



Technical Assistance

ADB TA 8053BAN:

Technical Assistance to the
People's Republic of Bangladesh

for

Preparing the Khilkhhet Water Treatment Plant Project

Final Report

Revised to reflect change of WTP location to Gandharbpur

Mott MacDonald Ltd.

June 2013



**ADB PPTA 8053 BAN:
Preparing the Khilket Water Treatment Plant
Project
Final Report**

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PREFACE

This document is the Final Report for the Asian Development Bank's Project Preparatory Technical Assistance TA 8053 BAN: Khilkhet Water Treatment Plant Project. It follows our Inception Report of 19 October 2012 and Interim Report of 25 December 2012 and DFR Reports

The Final Report draws upon the review of the Feasibility Study, site visits, analytical work, and the consultations conducted by the TA team with senior officers from Dhaka Water Supply and Sewerage Authority and the Institute of Water Modeling. Meetings with Bangladesh Inland Waterways Transport Authority (BIWTA), Bangladesh Water Development Board (BWDB), DoE, Department of Fisheries (DoF), Department of Forests, MoA, MoWR, PPP Office, RAJUK, RHD, Standard Chartered Bank, and WHO provided additional insights and information. The report takes into account the consultations held with numerous stakeholders including the participants to the Inception Brief presentation held on 3 October 2012 in Dhaka, tripartite meetings following the presentations of the Inception Brief and the Interim Report, and the PPP workshop on 10 December 2012, as well as numerous comments received from ADB, Dhaka Water Supply and Sewerage Authority, and Design and Management Consultants.

The Final Report takes into account the change in location of the water treatment plant from Khilkhet to Gandharbpur.

The views presented in the report are the responsibility of Mott MacDonald and the TA team and do not necessarily reflect the views of Dhaka Water Supply and Sewerage Authority, the Government of Bangladesh, and the Asian Development Bank.

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ACRONYMS

| | |
|--------|---|
| ADB | Asian Development Bank |
| ADF | Asian Development Fund |
| ADP | annual development plan |
| AFD | Agence Française de Développement |
| APs | affected persons |
| BOD | biochemical oxygen demand |
| BOI | Board of Investments |
| BOO | build-own-operate |
| BOOT | build-own-operate-transfer |
| BOT | build-operate-transfer |
| BWDB | Bangladesh Water Development Board |
| capex | capital expenditures |
| CBO | community-based organization |
| CEGIS | Centre for Environmental Geographical Information |
| COD | chemical oxygen demand |
| CS | cadastral survey |
| DCC | Dhaka City Corporation |
| DFR | draft final report |
| DI | ductile iron |
| DMC | Design and Management Consultants |
| DO | dissolved oxygen |
| DoE | Department of Environment |
| DoF | Department of Fisheries |
| DPD | Deputy project director |
| DPP | Development Project Proposal |
| DPHE | Department of Public Health Engineering |
| DPP | Development project proposal |
| DWASA | Dhaka Water Supply and Sewerage Authority |
| DWSSDP | Dhaka Water Supply Sector Development Project |
| EA | Executing Agency |
| ECA | Environmental Conservation Act |
| ECOP | Environmental Code of Practice |
| ECR | Environmental Conservation Rules |
| EIA | Environmental Impact Assessment |
| EMP | environmental management plan |
| FERA | Foreign Exchange Regulation Act |
| FGD | focus group discussion |
| FIDIC | International Federation of Consulting Engineers |
| FS | feasibility study |
| GAP | gender action plan |
| GDP | gross domestic product |
| GPS | global positioning system |
| GRP | glass fiber reinforced polyester resin |
| HDPE | high density polyethylene |

| | |
|------------------|---|
| IDC | interest during construction |
| IEE | initial environmental examination |
| ISA | initial social assessment |
| IsDB | Islamic Development Bank |
| ITO | income tax ordinance |
| IWM | Institute of Water Modelling |
| IWTA | Inland Water Transport Authority |
| JRC | Joint River Commission |
| kg | kilograms |
| kV | kilo Volts |
| kWh | kilo watt hours |
| L/s | liters per second |
| LCC | Location Clearance Certificate |
| Lcd | liters per capita per day |
| LGED | local government engineering department |
| LIC | low income community |
| MCC | motor control center |
| m ³ | cubic meters |
| mg/L | milligrams per liter |
| MLD | million (mega) liters per day |
| MoA | Ministry of Agriculture |
| MODS | Maintenance Operations and Distribution Services |
| MoLGRD&C | Ministry of Local Government, Rural Development and |
| MoWR | Ministry of Water Resources |
| NAV | net asset value |
| NBR | National Board of Revenue |
| NGO | non-governmental organization |
| NRW | non-revenue water |
| N _{tot} | total nitrogen |
| NTU | nephelometric turbidity units |
| NWRC | National Water Resources Council |
| O&M | operations and maintenance |
| opex | operating expenditures |
| PLC | programmable logic controller |
| P _{tot} | total phosphorus |
| RAJUK | Rajdhani Unnayan Kartripakkha (Capital Development |
| REA | rapid environmental assessment |
| REB | Rural Electrification Board |
| RHD | Department of Roads and Highways |
| RRI | River Research Institute |
| RS | revised survey |
| SIA | social impact assessment |
| SIM | social intermediation model |
| SMP | sewerage master plan |
| SPS | Safeguards Policy Statement |
| STP | sewage treatment plant |
| TDS | total dissolved solids |
| TSS | total suspended solids |

| | |
|--------|--|
| TOR | terms of reference |
| URECA | urgent rehabilitation education for children association |
| VAT | value added tax |
| VGf | viability gap financing |
| WACC | weighted average cost of capital |
| WARPO | Water Resources Planning Organisation |
| WATSAN | water supply and sanitation |
| WERC | Water Economic Regulatory Commission |
| WHO | World Health Organization |
| WL | water level |
| WTP | water treatment plant |
| wtp | willingness to pay |

Glossary

| | |
|--------------------|---|
| <i>inter alia</i> | among others |
| mastaan | illegal enforcer |
| mohalla | Neighborhood |
| Mouza | Administrative subdivision-village level |
| Parishad | Rural administrative and local government units |
| Pourashava | Municipality |
| <i>prima facie</i> | Apparently |
| shat rasta | Seven roads |
| Thana/Upazila | Sub-districts |
| <i>vis-à-vis</i> | Regarding |

EXECUTIVE SUMMARY

1. This consultancy was to review the previous Feasibility Study (FS) for a WTP to be built at Khilkhet and this report was written and issued on that basis on 13 March 2013. However, 2 days before issuing it, the PPTA team was advised by ADB that the location of the WTP should be changed from Khilkhet to Gandharbpur, some 10km nearer the intake, and also some 20 km of the raw water and treated water transmission pipeline routes had to change. This consultancy was extended to carry out a new feasibility study and detailed surveys for these new proposals. This report still contains the original review of the FS for a WTP at Khilkhet, but is now extended and revised to cover the new proposed system with the WTP re-located to Gandharbpur with its associated new raw water supply and treated water delivery pipe routes. The name of the PPTA project remains 'Khilkhet' and the review sections still refer to the reviewed Khilkhet WTP where the comments are nonspecific to the new location, e.g. when referring to recommended sizes or treatment process, but the name Gandharbpur is used wherever we refer specifically to the new WTP location. The future project will be named "Dhaka Environmentally Sustainable Water Supply Project".

Introduction and Background

2. Dhaka is surrounded by water and often inundated by monsoon downpours. And yet, it suffers from a potable water shortage. The primary reason is that population growth has overtaken its water supply, and particularly, its groundwater sources that are derived from the world's largest well field. The fact that the water supply system is burdened by over 40% non-revenue water (NRW) exacerbates the situation.

3. In response, the government, through Dhaka Water Supply & Sewerage Authority (DWASA) acting as the executing agency and assisted by the Asian Development Bank and other development banks and bilateral agencies, has embarked on an ambitious and much needed expansion and refurbishment of Dhaka's water and sewerage systems. The water sector is addressed by the Dhaka Water Supply Sector Development Project (DWSSDP), funded by ADB. It aims to increase surface raw water sources and thereby decrease reliance on groundwater abstraction, which, at current rates, mines the aquifers at the rate of 2 to 3 meters per year. It further aims to strengthen the distribution system, thereby adding to the service areas and significantly reducing the NRW. Under a Sewerage Master Plan (SMP), DWASA intends to deal with the additional volume of sewage generated by refurbishing and renewing existing sewers and treatment plants, adding to the collection network, and installing new pump stations and treatment plants.

4. One of the components of DWASA's plan to augment the overall water supply and to reduce the amount of groundwater abstraction is the Khilkhet Water Treatment Plant Project. DWASA published a comprehensive feasibility study (FS) in 2011, the review of which and endorsement or identification of and filling gaps are the central objectives of this PPTA.

5. The largest component of the Khilkhet Water Treatment Plant (WTP) Project (Phase 1) is the supply and construction of about 85 km large diameter raw and treated water transmission pipe lines connecting a 2000 MLD raw water intake and 1000MLD pump station on the Meghna River with the WTP (500MLD in Phase 1 and another 500MLD in Phase 2), as well as treated water transmission pipeline connecting with the water

distribution system inside Dhaka, mostly benefitting Uttara, Gulshan/Banani, North Badda, and Mirpur districts (Figure 1). The project also includes provision of pumping equipment and pipelines to supply Saidabad WTPs (475 MLD in phase 1 and another 475 MLD in phase 2).

6. We also reviewed DWASA's plan to collect, treat, and dispose of the resulting sewage and the sludge produced by the additional amount of water directed into the Dhaka water distribution system, approximately 75% of which will be converted to domestic sewage. The PPTA team considered which of nine Phase 1 and nineteen Phase 2 priority investments outlined in DWASA's sewerage master plan could be prepared to tender stage. After much consideration and discussions with DWASA, it was concluded that none of the priority projects would be included under the ensuing project.

7. **Objectives & Outcome.** The objective of the PPTA assignment is to obtain the agreement of the government, the executing agency (EA) that is the DWASA, and ADB to the Project design and feasibility study (FS) within 30 weeks from start¹ of the assignment. Because of the change in scope, the PPTA assignment was expanded to incorporate the changes that resulted from the relocated WTP and new raw and treated water pipelines.

8. The outcome is this Final Report, which is a composite of endorsements of the FS prepared for DWASA and clear identification of gaps therein with proposals and recommendations on how to fill those gaps.

9. **Issues still to be resolved.**

Table 1: Issues to be resolved

| Issue | Affected component | Status / Action |
|--------------------------------|---------------------------------------|---|
| River morphology | Intake design | ADB engaged an independent individual consultant whose report is summarised herein; Further recommended study /modeling is to be agreed as the contractor's scope of work. |
| River water quality monitoring | WTP design, bid documents + bid costs | Consultant's results expected prior to bid document preparation and during detailed design. WQ monitoring should start immediately and continue as long as possible to give bidders maximum information for their WTP + Intake bid designs to improve their bids, reduce risk cost and reduce claims against DWASA. |
| Gandharbpur WTP site flooding | WTP design, bid documents + bid costs | DWASA to obtain reliable hydrological data giving the expected 1:100 year Balu river flood level at the WTP site location, or commission a study to do it before bidding. |
| To include Saidabad | Loan funding | To be discussed and agreed at fact finding |

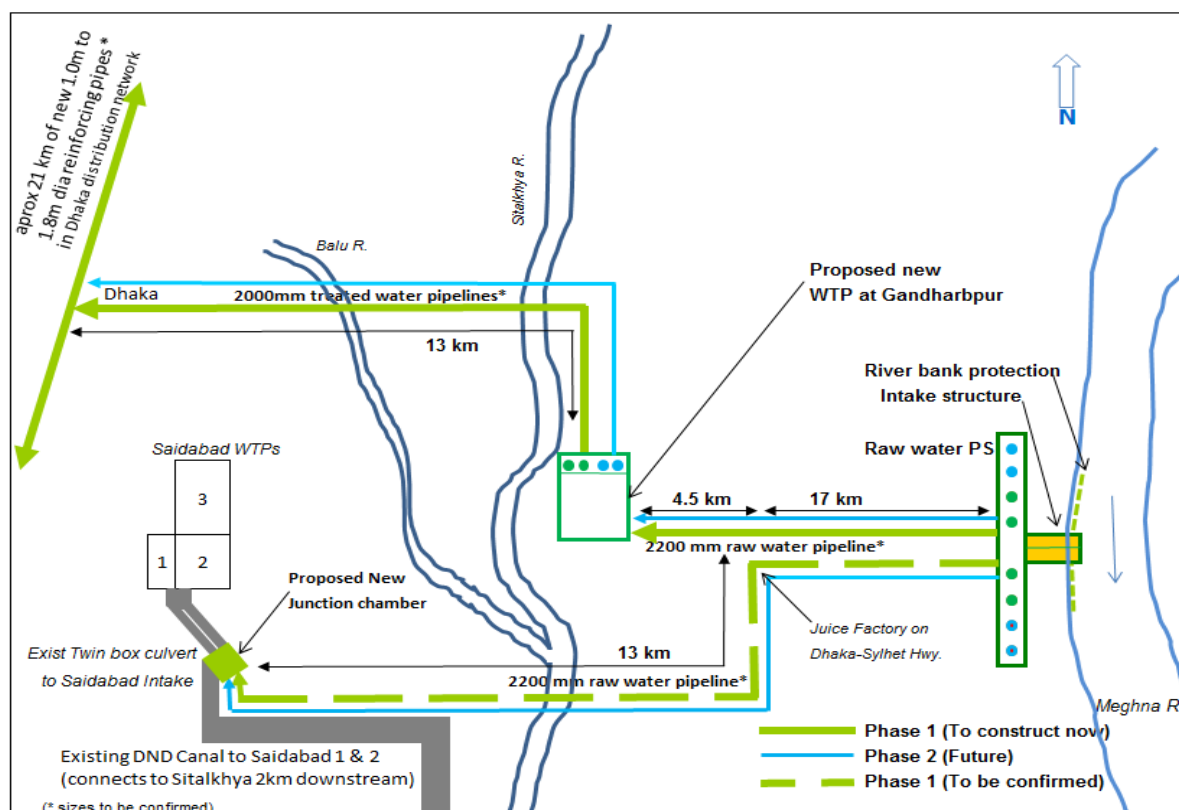
¹ The start of the assignment has been taken as 19 September 2012 with the arrival of the team leader in Dhaka. That determines the end of the 30-week PPTA as 16 April 2013, the submission of the Final Report incorporating comments from ADB and DWASA.

| | | |
|--|--|--|
| pipeline or not? | + much more | mission in Dhaka late July 2013 |
| Pipeline routes adjacent to existing roads | Pipeline design | DWASA to formally agree with RHD, RAJUK, LG, and Water Board on utilizing areas of their respective ROWs where pipelines are planned to be constructed near adjacent to roads. |
| Demand / Supply Projection | Timing of future new sources | The brief Demand / Supply projection in this report contains significant unknowns due to conflicting /unconfirmed data, which make it unreliable for predicting when future new sources are needed. IWM are preparing the first Water Supply Master Plan (first draft July '13), which should provide a more reliable projection. |
| Contract Packaging | Bid Documents and Contractor interest. | Final decisions on packaging have yet to be made by DWASA + financiers, but technical recommendations are included herein and market sounding results to verify these are expected by 23/6/13. |
| Operation Modality | DBO contract terms | PPTA recommendations are for long operating duration (15+ years), but ongoing market sounding will confirm the viability of reducing this period, then DWASA, (who prefer 3 years) and financiers must agree the best period of DBO. |
| Land Title + purchase | Contractor confidence /interest + Construction program | DWASA must confirm land title on the WTP site and proceed quickly with land purchase at Intake and the pipeline corridors, before Bid period to give contractors confidence and lower risk cost in bid prices. |
| Soils + Geotechnical surveys | Contractor confidence /interest + competitive price | PPTA advises DWASA to carry out soil surveys along the new TW pipe route + geotechnical borehole drilling at sites of river crossings and WTP, if not yet done, before Bid period to give contractors a basis for tender design + costing to lower risk cost in bid prices. |
| New Pipe modeling | Bid Documents + Design | IWM must remodel Dhaka distribution pipe reinforcement needed for new injection point before bid document issue. |
| Duty rate on GRP pipe | Pipe material selection + Bid Documents | A big apparent difference in total duty+ taxes for GRP pipes (29%) vs. others (60%) is very significant, and uncertain. Source duty data is not specific to large pipes (Table 14). If such low duty does apply, it will strongly favor GRP, but if DWASA pays duty on behalf of contractors, it will not influence their choice. DWASA must verify duty rate before bid document preparation. |
| Pipe bridges over rivers, vs. thrust boring under rivers | Bid Documents + Design | DWASA to decide, before bid documents, if difficulty of permissions for pipe bridges outweighs advantage of having pipes easily accessible for quick emergency repair, after failure, as on a bridge, vs inaccessible if thrust |

| | | |
|----------------------|------------------|---|
| | | bored under the rivers. |
| Public consultations | Pipeline and WTP | DWASA to ensure objections have been settled, especially at WTP site. |

10. PPTA team recommendations that are different from recommendations in the feasibility study are expected to be resolved by DWASA and ADB, prior to bid document preparation.

Figure 1: Gandharbpur WTP Project Schematic



Water Supply

11. The project comprises ten major components, some of which are recommended to be designed and constructed for the full Phase 2 capacity, as follows.

Table 2: Project Component Sizing

| Project Component | Design for Phase | MLD |
|---------------------------------------|------------------|-------|
| Riverbank protection | 2 | n/a |
| Intake structure | 2 | 2,000 |
| Raw water pumping station | 2 | 2,000 |
| Raw water pipe to Gandharbpur | 1 | 525 |
| Gandharbpur WTP | 1 | 500 |
| Treated water pipes to + in Dhaka | 1 | 500 |
| Raw water pipe to Saidabad | 1 | 475 |
| Intake & pipeline route land purchase | 2 | n/a |

| | | |
|--|---|-------|
| Power supply connections | 2 | n/a |
| Plant + pumps at Intake | 1 | 525 + |
| Plant + pumps at Gandh' WTP | 1 | 500 |
| Access roads to intake + along raw water pipelines | 2 | n/a |

The project costs in this report cover all the project components above, sized for the design phase as stated above, which are given in more detail in Table 11.

12. The feasibility of the design and construction of these major components, as well as associated lesser components, was demonstrated in the Feasibility Study. To a large extent, we agree, and we have stated our agreement in our detailed review comments. We have also stated our disagreement with some of the approaches taken in the FS.

13. Some will be resolved prior to the preparation of bid documents through discussions between DWASA and ADB based on review of our PPTA report. All others will be resolved through the process of designing and constructing the project because based on what appears to be an example of a successful design-build project - the recently inaugurated 225MLD Saidabad 2 WTP that came in on budget and slightly ahead of time – we have recommended that Gandharbpur Phase 1 be implemented likewise.

14. This will suit DWASA, having stated its desire to proceed via design-build. And this will suit ADB, as it is consistent with its desire to include PPP, where DB and operation of more than five years by the private sector is considered by ADB as a form of PPP. Essentially all differences noted will be accommodated through the market place; i.e., bidders for some or all of the project will be obliged to propose all design aspects showing why one option or another should be adopted. The main options are few:

- **Intake design** - an expert review of the morphology report has been made including detailed recommendations and cost estimates for physical river modeling, river bank protection works, and the intake channel design.
- **Intake pump station** - the design-build contractor will demonstrate that the pump type (vertical turbine or horizontal split-case) and line-up (the number and vari-speed or not) he proposes for implementation is optimum.
- **Transmission mains** – there are 2 options: (1) the design-build contractor will be asked in the bid to prove by way of optimization calculations, based on an approach with fixed economic parameters defined in the bid documents, and with the tenderer's actual tender costs what the economic pipe size for the project should be (considering that as the diameter increases, the cost of the pipe and attendant civil works increase but the cost of power to pump the water decreases) or (2) the consultants who prepare the bid documents can do an initial optimisation. The pros and cons of these alternatives are discussed in Appendix 23.
- **Water Treatment Plant** – we do not agree with the overall philosophy of the WTP design: full automation with inflow control. We have stated that it is possible to design a plant and to operate it in full automatic mode but we do not believe that the time is right for that to occur in Bangladesh.

We also have some reservations on two other aspects proposed in the FS. One is the use of tube or plate settlers in the sedimentation tanks. We believe that the plant should be designed more conservatively to operate without such settling devices so that they can be added at a later date to increase the throughput, if that should be required. The other is the concept of operating in direct filtration mode when turbidity is relatively low, even bypassing the flocculation process. We do not believe that the raw water quality is good enough for that mode of filtration to be successful. The design-build contractor will be required to show how his proposed unit process designs will at all times produce treated water of the quality standards required by DWASA.

15. **Project costs.** We agree with the approach to feasibility cost estimation taken in the FS and have adopted most of the estimates. Our estimate differs in four respects:

- (i) we have added certain sums for project components left out and others additionally proposed (e.g., the access road, social safeguards costs, and sludge dewatering);
- (ii) we have added for design and construction supervision (5.5% and 5% respectively, with 0.5% added to the design cost to account for expandability);
- (iii) we have included costs explicitly excluded in the FS (e.g., duty, VAT and other taxes, cost of resettlement and compensation actions, consultancy services, and land acquisition);
- (iv) we have revisited the pipeline costs and revised both supply and install rates for some of them based on up to date pipe supply quotations and more detailed pipe installation calculations.

The following tables show the total estimated cost of the project, including duties, taxes, contingencies, land acquisition, design and supervision. A tentative financing plan is also provided.

Table 3: Project Cost Breakdown

| Component | Construction Base Cost | |
|---|------------------------|-------------------------------|
| | Whole Project | excl. all Saidabd pipes+pumps |
| 1.0 Intake | 40,238,383 | 29,621,540 |
| 2.0 Gandharbpur WTP | 111,062,358 | 111,062,358 |
| 3.0 Pipelines (incl. river crossings) | | |
| 3.1 Intake to Juice Factory | 114,356,123 | 57,178,062 |
| 3.2 Juice Factory to WTP | 19,063,019 | 19,063,019 |
| 3.3 WTP to Injection point + 21 km of D | 102,158,317 | 102,158,317 |
| 3.4 Juice Factory to DND canal | 44,254,767 | - |
| 3.5 DND canal - Saidabad chamber | 20,635,831 | - |
| Total Design included above | 20,479,937 | 14,464,934 |
| Total Physical Contingency incl.above | 58,926,365 | 41,619,560 |
| 4.0 Other costs | | |
| 4.1 Land acquisition GoB | 61,000,000 | 61,000,000 |
| 4.2 Power supply (G) GoB | 1,543,750 | 1,543,750 |
| 4.3 Power supply (S) GoB | 1,787,500 | - |
| 4.4 River study & modeling | 388,500 | 388,500 |
| 4.5 Environmental cost GoB | 380,750 | 323,638 |
| 4.6 Social cost / resettlement GoB | 16,220,203 | 14,759,329 |
| 4.7 IDC | excl. | excl. |
| 4.8 Recurrent Cost of PMU | excl. | excl. |
| 4.9 Price Contingency | excl. | excl. |
| 4.10 Duty & taxes GoB | 119,510,415 | 95,343,438 |
| Construction Supervision | 18,618,125 | 13,149,940 |
| Project Cost (excl IDC, RC, PC, incl supervi | 671,218,042 | 505,591,891 |
| Saving if all Saidabad pipes + pumps omitted | | 165,626,151 |

The “without Saidabad” cost estimate assumes the intake and pump station civil works are constructed for 2,000 MLD to be able to accommodate the Saidabad mechanical and electrical plant when it goes ahead. Costs have been considerably refined since the draft FR. Significant changes are: Land acquisition and compensation increased, previously estimated but now known from completed, detailed surveys; pipe costs reduced due to reduced pipe length and more competitive, validated quotes received from pipe suppliers. A cost breakdown, with IDC + RC + PC for the “without Saidabad” option, is in Table 15.

The tentative financing plan (in Section B.16) for this “without Saidabad” option, is:

Table 4: Tentative Financing Plan

| | | |
|-----|-------|-----|
| ADB | 37.4% | 220 |
| AFD | 17.0% | 100 |
| EIB | 17.0% | 100 |
| GoB | 28.5% | 167 |
| | Total | 587 |

Notes

- Based on 5.5% design, 5% supervision, 15% physical contingencies
- 4% VAT + 5% Tax on civil works only, 60% duty + taxes on imported plant + pipes

Waste Water

16. **Introduction.** There are two main components referenced in the TOR; namely, waste water generated at the Gandharbpur WTP and the effects of additional water supplied to the Dhaka distribution system.

17. We have reviewed DWASA's plan to collect, treat, and dispose of the resulting sewage and the sludge produced by the augmented amount of water directed into the Dhaka water distribution system, approximately 75% of which will be converted into domestic sewage. The PPTA team considered which of Phase 1 and Phase 2 priority investments outlined in DWASA's sewerage master plan² (SMP) could be prepared to tender stage. In addition, the issue of sludge and septage management is implied as it is discussed in the SMP.

18. The importance of the proposed priority projects (Sewerage Systems and Sewage Treatment Plants at Uttara and Mirpur, and septic tank sludge management) has been assessed and justified.

19. Inventory and assessment of Operation and Maintenance (O&M) actions on bases of the SMP for the proposed priority projects are formulated and presented in Appendix 11 - Annex 3, including a brief overview of PPP Schemes for O&M actions.

20. A pilot study for improved Septic Tank Management with possible World Bank funding is under consideration at DWASA. Septage management is not further studied because it is reportedly part of another already funded project.

21. **Review of SMP 2012.** The review of the SMP resulted in our recommendations for improvements and extensions. The main observation is that the SMP covers essentially all DWASA MODS areas with adequate sewerage and STP construction projects with priorities in line with the water supply schemes reportedly contained in a proposed 50-year water supply master plan. Phase 1 priority projects as listed in the SMP are defined, funded, and under preparation so there is no need for further PPTA work on this issue. Phase 2 projects are under development by DWASA and will be prepared to tender stage by DWASA consultants. Reportedly, Development Project Proposals have been prepared.

Considerations and Recommendation

22. **Increased water supply from the** Gandharbpur WTP will serve the population in four DWASA MOD Zones (4, 5, 8 and 9). Review of the SMP and interviews with DWASA officials indicated that the increased wastewater volume from Zone 05 and 08 (together 262 MLD) can be fully treated by the ongoing government-funded Dasherbandi sewerage and 500MLD development project (Phase 1 Priority Projects).

23. However, for Zones 04 and 09, no STPs to treat their share of the increased water supply (178 and 60 MLD respectively) have been provided and therefore, DWASA is planning the construction of sewerage systems and STPs at Uttara and Mirpur on priority basis together with a Development Project Proposal.

² Dhaka Sewerage Master Plan Project Package DS-1A, funded by DWASA

24. **Importance of Phase 2 Priority Projects.** The following priority projects for Zones 04 and 09 have been identified by DWASA:

- Sewerage Dhaka North (Uttara): \$57 million
- Sewerage Dhaka West (Mirpur): \$86 million
- STP Dhaka North (Uttara): \$80 million
- STP Dhaka West (Mirpur): \$140 million

25. These projects are directly related to the increased water supply from the Gandharbpur WTP. Funding for these projects is not yet assured and as such subject of further investigation by DWASA.

26. **Key issues requiring government consideration and policy decisions include:**

- (i) Reconsideration of the waste water treatment technologies to be applied under the SMP (the initial recommended 'trickling filter' technology offers better sludge processing, disposal and energy recovering potential than the currently favored more advanced activated sludge technology whereas the operation and maintenance costs will be significantly lower, unless high levels of BOD, COD, N, and P removal are required based on environmental or legal considerations).
- (ii) Environmental assessment should be undertaken into the required removal levels of waste water treatment system for BOD, COD, total nitrogen (N_{tot}) and total phosphorus (P_{tot}) in order to select the minimum required treatment technology.
- (iii) Extensive technical and feasibility study is recommended into STP sludge processing and disposal as this is an increasing environmental problem.
- (iv) Combined STP and septage processing at the new STPs to be constructed under the SMP should be seriously considered as the probably most economic and practical way to deal with both problems.
- (v) Small Bore Sewer Systems should be reconsidered as economic and practical sanitation solution for urban poor settlements in spite of earlier failures and difficult but not insuperable organizational and managerial aspects.

Institutional Development

27. Dhaka Water & Sewerage Authority is embarking on a major investment to increase water supply to a growing population of Dhaka and to ensure sustainable sourcing of water. Financing of this investment will come from different sources including ADB, other cofinanciers, and the private sector. The objective of the institutional assessment component for the PPTA is to undertake a capacity assessment of DWASA and if required propose ways and means to strengthen the capacity of DWASA and related agencies. Specifically, the objective is to enhance competence levels; i.e., the skills and ability to cope with the required practices and technology that will allow the sectoral achievement of the government's goal, which is improved access to more reliable and sustainable water supply for greater Dhaka City. A financial assessment of DWASA has been also carried out with a

forecasted operational performance over the next 20 years. The assessment together with the forecast outlines the financial environment of DWASA and risks that may impact the loan payment position.

28. **Organization and Management.** The DWASA is a service oriented autonomous commercial organization in the public sector, entrusted with the responsibility of providing water supply, sewerage, storm water drainage services, and environmental health management. Its jurisdiction covers Dhaka and Narayangonj cities encompassing more than 360 sq. km service area. The service area of WASA is divided into 11 Maintenance, Operations and Distribution Services (MODS) and Revenue zones. The total number of staff positions is 4,375 of which 3,294 are currently employed.

29. The DWASA Board consists of 13 members from various disciplines including its chairman. The Board is the Governing Body of DWASA. In the spirit of the WASA Act 1996 the Board should perform its functions in full autonomy. However, political interference is not uncommon. The Managing Director (MD) and Deputy Managing Director (DMD) are employed on a contractual basis on commercial terms and conditions with a term of four years. It appears that recent reforms and “turn around program” introduced by the new MD are gradually turning DWASA into a more laudable and effective organization. Achievements include, (i) considerable improvement in financial performance and computerization of financial management systems, (ii) annual updating of the 5-year Business Plan, (iii) strengthening of the financial control systems, (iv) integrating billing and collection process and accounts through computer networking systems, and (v) public education and citizen’s awareness campaigns is bringing more transparency and spreading water conservation messages.

30. There is a lack of coordination between the O&M and other departments within DWASA. Functions performed by other departments directly impacts efficient operation of the O&M department. Under the current Financial Capacity Building (a component of the DWSSDP project of ADB) O&M manual and training has been developed and provided to a number of the staff. However, the training will remain limited since it is impossible to provide training to over 3,000 personnel. It appears that the current training program should continue even when DWSSDP implementation is completed.

31. DWASA complies with both government and IFI and donor procurement rules and regulations. The majority of large-scale procurement occurs under projects financed by the ADB and the WB. The procurement rules and guidelines in case the procurement is financed by ADB/WB are the particular procurement guidelines of the funding agency. These general procurement rules are applicable for all types of procurements; procurement of goods, works, and services. DWASA does not have experience with PPP procurement/agreements. PPP procurement includes review, analysis, and negotiations of commercial and technical details that require knowledge and skills not available within the organization.

32. DWASA has taken advantage of the provision in the WASA Act 1996 whereby authority is provided for autonomous increases in tariff by 5%, which DWASA has implemented from 2009 such that the current tariff for private consumers stands at BDT6.99/m³. Tariff setting and adjustments will remain key issue in the near future and will be

required to be addressed by WASA and the government for full cost recovery, including capital costs.

33. DWASA has very little private sector participation in its operation. All physical work is contracted out to local firms and international and national firms provide advisory support services under technical assistance programs. Bill collection in several zones is outsourced to an employees' cooperative, The Employees' Consumers Supplies Cooperative Society Ltd (ECSCSL), under contract with DWASA. The limited exposure of DWASA with the private sector suggests that procuring and managing a PPP project, if DWASA enters into one in the future, will require strengthening DWASA's capacity.

34. **Financial Assessment.** Given the expected significant increases in the capex and opex, it is highly relevant that a regular financial management assessment (FMA) of DWASA is conducted. Not only will the planned investments strongly increase DWASA's future debts and repayment capacity, but also DWASA's operating costs will significantly increase, since the O&M costs of surface water treatment are considerably higher than water supplied from ground water sources. To ensure sustainable DWASA financial results, up to date and effective financial management by DWASA is a critical success factor. If DWASA does not have the proper staff strength and competences to effectively manage its financial resources, the benefits of the projects may not be as sustainable as planned.

35. The FMA has considered two types of risks; (i) inherent risks; i.e., risks outside the direct control of the DWASA financial management (FM), and (ii) control risks; i.e., risks concerning the internal functioning and control of the DWASA Finance and Accounting division. A summary of the main risks identified is outlined in the ADB template risk assessment.

36. Clearly the biggest inherent risk that DWASA will be facing in the coming years is the increasing unstable political future situation, which may result in seriously hampering economic development and possibly reduced investments in water supply and sanitation (WSS) infrastructure projects. This risk may affect the on-going organizational reforms, given that DWASA may still not operate as a financially autonomous entity, that top management is still via political appointment, and last but not least, that tariff setting beyond 5% per annum is still dependent on political approvals.

37. The results of the FMA of the internal (control) risks indicate that the existing financial management capabilities and performances of DWASA Finance and Accounting division may be considered acceptable; however, with several medium to significant risks involved. These risks are acknowledged by the DWASA management and programs are on-going and further developed to mitigate these risks.

38. The double entry accounting system has been implemented some years ago and is currently operated without major problems. Improvement of the accounting software has been started under the FCB project but is not yet completed. An important bottleneck is that the existing hardware is outdated and insufficient to fulfil the requirements of the proposed new, custom-designed and interlinked DWASA accounting software system.

39. In addition to the lack of proper IT infrastructures, the DWASA Finance and Accounting staff does not presently have the required background and experience to operate the new accounting software systems. This may be considered at least as a medium risk, since this lack of adequate competences is a dominant and crucial issue. Without the FM division staff having the proper background, manpower strength, or competences, all targeted measures for FM system improvement and/or procedures will not show significant results or impacts.

40. The PPTA team recommends that DWASA top management give more focussed attention to initiate and monitor the necessary improvement of FM staff competences and IT infrastructure.

41. Other identified medium DWASA FM risks are:

(i) **Internal auditing unit.** An internal auditing unit does exist, but is mainly addressing queries from the Government and other stakeholders, concerning DWASA's annual report. It does not sufficiently address the internal auditing issues for which it was established.

(ii) **Monthly performance reporting.** The submission of the monthly performance reports is mostly late; i.e., about 4-5 months after the respective month, while 3 weeks is the target. As a result, the reported monthly performance data are not very useful for possibly required DWASA top management actions.

(iii) **Management information system (MIS).** MIS development and implementation and further development seems to have high interest of senior DWASA management, insufficient budgets are presently being made available. The DWASA Information Communication Technology (ICT)/MIS unit consists of only two staff collecting and processing all required MIS information. As noted, there is a lack of proper ICT hardware and software infrastructure, with inadequate hardware and slow (2G) internet connections, using mostly pirated software and no virus protection. The result is that no actual assessment or analyses of the collected data is being conducted.

42. **DWASA PPP.** The DWASA PPP cell is still in its infancy and does not have real experience with PPP type of projects. A specific training program is required, particularly if in the future a PPP set up within DWASA's WSS operations will be implemented. FMA indicates there are no significant FM risks. Nevertheless, given the on-going and planned major investments and expected strong increases of the DWASA annual operating and loan/DSL costs in the coming years, DWASA's top management should give more and serious attention to the identified FM risks, and make the necessary budgets available to mitigate these risks, in order to be able to effectively direct and guide the DWASA middle management and staff through the difficult operational and financial tasks which are expected to be encountered by the DWASA organization in the coming 5 to 10 years

43. **Project Institutional Framework.** DWASA at the central level through the field offices at the project level will have the overall responsibility for project implementation, coordination and planning, internal monitoring and overall reporting. DWASA will be the executing agency (EA) for the Khilkhet WTP project. A Project Management Unit (PMU) will

be set up to manage project activities with distinct parts being managed and implemented by DWASA.

44. The PMU should comprise a director, two deputy project directors (civil and mechanical), three executive engineers with staff consisting of assistant Engineers (6) and sub-assistant engineers (12), a water chemist, a procurement specialist with staff, an accountant with staff, and two safeguard specialists (environment and social).³

45. The Khilkhet WTP project will be financed by multi-donor organizations. While ADB is taking the lead for the investment funds, AFD and EIB are the other cofinanciers. DWASA has a sound record of experience with ADB and donor lending procedures and projects and in the past handled several projects and programs. DWASA has no experience with PPP, specifically with private sector equity investments. As suggested by the consultant’s legal analysis a local legal entity will need to be formed to assume the contractual obligations vis-à-vis DWASA. The shareholder structure and agreements will outline the provisions which are of interest of DWASA.

Table 5: Financial ratios

| Financial ratios | 2012/11 | 2011/10 | Remarks |
|-------------------------------------|----------------|----------------|---|
| Quick ratio | 1.79 | 2.75 | High; questionable since high amount (investments/ deposits) more likely to be fixed assets |
| Equity/Total Eq+Liabilities | 32.84% | 33.4% | Favourable, but will decrease due to new project/GOB loans |
| LT liability / Total Eq+Liabilities | 67.4% | 66.54% | High, see Audit comments on 'Grant & other Funds |
| Interest coverage ratio | 5.9 | 5.6 | High, mainly since interest payments are still limited; will in coming years rapidly decrease |
| Debt Service Coverage Ratio | 1.4 | 53. | Still favourable, but will further significantly decrease due to strong increase in due (GOB) loan repayments |

46. **20 yr financial forecast.** . The latest available Audit Report⁴ of DWASA is for the fiscal year (FY) 2011/2012. An overview of the present financial position of DWASA and some key financial ratios derived from the annual reports is shown in Table 5.

47. The starting year of the 20-year forecast of the financial performance of DWASA is based on the financial position in the FY 2011/12. Other relevant data were used from the 5-year DWASA business plan and multi-annual financial forecasts which were developed under the on-going FCB Project. A summary of the DWASA 20 year forecast Income Statement is given in the next page.

48. The following main observations are made:

³The PMU was officially announced on 15 May 2013; however, the full complement of staff has not been appointed.

⁴DWASA Auditor’s report and financial statements for year ending 30 June 2012, submitted 26 December 2012

- DWASA's annual net profits (after tax and interests) will remain positive in the coming 2-3 years, but will turn negative in 2015/16, when the Saidabad II loans become due for repayments, and expenses related to the construction of the Ghandarbpur WTP phase I expected to start in the FY 2017/18.
- DWASA's annual expenditures include presently a major (incidental) provision for additional contributions to the pension fund to close the existing pension 'gap'. For the FY 2011/12 this concerned about 2.0 billion BDT (i.e. 30% of total costs). This incidental provision may end in the coming 2 years, thus leaving significant financial 'room' to compensate for the expected increases in the annual O&M and Debt Service Liabilities (DSL) costs.
- The negative Return on Sales (RoS) will vary during 2015/2016 to 2020/2021 between -/-2.2% and -/-11.5%. The minimum Debt Service Coverage Ratio (DSCR) for the same period is 0.4, indicating a poor financial position.
- Clearly the most logical and effective measure to improve the DWASA future negative financial results is to increase the annual water-sewerage service fee/m³ from the current level. Different levels of tariff increases are possible and they are outlined in elsewhere in this document.

49. It may be concluded that with serious DWASA management efforts and actions to improve the revenues, increase tariff rates, and to control the expenditure levels, DWASA does have the financial capacity to absorb the expected strong O&M and financial cost increases, which will result from the necessary change from ground water sources to surface water sources in the coming 20 years.

Table 6: Summary

DWSA 20 yr Financial

Summary DWSA 20 yr Financial forecast

| Revenues (x BDT million) | | | | | Expenditures (x BDT million) | | | | | Results | | | | |
|--------------------------|--------------------------|-------------------|------------------------|-------|------------------------------|----------------------|----------------------|----------------------|-------------------|-------------------|-------------------------|------------|---------------------------|------------------------------------|
| Fiscal Year | Population covered (x m) | Domestic Revenues | Comm/Industry Revenues | Other | Total Revenue | Salary & Admin Costs | O&M costs GW sources | O&M costs SW sources | Other expenditure | Total Expenditure | Operating Result (EBIT) | Net Profit | Net Return on Sales (RoS) | Debt Service Coverage Ratio (DSCR) |
| 2011/12 | 9.137 | 2.998 | 1.285 | 2.680 | 6.963 | 3.685 | 1.937 | 148 | 955 | 6.724 | 239 | 70 | 1.0% | 1.2 |
| 2012/13 | 9.860 | 3.408 | 1.688 | 2.851 | 7.947 | 3.211 | 2.028 | 532 | 1.508 | 7.279 | 668 | 303 | 3.8% | 2.2 |
| 2013/14 | 9.988 | 3.635 | 1.801 | 3.036 | 8.472 | 2.263 | 2.098 | 557 | 1.500 | 6.418 | 2.054 | 1.446 | 17.1% | 3.4 |
| 2014/15 | 10.101 | 3.871 | 1.917 | 3.238 | 9.026 | 1.942 | 2.169 | 567 | 1.495 | 6.173 | 2.853 | 332 | 3.7% | 0.9 |
| 2015/16 | 10.096 | 4.073 | 2.018 | 3.457 | 9.548 | 2.000 | 2.212 | 754 | 1.493 | 6.458 | 3.090 | -982 | -10.3% | 0.5 |
| 2016/17 | 12.553 | 5.331 | 2.641 | 3.695 | 11.667 | 2.060 | 2.367 | 2.854 | 3.424 | 10.705 | 962 | -1.698 | -14.6% | 0.3 |
| 2017/18 | 13.021 | 5.760 | 2.853 | 3.924 | 12.537 | 2.122 | 2.532 | 3.054 | 3.310 | 11.018 | 1.519 | -1.001 | -8.0% | 0.5 |
| 2018/19 | 13.496 | 6.218 | 3.080 | 4.171 | 13.470 | 2.185 | 2.710 | 3.268 | 3.209 | 11.372 | 2.097 | -2.346 | -17.4% | 0.3 |
| 2019/20 | 15.201 | 7.296 | 3.619 | 4.437 | 15.352 | 2.251 | 2.642 | 4.003 | 3.121 | 12.018 | 3.334 | -837 | -5.5% | 0.6 |
| 2020/21 | 15.657 | 7.827 | 3.901 | 4.723 | 16.452 | 2.318 | 2.827 | 4.284 | 4.238 | 13.667 | 2.785 | -1.111 | -6.8% | 0.6 |
| 2021/22 | 16.127 | 8.397 | 4.203 | 5.032 | 17.632 | 2.388 | 3.025 | 4.583 | 4.088 | 14.085 | 3.548 | -65 | -0.4% | 0.7 |
| 2022/23 | 16.611 | 9.009 | 4.469 | 5.364 | 18.843 | 2.460 | 3.237 | 4.904 | 3.955 | 14.556 | 4.286 | 925 | 4.9% | 0.9 |
| 2023/24 | 17.109 | 9.665 | 4.692 | 5.723 | 20.081 | 2.533 | 3.463 | 5.248 | 3.839 | 15.083 | 4.998 | -183 | -0.9% | 0.7 |
| 2024/25 | 17.622 | 10.370 | 5.300 | 6.110 | 21.779 | 2.609 | 3.005 | 5.615 | 3.737 | 14.966 | 6.814 | 1.979 | 9.1% | 1.0 |
| 2025/26 | 18.151 | 11.125 | 5.565 | 6.526 | 23.217 | 2.688 | 3.215 | 7.038 | 4.842 | 17.783 | 5.434 | 944 | 4.1% | 0.9 |
| 2026/27 | 18.696 | 11.935 | 5.843 | 6.976 | 24.755 | 2.768 | 3.440 | 7.531 | 4.683 | 18.422 | 6.333 | 2.188 | 8.8% | 1.1 |
| 2027/28 | 19.256 | 12.805 | 6.136 | 7.461 | 26.401 | 2.851 | 3.681 | 8.058 | 4.544 | 19.134 | 7.267 | 3.685 | 14.0% | 1.4 |
| 2028/29 | 19.834 | 13.738 | 6.442 | 7.984 | 28.164 | 2.937 | 3.939 | 8.622 | 4.423 | 19.920 | 8.244 | 5.006 | 17.8% | 1.7 |
| 2029/30 | 20.429 | 14.738 | 6.765 | 8.548 | 30.051 | 3.025 | 4.214 | 9.225 | 4.318 | 20.783 | 9.268 | 6.375 | 21.2% | 2.0 |
| 2030/31 | 21.042 | 15.812 | 8.103 | 9.156 | 33.071 | 3.116 | 4.509 | 15.151 | 4.230 | 27.006 | 6.065 | 3.512 | 10.6% | 1.4 |
| 2031/32 | 21.673 | 16.964 | 9.559 | 9.813 | 36.336 | 3.209 | 4.825 | 16.212 | 4.157 | 28.403 | 7.932 | 1.568 | 4.3% | 1.1 |

Forecast

| Revenues (x BDT million) | | | | | Expenditures (x BDT million) | | | | | Results | | | | |
|--------------------------|------------------------------|-------------------|------------------------|-------|------------------------------|----------------------|----------------------|----------------------|--------------------|--------------------|------------------|------------|---------------------------|-----------------------------------|
| Fiscal Year | Population Covered (x mill.) | Domestic Revenues | Comm/Industry Revenues | Other | Total Revenues | Salary & Admin Costs | O&M costs GW Sources | O&M Costs SW Sources | Other Expenditures | Total Expenditures | Operating Result | Net Profit | Net Return on Sales (RoS) | Debt Service Coverage Rate (DSCR) |
| 2011/12 | 9137 | 2981 | 1278 | 2670 | 6930 | 3685 | 1937 | 148 | 955 | 6724 | 868 | 37 | 0.53% | 1.1 |
| 2012/13 | 9860 | 3577 | 1773 | 2852 | 8201 | 3211 | 2028 | 532 | 1508 | 7279 | 2639 | 558 | 6.80% | 2.7 |
| 2013/14 | 9988 | 3815 | 1891 | 3049 | 8756 | 2263 | 2098 | 557 | 1500 | 6418 | 5197 | 1730 | 19.75% | 3.8 |
| 2014/15 | 10101 | 4062 | 2013 | 3263 | 9339 | 1942 | 2169 | 567 | 1495 | 6173 | 4915 | 646 | 6.91% | 1.1 |
| 2015/16 | 10096 | 4275 | 2119 | 3496 | 9890 | 2000 | 2212 | 754 | 1493 | 6458 | 3868 | -640 | -6.47% | 0.6 |
| 2016/17 | 12553 | 5595 | 2773 | 3748 | 12116 | 2060 | 2367 | 2854 | 3424 | 10705 | 3147 | -1248 | -10.30% | 0.5 |
| 2017/18 | 13021 | 6046 | 2996 | 3993 | 13034 | 2122 | 2532 | 3054 | 3310 | 11018 | 1608 | -3252 | -24.95% | 0.2 |
| 2018/19 | 13496 | 6527 | 3235 | 4256 | 14017 | 2185 | 2710 | 3268 | 3209 | 11372 | 2876 | -2484 | -17.72% | 0.4 |
| 2019/20 | 15201 | 7657 | 3800 | 4540 | 15998 | 2251 | 2642 | 4003 | 3121 | 12018 | 5597 | -980 | -6.12% | 0.8 |
| 2020/21 | 15657 | 8215 | 4097 | 4846 | 17158 | 2318 | 2827 | 4284 | 4238 | 13667 | 5788 | -1385 | -8.07% | 0.9 |
| 2021/22 | 16127 | 8813 | 4413 | 5175 | 18402 | 2388 | 3025 | 4583 | 4088 | 14085 | 7442 | -374 | -2.03% | 0.9 |
| 2022/23 | 16611 | 9456 | 4693 | 5530 | 19678 | 2460 | 3237 | 4904 | 3955 | 14556 | 9034 | 583 | 2.96% | 0.8 |
| 2023/24 | 17109 | 10144 | 4927 | 5912 | 20983 | 2533 | 3463 | 5248 | 3839 | 15083 | 8657 | -419 | -1.99% | 0.8 |
| 2024/25 | 17622 | 10883 | 5566 | 6324 | 22772 | 2609 | 3005 | 5615 | 3737 | 14966 | 12522 | 1684 | 7.39% | 1.2 |
| 2025/26 | 18151 | 11676 | 5844 | 6767 | 24287 | 2688 | 3215 | 7038 | 4842 | 17783 | 11373 | 775 | 3.19% | 1.1 |
| 2026/27 | 18696 | 12527 | 6136 | 7245 | 25908 | 2768 | 3440 | 7531 | 4683 | 18422 | 13523 | 2149 | 8.30% | 1.4 |
| 2027/28 | 19256 | 13439 | 6443 | 7760 | 27643 | 2851 | 3681 | 8058 | 4544 | 19134 | 15694 | 3487 | 12.61% | 1.3 |
| 2028/29 | 19834 | 14418 | 6765 | 8316 | 29499 | 2937 | 3939 | 8622 | 4423 | 19920 | 18069 | 4965 | 16.83% | 1.5 |
| 2029/30 | 20429 | 15469 | 7103 | 8914 | 31486 | 3025 | 4214 | 9225 | 4318 | 20783 | 20565 | 6497 | 20.64% | 1.8 |
| 2030/31 | 21042 | 16596 | 8509 | 9560 | 34664 | 3116 | 4509 | 15151 | 4230 | 27006 | 12748 | 1874 | 5.41% | 1.0 |
| 2031/32 | 21673 | 17805 | 10037 | 10255 | 38097 | 3209 | 4825 | 16212 | 4157 | 28403 | 13033 | 260 | 0.68% | 0.9 |

Environmental Safeguards

50. An Initial Environmental Examination (IEE) has been prepared as part of the PPTA to address environmental impacts resulting from the Project. It is based on our review, identification of gaps, and updating of the Environmental Impact Assessment (EIA) carried out by the FS (Vol. VIII - Preliminary Environmental Assessment). The gaps identified in the EIA were addressed through field visits (including field visits to the relocated WTP site and all related pipeline route changes, collection of primary and secondary data to characterize the environment and identify potential impacts; and substantiated through consultations with stakeholders. The impacts during pre-construction, construction, and operation stages were identified for which mitigation/monitoring measures are identified and detailed in the IEE. Based on the IEE findings, an EMP outlining the specific environmental measures to be adhered to during implementation of the Project has been prepared.

