the DoE and selection of Consultants is in progress for package (1).

### 3.2.4 Emergency Water Supply Project financed by GOB

CWASA has been undertaking Emergency Water Supply Project financed by GOB from January, 2010 to complete on June, 2013. The project was designed to construct 30 deep wells in CCC area to produce a total of 20,000$m^3$/d.

## 3.3 Organization and Activities of CWASA

### 3.3.1 Historical Background and Legal Status of CWASA

Chittagong Water Supply and Sewerage Authority (CWASA) was first established in 1963 under the East Pakistan Water Supply and Sewerage Ordinance 1963 for the purpose of providing water supply, sewerage and storm water services to the city of Chittagong.

The name of the Ordinance was changed to the Water Supply and Sewerage Authority Ordinance in 1984 after the independence of Bangladesh. The Water Supply and Sewerage Authority Act (WASA Act 1996) enacted in 1996 repealed the previous Ordinance and provided for the establishment of Water Supply and Sewerage Authorities to provide water supply, sewerage and drainage services to the cities and towns in Bangladesh.

The WASA Act 1996 prescribes that the Government shall establish an Authority that carries out water supply and sewerage services with an autonomous corporate management in local areas by notification in the official Gazette.

Whereas the Dhaka Water Supply and Sewerage Authority (WASA) was reorganized to an autonomous corporate soon after the WASA Act 1996 came in force, CWASA remained in direct control of the Ministry of Local Government, Rural Development and Cooperatives (MLGRD&C) until 2008.

CWASA has been vested to reorganize to an autonomous corporate with the Gazette issued in May 2008. Under the WASA Act, the CWASA's equity is fully owned by the Government, and the CWASA's Management Board is organized with the Board Members appointed by the Government.

13 Board Members was officially appointed by LGRD&C at the date of 31st July 2012, and the first Board Meeting was held on 1st September 2012.

The first Board Meeting determined to remain the present Managing Director and three Deputy Managing Directors in office, and the Government is in process of approval on the appointed Managing Director and Deputy Managing Directors.

As such, CWASA's management has started a new era.

### 3.3.2 Organization and Staffing of CWASA

Figure 3.3.1 shows the current organization of CWASA and the numbers of personnel presently sanctioned by the MLGRD&C and actually positioned. The Managing Director executes the management of CWASA under the policy determined by the Management Board.

The current organization, as shown in the organization chart, broadly comprises three departments, namely Engineering, Finance and Administration, and each department has a Deputy Managing Director in charge.

**A. Engineering Department**

The Engineering Department has a Chief Engineer under the Deputy Management Director (Engineering) to manage this department.

It comprises three circles named Treatment & Production Circle, Maintenance, Operation & Distribution Circle, and Planning & Construction Circle, each organized as follows:

(1) Treatment & Production Circle:

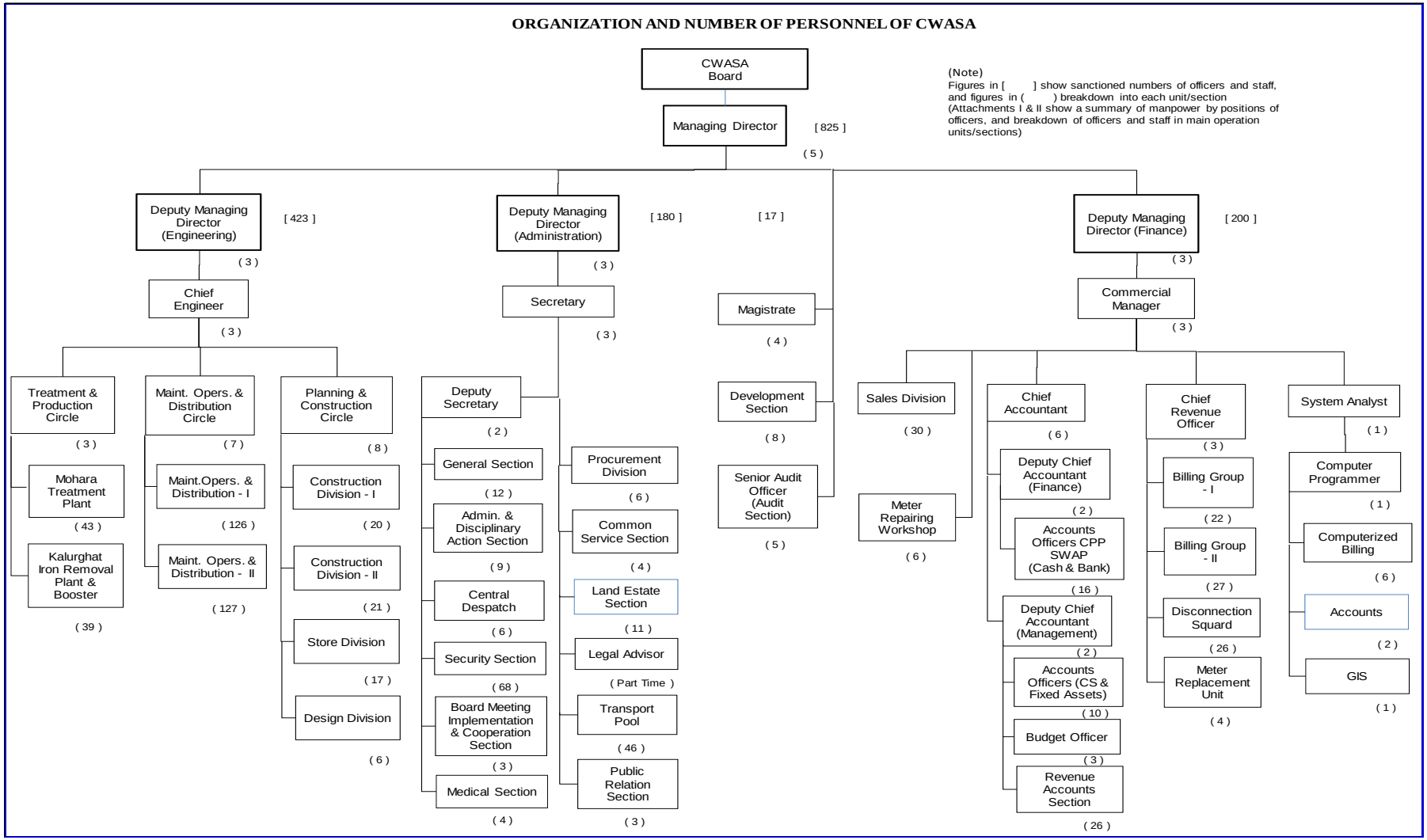
The Treatment & Production Circle is headed by a Superintendent Engineer and has two operational units; Mohara Water Treatment Plant (WTP) Unit, and Kalurghat Iron Removal Plant Unit.

(2) Maintenance, Operation and Distribution Circle:

The Maintenance, Operation and Distribution Circle are headed by a Superintendent Engineer and consist of two divisions named Maintenance, Operation and Distribution – I and Maintenance, Operation and Distribution – II.

(3) Planning & Construction Circle:

The Planning & Construction Circle consists of four Divisions; Construction Division – I, Construction Division – II, Store Division, and Design Division. The Planning and Construction Circle is headed by a Superintendent Engineer. He carries out duties for Planning by himself while supervising overall works of this Circle. The current organization of the Engineering Department is organized for the operation and maintenance of the existing water production and distribution facilities; Mohara WTP, Kalurghat IRP, Booster Stations, Deep Tube Wells, and water distribution pipelines/ network systems. The reorganization and enhancement of the Engineering Department should be immediately implemented to meet the requirements for efficient operation and maintenance of new large-scale water treatment plants, water transmission/distribution pipelines and network which will be put in operation with the completion of the on-going Karnaphuli Water Supply Project and other projects to be implemented in the near future.




*Source: CWASA*

**Figure 3.3.1 Organization and Number of Personnel of CWASA**

## Table 3.3.1 Breakdown of Manpower Sanctioned and Actually Positioned for Main Operation Units (1)

| MOHARA WTP | | | KALURGAT IRP AND BOOSTER STATION | | | MAINT. OPERS. AND DISTRIBUTION - I | | | MAINT. OPERS. AND DISTRIBUTION - II | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | |
| | Actual | Sanctioned | | Actual | Sanctioned | | Actual | Sanctioned | | Actual | Sanctioned |
| Executive Engr. | 1 | 1 | Executive Engr. | 1 | 1 | Executive Engr. | 1 | 1 | Executive Engr. | 1 | 1 |
| Assist. Engr. | 2 | 3 | Assist. Engr. | 1 | 2 | Assist. Engr. | 2 | 2 | Assist. Engr. | 3 | 1 |
| Sub-assist. Engr. | 4 | 5 | Sub-assist. Engr. | 4 | 3 | Sub-assist. Engr. | 2 | 3 | Supdt. Water Works | 0 | 1 |
| Chemist | 1 | 1 | Foreman | 0 | 1 | UDA | 1 | 2 | Sub-assist. Engr. | 3 | 3 |
| UDA | 1 | 1 | Overseer | 0 | 2 | LDA-Cum-Typist | 2 | 5 | UDA | 1 | 2 |
| LDA-Cum-Typist | 0 | 1 | LDA-Cum-Typist | 1 | 2 | Pipeline Supervisor | 2 | 3 | LDA-Cum-Typist | 2 | 5 |
| Electrician | 2 | 2 | Electrician | 1 | 2 | Head Plumbing Minstry | 1 | 1 | Pipeline Supervisor | 3 | 3 |
| Labo. Assist. | 2 | 2 | Pump Operator | 3 | 9 | Plumbing Mistry | 12 | 9 | Plumbing Mistry | 8 | 9 |
| Hight Lift Pump Operator | 3 | 3 | LIme Operator | 2 | 3 | Foreman (Tube - Well) | 1 | 1 | Electrician | 0 | 2 |
| Low Lift Pump Operator | 1 | 3 | Filter Operator | 2 | 3 | Electrician | 1 | 2 | Assist. Plumbing Mistry | 17 | 16 |
| Clarifier/Rapid Mixturte/ | | | Chlorine Operator | 2 | 3 | Assist. Plumbing Mistry | 15 | 16 | Pump Operator | 47 | 52 |
| Desilting Basin Operator | 3 | 3 | Assist. Plumbing Mistry | 0 | 3 | Pump Operator | 45 | 50 | Assist. Pump Operator | 7 | 21 |
| Alum Operator | 3 | 3 | Helper | 0 | 1 | Assist. Pump Operator | 7 | 14 | Work Assistant | 2 | 2 |
| Filter Operator | 3 | 3 | Cleaner | 1 | 2 | Overseer | 0 | 1 | Valve Operator | 5 | 3 |
| Chlorine Operator | 3 | 3 | MLSS | 1 | 2 | Work Assistant | 4 | 2 | Lineman | 1 | 1 |
| Cleaner/Helper | 4 | 5 | | | | Valve Operator | 4 | 6 | Meson | 0 | 1 |
| MLSS | 0 | 2 | | | | Welder | 1 | 1 | MLSS | 3 | 3 |
| Sweeper | 1 | 2 | | | | Helper | 0 | 1 | Sweeper | 1 | 1 |
| Overseer | 2 | | | | | Cleaner | 1 | 2 | Overseer | 1 | |
| | | | | | | MLSS | 1 | 3 | Mechanic | 1 | |
| | | | | | | Sweeper | 0 | 1 | | | |
| Total | 36 | 43 | Total | 19 | 39 | | 103 | 126 | | 106 | 127 |

*Source: CWASA*

**Table 3.3.1 Breakdown of Manpower Sanctioned and Actually Positioned for Main Operation Units (2)**

| CONSTRUCTION DIV. - I | | | CONSTRUCTION DIV. - II | | | STORE DIV. | | | SALES DIV. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | |
| | Actual | Sanctioned | | Actual | Sanctioned | | Actual | Sanctioned | | Actual | Sanctioned |
| Executive Engr. | 1 | 1 | Executive Engr. | 1 | 1 | Executive Engr. | 1 | 1 | Executive Engr. | 1 | 1 |
| Assist. Engr. | 2 | 2 | Assist. Engr. | 1 | 2 | Assist. Engr. | 1 | 2 | Assist. Engr. | 0 | 1 |
| Sub-assist. Engr. | 2 | 4 | Sub-assist. Engr. | 3 | 4 | Sub-assist. Engr. | 1 | 2 | Sub-assist. Engr. | 2 | 2 |
| UDA | 0 | 2 | UDA | 1 | 1 | UDA | 1 | 2 | Overseer | 0 | 2 |
| LDA-Cum-Typist | 2 | 2 | LDA-Cum-Typist | 0 | 4 | LDA-Cum-Typist | 1 | 3 | UDA | 2 | 1 |
| Work Assistant | 1 | 7 | Surveyor | 0 | 1 | Store Keeper | 1 | 2 | LDA-Cum-Typist | 1 | 2 |
| MLSS | 1 | 2 | Work Assistant | 1 | 5 | Compressor Operator | 0 | 1 | Work Assistant | 0 | 1 |
| | | | MLSS | 1 | 3 | Mix. Machine Operator | 0 | 1 | Plumbing Mistry | 2 | 6 |
| | | | | | | Cleaner | 0 | 1 | Assist. Plumbing Mistry | 4 | 12 |
| | | | | | | MLSS | 0 | 2 | MLSS | 2 | 2 |
| Total | 9 | 20 | Total | 8 | 21 | Total | 6 | 17 | | 14 | 30 |

*Source: CWASA*

**Table 3.3.1 Breakdown of Manpower Sanctioned and Actually Positioned for Main Operation Units (3)**

| METER REPAIRING WORKSHOP | | | BILLING GROUP - I | | | BILLING GROUP - II | | | DISCONNECTION SQUARD | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | | POSITION | NOS. OF PERSONS | |
| | Actual | Sanctioned | | Actual | Sanctioned | | Actual | Sanctioned | | Actual | Sanctioned |
| Assist. Engr. | 0 | 1 | Revenue Officer | 2 | 1 | Revenue Officer | 3 | 1 | UDA | 0 | 2 |
| Meter Mechanic | 0 | 2 | Revenue Supervisor | 5 | 4 | Revenue Supervisor | 2 | 4 | LDA-Cum-Typist | 1 | 5 |
| Assist. Plumbing Mistry | 0 | 2 | UDA | 2 | 2 | Meter Inspector | 1 | 12 | Plumbing Mistry | 3 | 6 |
| MLSS | 0 | 1 | Meter Inspector | 2 | 12 | Meter Inspector | 0 | 6 | Assist. Plumbing Mistry | 2 | 12 |
| | | | LDA-Cum-Typist | 7 | 2 | UDA | 2 | 1 | MLSS | 0 | 1 |
| | | | MLSS | 3 | 1 | LDA-Cum-Typist | 7 | 2 | | | |
| | | | WA | 4 | | MLSS | 0 | 1 | | | |
| | | | PLS | 1 | | | | | | | |
| | | | PO | 13 | | | | | | | |
| Total | 0 | 6 | Total | 39 | 22 | Total | 15 | 27 | Total | 6 | 26 |

*Source: CWASA*

(4) Planning & Construction Circle:

The Planning & Construction Circle consists of four Divisions; Construction Division – I, Construction Division – II, Store Division, and Design Division. The Planning and Construction Circle is headed by a Superintendent Engineer. He carries out duties for Planning by himself while supervising overall works of this Circle. The current organization of the Engineering Department is organized for the operation and maintenance of the existing water production and distribution facilities; Mohara WTP, Kalurghat IRP, Booster Stations, Deep Tube Wells, and water distribution pipelines/ network systems. The reorganization and enhancement of the Engineering Department should be immediately implemented to meet the requirements for efficient operation and maintenance of new large-scale water treatment plants, water transmission/distribution pipelines and network which will be put in operation with the completion of the on-going Karnaphuli Water Supply Project and other projects to be implemented in the near future.

**B. Finance Department**

The Finance Department has a Commercial Manager under the Deputy Managing Director (Finance) to manage this department. It comprises Accounting Division, Sales Division, Revenue Division, Meter Repairing Workshop and System Analyst, each organized as follows:

(1) Accounts Division:

The Accounts Division is headed by a Chief Accountant and divided into two sub-divisions; Accounts Division (Finance) and Accounts Division (Management), each headed by a Deputy Chief Accountant.

(2) Sales Division:

The Sales Division is headed by an Executive Engineer. The main duties of this division are as follows:

1) Receiving applications for service connections and procedural works for service connections
2) Connection works including the installation of meters and saddles
3) Periodical check of leakage from service connections and repair or replacement of deteriorated facilities and/or meters

(3) Revenue Division:

The Revenue Division is headed by a Chief Revenue Officer and comprises four units as follows:

1) Billing Group I
2) Billing Group II
3) Disconnection Squad
4) Meter Replacement Unit

Billing Groups I and II carry out meter reading and billing to customers. Disconnection Squad carries out the expedition of payment collection and disconnection of services for customers that have not paid their bills. The Meter Replacement Unit carries out the replacement of non-functioning meters.

(4) Meter Repair Workshop:

This workshop is currently not operated.

(5) Computer System Group:

This group is currently not active.

The Finance Department, as explained above, is responsible not only for corporate financial and accounting functions but also for works in respect of service connections and disconnections, meter setting and maintenance, meter reading and billing, and collection of payments. This organizational structure includes a mixture of various business fields and expertise.

As the quantity of water supplied will be significantly increased with the completion of the on-going Karnaphuli Water Supply Project and the implementation of the Phase 2 Project, it is critical to establish an adequate organization and enhance staffing, in order to efficiently manage the expansion of service connections, meter setting, billings and payment collection.

As the same time, the Accounts Division should also be reorganized and enhanced so as to establish efficient financial and accounting system to meet the expansion of CWASA's business activities under corporate management with full autonomy.

### C. Number of CWASA's Personnel

Table 3.3.2 shows a summary of CWASA's personnel sanctioned and actually positioned.

**Table 3.3.2 Summary of CWASA's Personnel**

| No. | Name of Position | Numbers of Personnel | |
|---|---|---|---|
| | | Actually Positioned | Sanctioned |
| 1. | Managing Director | 1 | 1 |
| 2. | Deputy Managing Director | 3 | 3 |
| 3. | Chief Engineer | 1 | 1 |
| 4. | Commercial Manager | 1 | 1 |
| 5. | Secretary | 1 | 1 |
| 6. | Superintendent Engineer | 2 | 3 |
| 7. | Chief Accountant | 1 | 1 |
| 8. | Chief Revenue Officer | 1 | 1 |
| 9. | Magistrate | 1 | 1 |
| 10. | Executive Engineer | 10 | 10 |
| 11. | Deputy Chief Accountant | 2 | 2 |
| 12. | Deputy Chief | 1 | 1 |
| 13. | Deputy Secretary | 1 | 1 |
| 14. | Senior Audit Officer | 1 | 1 |
| 15. | Assistant Secretary | 1 | 2 |
| 16. | Assistant Chief | 0 | 1 |
| 17. | Research Officer | 1 | 1 |
| 18. | Assistant Engineer | 15 | 18 |
| 19. | Superintendent Water Works | 0 | 1 |
| 20. | Public Relation Officer | 1 | 1 |
| 21. | Revenue Officer | 1 | 3 |
| 22. | Accounts Officer | 1 | 2 |
| 23. | Budget Officer | 0 | 1 |
| 24. | Purchase Officer | 0 | 1 |
| 25. | Estate Officer | 1 | 1 |
| 26. | Medical Officer | 1 | 1 |
| 27. | System Analyst | 0 | 1 |

| No. | Name of Position | Numbers of Personnel | |
|---|---|---|---|
| | | **Actually Positioned** | **Sanctioned** |
| 28. | Chemist | 1 | 1 |
| 29. | Computer Programmer | 0 | 1 |
| Total Class I Officer | | 50 | 64 |
| Total Class II Officer | | 26 | 31 |
| Total Class III Staff | | 403 | 576 |
| Total Class IV Staff | | 131 | 154 |
| **Grand Total** | | 610 | 825 |

*Source: CWASA*

The actual number of CWASA's personnel, including the Managing Director, is 610 compared to 825 sanctioned, of which the actual number of Class I Officers is 50 compared to 64 sanctioned numbers, the actually positioned numbers of Class II Officers are 26 against 31 sanctioned, and the actual number of Class III Staff is 403 compared to 576 sanctioned.

The CWASA's MIS Report in March 2012 indicates the number of employees as 12.8 persons per 1,000 service connections

In view of the staffing of operational units, as shown in Table 3.3.2, the numbers of staff engaged in the works for service connections and meter setting, maintenance of service connection facilities and installed meters, meter reading and billing and collection of payments are inadequate to meet the increasing needs for these activities.

Foreseeing that CWASA's business activities will substantially expand with the completion of the on-going Karnaphuli Water Supply Project and the implementation of the Phase 2 Project, the following issues should be urgent tasks for CWASA:

(1) Establish an appropriate organization and adequate staffing for the operation and maintenance of the Karnaphuli Water Treatment Plant and water supply and distribution facilities which are now in construction under the Karnaphuli Water Supply Project and future facilities under the Phase 2 Project, including the adoption of efficient operation and maintenance systems and training of engineers, operators and technicians. The engineers who have experience in the operation and maintenance of water treatment plants and water transmission and distribution systems are very limited. Recruiting experienced key engineers as well as training young engineers is urgent.

(2) Establish an appropriate organization and adequate staffing for efficient management of service connections, installation and maintenance of service connection facilities and meters, meter reading and billing and collection of payments to meet substantial increase in the quantity of water supplied, including the adoption of more efficient management system and staff training.

(3) Reorganization of CWASA's overall organizational structures, administrative procedures and management systems.

### 3.3.3 Current Activities for Institutional Improvement of CWASA

Institutional improvement is a challenge for CWASA in order to reorganize the management and business administration systems as well as enhance the financial, operational and institutional capacity in the transition to management with autonomy.

(1) Business Plan

CWASA employed Institutional Development Consultants (IDC) to assist the organization for the above

activities, by using a part of the JICA Loan provided for the on-going Karnaphuli Water Supply Project.

In accordance with the Terms of Reference, IDC has formulated, among others, a draft of CWASA's Business Plan, which outlines the direction and target for the performance to be achieved during the five years from FY 2011/12 to FY 2015/16.

CWASA organized a committee named Business Plan Committee for reviewing the draft Business Plan proposed by IDC. CWASA has approved the proposed Business Plan with some amendments, and submitted it to LGRD&C for their approval.

(2) Performance Agreement

Prior to the formulation of the Business Plan, CWASA concluded the Performance Agreement with GOB (LGRD&C) in early 2011 in accordance with the provision of Section 16 (3), Chapter IV of the WASA Act – 1996. This Performance Agreement sets the target for water service coverage to be attained up to the year 2015 as given in the following Table 3.3.3. The figures in planned and actual ones in 2011 are within a certain range of accuracy.

**Table 3.3.3 Performance Agreement up to year 2015**

| Item | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Population in Chittagong city (million) | 3.975 | 4.050 (4.000) | 4.125 | 4.200 | 4.275 | 4.350 |
| Population in CCC area (mill.) | 2.98 | 3.00 (2.60) | 3.10 | 3.20 | 3.40 | 3.60 |
| Population served with piped water (million) | 1.190 | 1.230 (1.222) | 1.302 | 1.376 | 2.72 | 2.88 |
| Service Coverage (%) | 40% | 41% (47%) | 42% | 43% | 80% | 80% |
| No. of Service Connections | 49,000 | 51,000 (45,000) | 54,000 | 56,500 | 61,500 | 66,500 |
| NRW (%) | 30% | 29% (33%) | 28% | 27% | 26% | 25% |

*Note: Figures in parenthesis in 2011 show updated information.*

In addition, the Performance Agreement sets forth CWASA's targets for improvement of its business operation, including, among others, the following targets:

**Table 3.3.4 Targets in Performance Agreement up to Year 2015**

| | | |
|---|---|---|
| 1. Technical Operation | 1.1 Inspection and maintenance | ・ Develop and keep up-to-date an inventory of all its water assets.<br>・ Develop and implement asset management procedures, including preventive maintenance procedures for all plants and networks. |
| | 1.2 Water losses | ・ Implement a NRW reduction program including zoning of the distribution system, leak detection, replacement of damaged meters and increase of the number of metered connections, reduction of illegal connections and other administrative and commercial losses to achieve a level of NRW of 25% by FY 2015. |

| | | |
|---|---|---|
| | | ・ Use all the resources available, internally or externally, including the option of contracting the implementation of this program to the private sector. |
| 2. Commercial Operation | Revenue collection | ・ Improve the level of revenue collection to attain a ratio of 90% in 2015.<br>・ Implement billing and revenue collection procedures in order that all active accounts are billed on a monthly basis. |
| 3. Customer Services | 3.1 Customer relations | ・ Improve commercial relations with customers along with prompt handling of queries and complaints so as to respond to a service complaint within 10 days.<br>・ Provide information to customers beforehand on expected water shortages, and reasons and estimated duration of the shortages. |
| | 3.2 Media Campaign | ・ Implement a media campaign to warm customers on the legal implication on the pilferage and theft of water.<br>Implement a media campaign to bring awareness in customers of the benefit of the conservation of water resources. |
| 4. Finance & Accounting | 4.1 Improvement of cost coverage | ・ Take adequate financial and regulatory measures to improve its total cost coverage ratio by at least 10% between 2010 and 2015. In 2015, the CWASA revenue shall at least cover the operation and financial costs (excluding depreciation). |
| | 4.2 Computerization of accounting | ・ Finalize computerization of accounting system, in particular, for revenue budget before 2013. |
| | 4.3 Budget procedures | ・ Review and update budget procedures, and issue manual of procedures and guidelines. |
| | 4.4 Cash management, account and ledger reconciliations | ・ Improve financial management in respect of cash management, account and ledger reconciliations and provide training to accounting staff to improve their efficiency. |
| 5. Tariff Policy | ・ Adapt a tariff structure leading towards the long-run marginal cost methodology.<br>・ Provide appropriate guidance to the charges to be applied to large, medium, small, commercial and domestic customers.<br>・ Take actions to adjust tariffs annually as required, based on an agreed inflation index, and to meet its financial objectives for the period 2010 – 2015, to enable it to achieve the performance targets. | |

However, CWASA faces difficulty to achieve the targets, due to various constraints including limited availability of adequate internal human resources.