51. The IEE has been prepared as a uniform document satisfying ADB and the government requirements. While any additional studies to conform to the government clearance requirements are not envisaged, data updating if required, will be carried out prior to seeking DoE approval.

52. There are no notified protected areas or environmentally sensitive areas or features in the project area that will be impacted adversely due to the proposed interventions. However, the magnitude of construction related impacts will be significant given the scale of the project components. The location related impacts are addressed through incorporation of environmental protection measures and specific design approaches to minimize impacts. IEE confirms that the significance of the environmental impacts will be more due to the construction related impacts. The resultant potential impacts during construction can be offset through provision of proven mitigation measures during the design and adoption of good engineering practices during construction and implementation. In addition to the construction impacts typically associated with construction of water intake and transmission lines, the key impacts identified in the IEE for which mitigation measures have been proposed include: (i) impacts on fisheries at the Meghna intake, (ii) impacts on the river crossings of Sitalkhya, Balu, and lesser streams and canals notified as ecologically critical areas, (iii) impacts on agricultural lands and low lying areas along the transmission mains, (iv) loss of trees/vegetation along the transmission mains; (iv) spoil/debris disposal due to laying of the transmission mains, and, (v) sludge disposal at the treatment plants.

53. The effective implementation of the measures proposed will be ensured through the building up of capacity towards environmental management within the PMU supplemented with the technical expertise of an Environmental Safeguards Specialist as part of the design-build contractor. Further, the environmental monitoring plans provide adequate opportunities towards course correction to address any residual impacts during construction or operation stages.

Social Safeguards

54. The preparation of the Social Impact Assessment and Resettlement Plan was delayed due to several reasons, including a large number of public disturbances and the difficulties to obtain useful survey and land title information. Consequently, these documents will be submitted under separate cover.

Gender & Poverty

55. As in some other developing countries, the women and girls of Bangladesh have less access to health, education, ownership of assets, infrastructure (market, toilet facilities, tube well, tap water, water reservoir), and other major services. Women are the primary collectors, transporters, and users of domestically consumed water. They spend a significant amount of time in collecting water for drinking, cooking, and washing. They also manage household hygiene. However, women's participation and their views are rarely reflected in institutional arrangements for the development and management of water supply and sanitation and other water resources. Focusing on gender mainstreaming, the "Khilkhet Water Treatment Plant Project" is expected to improve water supply for the people of Uttara, North Badda, Gulshan, and Mirpur areas in Dhaka.

56. In parallel with the improved water supply, DWASA has also planned improved sewage collection, treatment, and disposal, which, together with more abundant water, is expected to improve the health of affected residents. At the same time, a considerable number of households will be affected by the construction of this water supply project as well as the construction of the improvements to the sewerage system, albeit, temporarily. The project has two components for intervention: (i) surface water supply augmentation and (ii) institutional capacity development. The average citizens in Dhaka are the primary beneficiaries of the project. The poor and the socially excluded can also benefit from improved service level of the water supply services and new connection to the piped network. Therefore, the poorer sections of the community will also benefit from the project, including female-headed households.

57. The sections below provide a summary of intended measures to offset against these social trends as described above within the design of the proposed project.

58. **Project Component: Surface water supply augmentation.** This component should result in employment for many unskilled laborers to construct roads, pipelines, and major structural works. The target will be at least 30% women laborer to be recruited for construction of roads and earth work. In this regard, destitute women should be prioritized to get unskilled employment. Both men and women should get equal wages and female workers will be provided with separate toilet and water access facilities. These specifications will be written into the bidding documents and reviewed during assessments. Contractors will be expected to set aside adequate budget to ensure these contract specifications are respected. All job advertisements for civil works and for utility agency should include the proactive sentence "applications by women encouraged". 30% women representation will be in community consultation and 50% LIC women participation in design and implementation of water points as well as in awareness program. 50-60% women will be CBO members and 90-100% women are the members of water management committees in the position of leadership in LIC.

59. **Project Component: Institutional capacity development.** To support the implementing agencies to enhance competence levels; i.e., the skills and ability to cope with the required practices and technology that will allow the sectoral achievement of the

government's goal, which is improved access to more reliable and sustainable water supply for all the people in Dhaka City.

60. The PMU should include a gender focal person. At least 20% of staff should be women and special training session on gender awareness will be integrated in all training schedule where gender issues will also be addressed. This process will sensitize male and female staff to promote gender development plans and their implementation.

Project Finance and Economics

61. **Project Finance.** The major components of the project include investments in intake, water treatment plant, transmission lines, infrastructure and others. In provision of the consultant's ToR to assess PPP options and opportunities and from various discussions with ADB, it was agreed that the intake and water treatment plant will be considered for private financing depending on viability and interests from private sector. A PPP model with private equity participation and a combined project model were built to assess financial viability of the proposed PPP and the project. The financial viability of the PPP and the project depend on the following factors.

62. **Starting Price and Price Escalation:** Based on a number of assumptions, the private sector would require a price of BDT 14.9/m³ of bulk water sold to DWASA from Gandhabpur. This yields an Equity IRR of 25.01%. At a more realistic price of BDT 8/m³ the minimum DSCR is well below 1 and the Equity IRR is 10.02%. The model assumes an annual price increase of 10%, which currently exceeds DWASA's mandate.

63. **Capital Grant:** Availability of viability gap funding (VGF) was analyzed and that observed that VGF can significantly alter the treated water price required by the private sector. The price of BDT 14.9/m³ assumes a 20% capital grant to the private sector. Without this grant, the required treated water price would be BDT 17/m³ and the minimum DSCR would fall below 1. These prices for treated water is well below the end user price charged by DWASA which currently stands at BDT 7.44/m³ with a practice of annual increases of 5%.

64. It was concluded that unless DWASA is able to substantially increase water tariff private investments in Ghandarbpur is not viable. It is understood that under the current political regime substantial increases in water tariff is not possible, although some increases are being explored by DWASA for the future. Under the circumstances consultants assessments has come with the suggestions that Ghandarbpur will operate under a DBO contract somewhat similar to the Saidabad II WTP. Further financial analysis based on a project model with DBO scheme provide a treated water ("proxy") price of BDT 5.44m³ that fully covers all operational expenses of the intake and Ghandarbpur WTP. During the year of operation of the Gandharbpur WTP when treated water will be supplied the consumer price of water from DWASA will stand at BDT 9.02/m³, if no future tariff reforms are applied.

65. **Economics.** The project will replace groundwater sources in supplying water to four zones in Uttara, Gulshan, Badda, and Mirpur. The project will establish facilities within the intake pumping station to supply raw water to Saidabad WTPs. This is critical since the existing water source from Sitalakhya River is degenerating from major pollutions and raw water from Meghna River will replace the current water supply of Saidabad WTPs. The project therefore indirectly covers larger consumer base that includes not only the above four areas but also several other zones of DAWSA operations. The principal benefits will

therefore be sustainable water supply for a growing population within the above zones and improved quality of water supply services. There are also resource cost savings associated with replacement of non-incremental water and obviating need to boil water, and decrease in household health care expenditures from better water quality and reduction in water-borne diseases.

66. The proposed project is found to be economically viable under the base case scenarios and also under various adverse changes in conditions. The economic analysis is most sensitive to delay in project benefits and reduction in benefits. In all cases the EIRR remains above the EOCC.

Willingness-to-Pay. A willingness-to-pay survey was undertaken to understand whether tariff rates could be increased as well as to assess economic viability of the project, taking into consideration low-income households.

67. A total of 1,041 randomly selected households in Gulshan, Badda, Uttara and Mirpur were surveyed during the study through a structured questionnaire. A contingent valuation methodology was utilized with a dichotomous choice elicitation question to assess willingness-to-pay.

68. Mean willingness-to-pay values were estimated using an econometric model. A probit model was developed, through which household income and level of education were derived to estimate the willingness-to-pay of each household. As expected, it was found that willingness-to-pay rises with rising household income and higher level of education.

69. The average willingness-to-pay was 377.32 BDT per month per household (which is equivalent to BDT 11.43/m³, while the current tariff is BDT 6.99/m³) with a minimum value of 139.67 BDT, a maximum value of 775.88 BDT, and a standard deviation of 99.14. The median willingness-to-pay was given by 368.89 BDT.

70. An aggregate demand curve by income groups were derived from the study. All households keep connected so long the monthly expenditure does not exceed 200 BDT, (equivalent to BDT 6.02/m³) after which point, the poorest 20% of the households start to disconnect. At a price of 328 BDT (equivalent to a tariff of 9.94/m³) per month, no poor household keep connected. At this price, 84.5% of the remaining households maintain their connection.

71. In each income decile, the willingness to pay is substantially higher than the current monthly expense. This indicates that substantial tariff increases are economically viable.

72. Some inferences could be made about volumetric price (price per m³) from the results of the survey. Demand analysis indicates that at a rate of 7.22 taka per cubic meter of water consumed, no poor households would disconnect. The average willingness-to-pay of 377.32 BDT per month translates into a tariff of BDT 11.43/m³.

Legal Framework

73. We identified the two highest ranked PPP options in the Interim Report as (i) BOT and (ii) the JV-PPP option and discussed these options with DWASA and other relevant stakeholders; namely, ADB and the PPP office. In discussions, we found that the Joint Venture option is not seen as a viable alternative, mainly because the private and public sectors are not on a level playing field and the level of mutual trust is rather low. While still

legally possible, the Joint Venture Option as a PPP was dropped and another Operations and Maintenance Contract, was considered. During subsequent discussions and analysis it was observed that neither was a viable option mainly due to the inability of DWASA (and the GOB) to undertake any major tariff reforms. The appetite for a private sector participation at this stage appears to be one similar to Saidabad II scheme where a DB(O) type arrangement is acceptable. A design build contract with more than five years operation has been assessed and based on it the PPTA team formulated the technical and financial analysis of the project. Below we summarize the major issues relevant to a PPP scheme within the Bangladesh WSS.

74. A “Government PPP Support Agreement” should be considered, where relevant ministries not party to the PPP, or other institutions, commit to the PPP and the implementation phase. This might be necessary, since the competencies of the public party to the PPP contract will almost likely not be sufficient to address required issues (permits, exemption, etc.).

75. The following issues have been identified as “legally” important for the successful design and implementation of a PPP project:

- Delegation of water abstraction rights to the PPP
- Commercial security mechanism for private sector
- Ownership of assets
- Spatial planning
- PPP Corporate Structure
- Expatriation of profits
- VAT regime

The following paragraphs summarize the recommendations for these legally important issues.

76. **Delegation of Abstraction Rights to the PPP.** The Ministry for Water Resources (MoWR) should, as competent authority for river water abstraction, be committed into the project development, PPP contract design, and governmental support structure from an early stage. Whichever option is chosen , i.e. BOT, O&M contract, the permit for river water abstraction of sufficient quantities of river water is vital. The permit should be a condition precedent or a covenant of the public side to the contract. A “Governmental side-support Agreement” should be considered if vital ministries, such as the MoWR, are not considered as co-signatories to the PPP contract.

77. **Commercial security mechanism for private sector.** The private sector investment will require financial safeguards. The most promising, because least burdensome, would be an Escrow Account in favor of the operator. This could be a simple interest bearing current account that can be accessed by the operator if and when the public side fails to pay the operator for the undisputed delivery of services as per the contract. The escrow account would, as a condition precedent, be sourced with a number of months’ (3 to 6) worth of revenues. Each time the balance drops under a certain threshold (e.g., 50% of its original balance) it needs to be replenished fully. A letter of credit could back up the public replenishment obligation. The initial sourcing of the Escrow Account is a condition precedent, or subsequent to contract effectiveness. If the escrow account is not used, the balance could be reduced over time and cease with the anticipated recovery of the investment.

78. **Ownership of assets.** Assets should be categorized into (i) those in public and private ownership, (ii) those essential and not essential for the operation of the facilities, and (iii) those that have a book value and no longer have a book value. Accordingly, regimes can be tailored into the PPP contract, where (i) essential private assets with a residual book value are transferred to the public against appropriate compensation; and (ii) non-essential private assets can be removed, or left behind, and all other assets would either be transferred free of charge, or remain with the original owner. Some kind of fair compensation should be considered, as otherwise the operator would not invest in the final period and assets might be handed over in a state only fit for the purpose at the moment of transfer.

79. **Spatial planning.** All issues pertaining to spatial planning should be completed at the time of launch of the tender. Open issues, if any, would need to be conditioned in the draft PPP contract and be reflected in a “Governmental PPP Support Agreement”.

80. **PPP Corporate Structure.** The operator will appear as a legal entity established under Bangladeshi laws and regulations. Its shareholders will be, most likely or by majority, investors from abroad. The shareholding structure of the implementing / operating vehicle should be fixed so that an element of continuity is provided over the course of the PPP project. Legitimate concerns of shareholders should be addressed at the bidding or pre-bidding stage and reflected in the bid documents. These concerns usually pertain to issues like (i) non-recourse financing and parental guarantees, (ii) internal transfer of shares, and (iii) external share transfers. A market-sounding exercise can address these issues in the bid development phase and an element of flexibility should be kept in the bid documents.

81. **Expatriation of profits.** Investors need to feel comfortable about expatriation of their funds, profits, or dividends. The applicable regime should be clearly shown and demonstrated in an Information Memorandum. The “Government PPP Support Agreement” should contain a section on this issue, where the Central Bank of Bangladesh declares that relevant “approvals” for the expatriation of funds, profits, and dividends will be issued as soon as possible and practicable.

82. **VAT regime.** The issue of VAT exemption of local goods, works, and services, if remunerated in foreign currency, needs to be clarified further with the PPP Office and the Ministry of Finance. In order to reduce the VAT burden for the investor consortium (local and international companies), waivers and approvals will be required upon application. These should be listed in the Information Memorandum and the “Government PPP Support Agreement”.

83. **DBO Scheme.** The preferred option is Design-Build-Operate. In order to select a quality DBO contractor DWASA will require technical assistance in the pre-bid and bid phases. Either as one comprehensive TA project, or two smaller projects, with one addressing the development of the bid documents and DBO contracts and the other providing support during the bid, contract negotiations, and project start up.

84. The following activities would require assistance during the pre-bid phase:

- procurement plan
- expression of Interest
- prequalification criteria
- request for proposal
- draft DBO contract

- draft off-take agreement

85. The following activities would require assistance during the bid phase:

- prequalification evaluation
- shortlisting
- questions and answers
- bidders meetings
- bid evaluations
- DBO contract negotiation assistance
- project start-up assistance

I. INTRODUCTION & BACKGROUND

1. This consultancy was to review the previous Feasibility Study (FS) for a WTP to be built at Khilkhet and this report was written and issued on that basis on 13 March 2013. However, two days before issuing the Draft Final Report, the PPTA team was advised by ADB that the location of the WTP should be changed from Khilkhet to Gandharbpur, some 10km nearer the intake, and also some 20 km of the raw water and treated water transmission pipeline routes had to change. The PPTA consultancy was extended to carry out a new feasibility study and detailed surveys for these new proposals. This report still contains the original review of the FS for a WTP at Khilkhet, but is now extended and revised to cover the new proposed system with the WTP re-located to Gandharbpur with its associated new raw water supply and treated water delivery pipe routes. The name of the PPTA project remains 'Khilkhet' and the review sections still refer to the reviewed Khilkhet WTP where the comments are nonspecific to the new location, e.g. when referring to recommended sizes or treatment process, but the name Gandharbpur is used wherever we refer specifically to the new WTP location. The future project will be named "Dhaka Environmentally Sustainable Water Supply Project".

2. Dhaka is surrounded by water and often inundated by monsoon downpours. And yet, it suffers from a potable water shortage. The primary reason is that population growth has overtaken its water supply, and particularly, its groundwater sources that are derived from the world's largest well field⁵. The fact that the water supply system is burdened by over 40% non-revenue water⁶ (NRW) exacerbates the situation.

3. In response, the government, through Dhaka Water Supply and Sewerage Authority (DWASA) acting as the executing agency (EA), assisted by the Asian Development Bank (ADB) and other development banks and bilateral agencies, has embarked on an ambitious and sorely needed expansion and refurbishment of Dhaka's water and sewerage systems. The water sector is addressed by the Dhaka Water Supply Sector Development Project (DWSSDP), funded by ADB⁷. It aims to increase surface raw water sources and thereby decrease reliance on groundwater abstraction, which, at current rates, mines the aquifers at the rate of 2 to 3 meters per year. It further aims to strengthen the distribution system, thereby adding to the service areas and significantly reducing the NRW. Under a Sewerage Master Plan⁸, DWASA intends to deal with the additional volume of sewage generated by refurbishing and renewing existing sewers and treatment plants, adding to the collection network, and installing new pump stations and treatment plants.

⁵ Pers. comm., 2012: Director, Water Resources Planning Division, Institute of Water Modelling, (IWM), Dhaka

⁶ NRW is estimated to be over 40% and DWASA expects to be able to reduce that to about 20% through the replication of a successful pilot project that promises achievement of this ambitious reduction.

⁷ ADB. 2007. *Report and Recommendation of the President to the Board of Directors: Proposed Loans and Technical Assistance Grant to the People's Republic of Bangladesh for the Dhaka Water Supply Sector Development Program*. Manila. The scope of the program included preparation of a feasibility study of the project.

⁸ Dhaka Water Supply and Sewerage Authority, 2012, , *Master Plan Report (Updating/Preparation of Sewerage Master Plan of Dhaka City and Preparation of Detail Design & Bidding Documents for Priority Works for Existing Sewerage System of Dhaka City)*, Grontmij A/S, March 2012

4. One of the components of DWASA's plan to augment the overall water supply and to reduce the amount of groundwater abstraction is the 500 million liters per day⁹ (MLD) Khilkhet Water Treatment Plant Project. DWASA published a comprehensive feasibility study¹⁰ (FS) in 2011, the review of which and endorsement or identification and filling of gaps are the central objectives of this Project Preparatory Technical Assistance (PPTA)¹¹.

5. The largest component of the Gandharbpur Water Treatment Plant Project (Phase 1) is the supply and construction of about 85 km large diameter raw and treated water transmission pipe lines¹² connecting, as shown schematically in Figure 4, a 2000 MLD raw water intake and pump station on the Meghna River with the WTP, as well as treated water transmission lines connecting with the distribution system inside Dhaka, mostly benefitting Uttara, Gulshan/Banani, North Badda, and Mirpur districts. The project also includes provision of pumping equipment and pipelines to supply Saidabad WTPs.

6. We also reviewed DWASA's plan to collect, treat, and dispose of the resulting sewage and the sludge produced by the additional amount of water directed into the Dhaka water distribution system, approximately 75% of which will be converted to domestic sewage¹³. The PPTA team considered which of nine Phase 1 and nineteen Phase 2 priority investments outlined in DWASA's sewerage master plan¹⁴ could be prepared to tender stage¹⁵. After much consideration and discussions with DWASA, it was concluded that none of the priority projects would be included under the ensuing project. The revised Gandharbpur system with its new WTP location and revised pipe routes are in Figure 2 and the originally envisaged Khilkhet Water Treatment Plant Project is shown in Figure 3.

7. **Objectives & Outcome.** The objective of the PPTA assignment is to obtain the agreement of the government, the executing agency (EA) that is the Dhaka Water and Sewerage Authority (DWASA), and ADB to the Khilkhet Water Treatment Plant Project (Project) design and feasibility study (FS) within 30 weeks from start¹⁶ of the assignment.

8. The outcome is this Final Report (FR), which is a composite of endorsements of the FS prepared for DWASA and clear identification of gaps therein with proposals and recommendations on how to fill those gaps.

⁹ This is Phase 1, with an expansion of 500 MLD Phase 2 planned to go into production in 2020. The intake is proposed to be designed for 2000 MLD; i.e., the future supply for Gandharbpur 1 and 2 as well as Saidabad 1, 2, and 3.

¹⁰ DWASA, 2011, *Feasibility Study for Augmentation of Water Supply to Dhaka*, Design and Management Consultancy Services, Dhaka, August 2011

¹¹ The PPTA was approved by ADB on 21 February 2012 with an amount of \$900,000, financed on a grant basis by ADB's Technical Assistance Special Fund. The TA became effective on 24 July 2012, which was procedurally delayed due to a late approval of the Technical Project Proforma (TPP) by the government. DWASA is the executing agency of the TA.

¹² About 51 km of 2200 mm dia (including Saidabad), 13 km 2000 mm dia. (Treated Water main from WTP), and distribution reinforcement pipes within Dhaka, comprising: 0.9 km 1800 mm dia, 13.3 km 1400 mm dia., and 6.4 km 1000 mm dia.

¹³ The incremental volume of waste water is estimated at 70% of the Gandharbpur WTP due to groundwater replacement of which approximately 75% will end up as sewage; i.e., 262.5 MLD. The extension of Pagla STP from 100 to 200 MLD and the construction of the new 500 MLD Dasherbandi STP will amply treat this increased waste water volume.

¹⁴ Dhaka Sewerage Master Plan Project Package DS-1A, funded by DWASA

¹⁵ Tendering implies pre-design unless the design-build option is preferred, in which case, performance specifications are required.

¹⁶ The start of the assignment has been taken as 19 September 2012 with the arrival of the team leader in Dhaka. That determines the end of the 30-week PPTA as 16 April 2013, the submission of the Final Report incorporating comments from ADB and DWASA.

9. The TOR (Appendix 1) specify tasks and set out the expected output that is echoed in the Concept Paper¹⁷; namely, a more reliable and sustainable potable water supply in Dhaka. Our efforts have been in that direction.

10. The TOR require that “The outcome of the project preparatory technical assistance (PPTA) for Preparing the Khilkhet Water Treatment Plant Project will be project design and feasibility study that the government and ADB have agreed upon.” We have assessed a comprehensive Feasibility Study (FS) that asserts, and documents, technical feasibility and financial feasibility and in very general terms, we agree with both assertions. Evidently, the government (DWASA) also agrees, as witnessed by its activities, specifically those related to acquisition of necessary properties.

11. We have undertaken a due diligence exercise for the Asian Development Bank to support its intention to partially fund the Khilkhet Water Treatment Plant Project. To that end, we have reviewed the Feasibility Study by DMC for DWASA and discussed various aspects with pertinent agencies including, foremost, DWASA as well as Bangladesh Inland Waterways Transport Authority (BIWTA), Bangladesh Water Development Board (BWDB), DoE, Department of Fisheries (DoF), Department of Forests, MoA, MoWR, PPP Office, RAJUK, RHD, IWM, Standard Chartered Bank, and WHO. Since the FS is extensive, our approach is to list all sections in order of appearance in the FS and either endorse them or offer proposed or recommended changes. Interested parties need therefore read this report with reference to the FS.

¹⁷ ADB. February 2012. *Concept Paper for People’s Republic of Bangladesh: Khilkhet Water Treatment Plant Project (formerly Khilkhet Water Supply Project)*.

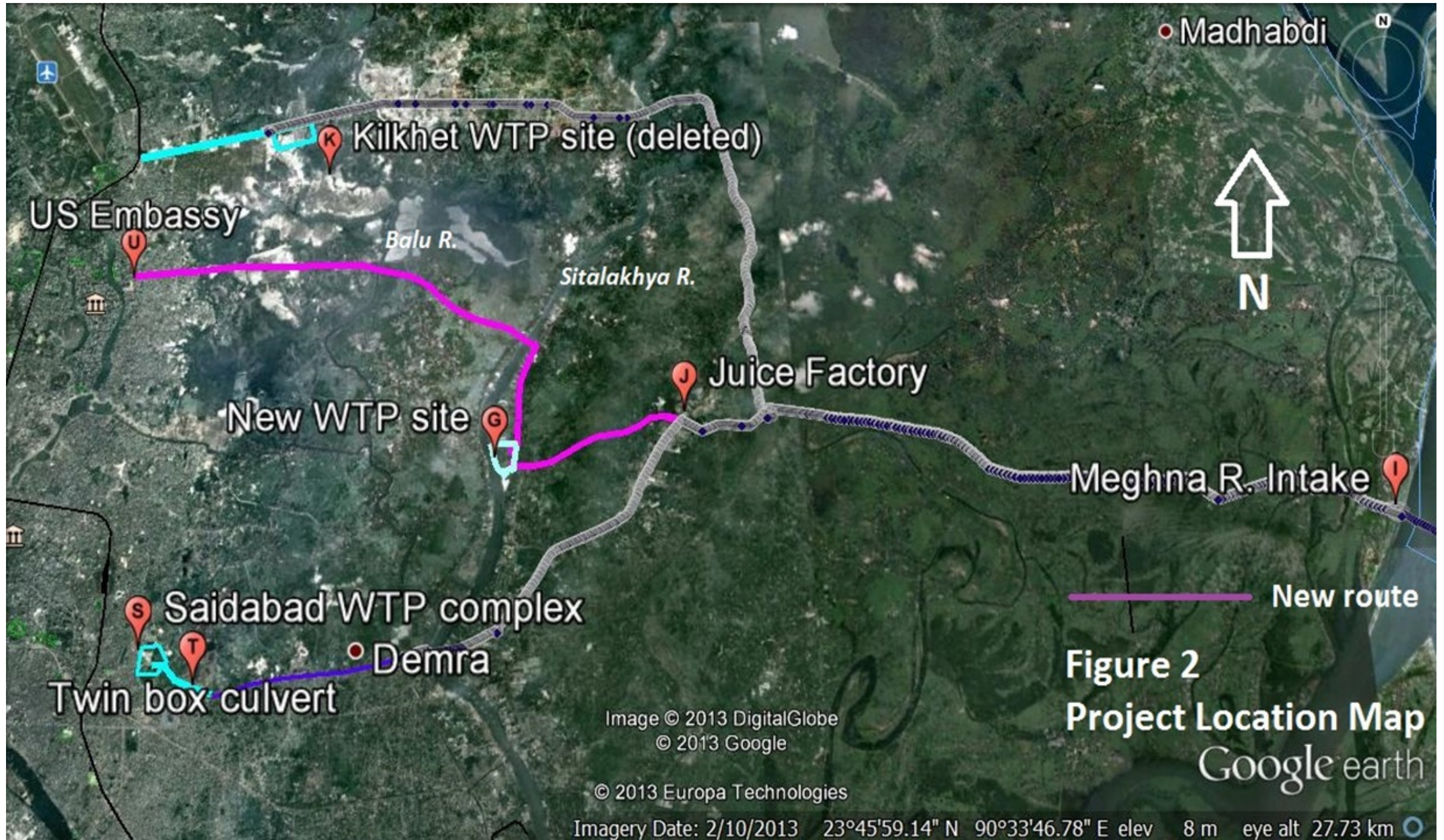


Figure 2: Project Layout Plan



Figure 3: STP Map

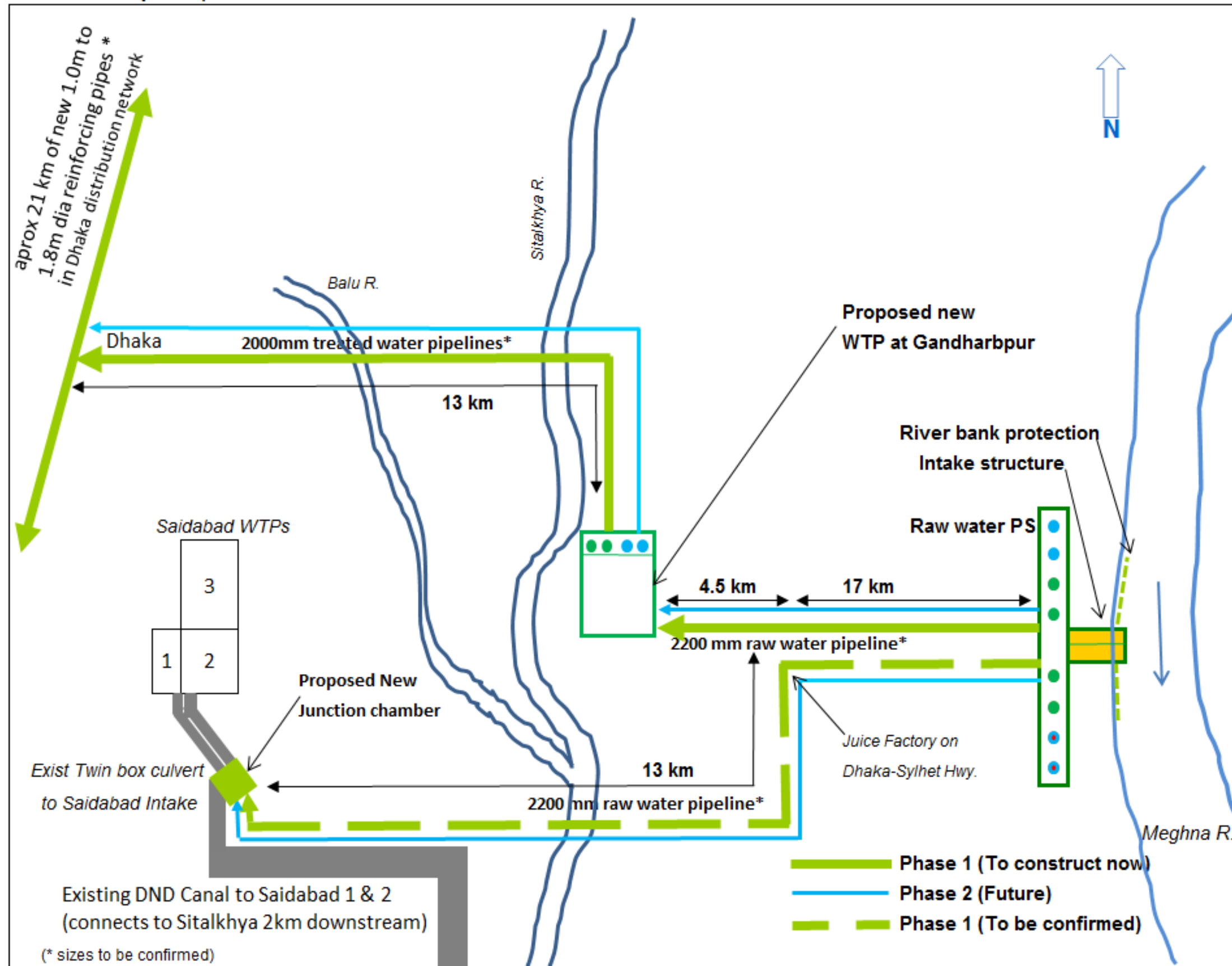


Figure 4: Schematic

12. We are referring to the *Feasibility Study for Augmentation of Water Supply to Dhaka*, Final Report, August 2011, by Design & Management Consultancy Services¹⁸ for Dhaka Water Supply Sector Development Project (DWSSDP), ADB Loan No 2382-BAN (SF). The FS consists of the following volumes:

Volume I Feasibility Study Report

- Vol I-1 Main Feasibility Report
- Vol I-2 Technical Report
- Vol I-3 Drawings (separate volume), and its appendices:
 - Appendix 1: Water Demand Calculations
 - Appendix 2: Hydraulic calculations and cost of pipeline construction
 - Appendix 3: Comparison of pipe material.
 - Appendix 4: Net Present Calculations of Investments
 - Appendix 5: Comments and Clarifications to Final Draft

Volume II. Morphological Assessment of Intake Sites

Volume III. Geotechnical Report

Volume IV Hydrogeological and hydrological Considerations

- Vol IV-1. Determination of minimum and maximum flow in Sitalkhya and Meghna rivers
- Vol IV-2. Dhaka Area Hydrogeological Assessment

Volume V Water Treatment

- Vol V-I Water Treatment Design Report
- Vol V-II Water Treatment Functional Analysis

Volume VI Dhaka Transmission system

Volume VII Topographic Survey

Volume VIII Preliminary Environmental Assessment.

Volume IX (SIA) was mentioned in the FS and we unofficially obtained a copy as DWASA did not approve it.

13. We have compared Volume I - 1 Main Feasibility Report and Volume I - 2 Technical Report and provided a summary opinion on the remaining volumes. Volume II. Morphological Assessment of Intake Sites has been reviewed by a bona fide expert. The results of that review will be included in the Final Report. Volume VIII Preliminary Environmental Assessment will be replaced by an IEE under separate cover. Similarly, a comprehensive SIA, together with an RP, will be submitted under separate cover.

¹⁸The Design and Management Consultants comprised Grontmij-Carl Bro (GMCB) in Joint Venture with AQUA Consultant and Associates (AQUA), Bangladesh Engineering & Technology Services (BETS), and the Institute of Water Modelling (IWM).

II FEASIBILITY STUDY REVIEW

A Volume I – 1: MAIN FEASIBILITY REPORT

14. This section reviews the FS for a WTP at Khilkhet, but is now extended and revised to cover the new proposed system with the WTP re-located to Gandharbpur with its associated new raw water supply and treated water delivery pipe routes. The name of the project remains 'Khilkhet' and the text still refers to the reviewed Khilkhet WTP Project, where the comments are non-specific to the new location, e.g. when referring to recommended size or treatment process, but the name Gandharbpur is used wherever we refer specifically to the new WTP location.

1. INTRODUCTION AND BACKGROUND

15. The introduction refers to the water supply to be augmented by 2013 through a new 500 MLD WTP to be located in Khilkhet. The FS was completed in August 2011 and it should have been recognized that the 2013 date was impossible to achieve. We have based our analysis on a 3-year construction period starting in 2015, which would put the Gandharbpur WTP on line by 2018.

1.1 Introduction

16. The introduction makes the valid case that surface water supplies are necessary to meet the demands of Dhaka's rapidly growing population since the vast aquifer underlying the city is mined at an average rate of over 2 m/year and that the poor state of the current distribution system exacerbates that situation¹⁹.

1.2 Terms of Reference

17. The TOR for the FS required that only preliminary social and environmental safeguard documents (SIA and EIA) be prepared and excludes institutional development, an economic analysis, gender action plan (GAP), and did not require the assessment of PPP feasibility. To satisfy the TOR for this PPTA, we have provided in addition to a detail review of the FS Study (i) an IEE to satisfy ADB environmental category B²⁰, (ii) a resettlement plan (RP), (iii) a GAP, (iv) a section on institutional development including a financial management assessment (FMA) of DWASA and a 20-year financial forecast, (v) development of a project finance model and analysis for private equity investment and alternative scenarios, and (v) an economic analysis including a willingness-to-pay survey, as well as (vi) a thorough review of the legal framework that pertains to PPP.

1.3 Methodology of Study

18. The study follows a rational methodology.

¹⁹The "Dhaka Water Supply Sector Development Project" (DWSSDP) which is currently under implementation, aims to reduce the present 40% NRW to around 20% by rehabilitating or replacing much of the distribution network in Dhaka as well as installing some 88 district meters and new household connection meters. The project is funded by the government and the Asian Development Bank.

²⁰An EIA to satisfy the DOE environmental category Red will be prepared by the design-build contractor. The EIA is expected to closely follow the content of the IEE. This arrangement has the agreement of the DOE and ADB.

1.4 Output of the study

The output is listed in paragraph 7.

1.5 Structure of this report (FS)

The six steps listed are well chosen; however, we have reservations about some of the content²¹, which we elaborate under the individual sections.

2. PROJECT AREA

19. This section provides a general introduction to Dhaka and Bangladesh with respect to geographic and demographic characteristics, topography, and socio-economic conditions.

2.1 Geographic and demographic characteristics

No comment.

2.2 Topography

No comment.

2.3 Socio-economic conditions

No comment.

3. DHAKA WATER SUPPLY SITUATION

3.1 Existing water supply situation

20. The existing water supply situation is generally described. However, we believe that the deep aquifer as a source is underestimated due to a misunderstanding of its capacity.

3.2 History of DWASA

21. Section 3.2 provides a very brief history of DWASA.

3.3 Related water projects in Dhaka

22. Section 3.3 lists related water projects in Dhaka.

(i) **Dhaka Water Supply Project.** The purpose of the project is to improve the water supply situation in Dhaka by improving the network and introducing District Metering Areas (DMA) which are hydraulically self-contained and maintain water pressure 24 hours per day. The project is ongoing with a scheduled finalization by 2013. The project is being funded by ADB and the government. The current estimated completion is mid-2014. It is expected that an extension of 2 years will be sought in order to complete the task.²²

(ii) **Pagla/Keraniganj WTP project.** A feasibility study has been completed by Institute of Water Modelling (IWM) with the purpose of assessing a 900 MLD WTP located in the south western part of Dhaka and drawing water from the river Padma. The project is in two phases with phase 1 with capacity of 500 MLD to be completed by year 2015 and Phase 2 with capacity 500 MLD to be finished by 2020. However,

²¹In order: river morphology, hydrological considerations, water quality, water treatment methodology, transmission system methodology and route alternatives, pipe material alternatives, cost estimates for options, and comparison of technical alternatives and recommendations.

²²Pers. comm., DMC

we understand the project has not started and have deferred it to 2017 in our Demand / Supply balance calculation.

(iii) **Saidabad WTP Phase 2.** Construction of the Saidabad II surface water treatment plants was started in 2010 and completed in mid-December 2012. The project doubles the capacity of Saidabad I from 225 MLD to 450 MLD. The project was financed by Danida and the government.

(iv) **Singair and Savar ground water project.** IWM has prepared hydraulic modeling for this project which covers a new well field to the west of Dhaka. The aim is to provide 300 MLD from the new well field with a possible implementation in the period from 2015 to 2020.

(v) A 150 MLD WTP Project (Tetuljhara-Bhakturta) was mentioned in PPTA Meeting Notes 9, but no further information could be obtained. This has not been included.

4. EXISTING RESOURCES

23. This section aims to describe all existing water resources available to DWASA.

4.1 Existing Groundwater Resources

24. The number of wells used in the FS is apparently a moving target. We have been advised that there are about 630 wells in operation. The extraction rate must be considered an estimate as most of the wells are reportedly not equipped with water meters. ADB (2007) is cited variously as advising that by 2015, about 50% of the wells will be inoperative. We assume that is based on the rate of the falling water table, rendering pumps inoperative, rather than DWASA's program of well retirements. In our discussion on supply vs. demand, we assume a present extraction rate from the aquifers of 1950 MLD. We have also assumed the IWM-recommended maximum of 1260 MLD from the upper aquifer and 380 MLD extraction from the lower aquifer through 94 wells for a total sustainable extraction rate of 1640 MLD. Since the lower aquifer is confined, sustainability does not apply; however, IWM has advised that the available volume may be tapped for many years, possibly decades, to come. Consequently, we have included the abstraction from the lower aquifer in our supply vs. demand analysis in Appendix 5.

25. Whereas the FS notes that one of its JV partners, Institute of Water Modelling (IWM), has estimated that a sustainable extraction from current groundwater sources is approximately 1640 MLD, the study is nevertheless based on significantly less, and in our view overly conservative, abstraction of 600 MLD. It should be noted that IWM arrived at its estimate based on scientific observations and up-to-date mathematical modeling. Consequently, we have based our supply assumption on the sustainable yield suggested by IWM, with a gradual reduction based on future measurable demands. In order to dispel any doubt about the sustainable availability of groundwater, we have recommended that IWM prepare a program of systematic retirement of deep wells since the aquifer is not depleted evenly, as the commonly referred to 2 to 3 meter subsidence implies. The TOR for that task, schedule, and estimated costs are in Appendix 5. We note that the FS also recommends "that further analysis is implemented regarding availability of groundwater."

26. The FS utilizes 600 MLD as safe extraction from upper and lower aquifer. In view of the fact that a bona fide scientific institution (IWM) is on record as pegging that number at 1640 MLD²³, we strongly believe that 600 MLD is overly conservative, the difference representing almost three Gandharbpur WTPs.

4.2 New Groundwater resources, Singair and Savar wellfield

27. We have adopted the exploitable yield from this well field of 300 MLD, as estimated by IWM, as well as the earliest dates of production in 2015 and 2020.

4.3 Existing Surface Water Sources

28. Saidabad 1 with design capacity of 225 MLD has been in operation for close to 10 years and Saidabad 2, with the same design capacity, has recently been inaugurated²⁴ and is under O&M contract for three years. Saidabad 2 is very similar in design to Saidabad 1 except for two features. To ensure treatability of the increasing ammonia load that is caused

²³A maximum abstraction rate of 1260 MLD sustainable yield from the upper 2 aquifers and 380 MLD from the lower, confined aquifer.

²⁴Saidabad 2 was inaugurated 13 December 2012, ahead of schedule and reportedly on budget.

by urban pollution, a biological ammonia reduction unit process²⁵ has been added. Secondly, the FS lauds the use of Degrémont's Pulsators^R; however, we recommend utilizing conventional settling tanks at a relatively small premium (additional concrete structure minus the cost of the inclined plates or tubes) since that would allow a simple retrofit of tubes or plates later on when additional output may be required.

29. **Chandnighat.** We have included the current output of 10 MLD from the Chandnighat WTP in our supply vs. demand analysis and assumed that it will be refurbished to deliver its design capacity of 39 MLD by 2015.

30. **Goodnail and Sonakanda.** The two WTPs supply about 19 MLD to Narayanganj, which, although in DWASA's service area, was not included in the project area. Consequently, the output is not included in our supply vs. demand analysis. Likewise, the planned 58MLD WTP for Narayanganj is not included in the project area and therefore not included in our supply vs. demand analysis.

4.4 Planned Surface water sources

31. Present and planned surface WTPs are listed in Table 7 and illustrated in Figure 3.

The Dhaka Water Supply Master Plan is under preparation by IWM (with draft findings due in July 2013) is expected to provide updated estimates of the sustainable aquifer yields, phasing of groundwater reduction and resulting impact on planned surface water sources.

5. WATER DEMAND

32. This section attempts to rationalize a design "demand" of 130 Lcd based primarily on the results of the Manikdi Pilot Study but also refers to the estimated water production from deep wells, an assumed 40% "leakage", and an assumed population base. Whereas we believe that the non-revenue water (NRW) may be 40% or more, we are quite certain that the 40% is not actually leakage; rather, it is a combination of real and administrative losses.

Table 7: Present and Planned Surface WTPs in DWASA Service Area

| WTP | Present MLD | Future MLD | Area served |
|-------------------------|-------------|-------------------------|--------------------------------|
| Chandnighat | 10 | 39 (2015) ^a | Dhaka |
| Goodnail & Sonakanda | 19 | | Narayanganj (not in project) |
| Narayanganj | | 58 (2017) | Narayanganj (not in project) |
| Saidabad 1 | 225 | | Dhaka (South-East) |
| Saidabad 2 ^b | 225 | | Dhaka (South-East) |
| Saidabad 3 | | 450 (2020) | Dhaka (South-East) |
| Gandharbpur 1 | | 500 (2018) | Uttara, Badda, Gulshan, Mirpur |
| Gandharbpur 2 | | 500 (2025) | Uttara, Badda, Gulshan, Mirpur |
| Pagla 1 | | 450 (2017) ^c | Dhaka (South-West) |
| Pagla 2 | | 450 (2025) | Dhaka (South-West) |

^a Dates shown above for bringing WTPs on line are as assumed by PPTA in the graph below, not necessarily reflecting the current DWASA plans, of FS, as these often conflict / change.

^b operational since 13 December 2012, 2 years ahead of the date in the FS

^c We do not believe that Pagla 1 can be operational in 2015, as suggested in Section 5.5 of the FS

²⁵It is interesting to note that the IFAS Meteor^R is marketed by Degrémont as a sewage treatment unit process.

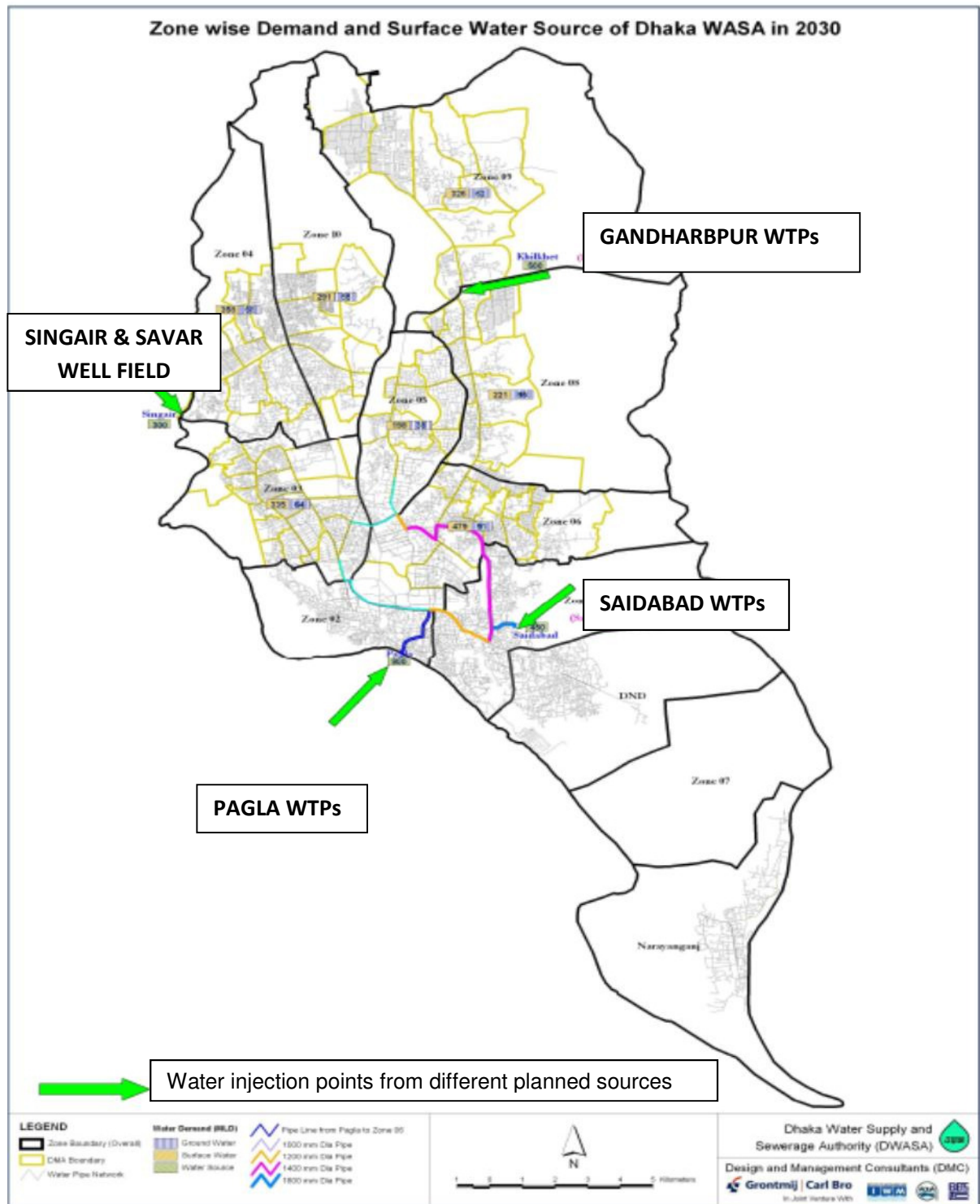


Figure 5: Planned Water Supplies

Source: DMC Feasibility Study

5.1 Introduction

33. Although the introduction promises that population projections are included in this section, none can be found except for one tentative population figure of around 10 million

based on an assumed percentage of coverage. We understand that the base population used in the FS derives from the 2001 Census while our population projections are based on the 2011 Census; i.e., 12 million.

5.2 Present water consumption and real losses

34. Since the only real data derived from the Manikdi Pilot Study showed a water consumption of 135 Lcd as a two-year average rising to 146 Lcd towards the end of the study, we have adopted 150 Lcd as a base (2012) consumption figure that is expected to level off once a rational tariff system is introduced by DWASA. By rational, we mean a progressive block system²⁶ that inherently promotes conservation where the first block is a small amount at a small rate (say 15 m³/month at BDT4/m³) to guarantee the very poor access to DWASA water supply and two (or more) blocks at progressively larger unit costs, such that the average tariff is sufficient to fund DWASA's O&M plus debt service.

5.3 Population forecast

35. As noted, we have based our population base on the 2011 Census²⁷; i.e., 12 million, and have further assumed that the service population will rise to 20 million by 2030, which represents a 3% annual compounded population increase.

5.4 Demand scenarios

36.

5.4.1 Demand Scenario Parameters

5.4.2 Best Scenario

5.4.3 Worst Scenario

5.4.4 Realistic Scenario

5.4.5 The realistic scenario with high groundwater supply

5.4.6 Realistic demand scenario with medium groundwater supply

5.5 Proposed Water Demand Scenario and Supply Scenario

We appreciate the idea of presenting three scenarios (best, worst, and realistic cases); however, we have pursued the objective of the PPTA constructing only a realistic case and testing the robustness through sensitivity analyses at the financial analysis stage. In addition, instead of presenting three separate cases with many similar assumptions, we have presented the output of a simple MS Excel model that is interactive and could serve as one of the planning tools for DWASA in its very difficult job of deciding how to satisfy its mandate to provide potable water to a large, rapidly growing population.

²⁶ The problem of multiple families living in apartment blocks equipped with only one meter needs to be resolved, as noted by ADB.

²⁷ The population of Dhaka district was 11,875,000 according to the 2011 Population & Housing Census: Preliminary Results, BBS, July 2011.

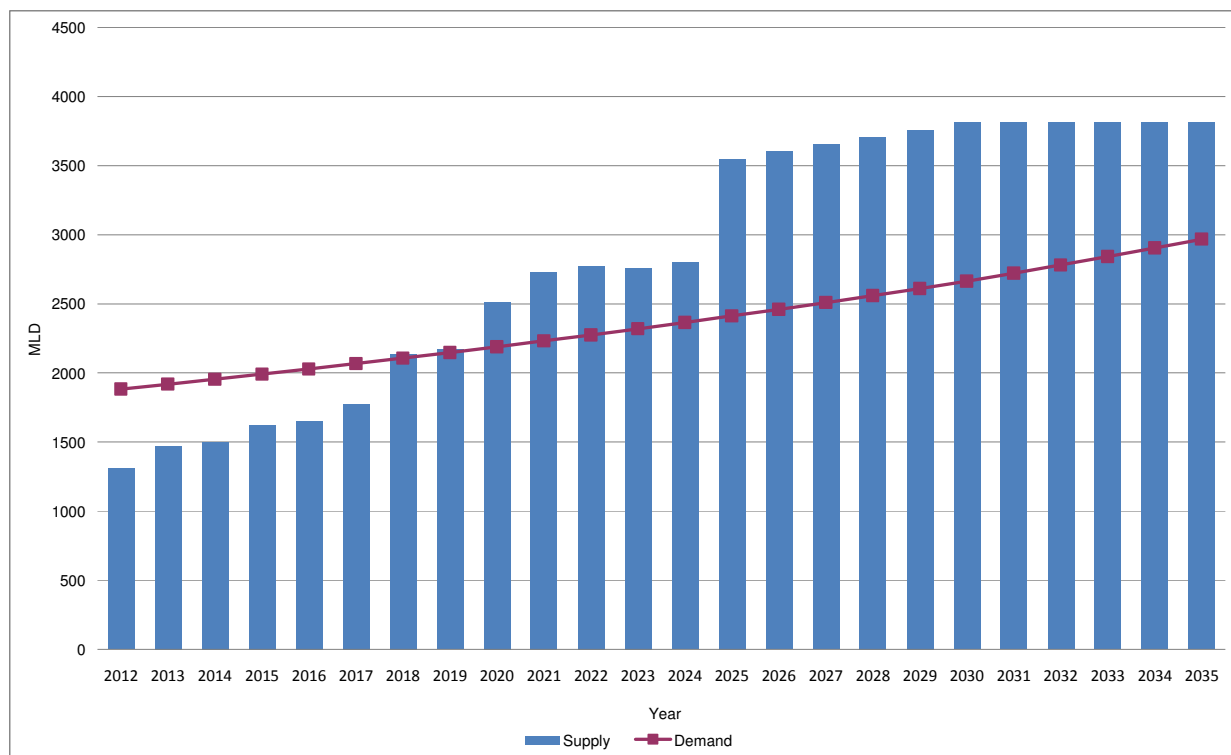


Figure 6: Water Supply vs Demand

5.6 Demand vs. supply

37. Figure 6 shows the output of a simple MS Excel model to derive a water balance of demand vs. supply. It illustrates the estimated total demand and supply of water in Dhaka for the period between 2012 and 2035. Demand is forecasted based on assumptions about population and per capita consumption as well as estimates of informal demand. Supply is forecasted as a function of existing and planned construction of water treatment plants and reduction in the abstraction of ground water with non-revenue water (NRW) deducted, e.g. “Supply” is actual water delivered to the consumers. Therefore non-revenue water is not included in the demand curve. Gandharbpur WTP is assumed to come on stream in 2018, Saidabad 3 in 2020 and Gandharbpur 2 in 2025, but these increments do not appear significant in the graph above, as they are matched by a simultaneous reduction in groundwater abstraction. The figure depicts a declining deficit until 2019 and a surplus in the following years. This result, however, depends on a number of assumptions which were validated over the course of the PPTA in close consultation with DWASA and IWM. All assumptions were discussed with DWASA and agreement was reached (Meeting Notes 16 refer).

- (i) The starting date and design capacity of operation for each planned water plant
- (ii) The starting date and safe yield of a new groundwater source
- (iii) The phasing-out dates of aquifer extractions²⁸

²⁸In our Interim Report, we observed that one of the most significant variables is the reduction of ground water as a source. The FS has assumed between 600 and 1000 MLD as a safe abstraction rate whereas IWM firmly believes that 1640 MLD is the sustainable yield from upper + lower aquifers. The difference is more than one Khilkhet WTP; i.e., a significant and costly difference. Meetings with IWM and perusal of its seminal report on ground water in Dhaka clearly show that ground water is depleted very unevenly, mostly in the central west

- (iv) The safe yields of aquifers
- (v) The linear reduction of NRW from present 45% to 20% in 2026
- (vi) A 2012 population of 12 million based on the preliminary results of the 2011 Population and Housing Census
- (vii) A population growth rate of 3.0% compounded per annum, to 2030
- (viii) A current per capita demand of 150 Lcd
- (ix) A decline of per capita demand at a rate of 0.8% per annum to 130Lcd in 2030 in response to an effective tariff structure and expected reduced wastage
- (x) Informal demand estimated at 84 MLD assuming 1300 wells, 20,000 persons @ 200 Lcd, and industrial demand assuming 400 industries at 200,000 L/d each
- (xi) A linear decline in informal demand to 5 MLD in 2030 based on DWASA's vigilant pursuit of illegal connections and industrial abstraction without adequate license fees

38. All variables are clearly identified in Appendix 5, an interactive MS Excel spreadsheet.

This is only a rapid water balance analysis which contains significant uncertainties (e.g. industrial demand and sustainable aquifer yield within the DWASA supply area), which make it unreliable for predicting the timing of future new sources.

Significant sources of potential error are:

- Only the industrial demand taken from DWASA is included, but as most is taken from private wells (quantity unknown) this will reduce the available groundwater for DWASA. If industries continue to use it, DWASA must reduce its extraction to ensure the overall sustainable aquifer yield is not exceeded by DWASA and industry combined. This reduced supply, not reflected in the graph above will require new sources to be brought on stream earlier than shown.

- Population in the actual DWASA service area must be smaller than the 12 million taken from the census, but a reliable figure was not available.

A Dhaka Water Supply Master Plan under preparation by IWM (with draft findings due in July 2013) will have a more reliable demand projection, which should be used instead of this for predicting when new sources are required.

6. OPTIONS FOR SUPPLY

6.1 Introduction

39. The section presents different options for the supply of 2000 MLD, including the 500 MLD from the Gandharbpur WTP Phase 1.

areas, although generally quoted as averaging 2 to 3 m/year. To assist DWASA with the orderly and effective reduction of ground water dependence, we believe that IWM is in the best position to serve that function. Consequently, we have recommended that IWM provides advisory services in this regard to DWASA by way of developing a plan of action for DWASA such that deep wells are taken out of service in the most critical areas of aquifer subsidence and as surface water treatment plants come on line.

6.2 Main Options for Supply of Water to Gandharbpur

40. Gandharbpur has been chosen for the revised location of the new WTP because DWASA had previously acquired the land, obviating the expense of land acquisition. Whereas we fully agree with the location of the injection into the Dhaka distribution network, serving mainly Uttara, Baddha, Gulshan, and Mirur, we expressed reservations about the location of the plant recommending it be better placed at the intake site on the Meghna River for good technical reasons, improved operational flexibility and potential cost savings of some \$43 million, Appendix 6 provides further details. Re-locating the WTP to Gandharbpur, as proposed, achieves most of those benefits, chiefly :

- 10km further from Dhaka city, so treated water can be supplied more easily to future expansion areas east of the city
- Using free land already acquired by DWASA many years ago for such a purpose on which only compensation payments must now be paid.

6.2.1 Saidabad raw water supply

41. Two separate raw water transmission lines are proposed in the FS to feed water to Khilkhet and also the Saidabad WTP via the DND canal. During a site visit we observed that the canal appears to serve as an open sewer. We therefore proposed that the canal not be utilized as a raw water source and that the 2200mm diameter pipeline be extended some 4.2 km to the twin 2.5m x 2.0m box culvert leading to Saidabad WTPs. Based on the FS unit cost rates, this would add about \$17 million to the project but it would ensure that the relatively good raw water quality from the Meghna River would be preserved. We further proposed to construct an inlet headworks chamber at the end of the pipeline to provide additional head in the existing box culvert. DWASA accepted both proposals.

42. We agree with the analysis in the FS that recommends Option 1A (except for the location of the WTP as detailed in Appendix 7) of the DFR “Alternative WTP location – Rationale”. The scheme is shown diagrammatically in Figure 4 and on satellite imagery in Figure 3.

6.3 Alternatives for Intake Locations

6.3.1 Introduction

43. We agree with all of the considerations listed in the FS and here in Table 8 for the selection of an intake

Table 8: Intake Criteria

| Intake criterion listed in Feasibility Study | PPTA team comment |
|---|---|
| (i) Raw water should be treatable by conventional methods. | (i) Raw water quality is suitable for conventional treatment |
| (ii) The distance from intake to treatment plant should be as short as possible. | (ii) The distance from the intake to the WTP is not as short as possible. |
| (iii) The risk of near future urban (domestic) or industrial development upstream of the intake point must be acceptable. | (iii) The location is quite remote. The nearest potential polluter is about 100 km upstream. Inter-ministerial cooperation will be sought to uphold |

| | |
|---|--|
| | watershed protection measures set out in DOE guidelines. The EMP contains related monitoring stipulations. |
| (iv) The river must be stable or controllable at the intake point site. | (iv) While the morphology study endorses the intake location, it is weak and unconvincing. Consequently, an expert review of the study did recommend further investigations, including a physical model study, to confirm the selection and provide guidance to the designers of the intake structure as well as the protection of the river bank in the vicinity. |
| (v) Intake points and transmission route should not involve unusual construction methods | (v) The intake will incorporate river bank protection as well as measures to exclude most fish. |
| (vi) A road should ideally be available between the intake point and the treatment site, where the transmission main can be constructed on the shoulder of the road | (vi) We have based our recommended route from the intake to the Sejan juice factory and onward to the WTP on adding a permanent road costing \$7.5m, for use during construction and later, for public transport as well as convenient maintenance access. |

6.3.2 Intake at Sitalkhya

44. We note that much unnecessary effort was devoted to the analysis of the Sitalkhya River since a cursory investigation revealed that (i) its quality is deteriorating at an alarming rate, making it at best a marginally acceptable source and certainly an expensive one²⁹ and (ii) the dry-weather flow barely exceeds the design capacity of Gandharbpur 1+2 plus Saidabad 1+2+3. This effort was also wasted in Volume II. *“Morphological Assessment of Intake Sites”*, and Volume IV - 1 *“Determination of minimum and maximum flow in Sitalkhya and Meghna rivers”*.

The FS leaves a key question unanswered: “Is it better /cheaper to upgrade the Saidabad WTP process so it can treat Sitalkhya raw water, or to build a new intake and 30km of 2.2m dia pipeline to pump better quality raw water from the distant Meghna river?”

The FS dismisses the question with the unsubstantiated claim that it may soon become impossible to treat such high levels of ammonia as may become common in R. Sitalkhya in the dry season. We have reviewed this more carefully.

DWASA operations staff at Saidabad confirmed that last dry season, the Sitalkhya had exceptionally high ammonia levels (up to 17mg/L, whereas the FS quoted 15mg/l), and these have increased each year due to uncontrolled and uncontrollable industrial effluent discharges into the Sitalkhya from paper pulp, edible oil and other factories.

²⁹The quality issue was reported but it was not demonstrated that the amortized cost of (i) providing the necessary unit processes to cope with the variety of pollutants and (ii) the increased O&M costs to treat Sitalkhya water exceeds the cost for the raw water pipelines and pumping from R Meghna,

Based on this information our water treatment process experts confirm that the current proposal, to pump from R Meghna, is probably the best long term solution for the following reasons:

- Also low oxygen 0 to 3 mg/L.
- From a safety view it is better to pump water with a better quality.
- Water with these levels of ammonia can be treated, but other issues arise.
- If the water quality is decreasing every year, the treatment plant must be oversized, which will have a huge impact on the cost.
- There is no catchment management and no way to limit pollution and ammonia levels
- From a process point of view, we recommend that it is preferable to treat a better quality raw water.
- If the quality deteriorates year after year the process solution may not be economically viable.

6.3.3 Intake at Meghna & 6.3.4 Conclusions on intake locations

45. We agree with the conclusions to locate the intake for this project on the Meghna River based on (i) abundant supply even during the dry season when the total future design flow of 2000 MLD is less than 1% of the 100-year dry weather flow of the Meghna and (ii) adequate water quality that should respond well to conventional treatment technology recommended for this project, requiring only two simple pre-treatment processes; i.e., sedimentation (to avoid settlement of particles in the transmission pipes) and chlorination (to avoid organic growth in the transmission pipes).

46. As noted in Table 3, (iv), the conclusion reached in the FS that an intake can safely be located along the river reach at Bisnondi may be correct; however, we do not believe that the morphology study presented convincing arguments. An expert review of the river morphology and its effect on the intake is expected to fill that gap.

47. Whereas the FS hydrological considerations focused on the flow variations in the Meghna, we are more concerned about the level variations. The FS quotes the 50 year flood level variation as 7m. We believe that for this project, a 100-year return period is more appropriate and have therefore recommended a conservative difference of 8m between low water level in the Meghna and high water level that will govern the design of the intake structure and the raw water pumps.

6.4 Alternatives for technical Solutions

48. Table 3 lists the six project components for which various technical solutions have been analyzed in the FS.

6.4.1 Intakes Types

49. As noted in Table 3, we agree with the recommended intake type – a twin concrete channel – that offers the advantage of serving as simple pre-sedimentation chambers.

6.5 Raw water pumping station

50. We agree with the FS to utilize vertical turbine pumps as they offer price advantages over dry-pit pumps. A disadvantage is, of course, that maintenance is more difficult and potentially, more onerous as vertical turbine pumps should be maintained by periodic withdrawal and dismantling whereas dry-pit pumps can be maintained based on external monitoring (such as sound analysis) and may therefore have to undergo major maintenance less frequently. We further agree that there will be two sets of pumps, one to supply Gandharbpur and one for Saidabad. We do not agree that the pump station should be designed such that each set could pump to both destinations as the discharge heads are not close enough. Because of the large inlet level variations that will be experienced and the large portion that the suction head variations represent of the total discharge head (TDH), we believe that the pump lineup should include several, variable speed pumps (through variable frequency drives) and possibly, all. This enables pumps to run more efficiently which will provide power cost savings many times the extra investment. Consequently, we have added 10% to the pump set costs in our cost estimate. The final line-up will be determined by the design-build contractor in his proposal for approval by DWASA and non-objection by ADB.

Table 9: Project Component Options

| Project component | 1. Technical solutions |
|--|--|
| (i) Type of intake | (i) We agree with the recommended intake type that offers the advantage of serving as a pre-sedimentation chamber. |
| (ii) Detailed routing of transmission line | (ii) We agree with the routing of the raw water transmission pipelines. (a) From the intake to Sejan juice factory, the pipelines will be constructed in a 31m wide corridor (mostly paddy fields to be acquired by DWASA) that will also contain the paved access road. (b) From Sejan juice factory to the DND canal, the pipelines will be contained within the road allowance of the road to the Tarabo/Demra Bridge. The RHD advises that the road will be widened from 2 lanes to 4 lanes no earlier than 2016; accordingly, our pipeline construction will precede road widening construction which should make RHD approval routine. (c) The FS proposed to inject the raw water from the Meghna into the DND canal. We recommended against that plan and instead, proposed to extend the pipelines some 4.2km to where the existing twin box culverts are located that currently feed Saidabad WTPs from the DND canal. DWASA accepted our proposal. |
| (iii) Transmission line Alternatives | (iii) The FS details a variety of alternatives for the transmission pipelines. We agree with the recommendation to install all pipelines underground via trenches. To save some land acquisition cost for the intake to Sejan juice factory route, we recommend the use of sheet piling. Sheet piling may also be used on the routes near existing roads. Ultimately, the design-build contractor will make the best choice. |
| (iv) Pipe material | (iv) The FS considered only GRP and DI as suitable materials for the pipelines. We believe that both PCCP and epoxy coated steel pipe, should be included in the evaluation of potential pipe materials. |
| (v) Treatment Processes | (v) We agree with the concept of conventional water treatment (pre-chlorination – pH adjustment if required - alum coagulation plus lime |

| | |
|---|--|
| | and polymer coagulation aid – flocculation – sedimentation – rapid sand filters – post-chlorination). We do not agree with several aspects proposed in the FS; i.e., (a) Full automation (b) Influent flow control based on turbidity (c) High rate sedimentation |
| (vi) Design of transmission system inside Dhaka | (vi) We agreed with the details proposed in the FS for the previous injection point, but now it has moved 3km south, the exact details of pipes required is yet to be determined through numerical modeling by IWM under contract to DWASA. |

6.6 Transmission Main Route and Methods

51. We agree with the concept of determining the pipeline route from the intake to Sejan juice factory based on minimizing resettlement. We also agree that the corridor from the intake to Sejan juice factory should be acquired so that all pipelines can be accommodated. We do not believe that the 24m width recommended in the FS is adequate and after several discussions with DWASA, our recommendation for a 31m width was accepted. One of the reasons for the additional width is that we recommended, and DWASA agreed, to construct an access road that would be permanent and as such, would become a useful link between Bisnondi and the Dhaka – Sylhet highway. Figure 7 shows the main dimensions and general design considerations of the access road / pipeline corridor.

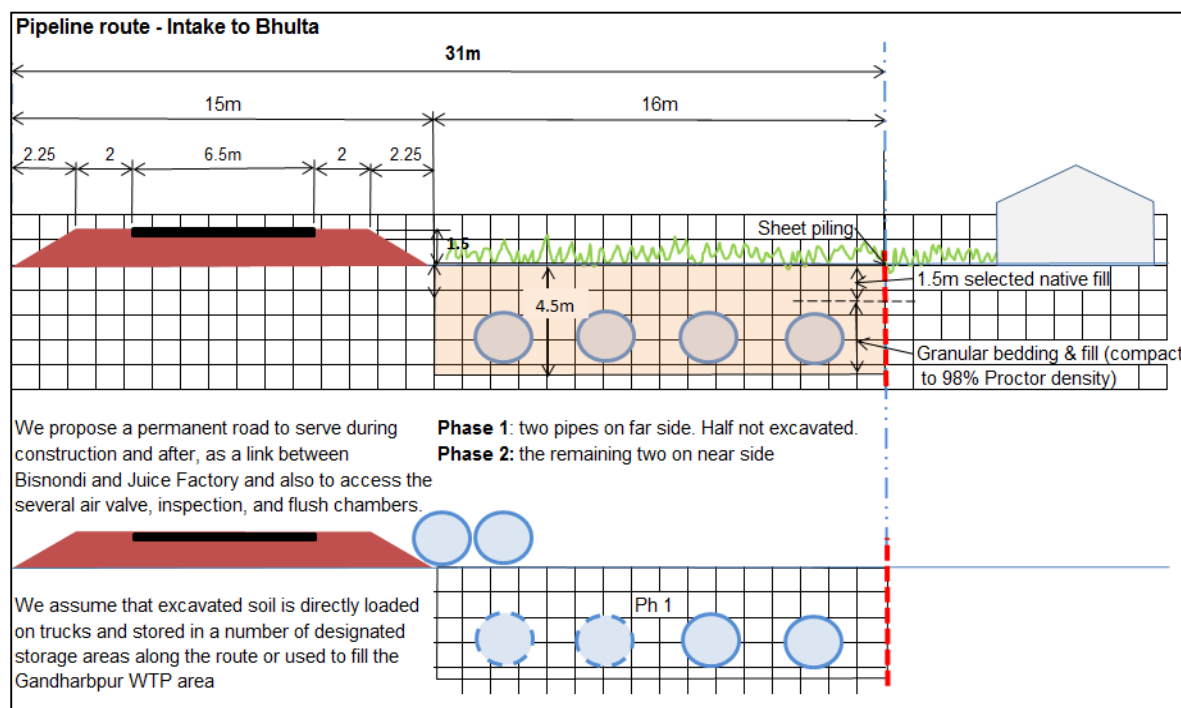


Figure 7: Typical Pipe Corridor

6.6.1 Transmission line route

52. We agree that:

- (i) there will be two separate transmission systems, one to Gandharbpur WTP but the other one not to the DND channel but a further 4.2 km to a purpose-built chamber

that then discharges the raw water to an existing twin box culvert leading to the Saidabad WTP complex;

- (ii) from Meghna to Sejan juice factory the system will consists of 4 x 2200 mm pipes in Phase 2 but only 2x2200 mm pipes are constructed in this Phase 1 project;
- (iii) from Sejan juice factory, the system will split with 2 x 2200 mm pipes going to Gandharbpur WTP in Phase 2 (1 x 2200 mm pipe in this Phase 1 project) and 2 x 2200 mm pipes going to Saidabad in Phase 2 (1 x 2200 mm pipe in this Phase 1 project);
- (iv) these pipes will supply the full amount of water in year 2030; i.e., 1050 MLD to Gandharbpur Phase 1 and 2 and 950 MLD to Saidabad Phases 1, 2, and 3;
- (v) from Meghna River to Sejan juice factory, the transmission lines will cross mostly open land (paddy fields), while the pipes will be installed alongside the main roads from Sejan juice factory to Gandharbpur and from Sejan juice factory to the Saidabad intake chamber;
- (vi) there are several river crossings along the route, most importantly, the crossings of Sitalkhya and Balu rivers.
- (vii) crossings of the Sitalkhya and Balu rivers pose special challenges. We do not agree these can equally well be achieved by either bridge crossings or by trenched method.
- (viii) Gandharbpur WTP to American Embassy:

53. Most of this route is rural. Going north from the WTP the 2000 dia pipes will lie in a Bangladesh Water Development Board reserve along the road to the river crossing, then they follow the alignment of a proposed RAJUK road. We have proposed the stronger DI or RCCP pipe here, rather than steel, because its inherent strength can resist crushing loads from vehicles, GRP is also possible, if strengthened with thicker walls, though this will make it less economical. Even though the pipe should lie in a reservation to one side of the road, and therefore be protected, it is likely the pipe will be laid before construction of the road and will therefore be at risk of damage from heavy road construction vehicles. The cheaper GRP pipe option is not suitable in this situation, unless the pipe walls are specially strengthened, but if the road (for which construction has started at both ends) is completed before pipe laying, this pipe may be changed to GRP with anticipated cost savings. The last 2km to the American Embassy injection point will be laid quite easily, but not cheaply under a wide, straight dual carriageway, currently under construction.

(ix) Juice Factory to DND Canal, South side:

This route section is characterized by a busy 2 lane asphalt road with many commercial properties alongside, some of which are built partly over the pipe corridor and will require partial demolition. The commercial nature of the area and the many industrial entrances which cross the pipe route mean extensive vehicle loading is inevitable and therefore GRP is risky and DI is recommended.

A wide, stagnant drain runs along much of the route on the S side of the road. It is typically only 8m from the edge of asphalt and 20m wide, extending right up to industry /property boundaries, so the pipes will inevitably have to be laid under water in the drain. The drain is stagnant with little or no flow, evidenced by many access roads which cross it and virtually

dam it. This means the 20m width of could be partly infilled for pipe laying without detrimental impact on hydraulic capacity. Some drain capacity may be needed for temporary balancing storage for road storm water runoff and this must be checked at detail design.

We recommend the pipes be laid at the far side of the drain channel, close to the property boundaries, to leave space for road widening. Pipelaying will be facilitated if a small portion of the drain can be filled to create an access track above water level, for pipe laying plant close to the property boundaries. The pipes can be laid under or beside this track and it should remain in place for access to do emergency pipe repairs.

Near the Sitalkhya river crossing, the drain is replaced by commercial buildings, some of which are multi-storey concrete and built within the road reserve, only 10m from edge of asphalt. We recommend designing the pipe to cross the road in these locations to avoid demolition of these obstructions if /where the route is free on the other side of the road.

DND Canal to Saidabad box culvert along Demra road

DWASA requested (verbally on 11/5/13 site visit) that the Saidabad raw water pipelines should be constructed on the North side of the Demra Road and not in the DND canal reservation on S side, as previously proposed.

Demra road south side - Advantages:

Less compensation because no demolition of illegal business or industry access roads, but the whole road is likely to be blocked to traffic for considerable periods during construction.

- Disadvantages:

The steep canal bank is so close to the edge of busy road, the 2 pipes (2.2m dia) must be laid either under the canal bed or above grade. The first option is not recommended because underwater excavation and earth filling to create a working platform in the canal will pollute Saidabad raw water (turbidity and likely worse), causing the treatment process to fail or, at best, to jeopardize the treatment process, increase treatment costs and cut the production rate. It is only possible to put the pipe here if it is elevated above ground on concrete piers on the canal bank.

Elevated pipes will be susceptible to vandalism and risk accident from traffic impact.

Elevated pipe will have to be steel, not GRP (corrosion risk).

Road will be fully blocked during construction (may require night only working, so slower).

Demra road north side –

Advantages:

- Wide working corridor means simpler, quicker pipe laying (buried in trench beside existing road – same as elsewhere).
- Busy road can remain open for traffic during construction.
- Minimal risk of polluting Saidabad intake source during construction.
- Buried pipe is safer from vandalism.

Disadvantages:

- Delay for extra social, environmental and topo surveys.
- More disruption / compensation during construction for industries + businesses on N side of road.

We agree with DWASA this change to the north side is the better option.

Route characteristics and pipe laying techniques are similar to the previous section from the Juice Factory to DND Canal.

6.6.2 Transmission line Alternatives

54. Not used.

55. The purpose of the analysis, as stated in the FS, was to find the optimum combination of cost and technical considerations. The FS failed in this attempt as the only component that was selected on a least-cost basis is the pipeline diameter, which was based on an economic pipe diameter analysis, with a minimum velocity restriction of 1.6m/s to limit solids deposition. We agree with the method and velocity restriction. We also agree with the pipeline routing, with these exceptions

i) Our recommendation that the DND canal not be utilized as a raw water source and that the 2200mm diameter pipeline be extended some 4.2 km to the twin 2.5m x 2.0m box culvert leading to Saidabad WTPs was accepted by DWASA.

ii) A late³⁰ request by DWASA to investigate the feasibility to utilize an approximately 4 km long, 30 ft (~9m) strip of land acquired by DWASA many years ago for the purpose of supplying a WTP near Demra was withdrawn by DWASA since the DPP process for land acquisition had advanced to a stage where changes such as this would result in unacceptable delays to the project.

iii) Pipe bridge vs. under river

There are many rivers to cross, ranging from a few meters wide to the Sitalkhya over 300m wide and the Balu River which both carry large ships. The FS considered 4 pipe crossing methods:

1. Pipe bridge at USD 6,000 /m
2. Pipe in shallow trench in river bed at USD 8,000 /m
3. Tunnel deep under river
4. Directional drilling up to 700 dia.

The FS was right to disregard the last 2 on account of high cost (3) and impracticality (too many small pipes required for option 4).

The FS supports both options 1 and 2, suggesting similar costs, but we believe the cost estimate for 2 is greatly underestimated. Also, in the absence of proven successful examples of other trenched pipe crossings in similar rivers, we strongly recommend avoiding this crossing method. It is very risky.

River depths, flow velocities and effects of seasonal floods on underwater scour depth and erosion are unknown. Scour depths are well known to be deep, unpredictable and destructive in some Bangladesh rivers. It is not feasible to bury the pipe in the river bed with more than 1 or 2 meters cover, which puts the pipe at risk of:

- losing its protective cover and support bedding due to scour,
- being holed or dragged by ship anchor,
- being swept away by erosion /flood.

We recommend bridge option (1) because it is the inherently safe, while trench alternative (2) is inherently risky and unproven. Such bridges are the most common pipe/river crossing method used in most other countries. Furthermore this is the only river crossing option that will allow quick and easy repairs.

However, DWASA consider that it will be impossible to get a permit (from navigation department) to construct bridges, and state a preference for micro tunnelling or thrust boring under the river bed from deep vertical shafts either side of the rivers. PPTA have estimated the cost for long thrust-bores with 2.4m dia. outer steel sleeve, some \$2,500 /m more

³⁰19 February 2013 Meeting Notes refer

expensive than steel box girder bridges. These rates need to be verified, but indicate the additional cost of thrust boring vs. bridges may be \$2.5m for an anticipated total of 1,000m of river crossings.

Although the bridge is cheaper to build than trench and thrustbore, it will be 20m above water level and raise the pipe above its normal level. We must therefore increase pumping pressure to lift Saidabad raw water over the Sitalkhya bridge.

The extra pumping required by a pipe bridge over such navigable rivers is 15m extra head, which will cost about \$715,000 /year extra in pumping costs. At 7% discount rate, the net present cost is around \$6.5 million. The Saidabad route has about 400m of river crossings, so may save \$1m in construction by using bridges rather than thrust boring, but cost a multiple of that over the life of the project in extra pumping costs. The extra pumping cost for using bridges on the raw water main to Gandharbpur is less than Saidabad, as the river crossings are further from the outlet, so the project life cost saving of bridges is less. These costs are less significant when considering the security of a pipe carrying a major part of Dhaka's water supply.

There is no extra pumping cost for using bridges on the treated water main from Gandharbpur to Dhaka because it is already at higher pressure, so the aprox 400m of river crossings will cost approx \$1m extra using thrust bore instead of bridges.

DWASA should decide, before bid document preparation, if the difficulty of getting permission for pipe bridges outweighs the advantage of having pipes easily accessible for quick emergency repair, in the event of failure, as on a bridge, vs thrust bored under the rivers. In this case, repairs could only be carried out, in a rudimentary fashion, after emptying the pipes with difficulty, by men working inside the pipes, with considerable danger, deep under the river. Alternatively, in case of a major failure, preventing man access, a new parallel thrust bore would have to be made, taking several months to construct, before reinstating the supply. In the case of Saidabad, the Sitalkhya might provide the alternative emergency supply.

6.7 Gandharbpur Water Treatment Plant

56. The FS discusses the plant and process aspects in detail but makes no mention of site and construction constraints or civil works aspects. The Gandharbpur site is on an island at the edge of the Balu river connected to a good permanent asphalt road by a short 2 lane causeway which is shared with at least 2 other industrial enterprises on the island. The other industries are on raised ground and the DWASA site is about 4m below river flood water level, according to local people who farm all the DWASA land in the dry season.

We anticipate the whole site will need massive land fill to raise it above the expected 1 in 100 year river flood level. This could be done with imported sand, as is done elsewhere, and also with spoil from the pipe laying works to save in spoil disposal costs. This filling operation will delay start of construction work on the site and likely lead to long term ground settlement. Therefore, all the WTP structures are likely to need deep piling. We recommend borehole geotechnical investigations be carried out as an urgent priority before bidding so that contractors have a sound basis for their designs and costing.

DWASA also need to obtain reliable hydrological data giving the expected 1 in 100 year river flood level at the site location, or commission a study to do it – again before bidding.

57. We agree that Gandharbpur WTP Phase 1 (this project) will have a design output capacity of 500 MLD, with provisions for doubling the capacity in Gandharbpur Phase 2; and that the treatment plant will include conventional unit processes: pre-chlorination, pH

correction (lime), coagulation (alum, lime, and polyelectrolytes), flocculation, sedimentation, rapid sand filtration, and post chlorination.

58. We have assumed 5% wastage to account for sedimentation sludge withdrawal, filter backwashing, and general housekeeping. Consequently, the WTP should be designed to process 525MLD. A corresponding adjustment has been made to the raw water pump design capacity. If backwash recycle and sludge dewatering with recycle are adopted in the final design, the wastage could be reduced to maybe 2% or even less. The decision to include either or both features is a financial one best taken at detail design stage when costs are more accurately known.

The splitting of inflow in three main treatment trains rather than two or four should be re-evaluated at design stage with a view to maximizing utility and minimizing cost. The same consideration should apply to the number of filters in each process train.

59. We do not agree that the plant is designed to be fully automatic³¹; rather, that it is operated manually, based on data provided by a full-fledged SCADA system, with only certain semi-automatic³² functions, such as backwashing and the opening and closing of process valves. We also do not agree with several other detail design recommendations in the FS

60. The FS pre-design includes for the settling of sedimentation and filtration sludge in 20 drying beds. The FS does not refer to the ultimate disposal method, which we include in the EMP. We are unclear how sludge would receive “preliminary thickening” in the sedimentation tanks. Consequently, we propose that sludge thickeners are added to the process.

61. The FS also proposes to (i) consider the recirculation of sludge to enhance coagulation and floc formation and (ii) pump sludge to the sewer line.

(i) We do not agree that recirculation of sludge that contains residual alum could benefit coagulation, as that is an almost instantaneous process.

(ii) Whether pumping sludge to a nearby planned sewage treatment plant (Dasherbandi) would be appropriate depends on the treatment process chosen for the STP and the pumping distance. If the distance is short, say, no more than 1 km, and the STP aims to remove phosphorous through chemical precipitation, then this option may have merit and should be further investigated.

6.8 Transmission lines inside Dhaka

62. The purpose of this project is to inject 500 MLD into the NE sector through large diameter pipelines. This decision was reportedly based on an overall analysis of the water

³¹It is conceded that to design and operate a fully automatic large water treatment plant is possible. However, the focus of maintenance would then need to shift from relatively routine mechanical and electrical O&M to include highly specialized electronic maintenance and IT capabilities and access to sophisticated spares and diagnostic instrumentation. To then integrate several fully automatic WTPs into an optimized system supply would pose added challenges, although, again, it is conceded that this would be possible.

³²By semi-automatic functions we mean manually initiated functions that are implemented automatically. For example, a pump is started in manual mode by an operator pushing a “pump start” button. That action triggers a program in a PLC (programmable logic controller) with input and output signals to start the motor, check the inlet valve for “open” status, open the discharge valve over a selectable period of time (say, 1 minute), check the discharge valve for “full open” status, and check the output signal of a flow meter for “adequate” flow. The same sequence, or one similar, could be initiated from an input signal such as a level measurement, which would make this particular pump start sequence fully automatic.

demand centers that appears rational, however, the details will change when IWM complete their Water Supply Network Master Plan modeling.

63. The FS recommends the use of DI for these treated water transmission mains. We recommend that the choice of pipe material should be proposed by the design-build contractor in his bid together with costs for several choices. Assisted by competent consultants, DWASA would make the final decision after bid evaluation. Source: DMC & IWM

64. Figure 8 shows the areas benefitting from the 500 MLD Gandharbpur WTP injection into the Dhaka water distribution network and the proposed pipe reinforcement provided

The 21 km of 1m to 1.8m dia pipes included in the project costs, for reinforcing the existing distribution system, to enable it to absorb the extra inflow, were modeled by IWM for the old injection point from Khilkhet WTP. IWM were unable to re-model this in the time available, for the new injection point 3km south of here. The pipe proposals and 21km cost estimates are therefore provisional and likely to change by +/- 30%. DWASA must commission IWM to redo the modeling before bid documents.

6.9 Environmental Considerations

65. The preliminary EIA that was presented by the FS in Volume VIII was considered inadequate and the following FS sections 6.9.1 to 6.9.7 have been replaced as follows.

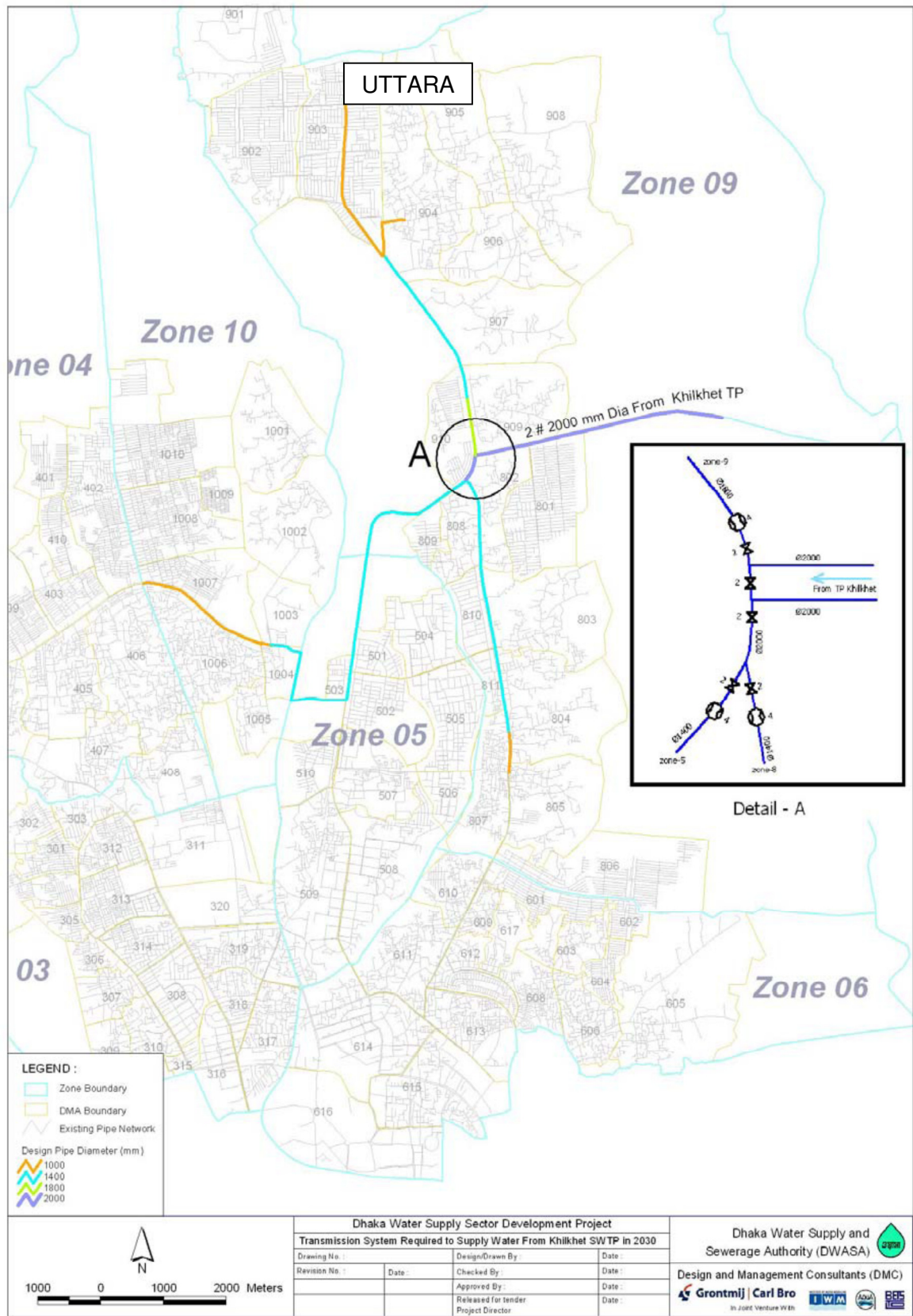


Figure 8: Effective Services Centers

Source: DMC & IWM

6.9.1 Background

66. Not used.

67. An Initial Environmental Examination (IEE) has been prepared as part of the PPTA to address environmental impacts resulting from the Project. It is based on our review identification of gaps, and updating of the Environmental Impact Assessment (EIA) carried out by the FS (Vol. VIII - Preliminary Environmental Assessment). The key gaps identified in the EIA are as follows:

- (i) While the EIA confirms that there are no significant or irreversible impacts envisaged due to the project interventions, it is not based on a comprehensive assessment of potential environmental impacts.
- (ii) The baseline information on the environment is not complete and the report did not include information like general environment of the project area, climate and weather conditions and data, soil characteristics, seismicity, etc.
- (iii) The baseline environmental status with respect to air, water, and noise quality along the project locations is not presented. In addition, specific information on the following key aspects is not included: (a) impacts on fisheries at the intake, (b) impacts on the ecologically critical areas (ECA) and the low lying areas in the project locations, (c) impacts from spoil disposal, and, (d) impacts on flora and fauna in the project locations;
- (iv) The EIA methodology includes public consultations and focus group discussions (FGDs). However, the report does not document the consultations carried out, the key issues discussed and identified, and whether the stakeholder concerns have been integrated into the project designs.
- (v) While a series of mitigation measures are proposed to address the identified impacts, the measures are not location specific and require to be described in sufficient detail to enable integration into the contract documents.
- (vi) The section on institutional arrangements is generic and does not specify the institutional structure with respect to safeguards implementation, roles and responsibilities of the environmental personnel of DWASA, capacity building requirements, and consultant support required.
- (vii) The costs for implementation of environment measures have been considered integral to the civil works / construction, and hence an environmental budget has not been provided. There is a need to include the following provisions in the environment budget: (a) monitoring of environmental parameters during construction and operation stages and (b) capacity building.

68. The gaps identified in the EIA were addressed through field visits, collection of primary and secondary data to characterize the environment and identify potential impacts; and substantiated through consultations with stakeholders. Secondary and primary data were used in updating the IEE. All possible secondary information and data were collected from relevant sources and from field observations. Primary surveys on air and noise levels at the project locations were carried out to establish the environmental baselines. Data collection on fisheries, wetlands, environmentally critical areas, upstream pollution sources, etc. have been carried out from site visits, secondary data sources, and consultations.

69. Review of Government's Statutory Requirements and ADB policies were carried out. This included review of relevant laws, ordinances acts, rules, public notices, standards

governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, etc. at the local, national, and international levels.

70. Consultations with relevant agencies were held to gather information including DWASA, DoE, Bangladesh Inland Waterways Transport Authority (BIWTA), Department of Fisheries (DoF), Bangladesh Water Development Board (BWDB), Department of Forests, and RAJUK. In addition, consultations at the project locations were undertaken to understand specific environmental concerns. Inputs from these consultations provided inputs to the identification of mitigation measures and integration into the project designs. The impacts during pre-construction, construction, and operation stages were identified for which mitigation/monitoring measures are identified and detailed in the IEE.

71. Based on the IEE findings, an EMP outlining the specific environmental measures to be adhered to during implementation of the Project has been prepared. During the detailed design, the IEE/EMP will be further updated as a stand-alone EMP for each of the procurement packages (and appended to the contract document). This will enable integration of environmental provisions and management measures in the contract document.

6.9.2 Environmental requirements of the government and ADB

72. In accordance with *ADB's Safeguard Policy Statement SPS, (2009)* the Project is classified as Category B as no significant impacts are envisioned. In accordance with the government's Environmental Impact Assessment requirements as outlined in the Environmental Conservation Act (ECA, 1997) (Amendment 2000) and the Environmental Conservation Rules (ECR, 1997) the project is classified as a Red Category requiring an EIA for necessary Environmental Clearance requirements.

73. In accordance with the government's and ADB's environmental and safeguard policies, the IEE assesses the environmental impacts due to the proposed Khilkhet water supply project. Consultations with the DoE on the nature of documentation required for the environmental clearances indicated conformance to ADB safeguard policies will be considered as compliance to the requirements of the government. This IEE therefore presents a uniform document satisfying ADB and the government requirements. While any additional studies to conform to the government clearance requirements are not envisaged, data updating if required, will be carried out, prior to seeking DoE approval.