(3) Development of computerized accounting system

CWASA still follows traditional culture for business administration procedures, internal documentation, approval process and document control, and this is inefficient and time consuming for daily business activities. CWASA is currently carrying out the development of computerized billing system and accounting systems by outsourcing system experts under the financial assistance by the World Bank. The computerized billing system was recently completed and test run will be carried out soon. It is targeted to complete the development of the computerized accounting system by the middle of 2013. In view of the current business practice based on traditional culture and manual-based accounting, however, it is uncertain when the developed computerized accounting system can be adopted for practice.

Another problem that although the computerised accounting system currently being developed is linked to the billing system for water charges, it is not integrated with the system for the control of customers' billing and collection and MIS data, in particular with GIS based customer data.

Another task should be how to develop an integrated electronic data system that enables CWASA to monitor the performance of its overall operation.

(4) Restructuring of CWASA's organization

IDC's services include the investigation of the CWASA's organization for restructuring. According to IDC's roadmap, this task has been started in September 2012 and will be completed by the end of November 2012. Under these situations, restructuring of CWASA's organization will be implemented after IDC's recommendation on the restructuring.

### 3.3.4 Partnership Framework among Bangladesh Government and Development Partners

The Bangladesh Government and the Development Partners jointly entered into the partnership framework on November 10, 2007, in order to contribute to the Bangladesh's socio-economic development in the urban water supply and sanitation sector.

The partnership arrangements will be reviewed by the Working Group on a biannual basis by the Development Partners and the Bangladesh Government.

## 3.4 Financial Status of CWASA

### 3.4.1 Overview of CWASA's Current Financial Situation

The latest audited financial statements published by CWASA is for Fiscal Year (FY) 2008/09 (beginning at 1st July 2008 and ending at 30th June 2009). Hence the current financial situation of CWASA was reviewed on the basis of the audited financial statements for FY 2006/07, FY 2007/08 and FY 2008/09.

Table 3.4.1 shows a summary of the Income Statements in FY 2006/07, FY 2007/08 and FY 2008/09.

**Table 3.4.1 Summary of Income Statements**

(In BDT)

| Particulars | FY 2006/07 | FY 2007/08 | | FY 2008/09 | |
|---|---|---|---|---|---|
| | Amount | Amount | Inc./Dec. % * | Amount | Inc./Dec. % * |
| A. Water Supply Operation Income | | | | | |
| A-1. Water Revenue | 300,123,533 | 342,267,601 | 14.0% | 360,252,575 | 5.3% |
| A-2. Water Production/Supply Cost | (241,884,811) | (270,176,637) | 11.7% | (275,991,022) | 2.2% |
| A-3. Gross Profit from Water Supply Operation (A-1. - A-2.) | 58,238,722 | 72,090,964 | 23.8% | 84,261,553 | 16.9% |
| B. Other Operating Revenue | | | | | |
| B-1. Service Connection Charges & related revenue | 10,738,554 | 26,370,414 | 145.6% | 22,079,134 | -16.3% |
| B-2. Licence and renewal fee of tubewells | 70,769,345 | 61,381,909 | -13.3% | 54,468,935 | -11.3% |
| B-3. Miscellaneous operating revenue | 3,750,475 | 1,734,300 | -53.8% | 416,650 | -76.0% |
| B-4. Other Operating Revenue - Total | 85,258,374 | 89,486,623 | 5.0% | 76,964,719 | -14.0% |
| C. General & Administrative Expenses, incluing collection expenses | (76,778,819) | (80,240,336) | 4.5% | (99,771,555) | 24.3% |
| D. Gross Operating Income (A-3. + B-4. - C.) | 66,718,277 | 81,337,251 | 21.9% | 61,454,717 | -24.4% |
| E. Non-operating Income | | | | | |
| E-1. Interest Income (Interest on Deposit) | 25,778,332 | 45,462,895 | 76.4% | 65,483,861 | 44.0% |
| E-2. Miscellaneous non-operational revenue | 21,966,410 | 7,644,809 | -65.2% | 2,574,725 | -66.3% |
| E-3. Paid Interest on Loans | (26,917,542) | (23,961,351) | -11.0% | (20,879,838) | -12.9% |
| E-4. Non-operating Net Income (E-1. + E-2. - E-3.) | 20,827,200 | 29,146,353 | 39.9% | 47,178,748 | 61.9% |
| F. Net Income (Profit/Loss) before tax (D. + E-4.) | 87,545,477 | 110,483,604 | 26.2% | 108,633,465 | -1.7% |
| G. Tax paid | (3,125,397) | (3,034,367) | -2.9% | (7,989,626) | 163.3% |
| H. Net Income (Profit/Loss) after tax | 84,420,080 | 107,449,237 | 27.3% | 100,643,839 | -6.3% |
| (Cost Recovery Status of Water Revenue) | | | | | |
| A. Water Revenue | 300,123,533 | 342,267,601 | 14.0% | 360,252,575 | 5.3% |
| B. Water Production/Supply Cost | (241,884,811) | (270,176,637) | 11.7% | (275,991,022) | 2.2% |
| C. Gross Profit from Water Supply Operation | 58,238,722 | 72,090,964 | 23.8% | 84,261,553 | 16.9% |
| D. General & Administrative Expenses, incluing collection expenses | (76,778,819) | (80,240,336) | 4.5% | (104,694,562) | 30.5% |
| C. - D. | (18,540,097) | (8,149,372) | -56.0% | (20,433,009) | 150.7% |

| Composition of Reveune Sources in Average of Three FYs (2006/07 - 2008/09) | | |
|---|---|---|
| Revenue Sources | Amount | Composition (%) |
| A. Water Revenue | 334,214,570 | 70% |
| B. Other Operating Revenue | 83,903,239 | 18% |
| C. Interest Income | 45,575,029 | 10% |
| D. Miscellaneous Non-operational Revenue | 10,728,648 | 2% |
| Total Revenue | 474,421,486 | 100% |

(Note) * Increase/Decrease % : against the previous year

(Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09)

In view of the financial positions recorded during the three fiscal years (FY) of 2006/07, 2007/08 and 2008/09, CWASA recorded increasing profit every year even after deducting financial expenses.

The yearly increasing profit was derived from increases in the revenue. There are three categories of revenue sources, namely, (a) water revenue (main operation revenue), (b) other operation revenue, including (i) service connection charges and related charges, (ii) license and renewal fee of tube wells, and (iii) miscellaneous operating revenue, and (c) non-operation revenue including interest on deposit and miscellaneous non-operational revenue. Based on the average of the three years considered, the revenue earned from each of the three sources (a) to (c) indicated above accounts for about 70%, 18%, and 12% respectively of the total revenue.

Water revenue increased steadily each year during the period by 14.0% in FY 2007/08 and 5.3% in FY 2008/09, while other operating revenue (service connection fees and other revenue) were unstable with increasing by 5.0% in FY 2007/08 and decreasing by 14.0% in FY 2008/09.

Although the water production/supply cost increased year-on-year by 11.7% in FY 2007/08 and 2.2% in FY 2008/09, the Gross Profit from the Water Supply Operation (main operation) increased from BDT58.23 million in FY2006/07 to BDT72.09 million by 23.8% in FY2007/08 and further to BDT84.26 million by 16.9% in FY2008/09.

The Gross Operating Income including other operating revenue and general and administration expenses including collection expenses in addition to the water supply operation (main operation) income increased from BDT66.72 million in FY2006/07 to BDT81.34 million by 21.9% in FY2007/08, but decreased to BDT61.45 million in FY2008/09.

The non-operating income based on interest on deposit and miscellaneous non-operational revenue less paid interest on loans also increased from BDT20.83 million in FY2006/07 to BDT29.15 million by 39.9% in FY2007/08 and further to BDT47.18 million by 61.9% in FY2008/09.

In summing up, the Net Income recorded profit in the amount of BDT110.48 million before tax and BDT107.45 million after tax in FY2007/08 and in the amount of BDT108.63 before tax and BDT100.64 million after tax in FY2008/09.

In view of cost recovery status of the Water Revenue, the Water Revenue in FY2007/08 can recover the water production/supply cost plus about 89.8 % of the general and administration expenses including collection expenses, and the Revenue in FY2008/09 can recover the water production/supply cost plus about 80.0 % of the general and administration expenses including collection expenses.

The above implies that CWASA's financial position has remained in positive profit with contribution by operating revenue other than Water Revenue and non-operating income, even though the Water Revenue has been inadequate to recover the CWASA's overall costs and expenses.

Table 3.4.2 shows a summary of the operating expenses with a breakdown into major items of expenses.

**Table 3.4.2 Summary of Operating Expenses**

(In BDT)

| Particulars | FY 2006/07 | FY 2007/08 | | FY 2008/09 | | Average of 3 FYs | |
|---|---|---|---|---|---|---|---|
| | Amount | Amount | Inc./Dec. %* | Amount | Inc./Dec. %* | Amount | Comp. % |
| A. Operation Cost for Water Production & Supply | | | | | | | |
| a. Personnel expenses | 48,730,491 | 61,116,419 | 25.4% | 60,589,054 | 24.3% | 56,811,988 | 21.6% |
| b. Electricity & Power | 106,982,612 | 122,190,346 | 14.2% | 117,268,088 | 9.6% | 115,480,349 | 44.0% |
| c. Chemicals | 21,034,770 | 21,930,702 | 4.3% | 29,638,489 | 40.9% | 24,201,320 | 9.2% |
| d. Repair & maintenance | 14,212,320 | 12,296,423 | -13.5% | 17,161,925 | 20.8% | 14,556,889 | 5.5% |
| e. Depreciation | 49,469,481 | 51,100,190 | 3.3% | 49,284,105 | -0.4% | 49,951,259 | 19.0% |
| f. Office & miscellaneous expenses | 1,455,137 | 1,542,557 | 6.0% | 2,049,361 | 40.8% | 1,682,352 | 0.6% |
| Total | 241,884,811 | 270,176,637 | 11.7% | 275,991,022 | 14.1% | 262,684,157 | 100.0% |
| B. Overall Costs and Expenses for CWASA's Operation | | | | | | | |
| a. Personnel expenses | 105,639,819 | 120,394,714 | 14.0% | 132,828,255 | 25.7% | 119,620,929 | 34.3% |
| b. Internal training, staff welfare, medical allowances | 634,473 | 593,737 | -6.4% | 1,065,162 | 67.9% | 764,457 | 0.2% |
| c. Electricity & Fuel | 115,729,824 | 132,256,053 | 14.3% | 126,832,873 | 9.6% | 124,939,583 | 35.9% |
| d. Chemicals | 21,034,770 | 21,930,702 | 4.3% | 29,638,489 | 40.9% | 24,201,320 | 6.9% |
| e. Repair & maintenance | 16,979,874 | 14,516,991 | -14.5% | 20,099,156 | 18.4% | 17,198,674 | 4.9% |
| f. Depreciation | 49,469,481 | 51,100,190 | 3.3% | 49,284,105 | -0.4% | 49,951,259 | 14.3% |
| g. Travelling & transportation expenses | 514,287 | 661,087 | 28.5% | 952,176 | 85.1% | 709,183 | 0.2% |
| h. Insurance | 575,933 | 632,004 | 9.7% | 567,196 | -1.5% | 591,711 | 0.2% |
| i. Office & miscellaneous expenses | 8,085,169 | 8,331,495 | 3.0% | 14,495,165 | 79.3% | 10,303,943 | 3.0% |
| Total | 318,663,630 | 350,416,973 | 10.0% | 375,762,577 | 17.9% | 348,281,060 | 100.0% |

(Note) *Increase/decrease %: against the expenses in FY2006/07

(Source: Financial Statements: FY2006/07; FY2007/08; FY2008/09)

In the table, Part A shows the Water Production/Supply Cost and Part B shows the CWASA's overall costs and expenses including the Water Production/Supply Cost, General and Administrative Expenses and Collection Expenses. The Water Production/Supply Cost includes all costs and expenses incurred for the production and distribution of water, including the operation and maintenance of the existing Mohara WTP, Kalurghat IR Plant, tube wells, booster pump stations, transmission and distribution pipelines, service connection facilities and meters.

Considering the average of the Water Production/Supply Cost during the three FYs (2006/07 – 2008/09), electricity and power account for about 44.0% of total, followed by 21.6% for personnel expenses, 19.0% for depreciation, 9.2% for chemicals and 5.5% for repair and maintenance. Comparing the expenses in FY2008/09 with FY2006/07, the Water Production/Supply Cost in FY2008/09 increased by 14.1% with increase in personnel expenses being 24.3%, electricity & power 9.6%, chemicals 40.9%, repair & maintenance 20.8%, and office and miscellaneous expenses 40.8%, although the depreciation decreased by 0.4%. It must be noted, however, that these figure show the operating costs for Mohara WTP and Kalurghat IRP on which the Rehabilitation were not completed yet. The depreciation will increase in FY2011/12 during which the Mohara and Kalurghat Rehabilitation Project was completed. Details of the depreciation schedule for FY2006/07 to FY2008/09 are enclosed in Supporting Report 3-1.

The financial expenses were interest of loans paid in each year. Table 3.4.3 shows details of interests paid during the three FYs (2006/07 – 2008/09).

**Table 3.4.3 Details of Interests Paid during Three Years**

(In BDT)

| Particulars | FY 2006/07 | FY 2007/08 | FY 2008/09 |
|---|---|---|---|
| | Amount | Amount | Amount |
| Financial Charges | | | |
| Interest on : | | | |
| a. First Interim WRSP Loan | 9,949,000 | 9,949,000 | 9,949,000 |
| b. Government loan, Non-project | 0 | 0 | 253,830 |
| c. Foreign Loan (IDA 1st Phase) | 380,746 | 317,288 | 0 |
| d. Foreign Loan (IDA 2nd Phase) | 16,587,796 | 13,695,063 | 10,677,008 |
| Sub-total | 26,917,542 | 23,961,351 | 20,879,838 |
| Bank charge | 0 | 0 | 0 |
| Total | 26,917,542 | 23,961,351 | 20,879,838 |

(Source: Financial Statements: FY2006/07; FY2007/08; FY2008/09)

Details of debt-services in FY2006/07 to FY2008/09 are enclosed in Supporting Report 3-2.

Table 3.4.4 shows CWASA's Cash-flow Statements for FY2006/07, FY2007/08 and FY2008/09.

**Table 3.4.4 Cash-Flow Statements**

(Amounts in BDT)

| Particulars | FY 2006/07 | FY 2007/08 | | FY 2008/09 | |
|---|---|---|---|---|---|
| | Amount | Amount | Inc./Dec. %* | Amount BDT | Inc./Dec. %* |
| **A. Cash Beginning of Period** | 146,762,444 | 177,711,567 | 21.09% | 193,636,374 | 8.96% |
| **B. Cash-flows from Operating Activities** | | | | | |
| B-1. Cash received from Customers | | | | | |
| Collection during the year | 328,980,019 | 355,130,984 | 7.95% | 368,526,953 | 3.77% |
| Other Operating Revenue | 128,716,413 | 137,402,323 | 6.75% | 139,385,757 | 1.44% |
| Total Receipts | 457,696,432 | 492,533,307 | 7.61% | 507,912,710 | 3.12% |
| B-2. Payments | | | | | |
| Cash paid to Suppliers, Contractors & Employees | 317,478,040 | 426,242,014 | 34.26% | 248,274,526 | -41.75% |
| Income Tax Paid | 6,000,000 | - | | - | |
| Cash paid to National Exchequer | 5,000,000 | 5,000,000 | | - | |
| Total Payments | 328,478,040 | 431,242,014 | 31.28% | 248,274,526 | -42.43% |
| B-3. Net Cash Flow from Operating Activities (B-1. less B-2.) | 129,218,392 | 61,291,293 | -52.57% | 259,638,183 | 323.61% |
| **C. Cash-flows from Investing Activities** | | | | | |
| (Increase)/Decrease in Investment | (117,592,093) | (121,196,058) | | 19,042,103 | |
| Proceeds/(Purchase) Fixed Assets | (71,516,922) | (2,014,218) | | (49,015,675) | |
| Capital Work in Progress | (22,290,354) | (66,290,166) | | (178,329,510) | |
| Cash Inflow/(Outflow) from Investing Activities | (211,399,369) | (189,500,442) | -10.36% | (208,303,082) | 9.92% |
| **D. Financing Activities from Equity & Loans** | | | | | |
| Fund Received | 600,000 | (10,779,000) | -1896.50% | (12,260,000) | 13.74% |
| Proceeds from Long Term Borrowing | 210,000,000 | 282,881,315 | 34.71% | 14,959,864 | -94.71% |
| Repayment of Long Term Borrowing | (97,469,900) | (127,968,358) | 31.29% | | |
| **E. Net Cash Inflow/(Outgflow) from Financing Activities** | 113,130,100 | 144,133,957 | 27.41% | 2,699,864 | -98.13% |
| **F. Net Increase/Decrease in Cash & Cash Equivalent (B-3. + C. + D-4.)** | 30,949,123 | 15,924,807 | -48.55% | 54,034,965 | 239.31% |
| **G. Cash at End of the Period (A. + F.)** | 177,711,567 | 193,636,374 | 8.96% | 247,671,339 | 27.91% |

(Note) * Increase/Decrease % : against the previous year

(Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09)

Cash receipts increased from BDT457.70 million in FY2006/07 to BDT492.53 million by 7.6% in FY2007/08 and further to BDT507.91 million by 3.1% in FY2008/09 with increases in water revenue collection as well as the receipt of other operating and non-operational revenue. On the other hand, the payments remained always in an amount less than the receipts, and in particular it is remarked that the payments in FY2008/09 was substantially reduced in FY2008/09.

The net cash-flow from operating activities was positive during the period, because of cash payments limited to available cash by means of delay in or arrears in payments due as reviewed and discussed earlier on the Balance Sheet.

Table 3.4.5 shows a summary of Balance Sheets in FY 2006/07, FY 2007/08 and FY 2008/09.

**Table 3.4.5 Summary of Balance Sheets**

(Amount in BDT)

| Assets | FY 2006/07 Amount | FY 2007/08 Amount | FY 2007/08 Inc./Dec. %* | FY 2008/09 Amount | FY 2008/09 Inc./Dec. %* |
|---|---|---|---|---|---|
| **Non-Current Assets** | | | | | |
| Property, Plant & Equipment | 1,093,271,849 | 1,044,185,877 | -4.5% | 1,115,639,117 | 6.8% |
| Capital work in Progress | 242,049,898 | 308,340,064 | 27.4% | 486,669,574 | 57.8% |
| Deferred expenditure | 135,514 | 135,514 | 0.0% | 135,514 | 0.0% |
| Investment | 419,265,568 | 540,461,626 | 28.9% | 521,419,523 | -3.5% |
| Total Non-Current Assets | 1,754,722,829 | 1,893,123,081 | 7.9% | 2,123,863,727 | 12.2% |
| **Current Assets** | | | | | |
| Stock & Stores | 88,853,289 | 103,798,768 | 16.8% | 102,688,791 | -1.1% |
| Accounts Receivable | 211,185,010 | 198,321,626 | -6.1% | 190,047,248 | -4.2% |
| Other Receivable | 15,435,241 | 20,627,245 | 33.6% | 26,264,794 | 27.3% |
| Advance, deposits and prepayments | 332,886,773 | 438,209,279 | 31.6% | 376,406,959 | -14.1% |
| Cash and bank balances | 177,711,567 | 193,636,374 | 9.0% | 247,671,339 | 27.9% |
| Total Current Assets | 826,071,880 | 954,593,292 | 15.6% | 943,079,131 | -1.2% |
| Total Assets | 2,580,794,709 | 2,847,716,373 | 10.3% | 3,066,942,858 | 7.7% |
| **Equity Fund** | | | | | |
| Capital fund | 1,070,887,680 | 1,060,108,680 | -1.0% | 1,224,722,777 | 15.5% |
| Excess value of assets due to physical verification | 280,067 | 280,067 | 0.0% | 280,067 | 0.0% |
| Surplus on revaluation of asset | 45,473,332 | 45,473,332 | 0.0% | 45,473,332 | 0.0% |
| Retained earnings | -545,705,113 | -443,255,876 | -18.8% | -342,612,037 | -22.7% |
| Total Equity | 570,935,966 | 662,606,202 | 16.1% | 927,864,139 | 40.0% |
| **Liabilities** | | | | | |
| **Non-Current Liabilities** | | | | | |
| Long term liabilities | 1,009,912,536 | 1,164,825,493 | 15.3% | 1,074,632,927 | -7.7% |
| **Current Liabilities** | | | | | |
| Accounts Payable | 11,660,682 | 8,023,283 | -31.2% | 15,438,118 | 92.4% |
| Creditors for expenses | 961,906,104 | 983,764,059 | 2.3% | 1,016,190,722 | 3.3% |
| Creditors for other finance | 25,429,121 | 27,562,161 | 8.4% | 31,891,649 | 15.7% |
| Employees Provident Fund | 950,300 | 935,175 | -1.6% | 925,302 | -1.1% |
| Total Current Liabilities | 999,946,207 | 1,020,284,678 | 2.0% | 1,064,445,792 | 4.3% |
| Total Liabilities | 2,009,858,743 | 2,185,110,171 | 8.7% | 2,139,078,719 | -2.1% |
| **Total Equity and Liabilities** | 2,580,794,709 | 2,847,716,373 | 10.3% | 3,066,942,858 | 7.7% |

(Note) *Increase/Decrease % against the previous year.
(Source: Audited Financial Statements in FY2006/07; FY2007/08; FY2008/09)

In view of the Balance Sheets in FY 2006/07, FY 2007/08 and FY 2008/09, the following points can be highlighted:

(1) Non-current Assets and Non-current Liabilities

Non-current assets substantially increased from BDT1,754.72 million as at the end of FY 2006/07 to BDT1,893.12 million, an increase of 7.9%, as at the end of FY 2007/08 and further to BDT2,123.86 million, an increase of 12.2% as at the end of FY 2008/09 with the construction works for the Mohara and Kalurghat Rehabilitation Project being carried out during this period. Non-current liabilities based on long-term liabilities also increased from DBT1,009.91 million as at the end of FY 2006/07 to BDT1,164.83 million, an increase of 15.3%, as at the end of FY 2007/08 and then decreased to BDT1,074.63 million as at the end of FY 2008/09. The substantial increase in the long-term liabilities during FY 2007/08 was due to an increase in the loans received from GOB for the Karnaphuli Water Supply Project and Mohara and Kalurghat Rehabilitation Project, exceeding the repayment amounts of the outstanding loans incurred during FY 2007/08. The decrease in the long-term liabilities during FY 2008/09 was due to the funds for the Mohara and Kalurghat Rehabilitation Project received from GOB being in the form of Grant and GOB Equity (i.e., BDT74,339,097 in Grant and BDT102,535,000 in GOB Equity), resulting in the loans received from GOB being less than the repayment amounts of the outstanding loans incurred during FY 2008/09. (Refer to Details of Debt-Services given in Supporting Report 3-2 and Details of Change in Equity Capital enclosed in Supporting Report 3-3.)

(2) Current Assets and Current Liabilities

Current assets substantially increased from BDT826.07 million as at the end of FY 2006/07 to BDT954.59 million, an increase of 15.6%, as at the end of FY 2007/08, then decreased to BDT943.08 million, an increase of 1.2%, as at the end of FY 2008/09, while current liabilities increased from BDT999.95 million as at the end of FY 2006/07 to BDT1,020.28, an increase of 2.0%, as at the end of FY 2007/08 and further to BDT1,064.45, an increase of 4.3%, as at the end of FY 2008/09.