6.9.3 Anticipated environmental changes prior to construction of the project

74. Not used.

75. **Land acquisition and resettlement at the intake site.** The proposed intake site on the banks of the Meghna River at the Bisnondi village is on private agricultural lands owned by 88 families. The crops cultivated are rice, other grains, and vegetables. There are no residential /commercial structures within the identified lands. A resettlement plan in line with the SPS, 2009 has been prepared based on census and socio-economic surveys of the affected persons to address the impacts due to land acquisition and resettlement in the project. Full details of the costs are given in Appendix 20.

76. **Impacts on fisheries / river ecology.** Intake screens are proposed to be designed considering the swimming characteristics of hilsa (the key species in the Meghna) to ensure that the impacts on hilsa as well as the smaller fish including the Jatka (Hilsa fry) are minimized. Inputs of a fisheries expert as part of the detailed design is recommended, to provide inputs to

the design of intake screen to minimize impacts on fish. With these interventions, the impacts on the fishery resources are expected to be minimal.

77. In addition to the small fish, eggs and larvae of the fishes will be impacted. The scale of impacts, based on consultations, is not significant as the eggs / larvae are uniformly available in the river. Efforts to minimize such will be integrated into the detailed designs by the fisheries expert.

78. **Impacts on downstream uses.** The proposed abstraction accounts for only 0.6% of the lean flow (Q-95) for 2035, and about 0.2% of the maximum flow (Q-5) for 2035. These levels of abstraction are within the safe levels of water uptake from the river and will not adversely impact downstream uses or adversely impact the ecological flows of the Meghna River. Further, these levels of abstraction are not envisaged to result in any flow modifications in the river, which can potentially lead to salinity intrusion or result in impacts on downstream water uses.

79. A 31m wide corridor is proposed to accommodate the transmission mains and provide an access road to the intake location. The alignment passes through agriculture fields and low lying areas. There are no environmentally sensitive areas in the vicinity of the proposed transmission main / access road. Land acquisition and resettlement of private agricultural lands and resettlement is envisaged. The impacts are being addressed through the provisions of the RP. Cutting of trees in private lands will be minimized through retaining of trees to the extent possible. Compensatory plantation for the trees lost at a rate of 10 trees for every tree cut will be taken up and the conditions for such replacements and estimated cost will be specified in the EMP. Impact on inland water bodies including fish ponds will be addressed in the detailed designs through appropriate measures to provide for cross-drainage to minimize severance impacts.

80. The Saidabad transmission lines from Sejan juice factory to Demra DND canal are proposed to be accommodated within the RoW of the RHD roads from Sejan juice factory to Demra en route to the Saidabad WTP. Along this, two pipes of 2200mm are to be laid within the road reserve (one during this project and one more for Phase 2). This section includes crossing of River Sitalkhya at Sultana Kamal bridge near Demra. Based on a review of options, supporting the transmission lines on bridges is preferred to burying the pipes within the river bed. Other impacts along these stretches include cutting roadside trees and filling low lying areas along the roads, which can be minimized by careful alignment design during the detailed designs. The last section along Demra road to the box culvert will run on the north side of Demra road, on the far side from the canal, in a wide, but partly overbuilt road corridor. Similar conditions exist as above.

81. Not Used.

82. The new pipe route from the WTP to Dhaka and the new WTP site will be described in the final IEE which was not ready for this report, as the new surveys took a long time

Transmission pipelines along the DND canal

83. It was proposed to locate the two 2200mm diameter pipelines within the DND canal corridor for a length of 4.2 km to the twin 2.5m x 2.0m box culvert leading to Saidabad WTPs. It was foreseen this would avoid compensation costs incurred by following the built up north side of the road. The pipe could not be laid underwater in the canal however, without serious impact on the raw water supply quality for Saidabad. It would have to be raised above ground on

plinths, but DWASA will not accept that for the security risk it poses. Fortunately DWASA now prefer the wide RoW on the north side of the road for other reasons. We also recommend this location. While land acquisition is not envisaged, impacts on non-titleholders at the junctions along the DND Canal are being addressed through the RP provisions. Laying these pipes will result in felling trees. While efforts to minimize tree felling will be carried out at the detailed designs stage, compensatory plantation towards the trees to be felled is integrated into the EMP costs.

Transmission pipelines from the WTP to Dhaka and within Dhaka

The two 2000mm diameter treated water feeder mains (one in Phase 1) leaving the WTP northwards, will be located first within a Bangladesh Water Development Board corridor on the road west side, then after the river crossing, laid beside the RoW of the RAJUK “300 foot” road for some 4km. Further on, 1800 ~ 1000mm diameter feeder mains will be laid along major arterial roads, connecting, as shown in Figure 8, at strategic points that are based on the Dhaka water distribution model designed and operated for DWASA by IWM under the DMC.

6.9.4 Anticipated environmental impacts during construction of the project

84. The impacts during construction will include typical construction related impacts associated with construction of water intakes, treatment plants, and laying of transmission lines. While the nature of these impacts is not expected to be significant, the magnitude is significant given the size and scale of the proposed facilities. However, these impacts are known and can be addressed through adoption of good engineering practices and undertaking specific mitigation measures towards minimization of construction impacts on the sensitive receptors and communities in the vicinity of locations / alignments of the proposed facilities.

85. Key impacts identified and addressed in the IEE include: (i) loss of productive agricultural lands and conservation of topsoil; (ii) impacts on low lying areas and water bodies wherein protection measures are required to minimize impacts on water quality, disposal of wastes/debris on to the water bodies, and potential disruption of flows; (iii) air, noise, and vibration impacts due to construction vehicles, equipment, and machinery in the vicinity of construction site and inhabited sections, in addition to dust control during construction activities; (iv) impacts on the river courses and the water quality during the construction of the transmission mains across the rivers Sitalkhya and Balu ; (v) management of spoil disposal due to the excavation for the transmission mains; (vi) safety measures during construction including traffic diversions; (vii) management of sites temporarily used for construction activities, including borrow areas, construction camps, etc., and rehabilitation of the sites after completion of the temporary use; and (viii) impacts on community health and safety hazards posed to the public, specifically in inhabited areas. In addition to these measures, environmental measures that shall be implemented as part of good engineering practices during construction are laid down in the IEE.

6.9.5 Anticipated environmental impacts during post-construction or O&M of the project

86. With the careful siting of the project components to avoid environmentally sensitive areas and the efforts to incorporate environmentally sound designs to minimize impacts (as part of the design of the components), the impacts during the maintenance and operation of the proposed facilities will not be significant. There will be beneficial impacts on the communities due to the improved access to potable water and minimization of extraction of ground water.

While the disposal of the alum sludge is proposed in the landfill site of Dhaka, efforts towards alternative uses will be explored and suitably incorporated in the designs.

87. To address risks during the operation of the proposed facilities, DWASA shall prepare and implement an Emergency Action Plan, which shall include environmental risks and potential pollution incidences. Capacity building and training of personnel on the emergency response systems and procedures shall be incorporated in the project.

88. The project will result in increased sewage generation. DWASA, with support from other development banks and bilateral agencies, has a sewerage master plan (SMP) and has a phased strategy to implement the SMP, which will address the additional wastewater to be generated in the city.

89. Protection of the source through regulation of upstream developments especially discharge of industrial effluents (either untreated or partially treated) has been identified as a key policy level intervention requiring inter-ministerial coordination. While consultations with other concerned line departments (Department of Industries and BWDB) do not indicate any large scale industrial development immediately upstream of the intake, enforcement of the discharge standards and treatment of the wastes in industrial clusters, both in case of small scale textile units and the larger industrial units in Ashuganj will be critical to ensure the long-term protection of the water quality at the intake. While the waste discharges from the existing Manikpur ferry ghat are not significant in terms of quantum of wastes, provision of sanitation facilities and waste collection facilities at the ferry ghat (as part of the project) will initiate an awareness towards arresting the direct discharges into the river.

6.9.6 Environmental monitoring

6.9.7 Conclusions

90. The proposed interventions will improve the environmental conditions in the Dhaka metropolitan areas, through improved access to treated water and significantly contribute to the DWASA's long term objective to reduce the existing pressure on groundwater extraction. While there are no notified protected areas or environmentally sensitive areas or features in the project area that will be impacted adversely due to the proposed interventions, the magnitude of construction related impacts will be significant given the scale of the project. The location related impacts pertaining are addressed through incorporation of environmental protection measures and specific design approaches to minimize the impacts.

91. The IEE confirms that the significance of the environmental impacts will be mostly due to construction related impacts. It is to be noted that the resultant potential impacts can be offset through provision of proven mitigation measures during the design and adoption of good engineering practices during construction and operation. The specific management measures laid down in the IEE will effectively address any adverse environmental impacts due to the project. The effective implementation of the measures proposed will be ensured through the building up of capacity towards environmental management within the PMU supplemented with the technical expertise of an Environmental Safeguards Specialist as part of the design-build contractor. Further, the environmental monitoring plans provide adequate opportunities towards course correction to address any residual impacts during construction or operation stages.

92. The IEE carried out for the Project shows that the adverse environmental impacts can be addressed through proper location, planning, and design of the proposed Project

components, control of construction activity, and mitigation measures. The EMP provides for mitigation of all identified impacts and the contract clauses for the environmental provisions will be part of the civil works contracts. Further, the proposed Project elements have been discussed with the stakeholders and no significant issues requiring redress in terms of environmental safeguards were identified.

7. COST ESTIMATES FOR MAIN OPTIONS

7.1 Basis for cost estimates

7.2 Cost estimates for options

93. The assumptions for the cost estimates at feasibility stage have been done in adequate detail and we agree with the source accuracy of most derived unit rates. We note, that the estimate includes some Phase 2 components but excludes some other required cost components, only some of which are noted in the FS. We have prepared new cost estimates that are segregated to facilitate extraction of cost items into separate components.. Further details are given under review section 16.

94. The FS text that accompanies the cost table states that civil, mechanical, electrical, and pipeline cost components comprise “bare” costs plus overhead and profit plus a percentage for installation. Table 10 shows the inconsistencies in the text and tables as well as the mark-up adopted for the PPTA estimates.

Table 10: Mark-ups

| Type | OH&P | Installation | | |
|-----------------------|------|--------------|-----------|------|
| | | FS text | FS tables | PPTA |
| Civil ^a | | | | |
| Mechanical | 20% | 20% | 20% | 20% |
| Electrical | 40% | 6% | 20% | 20% |
| Pipelines | 20% | 40% | 20%-33% | 40% |
| Fittings ^b | | | 20% | 20% |

^a civil costs are all inclusive

^b fittings are included as a percentage in pipelines

7.3 Operation and maintenance

95. We have adopted essentially all of the O&M costs detailed in the FS, except that the foreign exchange conversion rate has changed from BDT70/\$ in the FS to BDT80/\$. Our detailed capital and O&M cost estimates are in Appendix 6 with a summary and financing plan in review section 16.

8. COMPARISON OF OPTIONS

96. Figures 8-1 and 8-2 in the FS summarize the options that were compared and analyzed. Notwithstanding our recommendation that the optimum location of the WTP³³ would be at the intake, we agree with the recommended realistic option 1A and, have based our cost estimates on it.

8.1 Evaluation of water source and intake

97. We agree that the Sitalkhya River is not a suitable choice for the raw water supply for this project. We also agree that the Meghna River represents a suitable choice for that raw water source. The expert review of the morphology study includes an endorsement of the location of the intake at Bisnondi with possible caveats and recommendations for further investigations, including a physical model study.

³³Appendix 7 refers.

8.2 Evaluation of transmission system

98. We agree with the type of transmission lines; i.e., buried, even though it is more expensive than an above-ground system on pillars. Whereas the above-ground system would be more convenient to monitor and maintain, it would also afford much easier access for vandalism, terrorism, and pilferage.

99. The FS recommends DI where the pipeline is laid near or under roads and GRP elsewhere. We considered steel and precast concrete cylinder pipes (PCCP) as well, because these are often used and found economical on other projects with pumping mains of this very large size, but due to the particular installation conditions (weak soils, high groundwater, and high corrosion potential, we agree with the FS recommendations, but propose to allowing the bid documents for the design-build contractor to offer alternative materials with evidence of technical compliance that will be evaluated and will inform DWASA's final material choice.

8.3 Supply scenarios

100. The FS discusses the rationale for recommending for this project the infrastructure to deliver 500MLD treated water through the Gandharbpur WTP and 450MLD³⁴ raw water for treatment in the Saidabad WTPs 1 & 2. We agree with the approach but also recommend to include in the design of Phase 1 some of the components for the ultimate Phase 2 capacity of 2000MLD. Those components are:

- (i) Land acquisition suitable for the Phase 2 intake structure,
- (ii) intake channels for Phase 2,
- (iii) the intake pump station (but only Phase 1 pumps and associated electrical components),
- (iv) pipe and valve configuration to facilitate future expansion of the intake pump station,
- (v) power supply for the Phase 2 requirements (but only Phase 1 transformers),
- (vi) land acquisition for the intake-Sejan juice factory corridor to suit the construction of the access/service road and all pipelines for Phase 2 (but construct only two pipelines for Phase 1) – this would require 31m wide land acquisition instead of the 20m proposed in the FS,
- (vii) Phase 1 pipeline to Gandharbpur WTP (but construction of river crossings for Phase 2),
- (viii) Phase 1 pipeline to DND canal (but construction of river crossings for Phase 2),
- (ix) Phase 1 pipeline to existing twin box culvert feeding Saidabad with raw water from the DND canal (this was not contemplated in the FS; rather, the FS concept is to discharge the Meghna River water into the canal for conveyance, as now, to the Saidabad WTPs),
- (x) Gandharbpur WTP with rated capacity of 500MLD,
- (xi) pipe and valve configuration as well as channel, floor, and wall design to facilitate future expansion of the WTP,

³⁴As noted elsewhere, we have assumed 5% wastage and therefore added about 5% to the Saidabad design output capacity of 450MLD for a raw water feed of 475MLD.

- (xii) power supply for the Phase 2 requirements (but only Phase 1 transformers), and
- (xiii) land reservation suitable for the future expansion of the WTP.

101. The bid documents for the design-build contractor should specify these recommendations. A detailed list of components is in Table 9.

8.4 Financial analysis

102. We reviewed the financial analysis and found several anomalies³⁵. Aside from a few other details with which we differ, we have undertaken a comprehensive financial analysis that is described in detail in Section III D.

- (i) We have increased the design cost from 5% to 5.5% to account for the effort to include for expansion to Phase 2.
- (ii) We have assumed that the design-build contractor will apply for, and be awarded if applicable, exemption from tax and VAT on all cost items except civil works. The costs are included in the Financing plan as a cost for GoB.
- (iii) We agree that DWASA should finance the project from revenues, which are derived from water tariff and new connection fees. Our financial analysis does not, however, factor in future network expansion and water treatment plant capacity increases that must be derived from additional tariff increases or other sources.
- (iv) We agree with most of the assumptions underlying the NPV analysis in the FS except:
 - (a) We have estimated the yearly O&M at about \$14 million which compares to BDT69 crore, which at the FS ForEx rate of BDT70/\$ is approximately \$10 million.
 - (b) We have assumed a linear reduction of NRW from 40% to 20%, rather than the 15% in the FS.
 - (c) The assumed technical/design life of the different main project components and related replacements of major project components foreseen over the project's economic life are: Civil: 40-60 years, Mechanical/Electrical: 15 to 20 years and Control: 10 years.

103. We agree with the conclusion not to provide the facilities for Phase 2 capacity at this stage but to plan for a phased increase based on demand and sustainable groundwater availability.

104. The TOR for the FS did not include an economic analysis. The TOR for the PPTA include for such an analysis and it is presented in Section 3 D 2.

8.5 Recommended Option

8.5.1 Recommendation

105. We agree with the reasons in the FS for adopting option 1A and endorse that choice. We do not, however, endorse the construction of the full transmission system as proposed in the FS but endorse the phased construction, as also recommended in the FS.

³⁵Appendix 13 refers.

8.5.2 Components of the recommended system

106. We agree with the components listed and refer to Table 11 as a summary.

This is also the basis of the project cost estimate.

Table 11: Project Phasing

| Component | Sized + costed for | Phase |
|--|--------------------|-------|
| General | | |
| Land acquisition | | 2 |
| Environmental safeguards | | 1 |
| Social safeguards | | 2 |
| Gender & poverty considerations | | 2 |
| Intake | | |
| 33 kV power line to intake | | 2 |
| Transformers | | 1 |
| MCCs | | 1 |
| Access road | | 2 |
| Pretreatment channels | | 2 |
| Raw water pump station | | 2 |
| Raw water pumps, Gandharbpur WTP | | 1 |
| Isolating valves | | 2 |
| Check valves | | 1 |
| Raw water pumps, Saidabad | | 1 |
| Isolating valves | | 2 |
| Check valves | | 1 |
| Pre-chlorination building, Gandharbpur | | 1 |
| Pre-chlorination equipment, Gandharbpur | | 1 |
| Pre-chlorination building, Saidabad | | 1 |
| Pre-chlorination equipment, Saidabad | | 1 |
| Transmission pipelines | | |
| Raw water main - intake to Sejan juice factory | | 1 |
| Raw water main - Sejan juice factory to Gandharbpur | | 1 |
| Raw water main - Sejan juice factory to Saidabad box culvert | | 1 |
| Treated water mains to Dhaka distribution network | | 1 |
| Clean-out chambers and air valves | | 1 |
| Cleaning equipment | | 1 |
| River crossings | | 1/2 |
| Gandharbpur Water Treatment Plant | | |
| 33 kV power line to WTP | | 2 |
| Transformers | | 1 |
| MCCs | | 1 |
| Access road | | 2 |
| Control building | | 2 |

| | |
|---|---|
| WTP process units (coag, floc tanks, sed tanks, filters) | 1 |
| Backwash and high lift pumps | 1 |
| Chemical storage building | 2 |
| Chemical feed equipment (Cl ₂ , acid, alum, lime, polymer) | 1 |

8.6 Supply from Sitalkhya

107. As noted repeatedly, we agree that the Sitalkhya River is not an adequate source of raw water for this project.

8.7 Security of supply

108. The topic is repeated in 9.3 of Report Section I-2: Technical Report where we have addressed it.

8.8 Recommendation for additional Investigations

109. The FS recommends that the following three additional studies be undertaken.

(i) **Confirmation of available groundwater resources.** We fully agree that this fundamentally important project parameter be confirmed. We have proposed that IWM be engaged to advise DWASA on an orderly retirement of deep wells. This would necessarily require an up-to-date knowledge of the aquifer levels throughout Dhaka; knowledge we believe IWM has, or will confirm, when undertaking the assignment. The TOR for the task and a cost estimate have been forwarded to ADB and DWASA for approval.

(ii) **Additional water analysis.** We note that the FS did not obtain any samples during the dry season. Opinions are divided on the likelihood and magnitude of tidal influence at Bisnondi and more importantly, saline intrusion. It is therefore strongly recommended to immediately engage the services of a qualified entity to undertake a sampling regimen to augment existing qualitative and quantitative data of the Meghna River near the proposed intake location. The investigation should focus on the seasonal variations in water levels, tidal influence, salinity intrusion, TSS, TDS, and metals. If this study is commissioned soon, a very useful two years of data could be obtained. We also recommend that the program be set up to be continuous during the construction period and as an adjunct to the WTP O&M procedures. The TOR for the program and a cost estimate have been forwarded to ADB and DWASA and have been approved. ADB agreed to pay the water quality monitoring of Meghna River. But when DWASA evaluated proposals in April, they found that all the firms are not qualified. So they re-issued the request for quotation. Because of this, the implementation is being delayed. It is expected to start in July.

(iii) **Additional geotechnical investigations.** We believe that the geotechnical report was thoroughly prepared and informative. We do agree with the FS that additional geotechnical investigations will be undertaken by the design-build contractor as a matter of course since all designs have not been finalized.

(iv) **Meghna River morphology.** The review of the river morphology report (Vol. 2 in the FS) indicates two major issues. Firstly, only two sources are contemplated,

one of which, the Sitalkhya River that currently supplies raw water for Saidabad WTPs 1 & 2, which suffers from ever increasing pollution and lack of adequate flow in the dry season. Consequently the morphological data collected in this regard and the analyses presented are superfluous. The second choice; namely, the Meghna River, is obviously a better choice, since the only other choice presented is not a *bona fide* option. The effort devoted to accumulating that data would have been better spent adding to the insufficient data presented for the Meghna River. While the quantitative and qualitative data for the Meghna are significantly better and likely support the choice of intake in those regards, the morphology part is weak and fraught with repetitive, vague assertions and the suggestion to accept opinion instead of evidence. We have recommended that due to its significance in the design of the intake and pre-treatment process designs, we recommend that the report be reviewed by an expert to arrive at a sustainable intake structure and upstream and downstream river bank protection. We recommend that a physical model study should be seriously contemplated. ADB engaged the services of an expert who began the review in March 2013 and submitted a draft final in June 2013, which is summarized in Appendix 22 “Morphological assessment Meghna water intake”. He recommended river training works for the FS preferred intake option, costs for which (\$1,5m) have been included in our project cost estimate. He also required further modeling, which will be done by the DB contractor. However, he points out that the river training works may not be required if an alternative intake design option is chosen by the DB contractor.

8.9 Implementation arrangements

110. The FS notes that the preparation of bid documents according to ADB standards is part of the Feasibility Study. It further proposes to divide the works into three packages; namely, (i) Intake works and transmission lines, (ii) surface water treatment plant at Gandharbpur, and (iii) transmission lines inside Dhaka and estimates that the construction period will be at least 3 years.

111. Firstly, the FS appears not to contain tender documents and we recommend that they be prepared by DWASA, suitably assisted by competent and experienced consulting engineers, as shown in Figure 9: Project Implementation Schedule. Secondly, while any contract packaging proposed is possible, the final arrangement will depend on several factors, including (i) whether PPP through private investment is part of project financing and the amount, (ii) ADB and DWASA policy and preference on contract packaging, (iii) opinions expressed by potential bidders, and (iv) our recommendation. Lastly, we believe that bidding based on design-build, whether that includes PPP through private investment or not, can limit the construction period to 3 years. Based on assumed activities, their sequence, and their duration, we believe that Gandharbpur WTP Phase 1 can deliver 500MLD potable water by late 2017 - 2018 and raw water to Saidabad 1+2 by the same time. The Project Implementation Schedule below shows the major activities of consultants, contractors and other players.

112. Figure 9 shows the extent of the rainy season as demonstrated by a superimposed graph of the average monthly rainfall intensities (mm/month). Obviously, the total of the pipeline construction will require the most time. We have estimated that all of the pipes can be laid in the available time in relatively dry conditions so long as the successful bidder(s) will field a sufficient number of pipe laying crews. It also lists a maximum of seven design and build packages. These are not to be construed as procurement packages, although they could be.

Further discussion and recommendations are in Section D 4.

8.10 Social Impact Assessment

8.10.1 Methodology of SIA preparation

8.10.2 Review of survey findings

8.10.3 Impact on intake area

8.10.4 Impact of raw water transmission line

8.10.5 Impact of water treatment plant (WTP)

8.10.6 Impact of treated water transmission line inside Dhaka

8.10.7 Summary assessment of impact

8.10.8 Social impact assessment Conclusion

The preparations of the Social Impact Assessment and Resettlement Plan were delayed due to several reasons, including a large number of public disturbances, several late changes to the pipeline route and the difficulties to obtain useful survey and land title information. Consequently, these documents will be submitted separately.

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9. DESIGN PARAMETERS

9.1 Water demand

113. Water demand for Dhaka is discussed in Section 5.

9.2 Water quality and water treatment

114. The FS advises to produce treated water that conforms to WHO guidelines and Bangladesh drinking water quality ECR 1997. One of the two most important parameter that is reduced by the WTP is turbidity (the other is microbiological matter by providing a multi-stage barrier). In Section 10.3, the FS quotes WHO and Bangladesh standards of 10 and 5 NTU respectively. We recommend that the turbidity in the treated water leaving the WTP should never exceed 1.0 NTU and that the operational guideline should be set at 0.5 NTU, to be achieved 95% of the time.³⁶ The design of the process units and their controls should accommodate these recommendations. Operational procedures must be devised to achieve these recommendations. Computerized monitoring equipment must be provided and staff trained in its use to display real-time trends and record events. Laboratory staff must monitor, record, and report treated water quality parameters to review past trends and predict operational changes, if required.

115. As noted, we do not agree with the FS recommendation to design the WTP for fully automatic operation.³⁷

9.3 Security of Supply

116. The FS asserts that it has analyzed risks for the supply and taken into consideration the following factors during the choice of options and technical alternatives.

- (i) Failure of power supply
- (ii) Failure of utility components including pumps, valves, etc.
- (iii) Earthquake
- (iv) Flooding and low water levels
- (v) Human interference including vandalism, terrorism, etc.
- (vi) Pollution of source

117. We found no evidence in the FS of any special considerations to prevent any of the six situations from affecting the water supply.

(i) **Failure of power supply.** The FS discussed stand-by power generation but did not include for it in the cost estimate. We have included stand-by power generation in our capex and opex estimates.

(ii) **Failure of utility components.** The only stand-by component noted is one stand-by pump out of five; i.e., 20%. We have not added any other stand-by facilities except for an alternate power supply.

(iii) **Earthquakes.** It is a requirement under the Bangladesh building code to allow for seismic activity. While the project area is in a moderate zone where

³⁶We recently discussed this recommendation with WHO staff in Dhaka while sharing ideas on the components of a water safety plan for Dhaka

³⁷We assume that the FS recommendation for the WTP to be “fully operational” is a typographical error and what was meant was “fully automatic”.

$a=0.15g$, we recommend that greater acceleration is assumed during detail design to guard against what experts believe to be the likelihood of stronger earthquakes affecting the country. We recommend that this requirement will be reflected in the specifications for the design and construction of the works. Of particular concern is the choice of pipe material in locations where the geotechnical investigations have predicted the potential for liquefaction. GRP requires engineered bedding and fill, to enhance its strength in operation and to help protect it against detrimental liquefaction of surrounding material in an earthquake of sufficient magnitude..³⁸

(iv) **Flooding and low water levels.** The FS referred to 50-year return periods for flood levels and low flows whereas we propose a more prudent, and less risky, 100-year return.

(v) **Human interference.** We assume that based on the Saidabad examples, the facilities will be walled as a normal provision and security guards would patrol the premises on a 24-hour basis. Beyond that, we found no evidence of any other design features that would prevent willful damage. Our O&M costs include for 24h/d, 365d/yr security staffing.

(vi) **Pollution of source.** While we believe that the Meghna River water quality is good – now – we found no discussion on the steps required to ensure that upstream conditions will not deteriorate due to industrial or commercial activities in the waters. We recommend that DWASA initiates the preparation of a water safety plan as an adjunct to the EMP, at least as it would pertain to watershed protection and monitoring measures.

We have made recommendations for providing security of supply measures to pipelines under section 14.5.6

10. WATER QUALITY

10.1 Water Sources Analyzed

10.2 Sampling program

10.2.1 External sources of data

10.3 Results from water quality survey by the Project

118. The FS records a summary of water quality sampling results from its program. Two issues are apparent:

(i) The program was conducted from late March until August 2010 and as noted, did not obtain data for the dry season. We would expect some of the parameters to peak in the dry season. We recommended that a more comprehensive water quality sampling program be undertaken and one has been commissioned under the PPTA. It is expected to provide further information to be incorporated in the design-build specifications and then, be continued during the implementation and operation stages of the project.

³⁸We have on hand several quotations for 2200mm diameter GRP from different countries. The estimated cost varies by a factor of >2, but direct communication with the suppliers gives us confidence that the lower quoted rates used in our cost estimates are realistic and do not infer inferior materials or strength which will reduce its performance during earthquake..

(ii) Some of the values attributed to Bangladesh guidelines (presumably ECR 1997) in Figure 10-1 of the FS are apparently not for drinking water. These are DO (6mg/L), COD (4mg/L), and TSS (10mg/L) although the latter is approximately equivalent to the Bangla standard of 10 NTU. We agree with the FS assessment that the raw water quality of the Meghna River as evidenced by the FS sampling results is suitable for conventional treatment provided by a conventional WTP as described variously so long as the intake and the WTP are competently designed, constructed, and subsequently adequately operated and maintained. We further believe that such a WTP, aided by pre-treatment at the intake, will produce high-quality drinking water that will meet our recommended quality standards.

(iii) We have prepared a comparative set of guidelines from WHO, Europe, Canada, as well as ECR 1997 and have proposed water quality standards for this project and for general adoption by DWASA. One of the most important standards we propose is turbidity as it is the only one that can be affected by process design and plant operation. We recommend less than 0.5 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and less than 1.0 NTU at any time. The comparison and recommended project standards are in Appendix 7.

10.4 Data from Saidabad SWTP

119. Since there is unanimous agreement that the Sitalkhya River will not be the source of raw water for Saidabad WTPs, we will not comment on the various quality parameters presented.

10.5 Results from Department of Environment, Dhaka, August 1993

120. Results for 8 water quality parameters collected by DOE over a 3-year period are presented in 4 graphs: (i) solids, (ii) alkalinity, (iii) DO and BOD, and (iv) conductivity. Information about an eighth parameter, turbidity, was also provided.

- (i) **Solids.** The graph presents total solid (TS), total dissolve solids (TDS), and suspended solids (SS). TS peak four times over the 3-year period as does TDS, in April-May, September-October, May-June, and April-May. At all times, $TS > TDS > SS$. TS varies from 40mg/L to 225mg/L; TDS varies from 25 mg/L to 175mg/L; and SS varies from 10mg/L to 60mg/L. There is no discussion. We conclude that the SS concentrations are consistent with the rudimentary information about turbidity levels and that the TDS is, as expected, reflected by the conductivity measurements.
- (ii) **Alkalinity.** The graph provides no seasonal indicators although several lows are around mid-year. Alkalinity varied from 20mg/L to 70mg/L with an apparent upward trend. The FS provides no discussion. At the lower concentrations, the treatment will require lime addition to raise the alkalinity for better coagulation and it is noted that lime addition is contemplated.
- (iii) **DO and BOD.** DO varied from 5.5mg/L to 9mg/L with no seasonal indicator but an apparent slight downward trend. BOD varied from 1.0mg/L to 4.0mg/L

with no clear seasonal indicator although a reoccurring relative low around mid-year, a slight downward trend, and no clear correlation with DO.

- (iv) **Conductivity.** Conductivity varied from 30 μ S/cm to 190 μ S/cm with two relative peaks occurring around May-June followed by relative lows around July-August. There appears to be a slight upward trend. The discussion on conductivity
- (v) **Turbidity.** The FS notes that turbidity was measured; however, it was not graphed. It notes that 15 of 21 samples were assumed to have values of <25NTU, the lower detection level, and the other 6 samples were between 25 and 50NTU. We are concerned that the lack of precision was not discussed.

10.6 Water Quality Assessment

10.7 Conclusions

121. In summary, we agree with the FS conclusion that the Meghna River water quality will respond well to conventional treatment. However, we also believe that the water quality sampling program was inadequate and based on our recommendation, a water quality sampling program recommended under the PPTA soon to be underway will provide more useful and convincing information (Appendix 11 refers).

11. HYDROLOGICAL CONSIDERATIONS

11.1 Maximum and minimum flows

11.2 Meghna River

11.2.1 General description

11.2.2 Maximum and minimum flow in Meghna River

122. We agree with the FS assessment of minimum and maximum flows in the Meghna and note that at future design flow of 2000MLD, the abstraction by the project is less than 1% at the lowest predicted flow in the dry season. Consequently, there is no concern over the availability of raw water for this project. We are, however, concerned over the precise information on water levels (see Appendix 16).

11.2.3 Tidal Influence in Meghna River

123. We note in paragraph 114 that opinions are divided on the likelihood and magnitude of tidal influence at Bisnondi and more importantly, saline intrusion. The additional sampling program that we have recommended should, in addition to normal water quality parameters, focus on the seasonal variations in water levels, tidal influence, salinity intrusion.

11.3 Sitalkhya River

11.3.1 General description

11.3.2 Maximum and minimum flow in Sitalkhya River

11.3.3 Tidal influence in Sitalkhya River

Since the Sitalkhya River is obviously unsuitable as a raw water source for this project, a discussion on what the FS presents in this regard would not be useful.

12. RIVER MORPHOLOGY

12.1 Introduction and methodology

124. We have stated our position on the morphology report in Appendix 8. We expect that the expert review of the morphology report (Vol. 2 in the FS) will present a more convincing case for the intake location as well as discussing intake design and river bank protection upstream and downstream, a vital element that was not discussed in the FS.

12.2 Interpretation of water levels

125. This section in the FS prides the useful information that for the 1:50 year and 1:100 year floods, maximum water levels are predicted to be 7.75m and 8.2m respectively and for the 1:50 year and 1:100 year droughts, minimum water levels are predicted to be 1.18m and 1.07m respectively. The FS also notes that river levels vary about 4-5m in a year. The FS also emphasizes that the data behind the analysis stem from a mathematical model (Mike 11) which is only partly calibrated and that, therefore, the actual values may in reality vary. This is only one of the uncertainties that led us to recommend further investigations of the morphology and hydrology. Maximum and minimum expected water levels are very important design factors, both, for the design of the intake structure and surrounding banks and also, for the proper selection of pumps. The levels should be very carefully evaluated and utilized with a judiciously applied factor of safety.

12.3 Sediment data

126. The FS provides no useful information in this paragraph. We have proposed water quality monitoring to address this lack of essential design data and this was about to start in June 2013.

12.4 Satellite images

127. The FS suggests that the river bank at the proposed intake location shifts by about 1m/yr based, inter alia, the review of 30 years of satellite imagery. We believe that 30 years ago, the resolution of satellite imagery available to the general public was not nearly accurate enough to detect 1m. Recognizing that the average rate cited is based on all of the 30 years, we are obliged to point out that different residents in the area who have lived there for over 50 years have indicated on several occasions to several PPTA members that the bank in the vicinity of the intake has shifted much more than 30m over the past 30 or 40 years. Without relying seriously on one account, we were told that the bank had shifted from near the middle of the river, some 500m, in his 50 years of recollection. All this supports our recommendation to review the intake location and the requirement for further study and possibly a physical model study to indicate design considerations for the intake type and structure and river bank protection.

12.5 Cross section changes

12.6 Mathematical

12.7 Conclusion

128. This section in the FS does nothing to support a substantial position on morphological changes and consequently, the intake location. It refers to one section 2.5km upstream from the intake and inconclusive 1-D modeling results. Sections are available for only a 3-year period and the FS quite rightly notes that three years is “quite short ...for assessing morphological changes. “

13. GEOTECHNICAL ASSESSMENT

13.1 Introduction

13.2 Geological/geotechnical profiles

13.3 Seismicity/liquefaction

13.4 Engineering aspects

13.4.1 Dewatering of trenches

13.4.2 Bearing capacity of piles

13.5 Liquefaction

129. The geotechnical assessment was well prepared and should form a very solid base on which the design-build contractor can make more detailed soils investigations. In particular, the report provides sound advice on (i) dewatering during construction of the transmission lines across the flood plains between the Balu and Meghna rivers, (ii) river crossing difficulties and indicative techniques, and (iii) the issue of liquefaction as a result of earthquakes. The latter is of particular concern as it affects the selection of pipe material and pipe laying methods. The design-build contractor is expected to present the detailed analyses on which he will base his proposed pipe material and construction methods. It is entirely possible that he will offer two kinds of material, one for areas with liquefaction potential and one for areas without. The assessment reports will be reviewed during bid document preparation to inform the specifications and will be provided to contractors to assess location + extent of areas with greater liquefaction risk.

14. BASIC DESIGN

14.1 Introduction

130. This section summarizes the components of the recommended project with which we agree. Alternatives noted may be proposed by design-build contractor, which will be reviewed by DWASA's consultants and be subject to DWASA's approval and ADB's non-objection.

14.2 General description of system

131. We agree with the general description for A. Intake structure except (in order):

- (i) The intake structure and pump station shall be designed for the 100-year flood and the most probable drought.
 - (ii) The option for pre-chlorination, to avoid organic growth in the transmission mains (such as algae and mussels) is mentioned as included in the costs, but not elaborated. We think this is an essential pre-treatment process, unless the designer can prove from similar examples on this river that organic growth is not a problem. We recommend the bidders be required to make detailed proposals, which may include shock dosing of chlorine, rather than continuous. The water quality monitoring we have proposed will provide only limited data for bidders to assess this requirement and further investigation of the extent of the problem will be required at detail design.
132. We agree with the general description for B. Pumping station except (in order):
- (i) Raw water pumps for Saidabad 1 & 2 shall be designed for discharge into the existing twin box culvert.
 - (ii) To cope with significant variation in suction conditions, the pumps shall be equipped with variable speed motors (through variable frequency controls).
133. We agree with the general description for C. Transmission mains except (in order):
- (i) Raw water pumps for Saidabad 1 & 2 shall be designed for discharge into the existing twin box culvert instead of to the DND canal.
134. From Meghna to Sejan juice factory the system will consist of two 2200 mm pipes. From Sejan juice factory the system will split with one 2200 mm pipes going north to Gandharbpur and one 2200 mm pipes going to south to the existing twin box culvert instead of to the DND canal. These pipes will supply the design capacity of water in Phase 1; i.e., 525 MLD to Gandharbpur and 475 MLD for Saidabad 1 & 2.
135. We do not agree with the consideration for D. Optional Intake from Sitalkhya and therefore, have not commented on the details in the FS.
136. We agree with the general description for Gandharbpur Water Treatment Plant except (in order):
- (i) The WTP shall be designed for manual operation with specific automatic functions.
137. We agree with the general description for F. Treated Water Pumping Station except (in order):
- (i) The treated water pumping station shall be designed for delivering a maximum flow of 500MLD and peak capacities and pressures as determined by modeling of the Dhaka water distribution network.
 - (ii) The design-build contractor will be provided with the pipe sizes, capacities, and pressures at the injection points into the Dhaka distribution system by DWASA. IWM is currently carrying out a modeling study for DWASA to re-define the 8 supply Sectors in the city and prioritize retirement of tubewells to

identify the future surface water demand. This network modeling will provide (by mid-2013) the required information. In our cost estimates we have assumed an injection pressure of 3 bar.

138. We agree with the general description for G. Transmission system inside Dhaka.

14.3 Intake at Meghna River

139. While we agree with the conceptual design of the intake at Meghna River, the design-build contractor will submit the detail design for approval by DWASA and non-objection by ADB based on, inter alia,:

- (i) the finally agreed design high and low water levels and
- (ii) the outcome of the morphology review and further studies (if recommended).

14.3.1 Location and access

We agree with the general description of the location for, and access to, the intake. We have proposed a permanent access road.

14.3.2 Maximum and minimum water levels

We agree with the minimum and maximum design water levels of 0m and 8.2m respectively, pending the outcome of the morphological review and resulting further studies (if any) and the outcome of further hydrological investigations, resulting in the determination of the 100-year flood level and the minimum probable drought level.

140. The current review of the river morphology includes access to 30 years of satellite imagery and the expertise to interpret the data. This will provide a more precise estimate of where the high water mark should be considered.

14.3.3 Alternatives for intake

14.3.4 Intake channel Alternative 1

14.3.5 Intake with pipes in trench – Alternative 2

14.3.6 Intake with pier – Alternative 3

141. We agree with the FS recommendation to implement Alternative 1; however, based on his own investigations, the design-build contractor will submit the detail design for approval by DWASA and non-objection by ADB. The details noted in this section that will be reviewed and possibly changed by the design-build contractor are (in order):

- (i) The channel invert at -3.5m
- (ii) The flood level at 8.0m
- (iii) The dimensions of 32m x 7.5m x 15m
- (iv) The height of the bottom weir, if any

- (v) The use of penstocks to control the flow of water (rather than to isolate each channel)
- (vi) The placement of various structures in the flood plain (Fig 14-4 refers)
- (vii) A 5mm x 5mm fine screen instead of a mechanically operated fine screen
- (viii) The design particle size of 200 μ
- (ix) The design velocity in the channel of 0.25m/s
- (x) The size of each channel
- (xi) The mode of sludge removal. We recommend that consideration be given to include in the design a reservoir that would be filled during high water levels and utilized to back-flush the channels during low water levels, utilizing the difference in water levels as motive power. A preliminary estimate suggests a reservoir about 150m x 150m, the fixed cost of which would have to be compared to the NPV of a system involving pumping (and quite likely, double pumping, of, say, 12m³/s for, say, 2 hours each channel each year (or more).

14.4 Intake pump station

14.4.1 General

142. We agree with the general description of the intake pump station except that the design should include mechanically cleaned fine screens.

14.4.2 Pumps

14.4.2.1 Pumping philosophy

143. We agree with most of this section with the following recommendations (in order):

- (i) The supply to Gandharbpur Phase 1 shall be 525MLD and the supply to Saidabad 1 & 2 shall be 475MLD. For Phase 2, the plan is to double the Phase 1 capacities such that the Phase 2 intake capacity shall be 2000MLD.
- (ii) The duty and stand-by line-up will finally be determined by the design-build contractor for approval by DWASA and non-objection by ADB.
- (iii) The FS recommendations to reduce the number of duty pumps operating based on the demand at the WTP and the requirement to maintain the design minimum velocity in the pipelines cannot be implemented and some operating regime compromise will have to be adopted.
- (iv) We recommend against regulating the inflow at the WTP based on raw water turbidity.

14.4.3 Design parameters

144. The length of the raw water conveyance to Saidabad has increased by 4.2km as a consequence of our recommendation not to discharge Meghna River water into the DND canal but to continue to the existing twin box culvert.

145. We note that the minimum and maximum pump heads assumed (or calculated) in the FS are 42m and 37m respectively for the Gandharbpur route and 31m and 30m respectively for the Saidabad route. We believe that these numbers are basically incorrect as the total head on the pumps will vary by the difference of the high and low water levels in the Meghna River; i.e., 8.2m. As noted, the duty and stand-by line-up will finally be determined by the design-build contractor for approval by DWASA and non-objection by ADB as will the calculation for the total pump heads. The comment about maintaining minimum velocity at all times, even if the flow is at 66% of full capacity should be disregarded.

14.4.4 Monitoring and pump controls

146. We agree with the basic concept of pump control; however, the detail design for approval by DWASA and non-objection by ADB should include a ladder diagram detailing each input and output of the intake pump station PLC(s)

14.4.5 Power installations at Meghna

14.4.6 Design parameters for pump transformers at Meghna

14.4.7 Power distribution system for pumps

14.4.8 Power distribution system for building and control system

14.4.9 Emergency generator operation

We note that the TOR for the PPTA does not include the requirement for electrical expertise. Notwithstanding that caveat, we make the following comments.

147. We are in general agreement with the discussion on main and stand-by power supply; high, medium, and low voltage selection; duplicate power distribution (main and stand-by); redundant transformers; reduced-voltage motor starters, and UPS-backed control voltage; except, perhaps, the control and signal voltage (24V DC).

- (i) The FS does not recommend the type of stand-by generator, diesel or natural gas. Since natural gas is less expensive than diesel, and does not require potentially troublesome storage, natural gas is the preferred fuel and we recommend its application. Since potentially a large flow-rate is required, inter-ministerial agreement must be obtained to guarantee the supply (paragraph 94 refers).

14.5 Transmission mains

14.5.1 Introduction

148. We agree with the FS assessment that the construction of transmission main will pose large challenges, the largest of which will be the ground conditions in the intake – Sejan juice factory route and the various river crossings. Constructing pipelines along narrow, crowded roads will present special challenges of traffic control, implementation of

environmental safeguards, and social safeguards by way of many individual compensation scenarios. As noted, we agree with the recommended “pipe in trench” option.

14.5.2 Pipe material

149. We note that the FS has not considered steel or PCCP as potential pipeline materials even though for the size required, steel has been popular for a century and PCCP for some 30 years. Discussions with the DMC suggest that soil conditions were considered too aggressive to include steel as a pipe material option, although there is no reference to that in the FS. Procedures to mitigate corrosion, such as impressed current or sacrificial anode cathodic protection, have been used for many years and therefore, steel should at least be considered as a pipeline material. The characteristics that should define large diameter water pipes, apart from the manufacturing techniques and laying criteria and methods, are:

- Mechanical resistance to internal and external loads
- Resistance of physical, biological, and chemical nature related to the quality of the conveyed water and to the soil
- Flow resistance (smoothness) that must be the lowest possible
- Ease and safety of installation
- Comprehensive optimal cost, considering not only materials and installation but also Maintenance and duration

150. There are four *bona fide* pipe materials that can be considered for our application:

- PCCP
- DI
- GRP / FRP
- Steel
- HDPE (not really *bona fide* but is listed as it was mentioned in the FS)

- (i) **PCCP.** Prestressed Concrete Cylinder Pipe is reportedly used in China and elsewhere at these pressures and sizes. It has often been used at bigger sizes and higher pressures, but it is much less commonly used than Steel, DI or GRP for reasons that are valid on this project. It is a complex, composite pipe fabricated to special order, in specialist factories. It employs thin sheet steel, reinforced by high tensile, prestressed wire windings, protected by extra dense, high specification concrete. First class quality control in fabrication and care in transport, handling and installation is critical to its longevity. The fabrication process is arguably more complex than GRP and the potential for error much greater. Due to its weight and general brittleness, it may be impractical to import. The pipe could in theory be manufactured in Bangladesh, if the manufacturers decided to import and set up a factory here. We believe there is no facility yet capable of producing this product to appropriate specifications. Although a Chinese manufacturer promised to send quotes, they did not and we believe the price could not compete with other materials. However, contractors are better able to source and negotiate competitive deals for pipe supply and shipping, and assess the laying costs and problems, therefore, we do not discount it as an optional pipe material. PCCP. can be included in bid documents as an option, with tight

specifications on production control, quality testing and factory acceptance tests (witnessed).

- (ii) **DI.** Ductile iron pipe is a proven material for water pipe since the mid-1950s, when it essentially replaced cast iron due to its superior mechanical properties. Whereas DI is manufactured in the project diameter of 2200mm, few installations of that size or larger exist because it is rarely economic for general use at this size, when competing with GRP, steel or PCCP. Nevertheless, it is a recommended pipe material on this project where the situation requires a robust pipe and where laying conditions are less than ideal.
- (iii) **GRP /FRP.** We agree that glass-fiber reinforced plastic pipe is an excellent material as it is light (ease of handling) and almost unaffected by the elements. It is more rigid than steel, but it must be laid much more carefully than DI, or it can be easily damaged and fail. For underground use, it requires better engineered backfill than DI, hence vigilant construction supervision. For above ground applications, it needs more frequent supports than would be required for steel pipe. Therefore it is better to use steel for the pipe bridges. One factor that mitigates against its use is the little available practical evidence of longevity, because this type of pipe only came into common use in the last 30 years. Even so, there is little evidence that manufacturers' claims of a 50-year life or more, are in any way unfounded which has led to FRP /GRP replacing steel as the 'material of choice' for pumping mains of this size, anywhere that the pipes are protected against impact and /or in corrosive conditions with aggressive soils or seawater.

GRP pipes must be handled more carefully than steel or DI during loading, shipping, ground transport, unloading, and installation, to prevent cracking which can allow water to reduce adhesion between the fibers and the resin and cause the pipe to lose strength. The manufacturers provide a resin "gel" coat both internally and externally to provide a barrier to protect the fibers from the ingress of water. However if this "gel" coat is damaged during installation water can be absorbed and cause leakage. GRP has an advantage over other pipes that it can be 'nested' during shipping. (Thus pipes of 2m dia can be stacked inside pipes of 2.2m dia nearly halving the shipping cost).

Manufacturers of other pipe materials tend to exaggerate historic reports of GRP pipe failures. These have occurred, but are invariably related to failure of isolated fittings, which have been underdesigned, or individual pipes that have been physically damaged, usually during installation, but they do not question the integrity of whole pipelines, which would be the case with a corroding steel pipeline, for example. GRP is not used in UK for treated water because it does not yet meet the stringent Directorate of Water Inspectorate (DWI) Regulation 31 which ensures the material (coatings) cannot dissolve in water. We are not aware of any other country which

legislates against GRP for drinking water pipes and elsewhere in the world they are used for this purpose. Sophisticated software is nowadays used to design every GRP pipe component to meet the particular duty of its location in the pipeline (e.g. surge and working pressures and ground conditions vary along the route) which now address the cause of failures in the past. The remaining concerns for GRP are that it is well designed with sufficient data on pressures and soil conditions (there are design procedures specifically for earthquake loads and soils prone to liquefaction), supplied from a reputable manufacturer, and is installed with reasonable care to avoid physical damage.

- (iv) **Steel.** Steel pipe is traditionally the material of choice in large diameter pressure water mains (over about 1.5m dia). Nevertheless, steel usually outperforms all other materials in large diameter pressure pipe (high hoop strength with thin walls allows minimum material, low weight). The main drawbacks, are its susceptibility to corrosion and its flexibility. Flexing in transit tends to crack the normal cement mortar lining, but epoxy lining could be used at little extra cost. Its resistance to damage from external loads e.g. vehicles, depends on particularly good soil surround and backfilling, which is difficult to guarantee on this project due to the poor native soils and shortage of good granular fill material. Corrosion protection systems are quite expensive both to install and maintain. They need substantial and costly long term maintenance, which is often ignored with serious consequences – usually a much shorter pipe life than expected – commonly as little as 20-30 years
- (v) **HDPE.** High density polyethylene is a robust pipeline material with the best hydraulic characteristic; i.e., it exhibits the lowest loss of head due to friction, which is a significant factor in the power required to pump the water. Pipe lengths are usually fusion welded and a well-made fusion joint is stronger than the pipe itself. The ability of PE systems to withstand end loads and ground movement has been demonstrated dramatically in the Kobe earthquake in Japan in 1995 where Osaka Gas found a high level of failure in their iron and steel systems but none in the PE part of their network. This would be a great benefit for this project as the area is in a seismic zone and parts of the soils that will be encountered are prone to liquefaction. Unfortunately, HDPE pipe is not economical for pressure pipe at this large diameter where the poor tensile strength of the material makes the required wall thickness uneconomic. Furthermore, it is a more flexible pipe than steel and relies upon good compacted bedding and surround material for its in-situ strength, even more than steel, to prevent ovalisation in service and subsequent failure during negative pressure surge. For these reasons, HDPE will not be considered for use in this project.

151. Relatively thin-wall pipes of steel and GRP (and HDPE because it is so flexible) are affected by pressure surges that can cause vacuum in the pipeline if it is not protected. For that reason, surge protection facilities will be installed at the intake and the high-lift pump station at the WTP.

152. **Hydraulic characteristics.** Ductile iron pipes and the steel pipes with cement mortar lining have an absolute roughness greater than the fiberglass pipes and this is important in as much as higher head losses in pumped pipelines. GRP pipe has a polished internal surface and therefore a very low absolute roughness with benefits deriving from better flow and lower sedimentation and incrustation on the internal surface. Steel pipes are normally lined with centrifugally applied cement mortar; however, when large diameter steel pipes are so lined, the flexing during transport or installation can spall the mortar lining. The alternative coating is epoxy resin, which is not only crack-resistant and much more effectively repaired but also provides an internal smoothness similar to that of fiberglass and other plastic material.

153. **Installation**

(i) **DI** pipe installation is simpler as jointing is usually by push-on bell and spigot, but is also expensive due to its weight. As in the above cases heavy equipment is required and progress can reach 50m/day.

(ii) **GRP** pipes are lighter to install, do not require any corrosion protection, fittings are prefabricated and installed without slowing down the installation, heavy equipment and service roads are not required and with light equipment progress can be in the order of 100m/day, assuming engineered backfilling can keep pace.

(iii) **Steel** pipes are supplied in random lengths of around 10m, which determines the weight and therefore the weight limit of the site machinery. Progress is slowed by the joint welding process and therefore also the continuity of the internal and external protection that must be restored. Progress is reportedly about 40m/day. In order to benefit financially from the use of thin wall pipe with low rigidity, all resistance to vertical loading in operation must be provided by engineered bedding and backfill, adding to the cost..

154. **Corrosion resistance**

(i) Metallic pipes are subject to corrosion both chemical in the ground and from the transported fluid and also due to galvanic corrosion as opposed to GRP that is impervious to corrosion. Corrosion control in steel pipes is made possible with internal and external coatings of the pipes in the factory and during installation and during the life of the pipeline with cathodic protection on the external surface. Cathodic protection requires continuous monitoring and in certain areas is even subject to theft.

(ii) Ductile iron pipes in general are adequately protected from the cement mortar internal coating and from various external coatings related to the soil corrosiveness. In very aggressive environments DI pipes can be protected with insulating coatings and cathodic protection.

155. **Resistance to Ageing**

(i) Ductile iron, a development of cast iron, and steel pipes have had a history of over 100 years to establish a good record of resistance to ageing.

(ii) Neither HDPE nor GRP have been installed long enough, and studied, to make a definitive statement about their resistance to ageing. If PVC is any indication, HDPE should have good resistance to ageing – many of the first PVC pipes installed in Germany since 1936 are still in use.

(iii) GRP is designed with high safety factors to account for ageing. There are no data to support the longevity of large diameter GRP pressure pipelines; however, data extrapolation to 50 years of a study of the long-term failure of GRP pipes under the influence of moisture absorption predicts a reduction of strength of about 60%³⁹

156. **Cost Comparison.** We have reviewed the various assumptions in the FS and have made our own estimation based on quotations obtained previously by Mott MacDonald, in the course of this PPTA, and experience gained within Mott MacDonald and the PPTA team.

Table 12: 2200 Ø Pipe Cost Comparison

| | Class | \$/m | Install \$/m | Test \$/m | Total \$/m |
|---|-------|----------------|-----------------|--------------|---------------|
| Ductile Iron | | | | | |
| | | CIF Chittagong | | | |
| FS | | 2,352 | 1,129 | 80 | 3,560 |
| BX Steel (PRC) | K9 | 1,831 | | 80 | 1,911 |
| Isaeeme Group (PRC) | K10 | 2,295 | | 80 | 2,375 |
| Average | | 2,159 | 1038 | 80 | 3,277 |
| PPTA (avg (sum - hi - lo)) | | 2,295 | 1038 | 80 | 3,413 |
| GRP (all quotes for PN 16 although PN 6 is sufficient) | | | | | |
| FS | | 1,297 | 622 | 80 | 1,999 |
| Rukun (Indonesia) | 16 | 4,559 | | 80 | 4,639 |
| Graha (Indonesia) | 16 | 3,861 | | 80 | 3,941 |
| Amianti (S Arabia) | 16 | 8,026 | | 80 | 8,106 |
| Future Pipe (Abu Dhabi) | 16 | 1,179 | | 80 | 1,259 |
| Universal Polymers (India) | 16 | 1,748 | | 80 | 1,828 |
| Average | | 3,445 | 963 | 80 | 4,488 |
| PPTA (avg (sum - hi - lo)) | | 2,866 | 963 | 80 | 3,909 |
| Steel | | | | | |
| | mm | | | | - |
| FS | na | na | | | na |
| Tyco (Australia) | 16 | 3,225 | | 6 | 3,231 |
| Emek (Turkey) | 16 | 1,440 | | 6 | 1,446 |
| Indahl (Indonesia) | 18 | 2,655 | | 6 | 2,661 |
| KHI | 15 | 3,236 | | 6 | 3,242 |
| Average | | 2,639 | 964 | 6 | 3,609 |
| PPTA (avg (sum - hi - lo)) | | 2,940 | 964 | 6 | 3,910 |

Table 13: 2200 Ø Pipe Cost Comparison Summary

| Material | Length (km) | Unit cost (\$/m) | | Total cost (\$ million) | |
|----------|----------------|------------------|-------|-------------------------|------|
| | | FS | PPTA | FS | PPTA |
| GRP | 27.36 | 2179 | 3,909 | 60 | 107 |
| DI | 37.80 | 3951 | 3,413 | 149 | 129 |
| | | | | 209 | 236 |
| Steel | 65.16 | | 3,910 | | 255 |

³⁹POLYM. COMPOS., 2010. © 2009 Society of Plastics Engineers

157. Comparing the raw water pipeline costs in the FS with the PPTA estimated costs, as summarized in Table 13, three facts emerge:

- (i) The PPTA estimate for GRP/DI pipes is \$27 million higher than the FS estimate; i.e., 13%.
- (ii) Our estimate for GRP/DI pipes is 19 million lower than our estimate for steel pipes; i.e., 7.5%.
- (iii) We have adjusted the pipeline costs in the FS estimate in line with new rates we have obtained from two reputable suppliers. We have also revised some other FS costs where the impact is significant and we have more reliable rates. We have sized and costed some components for Phase 2; e.g., river crossings, where we believe it would be cost effective to construct Phase 2 elements at once.

158. **Recommendation.** All three alternatives can guarantee a long service life, Steel, GRP, and even ductile iron can be a cost-effective solution, depending on the specific site and service conditions. Although steel is usually the least expensive overall at this size and pressure, we are concerned that poor ground conditions and high water table risk its premature failure from corrosion or external vertical loading, DI is the most reliable in such conditions.. All things considered, GRP is likely to be the best choice for most of the route, being technically adequate, cheaper than DI, better suited to the ground conditions than steel and probably longer life.

159. From the required investment point of view, pipe prices have proven so variable that it is not possible to make an estimate lasting over long periods and also the location not only of the project but also of the manufacturing plants (they may be thousands of miles apart) can alter any economic evaluation. The very large range of pipe supply rates obtained, even within one material type, reflect a general problem with cost estimates based on quotations like these. Suppliers know when quotes are “for real” or just for comparative purposes like this. They know when projects are only at feasibility study stage and tend to under-quote to consultants to ensure future interest in their product, knowing the quotes will expire long before an order will be placed. For example, the quotations we received from Futurepipe of UAE for GRP pipe were very competitive compared to similar quotes received recently from the same company for another SE Asian country, because they see this as a market opening opportunity. Sometimes decisions on pipe materials are taken too long before the job is tendered resulting in a satisfactory and cheaper pipe material being excluded without good reason. The final material choice should be taken case by case in a defined market situation just before the pipe is needed. Flexibility in pipe material selection can be controlled to DWASA’s advantage with tight tender specifications to prevent contractors winning the contract with low cost, low quality pipe. A carefully written tender specification for the D&B contract can list the allowed pipe materials, the minimum technical specifications and define the variables for economic evaluation so that tender evaluation is straight forward.

Our approach for project cost estimating is to take an average of the lower pipe supply rates from quotations / sources we can trust. The aim is to base the cost estimate on the lowest rates we feel confident that bidders in competition will be able to meet or improve upon.

160. Since the actual installed unit price of a pipe cannot be accurately determined, in advance, and this is the key variable needed for optimal sizing, we recommend to allow the design-build contractors to propose the preferred and alternative pipeline materials over a small range of diameters so that economic optimization during evaluation can guarantee the optimal pipe material and diameter for DWASA..

14.5.3 Hydraulic calculations

161. The FS notes here that hydraulic calculations have been carried out based on the Hazen-Williams formula. That formula was derived based on empirical data for a limited set of conditions. Pertinent to this project, one of the conditions is water temperature at 60°F (15.6°C). Since Meghna River water routinely exceeds 30°C, a substantial error would be introduced due to the decrease in viscosity. Fortunately, the actual hydraulic calculations in Appendix 2 to the FS were based on the rational Darcy-Weissbach equation, with which we agree.

162. **Roughness.** The discussion on pipe roughness, one of the critical factors in determining headloss and with it, the cost to pump the water, is inadequate. We expect that when the design-build contractor submits his design calculations that will determine the size and type of pipe, they will include a comprehensive analysis of the appropriate roughness factor.

163. **Minor losses.** We agree in principle with the discussion on minor losses (losses induced by fittings along the pipeline). We do not, however, agree with the casual assessment of 1m/km for minor losses, which would add about 20m to the intake-Gandharbpur headloss. We believe this may be a mistake in the units as an averaged coefficient of 1.0/km (not 1m/km) would be appropriate. . A review of the assumed fittings indicates that both lists are short two tees (assumed to be required in the two blow-off/clean-out chambers in each route) and one 90° elbow. Based on a velocity of 1.6m/s, the minor losses⁴⁰ for the intake- Gandharbpur and intake-Saidabad (including the additional 4.2km) pipelines are 2.6m and 1.7m respectively; i.e., 0.8m and 1.7m respectively less than assumed⁴¹. Again, we expect that when the design-build contractor submits his design calculations that will determine the pump selection based on, *inter alia*, size and type of pipe and an accurate count of fittings along each route, they will include a comprehensive analysis of the appropriate k-factors for those fittings.

164. **Minimum velocity.** We agree that the determination of the raw water pipe diameter must take into account a minimum “self-cleaning” flow velocity to guard against solids deposition.

165. We note that this section in the FS includes a discussion on the operation during Phase 2 (four available pipelines), which does not apply here.

166. **Economical diameter.** We agree with the preliminary determination of the economical diameter of 2200mm. The FS analysis is based on sound principles, calculating the capital cost + discounted operating cost over long term operation for a range of pipe diameters and comparing these to establish life time least cost. The assumptions are sound and within the accuracy suited to a FS. Greater accuracy will be possible only when pipe

⁴⁰The minor losses are calculated based on $\Sigma kv^2/2g$, where k=loss coefficient for a fitting, v=velocity, and g=gravitational constant 9.81m/s²

⁴¹We calculate that to pump 500MLD against 1m head would cost USD 62,000/year based on a pump efficiency of 75% and the cost of electricity of BDT 7.1 /kWh.

costs are better known as they have by far the biggest impact on pipe size optimization. It is important to understand that the choice between a 2000 or 2200 dia pipe will have a very small impact on project life cost. Over such a range of sizes, the extra capital cost of the larger pipe closely matches the reduced lifetime cost of pumping, and vice versa, so concern over an exact ‘optimum diameter’ is often exaggerated. See Appendix 23 – “Notes on Pipe Size Optimisation”. We have based our O&M calculations and corridor sizing on the FS recommendation. We also agree with the FS recommendation that the design-build contractor performs a final calculation as part of his detailed design in order to achieve the final economical diameter.

167. **Final choice of pipe diameter.** We agree with the FS preliminary conclusion of pipelines with the same diameter but consequently, different head conditions requiring different pump sets. We also agree that another option would be to equalize the two headloss conditions by selecting different pipe sizes, which would have the benefit of using the same, and possibly fewer, pump sets for both applications. Again, we recommend, as does the FS, that the design-build contractor analyze the options during detail design.

168. **Design parameters for pumps.** We note several inconsistencies in this section; i.e.,

- (i) **Maximum water level at intake.** The assumed 8m⁴² is probably close to the 100-year flood level; however, further study of the hydrology and morphology will determine this factor more accurately.
- (ii) **Minimum water level at intake.** This level should reflect the 100-year drought level of near 0m, which, again, based on further study of the hydrology and morphology, will be determined more accurately.
- (iii) **Head losses.** Given that the river level variation is about 8m, it is difficult to reconcile differences in pump heads in Figure 14-13 of the FS of only 1m and 5m respectively for Saidabad and Gandharbpur for new pipes and 3m and 5m respectively for Saidabad and Gandharbpur for 10-year old pipes. There are other anomalies; however, these are all expected to be resolved when the design-build contractor presents his detail design for DWASA approval and ADB non-objection. For our O&M calculations, we have assumed total discharge heads of 30m for Saidabad and 40m for Gandharbpur.

14.5.4 Design of transmission lines

169. As noted, we agree with the construction of Phase 1 pipelines; i.e., one to Gandharbpur WTP and one to Saidabad box culvert.

14.5.5 Pipe corridor and pipe route

170. As noted and illustrated in Figure 7, we disagree with the width required to construct a permanent service road and ultimately, four 2200mm diameter pipelines in a 24m corridor.

171. RHD and RAJUK have advised the PPTA team that (i) the roads to Kanchan Bridge and Tarabo/Demra Bridge are planned to be widened from 2 lanes to 4 within the existing

⁴²This and other references to elevations are based on Bangladesh National bench mark elevations that are related to mean sea level.

RoW and (ii) that the road from Kanchan Bridge to the Khilkhet WTP site is a “300 foot”⁴³ road that should be able to accommodate two 2200mm pipelines. It will require further discussions between DWASA and RHD and RAJUK to establish (i) each agency’s agreement to construct the project pipelines within their RoWs and (ii) where exactly the pipelines can be constructed within those RoWs. It may be that 14m is sufficient to construct the two pipelines, one at a time. It should be noted that an excavation to house both would be at least 13m wide, unless costly sheet piling or trench boxes were used.

14.5.6 Installations on transmission line

172. We agree with the FS considerations regarding water hammer. Soft pump starts against closed valves that open slowly and slow valve closures against pump shut-off heads are standard procedures to avoid water hammer. What additional measures should be taken to reduce water hammer as a result of power failures are expected to be identified by the design-build contractor when he presents his detail design for DWASA approval and ADB non-objection.

173. **Air valves.** Installing air release and relief valves is standard procedure and both the FS and our cost estimates include an estimated number.

Installing access chambers every km is suggested in the FS. This may seem too frequent, but the distance is determined by safety requirements for workers in the pipeline involved in inspection and cleaning operations. These should be designed as wash-outs to facilitate the removal of silt deposits both manually and hydraulically. We have also included in our capital cost estimate, as has that in the FS, two chambers in each pipeline that would allow flushing each pipeline. We have also included periodic flushing, with the attendant loss of revenue water, in our O&M cost estimate.

The FS does not address security of supply for pipe burst / maintenance downtime. We recommend adding cross connections between the 2 parallel raw water pipes at both ends, so that in emergency and during maintenance shutdown of one pipeline, a partial supply can be provided by the other. Tee connections with blank flanges should also be added to all the single pipelines - Juice Factory to Saidabad and WTP to Dhaka, (and Intake to WTP, if Saidabad pipe is dropped from the project) to allow cross connections to be added when the parallel reinforcing pipes are installed in future.

174. **Thrust blocks.** Thrust blocks are required on all pipelines that utilize friction-type jointing and fittings. The only pipeline design that does not require thrust blocks is fully welded joints, which are only available for steel and HDPE pipe.

14.5.7 Transmission main alternative-pipe on surface

175. We agree with the FS assessment, based on expert opinion, that a tunnel solution would not be economically feasible; i.e., it would cost too much.

14.5.8 Culvert alternative

176. We do not agree with this alternative as it requires double pumping, never an economical idea, and its only plus is that the cost would probably be less than the pipeline option. We note that the calculated slope of the energy grade line $s=0.00001$ seems to be in error. Using the given dimensions and the FA assumed roughness factor $n=0.013$ for the

⁴³The RoW from Kanchan Bridge to the WTP and further, to Dhaka, actually varies from 300 to 200 ft.; however, the lesser width can still accommodate the pipelines.

Manning's equation⁴⁴, the corresponding flow rate is 3.72 m³/s, not the required 500MLD, or 11.6 m³/s. For n=0.013 and Q=11.6 m³/s, s=0.000113. The difference over 15km amounts to a significant 1.3 m. We note that the FS recommends this alternative (FS Figure 14-1 refers) but also rejects it variously. We note that this alternative is not part of the recommended Option 1A with which we agree.

14.5.9 Tunnel solution

177. We agree with the FS analysis on alternative conveyances and endorse the recommendation to utilize only the pipe-in-trench method.

14.5.10 River crossings

178. We appreciate the details presented under this section but suggest that ultimately, the choice of how to cross the various rivers should rest with the proposal by the design-build contractor, subject to any limitations imposed by the bid documents, such as disallowing bridges, IF this is what DWASA decide (see Table 1). The idea to try to persuade RHD to incorporate the Sitalkhya River pipe crossings into their design of a new bridge has been dropped. We have had these issues before and know road authorities to be very reluctant to commit themselves to the liability and inconvenience having huge infrastructure obstructing access to their structures..

179. We have revised the FS cost estimate for pipe bridges based on our own calculations for steel truss bridges with steel pipes..

14.6 Comparison of river crossing methods

180. We agree with the FS advice that utilizing bridge crossings would incur significant pumping costs. We therefore fully expect that the proposal for river crossings from the design-build contractor includes a detailed cost-benefit analysis. Extrapolating the previous calculated cost in footnote 41 for pumping 1m head, the yearly cost to pump across bridges per pipeline would be BDT42 million plus the differential cost of larger pumps and switchgear.

14.7 Optional Intake and pumping station at Kanchan bridge

181. We agree with the FS conclusion that an intermediate pumping station at Kanchan Bridge is not feasible.

14.8 Gandharbpur water treatment plant

14.8.1 Design parameters and reference design criteria. Raw water quality

182. We agree that turbidity is one of the important factors for the selection of the unit operations of the water treatment plant. We are, however, unclear as to the utility of normal, average, and maximum turbidity except perhaps to determine the amount of chemicals required to remove the solids. We do not agree in this context that treated water quality shall fulfill WHO and Bangladesh standards; instead, we have recommended a much more stringent standard for treated water turbidity.

⁴⁴ $V=nR^{2/3}s^{1/2}$, where v =velocity in m/s, R =hydraulic radius A/P, A =wetted area in m², P =wetted perimeter in m, and s =slope of the energy grade line in m/m

183. **Type of community.** We agree that the type of treatment should include rapid sand filtration but not because of the community this WTP will serve but because of the barriers to bacteriological contamination of the treated water it provides.

184. **Capacity for operation and maintenance.** We agree that DWASA has experience successfully operating a conventional WTP gained at Saidabad 1. Whether that success will continue at Saidabad 2 with its highly unconventional unit process to reduce ammonia is not been demonstrated. Regarding maintenance, what can be said is that DWASA has experience at routine plant maintenance but sub-contracts all major maintenance and repairs to off-site firms.

185. **Industrial development.** We are unclear as to the purpose of this discussion. We recommend to adopt tried and true design criteria and would relax on that recommendation only in case the WTP is part of a long-term BOT PPP. An example is the use of plate or tube settlers in the clarification process. We would recommend not to use such settling aids but instead, enlarge well designed conventional basins with the view to retrofit them at a later stage if a relatively small increase in demand warrants it.

186. **Limitations of the proposed design.** We fully agree with the correlation between turbidity and bacteriology of the raw water to be treated. We are therefore surprised that the FS recommends only the WHO and Bangladesh standard for treated water turbidity of 5 to 10 NTU, which is at least an order of magnitude greater than has been accepted in the industry for several decades.

187. We have assumed that the output of the WTP will be 500MLD based on a raw water flow of 525MLD; i.e., a 95% efficiency that can be obtained with well-designed and operated supernatant returns of settled water sludge and backwash water from dewatering plant.

188. The plant configuration will be decided based on alternatives proposed by the design-build contractor. It may well coincide with the FS configuration of 3 lines treating about 2m³/s each.

189. **Main sections of the plant.** We agree with most of the description, except (in order):

- (i) We do not agree with two rapid mix chambers in series as that defeats the purpose of near instantaneous mixing.
- (ii) We do not understand the theory behind 3 lines of 2x2 floc chambers in series; instead, we recommend 3 lines of 3 chambers in series to allow for tapered flocculation based on operational data.
- (iii) We recommend to use a more conservative design based on no tube or plate settlers (paragraph 204 refers).
- (iv) We agree in principle; however, we would encourage DWASA and the design-build contractor to consider declining rate filtration and/or inter-filter backwash. We endorse the recommendation for deep filter beds as it affords the opportunity later on to install Granular Activated Carbon (GAC) if the raw water quality demands it.

- (v) We are unclear to what configuration “common treated water pumping station”. If that is a suggestion to locate the PS so it can serve Phase 2, we agree and note that our cost estimate includes only for Phase 1 pump sets but also piping, valving, and structural considerations (at some additional cost) for convenient expansion.

- (vi) **Other facilities**
 - (a) If inter-filter backwashing is included in the WTP design, elaborate backwash water tanks and pumps will not be required.
 - (b) We are unclear to what by-products from water treatment refers and can only endorse the recycle of backwash water and supernatant from sedimentation tank sludge dewatering plant.
 - (c) We assume that the FS recommends to recycle water through the distribution chamber and endorse that recommendation.
 - (d) We recommend to include in the design sludge dewatering tanks to reduce the volume of sludge directed to sludge drying beds.
 - (e) We are not prepared to endorse the proposal to pump sludge to a sewer.
 - (f) We are not convinced that recycling sludge to enhance coagulation/flocculation would be beneficial but would endorse a side-stream pilot project to verify the utility of the proposal.

14.9 Detailed description of the plant

14.9.1 Inline water monitoring

190. We agree with the generality of the inline water monitoring recommendations.

191. We do not, however, agree with the recommendation to regulate plant inflow based on turbidity. Instead, we strongly recommend to include sufficient flexibility in the unit process that would be able to cope with turbidities in excess of “threshold”, which we interpret as 50 NTU (maximum per FS Figure 14-17).

192. We would endorse the added complexity of plant design to allow direct filtration only based on a pilot study since the average turbidity cited in Figure 14-17 of 20NTU that exceeds the US EPA guideline of 2NTU for application of direct filtration by an order of magnitude.

193. We recommend to add in-line monitoring of residual chlorine at various points in the plant, including: (i) upstream of post-chlorine addition, (ii) outlet of the chlorine contact chambers, (iii) outlet of the storage reservoirs, and (iv) in the discharge piping where it leaves the WTP site.

14.9.2 Raw water metering and flow regulation

194. We agree in general with the raw water metering and flow regulation provisions, except (in order):

- (i) We do not think regulating inflow with the 3 inlet valves is necessary. We recommend only open /shut, not modulating.

- (ii) We do not understand the purpose of the valve on the inlet pipe; if it is to regulate flow into the WTP, we recommend as above.
- (iii) The level of detail devoted to raw water sampling is superfluous, as that is one of many routine sampling points in a conventional WTP.
- (iv) Automation of the inlet regulating valve according to flow setting is unnecessary, We recommend non-automated open /shut.
- (v) Linking the start of all WTP equipment with the opening of the inlet valve implies a level of automation which we think inappropriate. Instead, we should ensure that the operations manual provided by the design-build contractor as a condition of his contract will detail the sequence of unit operations and their inter-relationship, whether it be manual or automatic.

14.9.3 Distribution chamber

195. We agree with the various details for the distribution chamber except, as variously noted, that we disagree with the regulation of the inlet valve by any means.

14.9.4 Rapid mixing chambers

196. We agree with the various details for the distribution chamber except we recommend to limit each line to one chamber. We do not agree to link the start of the rapid mixers with the opening of the inlet valve.

14.9.5 Flocculators

197. We agree with the various details for the flocculators and tankage except we recommend to consider providing tapered flocculation through 3 tanks in series, each equipped with variable speed flocculators. We do not agree to link the start of the flocculators with the opening of the inlet valve.

198. We do not understand the purpose of “by-pass facilities including 2 actuated valves between the flocculators and the filters – 2 lines to the filters”. If this arrangement is to facilitate direct filtration, we disagree with it.⁴⁵

14.9.6 Clarifiers

199. We agree with the various details for the clarifiers except, although not included in the description, the use of tube or plate settlers. We also do not agree to link the start of the clarifier mechanism with the opening of the inlet valve.

200. We question the operational utility of automating the speed of the scrapers and the timing of the sludge blow-down valves with inlet turbidity; however, since this provision is not costly and can be over-ridden by the operator, we have no objection. Perhaps a research project into the utility of this recommendation would benefit further WTP designs.

⁴⁵We note that the last FS recommendation under “Flocculators” appears to indicate a lack of understanding of the fundamentals of water treatment: it implies that direct filtration should occur without flocculation. In view of another unacceptable recommendation; i.e., to achieve treated water quality of only 5 or 10NTU, it is conceivable that an otherwise well designed plant could achieve 5 or 10 NTU based on 15 NTU raw water quality utilizing the connecting piping to induce some sort of floc formation. It is highly unlikely that the design-build contractor will offer this as a viable option.

14.9.7 Sludge pumping facilities

201. We agree with the various details for the sludge pumping facilities

14.9.8 Drying beds

202. In view of the fact that Saidabad 1 includes only two drying beds, we wonder why the FS recommends 20. The designer should review the need for so many drying beds (and associated piping and valves).

The FS is silent on modality and facilities for sludge handling. This must be addressed by the designers.

14.9.9 Rapid sand filters

203. We agree in general with the details proposed for the rapid sand filters and in particular with the provision of filtering to drain, except (in order):

- (i) We recommend to consider declining rate filtration because of its simplicity of control.
- (ii) We do not understand the relevance of All filter valves to be replaced including compressed air actuators – pipes and accessories. We assume it is a typographical error and will ignore it.
- (iii) We specifically do not agree to regulate filters linked with the opening of the inlet valve.
- (iv) We recommend to consider the addition of a surface wash system.
- (v) We note that automation of the backwash cycle is advocated, including the start of the backwash. We further note that the end of the backwash is not defined explicitly. It is usual to define the backwash cycles in terms of time, with the last cycle controlled by an experienced operator who stops the backwash before the water is clear.

14.9.10 Water metering at the outlet of the filters

204. This appears to be a gratuitous section as it provides information on components different from the title. We do not agree with chlorine dosage to the contact chambers controlled by inlet flow alone; rather, we prefer that the dosage is set through feed-back loop control based on chlorine residual.

14.9.11 Air scour blowers

205. We agree in general with the details proposed for the air scour blowers.

14.9.12 Backwash water pumps

206. We agree in general with the details proposed for the backwash water pumps except that we recommend only 3 units (2 duty+1 stand-by), which is sufficient to produce high and low backwash rates.

14.9.13 Back-wash recycling facilities

207. We agree in general with the details proposed for the backwash recycling facilities except that we recommend only 2 recycling pumps (1 duty+1 stand-by).

14.9.14 Contact and storage tank

208. We agree in general with the details proposed for the chlorine contact chambers and treated water reservoirs. We note that the last recommendation - to provide alarm before overflow and automatically stop back-wash process first, and after timer the entire WTP process – appears out of place.

14.9.15 Alum storage and dosing

209. We agree with the various details for the alum storage and dosing facilities except (in order):

- (i) Since we have recommended against direct filtration, we also do not agree with the injection of alum upstream of each filter battery.
- (ii) We also do not agree to link the start of the alum dosing pumps with the opening of the inlet valve.

14.9.16 Lime storage and dosing

210. We agree with the various details for the lime storage and dosing facilities except (in order):

- (i) Since it appears that lime is recommended for pH adjustment as a coagulant aid, we recommend to inject lime ahead of the rapid mix tanks, such as into a static in-line mixer.
- (ii) We do not agree to link the start of the lime dosing pumps with the opening of the inlet valve.
- (iii) We do not see the need for more than two dosing pumps (+ 1 stand-by) for pH correction in the two treated water discharge mains and in this connection, we note that there would be more than two suction pipes.

14.9.17 Full option (polymer) dosing facilities

211. We agree with the various details for the polymer storage and dosing facilities except (in order):

- (i) Since it appears that polymer is recommended for coagulant aid and specifically, cationic polymer, we recommend to base the initial selection of polymer for the WTP on a pilot study using Meghna River water at somewhat lower temperatures than were obtained during water quality sampling. An attempt should be made to calculate the lower temperature resulting from several hours of exposure to the underground pipeline.
- (ii) We do not agree to link the start of the polymer dosing pumps with the opening of the inlet valve.

- (iii) We make two recommendations based on the experience of the international water treatment engineer⁴⁶:
- (a) We recommend to pilot test polyaluminum chloride (PACl), which, if readily available, represents a less expensive option than aluminum sulphate.
 - (b) We recommend to provide polymer feed points at all filters such that a small dosage is fed at a precise time and duration to pre-coat the sand surface after a backwash.

14.9.18 Chemical storage room

212. We agree in general with the details proposed for the Chemical storage building.

14.9.19 Pre and post chlorination facilities

213. We agree with the various details for the pre and post chlorination facilities except we do not agree to link the regulation of the chlorinators with the opening of the inlet valve.

14.9.20 Instrumentation

214. We agree with the two general recommendations for laboratory equipment and sampling facilities and note that reference is made under the various unit process descriptions to individual unit process control and instrumentation. Usually, this section would refer to a PID.

14.9.21 Drainage issues to avoid flooding

215. We agree with the sentiment expressed in this section. We recommend that any critical components be designed for the 100-year flood level.

14.9.22 Gandharbpur treated water pump station

216. We agree with the general guidelines for the design of the Khilkhet treated water pumps and delivery piping. We have, however, some reservations about the proposed pump line-up. In order for centrifugal pumps in parallel to produce a design flow at a design head (here, 25,000m³/h at 25m TDH), each pump must be rated for more than 1/3 of the design capacity and head (here, 4,200m³/h at 25m TDH). We note that this is common procedure and fully expect the design-build contractor to submit calculations to support his pump selection for DWASA approval and ADB non-objection.

217. We agree in particular with the FS recommendation to provide variable speed (and thus, variable output) through frequency converter. How many of the pumps should be so equipped will be determined by the design-build contractor – our recommendation is for all, as we recommended for raw water pumps in the intake pump station.

218. The discharge piping of the treated water pumps will be about 800mm diameter. For such pipe size, we recommend motorized shut-off valves and our preference would be ball valves over gate valves. The type of valves finally selected will be determined through the design-build contractor's proposal.

⁴⁶ Hands-on experience gained during 4 years as Senior Engineer responsible for process and research at Metropolitan Toronto Water Supply Department in 4 WTPs (conventional and direct filtration plants).

219. **Controls.** We agree that the control method proposed can function. Since the water meter in each of the two 2000mm diameter distribution mains may be a revenue meter (if the WTP becomes a BOT PPP component based on a 500MLD take-or-pay agreement), great care must be exercised to select the meters to eliminate arguments about their accuracy. The design-build contractor should provide with his proposal evidence of the proposed meter's accuracy – such evidence should include certified factory test results and test witnessing by DWASA's construction supervision consultant.

220. **Level controls & Pressure meter outlet pipe.** We agree with the basic concept of pump control through level and pressure sensor signals; however, the detail design for approval by DWASA and non-objection by ADB should include a ladder diagram detailing each input and output of the intake pump station PLC(s).

14.9.23 Power Distribution at Gandharbpur WTP

14.9.24 Design parameters for transformers for WTP and treated water pumps

14.9.25 Power distribution system for WTP

14.9.26 Power distribution system for outlet pumps

14.9.27 Generator operation

We note that the TOR for the PPTA does not include the requirement for electrical expertise. Notwithstanding that caveat, we make the following comments.

(i) We are in general agreement with the discussion on main and stand-by power supply; high, medium, and low voltage selection; duplicate power distribution (main and stand-by); redundant transformers; reduced-voltage motor starters, and UPS-backed control voltage; except, perhaps, the control and signal voltage (24V DC).

(ii) The FS does not recommend the type of stand-by generator, diesel or natural gas. Since natural gas is abundant in Bangladesh, less expensive than diesel, and does not require potentially troublesome storage, natural gas is the preferred fuel and we recommend its application. Since potentially a large flow-rate is required, inter-ministerial agreement must be obtained to guarantee the supply.

14.9.28 Balancing reservoirs

221. We agree with the general discussion on the need for balancing reservoirs. We recommend that DWASA confers with IWM, whose staff are engaged with operating the water distribution network model and are currently preparing the Water Supply Master Plan for DWASA. That will recommend the size and location of the balancing/storage reservoir for the Gandharbpur WTP, if any. That recommendation must then be integrated with the basic design provided to prospective bidders, if the cost impact is acceptable. If not, the reservoir could be deferred and direct pumping to distribution, as done at present, continued as an interim measure.

14.10 Power Supply Consideration

14.10.1 Power demand for main plants

222. We agree with the brief description of, and estimate for, the power demand of the intake and WTP. We note that the FS advises that “considerable investments [are] necessary” for the provision of power supply, both grid-supplied and through stand-by. However, the FS cost estimate does not include for these project components whereas our cost estimates (capex and opex) do.

14.10.2 Sources of power supply

223. We agree with the options presented.

14.10.3 Power from National grid

224. **Supply to Bisnondi intake and Gandharbpur.** We agree that Rural Electricity of Bangladesh (REB) and Dhaka Electric Supply Company Ltd (DESCO) are the agencies responsible for 33kV power supply to the intake and Gandharbpur WTP respectively.

225. We note that the alternative of an intake at Kanchan Bridge will not be considered and therefore, power supply is not an issue.

14.10.4 Power generated by gas generators

226. We note that the two gas suppliers, Petrobangla for the intake and Titas Gas Co.Ltd for Gandharbpur, may be reluctant to commit to supply gas for the project due to a general lack of capacity of gas in Bangladesh. We recommend that the steering committee, through inter-ministerial assistance, obtains a Memorandum of Understanding (MOU) from the gas companies for sustained gas supply for the project.

227. As a back-up, we recommend that consideration be given to specify that the drivers for the stand-by power generating be designed to run on diesel or compressed natural gas (CNG).

14.10.5 Diesel generators

228. We agree with the reservations noted regarding diesel as fuel for the gen-sets.

14.10.6 Proposed supply of power

229. We agree that the primary power for the project should be provided from public grids. We recommend to fully explore the secure availability of natural gas for stand-by power fuel; however, DWASA should consider opting for dual-fuel engines in case natural gas becomes less available.

14.11 Philosophies of the control system

230. We agree with the control philosophy presented and expect that the design-build contractor will provide a fully documented description of it, including specifications for Man Machine Interfaces, events printers, and data storage and ladder diagrams for all Programme Logic Controllers and Remote Terminal Units, with his proposal for approval by DWASA and non-objection by ADB.

14.11.1 Automation technology

231. We are intimately familiar with the potential of full automation to reach the objectives noted in the FS. We also know from experience that automatic systems fail and that such failures need to be addressed immediately by on-site, highly trained and experienced electronics and control technicians. We do not believe that there is sufficient experience in Bangladesh in those disciplines and that hiring such expertise from abroad may be too costly. We therefore recommend that the design-build contractor provides a plan that describes in detail in an operations manual the operation of the intake PS and WTP, including the response from the operators in case of system failure of the automatic features. Ultimately, it will be people who are responsible for reaching the objectives stated and that means, people need to be able to over-ride all automatic functions envisaged.

14.11.2 Control concept

232. We agree in general with the details presented and add that the software should allow for real-time operator-selectable trend displays of various treatment parameters including incoming and outgoing pH, alkalinity, turbidity, chlorine residual, various flow rates, and various levels.

233. Control and monitoring communication between the Intake PS and Gandharbpur WTP. We recommend that the design-build contractor propose a secure communication system for digital signals (we do not see the need to transfer analog signals as noted in the FS) between the intake and the WTP that will be based on the best available technology at the time.

14.12 Cabling and installation

234. We agree with the details presented in the FS for cabling and its installation.

14.13 Building Services and Installations

235. We agree with the details presented in the FS for building services and their installations. We recommend to add the following:

- (iv) Telephones connected to the control room from various strategic locations throughout the WTP and intake.
- (v) Strategically located toilets for men and women.
- (vi) Strategically located refrigerated water fountains fed from the treated water pump header.

15. TRANSMISSION SYSTEM REQUIRED TO SUPPLY WATER FROM GANDHARBPUR

15.1 Introduction

15.2 Existing Transmission System

236. The introduction and brief description of the existing transmission system is noted.

15.3 Existing estimated water demand in zones

15.4 Hydraulic Model Construction

15.5 Basis of Analysis

15.6 Design Scenario

15.7 Transmission System Required to Supply Water from Gandharbpur

We believe that it is beyond the scope of the PPTA to study the various considerations on which the overall water supply for Dhaka has been planned. We believe that IWM is a competent organization and that the modeling on which the design requirements for the Khilkhet WTP project are based and which were adopted by the FS authors (DMC) are appropriate. Furthermore, we believe that the FS captures all of the design requirements and has addressed them, with a few exceptions noted in our review and with the addition of a few recommendations.

237. We note that the only design considerations for the Gandharbpur WTP project are:

- (i) 500MLD potable water to WHO and Bangladesh quality standards or better, as recommended and treated water pumps capable to provide flow for a daily peak factor of 1.2.
- (ii) An intake on the Meghna River designed for 2000MLD.
- (iii) A raw water pump station designed to provide 1000MLD in two directions: (a) 525MLD to Gandharbpur WTP and (b) 475MLD to Saidabad existing box culvert.
- (iv) Raw water transmission mains: (a) one 2200 mm diameter from intake to Gandharbpur WTP, (b) one 2200mm diameter from intake to Saidabad existing box culvert.
- (v) Large diameter treated water transmission mains from Khilkhet WTP to Dhaka water distribution network totaling some 34km⁴⁷.

15.8 Equalization storage close to treatment plant

238. We note that the design consideration for the equalization storage at the WTP are distinct from the design considerations for the WTP. We also note that Figure 15-11 incorrectly shows the average flow from the WTP as 520MLD; it is 500MLD.

16. DETAILED COST ESTIMATES

239. The assumptions for the cost estimates at feasibility stage have been done in adequate detail and we agree with the source accuracy of most derived unit rates. We note, that the estimate includes some Phase 2 components but excludes some other required cost components, only some of which are noted in the FS. We have prepared new cost estimates that are segregated to facilitate extraction of cost items into separate components that may comprise a PPP private investment.

16.1 Capital Cost

240. We agree with the approach to feasibility cost estimation taken in the FS and have adopted many of the unit rates. Our estimate differs in 4 respects:

⁴⁷Approximately 13km 2000mm dia, 0.9km 1800mm dia, 13.2km 1400mm dia, and 6.4km 1000mm dia.

- 1) we have added certain sums for project components left out and others additionally proposed (e.g., the access road, social safeguards costs, and sludge dewatering),
- 2) we have added for design and construction supervision (5.5% and 5% respectively, with 0.5% added to the design cost to account for expandability), and
- 3) we have included costs explicitly excluded in the FS (custom duty, VAT and other taxes, cost of resettlement and compensation actions, consultancy services, and land acquisition).
- 4) We have verified the most significant unit rates by comparison with our own company cost data base and recent similar projects. We also obtained new suppliers quotations to ensure the supply cost of the recommended pipe (GRP) was viable. Where we found significant difference, we have used new unit rates.

Assumptions in Cost Estimate:

The FS project cost estimate has been revised using new costs and rates where we disagree with the FS, and includes costs for all our revised recommendations. Our updated project cost estimate covers only Phase 1 investments, as detailed in Table 11, and assumes:-

- 1) Pipe cost rates for the following materials:
 - GRP for the raw water pipes to Gandharbpur and Saidabad
 - DI from WTP to Dhaka and within Dhaka
 - Steel for river crossings
- 2) Steel pipe bridges at river crossings
- 3) Partially manual control of the WTP.
- 4) Duty and VAT should be included on all materials, as advised by DWASA citing Saidabad as an example where DWASA paid duty and VAT on all M&E equipment. The cost estimate includes:
 - (i) Civil works: VAT and tax on basic price excl. overhead and profit (O&H)
 - (ii) M&E equipment, including pipes: 60% Duty and taxes on ex-works invoice price

The 60% is based on advice from DWASA and actual duty invoices for recent M&E imports, which indicate the duty breakdown shown below.

Table 14: Duties + Tax Rate Estimates from DWASA HS Codes

| Duties + Taxes due on Imports | | Electric | Pipes ⁽²⁾ | | |
|-------------------------------------|------------------------------|------------------------|---------------------------|--------------------|---------------------------|
| Payable on Invoice Price (ex-works) | | Equip't ⁽¹⁾ | Steel | GRP ⁽³⁾ | DI |
| CD | Custom Duty | 25% | 25% | 5% | Information not available |
| SD | Supplementary Duty | 0% | 0% | 0% | |
| VAT | VAT | 20% | 15% | 15% | |
| AIT | Advance IncomeTax | 5% | 5% | 5% | |
| RD | Regulatory Duty | 5% | 5% | 0% | |
| AVT | Advance Trade VAT | 0% | 3% | 3% | |
| DF | Document Process Fee | 0.0% | Information not available | | |
| CV | VAT on C&F Commission | 0.2% | | | |
| ITC | Income Tax on C&F Commission | 0.1% | | | |
| Total Assessment | | 55% | 59% | 29% | 60% |

(1) Source: DWASA project invoice

(2) Source: HS Codes from DWASA

(3) HS Code 70195910 for "Fibre Glass for deep tube well" but for 70195990 "Other fibre Glass fabrics" TTI = 37%

This suggests 55 to 60% duty+taxes are applicable, and this might be reduced by 5% for the AVT, which is adjustable /refundable, but DWASA advise from experience on Saidabad that overall duty varies from 50% to 70%, depending on type of material and other factors. It was not possible to obtain definitive data on the different duty rates, and which HS codes applied to pipes. It seems that duty is not always assessed consistently, so we have adopted an average of 60% for all imported materials.

The big difference between 29% total duty + taxes for GRP pipes vs. 60% for others is very significant, and uncertain. Contradictory information was provided which didn't related specifically to large pipes (footnote 3). If such a low duty rate does indeed apply to large imported GRP pipes, it will strongly favor selecting this pipe material, but if DWASA pays the duty on behalf of contractors, it will not influence their choice at bidding. The duty rate must be verified by DWASA before bid document preparation.

Our updated project cost estimate below covers all Phase 1 investments, as listed in Table 2

Table 15: Project Cost Estimate (excl. Saidabad)

| Component | Cost \$ |
|---|--------------------|
| 1.0 Intake | 30,092,888 |
| 2.0 Gandharbpur WTP | 111,062,358 |
| 3.0 Pipelines | |
| 3.1 Intake to Juice Factory | 57,178,062 |
| 3.2 Juice Factory to WTP | 19,063,019 |
| 3.3 WTP to Injection point + 21 km of Distribution Reinforcement | 102,158,317 |
| 4.0 Other costs | |
| 4.1 Land acquisition | 75,759,329 |
| 4.2 Power supply (G) | 1,543,750 |
| 4.3 Power Supply (S) | 0 |
| 4.4 River study & Modeling | |
| 4.5 Environmental cost | 323,638 |
| 4.6 Social cost / resettlement | |
| 4.7 IDC | 19,981,668 |
| 4.8 Recurrent cost of PMU | 2,348,403 |
| 4.9 Price contingency | 59,241,177 |
| 4.10 Duty & taxes | 95,343,438 |
| 4.11 Construction supervision | 13,169,365 |
| Total Cost (Excl Saidabad pipes, mech / elec, but incl full intake and pump stn) | 587,265,412 |

Table 16: Tentative Financing Plan (excl. Saidabad)

| | | |
|-----|-------|-----|
| ADB | 37.4% | 220 |
| AFD | 17.0% | 100 |
| EIB | 17.0% | 100 |
| GoB | 28.5% | 167 |
| | Total | 587 |

Notes

1. Includes 5.5% design, 5% supervision, 15% contingencies
2. 4% VAT + 5% Tax on civil works only, excl. OH and profit
3. 60% Duties + Taxes on imported pipes + equipment..

16.2 Operation and Maintenance Costs

241. We have adopted essentially all of the O&M costs detailed in the FS, except that the foreign exchange conversion rate has changed from BDT70/\$ in the FS to BDT80/\$. Our capital and O&M cost estimates are in Appendix 6.