The major current assets are (a) Accounts Receivable, (b) Advance, Deposits and Prepayment and (c) Cash and Bank Balances, which account for about 22%, 42% and 23% respectively, and 87% in total of the current assets in average of the three FYs (2006/07 to 2008/09). Accounts Receivable was the outstanding balance of uncollected water bills, as at the end of each fiscal year, calculated by (i) adding billed amounts during the year to (ii) the opening balance as at the beginning of the year and (iii) deducting collected amounts during the year. Bank Balances indicate the paid water bill amounts, since the customers pay water bills into CWASA's accounts at the designated banks.

Table 3.4.6 summarizes a trend of the above three items of current assets during the three FYs indicated above.

**Table 3.4.6 Trend of Major Items of Current Assets**

| Particulars | FY 2006/07 | FY 2007/08 | | FY 2008/09 | |
|---|---|---|---|---|---|
| | Amount (BDT) | Amount (BDT) | Inc./Dec. (%)* | Amount (BDT) | Inc./Dec. (%)* |
| a. Account Receivables (Water Bills) | 211,185,010 | 198,321,626 | -10.3% | 190,047,248 | -4.2% |
| b. Advance, Deposits and Prepayment | 332,886,773 | 438,209,279 | +31.6% | 376,406,959 | -14.1% |
| a. Cash and Bank Balances | 177,711,567 | 193,636,374 | +9.0% | 247,671,339 | +27.9% |
| Total (a. + b. + c.) | 721,783,350 | 830,167,279 | +15.0% | 814,125,546 | -1.9% |

*Note:*Increase/decrease % against the previous year.*

Accounts Receivable decreased every year, while Cash and Bank Balances increased every year. This trend implies substantial improvement of the collection of water bills. Nevertheless, a large amount of the accounts receivable was accounted at the end of every fiscal year due to a longer collection period. MIS reports indicate a collection period of about 200 days.

The current ratio (Current Assets divided by Current Liabilities) was within an allowable range of 0.83 in FY2006/07, 0.93 in FY2007/08 and 0.81 in FY2008/09. However, it must be noted that such a relatively stable balance was due to the Current Liabilities controlled with delay in and arrears in various payments.

Current Liabilities consist of four major components, namely, A. Accounts Payable, B. Creditors for Expenses, C. Creditors for Other Finance and D. Employees Provident Fund, accounting for about 1.1%, 96.0%, 2.8% and 0.1% respectively of the total Current Liabilities in average of the three FYs (2006/07 – 2008/09). In particular, it must be remarked that Creditors for Expenses account for about 96% of the Current Liabilities in each of the three FYs (2006/07 – 2008/09), although there were no short-term loans during this period.

Table 3.4.7 shows details of the Creditors for Expenses and Creditors for Other Finance reported in the Audited Financial Statements. Creditors for Expenses and Other Finance mean delay in or arrears in payment due.

**Table 3.4.7 Details of Creditors for Expenses and Other Finance**

(Amount in BDT)

| Particulars | FY 2006/07 | FY 2007/08 | | FY 2008/09 | | Average of 3 FYs | |
|---|---|---|---|---|---|---|---|
| | Amount | Amount | Inc./Dec. %* | Amount | Inc./Dec. %* | Amount | Comp. % |
| **Creditors for Expenses** | | | | | | | |
| a. Salary and allowance payable | 8,915 | 13,140 | 47.4% | 165,799 | 1759.8% | 62,618 | 0.0% |
| b. Staff welfare fund | 16,450 | 13,204 | -19.7% | 13,190 | -19.8% | 14,281 | 0.0% |
| c. Advance received against deposit works | 14,124,621 | 13,242,949 | -6.2% | 25,112,069 | 77.8% | 17,493,213 | 1.8% |
| d. Accrued interest on: | | | | | | | |
| - 1st Interim Water Supply & Rehabilitation Project | 201,270,464 | 211,219,464 | | 221,168,464 | | 211,219,464 | |
| - IDA Loan (1st Phase) | 2,521,768 | 2,017,414 | | 1,513,060 | | 2,017,414 | |
| - IDA Loan (2nd Phase) | 736,181,791 | 749,876,855 | | 760,553,863 | | 748,870,836 | |
| Sub-total | 939,974,023 | 963,113,733 | 2.5% | 983,235,387 | 4.6% | 962,107,714 | 97.4% |
| e. Salary and wage payable | 11,995 | 41,848 | 248.9% | 34,719 | 189.4% | 29,521 | 0.0% |
| f. Miscellaneous payable | 7,770,100 | 7,339,185 | -5.5% | 7,629,558 | -1.8% | 7,579,614 | 0.8% |
| Total | 961,906,104 | 983,764,059 | 2.3% | 1,016,190,722 | 5.6% | 987,286,962 | 100.0% |
| **Creditors for Other Finance** | | | | | | | |
| a. Custmers Security Deposits | 3,595,935 | 4,113,535 | 14.4% | 4,521,735 | 25.7% | 4,077,068 | 14.4% |
| b. Income tax deduction from contractors (non-project) | 57,848 | 84,655 | 46.3% | 640,982 | 1008.0% | 261,162 | 0.9% |
| c. Security deposits and other deduction from contractors & suppliers | 11,548,074 | 9,333,400 | -19.2% | 10,475,957 | -9.3% | 10,452,477 | 36.9% |
| d. Government Industries & Hotels etc. | 10,116,350 | 13,608,350 | 34.5% | 15,593,350 | 54.1% | 13,106,017 | 46.3% |
| e. Lease of Street Hydrant | 40,000 | 40,000 | 0.0% | 24,217 | -39.5% | 34,739 | 0.1% |
| f. VAT deduction from contractors & suppliers | 70,914 | 382,221 | 439.0% | 635,408 | 796.0% | 362,848 | 1.3% |
| Total | 25,429,121 | 27,562,161 | 8.4% | 31,891,649 | 25.4% | 28,294,310 | 100.0% |

(Note) *Increase/Decrease % against FY2006/07
(Source: Audited Financial Statements in FY2006/07; FY2007/08; FY2008/09)

In view of major items included in the Creditors for Expenses, accrued interest on loans account for about 97% of the total, increasing each year from BDT 939.97 million in FY2006/07 to BDT 963.11 million in FY2007/08 and further to BDT 983.24 in FY2008/09. This implies that CWASA falls into arrears in the payment of large amounts of loan interests to GOB.

(3) Equity Fund

The equity fund comprises four account items of A. Capital Fund, B. Excess Value of Assets due to Physical Verification, C. Surplus on Revaluation of Assets and D. Retained Earnings.

Retained Earnings recorded an accumulated loss in the amount of BDT545.71 million as at the end of FY2006/07, and then reduced to a loss of BDT 342.61 million as at the end of FY2007/09 with positive net income earned during this period. (Refer to Details of Retained Earning given in Supporting Report 3-4). The capital fund, which accounts for about 64% of total Equity Fund excluding the Retained Earnings, increased from BDT 1,070.89 million as at the end of FY2006/07 to BDT 1,224.72 million as at the end of FY2008/09. This increase was due to the GOB loans being transferred to GOB equity, as shown in the following table.

Table 3.4.8 shows details of the Capital Fund as at the end of FY2006/07, FY2007/08 and FY2008/09.

**Table 3.4.8 Details of Capital Fund**

(Amounts in BDT)

| Particulars | As At End of FY 2006/07 | As At End of FY 2007/08 | As At End of FY 2008/09 |
|---|---|---|---|
| a. Capital Grant | 7,191,958 | 7,191,958 | 7,191,958 |
| b. Grant for relief and rehabilitation from USA | 899,393 | 899,393 | 899,393 |
| c. Government Loan & Interest converted to Equity | 192,641,712 | 192,641,712 | 192,641,712 |
| d. Chittagong Pourasava Loan and Interest converted to Equity | 1,028,748 | 1,028,748 | 1,028,748 |
| e. Equity (2nd Phase) | 565,777,869 | 565,777,869 | 565,777,869 |
| f. Madunaghat Project Loan transferred to Equity | 83,865,000 | 73,086,000 | 60,826,000 |
| g. Equity for Sewerage Feasibility Study | 200,000 | 200,000 | 200,000 |
| h. 2nd IWSRP Loan converted to Grant | 219,283,000 | 219,283,000 | 219,283,000 |
| i. Grant for Mohara & Kalurghat Rehabilitation Project | | | 74,339,097 |
| j. Equity for Mohara Water Supply Project | | | 102,535,000 |
| Total | 1,070,887,680 | 1,060,108,680 | 1,224,722,777 |

*Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09*

It implies that CWASA's financial management has been heavily dependent on the financial subsidy provided by GOB in the form of grant or equity.

### 3.4.2 CWASA's Financial Structures and Sustainability

It is not known how CWASA's financial situations has changed in FY2009/10 and subsequently, as the Audited Financial Statements for these years have not been published yet. However, it is supposed that CWASA's financial situations should have changed considerably in FY2011/12 during which the Mohara and Kalurghat Rehabilitation Project was completed.

Nevertheless, the financial structures of CWASA reviewed on the basis of the Financial Statements for the three FYs (2006/07 – 2008/09), as discussed in Section 3.4.1, can be summarized as follows:

(1) CWASA's financial position showed a profit in each year, due to the contribution from non-operational revenue, even though the operational revenue has been marginal to recover even the operating expenses.
(2) If the operating revenue was confined to water revenue and service connection fees, it was inadequate to pay the financial expenses, although the financial expenses were limited only to the payment of interest of loans, not including the repayment of loans.
(3) Although current assets structure improved with substantial improvement in the collection of water bills, a comparatively large amount of the accounts receivable was accounted at the end of every fiscal year due to a longer collection period. MIS reports indicate a collection period of about 200 days.
(4) Despite of such position of accounts receivable, the position of the current assets and liabilities was maintained within a manageable range with the Current Liabilities controlled with delay in and creditors for various payments, including in particular arrears in the payment of large amounts of loan interest to GOB.
(5) In fact, large amounts of the project funds were provided in the form of grant or equity. In addition, large amounts of interests of the provided loans were transferred to grant or equity by GOB. As such, CWASA's financial management has been heavily dependent on the financial subsidy provided by GOB in the form of grant or equity.

In order to establish a financial structure that enables CWASA to manage with autonomy, it is vital for CWASA to take appropriate measures for improving the weakness of financial structure as stated above.

There are three factors affecting the CWASA's financial structure as enumerated below.

(1) Current tariff structure that is marginal to recover the operating and financial expenses
(2) Comparatively higher NRW in the distribution of water, constraining the water revenue while increasing unit water cost. The following Table 3.4.9 shows the records of water production and distribution volumes and billed water volumes reported in the Financial Statements in the three FYs (2006/07 – 2008/09):

**Table 3.4.9 Water Production/Distribution Volume and Billed Water Volume**

| | FY 2006/07 | FY 2007/08 | FY 2008/09 |
|---|---|---|---|
| A. Water Production Volume ($m^3$) | 66,986,364 | 71,145,455 | 68,581,818 |
| B. Water Distribution Volume ($m^3$) | 64,490,909 | 68,345,455 | 63,259,091 |
| C. Billed Water Volume ($m^3$) | 44,795,455 | 48,636,364 | 49,504,545 |
| D. (C-B)/C | 30.54% | 28.84% | 21.74% |

*Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09*

(3) Longer charge collection time period recorded as 200 days, affecting cash inflow and liquidity.

It is vital task for CWASA to take appropriate measures for improving these problems.

### 3.4.3 Review of Current Water Revenue

(1) Overview of water revenue during the last four years

The water revenue is the main source of CWASA's revenue, accounting for about 70% of annual revenue reported in the Financial Statements for FY2006/07, FY2007/08 and FY2008/09 (see Table 3.4.1).

Table 3.4.10 shows the recent records of water revenue during the last four fiscal years (FY2008/09 to FY2011/12).

**Table 3.4.10 Records of Water Revenue (2008/09 to 2011/12)**

| | Unit | 2008/09 | 2009/10 | 2010/11 | 2011/12* |
|---|---|---|---|---|---|
| 1. Billed Amounts<br>(Increase/Decrease %) | BDT mil. | 360.25 | 385.37<br>(+7.0%) | 406.10<br>(+5.4%) | 446.50<br>(+9.9%) |
| 2. Collected Amounts<br>(Increase/Decrease %) | BDT mil. | 356.99 | 366.86<br>(+2.8%) | 410.59<br>(+11.9%) | 432.38<br>(+5.3%) |
| 3. % of Collected Amounts vs. Billed Amount | | 99% | 95% | 101% | 96% |
| 4. Billed Water Vol.<br>(Increase/Decrease %) | $m^3$ mil. | 49.45 | 51.27<br>(+3.6%) | 51.65<br>(+0.7%) | 53.03<br>(+2.7%) |
| 5. Average Billed Amount per Billed Water Volume<br>(Increase/Decrease %) | BDT per $m^3$ | 7.29 | 7.52<br>(+3.2%) | 7.86<br>(+4.5%) | 8.42<br>(+7.1%) |

*Note: - Fiscal Year (FY): From 1st July until 30th June in the next year.*
*- Figures for 2011/12: Figures recorded up to May 2012 and added with an estimate for June 2012.*
*Source: CWASA Billing Reports*

Billed amounts increased from BDT 360.25 million in FY 2008/09 to BDT385.37 million, an increase of 7.0%, in FY 2009/10, to BDT406.10 million, an increase of 5.4%, in FY 2010/11 and further to BDT446.50 million, an increase of 9.9%, in FY 2011/12. These increases were due to two factors;

increases in both the billed water volume billed water rates. The collected amounts account for about 98% of the billed amount in average during the four FYs.

(2) Water consumption and water revenue by categories of consumers

Water consumers are broadly classified into two categories of Domestic Consumers and Non-domestic Consumers, and Domestic Consumers and Non-domestic Consumers are further classified as given below.

A. Domestic Consumers
- A-1. Private
- A-2. Government
- A-3. Street Hydrant
- A-4. Religious Institution
- A-5. Loose Waster (Sold by Bowser)

B. Non-domestic Consumers
- B-1. Private
- B-2. Government

Table 3.4.11 compares the structures of water consumption and billed amounts by classified consumers in June 2009, June 2011 and May 2012.

**Table 3.4.11 Comparison of Water Consumption and Billed Amounts by Classified Consumers (June 2009; June 2011; May 2012)**

| Categories of Consumers | | June, 2009 | | | | | June, 2011 | | | | | May, 2012 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Consumption | | Billed Amount | | Average Rate (BDT/$m^3$) | Consumption | | Billed Amount | | Average Rate (BDT/$m^3$) | Consumption | | Billed Amount | | Average Rate (BDT/$m^3$) |
| | | Vol. ($m^3$) | (%) | Amount (BDT) | (%) | | Vol. ($m^3$) | (%) | Amount (BDT) | (%) | | Vol. ($m^3$) | (%) | Amount (BDT) | (%) | |
| A. | Domestic | | | | | | | | | | | | | | | |
| A-1. | Private | 2,579,699 | 62.2% | 13,961,057 | 45.2% | 5.4 | 2,912,702 | 65.3% | 17,384,481 | 48.6% | 6.0 | 2,907,772 | 65.2% | 18,453,690 | 51.6% | 6.3 |
| A-2. | Government | 368,733 | 8.9% | 1,995,544 | 6.5% | 5.4 | 363,130 | 8.1% | 2,166,851 | 6.1% | 6.0 | 350,460 | 7.9% | 2,196,360 | 6.1% | 6.3 |
| A-3. | Street Hydrant | 375,367 | 9.1% | 2,031,448 | 6.6% | 5.4 | 375,367 | 8.4% | 2,133,144 | 6.0% | 5.7 | 387,879 | 8.7% | 2,429,799 | 6.8% | 6.3 |
| A-4. | Religious Institution | 33,414 | 0.8% | 180,835 | 0.6% | 5.4 | 33,414 | 0.7% | 189,888 | 0.5% | 5.7 | 33,414 | 0.7% | 209,318 | 0.6% | 6.3 |
| A-5. | Loose Water (Sold by Bowser) | 7,633 | 0.2% | 830,762 | 2.7% | 108.8 | 7,336 | 0.2% | 893,250 | 2.5% | 121.8 | 6,966 | 0.2% | 1,229,430 | 3.4% | 176.5 |
| | Sub-total (A) | 3,364,846 | 81.1% | 18,999,646 | 61.6% | 5.6 | 3,691,949 | 82.8% | 22,767,614 | 63.7% | 6.2 | 3,686,491 | 82.7% | 24,518,597 | 68.6% | 6.7 |
| B. | Non-domestic | | | | | | | | | | | | | | | |
| B-1. | Private | 477,016 | 11.5% | 7,234,042 | 23.4% | 15.2 | 496,682 | 11.1% | 8,396,097 | 23.5% | 16.9 | 475,858 | 10.7% | 8,423,937 | 23.6% | 17.7 |
| B-2. | Government | 304,681 | 7.3% | 4,620,542 | 15.0% | 15.2 | 271,019 | 6.1% | 4,580,236 | 12.8% | 16.9 | 299,793 | 6.7% | 5,318,885 | 14.9% | 17.7 |
| | Sub-total (B) | 781,697 | 18.9% | 11,854,584 | 38.4% | 15.2 | 767,701 | 17.2% | 12,976,333 | 36.3% | 16.9 | 775,651 | 17.4% | 13,742,822 | 38.4% | 17.7 |
| | Grand Total (A. + B.) | 4,146,543 | 100.0% | 30,854,230 | 100.0% | 7.4 | 4,459,650 | 100.0% | 35,743,947 | 100.0% | 8.0 | 4,462,142 | 100.0% | 38,261,419 | 107.0% | 8.6 |
| | (Source: Billing Reports) | | | | | | | | | | | | | | | |

As an average of the records given above, about 82% of water consumption was by domestic consumers and 18% by non-domestic consumers. Consumption by domestic consumers comprises 78.2% by private consumers, 10.1% by government consumers, 10.6% by street hydrant, 0.9% by religious institution and 0.2% by water sold by bowsers, whereas consumption by non-domestic consumers comprise 62.3% by private consumers, 17.7% by government consumers and 20% by others.

Comparing June 2009, June 2011 and May 2012, average billed amount per $m^3$ increased by 5% every year as given in Table 3.4.12.

**Table 3.4.12 Comparison of Average Billed Amount per Cubic Meter**

(BDT/$m^3$)

| Categories of Consumers | June 2009 | June 2011 | May 2012 |
|---|---|---|---|
| A. Domestic | | | |
| Private | 5.4 | 6.0 | 6.3 |
| Government | 5.4 | 6.0 | 6.3 |
| Street Hydrant | 5.4 | 5.7 | 6.3 |
| Religious Institutional | 5.4 | 5.7 | 6.3 |
| B. Non-domestic | | | |
| Private | 15.2 | 16.9 | 17.7 |
| Government | 15.2 | 16.9 | 17.7 |

*Note: Average Billed Amount per $m^3$ was calculated by dividing billed amounts with consumption volumes given in Table 3.4.12.*

(3) Performance of Service Connections and Water Distribution

Table 3.4.13 shows details of the service connection in June 2009, June 2011 and May 2012.

**Table 3.4.13 Performance of Service Connections**

(Nos. of connections)

| Particulars | June 2010 | June 2011 | May 2012 |
|---|---|---|---|
| A. Total Connection | 48,146 | 50,808 | 53,152 |
| B. Billable Connection | | | |
| B-1. Domestic | 38,831 | 41,134 | 43,149 |
| B-2. Non-domestic | 4,259 | 4,436 | 4,764 |
| Sub-total | 43,090 | 45,570 | 47,913 |
| B-3. Metered | 30,318 | 34,872 | 37,895 |
| B-4. Average-based bill | 12,229 | 10,298 | 9,879 |
| B-5. Non-meter bill | 543 | 400 | 139 |
| Sub-total | 43,090 | 45,570 | 47,913 |
| C. Billed Connection | | | |
| C-1. Domestic | 37,834 | 39,612 | 42,390 |
| C-2. Non-domestic | 4,072 | 4,230 | 4,644 |
| Sub-total | 41,906 | 43,842 | 47,034 |
| D. Unbilled Connection | 1,183 | 1,782 | 879 |
| Increase of Connections | | | |
| 1. Total Connections | | 2,662 | 2,344 |
| 2. Billable Connections | | | |
| 2-1. Domestic | | 2,303 | 2,015 |
| 2-2. Non-domestic | | 177 | 328 |
| Total | | 2,480 | 2,343 |
| 3. Metered Connection | | 4,554 | 3,023 |
| 4. Billed Connection | | | |
| 3-1. Domestic | | 1,778 | 2,778 |
| 3-2. Non-domestic | | 158 | 414 |
| Total | | 1,936 | 3,192 |

*Source: Billing Reports: June 2010; June 2011; May 2012*

Although the above figures indicates progress in providing additional connections, in particular metered connections, an acceleration in the rate will be required in order to utilize the substantial additional quantity of water that will be produced after the completion of the on-going Karnaphuli Water Supply Project and after implementation of the Phase 2 Project.

Table 3.4.14 shows the current performance of water distribution.

**Table 3.4.14 Current Performance of Water Distribution**

(Million $m^3$)

| Particulars | FY 2009/10 | FY 2010/11 | FY 2011/12 |
|---|---|---|---|
| A. Produced Water Volume | 73.50 | 76.40 | 70.84 |
| B. Volume Available for Distribution | 66.37 | 68.34 | 63.97 |
| C. Billed Volume | 51.27 | 51.65 | 53.03 |
| D. % [(B – C)/B] | 23.0% | 24.0% | 17.0% |

*Note: Figures for 2011/12: Figures recorded up to May 2012, with an estimate for June 2012.*
*Source: Billing Reports: June 2010; June 2011; May 2012*

Although the figures indicate improvement of billing in the recent years, considerably higher NRW rate is reported. Continuous efforts for improvement of NRW are required.

(4) Water tariff

Table 3.4.15 shows the current water tariff set by CWASA.

**Table 3.4.15 Water Tariff**

| Particulars | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| A. Domestic customers; including street hydrant and religious institution | Rate per $m^3$ (BDT/$m^3$) | 5.95 | 6.26 | 6.57 | 6.90 | 7.25 | 7.61 | 7.99 |
| | Minimum Charge Vol. ($m^3$) | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| B. Non-domestic customers | Rate per $m^3$ (BDT/$m^3$) | 16.89 | 17.73 | 18.61 | 19.55 | 20.53 | 21.56 | 22.64 |
| | Minimum Charge Vol. ($m^3$) | 21 | 21 | 21 | 21 | 21 | 21 | 21 |

*Source: CWASA*

The water tariff was set with upward adjustment every year. The tariff rates given for 2010 to 2012 are actually applied rates, and the rates in 2013 onward are those submitted to LGRD for their sanction. The rates were set with annual upward adjustment at 5% that was maximum range of increase allowed under the WASA Act 1996 (refer to Clause 22 (2) of the Act). The current water tariff of Dhaka WASA is shown below.

| Revised Date | Tariff for Domestic (BDT/$m^3$) | Tariff for Non-domestic (BDT/$m^3$) |
|---|---|---|
| 01-Aug-11 | 6.66 | 22.17 |
| 01-Jul-10 | 6.34 | 21.12 |
| 01-Jul-09 | 6.04 | 20.11 |

Comparing to the tariff of CWASA, the tariff of Dhaka WASA as of August 2011 is higher by about 6% for domestic and higher by about 25% for non-domestic. According to the HIES survey report in 2010 published by the Bangladesh Bureau of Statistics, the Average Monthly Household Nominal Income in Chittagong was BDT14,092, higher by 6.5% compared to BDT13,226 in Dhaka. The tariff of Dhaka WASA is much higher than the tariff of CWASA when the household income level is taken into account.

(5) Affordability of CWASA Water Tariff

According to the IDC Report submitted in July 2011, IDC assessed consumers' affordability to pay water tariff and concluded that consumers may be affordable to pay BDT30.22/$m^3$ as in 2011 based on the following assumptions:

1) Average monthly household income: BDT13,602
2) Affordable amount to pay for water: BDT408 per month (3% of the average income)
3) Water consumption per household: 13.50$m^3$ per month
4) Affordable amount per $m^3$: BDT408/13.50$m^3$ = BDT30.22/$m^3$

The above assessment implies that domestic consumers may be affordable to pay by about 4 to 5 times of the CWASA's tariff.

The survey conducted by the JICA Preparatory Survey Team indicates average income of habitants in the service areas is in a range between BDT 20,000 and 29,000 per month. If 3% of the income is taken as an affordable amount to pay for water, the affordable amount is estimated as BDT600 to 870. Assuming average water consumption of 15 to 18$m^3$ per month, the affordable payment range for water is estimated as BDT40 to 48 per $m^3$. These data indicate affordable amount for consumers to pay for water to be 6 to 7 times of the current CWASA tariff.

Considering these findings, consumers seem to be affordable to pay at least 4 times or more of the current tariff.

### 3.4.4 Review of Current Connection Charges

CWASA charges connection fees to the customers applying service connections. Table 3.4.16 shows the current connection fees set by CWASA.

**Table 3.4.16 Service Connection Charges**

(In BDT)

| Particulars | Connection Size (Dia) | | | | |
|---|---|---|---|---|---|
| | ¾" (20mm) | 1" (25mm) | 2" (30mm) | 4" (100mm) | 6" (150mm) |
| Connection Fee | 1,500 | 4,000 | 25,000 | 45,000 | 80,000 |
| Cost of Meter | 2,500 | 3,500 | 20,000 | 30,000 | 60,000 |
| Meter Fitting Charge | 200 | 250 | - | - | - |
| Security | 500 | 700 | 7,500 | 12,500 | 30,000 |
| Development Charge (Tax) | 2,525 | 4,150 | 11,250 | 19,250 | 42,000 |
| Total | 7,225 | 12,600 | 63,750 | 106,750 | 212,000 |

*Source: CWASA*

Foreseeing the needs for a significant increase in the number of service connections in order to meet the future water production volume, it would be prudent to review the current connection charges in order to ensure that the applied connection charges do not cause constraints in the planned increase in the number of service connections.

### 3.4.5 Debt Service Requirements for Loans

The Ministry of Finance of GOB issued a policy for re-lending terms of subsidiary loans provided to autonomous/semi-autonomous bodies and public sector corporations, under which CWASA is required to make repayment of subsidiary loan proceeds with 15 annual instalments within 20 years including 5 years grace period and also payment of interest at 4% per annul for local currency loans and 5% per annum for foreign currency loans.

The policy states that the Government will consider larger equity participation or limited grant by the Government because of public interest in terms of urbanization/human settlements, provided that recovery of full cost (investment and operation) should be justified.

CWASA obligates to make repayments of loan proceeds and payment of interest in respect of several loans previously provided by the Government. Repayment of those loans and payment of accrued interest cause burden to CWASA.

CWASA submitted a draft of Subsidiary Loan Agreement to the Government in relation to the JICA Loan provided for the on-going Karnaphuli Water Supply Project, however, the Government decided to suspend the execution of the Subsidiary Loan Agreement for the Phase 1 Project until the implementation of Phase 2 Project is determined.

# CHAPTER 4

# WATER DEMAND PROJECTION IN THE SURVEY AREA

# CHAPTER 4 WATER DEMAND PROJECTION IN THE SURVEY AREA

In order to determine the extent of the area to be served by the Karnaphuli water treatment plant (hereinafter referred to as the "Karnaphuli Service Area"), water demand in the Chittagong City Cooperation area (hereinafter referred to as CCC area) will be projected ward by ward up to the target year 2030. Major factors for the water demand projection include population, unit water consumption rate (daily average/daily maximum), and connection percentages to the distribution system by type of house/building and NRW/leakage percentage, as practiced in the previous studies. The following are study results by concerned factor.

## 4.1 Population Projection

### 4.1.1 Population Census Results

(1) Population in Chittagong City Corporation Area

A sharp rise in the population of Chittagong Municipality occurred after the independence of the country in 1971. This rise was due to rural to urban migration of people in search of better jobs and other opportunities.

Growth of population and urbanization results in an increase in demand for clean water and hence the need for additional water supply to the city. Table 4.1.1 shows the growth in population since 1901 in the Chittagong municipal area, the boundary of which was extended between 1974 and 1981, resulting in a high annual increase in the population during this period, as shown in the above table. It should be noted that the result of the Population and Housing Census, which was conducted from the 15th to 19th of March, 2011 is not officially available as of June 1st, 2012 (Information from Director General, Bangladesh Bureau of Statistics).

**Table 4.1.1 Population Census Results with Growth Rate in Chittagong Municipality (CCC Area)**

| Year | Population* | Growth Period | Annual Increase Rate | Remark |
|---|---|---|---|---|
| 1901 | 27,400 | - | - | |
| 1911 | 34,800 | 1901 - 1911 | 2.7% | |
| 1951 | 143,300 | 1911 - 1951 | 7.7% | |
| 1961 | 175,200 | 1951 - 1961 | 2.0% | |
| 1974 | 633,600 | 1961 - 1974 | 6.7%[1] | |
| 1981 | 1,209,500 | 1974 - 1981 | 9.7%[2] | |
| 1991 | 1,599,000 | 1981 - 1991 | 3.0% | |
| 2001 | 2,218, 000 | 1991 - 2001 | 3.3% | |
| 2011 | No official information released as of June 1, 2012 | | | Conducted from 15th to 19th of March, 2011 |

*Note: Round up to nearest thousand*
*Source: Population Census, the Bangladesh Bureau of Statistics (BBS).*

(2) Composition of Wards and Historical Population in Chittagong City

Chittagong City (CCC) consists of 41 wards as shown in Figure 4.1.1, with Table 4.1.2 showing the Population Census results by Ward in 1974, 1981, 1991 and 2001 (official figures).

[1] The 1974 population figure is for the extended boundary of the Municipality in this year. The high growth of 6.7% occurred mainly due to the increase in the area of the Municipality.

[2] The above applies to the growth rate of 9.7% in the period from 1974 to 1981.

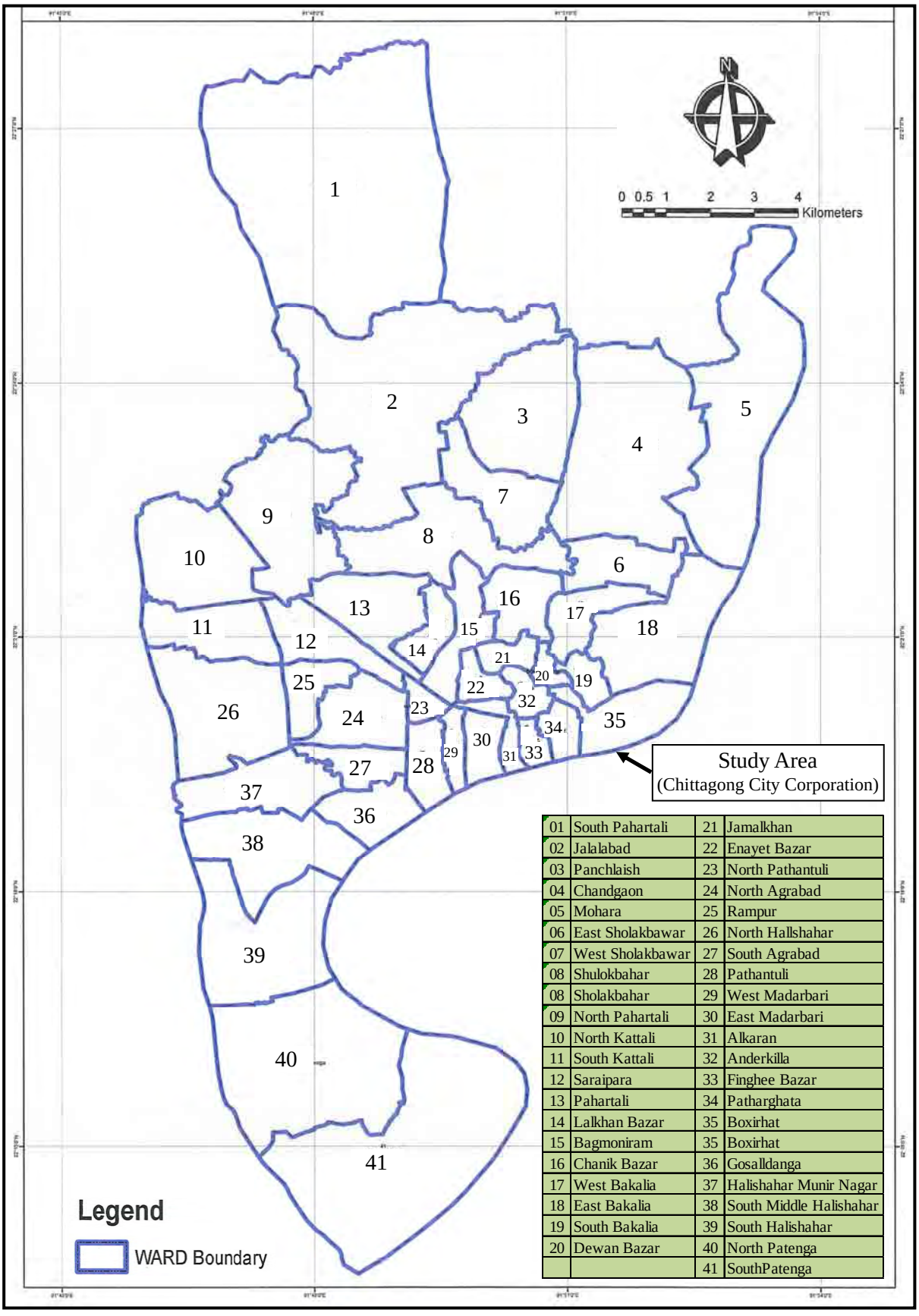



**Figure 4.1.1 Location of Wards in CCC Area**

**Table 4.1.2 Historical Population Census Results by Ward**

| Mahallah Name with Deo-code | | | | Population Census | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1974 | 1981 | 1991 | 2001 |
| **Chittagong City Corporation** | | | | | | | |
| **01** | **16** | **Bayeijid Bostami Thana** | | **0** | **46,071** | **99,377** | **239,550** |
| | 01 | Ward No.01 | South Pahartali | N/A | 46,071 | 26,391 | 101,370 |
| | 02 | Ward No.02 | Jalalabad | N/A | N/A | 39,836 | 75,420 |
| | 03 | Ward No.03 | Panchlaish | N/A | N/A | 33,150 | 62,760 |
| **02** | **57** | **Panchlaish Thana** | | **46,405** | **116,126** | **120,371** | **197,280** |
| | 07 | Ward No.07 | West Sholakbawar | 21,393 | 56,879 | 46,237 | 77,910 |
| | 08 | Ward No.08(Part) | Shulokbahar | 25,012 | 59,247 | 74,134 | 119,370 |
| **03** | **19** | **Chandgaou Thana** | | **58,520** | **94,800** | **106,543** | **178,050** |
| | 04 | Ward No.04 | Chandgaon | 24,674 | 37,695 | 43,724 | 73,070 |
| | 05 | Ward No.05 | Mohara | 24,010 | 34,767 | 47,089 | 78,690 |
| | 06 | Ward No.06 | East Sholakbawar | 9,836 | 22,338 | 15,730 | 26,290 |
| **04** | **10** | **Bakalia** | | **59,409** | **69,218** | **124,666** | **203,850** |
| | 17 | Ward No.17 | West Bakalia | 46,114 | 26,275 | 40,298 | 66,750 |
| | 18 | Ward No.18 | East Bakalia | | 10,400 | 25,732 | 42,620 |
| | 19 | Ward No.19 | South Bakalia | | 26,038 | 47,068 | 77,970 |
| | 35 | Ward No.35(Part) | Boxirhat | 13,295 | 6,505 | 11,568 | 16,510 |
| **05** | **41** | **Kotwali Thana** | | **132,963** | **224,853** | **235,325** | **287,760** |
| | 15 | Ward No.15 | Bagmoniram | 18,672 | 19,687 | 26,883 | 32,220 |
| | 16 | Ward No.16 | Chawk Bazar | 15,195 | 32,940 | 33,418 | 45,750 |
| | 20 | Ward No.20 | Dewan Bazar | 13,672 | 30,131 | 28,087 | 33,670 |
| | 21 | Ward No.21 | Jamalkhan | 23,115 | 31,266 | 33,976 | 40,720 |
| | 22 | Ward No.22 | Enayet Bazar | 16,134 | 21,031 | 25,158 | 30,150 |
| | 31 | Ward No.31 | Alkaran | 12,441 | 17,133 | 24,618 | 29,510 |
| | 32 | Ward No.32 | Anderkilla | 10,278 | 29,747 | 17,675 | 21,190 |
| | 33 | Ward No.33 | Finghee Bazar | 13,413 | 13,171 | 19,330 | 23,170 |
| | 34 | Ward No.34 | Patharghata | 10,043 | 29,747 | 26,180 | 31,380 |
| | 35 | Ward No.35(Part) | Boxirhat | | | | |
| **06** | **43** | **Khulshi Thana** | | **53,120** | **149,434** | **125,050** | **200,210** |
| | 08 | Ward No.08(Part) | Sholakbahar | | | | |
| | 09 | Ward No.09 | North Pahartali | 15,458 | 27,281 | 38,205 | 64,700 |
| | 13 | Ward No.13 | Pahartali | 23,504 | 51,350 | 43,560 | 67,970 |
| | 14 | Ward No.14 | Lalkhan Bazar | 14,158 | 70,803 | 43,285 | 67,540 |
| **07** | **55** | **Pahartali** | | **20,347** | **74,961** | **89,900** | **127,920** |
| | 10 | Ward No.10 | North Kattali | N/A | N/A | 20,705 | 29,560 |
| | 11 | Ward No.11 | South Kattali | N/A | N/A | 22,655 | 31,910 |
| | 12 | Ward No.12 | Saraipara | 20,347 | 74,961 | 46,540 | 66,450 |
| **08** | **28** | **Double Mooring Thana** | | **118,764** | **181,132** | **234,340** | **302,750** |
| | 23 | Ward No.23 | North Pathantuli | 14,131 | 5,819 | 26,501 | 33,900 |
| | 24 | Ward No.24(Part) | North Agrabad | 16,059 | 26,623 | 34,995 | 47,710 |
| | 27 | Ward No.27 | South Agrabad | 24,544 | 52,367 | 71,210 | 91,110 |
| | 28 | Ward No.28 | Pathantuli | 17,373 | 21,045 | 33,619 | 43,010 |
| | 29 | Ward No.29 | West Madarbari | 24,365 | 46,860 | 37,452 | 47,920 |
| | 30 | Ward No.30 | East Madarbari | 22,292 | 28,418 | 30,563 | 39,100 |
| **09** | **35** | **Halishahar Thana** | | **9,637** | **10,612** | **49,730** | **67,800** |
| | 24 | Ward No.24(Part) | North Agrabad | | | | |
| | 25 | Ward No.25 | Rampur | 9,637 | 10,612 | ***22,501*** | 30,680 |
| | 26 | Ward No.26 | North Hallshahar | N/A | N/A | 27,229 | 37,120 |
| **10** | **20** | **Chittagong Port Thana** | | **63,603** | **102,483** | **134,787** | **205,320** |
| | 36 | Ward No.36 | Gosaldanga | 10,225 | 20,773 | 19,819 | 30,190 |
| | 37 | Ward No.37 | Halishahar Munir Nagar | 35,834 | 17,851 | 32,276 | 49,170 |
| | 38 | Ward No.38 | South Middle Halishahar | | 34,879 | 36,020 | 54,870 |
| | 39 | Ward No.39 | South Halishahar | 17,544 | 28,980 | 46,672 | 71,090 |
| **11** | **65** | **Patenga Thana** | | **27,211** | **45,542** | **72,771** | **85,360** |
| | 40 | Ward No.40 | North Patenga | 14,421 | 22,294 | 39,828 | 46,720 |
| | 41 | Ward No.41 | SouthPatenga | 12,790 | 23,248 | 32,943 | 38,640 |
| | | | | | | | |
| **Municipality Total** | | | | **589,979** | **1,115,232** | **1,392,860** | **2,095,850** |

### 4.1.2 Population Projection

(1) Population Projection in Previous Studies

With reference to water supply projects in Chittagong City (CCC area), the following studies have been conducted as of today.

1) The Feasibility Study of Extension and Expansion of MOHARA Water Treatment Plant in Chittagong, People's Republic Bangladesh; JICA, December 2000 – refer to Table 4.1.3.

**Table 4.1.3 MOHARA WTP Study, December 2000, JICA**

| Name of Thana | Area (ha) | Population in 1991 Census | Population Projection | | |
|---|---|---|---|---|---|
| | | | 2000 | 2005 | 2010 |
| Kotwali | 625 | 283,433 | 352,600 | 400,600 | 457,500 |
| Double Mooring | 1,499 | 367,296 | 537,900 | 667,400 | 830,200 |
| Panchlaish | 2,601 | 221,974 | 309,700 | 372,800 | 449,000 |
| Pahartali | 4,663 | 228,330 | 352,900 | 450,800 | 576,700 |
| Chandgaon | 3,214 | 252,147 | 387,800 | 494,500 | 632,600 |
| Chittagong Port | 4,464 | 215,523 | 364,400 | 488,400 | 654,900 |
| Hathazari (Munici) | 2,938 | 30,297 | 45,000 | 56,100 | 69,900 |
| Municipality (CCC) Total | 20,004 | 1,599,000 | 2,350,300 | 2,930,600 | 3,670,800 |

2) Special Assistance for Project Formation (SAPROF) for Karnaphuli Water Supply Project; JBIC, November 2005 – refer to Tables 4.1. 4 and 4.1.5.

**Table 4.1.4 SAPROF, November 2005, JBIC**

| Name of Thana | | Area (ha) | Population in Census | | Population Projection | | |
|---|---|---|---|---|---|---|---|
| | | | 1991 | 2001 | 2005 | 2010 | 2020 |
| Zone-1 | Kotwali | 1,229 | 283,433 | 321,948 | 344,800 | 368,200 | 409,200 |
| Zone-2 | Double Mooring | 1,224 | 367,296 | 456,210 | 478,800 | 503,600 | 542,800 |
| Zone-3 | Panchlaish | 2,847 | 221,974 | 354,950 | 402,500 | 460,900 | 577,100 |
| Zone-4 | Pahartali | 2,349 | 228,330 | 315,007 | 358,800 | 413,900 | 511,600 |
| Zone-5 | Chandgaon | 3,100 | 252,147 | 386,619 | 445,200 | 512,000 | 643,800 |
| Zone-6 | Chittagong Port | 3,736 | 215,523 | 275,624 | 334,200 | 403,100 | 542,400 |
| Zone-7 | Hathazari (J.D.Pahartali) | 1,077 | 30,297 | 107,260 | 131,400 | 158,300 | 214,800 |
| Municipality (CCC) Total | | 15,562 | 1,599,000 | 2,217,619 | 2,495,700 | 2,820,000 | 3,441,700 |

**Table 4.1.5 Proposed Annual Growth Rate for Study Area in SAPROF**

| Present Density (pop./ hectare) | Proposed Growth Rate (2001-05) | Proposed Growth Rate (2005-10) | Proposed Growth Rate (2010-20) | Growth Rate (1981-1991 Average) |
|---|---|---|---|---|
| > 50 | 5.6% | 4.8% | 4.0% | 3.3% |
| 51 - 100 | 5.2% | 4.4% | 3.6% | 5.7% |
| 101- 150 | 4.4% | 3.8% | 3.1% | 3.7% |
| 151- 200 | 3.4% | 2.8% | 2.4% | 2.1% |
| 201 - 300 | 2.0% | 1.6% | 1.5% | 2.4% |
| 301 - 400 | 1.4% | 1.2% | 1.0% | -1.4% |
| 401 - 500 | 1.0% | 0.8% | 0.6% | -0.1% |
| 500 - 700 | 0.4% | 0.4% | 0.4% | -4.3% |
| 700 < | 0.0% | 0.0% | 0.0% | -0.1% |
| City Area Overall | 3.0% | 2.5% | 2.0% | 2.8% |

3) Project Evaluation Report for Karnaphuli Water Supply Project (Detailed Design Stage); 2008 – refer to Tables 4.1.6 and 4.1.7.

**Table 4.1.6 Detailed Design for KWSP, 2008, Phase 1 D/D**

| Name of Thana | | Area (ha) | Census Population | | Population Projection | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1991 | 2001 | 2010 | 2015 | 2020 | 2025 | 2030 |
| 01 | Bayeijid Bostami | 1,758 | 121,827 | 168,051 | 227,000 | 260,600 | 299,100 | 336,800 | 379,100 |
| 02 | Panchlaish | 830 | 21,709 | 148,120 | 200,100 | 229,800 | 263,700 | 296,900 | 334,300 |
| 03 | Chandgaon | 2,532 | 111,210 | 178,390 | 281,600 | 349,300 | 433,200 | 517,100 | 617,000 |
| 04 | Balkalia | 1,233 | 113,446 | 196,877 | 266,000 | 305,400 | 350,600 | 394,800 | 444,400 |
| 05 | Kotwali | 768 | 201,175 | 282,975 | 320,600 | 340,200 | 361,300 | 379,700 | 399,000 |
| 06 | Khulshi | 1,312 | 152,657 | 243,351 | 328,900 | 377,600 | 433,500 | 488,000 | 549,500 |
| 07 | Pahartali | 1,331 | 95,618 | 127,243 | 171,800 | 197,300 | 226,500 | 255,000 | 287,200 |
| 08 | Double Mooring | 812 | 222,165 | 259,181 | 293,800 | 312,000 | 331,000 | 348,000 | 365,600 |
| 09 | Halishahar | 964 | 73,993 | 125,255 | 169,300 | 194,400 | 223,200 | 251,300 | 283,000 |
| 10 | Chittagong Port | 2,004 | 108,816 | 213,598 | 314,800 | 379,300 | 457,100 | 532,500 | 620,400 |
| 11 | Patenga | 3,263 | 78,924 | 80,448 | 87,900 | 91,400 | 95,200 | 98,100 | 101,000 |
| Municipality (CCC) Total | | 16,807 | 1,301,540 | 2,023,489 | 2,661,800 | 3,037,300 | 3,474,400 | 3,898,200 | 4,380,500 |

Note) Population Census-2001; Bangladesh Bureau Statics, Planning Division, Ministry of Planning (2007)

**Table 4.1.7 Proposed Annual Growth Rate for Study Area, 2008, Phase 1 D/D**

| Present Density (pop./ hectare) | Proposed Growth Rate (2001-10) | Proposed Growth Rate (2010-20) | Proposed Growth Rate (2020-30) | Growth Rate (1981-1991 Average) |
|---|---|---|---|---|
| > 50 | 5.6% | 4.8% | 4.0% | 3.3% |
| 51 - 100 | 5.2% | 4.4% | 3.6% | 5.7% |
| 101- 150 | 4.4% | 3.8% | 3.1% | 3.7% |
| 151- 200 | 3.4% | 2.8% | 2.4% | 2.1% |
| 201 – 300 | 2.0% | 1.6% | 1.5% | 2.4% |
| 301 – 400 | 1.4% | 1.2% | 1.0% | -1.4% |
| 401 – 500 | 1.0% | 0.8% | 0.6% | -0.1% |
| 500 – 700 | 0.4% | 0.4% | 0.4% | -4.3% |
| 700 < | 0.0% | 0.0% | 0.0% | -0.1% |

4) Preparation of Detailed Area Plan (DAP) for Chittagong Metropolitan Master Plan (CMMP), Draft Final Report Report-IV; Chittagong Development Authority(CDA), January 2008– refer to Table 4.1.8

**Table 4.1.8 CMMA by CDA, January, 2008**

| | Population in Census | | Population Projection 2015 |
|---|---|---|---|
| | 1991 | 2001 | |
| City Area | 1,442,026 | 2,023,489 | 3,382,653 |

5) Preparation of Master Plan (MP) for Water Supply and Wastewater Management of the Detailed Planned Area of Chittagong, Bangladesh, Mater Plan for Water Supply; KOICA. August 2009 – refer to Table 4.1.9

**Table 4.1.9 MP, August 2009, KOICA**

| Area (ha) | | Population in Census | | Population Projection | | | |
|---|---|---|---|---|---|---|---|
| | | 1991 | 2001 | 2007 | 2011 | 2021 | 2031 |
| City Area (CCC) | 15,562 | 1,392,860 | 2,095,850 | 2,700,000 | 2,900,000 | 3,800,000 | 4,700,000 |

Table 4.1.10 summarizes the results of the projections in the previous studies, in which the base and target years vary. The population in the CCC area in 2010/2011 is more than 3 million according to preliminary information from CWASA. In this regard, the projection in the KOICA MP is similar.

**Table 4.1.10 Summary of Population Projection in the Previous Studies**

| | | | 2007 | 2010 | 2011 | 2015 | 2020 | 2021 | 2025 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chittagong City Corporation | a. MOHARA, 2000,JICA | *Pop.* | - | 3,670,800 | - | - | - | - | - | - | - |
| | b. SAPROF, 2005,JBIC | *Pop.* | - | 2,820,000 | - | - | 3,441,700 | - | - | - | - |
| | | *Growth* | | 2.01% | | | | | | | |
| | c. D/D, 2008, NJS | *Pop.* | - | 2,661,800 | - | 3,037,300 | 3,474,400 | - | 3,898,200 | 4,380,500 | - |
| | | *Growth* | | 2,67% | | 2.73% | 2.33% | | 2.36% | | |
| | d. CMMA, 2008, CDA | *Pop.* | - | - | - | 3,382,653 | - | - | - | - | - |
| | e. M/P, 2009, KOICA | *Pop.* | 2,700,000 | - | 2,900,000 | - | - | 3,800,000 | - | - | 4,700,000 |
| | | *Growth* | 1.80% | | | 2.74% | | | 2.15% | | |

(2) Population Projection

As mentioned above, the results of the population census in 2011 have not been officially released as of June 1st, 2012. As such the projection in the most recent study (MP by KOICA) has been basically used for this study. According to the MP, annual growth rates of 1.8 – 4.3 % rates were applied between 1991 and 2031 for the population projection in the CCC area, as shown in Table 4.1.11.