C. FS APPENDICES

FS Appendix 1: Water Demand Calculations

FS Appendix 2: Hydraulic calculations and cost of pipeline construction

FS Appendix 3: Comparison of pipe material.

FS Appendix 4: Net Present Calculations of Investments.

We have addressed the contents of these appendices.

FS Appendix 5: Comments and Clarifications to Final Draft

D. Volume I – 3: DRAWINGS

E. Summary Opinions on other FS volumes

242. Vol I-3 contains all topographic maps for the three routes (intake to Sejan juice factory, Sejan juice factory to Demra, and Sejan juice factory to Gandharbpur) showing contours, land features, structures, center lines of pipeline corridors, and cadastral plots. Since the cadastral survey (CS) was performed over 70 years ago, the plots and their assigned plot numbers are no longer current and consequently, are of no use to the social surveyors. Consequently, we produced mapping in GPS coordinates that reflects current ownership, in accordance with the Revised Survey (RS) and mouza maps.

Volume II - Morphological Assessment of Intake Sites

243. The morphology study for the assessment of intake sites was not convincing. Consequently, we recommended that it be reviewed by a bona fide expert to either endorse its findings or recommend and specify further study and possibly, a physical model study. . Our review comments of the report are in Appendix 8.

Volume III Geotechnical Report

Volume IV Hydrogeological and hydrological Considerations

Volume IV-1 Determination of minimum and maximum flow in Sitalkhya and Meghna rivers

Volume IV-2 Dhaka Area Hydrogeological Assessment

Volume V Water Treatment
V-I Water Treatment Design Report
V-II Water Treatment Functional Analysis
Volume VI Dhaka Transmission system
Volume VII Topographic Survey
Volume VIII Preliminary Environmental Assessment
Volume IX (SIA)

A preliminary SIA was mentioned in the FS and we unofficially obtained a copy as DWASA did not approve it. The preparation of our Social Impact Assessment and Resettlement Plan was delayed due to several reasons, including a large number of public disturbances and the difficulties to obtain useful survey and land title information. Consequently, these documents will be submitted under separate cover.

III OTHER TOPICS

244.

The following topics were included in our TOR but were not in the FS:

- Waste Water
- Institutional Development
- Gender & Poverty
- Project Finance and Economic Analyses
- Legal Framework
- Contract Packaging and Operational recommendations

A. Waste Water

1. Introduction

245. There are two main components referenced in the TOR; namely, waste water generated at the Gandharbpur WTP and the effects of additional water supplied to the Dhaka distribution system. The latter were subject of the PPTA Waste Water & Sewerage component. In addition, the issue of sludge and septage management is implied as it is discussed in the Dhaka Sewerage Master Plan (SMP).

246. We have reviewed DWASA's plan to collect, treat, and dispose of the resulting sewage and the sludge produced by the augmented amount of water directed into the Dhaka water distribution system, approximately 75% of which will be converted to domestic sewage⁴⁸. The PPTA team considered which of the Phase 1 and Phase 2 priority projects outlined in DWASA's sewerage master plan⁴⁹ could be prepared to tender stage⁵⁰.

247. The effects of additional water supplied to the Dhaka distribution system are in principle foreseen in the SMP; i.e., it sets out priority projects to cope with initially 500 MLD water supply from the Gandharbpur WTP as discussed in this section. Our progress of the activities on the Waste Water & Sewerage Component is summarized in Table 12.

2. Review of SMP 2012

248. The review of the SMP is summarized in Appendix 9 - Annex 1 including recommendations for improvements and extensions. Besides chapter-wise detailed findings, comments, and recommendations, the main observation is that the SMP covers in principle

⁴⁸The incremental volume of waste water is estimated at 70% of the Khilkhet WTP due to groundwater replacement of which approximately 75% will end up as sewage; i.e., 263 MLD.

⁴⁹ Dhaka Sewerage Master Plan Project Package DS-1A, funded by DWASA

⁵⁰ Tendering implies pre-design unless the design-build option is preferred, in which case, performance specifications are required.

all DWASA MODS areas with adequate sewerage and STP construction projects with priorities in line with the planned water supply schemes in DWASA's 50-year Water Supply Master Plan. However, the recommended waste water treatment technologies (trickling filter) are reportedly replaced by activated sludge systems, which may entail considerable consequences for type and amount of sludge generation and its more complex treatment and disposal technology are not properly addressed in the SMP. This will need further consideration by DWASA consultants for detailing of the priority projects. Phase 1 priority projects as listed in the SMP are defined, funded, and under preparation so there is no need for further PPTA work on this issue. Phase 2 projects as listed in Table 19 are under development by DWASA and will be prepared to tender stage by DWASA consultants (reportedly Development Project Proposals (DPPs) have been prepared).

Table 17: Waste Water & Sewerage Component – Progress to date

| No. | Task | Progress | Status |
|----------|---|---|--|
| 1 | <i>Review of the DWASA Sewerage Master Plan (SMP)</i> | | |
| 1.1 | Selection of relevant priority projects, including improved sewage and septic tank sludge processing out of the (SMP) | The SMP has been reviewed and priority projects have been selected. Referred is to Annex 1 ⁵¹ for the SMP Review and Annex 2 for the list of selected priority projects. Alternatives for sludge disposals are presented in Annex 4. | Completed |
| 1.2 | Cost estimate of priority projects | Largely available in the following vital information sources: (i) Sewerage Master Plan (SMP) Report: Appendix 6 - Cost Estimates for Wastewater Treatment. (ii) Development Project Proposal (DPP) for Sewerage Systems and Sewage Treatment Plants at Uttara and Mirpur. | The requested SMP appendices were received on 4 December 2012 and have been reviewed The DPP has not been received yet. |
| 1.3 | Identification of potential sources of funding | Sewerage Systems and Sewage Treatment Plants at Uttara and Mirpur are not funded yet. | Further investigation were cancelled. |
| 1.4 | Description of importance of priority projects | The importance of the proposed priority projects (Sewerage Systems and Sewage Treatment Plants at Uttara and Mirpur, and septic tank sludge management) is discussed in this report. | Completed |
| 2 | <i>Actions for sound operation and management (O&M)</i> | | |

⁵¹Where Annexes 1 - 4 are referenced in this section, they are located in Appendix 9.

| No. | Task | Progress | Status |
|----------|--|---|---------------------------|
| 2.1 | Inventory and assessment of O&M actions, including improved sewage and septic tank sludge processing | Inventory and assessment of O&M actions on bases of the SMP for the proposed priority projects are formulated and presented in Annex 3. | Completed |
| 2.2 | Rehabilitation and removal of existing sewerage system | This work is supposed to be included in the ongoing detailed designs of the priority projects by the design consultant | Cancelled |
| 3 | <i>Program of investments</i> | | |
| 3.1 | Preparation of a prioritized program of investments | The prioritized investment program is included in the SMP 2012. | Skipped because redundant |
| 3.2 | Preparation of an implementation schedule | Ditto | Ditto |
| 4 | <i>Overview of PPP schemes</i> | | |
| 4.1 | Prepare an overview of PPP schemes | A brief overview of PPP Schemes for O&M actions is included in Annex 3. | Completed |
| 5 | <i>Diagnostic review of regulations, policies, and guidelines in Bangladesh relevant to PPP</i> | | |
| 5.1 | Prepare the diagnostic review | No actions taken as per decision of the TL and Project Director. | Cancelled |
| 5.2 | Analyzing PPP options | No actions taken as per decision of the TL and Project Director. | Cancelled |
| 6 | <i>Preliminary set of proposals with outline scope of consulting services</i> | | |
| 6.1 | Preparation of proposals | No actions taken as per decision of the TL and Project Director. | Cancelled |
| 6.2 | Preparation of draft TOR | No actions taken as per decision of the TL and Project Director. | Cancelled |

3. Considerations and Recommendation

249. Increased water supply from the Gandharbpur WTP

250. The Khilkhet WTP Feasibility Study shows that the projected water supply from the Khilkhet WTP will serve the population with water supply as listed in Table 11.

Table 18: Water Supply from Gandharbpur WTP

| MODS Zone | Name | Population | % | Water supply (MLD) |
|-----------|---------|------------|------|--------------------|
| 04 | Mirpur | 537,300 | 36% | 178 |
| 05 | Gulshan | 253,050 | 17% | 84 |
| 08 | Badda | 536,621 | 36% | 178 |
| 09 | Uttara | 179,907 | 12% | 60 |
| Total | | 1,506,878 | 100% | 500 |

251. We learned through review of the Dhaka SMP and interviews with DWASA officials that the increased waste water volume from Zone 05 and 08 (together 262 MLD) will be fully absorbed by the ongoing government-funded Dasherbandi sewage collection system and STP (500 MLD) development project (Phase 1 Priority Projects). So no input from PPTA is envisaged in this respect. However Zones 04 and 09 have as yet no funding for facilities to treat their share of the increased water supply (178 and 60 MLD respectively). For this reason, DWASA is planning the construction of sewerage systems and Sewage Treatment Plants at Uttara and Mirpur on priority basis and reportedly, a DPP has been developed.

252. **Importance of Phase 2 Priority Projects.** Table 19 lists priority projects for Zones 04 and 09 identified by DWASA:

Table 19: Phase 2 Priority Projects

| | Project | Dimension/ Capacity | Details | Cost estimate (\$million) |
|----|-------------------------------|------------------------|---|------------------------------|
| 1. | Sewerage Dhaka North (Uttara) | Not yet available* | Construction of the sewerage system and transmission mains to the new STP | 57 |
| 2. | Sewerage Dhaka West (Mirpur) | Not yet available* | Construction of the sewerage system and transmission mains to the new STP | 86 |
| 3. | STP Dhaka North (Uttara) | 240,000 MLD | Construction of a new sewage treatment plant | 80 |
| 4. | STP Dhaka West (Mirpur) | 420,000 MLD | Construction of a new sewage treatment plant | 140 |

253. These projects are directly related to the increased water supply from the Khilkhet WTP. Funding of these projects is not yet assured and as such subject of further investigation by DWASA.

4. Key issues requiring government consideration and policy decisions

- (i) Reconsideration of the waste water treatment technologies to be applied under the SMP (the initial recommended 'trickling filter' technology offers better sludge processing, disposal and energy recovering potential than the currently favored more advanced activated sludge technology whereas the operation and maintenance costs will be significantly lower, unless high levels of BOD, COD, N, and P removal are required based on environmental or legal considerations).
- (ii) Environmental assessment should be undertaken into the required removal levels of waste water treatment system for BOD, COD, total nitrogen (N_{tot}) and total phosphorus (P_{tot}) in order to select the minimum required treatment technology.
- (iii) Extensive technical and feasibility study is recommended into STP sludge processing and disposal as this is an increasing environmental problem.
- (iv) Combined STP and septage processing at the new STPs to be constructed under the SMP should be seriously considered as the probably most economic and practical way to deal with both problems.
- (v) Small Bore Sewer Systems should be reconsidered as economic and practical sanitation solution for urban poor settlements in spite of earlier failures and difficult but not insuperable organizational and managerial aspects.

254. The tangible outputs of the work on the waste water component of the Khilkhet WTP Project PPTA are presented in the annexes of this section that can be found in Appendix 9.

- Annex 1 - Review of the Dhaka Sewerage Master Plan (March 2012)
- Annex 2 - Identified Priority Projects from the Sewerage Master Plan (March 2012)
- Annex 3 - Actions for Sound Operation and Management (O&M)
- Annex 4 - Alternatives for Sludge Disposal

B. Institutional Development

255. In this section, we present (i) Institutional Assessment, (ii) Financial Management Assessment, and (iii) a 20-year Financial Forecast of DWASA operations.

1. Institutional Assessment

256. **Introduction.** DWASA is embarking on a major investment to increase water supply to a growing population of Dhaka and to ensure sustainable sourcing of water. Financing of this investment will come from different sources including ADB, other cofinanciers, and may include the private sector. The objective of the institutional assessment component for the PPTA is to undertake a capacity assessment of DWASA and if required, propose ways and means to strengthen the capacity of DWASA and related agencies. Specifically, the objective is to enhance competence levels; i.e., the skills and ability to cope with the required practices and technology that will allow the sectoral achievement of the government's goal, which is improved access to more reliable and sustainable water supply for greater Dhaka City.

257. **Institutional arrangements.** Currently, DWASA is implementing water and sanitation sector development programs with separate consultancy services addressing financial and capacity building (FCB) and project performance monitoring. This program has addressed several key reform and organizational issues impacting DWASA operation. Our assessment of the DWASA capacity and organization follows from discussions with the FCB team and various officials of DWASA..

2. Capacity assessment of DWASA

The FCB team undertook a comprehensive review and assessment of the human resources of DWASA. A training needs assessment (TNA) was carried out for all the Class 1, 2, and 3 employees. Following the TNA, a detailed 5-year Human Development Plan (HDP) has been prepared. The Board of DWASA approved the HDP and implementation started in 2010. This plan provides systematic strategies for human resource development and proposes comprehensive trainings on relevant areas in order to strengthen management and staff skills and institutional capacity for managing and operating DWASA. Our assessment of DWASA capacity and skills level of staff heavily relies on this recent assessment. However, focus is placed in the areas of financial management, procurement, and technical areas of operation.

258. **Organization.** DWASA is a service oriented, autonomous, commercial organization in the public sector, entrusted with the responsibility of providing water supply, sewerage, storm water drainage services, and environmental health management. Its jurisdiction covers Dhaka and Narayangonj cities encompassing more than 360km² service area.

259. DWASA was established in 1963 as an independent organization under the East Pakistan Ordinance XIX of 1963; namely, The Water Supply and Sewerage Authority Ordinance 1963. In 1989, the drainage system of Dhaka City was handed over to DWASA. In the year 1990, water and sanitation and drainage service of Narayangonj City were added to the operational responsibility of DWASA. Since then, it has been expanding its service domain and upgrading level of services to keep pace with the growing demand. Now, Dhaka WASA is functioning under the newly approved "Table of Organization & Equipment" run by the Dhaka WASA Board, which consists of 13 members who formulate policy and provide overall guidelines. The chief executive of DWASA is the Managing Director.

260. The service area of WASA is divided into 11 Maintenance, Operations, and Distribution Services (MODS) and Revenue Zones. Several reform agendas have been initiated by the government through the Dhaka Water Supply Sector Development Program

(DWSSDP) relating to its governance and operational matters, the most significant of which are outlined below.

- (i) As per the WASA Act, 1996 coupled with the Financial Regulations⁵², DWASA has the power to exercise financial autonomy to manage its affairs.
- (ii) As per WASA Act 1996 together with the Service Regulations 2009, DWASA has autonomy in matters of personnel management.
- (iii) DWASA can borrow money from commercial banks or any other financial institutions to perform its responsibilities. The terms and conditions of borrowing will be fixed by the government, if the borrowings are taken from the government or its guarantors.
- (iv) Under section 4 of the WASA Act 1996, the Share Capital of DWASA will be fixed as determined by the government and all share capital will be assumed by the government. The capital may be increased by the government from time to time for its necessity.
- (v) DWASA Board⁵³ approves investments funded from its own sources. For investments by the government, the Executive Committee of National Economic Council (ECNEC) approves large investments. The Prime Minister is the chairperson of the committee and the finance minister is the alternative chairperson.

261. The present organogram as shown in Figure 9 was approved in 2009. According to the management, the organizational structure is appropriate and reflects the service requirement and planned geographic expansion of DWASA. The total number of staff positions is 4,375 of which 3,294 are currently employed.

262. **Technical.** The Operations and Maintenance (O&M) department of DWASA consists of 3,169 staff. A deputy managing director heads the unit and the chief engineer of O&M reports to him.

263. DWASA has established a total of 11 MODS areas throughout the Dhaka metropolitan area to undertake O&M activities. The number of staff in each MODS varies and according to the DWASA officials, capacity is inadequate to undertake appropriate O&M requirements. This limits the effectiveness of these zones. Additionally, funding shortage constrains proper O&M activities.

264. There is a lack of coordination between the O&M and other departments within DWASA. Functions performed by other departments directly impact efficient operation of the O&M department. For example, when MODS require chlorine for water treatment, purchase orders are placed to the procurement unit where often delays occur. This is not to say that there is a lack of synergy and cooperation between O&M department and other departments and units of DWASA but to point out that efficiency of the O&M department significantly depends on having adequate funds, number of personnel, and reasonably satisfactory responses from other departments.

265. The FCB team has prepared an O&M manual and training has been provided to a number of the staff. However, the training will remain limited since it is impossible to provide training to over 3,000 personnel through the present training program under DWSSDP. We strongly recommend that it continue even when implementation is completed.

⁵²Dhaka Water Supply & Sewerage Authority (Financial) Regulations, 2009 were published in gazette on 27 July 2010.

⁵³ Under section 34 of the WASA Act 1996

266. **Procurement.** DWASA being a public utility follows rules and regulations framed by the government. Many procurement initiatives are financed by international financial institutions (IFIs) and donor resources and it is mandatory to follow the rules and guidelines of IFIs and donors. Therefore, DWASA complies with both government and IFIs and donors. The majority of large-scale procurement occurs under projects financed by ADB and the World Bank (WB) under their respective procurement rules and guidelines that are applicable for all procurements of goods, works, and services.

267. Procurement of goods and services under government financing and internal funds of DWASA is conducted under the guidelines of the Public Procurement Rules 2008 following a competitive bidding process. Tenders for works and services follow a two-stage process of shortlisting by evaluating qualifications and capacity of interested bidders and with review of technical and financial positions of bids. Over 90% of all bids are for goods conducted by reviewing quotations and selecting the least cost products.

Figure: DWASA Organogram

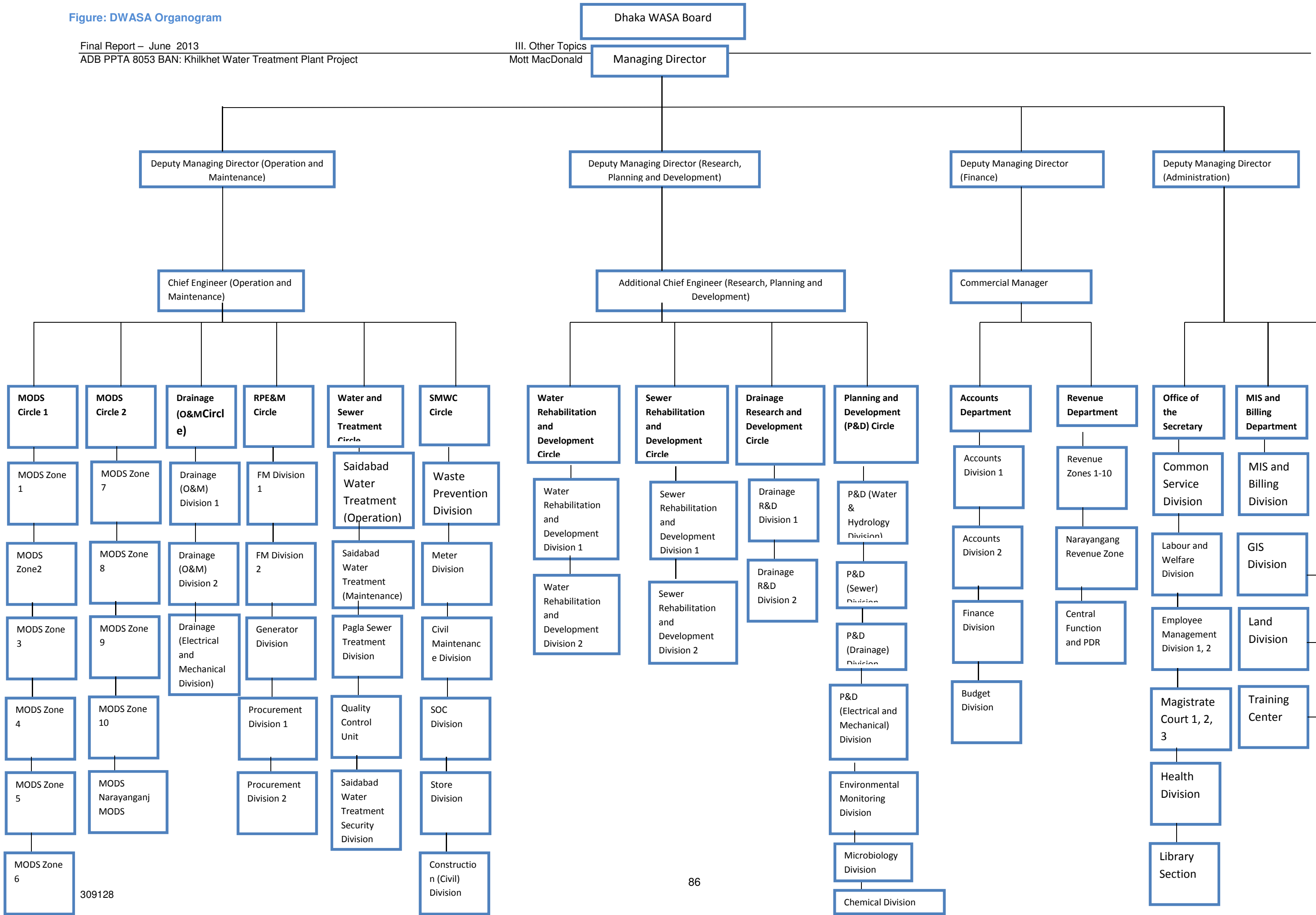


Table 20: Relevant Procurement Guidelines for DWASA under PPR 2008

| Relevant Procurement Guidelines for DWASA under PPR 2008 | | |
|---|------------------------------------|---|
| PW1 | National/International Procurement | Standard Request for Quotation Document for Procurement of Works under Request for Quotation Method (SRFQ) (for values up to BDT0.5 million) |
| PW2 | National Procurement | Standard Tender Document for Procurement of Works under Limited Tendering Method (STD) |
| PW3 | National Procurement | Standard Tender Document for Procurement of Works under Open Tendering Method without Pre-qualification (STD) (for values up to BDT350 million) |
| PW4 | National Procurement | Standard Tender Document for Procurement of Works or Design Build Infrastructure under Open Tendering Method (STD) (for values above BDT350 million) |

268. Purchase Department Project Division is responsible for procurement. On receiving the approved requisition from the concerned department the Purchase Department takes initiative to complete the formalities required as per guidelines.

269. The following steps involve the procurement process:

- (i) Preparation and approval of a procurement plan outlining the entire procurement;
- (ii) deciding on the procurement method;
- (iii) preparation of terms of reference and tender documents by the Procurement Committee;
- (iv) publication of procurement notice (expression of interest and pre-qualifications criteria);
- (v) shortlisting and issuing Request for Proposal (RFP);
- (vi) tender evaluation and selection of firms;
- (vii) signing of contract document;
- (viii) delivery of goods/completion of works and services; and
- (ix) work order for goods follow inspection procedures, payment, and monitoring procurement.

270. DWASA does not have experience with PPP procurement/agreements. Although similar in approach as above, PPP procurement includes review, analysis, and negotiations of commercial and technical details that require knowledge and skills not available within the organization.

271. **Management.** The DWASA Board consists of 13 members from various disciplines including its chairman. The Board is the governing body of DWASA. In the spirit of the WASA Act 1996, the Board should perform its functions in full autonomy. However, political interference is not uncommon. The Managing Director (MD) and Deputy Managing Director (DMD) are employed on a contractual basis with a term of four years. They are recruited

from outside the organization on commercial terms and conditions. The salaries and benefits of staff at other levels are fixed as per the public service benefit structure with no incentive packages.

272. For several years the governance of DWASA has been strengthened such that the DWASA Board and MD are currently able to exercise their powers without undue interference from the government. Management is able to rationalize staff positions, recruitments, and operations. Because of short tenure and high turnover of management in the past, DWASA suffered from many operational difficulties that hurt its performance. It appears that recent reforms and “turn around program” introduced by the new MD are gradually turning DWASA into a more laudable and effective organization. A review of DWASA operations by ADB in late 2011 pointed out that, “the current assessment is – per provisions of the WASA Act 1996, coupled with the Service Regulations – that DWASA has sufficient autonomy in personnel management...strong management and expert board – DWASA is gradually gaining ownership of its operations.” It appears that indeed much gradual improvement in operations is being made by DWASA with continued encouragement from the government and an effective management and board.”⁵⁴

3. Review of progress of ongoing capacity development programs and sector reform issues

273. In December 2007, ADB approved a program loan, a project loan, and a TA grant to the government for the Dhaka Water Supply Sector Development Program. The aim of the Program is to contribute to sustained economic growth and improved health conditions in the urban centers of Bangladesh by improving the water supply services. ADB’s Special Funds resources financed the program loan of \$50 million, the project loan of \$150 million, and the TA grant of \$2.5 million.

274. With the support of the DWSSDP as well as a DWASA Turnaround Plan, several key issues relating to administrative and financial autonomy of DWASA were addressed, including: (i) strengthening of capacity of staff with increased budget allocations for training, (ii) development of a comprehensive human resources strategy, and (iii) development of a 5-year business plan have been addressed.

275. The following achievements outline the progress of ongoing capacity development programs:

- (i) DAWSA has prepared an organogram and is implementing its organization structure by recruiting new staff and personnel.
- (ii) The accounts have been fully computerized and currently up-to-date accounts are produced. However, they remain incomplete because of the late processing of revenue details from the Zonal sites.⁵⁵ The audited accounts of FY2012 have been made available in December 2012.

⁵⁴Bangladesh: Dhaka Water Supply Sector Development Program (Second Tranche): Progress Report on Tranche Release November 2011

⁵⁵For details see Financial Management Assessment report

(iii) DWASA financial performance has considerably improved and with ongoing programs for computerization and efficiency improvements further strengthening of financial management are expected to occur.

(iv) The 5-year Business Plan is being annually updated. The FCB team is carrying out training and workshops to strengthen staff skills in order to enable preparation of corporate plans without outside assistance.

(v) To strengthen the existing financial control systems, a Finance and Accounts Manual comprising 13 relevant sections has been prepared. Once the manual is approved by the management, intensive training on operation flow, computerization, and accounting systems will be carried out.

(vi) Although the billing and collection process and accounts have been computerized, the two processes are being integrated through the development of computer networking systems.

(vii) Public education and citizens' awareness campaigns are being carried out to involve citizens in the activities of DWASA for more transparency and to spread important messages such as water conservation. Since January 2012, several NGOs⁵⁶ have been contracted to carry out consumer perception studies and report on consumer satisfactions. They are also engaged in carrying out campaigns for water conservation, meter reading, and water supply features/facilities for better maintenance especially among low-income communities.

(viii) Under the DWSSDP project, around 46 training courses have been provided. The majority of the training has been provided through the DWASA training center, while a few have been conducted in other specialized institutions⁵⁷. Only one course has been provided internationally⁵⁸. So far, around 800 DWASA employees have received training. Table 21 shows the type and number of employees undertaking training. In order to build the capacity of the DWASA training center and help facilitate to be sufficient, external trainers are sometimes brought in. DWASA established a Training Center in 1980 with two branches: (i) engineering and (ii) administration and finance. These branches provide training to DWASA employees in their respective fields. In FY2010-11, the Training Center carried out most of the organized training for over 400 DWASA personnel. Aside from the training provided by the Training Center external institutions such as Bangladesh Public Administration Training Center, Planning and Development Academy, Bangladesh Computer Council, Institute of Diploma Engineers, Institute of Personnel management, BUET etc. are also engaged to train DWASA staff.

Table 21: Training provided under the FCB component

| | No Trainings | No Officers | No Staff |
|---------------------|--------------|-------------|----------|
| Management Training | 13 | 181 | 58 |

⁵⁶DWASA has partnered with 19 NGOs. They are DSK, WSUP, Water Aid, Plan International, UNICEF, Desh Bidesh International, Resource Integration Center, Shobar Jonno Pani, Prodipon, FULKI, ASD, BASA, NDIBUS, PSTC, CUP, Shelter for the Poor and Nogar Seba

⁵⁷Bangladesh Public Administration Training center, Planning and Development Academy, Bangladesh Computer Council, Institute of Diploma Engineers, Institute of Personnel management, BUET

⁵⁸ Bangkok, Thailand (unspecified institution)

| | | | |
|--------------------|-----------|------------|------------|
| Financial Training | 15 | 96 | 121 |
| Technical Training | 12 | 41 | 194 |
| Awareness Training | 3 | 50 | - |
| Total | 43 | 368 | 373 |

276. The formal training courses are a major source for strengthening the capacity of DWASA and enhancement of skills level of staff. According to the FCB team there are several bottlenecks being faced that have slowed down the achievements of the capacity building program. They are:

- (i) Short tenure of training center staff: Most staff (trainers) of the Training Center are seconded from other DWASA departments, with tenure of around 3 years. These staff also lack training center management and operational skills. Hence, long term planning and target implementation are hampered in the training center.
- (ii) Funding restrictions: Government policy stipulates that no internal training course can spend over BDT50, 000 per course. In order to accommodate this budget, the number of trainees has to be restricted while the course lengths sometimes need to be shortened. Hence all employees with a particular training need may not receive it while those who do, cannot get a comprehensive one.
- (iii) Lack of incentive for trainees: Training attendances are not recorded in the annual confidential report of employees. Hence it does not add to their career progress. This creates a disincentive to those who receive training.

277. DWASA has variously stated that its operational efficiency has improved in the last few years. Reportedly, non-revenue-water is down to 29% from a high of 40%, operating ratio⁵⁹ is down to 0.79 from a high of 0.90, and collection rate improved to bring about a 25% increase in revenue income in FY2011-2012 compared to the previous FY. Notwithstanding the validity and accuracy of these figures, it is commendable that serious attempts are being made to improve operational efficiency and hence performances of DWASA by the incumbent management. Many challenges remain and addressing the water need of a growing population of Dhaka will require a strong DWASA willing to meet those challenges.

278. Although DWASA has been able to recently increase its tariff by 5%, there is a need for higher rate increases to meet its costs. Under the WASA Act 1996, WASAs have the authority to increase tariff by 5% annually and with approval of the government, they can increase tariff by more than 5%. DWASA has taken advantage of the provision in the Act only recently and has increased tariff rates over the last two years by 5%. The Tariff Adjustment Plan prepared together with the 5-year Business Plan recommended a base tariff increase of 59% and thereafter a 5% increases. This recommendation has not been accepted. Tariff setting and adjustments will remain key issue in the near future and will be required to be addressed by WASA and the government for full cost recovery, including capital costs.

279. Tariff setting processes and other regulatory issues such as water quality, service quality, water resource allocation and protection, etc. will be addressed in an upcoming project “Establishing Regulatory Framework for Urban Water Supply and Sanitation Sector” funded by ADB. The project intends to assist the government in making the water cell in the Policy Support Unit (PSU) of the Local Government Division (LGD) fully functional by

⁵⁹Operating expenses as a percentage of net sales

developing necessary rules and standards for regulating water utilities operating in the urban sector and starting performance monitoring of major water utilities. Specific outputs will include: (i) drafting adequate rules and standards for regulating water utilities, including financial management regulations, tariff setting and review methodologies, service standards and key performance indicators, and customer service regulations; (ii) preparing monitoring reports on the performance of major water utilities by using the approved rules and standards by reviewing the reports submitted by water utilities; (iii) initiating preparation for the establishment of a water economic regulatory commission (WEREC), including preparation of a road map; and (iv) capacity building of the government officers, particularly those of the water cell, to meet their obligations.

280. DWASA has very little private sector participation in its operation. All physical work is contracted out to local firms and advisory support services are provided by international and national firms under technical assistance programs. Bill collection in several zones is outsourced to an employees' cooperative, The Employees' Consumers Supplies Cooperative Society Ltd (ECSCSL). The limited exposure of DAWSA with the private sector suggests that procuring and managing a PPP project will require strengthening DWASA's capacity. There is currently a PPP Cell at DWASA that is moribund and does not have any activities under it.

4. Proposed measures for further strengthening capacity

281. As noted, DWASA is currently undergoing substantial capacity strengthening from the DWSSP within the financial and capacity building component. Capacity building processes mainly deliver formal training with developed course modules and preparation of operating manuals such as O&M manual. Training has focused particularly on technical and financial aspects. There is a need for further training of staff since the FCB component will be ending in December 2013 and delivery of planned training could not be fully completed due to constraints noted. Training needs to focus on financial management and IT systems and applications. Although DWASA has embarked on preparing corporate plan and budget with support of the FCB team, there is little capacity within its own staff to ensure continued updating and preparation of such plans and budgets.⁶⁰ We understand that the IT hardware is only being revamped but it still is a long way for the field offices to digitize operations and establishing fully connected networking with the central unit in DWASA. Very few of the staff are computer literate and capacity for both computer literacy and use of computers needs to be increased.

282. DAWSA needs to strengthen its capacity for PPP management as well as skills/knowledge of its staff with respect to procurement and regulatory areas of PPP projects. Although specific transaction advisory services from external parties will be sought, it is clear that a strong PPP unit staffed with a few knowledgeable and skilled senior professionals is necessary if the PPP route is selected. Strengthening of the capacity in this area could entail several new recruitments as well as training cum study tours for staff responsible for various aspects of the PPP project during the pre-tender and tender phases.⁶¹

5. Project Institutional Framework

⁶⁰ Further details on capacity strengthening for financial management is outlined in the Financial Management Assessment Report

⁶¹ Further details on specific areas of pre-tender and tender phases are outlined in the Legal Framework

283. **Introduction.** Timely establishment and involvement of appropriate institutions would significantly facilitate achievement of the project objectives. Several institutions, largely government departments, are key players in the establishment and operation of the Gandharbpur WTP and cooperation and timely implementation of each institution's activities will be a deciding factor for timely delivery of project outputs/milestones. The main institutions involved in the Khilkhet WTP project activities will be:

- (i) DWASA (Ministry of Local Government, Rural Development and Cooperatives)
- (ii) RAJUK (Ministry of Housing and Public Works)
- (iii) Directorate of Land Records and Survey (Ministry of Land)
- (iv) LGED (Ministry of Local Government, Rural Development and Cooperatives)
- (v) BWDB (Ministry of Water Resources)
- (vi) RHD (Roads and Highways Department, LGED)
- (vii) DoE (Ministry of Environment and Forests)
- (viii) Local Level authorities
- (ix) PPP Cell

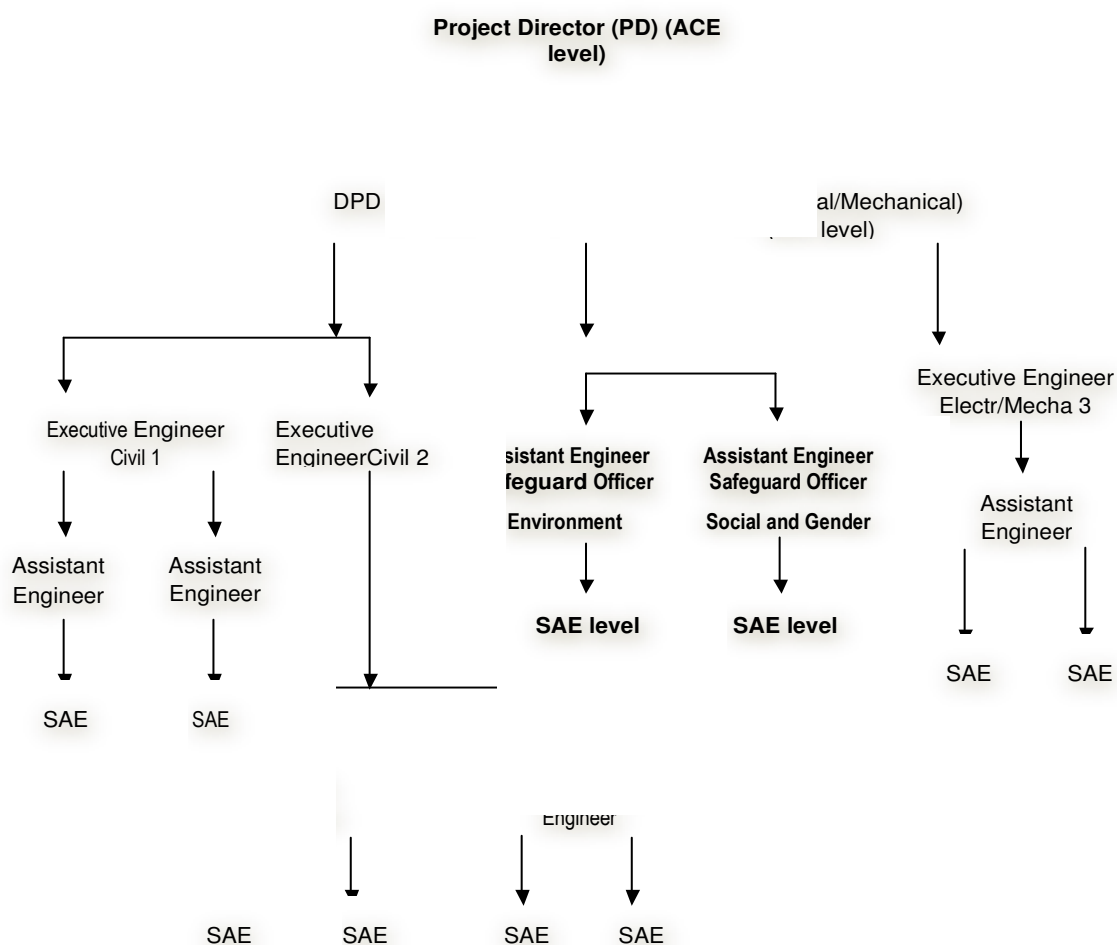
284. **Project institutions and framework.** DWASA, at the central level through the field offices and at the project level, will have the overall responsibility for project implementation, coordination and planning, internal monitoring, and overall reporting. DWASA will depute officials in the central office (HQ) and in the field office/PMU who will be responsible for the implementation of the project activities.

285. Close cooperation and coordination of work will be organized during the early stages of the project with RAJUK and Directorate of Land Records for land acquisition, and with LGED for construction of access roads. DoE will provide site certificate and clearance for the construction of the intake, pipelines, and WTP and approval of the EIA and EMP in order to start construction activities. DoE will remain a critical partner to the project as monitoring and control of pollution discharged in the Meghna River, particularly upstream will have to be controlled and made compliant. Finally, the project will need to define water abstraction right and provide assurances to the Project Company, if PPP option is selected, so that the Ministry of Water Resources grants water abstraction rights to the Project Company.⁶²

286. **Roles and Responsibilities.** DWASA will be the executing agency for the Khilkhet WTP project. A Project Management Unit (PMU) will be set up to manage project activities with distinct parts being managed and implemented by DWASA. The PMU should comprise of at least a director, three engineers with staff (civil, mechanical, electrical, one or two of whom would be designated deputy directors), a procurement specialist with staff, an accountant with staff, and two safeguard specialists (environment and social).

⁶² Further details on this issue is outlined in the Legal Framework

Project Implementation Unit



287. The roles and responsibilities of DWASA in implementing the Khilkhet WTP project are outlined below. It will:

- (i) co-ordinate the implementation of Khilkhet WTP project activities with field staff;
- (ii) review monthly progress reports prepared by the contractors and the PMU;
- (iii) monitor the progress on project design and construction implementation;
- (iv) advise PMU on policy related issues during design (if design--build) and construction;
- (v) coordinate tasks relating to PPP with the PPP Office and transaction advisory team for any PPP components of the Project;
- (vi) coordinate tasks relating to water abstraction rights with Ministry of Water Resources;
- (vii) coordinate tasks relating to land acquisition with Ministry of Lands and its local offices;
- (viii) coordinate tasks relating to policy reform issues dealing with the water and sanitation sector with the Water Cell and the Water Economic Regulatory Commission when it is established;
- (ix) coordinate tasks with DoE and ensure timely submission of

- reports/documents necessary to obtain statutory licenses;
- (x) appoint service provider for resettlement and rehabilitation implementation;
- (xi) appoint Independent Engineer for assistance with contract document preparation, design check, and construction supervision; and
- (xii) appoint contractors and construction supervision engineers.

288. **Modalities for Investment and O&M.** The Khilkhet WTP project will be financed by multi-donor organizations. While ADB is taking the lead for the investment funds, AFD and EIB are the other cofinanciers. DWASA has a sound record of experience with ADB and bi-lateral donor lending procedures and projects and in the past handled several projects and programs. The fund flow mechanism and disbursements are detailed in ADB template Fund Flow mechanism.

289. DWASA has no experience with PPP, specifically with private sector equity investments. As suggested by the consultant's legal analysis a local legal entity will need to be formed to assume the contractual obligations vis-à-vis DWASA. The shareholder structure and agreements will lay out the provisions which are of interest of DWASA. Detailed analyses are provided in the Section E - Legal Framework.

290. Under a PPP scheme and operation, such as BOT, it is expected that the private operator will undertake O&M both on and off-site. The O&M agreements between DAWSA and the private operator may follow similar modality as in the current Saidabad plant.

6. Financial Management Assessment of DWASA

291. One of the components of DWASA's long term plans to increase the overall water supply capacity and to reduce the amount of present groundwater abstraction is the establishment of the 500 MLD Khilkhet Water Treatment Plant Project phase 1, with an estimated investment costs of about \$587 million.

Other components of the DWASA long term plan are (i) the recent construction of the Saidabad WTP phase 2 (total costs about \$110 million), (ii) the ongoing DWSSDP network rehabilitation project (total costs about \$200 million), and (iii) the future construction of Pagla WTP phase 1 & 2 as well as the Saidabad WTP phase 3, totaling more than \$1 billion, and several priority wastewater projects that our outlined in the SMP. Not only will these projects strongly increase the DWASA debt service loan costs in the near future but DWASA's operating costs will also significantly increase, since the O&M costs of surface water treatment are considerably higher than water supplied from ground water sources.

Given the expected significant increases in the capex and opex, it is highly relevant that a regular financial management (FM) assessment of DWASA be conducted. To ensure sustainable DWASA financial results, up to date and effective financial management by DWASA is a critical success factor. If DWASA does not have the proper staff strength and competences to effectively manage its financial resources, the benefits of the projects may not be as sustainable as planned.

292. Our assessment is based on the results of a financial management assessment questionnaire (Appendix 10 refers), discussions with senior officials of DWASA, and information made available by the presently ongoing ADB funded Financial Capacity Building component of the DWSSDP project. The FMA has considered two types of risks; (i) inherent risks; i.e., risks beyond the direct control of the DWASA FM, and (ii) control risks;

i.e., risks related to the internal functioning and control of the DWASA Finance and Accounting division.

293. Clearly, the biggest inherent risk that DWASA will be facing in the coming years is the increasing unstable political situation, which may result in seriously hampering economic development and possibly reduced investments in water supply and sanitation (WSS) infrastructure projects. This risk may affect the ongoing organizational reforms, given that DWASA may still not operate as a financially autonomous entity, that top management is still via political appointment, and last but not least, that tariff setting is still dependent on political approvals.

294. The immediate risk may also involve delays with the internal bureaucratic procedure of the GOB with respect of the project. This may involve in delays occurring from the preparation of the Development Project Proforma (DPP) that details out the GOB and in processing approval of the DPP. Lessons from development projects informs delays ranging from anywhere between 9 to 12 months. Delays of such length will jeopardize the implementation schedule for the Gandharbpur WTP construction and operation resulting in cost overruns and further delays. It is highly recommended that DWASA is assisted by ADB to ensure the preparation of DPP is carried out on schedule. Frequent monitoring of the DPP approval process is also recommended.

295. The results of the FM assessment of the internal (control) risks indicate that the existing financial management capabilities and performances of DWASA Finance and Accounting division may be considered acceptable; however, with several medium to significant risks involved. These risks are acknowledged by the DWASA management and programs are ongoing and further developed to mitigate these risks.

296. Since several years the double entry accounting system has been implemented and is currently operated without major problems. The former, manual accounting system has been mostly automated; however, the accounting software is considered of too low a level, using simple standard accounting software packages that cannot be interlinked to other systems.

297. Improvement of the accounting software has been started under the FCB project but is not yet completed. An important bottleneck is that the existing hardware is outdated and insufficient to accommodate the requirements of the proposed new, custom-designed and interlinked DWASA accounting software system.

298. In addition to the lack of proper Information Technology (IT) infrastructures, the DWASA Finance and Accounting staff does not presently have the required background and experience to operate the new accounting software systems. This may be considered at least as a medium risk, since this lack of adequate competences is a dominant and crucial issue. Without the FM division staff having the proper background, manpower strength, or competences, all targeted measures for FM system improvement and/or procedures will not show significant results or impacts.

299. We recommend that DWASA top management give more focused attention to initiate and monitor the necessary improvement of FM staff competences and IT infrastructure

300. Other identified medium DWASA FM risks are:

- (iv) **Internal auditing unit.** An internal auditing unit does exist, but is mainly addressing queries from the government and other stakeholders, concerning DWASA's annual report. It does not sufficiently address the internal auditing issues for which it was established.
- (v) **Monthly performance reporting.** The submission of the monthly performance reports is mostly late; i.e., about 4-5 months after the respective month, while 3 weeks is the target. As a result, the reported monthly performance data are not very useful for possibly required DWASA top management actions.
- (vi) **Management information system (MIS).** MIS development and implementation and further development seems to have high interest of senior DWASA management, insufficient budgets are presently being made available. The DWASA ICT/MIS unit consists of only two staff, who have to collect and process all required MIS information. As noted, there is a lack of proper ICT hardware and software infrastructure, with inadequate hardware and slow (2G) internet connections, using mostly pirated software and no virus protection. The result is that no actual assessment or analyses of the collected data is being conducted.
- (vii) **DWASA PPP Cell.** The DWASA PPP cell is still in its infancy and does not have real experience with PPP type of projects such as Gandharbpur WTP phase 1 may include. A specific training program is required, particularly if a Gandharbpur PPP set up will be implemented.

301. In summary, we conclude that we did not identify any significant FM risks. Nevertheless, given the on-going and planned major investments and expected strong increase of the DWASA annual operating and loan/DSL costs in the coming years, DWASA's top management should give serious attention to the identified FM risks, and make the necessary budgets available to mitigate these risks, in order to be able to effectively direct and guide the DWASA middle management and staff through the difficult operational and financial tasks which are expected to be encountered by the DWASA organization in the coming 5 to 10 years

7. 20-Year Financial Projections of DWASA

302. One of the project tasks is to undertake an analysis of the financial position, performance, and projections of DWASA for the coming 20 years in order to assess the financial capacity of the DWASA to absorb on a sustainable basis not only the investment in the Gandharbpur WTP, but also in view of the other major on-going and future investments which will significantly increase both the annual O&M costs as well as the Debt Service Liability (DSL) Costs; i.e., the principal loan repayments and the interest costs.

303. These on-going and planned major water and sanitation investments are listed below and summarized in Table 22:

- (i) Saidabad WTP 1 - in operation since about 8-9 years ago and of which the payments of DSL costs will start in 2013/2014.
- (ii) Saidabad WTP 2 – in operation since December 2012 and of which the payment of the DSL costs will be starting in 2015/2016.