**Table 4.1.11 Population Projection by KOICA**

| | | Area (ha) | Population in Census | | | Population Projection & Growth Rate | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1991 | 2001 | 2007 | 2011 | 2021 | 2031 |
| City Area (CCC) | Population | 15,562 | 1,392,860 | 2,095,850 | 2,700,000 | 2,900,000 | 3,800,000 | 4,700,000 |
| | Average Rate (%) | | | 4.2 | 4.3 | 1.80 | 2.74 | 2.15 |

*Note: Base year for the projection is Year 2001.*
*Population growth rates were estimated using projected population in the MP.*

The population in each ward in the CCC area from 2015 to 2030 at five- year intervals has been projected using the MP assumptions on the annual growth rate by ward and using the 2011 population as the base year population. The growth rate which has been adopted for the projections in 2015 and 2020 is that in the MP for the projection from 2011 to 2021, while for the projections in 2025 and 2030, the growth rate in the MP from 2021 to 2031 has been used. Table 4.1.12 shows the projected population for each ward for the target year of 2030 and other years, together with the information on past census results, population density and growth rate assumed in the MP.

**Table 4.1.12 Population Projection for the Phase 2 Project**

| Mahallah Name with Deo-code | | | | Population | | | | | | | Proposed Growth Rate | | Population Projection | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1991 | 2001 | 2011 | Population/ha | | | Growth Rate | | | | | | |
| | | | | | | | 1991 | 2001 | 2011 | 1991-2001 | 2001-2011 | 2011-2021 | 2021-2031 | 2015 | 2020 | 2025 | 2030 |
| **Chittagong City Corporation** | | | | | | | | | | | | | | | | | |
| **01** | **16** | **Bayeijid Bostami Thana** | | **99,377** | **239,550** | **313,000** | **33** | **79** | **104** | **9.20%** | **5.49%** | **2.26%** | **1.85%** | **342,200** | **382,700** | **421,100** | **461,500** |
| | 01 | Ward No.01 | South Pahartali | 26,391 | 101,370 | 128,000 | 25 | 94 | 119 | 14.41% | 4.78% | 1.95% | 1.63% | 138,300 | 152,300 | 165,700 | 179,700 |
| | 02 | Ward No.02 | Jalalabad | 39,836 | 75,420 | 105,800 | 29 | 56 | 78 | 6.59% | 7.00% | 2.84% | 2.22% | 118,300 | 136,100 | 152,800 | 170,500 |
| | 03 | Ward No.03 | Panchlaish | 33,150 | 62,760 | 79,200 | 57 | 108 | 137 | 6.59% | 4.76% | 1.95% | 1.64% | 85,600 | 94,300 | 102,600 | 111,300 |
| **02** | **57** | **Panchlaish Thana** | | **120,371** | **197,280** | **304,500** | **132** | **217** | **335** | **5.06%** | **9.07%** | 3.53% | 2.60% | **349,800** | **416,200** | **477,500** | **543,000** |
| | 07 | Ward No.07 | West Sholakbawar | 46,237 | 77,910 | 120,300 | 114 | 191 | 296 | 5.36% | 9.08% | 3.54% | 2.60% | 138,200 | 164,500 | 188,700 | 214,600 |
| | 08 | Ward No.08(Part) | Shulokbahar | 74,134 | 119,370 | 184,200 | 148 | 238 | 367 | 4.88% | 9.06% | 3.53% | 2.60% | 211,600 | 251,700 | 288,800 | 328,400 |
| **03** | **19** | **Chandgaon Thana** | | **106,543** | **178,050** | **281,600** | **51** | **86** | **136** | **5.27%** | **9.60%** | 3.69% | 2.69% | **325,500** | **390,200** | **449,900** | **513,900** |
| | 04 | Ward No.04 | Chandgaon | 43,724 | 73,070 | 115,600 | 47 | 79 | 125 | 5.27% | 9.61% | 3.69% | 2.69% | 133,600 | 160,200 | 184,700 | 211,000 |
| | 05 | Ward No.05 | Mohara | 47,089 | 78,690 | 124,500 | 52 | 87 | 138 | 5.27% | 9.61% | 3.70% | 2.69% | 144,000 | 172,600 | 199,000 | 227,300 |
| | 06 | Ward No.06 | East Sholakbawar | 15,730 | 26,290 | 41,500 | 64 | 108 | 170 | 5.27% | 9.56% | 3.67% | 2.69% | 47,900 | 57,400 | 66,200 | 75,600 |
| **04** | **10** | **Bakalia** | | **124,666** | **203,850** | **317,300** | **94** | **154** | **240** | **5.04%** | **9.25%** | 3.59% | 2.63% | **365,300** | **435,700** | **500,800** | **570,300** |
| | 17 | Ward No.17 | West Bakalia | 40,298 | 66,750 | 105,600 | 166 | 275 | 435 | 5.18% | 9.61% | 3.70% | 2.69% | 122,100 | 146,400 | 168,800 | 192,700 |
| | 18 | Ward No.18 | East Bakalia | 25,732 | 42,620 | 67,400 | 39 | 65 | 103 | 5.18% | 9.60% | 3.70% | 2.69% | 77,900 | 93,400 | 107,700 | 123,000 |
| | 19 | Ward No.19 | South Bakalia | 47,068 | 77,970 | 123,400 | 371 | 614 | 972 | 5.18% | 9.62% | 3.70% | 2.69% | 142,700 | 171,100 | 197,300 | 225,300 |
| | 35 | Ward No.35(Part) | Boxirhat | 11,568 | 16,510 | 20,900 | 39 | 55 | 70 | 3.62% | 4.83% | 1.93% | 1.65% | 22,600 | 24,800 | 27,000 | 29,300 |
| **05** | **41** | **Kotwali Thana** | | **235,325** | **287,760** | **363,000** | **253** | **309** | **390** | **2.03%** | **4.76%** | 1.94% | 1.63% | **392,100** | **431,700** | **469,500** | **508,800** |
| | 15 | Ward No.15 | Bagmoniram | 26,883 | 32,220 | 40,600 | 149 | 179 | 226 | 1.83% | 4.73% | 1.96% | 1.62% | 43,900 | 48,400 | 52,600 | 57,000 |
| | 16 | Ward No.16 | Chanik Bazar | 33,418 | 45,750 | 57,700 | 189 | 258 | 326 | 3.19% | 4.75% | 1.94% | 1.62% | 62,300 | 68,600 | 74,500 | 80,800 |
| | 20 | Ward No.20 | Dewan Bazar | 28,087 | 33,670 | 42,500 | 720 | 863 | 1,090 | 1.83% | 4.77% | 1.96% | 1.64% | 45,900 | 50,600 | 55,100 | 59,700 |
| | 21 | Ward No.21 | Jamalkhan | 33,976 | 40,720 | 51,300 | 447 | 536 | 675 | 1.83% | 4.73% | 1.95% | 1.63% | 55,400 | 61,000 | 66,400 | 71,900 |
| | 22 | Ward No.22 | Enayet Bazar | 25,158 | 30,150 | 38,000 | 293 | 351 | 442 | 1.83% | 4.74% | 1.95% | 1.61% | 41,100 | 45,200 | 49,100 | 53,200 |
| | 31 | Ward No.31 | Alkaran | 24,618 | 29,510 | 37,300 | 268 | 321 | 405 | 1.83% | 4.80% | 1.94% | 1.64% | 40,300 | 44,300 | 48,200 | 52,300 |
| | 32 | Ward No.32 | Anderkilla | 17,675 | 21,190 | 26,800 | 167 | 200 | 253 | 1.83% | 4.81% | 1.95% | 1.63% | 28,900 | 31,900 | 34,700 | 37,600 |
| | 33 | Ward No.33 | Finghee Bazar | 19,330 | 23,170 | 29,200 | 233 | 279 | 352 | 1.83% | 4.73% | 1.92% | 1.63% | 31,500 | 34,600 | 37,700 | 40,800 |
| | 34 | Ward No.34 | Patharghata | 26,180 | 31,380 | 39,600 | 285 | 341 | 430 | 1.83% | 4.76% | 1.94% | 1.63% | 42,800 | 47,100 | 51,200 | 55,500 |
| | 35 | Ward No.35(Part) | Boxirhat | 0 | 0 | 0 | | | | | | | | | | | |
| **06** | **43** | **Khulshi Thana** | | **125,050** | **200,210** | **308,900** | **138** | **222** | **342** | **4.82%** | **9.06%** | 3.53% | 2.60% | **354,800** | **422,100** | **484,300** | **550,700** |
| | 08 | Ward No.08(Part) | Sholakbahar | 0 | 0 | 0 | | | | | | | | | | | |
| | 09 | Ward No.09 | North Pahartali | 38,205 | 64,700 | 99,800 | 69 | 117 | 181 | 5.41% | 9.05% | 3.52% | 2.61% | 114,600 | 136,300 | 156,400 | 177,900 |
| | 13 | Ward No.13 | Pahartali | 43,560 | 67,970 | 104,900 | 192 | 299 | 462 | 4.55% | 9.07% | 3.52% | 2.61% | 120,500 | 143,300 | 164,400 | 186,900 |
| | 14 | Ward No.14 | Lalkhan Bazar | 43,285 | 67,540 | 104,200 | 349 | 545 | 840 | 4.55% | 9.06% | 3.54% | 2.60% | 119,700 | 142,500 | 163,500 | 185,900 |
| **07** | **55** | **Pahartali** | | **89,900** | **127,920** | **144,800** | **102** | **145** | **164** | **3.59%** | **2.51%** | 0.81% | 0.76% | **149,600** | **155,700** | **161,800** | **168,000** |
| | 10 | Ward No.10 | North Kattali | 20,705 | 29,560 | 33,500 | 73 | 104 | 118 | 3.62% | 2.53% | 0.83% | 0.77% | 34,600 | 36,100 | 37,500 | 39,000 |
| | 11 | Ward No.11 | South Kattali | 22,655 | 31,910 | 36,100 | 68 | 96 | 109 | 3.48% | 2.50% | 0.80% | 0.74% | 37,300 | 38,800 | 40,300 | 41,800 |
| | 12 | Ward No.12 | Saraipara | 46,540 | 66,450 | 75,200 | 174 | 248 | 281 | 3.63% | 2.50% | 0.81% | 0.76% | 77,700 | 80,800 | 84,000 | 87,200 |
| **08** | **28** | **Double Mooring Thana** | | **234,340** | **302,750** | **363,800** | **304** | **393** | **472** | **2.59%** | **3.74%** | 1.47% | 1.28% | **385,400** | **414,800** | **443,000** | **472,000** |
| | 23 | Ward No.23 | North Pathantuli | 26,501 | 33,900 | 42,700 | 344 | 440 | 555 | 2.49% | 4.72% | 1.95% | 1.63% | 46,100 | 50,800 | 55,300 | 59,900 |
| | 24 | Ward No.24(Part) | North Agrabad | 34,995 | 47,710 | 54,000 | 168 | 229 | 260 | 3.15% | 2.51% | 0.82% | 0.74% | 55,800 | 58,100 | 60,400 | 62,600 |
| | 27 | Ward No.27 | South Agrabad | 71,210 | 91,110 | 103,000 | 481 | 616 | 696 | 2.49% | 2.48% | 0.82% | 0.75% | 106,400 | 110,900 | 115,200 | 119,600 |
| | 28 | Ward No.28 | Pathantuli | 33,619 | 43,010 | 54,300 | 276 | 353 | 445 | 2.49% | 4.77% | 1.94% | 1.62% | 58,600 | 64,500 | 70,200 | 76,100 |
| | 29 | Ward No.29 | West Madarbari | 37,452 | 47,920 | 60,500 | 350 | 448 | 565 | 2.50% | 4.77% | 1.94% | 1.63% | 65,300 | 71,900 | 78,200 | 84,800 |
| | 30 | Ward No.30 | East Madarbari | 30,563 | 39,100 | 49,300 | 280 | 359 | 452 | 2.49% | 4.75% | 1.93% | 1.62% | 53,200 | 58,600 | 63,700 | 69,000 |
| **09** | **35** | **Halishahar Thana** | | **49,730** | **67,800** | **76,700** | **56** | **77** | **87** | **3.15%** | **2.50%** | 0.82% | 0.76% | **79,200** | **82,500** | **85,700** | **89,000** |
| | 24 | Ward No.24(Part) | North Agrabad | 0 | 0 | 0 | | | | | | | | | | | |
| | 25 | Ward No.25 | Rampur | 22,501 | 30,680 | 34,700 | 117 | 159 | 180 | 3.15% | 2.49% | 0.81% | 0.75% | 35,800 | 37,300 | 38,700 | 40,200 |
| | 26 | Ward No.26 | North Hallshahar | 27,229 | 37,120 | 42,000 | 40 | 54 | 61 | 3.15% | 2.50% | 0.83% | 0.76% | 43,400 | 45,200 | 47,000 | 48,800 |
| **10** | **20** | **Chittagong Port Thana** | | **134,787** | **205,320** | **293,100** | **71** | **108** | **155** | **4.30%** | **7.38%** | 2.98% | 2.30% | **329,300** | **381,800** | **430,400** | **482,400** |
| | 36 | Ward No.36 | Gosalldanga | 19,819 | 30,190 | 34,200 | 146 | 222 | 251 | 4.30% | 2.53% | 0.82% | 0.76% | 35,300 | 36,800 | 38,200 | 39,700 |
| | 37 | Ward No.37 | Halishahar Monir Nagar | 32,276 | 49,170 | 62,000 | 85 | 130 | 164 | 4.30% | 4.75% | 1.96% | 1.63% | 67,000 | 73,900 | 80,300 | 87,100 |
| | 38 | Ward No.38 | South Middle Halishahar | 36,020 | 54,870 | 85,800 | 66 | 101 | 158 | 4.30% | 9.35% | 3.62% | 2.66% | 98,900 | 118,100 | 135,900 | 155,000 |
| | 39 | Ward No.39 | South Halishahar | 46,672 | 71,090 | 111,100 | 56 | 85 | 132 | 4.30% | 9.34% | 3.62% | 2.65% | 128,100 | 153,000 | 176,000 | 200,600 |
| **11** | **65** | **Patenga Thana** | | **72,771** | **85,360** | **133,300** | **37** | **43** | **67** | **1.61%** | **9.32%** | 3.62% | 2.64% | **153,700** | **183,600** | **211,100** | **240,500** |
| | 40 | Ward No.40 | North Patenga | 39,828 | 46,720 | 73,000 | 41 | 49 | 76 | 1.61% | 9.34% | 3.62% | 2.65% | 84,200 | 100,600 | 115,700 | 131,800 |
| | 41 | Ward No.41 | SouthPatenga | 32,943 | 38,640 | 60,300 | 32 | 38 | 59 | 1.61% | 9.31% | 3.61% | 2.64% | 69,500 | 83,000 | 95,400 | 108,700 |
| | | | | | | | | | | | | | | | | | |
| **Municipality Total** | | | | **1,392,860** | **2,095,850** | **2,900,000** | **90** | **135** | **186** | **4.17%** | **6.71%** | 2.74% | 2.15% | **3,226,900** | **3,697,000** | **4,135,100** | **4,600,100** |

Table 4.1.13 presents the projected population from 2015 to 2030 for the CCC area. The projected population in 2030 is 4.6 million (rounded up to the nearest thousand).

**Table 4.1.13 Summary of Population Projection as a Total of CCC Area**

unit: person

| Item | 2011 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Population | 2,900,000 | 3,226,900 | 3,697,000 | 4,135,000 | 4,600,000 |

The population by word is further distributed into the three categories of house /building types. The MP disregarded the composition of house/building types, seemingly in order to study from a more macroeconomic view point, covering the entire city. However, the composition of hose/building types varies considerably ward by ward.

Based on the composition percentages for respective wards by the type of house/building in the population censuses in 1991 and 2001, the SAPROF projected the shares of the three types of housing for the years 2010 and 2020 by ward. In this study, the shares of the housing types by ward for the years 2015, 2025 and 2030 are assumed according to the following conditions:

Year 2015: Pucca; proportionally increase using the ratio between 2010 and 2020
Kutcha; proportionally decrease using the ratio between 2010 and 2020
Semi-Pucca; 100% - (Pucca % + Kutcha %)

Year 2025 and Year 2030:
Pucca; proportionally increase using the ratio between 2010 and 2020
Kutcha; the percentage in 2020 is discounted
Semi-Pucca; 100%- (Pucca % + Kutcha %)

Table 4.1.14 presents the ranges of the shares by type of housing by ward in the past and future. It is assumed that the present year for the study is 2011 (base year of MP projection; data in year 2010 and 2012 are regarded as the same level in 2011). Table 4.1.15 shows the city average percentage by year as a result of the calculation for the concerned wards.

**Table 4.1.14 Ranges of the Shares by Type of Housing by Ward**

unit: %

| Type of Housing | Population Census 1991 | Population Census 2001 | 2011 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| Pucca | 22-47 | 23-51 | 28-61 | 30-60 | 35-76 | 40-70 | 45-75 |
| Semi-Pucca | 30-39 | 20-30 | 30-39 | 25-35 | 22-29 | 25-35 | 25-35 |
| Kutcha | 18-43 | 23-49 | 4-35 | 2-35 | 0-35 | 0-35 | 0-35 |

**Table 4.1.15 Population Shares assumed by Housing Type as a City Average**

unit:%

| Type of Housing | Population Census 1991 | Population Census 2001 | 2011 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| Pucca | 31 | 32 | 40 | 45 | 50 | 53 | 58 |
| Semi-Pucca | 34 | 39 | 34 | 30 | 25 | 30 | 28 |
| Kutcha | 35 | 29 | 26 | 25 | 25 | 17 | 14 |

## 4.2 Unit Water Consumption

Water consumption for the target and intermediate years will be assumed by domestic use (individual house connection and hydrant/communal faucet), and other uses; commercial, institutional and industrial. A uniform per capita consumption for individual house connections is applied to the three house/building types. For public hydrant/communal faucets, a lower consumption volume/person/day than that of individual house connections is used based on current practices. For other water users, a percentage of the domestic water consumption is used. This manner of calculation was adopted in previous studies.

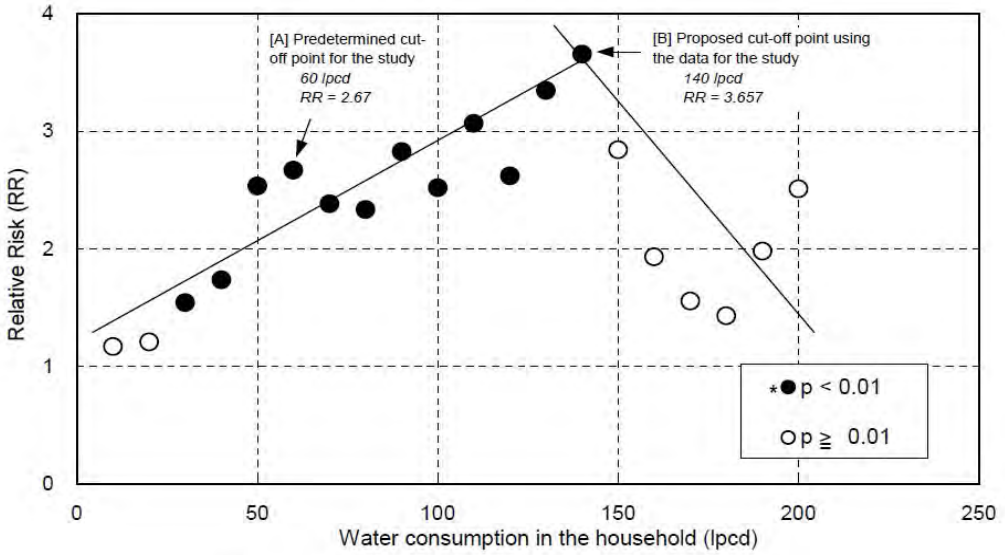
(1) Per Capita Water Consumption for House Connections and Public Hydrant

1) Daily Average Per Capita Water Consumption

Unit daily water consumption rate by different type of consumers shall be determined by referring to previous study results and findings by PANI, as well as figures which have been adopted for other cities in Bangladesh and neighbouring countries. As another reference, there is a report by the World Health Organization (hereinafter referred to as "WHO") in 2003 on the relationship between the water consumption rate and health conditions. In this report it is stated that a considerable reduction in water related/borne diseases can be expected with a consumption rate of 100 lpcd and the WHO recommends 140 lpcd to ensure healthy life. Table 4.2.1 shows the interrelationship between water consumption and health and Figure 4.2.1 presents water usage and health damage. Table 4.2.2 shows the assumptions on per capita water consumption rates in different projects.

**Table 4.2.1 Summary of Water Supply Level for Promoting Health**

| **Service level** | **Access measure** | *Needs met* | **Level of health concern** |
|---|---|---|---|
| No access (quantity collected often below 5 l/c/d) | More than 1000m or 30 minutes total collection time | Consumption – cannot be assured<br>Hygiene – not possible (unless practised at source) | Very high |
| Basic access (average quantity unlikely to exceed 20 l/c/d) | Between 100 and 1000m or 5 to 30 minutes total collection time | Consumption – should be assured<br>Hygiene – handwashing and basic food hygiene possible; laundry/ bathing difficult to assure unless carried out at source | High |
| Intermediate access (average quantity about 50 l/c/d) | Water delivered through one tap on-plot (or within 100m or 5 minutes total collection time | Consumption – assured<br>Hygiene – all basic personal and food hygiene assured; laundry and bathing should also be assured | Low |
| Optimal access (average quantity 100 l/c/d and above) | Water supplied through multiple taps continuously | Consumption – all needs met<br>Hygiene – all needs should be met | Very low |




* *P*-values in Chi-square test for a crosstable (e.g. Table 4).
Data source: Aiga H, *et al*. (1999). *Environ Health Prev Med*. **4** (3): 111-116.

**Figure 4.2.1 Water Usage and Health Damage**

**Table 4.2.2 Summary of Daily Average Per Capita Water Consumption Rate**

unit: lpcd

| Project/organization | | 2011 | 2012 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Chittagong Water Supply projects | Mohara M/P | 130 | | | | |
| | SAPROF | 105 | | 110 | | |
| | KOICA | 115(2011) | | 145(2021) | | 180(2031) |
| | PANI | 99 – 195 (100-130) | | | | |
| WHO | | 100 - 140 | | | | |
| Other Projects | Khulna, Bangladesh | | | 105 | 113 | 120 |
| | Sri Lanka Killinochchi District Water Supply | 120 | | | | |
| | Sri Lanka Jaffna Peninsula Water Supply | 120 | | | | |
| | Goa, India | 135 (Urban Area), 70 (Rural Area) | | | | |
| | AGRA, India | | | | | 150 (2036) |

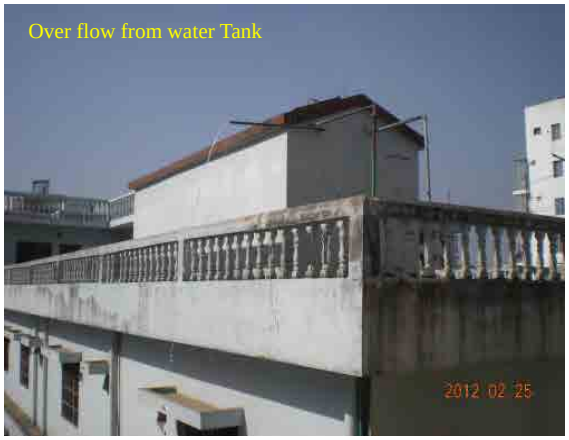
*Note: PANI- The figures in parenthesis show adjusted ones judging from current practices by users (wasting water).*

As shown in the above table, the consumption rates obtained in PANI area range from 99 lpcd to 195lpcd. Table 4.2.3 shows the results of analyses on the per capita consumption rate for respective survey points. Supporting Report 4.2.1 shows the location map of the survey points and survey results by the PANI team and CWASA calculation results using water charges collected. As a result of analyses on the background information on each survey point, the present consumption rate for residents with a higher living standard and under comparatively favourable water supply conditions, seems to be 100 lpcd -130 lpcd (Khulshi area falls in representative higher living standard area and the sample in Agrabad seems to be on the same level, 105-138 lpcd; refer to Table 4.2.3. These figures may be at least the targets as an overall average for the entire service area through the future, when water supply service would be improved.

**Table 4.2.3 Analysis on Daily Average Per Capita Consumption by Survey Site**

| Survey Point | Location | lpcd | Analyses on per capita consumption |
|---|---|---|---|
| Chandgaon A | North east of PANI area | 189-195 | Located in Pucca area; No water supply through the day and residents store water in individual tanks during water supply period using private pump unit. It is common practice that water is overflowing from the tank without controlling inflow water by users. Thus, the consumption rate may be overestimated. |
| Chandgaon B | -do- | 187-195 | Almost same location as Chandgaon A and located in Pucca area; The practice of wasting water is same as that in Chandgaon A. |
| Khulshi | North west of MANI area | 100-130 | Residential area on the hill for people with a higher living standard. There are some areas where the water pressure is low due to higher ground elevation. |
| Agrabad | South west of PANI area | 126-166 (105-138) | Located in commercial area. In this regard consumption rate seems to be higher than common residential area. Assuming commercial use of 20% of domestic demand, 105-138 lpcd coincides with domestic consumption. |

*Note: The picture shows overflow of water from private tank after utilisation of tank capacity in Chandgaon A. It means that actual water consumption is much less than estimated.*




The domestic water consumption rate for the year 2030 may be set as 120 lpcd considering the water consumption rate by people with a comparatively higher living standard in PANI area (100-130 lpcd), and the target consumption rate in the Khulna and Sri Lanka projects (120 lpcd) as well as recommendations by WHO (100-140 lpcd). For public hydrants/communal faucets, the same figure as adopted by SAPROF is applied up to the year 2020, but from year 2025 it is assumed that there will be no public hydrant/communal faucets. The daily average per capita consumption for domestic use for the target and intermediate years is shown in Table 4.2.4 (The planned volume for house connection for the years 2010 and 2020 is used for the Phase 1 Project and the figures in other years are calculated proportionately).

**Table 4.2.4 Per Capita Water Consumption (Domestic water supply)**

unit: lpcd

| **Year/Type** | | **2010** | **2015** | **2020** | **2025** | **2030** |
|---|---|---|---|---|---|---|
| Domestic water supply | House Connection | 105 | 108 | 110 | 115 | 120 |
| | Hydrant | 58 | 58 | 58 | N.A | N.A |

*Note: N.A- Not Applicable*

Upon completion of the Phase 2 Project, it is indispensable that proper use of water as planned shall be practiced by the consumers to realize the water supply services as planned with a limited supply capacity for the entire Karnaphuli service area. Therefore, CWASA shall be ready to manage the requirements to control the water supply amount and consumption before completion of the Phase 2 Project including improvement of tariff structure, proper metering maintenance and proper penalty rules, as well as enhancement of capacity for operation and management of the waterworks.

2) Daily Maximum Water Consumption and Hourly Maximum Water consumption

The peak factor for the estimation of daily maximum water consumption is assumed referring to the PANI survey results and plan in Khulna Water Supply Project as well as common experiences in the developing countries. The survey results by PANI showed 1.1 as the seasonal fluctuation in daily water consumption (refer to Supporting Report 4.2.2), while the Khulna water supply project adopted a factor of 1.15.

In consideration of the improvement of water use in the Karnaphuli service area by the year 2030 compared to the present situation, as well as the planning target figure used in some developing countries (1.2), a factor of 1.15 is adopted for the daily maximum water consumption in this project. For the factor of hourly maximum water consumption to daily maximum water consumption, 1.5 is adopted as is commonly used in developing countries, as there is no reliable in historical information and also considering the current levels of service (pressure, number of hours of water supply, etc.).

## 4.3 Service Connection Percentage by Type of Housing for Domestic Water Supply

The service connection percentages for the three types of housing up to year 2020 are assumed in the SAPROF study, common to all concerned wards. These have been used by other studies (MP assumed the percentage as an average for the CCC area). In this study, the percentages for 2025 and 2030 by type of housing for house connections are assumed as follows:

- Pucca: assumed that 100% in 2020 will be kept.
- Semi-Pucca: assumed at 95% in 2030
- Kutcha: assumed at 70% in 2030

For hydrant the following assumptions are used.

- Pucca: assumed that 0% in 2020 will be kept.
- Semi-Pucca: assumed at 0%
- Kutcha: assumed at 0%

Table 4.3.1 shows planned connection percentages for domestic water supply by house connection and hydrant.

**Table 4.3.1 Planned Connection Percentage by Type of Housing for Domestic Connections**

unit: %

| Type of Housing | | SAPROF (2010/2011) | Planned Connection | | | |
|---|---|---|---|---|---|---|
| | | | 2015 | 2020 | 2025 | 2030 |
| House Connection | Pucca | 95 | 97.5 | 100 | 100 | 100 |
| | Semi-Pucca | 60 | 65 | 70 | 85 | 95 |
| | Kutcha | 25 | 27.5 | 30 | 50 | 70 |
| Hydrant | Pucca | 5 | 2.5 | 0 | 0 | 0 |
| | Semi-Pucca | 10 | 10 | 10 | 0 | 0 |
| | Kutcha | 11.5 | 18 | 25 | 0 | 0 |

Using the above mentioned connection percentages, about 94.7 % of the population in the CCC area will be considered as the potential population to be served in 2030. The GOB established "The Sixth National Five-Year Development Plan (2011-2015)" with a special emphasis on safe water supply to all people at an early stage. In the plan, the targets for service coverage for the four major cities in the country, including Chittagong are planned to be 65% in 2005, 90% in 2025 and 95% in 2050. In this regard, planned service coverage required is on the same level of 95% in 2030.

In connection with the achievement of the service coverage, water supply services shall be increased in provision of some self-contented water supply systems by the year 2030. The water supply for Karnaphuli service area through Phase 1 and 2 projects is one of the major countermeasures to meet the water demand required in the CCC area.

## 4.4 Water Demand Projection for Commercial, Institutional and Industrial Uses

Water demand for uses other than domestic use is calculated using percentages of domestic water demand. Such a manner of calculation has been adopted since "the Feasibility Study of Extension and Expansion of MOHARA Water Treatment Plant in 2000".

The MP projected the demand in two categories, non-domestic individual use (commercial and industrial uses) and non-domestic governmental use (institutional use). Uniform consumption rates common to all concerned wards in the entire city were adopted to calculate the demand for the two categories. Present land use and future prospects by ward were neglected in the MP. On the other hand, in

the SAPROF study the CCC area was categorized into 7 zones in terms of general land use (residential, commercial and industrial uses) by referring to the existing land use. This study utilizes SAPROF study results to consider the differences by ward in land uses. Table 4.4.1 presents the composition of wards by zone categorized by land use type.

**Table 4.4.1 Composition of Wards by Block Categorized in Terms of Land Use**

| Zone | Name of Thana | Land Use category | Composition of Wards |
|---|---|---|---|
| 1 | Kotwali | Residential | 15. Bagmoniram, 16.Chanik Bazar, 20.Dewan Bazar, 21. Jamalkhan, 22. Enayat Bazar, 31. Alkaran, 32, Anderkilla, 33. Finghee Bazar, 34. Patharghata, 35. Boxirhat |
| 2 | Khulshi, Doble Mooring, Halishahar, Chittagong Port, | Residential | 9. North Kattali, 14. Lalkhan Bazar, 24. North Agrabad, 25. Rampur, 27. South Agrabad, 28. Pathantuli, 29. West Madarbari, 30. East Madarbari, 36. Gosalldanga, |
| 3 | Bayazid Bostami, Panchlaish | Commercial | 2. Jalalabd, 3. Panchlaish, 7. West Sholakbawar, 8. Shulokbahar, |
| 4 | Pahartali, Khulishi, Halishahar | Commercial | 10. North Kattali, 11.South Kattali, 12. Saraipara, 13. Pahartali, 26. North Halishahar |
| 5 | Chandgaon, Balalia | Commercial | 4. Chandgaon, 5. Mohara, 6. East Sholakbawar, 17. West Bakalia, 18. East Bakalia. 19. South Bakalia |
| 6 | Chittagong Port, Patenga | Industrial | 37. Halishahar Munir Nagar, 38. South Middle Halishahar, 39. South Halishahar, 40. North Patenga, 41. South Patenga |
| 7 | Bayazid Bostami | Residential | 1. South Pahartali |

Water demand as percentages of domestic water demand by land use type are assumed for commercial, institutional and industrial uses. The percentages by different water uses for the years 2010 (2011) and 2020 in the SAPROF study are used. This study utilizes the same manner and percentages up to the year 2030 as shown in Table 4.4.2. Under the assumptions on the percentages, domestic and other water use in the CCC are about 70 % and 30% respectively (in the CCC area there are large industrial areas, which contribute to the percentage of 30% for others (non-domestic).

**Table 4.4.2 Water Demand Percentages to Domestic Water Demand in Terms of Commercial, Institutional and Industrial Uses by Characterized Land Use Type**

unit: %

| Land use type | Commercial | Institutional | Industrial | Remarks |
|---|---|---|---|---|
| Residential area | 5 | 2 | 0 | Overall average figures present percentages in CCC area from 2010 to 2020 using the following formula. (Year 2010/2020 total water demand by water use type) divided by (Year 2010/2020 total domestic water demand) |
| Commercial area | 20 | 15 | 30 | |
| Industrial area | 5 | 1 | 100 | |
| Overall average | 7 | 5 | 19 | |

## 4.5 NRW Percentage and Leakage Percentage

The NRW percentage at present is reported at 33% by CWASA. It is self-explanatory that without improvement of the water supply system in the future, the NRW percentage would not be improved keeping same figure of 33% at present (Case 1).

In the PANI replacement of water meters and old pipes was carried out, where leakage was observed in Pilot Area, resulting in a reduction in NRW from more than 50% to 15%. This result is evidence that it is possible to reduce NRW to about 15% in the CWASA service area by the provision of adequate countermeasures.

In addition, there is sufficient experience of the significant reduction in NRW in developing countries, as experienced in the PANI trial work, after the improvement of distribution facilities. In the Phase 2 Project, installation of new distribution pipelines with flow/pressure control arrangements is planned to achieve self-contained and physically separated area. In this context, NRW may be assumed to be improved significantly from 33% at present to 15% in 2030 (Case 2).

Table 4.5.1 shows the two cases; Case 1 – No improvement in NRW in the future and Case 2 - Provision of countermeasures through the implementation of appropriate projects such as the Karnaphuli water supply projects. In Case 2, the level of NRW from the present to the year 2030 is planned considering staged improvement after realization of the Phase 1 and Phase 2 projects (As of today, completion of Phase 2 Project to cover all distribution facilities in the service area is scheduled in 2018).

**Table 4.5.1 Assumption of NRW Percentages for 2 Cases**

unit: %

| Case/Year | 2011 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Case 1 | 33 | 33 | 33 | 33 | 33 |
| Case 2 | 33 | 33 | 20 | 15 | 15 |

Under the above assumptions on NRW percentages by case, leakage percentages are assumed for the two cases as shown in Table 4.5.2. In Case 1, about 75% of NRW is assumed as leakage and the figure will be the same in the future. However, in the provision of the Phase 1 and 2 projects (Case 2), the leakage percentages for planning purpose are assumed considering staged improvements. Before completion of the Phase 2 Project, the same percentage as case 1 is adopted, but a gradual reduction of the percentage is assumed finally to reach 10% in 2025 (about 60% of NRW).

**Table 4.5.2 Assumption of Leakage Percentages for 2 Cases**

unit:%

| Case/Year | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Case 1 | 25 | 25 | 25 | 25 | 25 |
| Case 2 | 25 | 25 | 15 | 10 | 10 |

## 4.6 Manner of Water Demand Calculation

Overall water demand in CCC area for target years is calculated using the factors studied in the previous sub-sections. Table 4.6.1 presents calculation method.

**Table 4.6.1 Calculation Method of Water Demand**

| Items | | Calculation | |
|---|---|---|---|
| Domestic<br>a=a-1 + a-2 +a-3 | Pucca | Population of each Ward x rate of Pucca x rate of Connection x Per-Capita Water Consumption | a-1 |
| | Semi-Pucca | Population of each Ward x rate of Semi-Pucca x rate of Connection x Per-Capita Water Consumption | a-2 |
| | Kutcha | Population of each Ward x rate of Kutcha x rate of Connection x Per-Capita Water Consumption | a-3 |
| Public Hydrant<br>b=b-1 + b-2 +b-3 | Pucca | Population of each Ward x rate of Pucca x rate of Connection x Unit flow of Hydrant | b-1 |
| | Semi-Pucca | Population of each Ward x rate of Semi-Pucca x rate of Connection x Unit flow of Hydrant | b-2 |
| | Kutcha | Population of each Ward x rate of Kutcha x rate of Connection x Unit flow of Hydrant | b-3 |
| Commercial; c | | (a + b) x rate of Commercial at each Ward | c |
| Institution; d | | (a + b) x rate of Institution at each Ward | d |
| Industrial; e | | (a + b) x rate of Industrial at each Ward | e |
| Leakage ; f | | (a + b + c + d + e) x Leakage% / (100 - Leakage%) | f |
| Total Water Demand at each Ward | | a + b + c + d + e + f | |

## 4.7 Water demand Projection in CCC Area

Based on the above study, water demand for the year 2030 in the CCC area is projected for two cases as follows:

(1) Water Demand Projection in 2030 assuming 25% of leakage (in case that there would be no improvement of water supply in the CCC area from present up to the year 2030)
(2) Water Demand Projection in 2030 assuming 10% of leakage ( in case that planned improvement for Karnaphuli service area could be expanded to the entire CCC area)

Water Demand in the CCC area by water use type is summarized for the above mentioned two cases in Table 4.7.1 and shown in Figure 4.7.1. Table 4.7.2 presents the demand projection by ward for the two cases. The present demand (2011) of Qdmax=470,400 $m^3$/d will be more than double in 2030 in both cases: case1; Qdmax=1,215,700 $m^3$/d and case 2; Qdmax=1,012,900 $m^3$/d.

Water supply to slum areas in KASA is also considered in this plan.

**Table 4.7.1 Water Demand in CCC Area by Target Year for 2 Cases**

| Item | | | 2011 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| Case-1 Leakage 25% in 2030 | Daily average water demand; Qdave | Service Connection | 192,300 | 242,800 | 310,800 | 413,100 | 522,700 |
| | | Hydrant | 14,400 | 16,300 | 17,600 | 0 | 0 |
| | | Others (Commercial, Institutional, and Industrial) | 100,300 | 127,400 | 165,200 | 211,500 | 269,800 |
| | | Leakage | 101,900 | 128,900 | 165,000 | 208,000 | 264,500 |
| | Total ($m^3$/d) | Qdave | **408,900** | **515,400** | **658,600** | **832,600** | **1,057,000** |
| | | Qdmax | **470,400** | **592,500** | **757,500** | **957,700** | **1,215,700** |
| Case-2 Leakage 10% in 2030 | Daily average water demand; Qdave | Service Connection | 192,300 | 242,800 | 310,800 | 413,100 | 522,700 |
| | | Hydrant | 14,400 | 16,300 | 17,600 | 0 | 0 |
| | | Others (Commercial, Institutional, and Industrial) | 100,300 | 127,400 | 165,100 | 211,400 | 269,800 |
| | | Leakage | 101,900 | 128,900 | 87,400 | 69,300 | 88,300 |
| | Total ($m^3$/d) | Qdave | **408,900** | **515,400** | **580,900** | **693,800** | **880,800** |
| | | Qdmax | **470,400** | **592,500** | **668,200** | **797,800** | **1,012,900** |

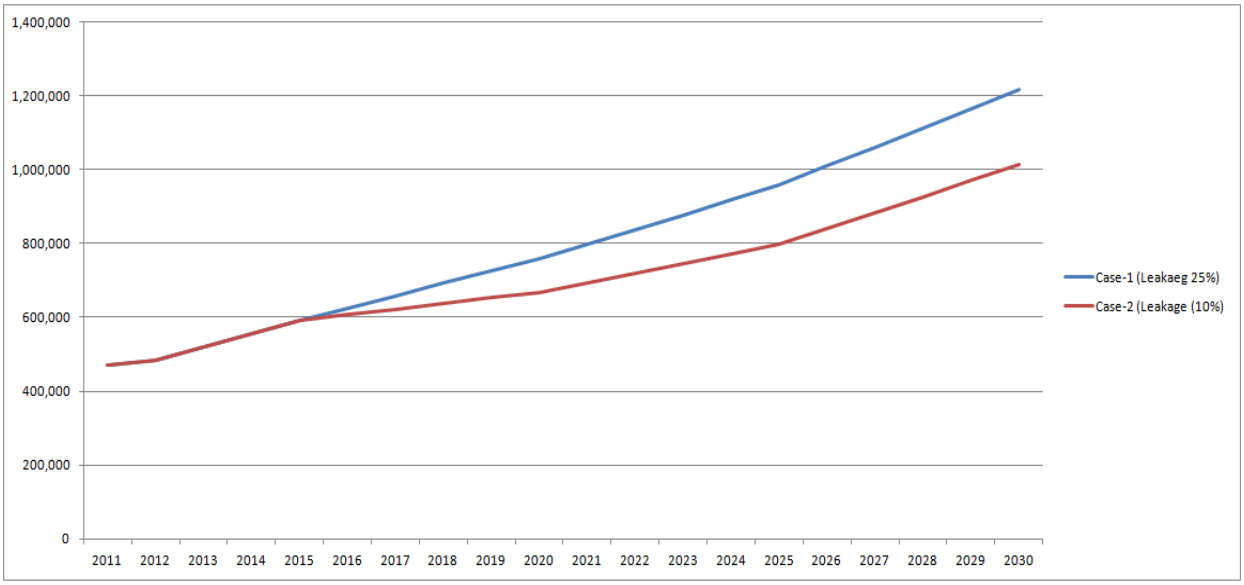



**Figure 4.7.1 Water Demand in CCC**

## Table 4.7.2 (a) Case-1: Water Demand Projection by Ward assuming 25% Leakage from 2011 to 2030

| Ward | | Year | | 2011 | | 2015 | | 2020 | | 2025 | | 2030 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Per-capita water consumption Lpcd | | 105 | | 108 | | 110 | | 115 | | 120 | |
| | | 1.15 | = Qdmax/Qdave | Qdave | Qdmax | Qdave | Qdmax | Qdave | Qdmax | Qdave | Qdmax | Qdave | Qdmax |
| **01** | **16** | **Bayeijid Bostami Thana** | | **37,400** | **43,100** | **48,500** | **55,800** | **60,800** | **69,900** | **74,400** | **85,600** | **95,900** | **110,300** |
| | 01 | Ward No.01 | South Pahartali | 11,100 | 12,800 | 14,300 | 16,400 | 17,800 | 20,500 | 21,900 | 25,200 | 28,000 | 32,200 |
| | 02 | Ward No.02 | Jalalabad | 15,000 | 17,300 | 19,800 | 22,800 | 25,400 | 29,200 | 31,400 | 36,100 | 41,100 | 47,300 |
| | 03 | Ward No.03 | Panchlaish | 11,300 | 13,000 | 14,400 | 16,600 | 17,600 | 20,200 | 21,100 | 24,300 | 26,800 | 30,800 |
| **02** | **57** | **Panchlaish Thana** | | **46,800** | **53,800** | **60,900** | **70,000** | **80,200** | **92,300** | **104,200** | **119,900** | **135,100** | **155,400** |
| | 07 | Ward No.07 | West Sholakbawar | 18,500 | 21,300 | 24,100 | 27,700 | 31,700 | 36,500 | 41,200 | 47,400 | 53,400 | 61,400 |
| | 08 | Ward No.08(Part) | Shulokbahar | 28,300 | 32,500 | 36,800 | 42,300 | 48,500 | 55,800 | 63,000 | 72,500 | 81,700 | 94,000 |
| **03** | **19** | **Chandgaon Thana** | | **42,100** | **48,400** | **55,600** | **63,900** | **74,100** | **85,200** | **97,300** | **111,900** | **127,600** | **146,800** |
| | 04 | Ward No.04 | Chandgaon | 17,300 | 19,900 | 22,800 | 26,200 | 30,400 | 35,000 | 40,000 | 46,000 | 52,400 | 60,300 |
| | 05 | Ward No.05 | Mohara | 18,600 | 21,400 | 24,600 | 28,300 | 32,800 | 37,700 | 43,000 | 49,500 | 56,400 | 64,900 |
| | 06 | Ward No.06 | East Sholakbawar | 6,200 | 7,100 | 8,200 | 9,400 | 10,900 | 12,500 | 14,300 | 16,400 | 18,800 | 21,600 |
| **04** | **10** | **Bakalia** | | **45,200** | **52,000** | **59,600** | **68,600** | **79,700** | **91,700** | **105,100** | **120,900** | **139,300** | **160,300** |
| | 17 | Ward No.17 | West Bakalia | 15,000 | 17,300 | 19,900 | 22,900 | 26,800 | 30,800 | 35,400 | 40,700 | 47,100 | 54,200 |
| | 18 | Ward No.18 | East Bakalia | 9,600 | 11,000 | 12,700 | 14,600 | 17,100 | 19,700 | 22,600 | 26,000 | 30,000 | 34,500 |
| | 19 | Ward No.19 | South Bakalia | 17,600 | 20,200 | 23,300 | 26,800 | 31,300 | 36,000 | 41,400 | 47,600 | 55,000 | 63,300 |
| | 35 | Ward No.35(Part) | Boxirhat | 3,000 | 3,500 | 3,700 | 4,300 | 4,500 | 5,200 | 5,700 | 6,600 | 7,200 | 8,300 |
| **05** | **41** | **Kotwali Thana** | | **44,700** | **51,400** | **52,400** | **60,200** | **62,100** | **71,500** | **73,400** | **84,500** | **86,200** | **99,200** |
| | 15 | Ward No.15 | Bagmoniram | 5,000 | 5,800 | 5,900 | 6,800 | 6,900 | 7,900 | 8,200 | 9,400 | 9,700 | 11,200 |
| | 16 | Ward No.16 | Chanik Bazar | 7,100 | 8,200 | 8,300 | 9,500 | 9,800 | 11,300 | 11,700 | 13,500 | 13,700 | 15,800 |
| | 20 | Ward No.20 | Dewan Bazar | 5,200 | 6,000 | 6,100 | 7,000 | 7,300 | 8,400 | 8,600 | 9,900 | 10,100 | 11,600 |
| | 21 | Ward No.21 | Jamalkhan | 6,300 | 7,200 | 7,400 | 8,500 | 8,800 | 10,100 | 10,400 | 12,000 | 12,200 | 14,000 |
| | 22 | Ward No.22 | Enayet Bazar | 4,700 | 5,400 | 5,500 | 6,300 | 6,500 | 7,500 | 7,700 | 8,900 | 9,000 | 10,400 |
| | 31 | Ward No.31 | Alkaran | 4,600 | 5,300 | 5,400 | 6,200 | 6,400 | 7,400 | 7,500 | 8,600 | 8,800 | 10,100 |
| | 32 | Ward No.32 | Anderkilla | 3,300 | 3,800 | 3,900 | 4,500 | 4,600 | 5,300 | 5,400 | 6,200 | 6,400 | 7,400 |
| | 33 | Ward No.33 | Finghee Bazar | 3,600 | 4,100 | 4,200 | 4,800 | 5,000 | 5,800 | 5,900 | 6,800 | 6,900 | 7,900 |
| | 34 | Ward No.34 | Patharghata | 4,900 | 5,600 | 5,700 | 6,600 | 6,800 | 7,800 | 8,000 | 9,200 | 9,400 | 10,800 |
| | 35 | Ward No.35(Part) | Boxirhat | | | | | 0 | | 0 | | 0 | |
| **06** | **43** | **Khulshi Thana** | | **35,500** | **40,900** | **46,500** | **53,500** | **61,500** | **70,700** | **80,600** | **92,700** | **104,900** | **120,700** |
| | 08 | Ward No.08(Part) | Sholakbahar | | | | | 0 | | | | | |
| | 09 | Ward No.09 | North Pahartali | 9,700 | 11,200 | 12,700 | 14,600 | 16,800 | 19,300 | 22,000 | 25,300 | 28,600 | 32,900 |
| | 13 | Ward No.13 | Pahartali | 15,700 | 18,100 | 20,600 | 23,700 | 27,200 | 31,300 | 35,600 | 40,900 | 46,400 | 53,400 |
| | 14 | Ward No.14 | Lalkhan Bazar | 10,100 | 11,600 | 13,200 | 15,200 | 17,500 | 20,100 | 23,000 | 26,500 | 29,900 | 34,400 |
| **07** | **55** | **Pahartali** | | **21,200** | **24,400** | **25,100** | **28,900** | **29,000** | **33,400** | **34,700** | **39,900** | **41,600** | **47,800** |
| | 10 | Ward No.10 | North Kattali | 4,900 | 5,600 | 5,800 | 6,700 | 6,700 | 7,700 | 8,000 | 9,200 | 9,700 | 11,200 |
| | 11 | Ward No.11 | South Kattali | 5,300 | 6,100 | 6,300 | 7,200 | 7,200 | 8,300 | 8,700 | 10,000 | 10,300 | 11,800 |
| | 12 | Ward No.12 | Saraipara | 11,000 | 12,700 | 13,000 | 15,000 | 15,100 | 17,400 | 18,000 | 20,700 | 21,600 | 24,800 |
| **08** | **28** | **Double Mooring Thana** | | **37,200** | **42,800** | **44,500** | **51,100** | **53,000** | **60,900** | **62,100** | **71,400** | **77,300** | **88,900** |
| | 23 | Ward No.23 | North Pathantuli | 4,400 | 5,100 | 5,300 | 6,100 | 6,500 | 7,500 | 8,000 | 9,200 | 9,800 | 11,300 |
| | 24 | Ward No.24(Part) | North Agrabad | 5,500 | 6,300 | 6,500 | 7,500 | 7,400 | 8,500 | 8,700 | 10,000 | 10,300 | 11,800 |
| | 27 | Ward No.27 | South Agrabad | 10,500 | 12,100 | 12,300 | 14,100 | 14,200 | 16,300 | 16,700 | 19,200 | 19,600 | 22,500 |
| | 28 | Ward No.28 | Pathantuli | 5,600 | 6,400 | 6,800 | 7,800 | 8,200 | 9,400 | 10,100 | 11,600 | 12,400 | 14,300 |
| | 29 | Ward No.29 | West Madarbari | 6,200 | 7,100 | 7,500 | 8,600 | 9,200 | 10,600 | 11,300 | 13,000 | 13,900 | 16,000 |
| | 30 | Ward No.30 | East Madarbari | 5,000 | 5,800 | 6,100 | 7,000 | 7,500 | 8,600 | 7,300 | 8,400 | 11,300 | 13,000 |
| **09** | **35** | **Halishahar Thana** | | **10,100** | **11,600** | **11,800** | **13,600** | **13,700** | **15,700** | **16,100** | **18,500** | **18,900** | **21,700** |
| | 24 | Ward No.24(Part) | North Agrabad | | | | | | | | | | |
| | 25 | Ward No.25 | Rampur | 3,500 | 4,000 | 4,100 | 4,700 | 4,800 | 5,500 | 5,600 | 6,400 | 6,600 | 7,600 |
| | 26 | Ward No.26 | North Hallshahar | 6,600 | 7,600 | 7,700 | 8,900 | 8,900 | 10,200 | 10,500 | 12,100 | 12,300 | 14,100 |
| **10** | **20** | **Chittagong Port Thana** | | **61,900** | **71,200** | **76,200** | **87,500** | **98,800** | **113,600** | **125,500** | **144,300** | **154,300** | **177,400** |
| | 36 | Ward No.36 | Gosalldanga | 7,200 | 8,300 | 8,200 | 9,400 | 9,500 | 10,900 | 11,200 | 12,900 | 12,700 | 14,600 |
| | 37 | Ward No.37 | Halishahar Munir Nagar | 13,100 | 15,100 | 15,500 | 17,800 | 19,100 | 22,000 | 23,400 | 26,900 | 27,900 | 32,100 |
| | 38 | Ward No.38 | South Middle Halishahar | 18,100 | 20,800 | 22,900 | 26,300 | 30,600 | 35,200 | 39,600 | 45,500 | 49,600 | 57,000 |
| | 39 | Ward No.39 | South Halishahar | 23,500 | 27,000 | 29,600 | 34,000 | 39,600 | 45,500 | 51,300 | 59,000 | 64,100 | 73,700 |
| **11** | **65** | **Patenga Thana** | | **26,800** | **30,800** | **34,300** | **39,400** | **45,700** | **52,600** | **59,200** | **68,100** | **75,900** | **87,200** |
| | 40 | Ward No.40 | North Patenga | 14,700 | 16,900 | 18,800 | 21,600 | 25,000 | 28,800 | 32,400 | 37,300 | 41,600 | 47,800 |
| | 41 | Ward No.41 | SouthPatenga | 12,100 | 13,900 | 15,500 | 17,800 | 20,700 | 23,800 | 26,800 | 30,800 | 34,300 | 39,400 |
| | | | | | | 0 | | | | | | | |
| **Chittagong City Corporation Total** | | | | **408,900** | **470,400** | **515,400** | **592,500** | **658,600** | **757,500** | **832,600** | **957,700** | **1,057,000** | **1,215,700** |