- (iii) Dhaka WWSDP project (rehabilitation of distribution network; investment costs about \$150 million), of which the payment of the DSL costs will start in 2012/13⁶³
- (iv) Ghandarbpur WTP Phase 1 project (estimated investment \$600 million), planned to become operational in 2017/18, and of which the payment of the DSL costs will start 5 years after start of construction.
- (v) Pagla (/Jasaldia) WTP 1 project (estimated investment \$450 million), planned to become operational in 2020/2021, and of which the payment of the DSL costs will start 5 years after start of construction.
- (vi) Saidabad WTP 3 project (estimated investment costs \$450 million), planned to become operational by 2020, and of which the payment of the DSL costs will start 5 years after start of construction.
- (vii) Pagla (/Jasaldia) WTP 2 project (estimated investment \$500 million), planned to become operational in 2025/2026, and of which the payment of the DSL costs will start 5 years after start of construction.
- (viii) Khilkhet WTP Phase 2 project (estimated investment \$550 million), planned to become operational in 2030/2031, and of which the payment of the DSL costs will start 5 years after start of construction.
- (ix) Phase 1 priority SMP projects (estimated investment \$69 million), planned to become operation in 2015 but since no action has been taken yet possibly at end 2030
- (x) Phase 2 priority projects (estimated investment \$1,087 million) planned to become operational in 2025.
- (xi) Phase 3 priority projects (estimated investment \$530 million, planned to become operation in 2035 and not impacting the 20 year projection ending in 2031/32.

304. Not only will the above projects significantly increase the annual DSL costs in the coming years, also the respective O&M costs will significantly increase DWASA's overall annual expenditures, since the O&M costs of surface water treated by a water treatment plant are considerable higher than water being produced from ground water wells.

Table 22: Ongoing and planned WS investments

| Project | Start Operations |
|-----------------------|------------------|
| WTP Saidabad II | 2012/13 |
| WTP Gandharbpur I | 2017/18 |
| WTP Pagla/Jasaldia I | 2020/2021 |
| WTP Saidabad III | 2025/2026 |
| WTP Pagla/jasaldia II | 2025/2025 |
| WTP Gandharbpur II | 2030/2031 |
| SMP Phase 1 | 2015/2020 |
| SMP Phase 11 | 2020/2035 |

305. The 20-year DWASA financial forecast starts from the fiscal year (FY) 2011/2012, for which year the Auditor's report and financial statements have been made available. A

⁶³according to Loan Agreement no. 2382-BAN (SF) between GOB and DWASA, dated 22.09.2008

summarised overview of the key items of the present financial position of DWASA, as reflected in the DWASA Income Statement, Balance Sheet for the years 2011 and 2012, as well as key financial ratios are given in Table 23, Table 24 and Table 25.

306. The starting point for the DWASA 20-year forecast is the officially recorded financial position for the fiscal year (FY) 2011/12 (ending 30 June 2012), as laid down in the Auditors report and financial statement⁶⁴.

307. Relevant data were used from the Audit report 2011/2012, but also from the 5-year DWASA business plan and multi-annual financial forecasts, which were developed in the on-going ADB FCB project. Unfortunately the local financial FCB expert, responsible for the set up and drafting of the DWASA financial model had left the FCB project earlier and therefore no clarifications on the many, sometimes different and inconsistent figures, could be obtained. In drafting the DWASA 20-year financial forecasts, also Gandharbpur PPTA cost reference data were used, such as investment cost components and O&M cost figures.

308. To obtain the relevant additional financial information from the DWASA financial departments, for instance on the existing and upcoming DSLs, turned out a time consuming activity.

Table 23: Summary DWASA income statement

| Item | (million BDT) | |
|-------------------------------|---------------|--------------|
| | 2012/11 | 2011/10 |
| Revenues | | |
| Water | 4,283 | 3,602 |
| Sewage surcharge | 1,642 | 1,331 |
| Other | 1,038 | 814,7 |
| Total income | 6,964 | 5,747 |
| Operating expenses | | |
| Salary & wages | 3,176 | 2,307 |
| Repair and Maintenance | 2,389 | 2,114 |
| Administration | 508 | 443 |
| Depreciation-Amortization | 625 | 661 |
| Other | 26 | 5 |
| Total expenses | 6,724 | 5,530 |
| Operating profit | 240 | 218 |
| Interest expenses | 146 | 158 |
| Income tax | 23 | 15 |
| Net profit (after tax) | 70 | 45 |

Table 24: DWASA Balance Sheet

| Item | million BDT | |
|-----------------------------|-------------|---------|
| | 2012/11 | 2011/10 |
| Assets | | |
| Fixed assets | . | . |
| Property, plant & equipment | 42,949 | 43,522 |

⁶⁴DWASA Auditor's report and financial statements for year ending 30 June 2013, submitted 26 December 2012

| | | |
|---------------------------------------|---------------|---------------|
| Capital work in progress | 13,941 | 10,458 |
| Other | 20 | 20 |
| Total Fixed assets | 56,909 | 53,999 |
| Current assets | . | . |
| Materials and supplies | 422 | 149 |
| Accounts receivables | 3,599 | 3,108 |
| Advances-prepayments | 771 | 908 |
| Investments/deposits | 4,433 | 3,371 |
| Cash | 663 | 1,884 |
| Other | 39 | 28 |
| Total Current assets | 9,928 | 9,450 |
| Total Assets | 66,838 | 63,449 |
| | | |
| Equity & Liabilities | | |
| Capital & Reserves | 20,263 | 20,192 |
| LT Liabilities | . | . |
| Grant & Funds | 29,563 | 27,588 |
| Deferred tax liability | 7,787 | 7,787 |
| Other LT liabilities | 4,374 | 4,839 |
| Total LT liabilities | 41,724 | 40,214 |
| Current liabilities | . | . |
| For expenses | 4,305 | 2,610 |
| Other | 545 | 433 |
| Total current liabilities | 4,850 | 3,043 |
| Total Equity & Liabilities | 66,838 | 63,449 |

Table 25: Operational & Financial Ratios

| Operational & Financial ratios | 2012/11 | 2011/10 | Remarks |
|--|---------|---------|--|
| Operational | | | |
| Operating margin | 12.4% | 12.5% | All 3 ratios are too low, due to insufficient operating result, i.e. too low revenue incomes |
| Gross margin | 3.4% | 3.8% | |
| Return (net) on Sales | 1.0% | 3.8% | |
| Revenue collection period (months) | 7.2 | 7.5 | Too long, action to reduce this period are undertaken |
| Costs | | | |
| Salary costs (% total expenses) | 47.2% | 41.7% | Very high, mainly due to (incidental) high provisions for extra pension fund contributions |
| „ „ (excl. pension fund provisions) | 17.1% | 18.6% | |
| Admin. costs (% of total expenses) | 7.6% | 8.0% | |
| Maintenance & Repair costs (% of total expenses) | 52.8% | 61.8% | High, mainly due to high power costs. Overall result vulnerable for power costs increases (in particular when more WTP's will come in operation) |
| Power costs (% of M&R expenses) | 40.6% | 38.6% | |
| Financial | | | |
| Quick ratio | 1.7 | 2.75 | High; questionable since high amount (investments/ deposits) more likely to be fixed assets |

| | | | |
|-------------------------------------|-------|-------|--|
| Equity/Total Eq+Liabilities | 32.8% | 33.4% | Favourable, but will decrease due to new project/GOB loans |
| LT liability / Total Eq+Liabilities | 67.4% | 66.5% | High, see Audit comments on 'Grant & other Funds |
| Interest coverage ratio | 5.9 | 5.6 | Satisfactory, mainly since interest payments are still limited; will rapidly decrease in the coming years |
| Debt Service Coverage Ratio | 1.4 | 5.3 | Still favourable, but will further significantly decrease due too strong increase in due (GOB) loan repayments |

The forecasting of the 20-year DWASA financial results was carried out under various assumptions that are included in the data input sheet in Appendix 10.

309. For the presentation the DWASA 20-year financial forecast, a summary of the annual Income Statement (with forecasted revenues and expenditures) was made, while for the supporting calculations of the main revenue streams and cost components are made in separate excel sheets. The Income Statement summary sheet is presented on the following page.

DWSA 20 YR FORECAST (P&L - CASHFLOW)

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | |
|---|-------------------|----------------|----------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Income Statement Items | unit | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
| No. of population covered | % | 9,137 | 9,860 | 9,988 | 10,101 | 10,096 | 12,553 | 13,021 | 13,496 | 15,201 | 15,657 | 16,127 | 16,611 | 17,109 | 17,622 | 18,151 | 18,696 | 19,256 | 19,834 | 20,429 | 21,042 | 21,673 |
| | | 76% | 80% | 78% | 77% | 75% | 90% | 91% | 91% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| I. Revenues | | | | | | | | | | | | | | | | | | | | | | |
| 1. Domestic Water Supply | | | | | | | | | | | | | | | | | | | | | | |
| Domestic consumption | MLY | 500,247 | 535,514 | 538,150 | 539,840 | 535,293 | 660,218 | 679,355 | 698,492 | 780,471 | 797,454 | 814,806 | 832,536 | 850,652 | 869,163 | 888,076 | 907,400 | 927,145 | 947,320 | 967,933 | 988,996 | 1,010,516 |
| fee/m3 | BDT | 6.66 | 6.99 | 7.34 | 7.71 | 8.10 | 8.50 | 8.93 | 9.37 | 9.84 | 10.33 | 10.85 | 11.39 | 11.96 | 12.56 | 13.19 | 13.85 | 14.54 | 15.26 | 16.03 | 16.83 | 17.67 |
| Billing collection rate | % | 90% | 91% | 92% | 93% | 94% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% |
| Total | mill. BDT | 2,998.5 | 3,407.8 | 3,635.3 | 3,870.7 | 4,073.3 | 5,331.3 | 5,760.1 | 6,218.5 | 7,295.7 | 7,827.2 | 8,397.4 | 9,009.1 | 9,665.4 | 10,369.5 | 11,124.9 | 11,935.4 | 12,804.8 | 13,737.7 | 14,738.4 | 15,812.1 | 16,964.0 |
| 2. Commercial/Industrial Water Supply | | | | | | | | | | | | | | | | | | | | | | |
| Commercial/Industr. consumption | MLY | 67,447 | 83,453 | 83,864 | 84,128 | 83,419 | 102,887 | 105,869 | 108,852 | 121,799 | 125,047 | 128,295 | 129,919 | 129,919 | 139,762 | 139,762 | 139,762 | 139,762 | 139,762 | 139,762 | 159,446 | 179,131 |
| fee/m3 | BDT | 21.17 | 22.23 | 23.24 | 24.51 | 25.73 | 27.02 | 28.37 | 29.79 | 31.28 | 32.84 | 34.48 | 36.21 | 38.02 | 39.92 | 41.92 | 44.01 | 46.21 | 48.52 | 50.95 | 53.50 | 56.17 |
| Billing collection rate | % | 90% | 91% | 92% | 93% | 94% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% |
| Total | mill. BDT | 1,285.1 | 1,688.1 | 1,800.8 | 1,917.4 | 2,017.8 | 2,640.9 | 2,853.3 | 3,080.4 | 3,619.1 | 3,901.4 | 4,202.9 | 4,468.9 | 4,692.3 | 5,300.2 | 5,565.2 | 5,843.5 | 6,135.7 | 6,442.4 | 6,764.6 | 8,103.2 | 9,558.8 |
| 3. Sewerage | | | | | | | | | | | | | | | | | | | | | | |
| Volume generated | MLY | 274,068 | 282,290 | 290,759 | 299,482 | 308,466 | 317,720 | 327,252 | 337,069 | 347,181 | 357,597 | 368,325 | 379,374 | 390,755 | 402,478 | 414,552 | 426,989 | 439,799 | 452,993 | 466,582 | 480,580 | 494,997 |
| fee/m3 | BDT | 6.66 | 6.99 | 7.34 | 7.71 | 8.10 | 8.50 | 8.93 | 9.37 | 9.84 | 10.33 | 10.85 | 11.39 | 11.96 | 12.56 | 13.19 | 13.85 | 14.54 | 15.26 | 16.03 | 16.83 | 17.67 |
| Billing collection rate | % | 90% | 91% | 92% | 93% | 94% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% |
| Total | mill. BDT | 1,642.8 | 1,796.4 | 1,964.1 | 2,147.3 | 2,347.3 | 2,565.6 | 2,774.7 | 3,000.8 | 3,245.4 | 3,509.9 | 3,796.0 | 4,105.3 | 4,439.9 | 4,801.8 | 5,193.1 | 5,616.3 | 6,074.1 | 6,569.1 | 7,104.5 | 7,683.5 | 8,309.7 |
| 4. Other incomes | | | | | | | | | | | | | | | | | | | | | | |
| Water/Sewer connections + meter sales | mill. BDT | 103 | 106 | 109 | 112 | 116 | 119 | 123 | 127 | 130 | 134 | 138 | 142 | 147 | 151 | 156 | 160 | 165 | 170 | 175 | 180 | 186 |
| Other incomes | .. | 475 | 490 | 504 | 519 | 535 | 551 | 568 | 585 | 602 | 620 | 639 | 658 | 678 | 698 | 719 | 741 | 763 | 786 | 809 | 833 | 858 |
| Interest on investments/dividends | .. | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 |
| Total | .. | 1,037 | 1,054 | 1,072 | 1,091 | 1,110 | 1,129 | 1,149 | 1,170 | 1,191 | 1,213 | 1,236 | 1,259 | 1,283 | 1,308 | 1,333 | 1,360 | 1,387 | 1,414 | 1,443 | 1,473 | 1,503 |
| Total Annual Revenues | | 6,963.3 | 7,946.6 | 8,472.5 | 9,026.0 | 9,548.0 | 11,666.9 | 12,537.3 | 13,469.6 | 15,351.5 | 16,451.7 | 17,632.1 | 18,842.5 | 20,080.9 | 21,779.4 | 23,216.7 | 24,754.8 | 26,401.2 | 28,163.7 | 30,050.6 | 33,071.5 | 36,335.5 |
| | acc. Audit Report | 6,964.0 | 14.1% | 6.6% | 6.5% | 5.8% | 22.2% | 7.5% | 7.4% | 14.0% | 7.2% | 7.2% | 6.9% | 6.6% | 8.5% | 6.6% | 6.6% | 6.7% | 6.7% | 10.1% | 9.9% | |
| II. Operating Expenditures | mill. BDT | | | | | | | | | | | | | | | | | | | | | |
| 5. Salaries & wages (excl. Pension fund provision) | | 1,153 | 1,188 | 1,224 | 1,260 | 1,298 | 1,337 | 1,377 | 1,419 | 1,461 | 1,505 | 1,550 | 1,597 | 1,645 | 1,694 | 1,745 | 1,797 | 1,851 | 1,906 | 1,964 | 2,023 | 2,083 |
| . Pension fund provision | | 2,023 | 1,500 | 500 | 126 | 130 | 134 | 138 | 142 | 146 | 151 | 155 | 160 | 164 | 169 | 174 | 180 | 185 | 191 | 196 | 202 | 208 |
| 6. Administrative expenses | | 508 | 523 | 539 | 555 | 572 | 589 | 607 | 625 | 644 | 663 | 683 | 703 | 724 | 746 | 769 | 792 | 815 | 840 | 865 | 891 | 918 |
| 7. Ground Water sources | | | | | | | | | | | | | | | | | | | | | | |
| m3 GW produced (MLY) | | 850,450 | 832,200 | 804,825 | 777,450 | 740,950 | 740,950 | 740,950 | 740,950 | 675,250 | 675,250 | 675,250 | 675,250 | 675,250 | 547,500 | 547,500 | 547,500 | 547,500 | 547,500 | 547,500 | 547,500 | 547,500 |
| O-M costs (BDT/m3 produced) | | 2.28 | 2.44 | 2.61 | 2.79 | 2.99 | 3.19 | 3.42 | 3.66 | 3.91 | 4.19 | 4.48 | 4.79 | 5.13 | 5.49 | 5.87 | 6.28 | 6.72 | 7.19 | 7.70 | 8.24 | 8.81 |
| <i>Production costs GW sources</i> | | 1,937 | 2,028 | 2,098 | 2,169 | 2,212 | 2,367 | 2,532 | 2,710 | 2,642 | 2,827 | 3,025 | 3,237 | 3,463 | 3,905 | 3,215 | 3,440 | 3,681 | 3,939 | 4,214 | 4,509 | 4,825 |
| 8. Surface Water Sources | | | | | | | | | | | | | | | | | | | | | | |
| .Existing (small) SW systems | | 148 | 158 | 169 | 181 | 194 | 207 | 222 | 237 | 254 | 272 | 291 | 311 | 333 | 356 | 381 | 408 | 436 | 467 | 500 | 535 | 572 |
| .SaidabadWTP II (+ Saidabad III, after 2025/26) | | | 374 | 388 | 386 | 560 | 600 | 641 | 686 | 734 | 786 | 841 | 900 | 963 | 1,030 | 2,132 | 2,282 | 2,441 | 2,612 | 2,795 | 2,991 | 3,200 |
| .Khilkhet WTP I (+ II, after 2030/31) | | | | | | 2,048 | 2,191 | 2,344 | 2,508 | 2,684 | 2,872 | 3,073 | 3,288 | 3,518 | 3,764 | 4,028 | 4,310 | 4,612 | 4,934 | 5,281 | 5,653 | 6,053 |
| .Pagla/Jasaldia I (+ II, after 2025/26) | | | | | | | | | 507 | 542 | 580 | 621 | 664 | 710 | 760 | 813 | 870 | 931 | 996 | 1,066 | 1,141 | |
| <i>Production Costs Surface Water (WTP's)</i> | | 148 | 532 | 557 | 567 | 754 | 2,854 | 3,054 | 3,268 | 4,003 | 4,284 | 4,583 | 4,904 | 5,248 | 5,615 | 7,038 | 7,531 | 8,058 | 8,622 | 9,225 | 15,151 | 16,212 |
| 9. O-M Sewerage system | 7% | 233 | 250 | 267 | 286 | 306 | 327 | 350 | 375 | 401 | 429 | 459 | 491 | 526 | 562 | 602 | 644 | 689 | 737 | 789 | 844 | 903 |
| 10. Other expenditures/costs | | | | | | | | | | | | | | | | | | | | | | |
| Provisions bad debts | 3% | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 43 | 44 | 45 | 47 |
| Miscellaneous | 3% | 71 | 73 | 76 | 78 | 80 | 83 | 85 | 88 | 90 | 93 | 96 | 99 | 101 | 105 | 108 | 111 | 114 | 118 | 121 | 125 | 129 |
| Depreciation | | 625 | 1,159 | 1,130 | 1,103 | 1,078 | 2,984 | 2,844 | 2,715 | 2,597 | 3,682 | 3,499 | 3,330 | 3,175 | 3,032 | 4,093 | 3,888 | 3,699 | 3,525 | 3,264 | 3,216 | 3,079 |
| Total Operating Expenditures/Costs | | 6,724 | 7,279 | 6,418 | 6,173 | 6,458 | 10,705 | 11,018 | 11,372 | 12,018 | 13,667 | 14,085 | 14,556 | 15,083 | 14,966 | 17,783 | 18,422 | 19,134 | 19,920 | 20,783 | 27,006 | 28,403 |
| | | 8.3% | -11.8% | -3.8% | 4.6% | 65.7% | 2.9% | 3.2% | 5.7% | 13.7% | 3.1% | 3.3% | 3.6% | -0.8% | 18.8% | 3.6% | 3.9% | 4.1% | 4.3% | 29.9% | 5.2% | |
| EBIT | | 239 | 668 | 2,054 | 2,853 | 3,090 | 962 | 1,519 | 2,097 | 3,334 | 2,785 | 3,548 | 4,286 | 4,998 | 6,814 | 5,434 | 6,333 | 7,267 | 8,244 | 9,268 | 6,065 | 7,932 |
| Interests to be paid | | 146 | 364 | 608 | 2,521 | 4,071 | 2,660 | 2,521 | 4,443 | 4,171 | 3,896 | 3,613 | 3,362 | 5,180 | 4,835 | 4,490 | 4,145 | 3,583 | 3,237 | 2,892 | 2,553 | 6,365 |
| EBT | | 93 | 303 | 1,446 | 332 | -982 | -1,698 | -1,001 | -2,346 | -837 | -1,111 | -65 | 925 | -183 | 1,979 | 944 | 2,188 | 3,685 | 5,006 | 6,375 | 3,512 | 1,568 |
| Taxes | | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Net Profit | | 70 | 303 | 1,446 | 332 | -982 | -1,698 | -1,001 | -2,346 | -837 | -1,111 | -65 | 925 | -183 | 1,979 | 944 | 2,188 | 3,685 | 5,006 | 6,375 | 3,512 | 1,568 |
| Operating Result (Net profit+Depr.+ Interest) | | 934 | 2,129 | 4,630 | 4,288 | 3,185 | 2,248 | 3,361 | 2,467 | 5,094 | 5,356 | | | | | | | | | | | |

310. Considering the financial results of the DWASA 20-year forecast, the following can be observed:

(i) The annual financial results, i.e. the net profit (after tax and interests), will remain positive in the coming years, but will become negative in 2015/16 (when the Saidabad II loans are due for repayments) and more negative after the Khilkhet WTP phase I is expected to start its operations in the FY 2016/17.

(ii) The DWASA annual profits show good positive results till 2014/2015, mainly since for the FY 2011/12 and 2013/14 a significant part of the annual expenditures consists of a major (incidental) provision for additional contributions to the pension fund, in order to close the existing 'gap'. This provision for the fiscal year 2011/12 was about 2.02 billion BDT (i.e., about 30% of the total costs), i.e. without this incidental provision the DWASA annual operating result would have been 2.0 BDT billion higher, mainly due to relatively strong increased revenue incomes over the past 2 years. It may be expected that this incidental provision for the pension fund will end in the coming 2 years, thus leaving significant 'room' to compensate for the expected increases in the annual O&M and DSL costs.

(iii) After the Gandharbpur WTP phase I may come into operations in 2017/18, the DWASA annual results will become more negative, due to the high Gandhabpur investment costs for the treated water (BDT 5.44/m³), and also due to the fact that various DSL costs (i.e., interest and principal repayments) of the different committed loans of the past years will have to be paid for from that year on. (i.e. Saidabad 1 & 2, DWSSDP project, ADB loans (no. 1, 2, 3 and 4), Gandhabpur 1).

(iv) The net annual profit losses will further increase due to a strong increase of the depreciation cost resulting from the on-going and planned WTP investments.

(v) The expected Return on Sales (RoS) will vary after 2015/2016 between ~2.2% and ~11.5%, and the debt service cover rate (DSCR) may become as low as 0.4, which is an indication of the poor financial position reached by DWASA.

311. The 20-year DWASA forecast show that also the annual revenues are expected to increase significantly, due to the following factors:

- increase of population to be covered, and thus more connections and consumption
- increased water supply resources and capacity
- reduction of UfW, thus less production losses
- annual increase of the water/sewerage fee (5% increase per year)
- increase billing collection rate

312. Future cost reductions may be expected:

- from some lower O&M costs for Saidabad WTP II operations, when the 3 yr O&M contract with French company Degremont ends.
- if DWASA will be able to re-negotiate the various on-going or future loan/DSL agreements with the GOB.

313. Besides the above mentioned possible cost reductions, clearly the most logical and preferred option to improve the DWASA expected negative annual financial results, is an annual increase of the water-sewerage fee/m³ to be charged to the households and commercial/industrial users. It is generally acknowledged that the present water fee of 6.99 BDT/m³ (recently increased to BDT 7.34/m³) is much too low to enable DWASA to deliver adequate water supply and sewerage services at the required quality level and on a sustainable basis.

317. In order for a greater understanding of the impact of service fees on the financial position of DWASA estimates and analysis based on several tariff options have been carried out. Four scenarios have been analyzed and they are:

- 1) Business-as-usual case: under this scenario DWASA financial performances are analyzed with the current levels of tariff rate and annual increases. DWASA in the past few years have increased tariff rates by 5% which is what its management has the authority to do without seeking approval from the government.
- 2) Initial high tariff levels case: Tariff rates are substantially increased in the initial period and leveled off for later years at the 5% annual increases.
- 3) Delayed tariff increase case: Under this scenario tariff rates are kept at the current levels for the first few years annual increases are at 5%. A steeper tariff rate is introduced at a later year subsequently leveling it off with annual 5% increases.
- 4) Increasing tariff by BDT 1 each year for 5 years.

In order to mitigate tariff increase impacts on the poorest population DWASA could introduce block tariff structure that is not currently used. From the Willingness-to Pay survey the derived aggregate demand curve indicates that all households keep connected so long the water tariff is BDT 6.06/ m³, after which point, the poorest 20% of the households start to disconnect. At a tariff of 9.94/m³, no poor household keep connected.

The main input data/ assumptions used are detailed below.

Table 26: Input Data

| | Unit | Amount |
|--|------|--------|
| Water demand | | |
| Population (x1000) | | 12,000 |
| annual increase | % | 3.0% |
| lpcd (liter per capita per day) | ltr | 150 |
| annual in/decrease | % | -0.8% |
| Commercial /Industry sector (% of total) | MLD | 30% |
| annual increase | MLD | 3% |
| UfW/NRW | % | |

| | | |
|---------------------------------------|--------------------|---------|
| annual decrease | % | -2.0% |
| Revenues | | |
| Water fee charge/m ³ | | 2012/13 |
| . Domestic & sewerage | BDT/m ³ | 6.99 |
| . Comm/Industry | BDT/m ³ | 22.23 |
| . Billing collection rate | | 90% |
| annual increase | | 1% |
| O&M costs | | |
| O&M Cost increases | | 7% |
| Other cost increases | | 3% |
| Costs raw water supply Saidabad (PPP) | BDT/m ³ | 1.7 |
| Production costs Gandharbpur WTP | BDT/m ³ | 11.7 |
| Costs Khilkhet (non-PPP, Pipelines) | BDT/m ³ | 5.8 |

Results and Conclusions from Different Tariff Level Analysis

Service fee levels over the 20 years, Operating cash flows and DSCR is shown in Table 27 below. The conclusions are as follows:

- 1) Under the business-as-usual case the minimum DSCR falls to 0.6 and over several years the DSCR is less than 1 indicating that DWASA is unable to service its loan and perhaps unable to meet operating expenses. Earnings before interest and taxes remain positive.
- 2) An increase of tariff in the order of 30% in year 2013 and thereafter, annual increases of 5% make the financial position of DWASA much better and reasonably satisfactory. This increase is both for domestic and non-domestic tariff. If only domestic tariff would be considered then an increase of around 50% would become necessary. This increase is commensurate with the recommendations being provided by FCB team that asked for 57% increases and then leveling off with annual increases of 5%.
- 3) With a delay in tariff increases and following current trends of annual 5% increases 2015/16 there would be a need of 40% increase in tariff rates to reach a viable financial position by DWASA. This indicates that it would be more prudent for DWASA to approve a steep increase in tariff over the current levels and then leveling off over the years to come.
- 4) As a variation of the above scenario viewed by the management of DWASA, is to increase tariff rates by BDT 1 each year for five years and then move towards a yearly increase of 5%. The DSCR for each year is above 1 and indicates a more healthy financial position. However, this increases needs to be undertaken in Fiscal Year 2013-2014, since further delay will increase the amount needed to obtain a sound financial position for DWASA.

Table 27: Results of Different Tariff levels on Financial Performance of DWSA

| | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Scenario 1 (Business-as-usual) | | | | | | | | | | | | | | | | | | | | | |
| Service Fees | | | | | | | | | | | | | | | | | | | | | |
| Domestic | 6.99 | 7.34 | 7.71 | 8.09 | 8.50 | 8.92 | 9.37 | 9.84 | 10.33 | 10.84 | 11.39 | 11.96 | 12.55 | 13.18 | 13.84 | 14.53 | 15.26 | 16.02 | 16.82 | 17.66 | 18.55 |
| Non-Domestic | 22.23 | 23.34 | 24.51 | 25.73 | 27.02 | 28.37 | 29.79 | 31.28 | 32.84 | 34.49 | 36.21 | 38.02 | 39.92 | 41.92 | 44.01 | 46.21 | 48.53 | 50.95 | 53.50 | 56.17 | 58.98 |
| Cashflow from operations | 808 | 2,081 | 3,467 | 4,269 | 4,509 | 4,396 | 4,860 | 5,360 | 6,577 | 7,173 | 7,816 | 8,452 | 9,075 | 10,839 | 10,598 | 11,374 | 12,208 | 13,104 | 14,068 | 10,874 | 12,773 |
| DSCR | 1.1 | 2.7 | 3.8 | 1.1 | 0.6 | 0.5 | 0.2 | 0.4 | 0.8 | 0.9 | 0.9 | 0.8 | 0.8 | 1.2 | 1.1 | 1.4 | 1.3 | 1.5 | 1.8 | 1.0 | 0.9 |
| Scenario 2 (Initial High Tariff) | | | | | | | | | | | | | | | | | | | | | |
| Service Fees | | | | | | | | | | | | | | | | | | | | | |
| Domestic | 6.99 | 7.34 | 9.54 | 10.02 | 10.52 | 11.05 | 11.60 | 12.18 | 12.79 | 13.43 | 14.10 | 14.80 | 15.54 | 16.32 | 17.13 | 17.99 | 18.89 | 19.84 | 20.83 | 21.87 | 22.96 |
| Non-Domestic | 22.23 | 23.34 | 30.34 | 31.86 | 33.45 | 35.13 | 36.88 | 38.73 | 40.66 | 42.70 | 44.83 | 47.07 | 49.43 | 51.90 | 54.49 | 57.22 | 60.08 | 63.08 | 66.24 | 69.55 | 73.03 |
| Cashflow from operations | 808 | 2,081 | 5,291 | 6,224 | 6,587 | 6,995 | 7,670 | 8,395 | 10,074 | 10,935 | 11,864 | 12,792 | 13,715 | 15,892 | 15,999 | 17,147 | 18,380 | 19,703 | 21,124 | 18,670 | 21,369 |
| DSCR | 1.1 | 2.7 | 6.4 | 1.9 | 1.2 | 1.2 | 1.1 | 1.3 | 1.9 | 2.1 | 1.9 | 1.7 | 1.7 | 2.2 | 2.2 | 2.5 | 2.3 | 2.6 | 3.0 | 2.1 | 2.0 |
| Scenario 3 (Delayed Tariff Increase) | | | | | | | | | | | | | | | | | | | | | |
| Service Fees | | | | | | | | | | | | | | | | | | | | | |
| Domestic | 6.99 | 7.34 | 7.71 | 10.79 | 11.33 | 11.89 | 12.49 | 13.11 | 13.77 | 14.46 | 15.18 | 15.94 | 16.74 | 17.57 | 18.45 | 19.38 | 20.34 | 21.36 | 22.43 | 23.55 | 24.73 |
| Non-Domestic | 22.23 | 23.34 | 24.51 | 34.31 | 36.03 | 37.83 | 39.72 | 41.71 | 43.79 | 45.98 | 48.28 | 50.69 | 53.23 | 55.89 | 58.69 | 61.62 | 64.70 | 67.94 | 71.33 | 74.90 | 78.64 |
| Cashflow from operations | 808 | 2,081 | 3,467 | 7,006 | 7,418 | 8,035 | 8,793 | 9,609 | 11,472 | 12,440 | 13,483 | 14,528 | 15,571 | 17,913 | 18,159 | 19,456 | 20,848 | 22,343 | 23,946 | 21,789 | 24,808 |
| DSCR | 1.1 | 2.7 | 3.8 | 2.2 | 1.4 | 1.6 | 1.4 | 1.7 | 2.3 | 2.5 | 2.3 | 2.0 | 2.1 | 2.6 | 2.6 | 3.0 | 2.7 | 3.1 | 3.5 | 2.6 | 2.4 |
| Scenario 4 (Tariff increase by 1 taka for five years) | | | | | | | | | | | | | | | | | | | | | |
| Service Fees | | | | | | | | | | | | | | | | | | | | | |
| Domestic | 6.99 | 7.34 | 8.34 | 9.34 | 10.34 | 11.34 | 12.34 | 12.957 | 13.605 | 14.285 | 14.999 | 15.749 | 16.537 | 17.364 | 18.232 | 19.143 | 20.101 | 21.106 | 22.161 | 23.269 | 24.432 |
| Non-Domestic | 22.23 | 23.34 | 24.34 | 25.34 | 26.34 | 27.34 | 28.34 | 29.757 | 31.245 | 32.807 | 34.447 | 36.17 | 37.978 | 39.877 | 41.871 | 43.965 | 46.163 | 48.471 | 50.895 | 53.439 | 56.111 |
| Cashflow from operations | 808 | 2,081 | 3,467 | 7,006 | 7,418 | 8,035 | 8,793 | 9,609 | 11,472 | 12,440 | 13,483 | 14,528 | 15,571 | 17,913 | 18,159 | 19,456 | 20,848 | 22,343 | 23,946 | 21,789 | 24,808 |
| DSCR | 1.1 | 2.7 | 4.4 | 1.5 | 1 | 1.1 | 1.1 | 1.3 | 1.8 | 2 | 1.8 | 1.6 | 1.7 | 2.1 | 2.1 | 2.4 | 2.3 | 2.6 | 2.9 | 2 | 1.9 |

314. Therefore it may be concluded that with focussed and adequate DWASA management actions to improve the revenues and to control the necessary expenditures, DWASA has in principle the capacity to absorb the expected strong operating and financial cost increases which will result from the necessary future change from ground water sources to surface water sources.

C. Gender & Poverty

315. The result of our surveys and investigations into the integration into this project of gender mainstreaming is contained in Appendix 12: Gender Action Plan.

D. Project Financial and Economic Analysis

1. Project Financial Analysis

Initially the PPTA team developed a project finance model with private equity financing for the Intake and Water Treatment Plant components. The Project Finance model consists of two components: (i) privately financed component that includes the Intake and Water Treatment Plant components of the project and (ii) publicly financed component that includes transmission lines, infrastructures and others. The two components are combined under a separate worksheet to arrive at the assessment for the total project. The analysis based on several assumptions indicates the requirement of a treated water price of 14.9 BDT/m³ in order to maintain an Equity IRR of 25% and a DSCR above 1.2. Under various scenarios and assumptions the model indicates that at a price of 8 BDT/ m³ the minimum DSCR is well below 1 and Equity IRR drops to 10.02%. This treated water price levels are reached by incorporating a viability gap funding of 20% of total capital costs. The outputs of the model are in Table.

Table 28: PE Model Outputs

| | With 20% Capital Grant (14.7 BDT/m ³) | Without Capital Grant (16.5 BDT/m ³) | Without Intake, no Capital Grant (8 BDT/m ³) |
|----------------------------------|--|---|---|
| Total Project Cost (BDT million) | 12,636 | 12,837 | 12,636 |
| Min DSCR | 1.16 | 0.93 | 0.31 |
| Project IRR | 20.65% | 23.47% | 8.89% |
| Equity IRR | 25.01% | 25.11% | 10.02% |

316. **PE Model– Sensitivity.** Table 29 records the sensitivity of the cases modeled to various factors. Sensitivity was tested for changes in key parameters; e.g., price ($\pm 20\%$), capital cost ($\pm 10\%$), O&M costs ($\pm 10\%$), capital grant (0-30%), interest rates (10-20%), and D/E (1-2.3).

Table 29: PE Model Sensitivity

| Case No. | Sensitivity Cases | Total Project Cost (BDT million) | Min DSCR | TEST DSCR> 1 | Project IRR | Equity IRR |
|----------|----------------------------|----------------------------------|----------|--------------|-------------|------------|
| 1 | Base | 12636 | 1.16 | YES | 20.65% | 25.01% |
| 2 | Lower Capital Cost | 11372 | 1.31 | YES | 22.37% | 27.36% |
| 3 | Higher Capital Cost | 13899 | 1.04 | NO | 19.17% | 23.01% |
| 4 | Lower Price | 12636 | 0.80 | NO | 16.21% | 19.10% |
| 5 | Higher Price | 12636 | 1.53 | YES | 24.60% | 30.46% |
| 6 | Lower Capital & O&M Costs | 11372 | 1.43 | YES | 23.42% | 28.85% |
| 7 | Higher Capital & O&M Costs | 13899 | 1.00 | NO | 18.72% | 22.39% |
| 8 | No Capital Grant | 12837 | 0.76 | NO | 20.65% | 21.47% |
| 9 | Higher Capital Grant | 12538 | 1.56 | YES | 20.65% | 26.98% |
| 10 | Lower Interest Rate | 12362 | 1.43 | YES | 20.65% | 26.43% |
| 11 | Higher Interest Rate | 12910 | 0.97 | NO | 20.65% | 23.66% |
| 12 | Lower D/E Ratio | 12345 | 1.59 | YES | 20.65% | 24.45% |
| 13 | Higher D/E Ratio | 12940 | 0.91 | NO | 20.65% | 25.72% |
| 14 | Combined Negative | 14045 | 0.45 | NO | 14.43% | 13.04% |
| 15 | Combined Positive | 11242 | 2.24 | YES | 27.55% | 41.14% |

The model is most sensitive to prices. Currently DWASA has the mandate to independently increase service fees by 5% annually. Given a 7-8% inflation rate p.a., the real cost of water is actually decreasing. Under the circumstances, DWASA needs to accommodate higher price increases in order to sustain and expand its operations that are not being considered at this stage. The feasibility of the PPP hence largely depends on the ability of DWASA to charge higher tariffs as well as the availability of viability gap funding.

317. Under the circumstances that substantial tariff rate increases whether initially or after a few years and debt restructuring of DWASA loan by the Ministry of Finance is not forthcoming the private equity project financing is not feasible option since a private equity investment will not be viable. An alternative PPP scheme that of Design-Build-Operate (DBO) is analyzed as an option to private sector participation in the project.

Operating Gandharbpur WTP under a Design-Build-Operate scheme

318. The project financial model under a DBO scheme assumes that the project capital costs are 100% debt financed by loans from IFIs and developing partners. It assumes that the design, supervision, and operations and maintenance of the plant and transmission lines are outsourced under a performance based DBO contract. In addition, we assume that the required maintenance capital costs are borne by the contracted party and financed from its cash reserves. We also assume that in the DBO contract, an additional three international

staff will be employed full time at a cost of USD 24,000 per month per person. Full list of assumptions are produced in Appendix 10. The financing plan is shown in Table 30, while the detailed capital costs are presented in Appendix 6.

Table 30: Financing Plan (\$ Million)

319.

| Source | Total | % |
|--------------|--------------|--------------|
| ADB Loans | 220.0 | 37.4 |
| AFD Loans | 100.0 | 17.0 |
| EIB Loans | 100.0 | 17.0 |
| Government | 167.8 | 28.5 |
| | | |
| Total | 587.8 | 100.0 |

Financial Results

The weighted cost of capital (WACC) is 3.5% estimated based on the GoB on lending rate of 5% to DWASA. However, based on the actual rates of the loans from the financiers the WACC is 2.24% as shown below.

Table 31: Weighted Average Cost of Capital (Actual Rates)

| | Value | Rate |
|---------------------------|--------|--------------|
| ADB | 220000 | 2.00% |
| AFD | 100000 | 3.07% |
| EIB | 100000 | 2.98% |
| GoB | 167765 | 5% |
| Return on Debt (Weighted) | | 3.21% |
| WACC | | 2.24% |

320. Four different pricing scenarios are presented below: (i) business-as-usual scenario, which is just 5% per annum increase, (ii) increase in price of 1 taka per year until 2018, (iii) base case with initial price of 14 followed by 10% price increase per annum, (iv) initial high increase in tariff followed by gradual increase (5%). Table 32 shows the results of the financial analysis for the project under the four scenarios.

Table 32: DBO Model Outputs

| | Scenario (i) | Scenario (ii) | Scenario (iii) | Scenario (iv) – Base |
|--------------------------------------|--------------|---------------|----------------|----------------------|
| Initial tariff (BDT/m ³) | 9.37 | 12.34 | 12.30 | 20.55 |

| | | | | |
|-------------------------|--------|--------|--------|--------|
| Tariff Increase | 5% | 10.0% | 10.0% | 5% |
| Project IRR | -9.84% | 3.54% | 3.51% | 3.50% |
| Operating Expense Ratio | 75.70% | 35.56% | 35.67% | 34.52% |

The above table shows different combinations of initial tariff and subsequent annual tariff increases needed. In scenario (i), in which the current 5% annual tariff increase persists until 2018 and beyond, the project is not viable as the project IRR is negative.

Scenario (ii) includes an increase in price of 1 taka per year until 2018, as suggested by the MD of DWASA, followed by subsequent increased a 10% p.a. The project IRR exceeds WACC in this scenario and this is a viable option.

Scenario (iii), our base case, requires an initial tariff of 12.30 BDT/m³ and subsequent increases at 10% p.a. This initial tariff can be achieved by increasing the tariff at 11% annually from 2013 to 2018. In the base scenario the operating expense ratio is at a 35.67%.

Scenario (iv) depicts that a very high initial price of 20.55 BDT/m³ is needed if DWASA wants to maintain annual tariff increase at 5% and still exceed the WACC of 3.5%.

Hypothetically, eliminating all capital costs, the project's net cashflows yield an NPV of BDT 55,052 Million using a WACC of 3.5%. Operating expenses are BDT 5.78/m³.

321. Two main issues emerge from the financial analysis. Both the Private Equity and DBO options require substantial increases in DWASA's present level of tariff. While the DBO option requires a lower tariff than the PE option, in both cases it is crucial to ensure that DWASA is committed to adequately increase the level of tariff required in order to ensure the financial viability of the project. Debt service coverage is a major point of sensitivity for the project in either of the two options. A revision of loan conditions or restructuring of debt repayment structure may become essential.

2. Economic Analysis

322. **Methodology and Assumptions.** Economic analyses have been conducted in accordance with the ADB's Guidelines for the Economic Analysis of Projects (1997) and the Guidelines for the Economic Analysis of Water Supply Projects (March 1998).

323. The following approach and assumptions have been used in the analysis:

Without Project Scenario

In order to assess the existing situation (without project) the following estimations have been carried out.

- The total population has been estimated from the 2011 census data as 2.5 million and growing by 3% each year
- Annual production of water has been obtained from the MIS report of end June 2012. The only figures reported for the four zones are volume of water supplied to DWASA

connection points. The production volume is estimated accounting for NRW. The total production is estimated as 566 MLD for the four zones.

- MLD reduces in “without” project scenario because it is assumed without project the production of water will fall due to the reduction of groundwater abstraction. Production capacity has been assumed to drop gradually and stand at around 350 MLD during the final year of the analysis.
- Non Revenue Water has been included in line with the water balance analysis. DWASA has an ongoing pipe rehabilitation and strengthening project covering most of its distribution system and planned reduction in NRW by DAWASA has been reflected in the water balance analysis.
- Number of domestic and non-domestic connections have been derived from MIS reports (2012)
- 153 Lcd has been assumed to be unchanged throughout the analysis period.
- Water tariff increases are at the current level of 5% per year. The current tariff is BDT 6.99/m³ for domestic water and 23/m³ for non-domestic water.

With Project Scenario

- Population figure and growth remains same as in “without” project case.
- Treated surface water is intended to replace ground water with the reduction calculated to be 150 MLD. During the period the Ghandarbpur WTP become operational the production capacity is estimated to be 416 from the current ground water source and 500 from the WTP.
- It is assumed that the excess capacity of water will be used in other zones of DWASA and indicated service coverage drops below 100% with population growth
- Lpcd drops in accordance with the water balance analysis
- Reduction in NRW is similar to without project scenario because of the ongoing program of DWASA
- The ratio of domestic to non-domestic consumption is kept unchanged throughout the analysis period

324. Additionally we have used the following assumptions:

- (i) All prices are expressed in 2012 prices and economic analysis is conducted at 2012 constant price. A simple 15 year time series trend analysis of inflation reflects complex economic cycle variability and it is not possible to prepare a forecast of inflation. Instead a qualitative value has been selected and kept constant throughout the analysis period.
- (ii) Exchange rate assumed is Taka 80 per US\$1.00
- (iii) Economic prices of capital works and annual operation and maintenance are calculated from the financial cost estimates, adjusted to allow for transfer payments and to correct for any other market distortions;

- (iv) Price contingencies and interest during construction (as a result of any debt financing) are excluded in the calculation of economic internal rate of return (EIRR) but physical contingencies are included because they represent real consumption of resources;
- (v) Taxes and duties are excluded because they represent transfer payments;
- (vi) All costs are valued using the domestic price numeraire; tradable inputs, net of duties and taxes, are adjusted by the shadow exchange rate factor of 1.13 while non-tradable inputs (except for unskilled labor), net of duties and taxes, are adjusted by a conversion factor of 0.9; unskilled labor is adjusted by a conversion factor of 0.7 of the market wage rate to estimate the shadow wage rate;⁶⁵
- (vii) Consumers benefits and satisfaction is derived from better quality water and regular supply of water compared to the without project scenario. Consumers will save costs from not boiling water, from less expenditures in health care (assumed to be 3% of annual expenditures on health), and resource cost savings by reducing costs of alternative water supply
- (viii) The economic opportunity cost of capital (EOCC) is assumed at 12% in real terms. The purpose of the economic analysis is to determine if the project's EIRR exceeds the EOCC, in real terms. If the component's EIRR exceeds the EOCC, it can be concluded that the component is economically viable; and
- (ix) Useful economic life of the project is assumed to be 50 years with zero residual value.

325. Sensitivity analyses have been undertaken in order to test the robustness of the economic results to adverse changes in conditions. The following adverse changes have been analysed:

- (i) A capital cost overrun of 10%;
- (ii) An increase in the O&M cost by 10%;
- (iii) A reduction in the benefits by 10%; and
- (iv) Project component benefits delayed by one year.

Results. The Gandharbpur Water Treatment Plant will supply bulk water to DWASA for distribution to the four zones in Uttara, Gulshan, Badda, and Mirpur. Major portions of water currently supplied to these areas are extracted ground water. The project will mitigate the current depletion of groundwater resources by reducing the amount of water being supplied from Gandharbpur. The principal benefits that would be derived are a sustainable water supply for the future to a growing population including improved accessibility, convenience and reliability of water supply, as well as increased quantities of water and improved water quality. The benefits of the project component therefore have been quantified in terms of:

- Resource cost savings associated with the replacement of non-incremental water consumed previously obtained from non-piped alternative sources with those from the piped water supply system, valued in terms of the average supply price from existing non-piped water sources estimated at about BDT 13/m³;

⁶⁵ Conversion factors for economic shadow pricing are based on recently approved ADB project "City region Development (2010) in Bangladesh.

- Access to water supply, reflected in the incremental water consumed in the four project zones and in other DWASA zones, valued in terms of the price of water of existing domestic and non-domestic water consumptions; per capita water consumption decreases each year to reach 125 lpcd in year 2040, based on the water balance analysis;
- Improved water quality will eradicate the need to boil water. Cost savings associated with it is valued in terms of the consumption of water and costs foregone for boiling it;
- Health benefits likely to occur have been assessed as 3% reduction of household health expenditures. Total household expenditures have been obtained from the household survey undertaken by the PPTA team.

Sustainability

326. Based on the above assumptions, a 50-year economic cash flow has been prepared for the project indicating incremental costs and benefits, and the net incremental cash flow from which economic internal rates of return (EIRRs) have been estimated. All costs and benefits are considered to be incremental. The project is found to be economically viable under the base case scenario⁶⁶ and also under various adverse changes in conditions. The proposed component is most sensitive to delay in project benefits and reduction in benefits. In all cases the EIRR remains close to or above the EOCC of 12%. Switching values indicate the percentage by which benefits would need to decline or costs increase to reduce the EIRR after allowing for project costs to the assumed cut-off rate of 12% below which the project is not considered economically viable.