## Table 4.7.2 (b) Case-2: Water Demand Projection by Ward assuming 10% Leakage from 2011 to 2030

| Ward | | | Year | 2011 | | 2015 | | 2020 | | 2025 | | 2030 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Per-capita water consumption Lpcd | 105 | | 108 | | 110 | | 115 | | 120 | |
| | | 1.15 | = Qdmax/Qdave | Qdave | Qdmax | Qdave | Qdmax | Qdave | Qdmax | Qdave | Qdmax | Qdave | Qdmax |
| **01** | **16** | **Bayeijid Bostami Thana** | | **37,400** | **43,100** | **48,500** | **55,800** | **53,600** | **61,700** | **62,000** | **71,200** | **79,900** | **91,900** |
| | 01 | Ward No.01 | South Pahartali | 11,100 | 12,800 | 14,300 | 16,400 | 15,700 | 18,100 | 18,200 | 20,900 | 23,300 | 26,800 |
| | 02 | Ward No.02 | Jalalabad | 15,000 | 17,300 | 19,800 | 22,800 | 22,400 | 25,800 | 26,200 | 30,100 | 34,200 | 39,300 |
| | 03 | Ward No.03 | Panchlaish | 11,300 | 13,000 | 14,400 | 16,600 | 15,500 | 17,800 | 17,600 | 20,200 | 22,400 | 25,800 |
| **02** | **57** | **Panchlaish Thana** | | **46,800** | **53,800** | **60,900** | **70,000** | **70,800** | **81,400** | **86,800** | **99,800** | **112,600** | **129,500** |
| | 07 | Ward No.07 | West Sholakbawar | 18,500 | 21,300 | 24,100 | 27,700 | 28,000 | 32,200 | 34,300 | 39,400 | 44,500 | 51,200 |
| | 08 | Ward No.08(Part) | Shulokbahar | 28,300 | 32,500 | 36,800 | 42,300 | 42,800 | 49,200 | 52,500 | 60,400 | 68,100 | 78,300 |
| **03** | **19** | **Chandgaon Thana** | | **42,100** | **48,400** | **55,600** | **63,900** | **65,300** | **75,000** | **81,100** | **93,300** | **106,200** | **122,100** |
| | 04 | Ward No.04 | Chandgaon | 17,300 | 19,900 | 22,800 | 26,200 | 26,800 | 30,800 | 33,300 | 38,300 | 43,600 | 50,100 |
| | 05 | Ward No.05 | Mohara | 18,600 | 21,400 | 24,600 | 28,300 | 28,900 | 33,200 | 35,900 | 41,300 | 47,000 | 54,100 |
| | 06 | Ward No.06 | East Sholakbawar | 6,200 | 7,100 | 8,200 | 9,400 | 9,600 | 11,000 | 11,900 | 13,700 | 15,600 | 17,900 |
| **04** | **10** | **Bakalia** | | **45,200** | **52,000** | **59,600** | **68,600** | **70,300** | **80,800** | **87,600** | **100,700** | **116,100** | **133,600** |
| | 17 | Ward No.17 | West Bakalia | 15,000 | 17,300 | 19,900 | 22,900 | 23,600 | 27,100 | 29,500 | 33,900 | 39,200 | 45,100 |
| | 18 | Ward No.18 | East Bakalia | 9,600 | 11,000 | 12,700 | 14,600 | 15,100 | 17,400 | 18,900 | 21,700 | 25,000 | 28,800 |
| | 19 | Ward No.19 | South Bakalia | 17,600 | 20,200 | 23,300 | 26,800 | 27,600 | 31,700 | 34,500 | 39,700 | 45,900 | 52,800 |
| | 35 | Ward No.35(Part) | Boxirhat | 3,000 | 3,500 | 3,700 | 4,300 | 4,000 | 4,600 | 4,700 | 5,400 | 6,000 | 6,900 |
| **05** | **41** | **Kotwali Thana** | | **44,700** | **51,400** | **52,400** | **60,200** | **54,600** | **62,900** | **61,300** | **70,500** | **71,700** | **82,500** |
| | 15 | Ward No.15 | Bagmoniram | 5,000 | 5,800 | 5,900 | 6,800 | 6,100 | 7,000 | 6,900 | 7,900 | 8,000 | 9,200 |
| | 16 | Ward No.16 | Chanik Bazar | 7,100 | 8,200 | 8,300 | 9,500 | 8,700 | 10,000 | 9,700 | 11,200 | 11,400 | 13,100 |
| | 20 | Ward No.20 | Dewan Bazar | 5,200 | 6,000 | 6,100 | 7,000 | 6,400 | 7,400 | 7,200 | 8,300 | 8,400 | 9,700 |
| | 21 | Ward No.21 | Jamalkhan | 6,300 | 7,200 | 7,400 | 8,500 | 7,700 | 8,900 | 8,700 | 10,000 | 10,100 | 11,600 |
| | 22 | Ward No.22 | Enayet Bazar | 4,700 | 5,400 | 5,500 | 6,300 | 5,700 | 6,600 | 6,400 | 7,400 | 7,500 | 8,600 |
| | 31 | Ward No.31 | Alkaran | 4,600 | 5,300 | 5,400 | 6,200 | 5,600 | 6,400 | 6,300 | 7,200 | 7,400 | 8,500 |
| | 32 | Ward No.32 | Anderkilla | 3,300 | 3,800 | 3,900 | 4,500 | 4,000 | 4,600 | 4,500 | 5,200 | 5,300 | 6,100 |
| | 33 | Ward No.33 | Finghee Bazar | 3,600 | 4,100 | 4,200 | 4,800 | 4,400 | 5,100 | 4,900 | 5,600 | 5,800 | 6,700 |
| | 34 | Ward No.34 | Patharghata | 4,900 | 5,600 | 5,700 | 6,600 | 6,000 | 6,900 | 6,700 | 7,700 | 7,800 | 9,000 |
| | 35 | Ward No.35(Part) | Boxirhat | | | | | 0 | | 0 | | 0 | |
| **06** | **43** | **Khulshi Thana** | | **35,500** | **40,900** | **46,500** | **53,500** | **54,300** | **62,400** | **67,000** | **77,000** | **87,500** | **100,600** |
| | 08 | Ward No.08(Part) | Sholakbahar | | | | | 0 | | | | | |
| | 09 | Ward No.09 | North Pahartali | 9,700 | 11,200 | 12,700 | 14,600 | 14,800 | 17,000 | 18,300 | 21,000 | 23,900 | 27,500 |
| | 13 | Ward No.13 | Pahartali | 15,700 | 18,100 | 20,600 | 23,700 | 24,000 | 27,600 | 29,600 | 34,000 | 38,700 | 44,500 |
| | 14 | Ward No.14 | Lalkhan Bazar | 10,100 | 11,600 | 13,200 | 15,200 | 15,500 | 17,800 | 19,100 | 22,000 | 24,900 | 28,600 |
| **07** | **55** | **Pahartali** | | **21,200** | **24,400** | **25,100** | **28,900** | **25,600** | **29,500** | **28,900** | **33,300** | **34,700** | **39,900** |
| | 10 | Ward No.10 | North Kattali | 4,900 | 5,600 | 5,800 | 6,700 | 5,900 | 6,800 | 6,700 | 7,700 | 8,100 | 9,300 |
| | 11 | Ward No.11 | South Kattali | 5,300 | 6,100 | 6,300 | 7,200 | 6,400 | 7,400 | 7,200 | 8,300 | 8,600 | 9,900 |
| | 12 | Ward No.12 | Saraipara | 11,000 | 12,700 | 13,000 | 15,000 | 13,300 | 15,300 | 15,000 | 17,300 | 18,000 | 20,700 |
| **08** | **28** | **Double Mooring Thana** | | **37,200** | **42,800** | **44,500** | **51,100** | **46,700** | **53,800** | **51,800** | **59,600** | **64,400** | **74,000** |
| | 23 | Ward No.23 | North Pathantuli | 4,400 | 5,100 | 5,300 | 6,100 | 5,700 | 6,600 | 6,700 | 7,700 | 8,200 | 9,400 |
| | 24 | Ward No.24(Part) | North Agrabad | 5,500 | 6,300 | 6,500 | 7,500 | 6,500 | 7,500 | 7,300 | 8,400 | 8,500 | 9,800 |
| | 27 | Ward No.27 | South Agrabad | 10,500 | 12,100 | 12,300 | 14,100 | 12,500 | 14,400 | 13,900 | 16,000 | 16,300 | 18,700 |
| | 28 | Ward No.28 | Pathantuli | 5,600 | 6,400 | 6,800 | 7,800 | 7,300 | 8,400 | 8,400 | 9,700 | 10,400 | 12,000 |
| | 29 | Ward No.29 | West Madarbari | 6,200 | 7,100 | 7,500 | 8,600 | 8,100 | 9,300 | 9,400 | 10,800 | 11,600 | 13,300 |
| | 30 | Ward No.30 | East Madarbari | 5,000 | 5,800 | 6,100 | 7,000 | 6,600 | 7,600 | 6,100 | 7,000 | 9,400 | 10,800 |
| **09** | **35** | **Halishahar Thana** | | **10,100** | **11,600** | **11,800** | **13,600** | **12,000** | **13,800** | **13,500** | **15,500** | **15,800** | **18,100** |
| | 24 | Ward No.24(Part) | North Agrabad | | | | | | | | | | |
| | 25 | Ward No.25 | Rampur | 3,500 | 4,000 | 4,100 | 4,700 | 4,200 | 4,800 | 4,700 | 5,400 | 5,500 | 6,300 |
| | 26 | Ward No.26 | North Hallshahar | 6,600 | 7,600 | 7,700 | 8,900 | 7,800 | 9,000 | 8,800 | 10,100 | 10,300 | 11,800 |
| **10** | **20** | **Chittagong Port Thana** | | **61,900** | **71,200** | **76,200** | **87,500** | **87,300** | **100,500** | **104,500** | **120,200** | **128,600** | **147,900** |
| | 36 | Ward No.36 | Gosalldanga | 7,200 | 8,300 | 8,200 | 9,400 | 8,400 | 9,700 | 9,300 | 10,700 | 10,600 | 12,200 |
| | 37 | Ward No.37 | Halishahar Munir Nagar | 13,100 | 15,100 | 15,500 | 17,800 | 16,900 | 19,400 | 19,500 | 22,400 | 23,200 | 26,700 |
| | 38 | Ward No.38 | South Middle Halishahar | 18,100 | 20,800 | 22,900 | 26,300 | 27,000 | 31,100 | 33,000 | 38,000 | 41,300 | 47,500 |
| | 39 | Ward No.39 | South Halishahar | 23,500 | 27,000 | 29,600 | 34,000 | 35,000 | 40,300 | 42,700 | 49,100 | 53,500 | 61,500 |
| **11** | **65** | **Patenga Thana** | | **26,800** | **30,800** | **34,300** | **39,400** | **40,400** | **46,400** | **49,300** | **56,700** | **63,300** | **72,800** |
| | 40 | Ward No.40 | North Patenga | 14,700 | 16,900 | 18,800 | 21,600 | 22,100 | 25,400 | 27,000 | 31,100 | 34,700 | 39,900 |
| | 41 | Ward No.41 | SouthPatenga | 12,100 | 13,900 | 15,500 | 17,800 | 18,300 | 21,000 | 22,300 | 25,600 | 28,600 | 32,900 |
| | | | | | | 0 | | | | | | | |
| **Chittagong City Corporation Total** | | | | **408,900** | **470,400** | **515,400** | **592,500** | **580,900** | **668,200** | **693,800** | **797,800** | **880,800** | **1,012,900** |

# CHAPTER 5

# ESTABLISHMENT OF KARNAPHULI SERVICE AREA

# CHAPTER 5 ESTABLISHMENT OF KARNAPHULI SERVICE AREA

## 5.1 Manner of the Selection of Wards to Include in Karnaphuli Service Area

It was confirmed at the Steering Committee Meeting on the Preparatory Survey on Chittagong Water Supply Improvement Project on May 24, 2012 that the Karnaphuli Service Area should be self-contained and therefore, there should be no water transfer into the service area from the other water treatment plants in the future. In this context, the Karnaphuli service area is established in consideration of the balance between the water supply capacity from Karnaphuli water treatment plant (combined capacity of Phase 1 and 2 projects) and water demand in the CCC area for the year 2030.

The total water demand in the CCC area for the year 2030 is estimated at 1,012,900 $m^3$/d (daily maximum demand) as Case 2 in the previous Chapter assuming that improvement of distribution facilities would be realized in the entire CCC area. However, the water supply capacity from the Karnaphuli water treatment plant is limited to 286,000 $m^3$/d. Therefore, the area (wards) to be covered in the 41 wards is decided with priorities to the following areas:

- PANI Area
- Planned area to be covered with main/sub-main pipelines by Phase-1 Project
- Wards with a higher demand (more than 100$m^3$/d/ha) geographically being continuous from PANI area

## 5.2 Selection of Wards to be covered by Karnaphuli Service Area

Table 5.2.1 shows a summary of the evaluation of the wards to be included in the Karnaphuli service area, based on the selection criteria in Chapter 5.1. Supporting Report 5.2.1 presents detailed information by ward on the selection process. A total of 21 wards with a total area of 3,063 ha are selected for the service area.

Table 5.2.2 shows the wards to be covered in the Karnaphuli service area to meet a total supply amount of 286,000$m^3$/d by considering the priority areas in Section 5.1. Figure 5.2.1 presents concerned information on the selected wards to be covered by the Karnaphuli service area.

The service coverage in the CCC area in terms of service area and population to be served is as follows:

- Service area to be covered: 19.7 % (3,063 ha/ 15,562 ha)
- Population to be covered: 33.5 % (1,540,200/4,600,000)

## Table 5.2.1 Selection of Wards for Karnaphuli Service Area

| Chittagong City Corporation | | | 2030 Water Demand (WD) | | | Priority Ward | | | | | | Selected KSA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WD by Ward | Area by Wrad | WD/ha | PANI | Phase-1 Project | | | Higher | less water | |
| | | | **Qdmax(m3/d)** | ha | m3/d/ha | Project | North | Central | South | Demand | supply | |
| 01 | 16 | Bayeijid Bostami Thana | **91,900** | **3,015** | **30.5** | | | | | | | |
| | 01 | Ward No.01 South Pahartali | 26,800 | 1,077 | 24.9 | | | | | | | |
| | 02 | Ward No.02 Jalalabad | 39,300 | 1,358 | 28.9 | | ✓ | | | | | |
| | 03 | Ward No.03 Panchlaish | 25,800 | 580 | 44.5 | | ✓ | | | | | |
| 02 | 57 | Panchlaish Thana | **129,500** | **909** | **142.5** | | | | | | | |
| | 07 | Ward No.07 West Sholakbawar | 51,200 | 407 | 125.8 | | ✓ | | | ✓ | | ○ |
| | 08 | Ward No.08(Part) Shulokbahar | 78,300 | 502 | 156.0 | ✓(part) | ✓ | | | ✓ | | ○ |
| 03 | 19 | Chandgaon Thana | **122,100** | **2,075** | **58.8** | | | | | | | |
| | 04 | Ward No.04 Chandgaon | 50,100 | 927 | 54.0 | | | | | | | |
| | 05 | Ward No.05 Mohara | 54,100 | 904 | 59.8 | | | | | | | |
| | 06 | Ward No.06 East Sholakbawar | 17,900 | 244 | 73.4 | | | | | | | |
| 04 | 10 | Bakalia | **133,600** | **1,323** | **101.0** | | | | | | | |
| | 17 | Ward No.17 West Bakalia | 45,100 | 243 | 185.6 | ✓(part) | | | | ✓ | | |
| | 18 | Ward No.18 East Bakalia | 28,800 | 655 | 44.0 | | | | | | | |
| | 19 | Ward No.19 South Bakalia | 52,800 | 127 | 415.7 | | | | | ✓ | | |
| | 35 | Ward No.35(Part) Boxirhat | 6,900 | 298 | 23.2 | | | | | | | |
| 05 | 41 | Kotwali Thana | **82,500** | **931** | **88.6** | | | | | | | |
| | 15 | Ward No.15 Bagmoniram | 9,200 | 180 | 51.1 | ✓ | | ✓ | | | | ○ |
| | 16 | Ward No.16 Chanik Bazar | 13,100 | 177 | 74.0 | ✓ | | ✓ | | | | ○ |
| | 20 | Ward No.20 Dewan Bazar | 9,700 | 39 | 248.7 | ✓ | | | | ✓ | | ○ |
| | 21 | Ward No.21 Jamalkhan | 11,600 | 76 | 152.6 | ✓ | | ✓ | | ✓ | | ○ |
| | 22 | Ward No.22 Enayet Bazar | 8,600 | 86 | 100.0 | ✓ | | | | | | ○ |
| | 31 | Ward No.31 Alkaran | 8,500 | 92 | 92.4 | ✓ | | | | | | ○ |
| | 32 | Ward No.32 Anderkilla | 6,100 | 106 | 57.5 | ✓ | | ✓ | | | | ○ |
| | 33 | Ward No.33 Finghee Bazar | 6,700 | 83 | 80.7 | ✓ | | | | | | ○ |
| | 34 | Ward No.34 Patharghata | 9,000 | 92 | 97.8 | ✓ | | | | | | ○ |
| | 35 | Ward No.35(Part) Boxirhat | | | | | | | | | | |
| 06 | 43 | Khulshi Thana | **100,600** | **903** | **111.4** | | | | | | | |
| | 08 | Ward No.08(Part) Sholakbahar | | | | | | | | | | |
| | 09 | Ward No.09 North Pahartali | 27,500 | 552 | 49.8 | | | | | | | |
| | 13 | Ward No.13 Pahartali | 44,500 | 227 | 196.0 | ✓(part) | | | | ✓ | | |
| | 14 | Ward No.14 Lalkhan Bazar | **28,600** | **124** | **230.6** | ✓ | | | | ✓ | | ○ |
| 07 | 55 | Pahartali | **39,900** | **882** | **45.2** | | | | | | | |
| | 10 | Ward No.10 North Kattali | 9,300 | 283 | 32.9 | | | | | | | |
| | 11 | Ward No.11 South Kattali | 9,900 | 331 | 29.9 | | | | | | | |
| | 12 | Ward No.12 Saraipara | 20,700 | 268 | 77.2 | | | | ✓ | | ✓ | ○ |
| 08 | 28 | Double Mooring Thana | **74,000** | **771** | **96.0** | | | | | | | |
| | 23 | Ward No.23 North Pathantuli | 9,400 | 77 | 122.1 | ✓ | | | ✓ | ✓ | | ○ |
| | 24 | Ward No.24(Part) North Agrabad | 9,800 | 208 | 47.1 | | | | ✓ | | | ○ |
| | 27 | Ward No.27 South Agrabad | 18,700 | 148 | 126.4 | | | | ✓ | ✓ | | ○ |
| | 28 | Ward No.28 Pathantuli | 12,000 | 122 | 98.4 | ✓ | | | ✓ | | | ○ |
| | 29 | Ward No.29 West Madarbari | 13,300 | 107 | 124.3 | ✓ | | | | ✓ | | ○ |
| | 30 | Ward No.30 East Madarbari | 10,800 | 109 | 99.1 | ✓ | | | | | | ○ |
| 09 | 35 | Halishahar Thana | **18,100** | **881** | **20.5** | | | | | | | |
| | 24 | Ward No.24(Part) North Agrabad | | | | | | | | | | |
| | 25 | Ward No.25 Rampur | 6,300 | 193 | 32.6 | | | | ✓ | | ✓ | ○ |
| | 26 | Ward No.26 North Hallshahar | 11,800 | 688 | 17.2 | | | | ✓ | | ✓ | ○ |
| 10 | 20 | Chittagong Port Thana | **147,900** | **1,896** | **78.0** | | | | | | | |
| | 36 | Ward No.36 Gosalldanga | 12,200 | 136 | 89.7 | | | | | | | |
| | 37 | Ward No.37 Halishahar Munir Nagar | 26,700 | 378 | 70.6 | | | | | | | |
| | 38 | Ward No.38 South Middle Halishahar | 47,500 | 542 | 87.6 | | | | | | | |
| | 39 | Ward No.39 South Halishahar | 61,500 | 840 | 73.2 | | | | | | | |
| 11 | 65 | Patenga Thana | **72,800** | **1,976** | **36.8** | | | | | | | |
| | 40 | Ward No.40 North Patenga | 39,900 | 962 | 41.5 | | | | | | | |
| | 41 | Ward No.41 SouthPatenga | 32,900 | 1014 | 32.4 | | | | | | | |
| Total | | | **1,012,900** | **15,562** | **65.1** | | | | | | | **21** |

**Table 5.2.2 Information on the Selected Wards for Karnaphuli Service Area at Year 2030**

| Ward No. | Ward Name | Area (ha) | Population (person) | | Daily max Water Demand ($m^3$/d) |
|---|---|---|---|---|---|
| | | | Administrative | To be served | |
| 07 | West Sholakbawar, (Part) | 330 | 173,800 | 163,900 | 41,500 |
| 08 | Shulokbahar (part) | 236 | 154,300 | 145,500 | 36,800 |
| 12 | Saraipapa (part), | 134 | 43,600 | 40,900 | 10,400 |
| 14 | Lalkhan Bazar, | 124 | 185,900 | 174,700 | 28,600 |
| 15 | Bagmoniram | 180 | 57,000 | 56,400 | 9,200 |
| 16 | Chanik Bazar , | 177 | 80,800 | 79,800 | 13,100 |
| 20 | Dewan Bazar | 39 | 59,700 | 59,000 | 9,700 |
| 21 | Jamalkhan, | 76 | 71,900 | 71,000 | 11,600 |
| 22 | Enayet Bazar, | 86 | 53,200 | 52,500 | 8,600 |
| 23 | North Pathantuli, | 77 | 59,900 | 57,200 | 9,400 |
| 24 | North Agrabad, | 208 | 62,600 | 59,900 | 9,800 |
| 25 | Rampur, | 193 | 40,200 | 38,400 | 6,300 |
| 26 | North Halishahar (part), | 344 | 24,400 | 23,300 | 5,900 |
| 27 | South Agrabad, | 148 | 119,600 | 114,300 | 18,700 |
| 28 | Pathantuli, | 122 | 76,100 | 72,700 | 12,000 |
| 29 | West Madarbari, | 107 | 84,800 | 81,000 | 13,300 |
| 30 | East Madarbari, | 109 | 69,000 | 65,900 | 10,800 |
| 31 | Alkaran | 92 | 52,300 | 51,600 | 8,500 |
| 32 | Anderkilla | 106 | 37,600 | 37,100 | 6,100 |
| 33 | Finghee Bazar | 83 | 40,800 | 40,300 | 6,700 |
| 34 | Patharghata | 92 | 55,500 | 54,800 | 9,000 |
| **Total 21 wards** | | **3,063** | **1,603,000** | **1,540,200** | **286,000** |

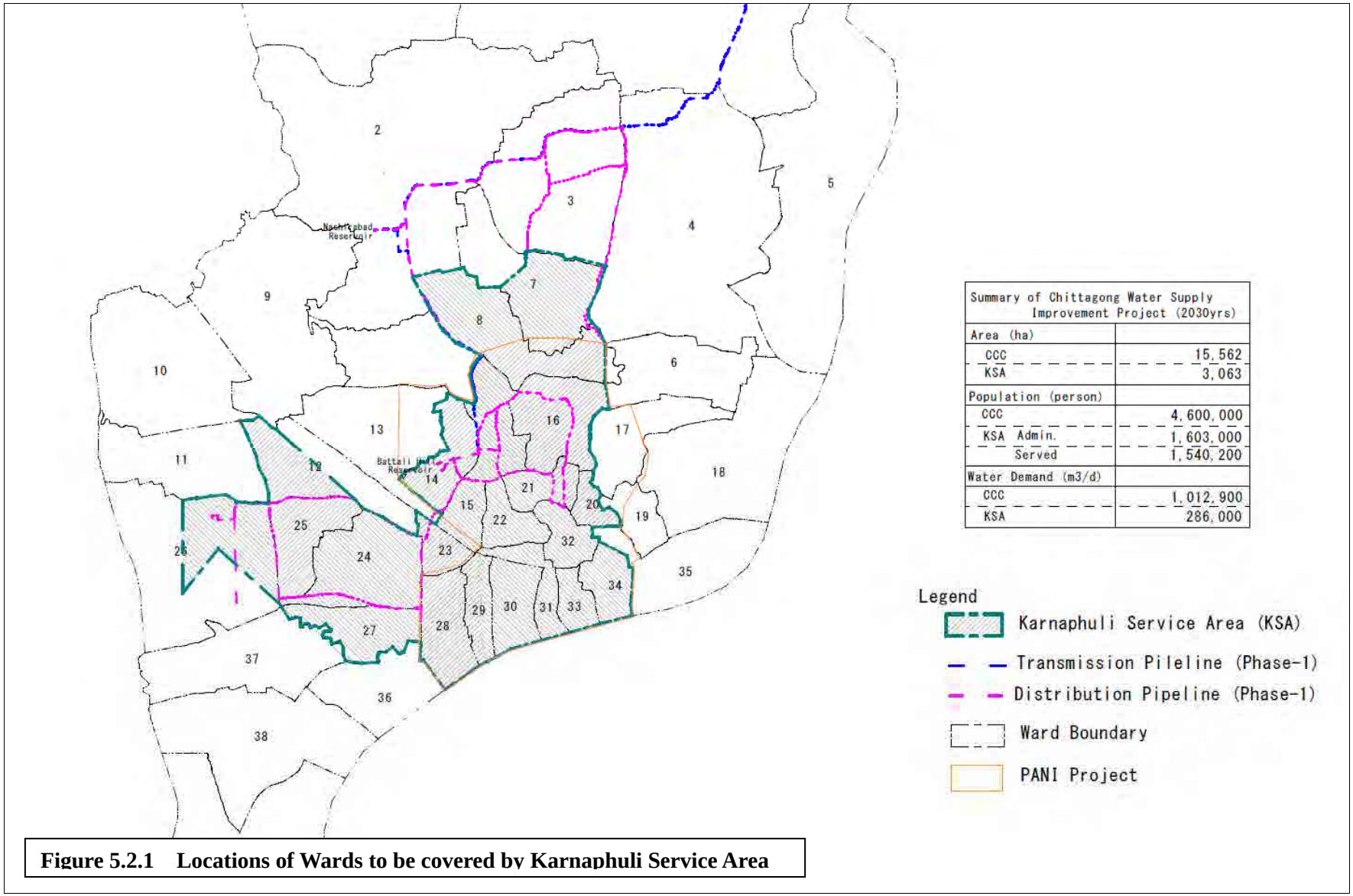



**Figure 5.2.1 Locations of Wards to be covered by Karnaphuli Service Area**

## 5.3 Basic Concept and Manner of Operation of Karnaphuli Water Supply System

### 5.3.1 Justification of KSA

(1) Major issues and problems on the existing water supply

Currently the water supply in the CCC area is provided by water from two WTPs (Mohara and Kalurghat). Under the present arrangements of water supply, CWASA has no option but to supply customers on a case by case basis without effective control of water supply from the WTPs to and throughout the distribution system. The exact locations of the distribution pipes have not yet been determined, except for the main distribution pipelines from the WTPs; because of the non-existence of proper information/ inaccuracy on existing pipes. The quantity of and breakdown of NRW in the distribution network is not known, except to some extent in areas where work has been carried out under the PANI. Furthermore, based upon the investigation carried out in the PANI, rehabilitation of existing pipes is not an appropriate solution, which means that pipe replacement is required. Replacement also allows the capacity of the system to be increased to allow for future water demands and for the design pressure.

The time required to address the above issues as well as to develop a functional and realistic hydraulic model of the existing system, which could then be used to develop an optimized and efficient water supply and distribution system for the long term, is likely to be several years. On completion of the above works several years would be required to implement the first phase of measures, allowing for arranging finance, design, procurement, construction, etc.

(2) The reason for the establishment of KSA

The comprehensive and up to date Master Plan for water supply, including a construction plan for the distribution network to cover the entire Chittagong city does not exist up to now. However, operation of water supply facilities planned in the Phase 1 Project is scheduled to start in 2014. Once existing network receives water from KWSP 1, it is obvious to arise the following:

- Leakage will be more serious as existing network consists of old AC pipes, and
- Customers still cannot receive sufficient water as capacity of existing network is too small.

Therefore, it is urgent to construct distribution network to deliver water through the main/ sub-main distribution pipelines to be constructed by the Phase 1Project.

KWSP 1 and 2 cannot satisfy water demand in entire CCC area. In this case, CWASA has two choices as follows:

- Enough pressure and continuous supply with minimum water losses in the limited area. At the same time, CWASA has to consider countermeasures outside KSA.
- Low pressure and intermittent supply with considerable water losses in whole CCC area.

The water supply for KSA is planned to provide the customers with sustainable access to safe water with appropriate water pressure on a 24/7 basis in consideration of the water supply capacity of the Karnaphuli WTP (286,000$m^3$/d). The KSA should be independent from other water supply systems as a self-contained system, in order to ensure that the above mentioned service levels are met. There are a lot of cases of water supply system operated independently (except for in emergency cases) by dividing the overall system in the city into several sub-systems, which are supplied by different water sources/WTPs in order to achieve effective O&M of water supply facilities.

(3) Manner of selection of the KSA and the establishment of Sectors and DMAs

KSA is selected to cover high priority area (PANI area) in consideration of the balance between water supply capacity from Karnaphuli WTPs and water demand in 2030 in the priority area. KSA boundary does not have to follow ward boundary and not based on any hydraulic considerations.

The provisions of sectors and DMAs will allow for the monitoring and effective control of water supply in terms of water quality, flow rate and water pressure. In addition, information required to manage NRW will be easily collected through measurement of the flow rates in the system.

On the establishment of the 10 sectors, the following conditions were taken into account in order to ensure effective and fair distribution of water to all concerned sectors.

- Location of the Wards
- Topographic conditions
- Location of major infrastructure (main roads, railway, canals/rivers)
- Main/sub-main pipeline routes planned in the Phase 1 Project
- Planned water demand by sector in the range of about 20,000$m^3$/d to 50,000$m^3$/d (manageable size)

Each Sector will have only one inlet with a flow meter, a pressure gauge and a pressure regulating valve. This arrangement will allow for the adjustment of water pressure at the inlet chamber resulting in the promotion of equitable water distribution to all sectors. Flow and pressure measurement data will be transmitted on a continuous basis through a SCADA system to the Central Control Room located at Karnaphuli WTP. Instructions will be made, as required for the adjustment of the water pressure at the inlet pipe to each sector.

For the effective control of NRW, each sector will be further divided into a number of small DMAs. On average, each DMA will be designed so that they can be hydraulically isolated from the rest of the distribution network by 3 to 4 valves whenever necessary. This arrangement will allow for the collection of accurate data on leakage and NRW in each DMA. For example, the quantity of leakage in a DMA can be estimated through measuring minimum night flow by using a vehicle on-board electro-magnetic flow meter.

(4) The reason of new construction of distribution pipes in KSA instead of rehabilitation of existing pipes

As of today, the exact locations, material types and conditions of the existing distribution pipes as well as the interconnection details and location have not yet been determined. Therefore it is a pre-requisite for evaluation of the possibility for reusing existing pipelines to conduct extensive field investigations, including trial excavations. However, based on the difficulties encountered in the trial excavations carried out under the PANI (limited to a central part of the city), investigation covering a large service area is not realistic in terms of both time and cost requirements, aside from the huge magnitude of disturbances to the residents and traffic in the built up area. Even if existing pipes are found, reuse of deteriorated AC pipes in the areas with a high population density area may be difficult. In addition, the diameters of the existing pipes are not sufficient for the present demand because those pipes were thought to be installed more than 20 years ago. Furthermore, frequent and long interruptions to water supply in a large are would occur if rehabilitation of existing pipes is implemented because CWASA does not have accurate data on the locations of existing pipes especially secondary and tertiary mains and it is difficult for CWASA to identify the location with higher priority. This may cause the large inconvenience of customers due to the ineffective construction work. On the other hand, the time period for interruption of water supply can be minimized under construction of new distribution pipes up to the service connections because cut off of the water supply is necessary only when new service connection

is connected to existing service pipes in the premises of each customer.

Accordingly, new construction of pipelines is advantageous in order to provide effective water supply facilities in terms of reduction of leakage from the start of operation of the system and without causing major problems during the construction period. The construction cost and period required are also reduced considerably as extensive trial excavations for existing pipes will not be required. However, existing distribution mains, which run through KSA and deliver water outside KSA, remain as they are (e.g. Mohara WTP –Patenga B.P).

### 5.3.2 FAQs regarding KSA

(1) Changes in the water supply plan from SAPROF/Phase 1 to Phase 2

Water supply improvement plan for two phases was prepared by SAPROF in 2005 and Detailed Design of Phase 1 facilities in 2008. After the previous study/design, preparatory survey for Phase 2 was conducted in 2012. The comparison of framework between SAPROF and JICA Survey is summarized in Table 5.3.1. Supporting Report 5.3.1 presents the comparison of basic conditions among SAPROF, Phase 1Project and Phase 2 Projects.

KSA must be smaller than that in SAPROF, as

- CCC's water demand in 2030 is 1.65 times as much as that in 2020, however,
- Production volume of KWSP 1& 2 is almost same.

It is not likely that WTPs are materialized as scheduled in SAPROF report except for KWSP 1&2. Current situation is different from what was planned in SAPROF

**Table 5.3.1 Comparison of Framework between SAPROF and JICA Survey**

| Item | | SAPROF (2005) | JICA (2012) |
|---|---|---|---|
| Target Year | | 2020 | 2030 |
| Water Demand in CCC ($m^3$/d) | | 614,000 (2020) | 668,200 (2020)<br>1,012,900 (2030) |
| Water Production ($m^3$/d) | Karnaphuli | 272,000 | 286,000 |
| | Other WTPs | (2020)<br>- Mohara 1&2 181,800<br>- Kalurghat 68,200<br>- Madunaghat 1&2 91,000 | (current situation)<br>- Mohara 1 90,000<br>- Kalurghat 68,200 |
| | Total | 614,000 | 445,100 |

Table 5.3.2 shows the comparison on Karnaphuli water supply system between SAPROF and JICA Survey.

**Table 5.3.2 Karnaphuli Service Area**

| Item | SAPROF (2005) | JICA Survey (2012) |
|---|---|---|
| Reservoir | Nashirabad & Battali Hill | |
| Way to establish service area | Adjust service area by means of meeting both water demand in service area and supply volume from WTPs | |
| Priority area to be covered | None | -PANI<br>-Area along distribution mains to be installed under KWSP 1<br>-Neighboring area of PANI area with high demand |

Two reservoirs (Nashirabad and Battali Hill) are included in Karnaphuli water supply system in SAPROF. The capacity of the two reservoir isn't still sufficient for KSA, even though KSA doesn't receive Madunaghat WTP water. As for priority area to be covered, in KSA, it is considered to include priority areas where water demand is high and urgent measures are needed, while, in SAPROF, no consideration is given to priority area (Its service area is simply set at hillside area).

(2) Needs of accurate GIS data and maps for hydraulic simulation and rehabilitation work

WB recognizes that existing GIS data and maps are not accurate in terms of location. Besides location, following data and information are required;

- Materials (AC pipes must be replaced, no matter how fine they look.)
- Diameter (which hydraulic model depends on, but there are no accurate data)
- Conditions (Leakage occurs everywhere in unreliable network, but only limited information is available)

We must recognize that all data and information necessary for hydraulic simulation and rehabilitation work aren't available at present. There are two options to solve this problems follows:

- Conduct trial excavation along all the pipelines laid in CCC area, then hydraulic simulation and rehabilitation work, or
- Abandon all existing network, then design completely brand-new network.

(3) Expansion of water supply toward outside of KSA

It will take a longer time for CWASA to construct water supply systems required to cover the entire Chittagong city. Therefore, it is reasonable for CWASA to apply a staged construction of water supply systems with priority for different areas. If the planned quantity of water for the KSA (286,000$m^3$/d) is used for the entire city area, some improvements such as a longer supply time (than presently practiced) may be expected. However, such arrangement will mean that the service levels for the KSA in terms of drinking water quality, adequate water pressure on a 24/7 basis will never be met. It is an obligation of CWASA to provide customers with safe and sufficient water supply services.

It should be noted that the water currently supplied from Mohara and Kalurghat WTPs to planned KSA (more than half of the quantity of water, i.e. more than 100,000$m^3$/d) will be used in the future in the areas outside of the KSA due to the change in the water source and supply. This shall contribute to the improvement of water supply service in terms of the quality and quantity of water supplied to areas around KSA. Figure 5.3.1 shows projected expansion of water supply services in provision of KWSP 1 and 2 from present to year 2020.

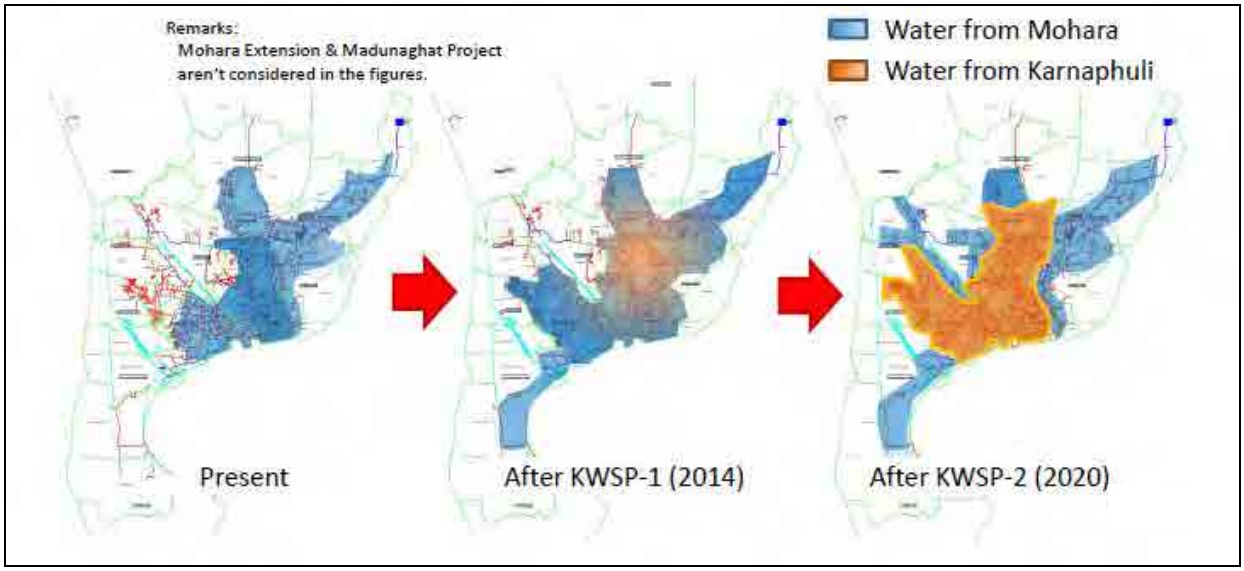



**Figure 5.3.1 Contribution of KWSP 1 & 2 to the Areas outside of KSA**

On the other hand, before effective design and construction such as KSA are achieved in the areas around KSA, careful and effective operation should be basically kept to avoid the deterioration of water supply service in KSA because sudden reduction in water pressure as well as the outflow of a large amount of water without flow control would occur if water supply to the surrounding area of KSA would be made by opening the valve(s) installed to stop the outflow to neighboring distribution systems (in the target year 2030). Except for emergency cases, water supply systems between KSA and neighboring distribution areas should be kept independent to maintain the control of the service level for KSA and surrounding areas.

All water supply systems to be constructed in the city shall be managed independently and at the same time operated comprehensively, supplementing each other and in consideration of countermeasures in emergency cases for each water supply system.

The Karnaphuli water supply system will play a role as a pilot water supply system in the process of the formation of an integrated water supply for the city. Thus it is important for all concerned parties to recognize the Karnaphuli water supply system as the pre-condition in the preparation of Master Plan for the realization of the integrated water supply covering the entire city area.

(4) Huge social impact of different water supply quality inside and outside of KSA

Service boundary shall be established anyway both in JICA study and WB study unless supply capacity can satisfy the entire water demand of whole CCC area. CWASA shall make efforts to establish the appropriate water supply areas outside KSA with support from GOB and/or donors.

Water supply service will be significantly improved even outside KSA after completion of KWSP 1 and 2. The supply conditions outside KSA can be further improved if additional supply from the Madunaghat WTP is materialized.

(5) Combination of new network and existing not abandoned in KSA

The new pipes in KSA are planned to be connected to existing pipes in some locations. However, the two areas; the KSA and the areas served by the existing pipes (outside of the KSA) will be under different and independent water supply systems separated by valves.

If water supply in surrounding areas of the KSA is highly necessary, CWASA may conduct water supply to such areas as a temporary measure until the year 2030. However, the following conditions should be satisfied in order to provide the temporary measures and avoid serious deterioration of service in the KSA.

- CWASA shall monitor the overall water supply conditions up to 2030 and confirm the possibility of surplus water (excess of the demand in the KSA available for use in limited parts of the surrounding areas).
- Hydraulic study and analysis shall be carried out in order to confirm the technical feasibility of the above option and to determine necessary low cost countermeasures for the service area outside of the KSA.
- Agreement shall be made between CWASA and concerned residents/other consumers to confirm the following conditions with full cooperation from the consumers.
  - Explain to and get understanding from the residents on the staged expansion of water supply systems by CWASA to finally cover the entire Chittagong city and the position of KSA in the overall water supply of the city
  - The service is limited in terms of the use of surplus water from KSA and 2030 in latest date for use of surplus water. In this regard, the service is beyond the normal operation of the Karnaphuli water supply system and is provided as temporary countermeasures.

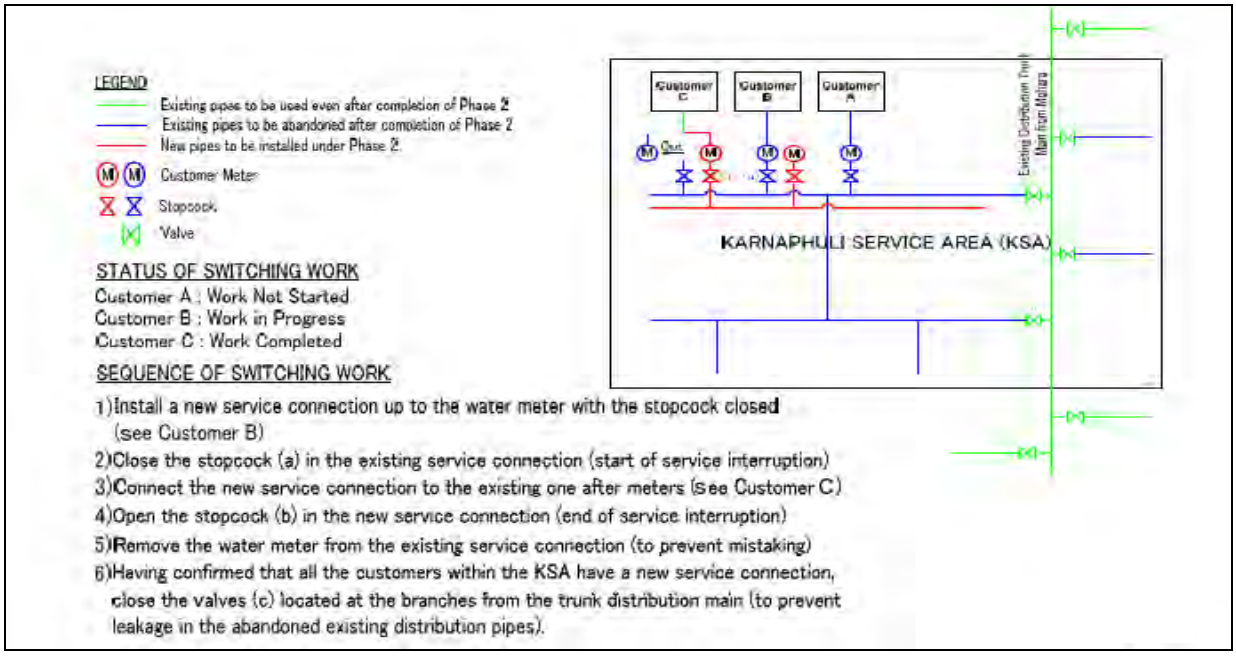



**Figure 5.3.2 Service Connection**

(6) Countermeasures to reduce leakage in KSA in early stage

KWSP 2 will give a construction priority to the priority sectors in PANI to commence normal water supply starting from year 2016, as shown in Figure 5.3.3.

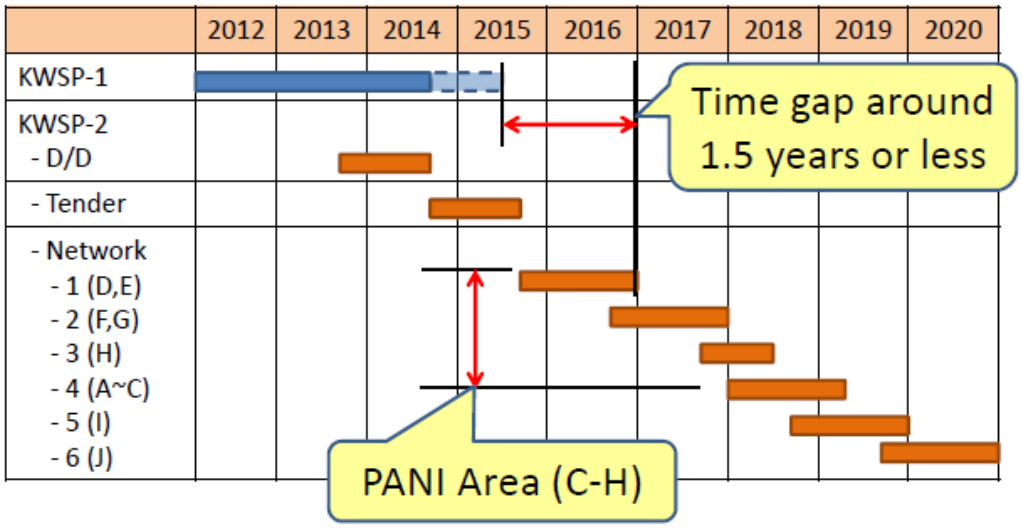



**Figure 5.3.3 Construction Schedule of Distribution Network to expedite Water Delivery to Priority Areas**