Table 32: EIRR and Sensitivity Analyses – Gandhabpur Water Treatment Plant

| Scenario | NPV / 1 (‘000 Taka) | EIRR (%) | SI / 2 | SV / 3 | % Change |
|--------------------------------------|------------------------|----------|--------|--------|-------------|
| Base Case | 37,369,572 | 22.48% | | | |
| 10% Increase in Capital Costs | 33,481,121 | 21.34% | 17.79 | 6% | 10% |
| 10% Increase in O&M Costs | 33,965,831 | 20.07% | 18.39 | 5% | 10% |
| 10% Decrease in Benefits | 29,052,232 | 20.83% | 17.35 | 6% | 10% |
| Project Benefits Delayed by One Year | 28,059,285 | 19.73% | 16.45 | 6% | 10% |

1/ NPV = Net Present Value discounted at EOCC

2/ SI = Sensitivity Indicator (ratio of % change in EIRR above the cut-off rate of EOCC to % change in a variable)

3/ SV = Switching Value (% change in a variable to reduce the EIRR to the cut-off rate of EOCC)

Source: Consultant's calculation

The project finances are assured and adequately reflect the project expenditure (both capital and operation) requirements. Over 28% of the project costs will be met from the budget of the Government. Past experiences and commitment of the GOB for this project ensures that these funds will be made available as required and without delays. Detailed cost of the project and financing plan is outlined in the financial analysis section.

⁶⁶The base case assumes capital cost BDT 39,580,174 thousand, existing O&M cost per m³ = BDT 8.3, additional O&M cost from project finance model, current cost per m³ of untreated water = BDT 12, cost per m³ of boiling water = BDT 3.92

The financial IRR is around 10% and is above the WACC of 3.5% estimated from on-lending rates of 5% to DWASA by the GOB. The revenue derived from treated water is able to recover all operational expenditures. With increases in revenue some 35% to 40% operating expenses will be met from the project beneficiaries.

The project aims to ensure its contribution to sustainable water resource management in Bangladesh. Switching from groundwater to surface water accomplishes that by maintaining a balanced groundwater abstraction level. This will significantly contribute to the environmental management and sustainability in Bangladesh. Sourcing surface water from Meghna River, where the water is of reasonable good quality, will also require over the long-term to maintain the quality of water. The water quality monitoring plan and implementation of it will ensure that the quality of water in Meghna will be maintained.

Distribution Analysis

327. A distribution analysis to determine to what extent the poor benefit from the project is difficult to undertake mainly because disaggregated data on household income for the four zones is not available. DWASA also does not maintain any disaggregated data on end users. However, utilizing the household survey carried out by the PPTA some qualitative observations with strong assumptions can be made and they are described below.

The benefits of the projects as outlined in the economic analysis all accrue to the poor. The survey indicates that 14% of the sample households are unconnected to piped water and they are the poorest decile of the population with an average household monthly income of BDT 6,282.75. Currently these households pay BDT 20.12/m³ for water obtained from vendors. Significant resource cost savings are obtained by the poor being connected to and accessing water from the project. Similarly, benefits from health cost savings and increased consumption of water can be estimated assuming 14% of the beneficiaries are poor⁶⁷. The estimates from the above provide a weighted share of net benefit to the poor being 20%.

There are other indirect benefits arising from the one-off employment as skilled and semi-skilled workers engaged in the construction of civil works, access roads, and pipelines. As is the practice in Bangladesh it is expected that many laborer days will be utilized from the poorer segment of the population for those works. Without further data and numbers on the labor requirements no specific results can be presented.

3. Willingness-to-Pay (wtp)

328. **Introduction.** This willingness-to-pay study was conducted as part of the Khilkhet WTP Plant Project. The project aims at improving the water supply services and ensuring future access to water in Dhaka City through establishing a surface water treatment plant.

329. Dhaka is the largest city in Bangladesh with a population of approximately 12 million. According to our household survey, 41% of the surveyed households perceived the supplied water to be of poor quality, and 21% rated the service standards very poor or poor. Evidently, there is room for improvement in the current quality of supplied water.

⁶⁷ The incidences of poverty in urban population in the Dhaka division in HIES 2010 (Chapter 6, Table 6.2) is 18%.

330. This study was undertaken partly to understand the benefits of improved water services. Since there is no existing market for improved water services, direct questioning is the only way to estimate the benefits. Willingness-to-pay (wtp) values provide crucial information for assessing economic viability of projects, setting affordable tariff, and assessing financial sustainability. The current water tariff in Dhaka is a very low rate of BDT6.99/m³ for domestic connections. This low tariff does not meet the costs of operation and maintenance and therefore a study to understand consumer willingness to pay is necessary to learn whether tariff rates can be increased. ADB and current research practices⁶⁸ recommend undertaking contingent valuation studies in preparation of water supply projects to understand the consumer preference and design the projects aligning to consumer needs.

331. **Survey Methodology.** A household survey covering 1,041 households in the Gulshan, Badda, Uttara, and Mirpir areas was conducted during November and December 2012. Of the 1041 households sampled, 1,000 were connected to the network, reflecting the strong network coverage of DWASA in the selected areas.

332. A stratified random sampling procedure was used to develop the sampling frame. The number of samples drawn from each of the four target areas and all neighborhoods (mohallas) within those areas were proportionate to the total number of households in those areas as indicated by the preliminary results of the 2011 population and household census. Mohallas were randomly selected. Details of selected mohallas are provided in Appendix 14 - Annex 2. Sample households were chosen by taking the 5th building/house along streets in chosen mohallas. In case the original sample household was unwilling or unavailable to complete the survey, enumerators were instructed to replace the sample with the house immediately to the right. In the absence of a complete list of households together with addresses, this was the only pragmatic way to select a representative sample.

333. Questions and multiple-choice responses were prepared and refined through review and pre-testing. About 100 households were interviewed in pre-tests. Based on the results of pre-tests, some questions were rephrased, and the initial bid distribution was refined. The survey includes household characteristics (income, expenditures, employment status, and others), use of various sources of water (consumption, cost, perception on quality and cost), and contingency valuation of piped water services. The enumerators were deployed after training and supervised by field supervisors. The enumerators were trained particularly to propose contingency questions in a proper manner. Survey design, enumerator training, and survey implementation closely followed the good practices recommended in Whittington (2002)⁶⁹, barring restrictions from time constraints.

334. During the survey, households were asked whether they were willing to continue to be connected to the network by paying a certain monthly charge and a one-time connection cost for those not currently connected. The monthly charge and the connection cost (called bid price) were randomly assigned to each household covered under the survey. The

⁶⁸ ADB Economics and Research Department (ERD) Technical Notes 23 (Gunatilake et al., 2007)

⁶⁹ Whittington, D., 2002, 'Improving the Performance of Contingent Valuation Studies in Developing Countries, Environmental and Resource Economics 22: 323–367, 2002

monthly charge was 100, 200, 300, 400, 500, or 800 BDT⁷⁰; the connection cost was BDT2,000, 4,000, or 6,000. The respondents were informed about the contingent scenario: by paying these charges, they will have continuous and sufficient water supply with sufficient pressure, and the water will be of good quality, potable without boiling or any other treatment. The full English version of the questionnaire is attached in Appendix 14 - Annex 3⁷¹.

335. It is important that respondents were asked whether they would remain connected to the improved services by paying the proposed charges, rather than asking an open-ended question such as how much they would pay for the proposed services. Closed-ended or dichotomous choice questions have been the preferred form of elicitation question (Gunatilake et al, 2007)⁷². This is because answering an open-ended question on a new commodity requires a higher level of cognitive demand on the part of respondents.

336. Households without a connection with the network were asked whether they would choose to connect to the network by paying the connection fee and monthly charges. The following sections focus on analysis of households which have a connection, since over 96% of the households in the surveyed areas were connected to the DWASA network.

337. **Model Estimation.** Although easier for respondents to answer than open-ended questions, a closed-ended question does not directly reveal the respondent's wtp. The mean wtp values of respondents should be estimated using econometric models.

338. Our study focused exclusively on monthly charge and used a conventional wtp model. Based on a Probit model, $1/\sigma$ and β/σ were estimated, which then identifies β and σ . With the estimated β , willingness to pay can be estimated for each household by

$$wtp = \exp(X\beta)$$

where X is a matrix of explanatory variables and β a matrix of their coefficients

Our wtp estimation is given by:

$$wtp = \exp(1.772 + 0.370 * \text{Log}(\text{Total Expenditure}) + 0.020 * \text{Years education})$$

Table 33: Estimated coefficients

| | β | Wald | p-value |
|--------------------------------------|---------|---------|---------|
| Bid Price ⁷³ | -3.074 | 217.969 | 0.000 |
| Household Expenditure | 1.137 | 47.510 | 0.000 |
| Years of Education of Household Head | 0.061 | 9.749 | 0.002 |
| Constant | 5.448 | 9.190 | 0.002 |

⁷⁰The level of the bid price was chosen based on the current cost of water and such that most respondents answer positively to the lower offered bid price, and negatively to the highest offered price. Suitability of the bids was tested during the pretesting and a bid level of BDT800 was added.

⁷¹The survey instrument was translated to Bangla and the survey was conducted in Bangla.

⁷²Gunatilake, H., Yang, J., Pattanayak, S., and Choe, K., 2007, 'Good Practices for Estimating Reliable Willingness-to-Pay Values in the Water Supply and Sanitation Sector', ERD TECHNICAL NOTE Series No. 23

⁷³The transformed bid price equals (1) the original bid price when the respondent would pay a higher amount to stay connected or (2) the original bid price plus 100 Taka when the respondent declares that he would not pay more than the original bid price to keep connected. We assume that the respondent will disconnect when he declares that the original bid price is his maximum price to be connected and this original bid price is increased in 100 Taka.

339. Table 38 summarizes the estimated results of the model. Attributes of households, which were found statistically significant at the 5% confidence level, are household expenditure, and years of education of household head. These variables have the expected signs. Statistical significance and expected signs indicated the construct validity of the elicitation question; i.e., that the respondents have understood the questions and answered truthfully. The willingness to pay of households rises as households become richer. More educated household heads are also ready to pay higher charges for water.

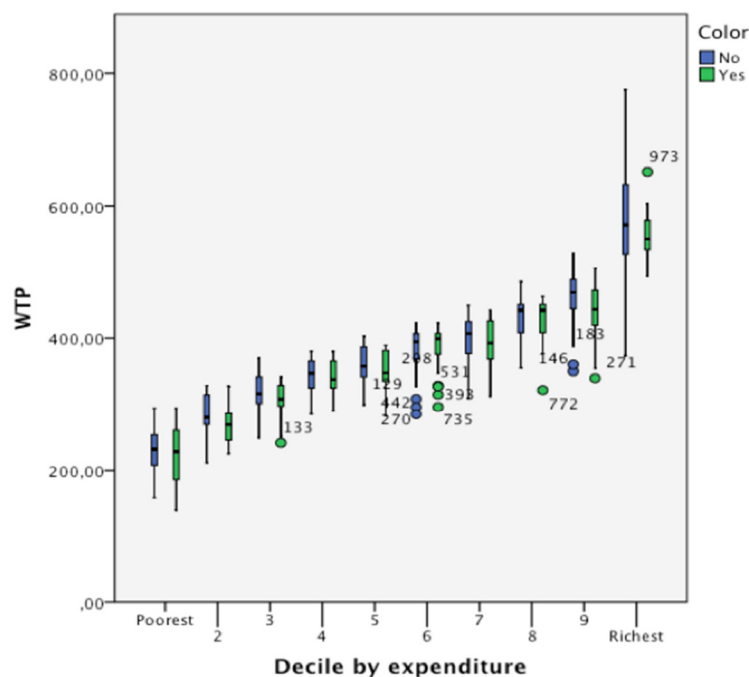


Figure 11: Expenditure vs Reported Problems

340. Dummy variables for perception, such as those indicating problems with pressure, color, dirt, and iron were tested but found to be not very significant. Figure 10 shows that in each decile of income, the distribution of the wtp is quite similar in the cases in which problems with turbidity are reported to those in which none are reported. The same holds true for other problems, such as odor, cleanliness, and pressure adequacy. Moreover, most of the problems with water appear in those households with lower income. Consequently, once the effect of the income is discounted in the Probit model, the water quality variables do not modify the wtp of the respondents.

341. The direct relation between the WTP and total expenditure is clearly represented in the box-plot graph in Figure 11 using deciles of total expenditure. The relation between wtp and education is shown in Figure 12.

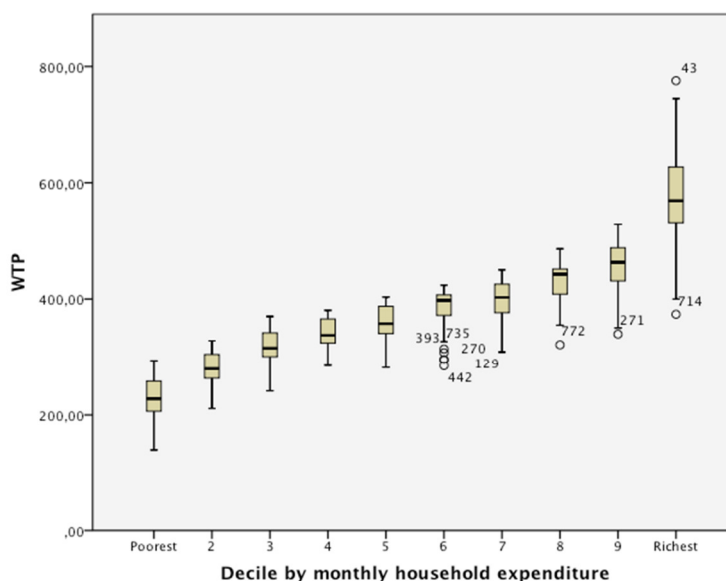


Figure 12: Deciles of household expenditure versus wtp

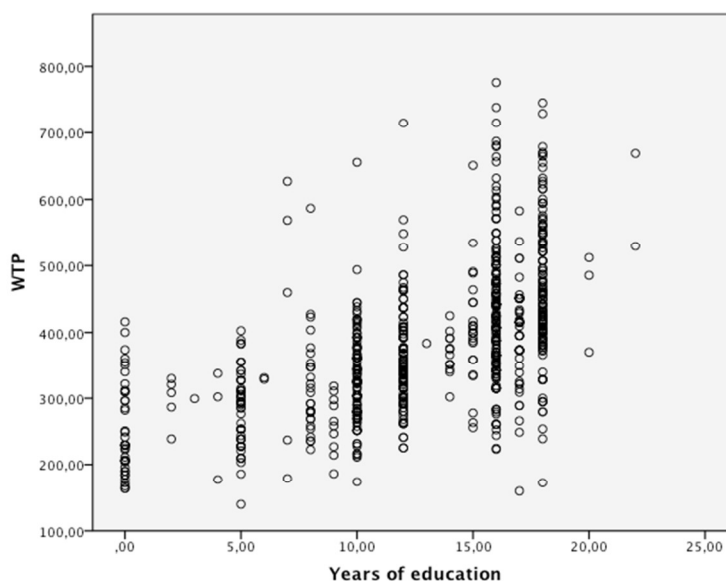


Figure 13: Years of education versus willingness to pay

342. The wtp is estimated for each household with the coefficients obtained in the regression. wtp has minimum values of 139.67 Taka and maximum value of 775.88 Taka, with an average of 377.32 Taka and a standard deviation of 99.14. The median of the wtp is 368.89 Taka.

343. **Consumer Demand Analysis - Flat rate (BDT per month).** The aggregated demand curve is presented in Figure 14 with the following results:

- (i) All the households keep connected until the price per month reaches 200 Taka.
- (ii) To analyze the viability of a change in the monthly price of water connection on poor households, we apply the concept of relative poverty. We also consider the total expenditure of the household as a proxy variable for the income level. Under this approach, we define as 'poor' those 20% of the households in our survey with the lowest monthly expenditure (households corresponding to deciles 1 and 2 as defined in the previous section). In absolute figures, a household is considered poor when its total monthly expenditure is lower or equal to 21,000 Taka.

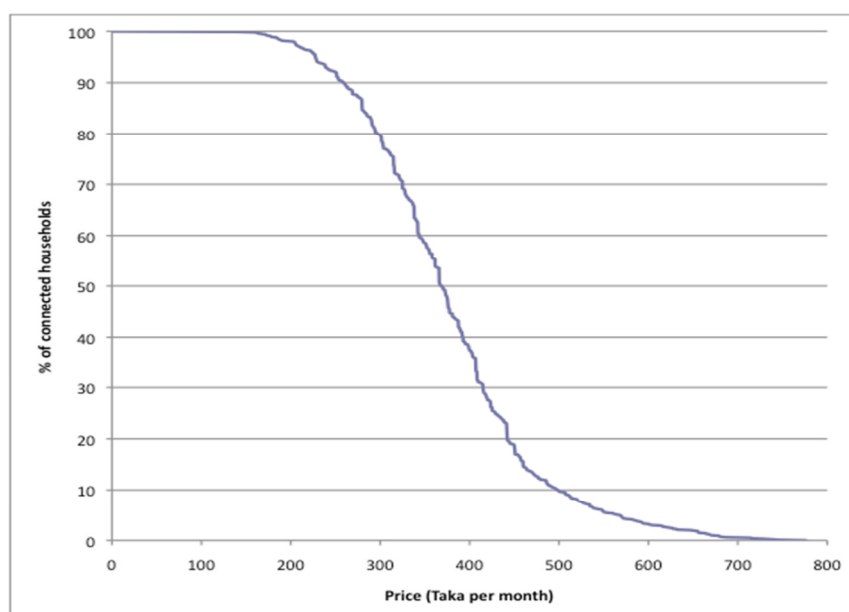


Figure 14: Aggregate Demand

344. The graphs Figure 15 present the comparison of the aggregated demand curves for the 20% of the households with the lowest expenditure level (poor households) and the 80% of the households with the largest expenditure (rich households). All the households, no matter what their expenditure levels are, keep connected until the price reaches 200 Taka per month. No rich household would disconnect until the price rises to 300 Taka. At a monthly price slightly higher than 300 Taka (328 Taka per month), no poor household keeps connected. At this price, 84.5% of the rich households would maintain their connection.

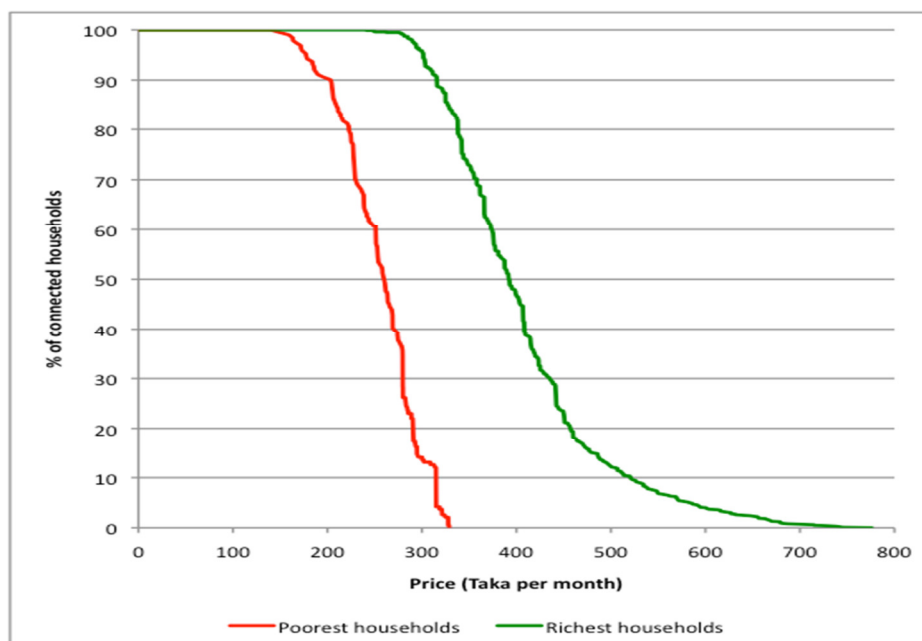


Figure 15: Demand for Water: Poorest and richest households

345. To complete the analysis of the viability for poor households, Table 39 and the graph in Figure 16 show the evolution of the willingness to pay in terms of the household expenditure:

| Decile expenditure | Median | Average | Standard Deviation |
|--------------------|---------------|---------------|--------------------|
| 1 (Poorest) | 216.46 | 216.67 | 49.68 |
| 2 | 279.71 | 280.3 | 29.55 |
| 3 | 316.08 | 316.89 | 26.76 |
| 4 | 340.87 | 346.15 | 24.54 |
| 5 | 357.97 | 358.96 | 31.73 |
| 6 | 398.49 | 386.84 | 31.08 |
| 7 | 402.75 | 396.88 | 36.37 |
| 8 | 442.41 | 431.52 | 28.19 |
| 9 | 462.59 | 457.17 | 41.13 |
| 10 (Richest) | 569.49 | 577.69 | 76.05 |
| Total | 368.89 | 377.32 | 99.14 |

Table 34: Willingness to Pay by Expenditure (Income) Category

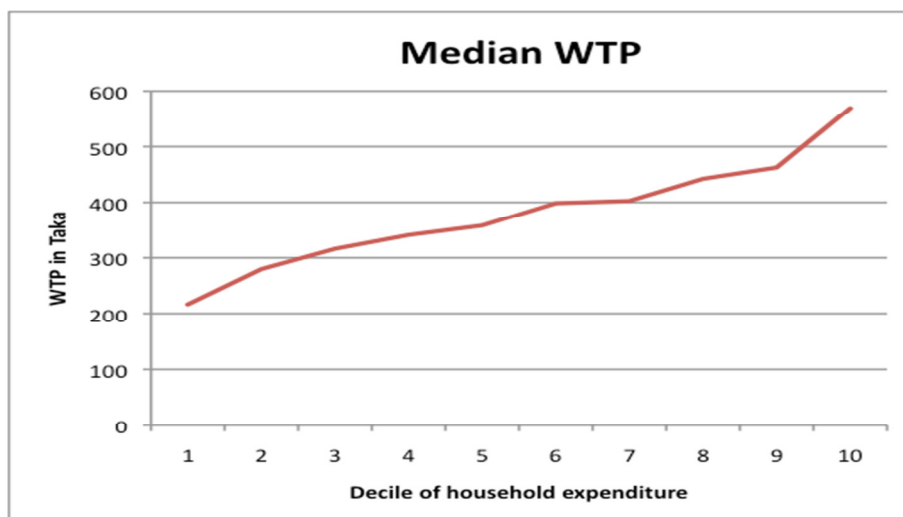


Figure 16: Median WTP by expenditure category

346. **Volumetric Price.** Apartments in our four areas of DWASA (and in major parts of Dhaka City) have a single metered connection to the building and households are unable to measure how much water is actually being consumed by each. A flat rate is charged to the households by splitting the total water consumed in the building. The survey thus failed to obtain direct information of the willingness to pay in terms of Taka per cubic meter. However, the available data do provide some indirect information on this issue.

347. **Relation between expenditure and consumption.** The first step to transform the flat rate wtp into a wtp in terms of Taka per cubic meter is the analysis of the relation between expenditure and consumption. The following graph shows this relation (after the elimination of the consumption outliers):

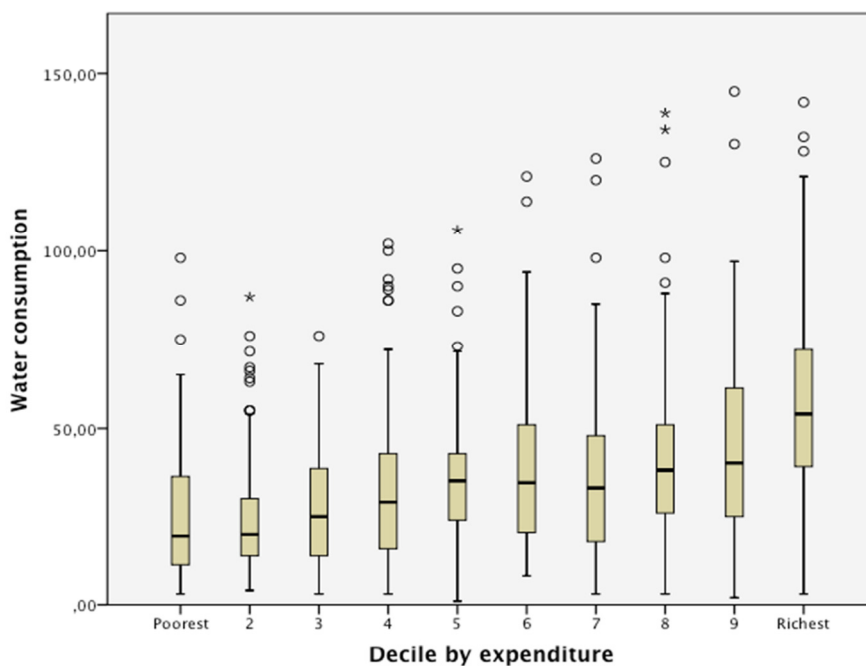


Figure 17: Water consumption by expenditure

348. The existence of a direct relation between these two variables is confirmed by the rejection of the null hypothesis of equality of the means of the consumption⁷⁴ among the different deciles of expenditure by a one-way ANOVA statistical test. Table 35 shows the mean and median of water consumption among expenditure deciles:

Table 35: Water consumption and expenditure

| Decile expenditure | Median m ³ /mo | Average m ³ /mo |
|--------------------|---------------------------|----------------------------|
| 1 | 20.0 | 27.7 |
| 2 | 20.0 | 26.2 |
| 3 | 25.0 | 27.8 |
| 4 | 29.0 | 35.9 |
| 5 | 35.0 | 64.8 |
| 6 | 35.0 | 42.6 |
| 7 | 33.0 | 43.8 |
| 8 | 39.0 | 44.8 |
| 9 | 42.5 | 52.1 |
| 10 | 54.0 | 82.0 |
| Total | 33.0 | 44.6 |

349. The flat tariff wtp is transformed into a unitary price wtp dividing the first one by the median consumption of the corresponding expenditure decile. For example, if an interviewee in decile 5 is able to pay a maximum price of 350 Taka per month and the median consumption of decile 5 is 35 cubic meters per month, we assume that the maximum amount that a person is willing to pay for water is $350 / 35 = 10$ Taka per cubic meter. In this instance we are actually assuming that the demand of water (number of cubic meters per month) is completely inelastic and that the water tariff is established through a constant unitary price for each cubic meter that is consumed by the household, without any other type of fixed payment (the connection rate is zero).

350. This assumption is unrealistic and may distort (and actually does as discussed below) the estimation of the wtp for the richest households exhibiting large water consumption (average consumption = 82 cubic meters in decile 10). These households would rationalize and reduce their consumption as a reaction to a unitary tariff increment before getting disconnected. Notice that the assumption of inelastic water demand will have a lighter impact on the poorest households that have already adjusted their consumption. Following the above methodology, the aggregated demand curve for all the households and the poor households is presented in Figure 19 Figure 20 and Figure 20.

⁷⁴The one-way ANOVA have been performed with the logarithm of the consumption that satisfies the requirement of normality. The p-value of this test is 0.000.

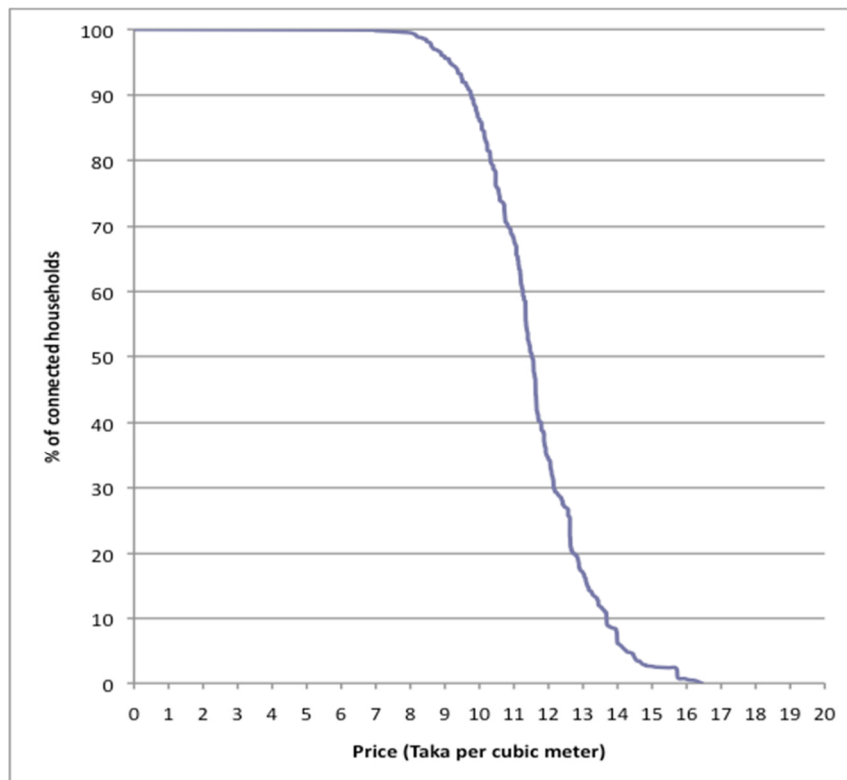


Figure 18: Water demand with a volumetric rate

351. As discussed, a distortion of the demand curve appears when wtp is estimated with this methodology and the 20% poorest and the 80% richest households are considered separately. For prices over BDT10/m³, the assumption of inelastic demand makes the willingness to pay of the richest households lower than that of the poorest ones.

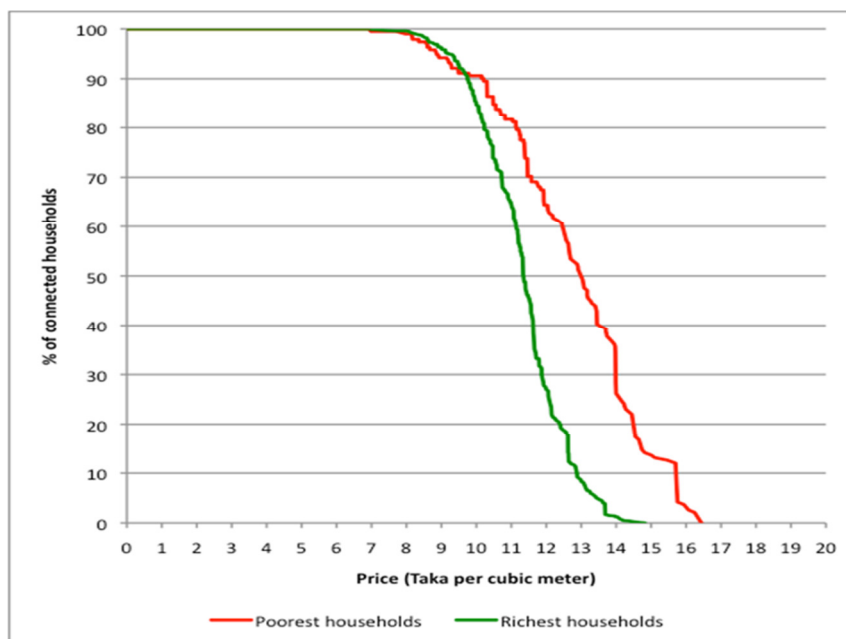


Figure 19: Aggregated Water Demand

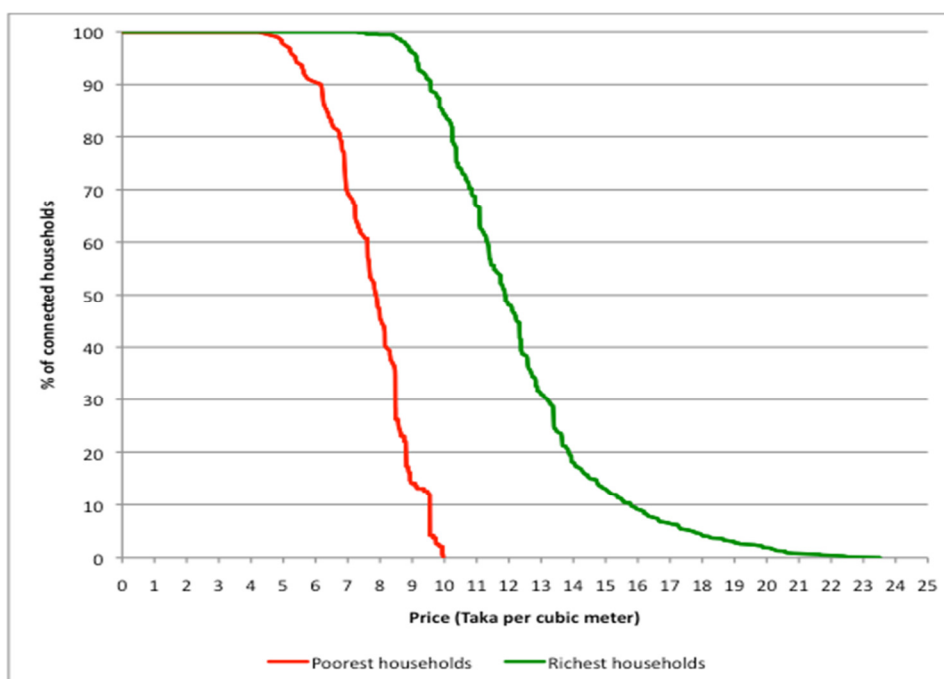


Figure 20: Aggregate water demand with a volumetric rate

352. Figure 20 is a transformation of the demand curve for monthly rates with a change of scale (the price per month is divided by the mean consumption of 33.0 cubic meters per month). As an alternative approach to deal with this problem, we could estimate a new demand curve in terms of a unitary wtp obtained as the quotient between the total wtp per month and the mean consumption of water of all the households. The result for the richest and poorest households is presented in Figure 20.

353. Summary of Key Findings and Conclusions. This contingent valuation study was undertaken following the good practices recommended by ADB's Economics and Research Department (ERD) Technical Note 23 (Gunatilake et al. 2007). The survey covered 1,000 households and was carefully conducted to ensure sound sampling and measures to avoid the potential biases of contingent valuation studies. The regression results verify that the respondents understood the wtp-eliciting questions and provided reasonable responses. The study results show that perceived benefits by households of the improved water services are large enough to justify the project costs. Further assessments are needed to determine whether the required tariff increases are otherwise viable. The following conclusions can be drawn:

- (i) Of the 1041 sampled households, 1,000 were connected to the network, reflecting the strong network coverage of DWASA in the selected areas
- (ii) Willingness to pay has a minimum value of 139.67 Taka/month and a maximum value of 775.88 Taka/month, with an average of 377.32 Taka/month and a standard deviation of 99.14.
- (iii) The distribution of the estimated WTP is positively skewed and the median value is 368.89 Taka/month, lower than the mean.
- (iv) There is a strong correlation between household expenditure (proxy for income) and willingness to pay. Similarly, higher education is strongly correlated with willingness to pay higher fees for improved water services, such as better water quality and regular water supply.
- (v) Monthly expenses per category of income are:
 - (a) Low income households (<28,200 Taka/Month) spend 184 Taka/month.
 - (b) Medium income households (>28,200) and (<44,200 Taka/month) spend 260 Taka/month
 - (c) High income households (>44,200 taka/month) spend 352 Taka/month.
- (vi) In comparison, the average willingness to pay is:
 - (a) 280.3 Taka/month for the 2nd income decile
 - (b) 358.96 Taka/month for the 5th income decile
 - (c) 431.52 Taka/month for the 8th income decile
- (vii) In each of the income group, the willingness to pay is substantially higher than the current monthly expense. This indicates that substantial tariff increases are economically viable. Project financial and economic analyses indicate that with the current low tariff, the project is not feasible financially with a negative FIRR under different scenarios. The economic analysis, however, indicates that the incremental benefits outweigh the incremental costs and the EIRR is above 12%; i.e., the project is economically feasible.
- (viii) Our demand analysis indicates that as long as the monthly payment for water consumed does not exceed 200 Taka, no poor household will disconnect. The average willingness-to-pay is BDT 377.32/m³. All households keep

connected so long the monthly expenditure does not exceed 200 BDT (equivalent to BDT 6.06/m³), after which point, the poorest 20% of the households start to disconnect. At a price of 328 BDT per month (equivalent to a tariff of 9.94/m³), no poor household keep connected. At this price, 84.5% of the remaining households maintain their connection.

- (ix) The regression results verify that the respondents understood the wtp-eliciting questions and provided reasonable responses. The study results show that perceived benefits by households for improved water services are large enough to justify the project costs.

354. The proposed component is found to be economically viable under the base case scenario⁷⁵ and also under various adverse changes in conditions. The proposed component is most sensitive to delay in project benefits and reduction in benefits. In all cases the EIRR remains above the EOCC of 12%.

4. Contract Packaging

If Saidabad is built, the DBO contractor 'A' for the intake + WTP could be monitored for performance by a bulk raw water meter at the Sejan Juice factory, into the pipeline built by another D&B contractor 'B'. DWASA will then be responsible for running the system from Sejan Juice Factory to the DND box culvert.

Table 36: Project Contract Packaging

| PROJECT Contract Packaging | | | | | |
|----------------------------|-----|---|--|-------------------|---------------------|
| Contract Package Type | | | | Contract Value \$ | + Duties + taxes \$ |
| 1 | DBO | 2000 Mld Bisnondi Intake + river training works + 1000 Mld pump station + 2 raw water pipes (17 km + 22 km), in same trench + 250m of twin pipe bridges, to Gandharbpur + 500 Mld WTP. (but only operate 1 pipe). | | 284,992,865 | 69,805,734 |
| 2 | D&B | 2 m dia. treated water pipeline 13 km from Gandharbpur WTP to Dhaka city injection point + 21 km of buried network reinforcement pipes within Dhaka 1 m to 2 m dia. + 650m of pipe bridges. | | 102,158,317 | 29,791,239 |
| 3 | D&B | 2.2 m dia. raw water pipeline 13 km from Sejan Juice Factory, buried along Dhaka - Sylhet highway to culvert near Saidabad WTP + 200m of pipe bridges, | | 64,890,598 | 19,913,443 |

5. Procurement Plan

This is presented in Section III F

⁷⁵ The base case assumes capital cost BDT 48,973,890 million, existing O&M cost per m³ = BDT 8.3, additional O&M cost from project finance model, cost per m³ of current untreated water = BDT 10, cost per m³ of boiling water = BDT 3.99

Packages 2 and 3 can both be split conveniently into two smaller D&B packages.

More packages can lead to faster construction but usually create more problems, requiring more management and administration.

If split, Package 3 could be:

1. Sejan Juice factory to the Sitalkhya River.
2. From Sitalkhya River to the Saidabad box culvert inlet.

The pipe laying conditions for these 2 are not very different – along busy highway verges with a lot of ponds / wide stagnant drains that need access tracks to be built within them for access for excavation plant and construction.

If split, Package 2 could be:

3. The straight forward rural section from Gandharbpur to the injection point near American Embassy all 2m dia. But including some long river bridges.
4. The more difficult under-asphalt road sections of network reinforcement within urban Dhaka, which require traffic management and very different construction methods. 1m to 1.8m dia.

E. Legal Framework

1. Introduction

355. The methodology for this final part of the legal delivery follows the structure set out in the inception report, which was aligned to the TOR for this project.

356. The detailed PPP Analysis focuses on the preferred PPP options and address the most important issues pertaining to a viable PPP, as those have been mentioned during the implementation of this project and as those have become apparent during interviews, workshops and based on the analytical review of the applicable legal and regulatory framework. In parallel, this more detailed analysis will define the legal framework for the PPP.

357. The final chapter defines additional requirements for the PPP project to be implemented successfully, such as further technical assistance in the final preparation of the transaction, support during the transaction and start up assistance.

358. The project has progressed since the Interim Report was issued, the following amendments, or further developments to the findings, recommendations, etc of the Interim Report, legally relevant can be stated, or indicated and therefore guide the detailed analysis:

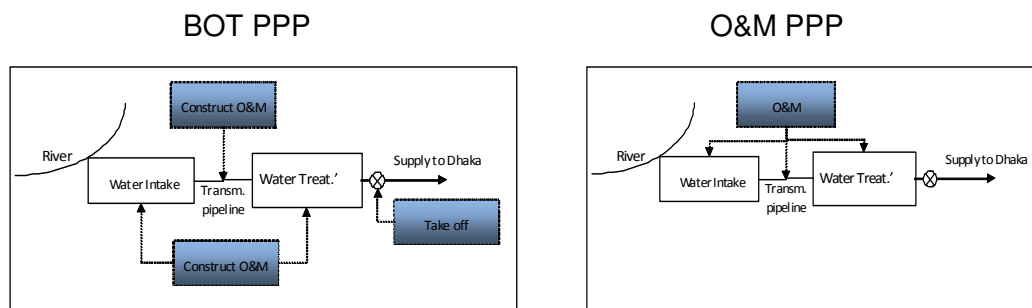
(i) The investment required for the private sector and the repayment obligations would entail a higher tariff. If this higher tariff is deemed unaffordable, viability gap financing or another method needs to be identified to keep the tariffs at an affordable level. One version would be to reduce the investment burden for the private sector to the treatment plant only and to publicly finance the construction of the transmission and intake structures. To which extent this would affect the tariff is more a financial question.

(ii) The ultimate decision on the affordability of a particular tariff is less a legal but more a political and social issue. Therefore, if the required (even if subsidized) tariff for a PPP (BOT) project is deemed unacceptable, another “fall back” option shall forthwith be considered; a publicly financed PPP project, where the private sector assumes the operational risk only; in other words, the construction and demand risks are with the public.

(iii) This would be an engagement with the private sector in operating, maintaining and managing the PPP project. If this option is chosen, it would need to be brought in line with (one of) the mandatory elements of Article 3 of the Policy and Strategy for PPP, 2010. This could be done by shifting the entire operation and maintenance risk to the private sector, together with a capital contribution to the project as such.

(iv) The originally second ranked PPP option in the Interim Report, the “Joint Venture type PPP”, shall no longer be considered. Experience shows the difficulties in establishing a level playing field between the public and private partners in a Joint Venture. There are not many positive examples in the wider region where this approach is deemed successful.

359. To re-emphasize, and to provide a visual aid, the PPP BOT and the PPP O&M would be structured as shown below. The first graph shows the privately financed Intake Facilities, Water Treatment Plant and related facilities and the transmission lines from the Water Intake to the Water Treatment Plant publicly financed. The second graph shows the entire investment being publicly financed, with the private sector assuming only the operational risk, with investments added (to be defined), not on the scale of large facilities though:



2. Detailed PPP Analysis and PPP Framework

360. The interim report provided a comprehensive high level review of applicable laws and regulations. This detailed PPP analysis addresses the most important issues specifically. In each chapter below, the applicability of the issues pertaining to the (i) BOT PPP option and the (ii) O&M PPP option is indicated. The chapter concludes with a table summarizing the issues addressed. The important issues pertain to the following:

- (i) Delegation of water abstraction rights to the PPP
- (ii) Commercial security mechanism for private sector
- (iii) Ownership of assets
- (iv) Spatial planning
- (v) PPP Corporate Structure
- (vi) Expatriation of profits
- (vii) VAT regime

1.1. Water Abstraction Rights

361. **Issue.** Water abstraction rights are essential, as any significant abstraction of water will affect others with entitlement to the water resource, both up and downstream. The issuing of abstraction rights is a public act. Therefore, clarity is needed as to who issues these abstraction rights and under which circumstances and also as to the future possibilities to revoke, reduce, or increase any water abstraction entitlement.

362. In addition, the issue as to who will be entitled to abstract water will be important; this could be the private PPP operator, or DWASA, who will pass on the water for “treatment” and transmission to the operator and then takes it back at the delivery points. This is part of any investor’s due diligence and upfront clarity of this issue is required. This would also be a condition precedent to PPP contract effectiveness.

363. **Analysis.** Any abstraction of water requires a permit from the competent authorities; this case concerns abstraction of river water. According to the National Water Policy of Bangladesh, Chapter 4.3, the ownership of water vests not on any individual but on the

State. The National Water Policy allows the Government to develop rules for water allocation for the purpose of, *inter alia*, abstraction. However, no such unified rule has been developed by the Government of Bangladesh to this date. Thus it would be the designated ministry of the Government; i.e., Ministry of Water Resources, who would exercise the rights over river water on behalf of the State, and can therefore grant abstraction rights. This is in line with the Rules of Allocation of Business between Ministries as Amended vide S.R.O No. 231-Law/2008-CD-4/5/2008-Rules, dated 24 July 2008, Ministry of Water Resources has authority for regulation of rivers and river resources.

364. Although Bangladesh Water Development Board and local Water Supply & Sewerage Authorities have been given the prerogative to abstract water under the Bangladesh Water Development Board Act 2000 and the Water Supply and Sewerage Authority Act 1996 respectively, there exists no law which empowers a third party to abstract water from the rivers for any purpose.

365. Thus for the project company to have water abstraction rights, the Ministry of Water Resources needs to be made a party to the original Concession Agreement and grant of abstraction rights for a specific period of time and renewable upon application thereafter can be made part of the concession. This way, even if the construction of the facilities takes longer than anticipated, the abstraction rights can be renewed pursuant to the Concession Agreement.

366. Recommendation. If and when a “project implementing steering committee” is established, the Ministry for Water Resources (MWR) should definitely be a member. This is to demonstrate the MWR commitment to the PPP project, conveying comfort to the potential investors that the respective water abstraction permit will be issued to the implementing consortium.

367. In addition, it should be considered to have the Ministry for Water Resources bound into the PPP agreement, either as co-signatory, in which case there should be an undertaking obliging the “public side” (as the public contractual parties could be defined) to renew any permits and licenses when and to the extent required; alternatively, there could even be a brief side agreement, a “Governmental Support Agreement” regulating issues outside the direct scope of competencies of the parties to the agreement and their respective functions.

1.2. Commercial security mechanism for private sector

368. **Issue.** This chapter concerns more the BOT type PPP since guarantees are for protection and securing of investments. . The private sector investing into this PPP project has a legitimate wish to secure payment for its provision of services. In other words, the private investor consortium, with its lending banks in the background, will require a guarantee mechanism accompanying the public payment obligation for the provision of the output; i.e., the supply of treated water to the interconnector and then to the “owner” DWASA.

369. It is at least questionable how traditional Operation and Management contracts could classify as PPP projects, if there is little investment and therefore little risk burden shifted to the private sector. However, if this option is chosen and in order to classify as a PPP under the draft PPP law and the Strategy and Policy for PPP (2010) (PPP Policy), an investment component can be woven into the PPP.

370. **Analysis.** Operations and Management Contract as PPP. The first issue to analyze pertains to the potential of having an “Operation and Management Contract” classifying as a PPP. For this, one of the basic criteria of Article 4(a) of the PPP Policy will need to be met. All these pertain to investment needs and requirements.

371. These five PPP entry points merit a brief discussion as to their suitability to serve as a basis for an Operation and Management PPP contract. These are listed in Table 37 below.

Table 37: PPP Entry Points

| Lit. | Provision text | Comment |
|------|--|---|
| i. | The implementation of the project is difficult with the financial resources or expertise of the government alone. | While this might be the case, an Operation and Management Contract will not render the required investments, so lit. i cannot be used. |
| ii. | Private investment would increase the quality or level of service or reduce the time to implement compared to what the government could accomplish on its own. | This lit. ii might be a possible entry point for Operations and Management contracts, if a significant investment component can be tailored to the contract. |
| iii. | There is an opportunity for competition, where possible, among prospective private investors, which may reduce the cost of providing a public service. | Not <i>per se</i> suitable, this provision is meant for sectors that are not a natural monopoly. |
| iv. | Private investment in public service provides an opportunity for innovation. | Not suitable, since the investment would not lead to innovation. |
| v. | There are no regulatory or legislative restrictions in taking private investment in the delivery of public service. | This would seem a “catch all” provisions, if none of the others (lit. i to vi) apply. But, it is an investment heavy provision and is therefore less suitable than lit. ii. |

372. Following the table above, Article 4(a) lit. ii would appear to be the provisions most suitable for the classification of an investment type Operation and Management PPP contract. This requires further analysis. This provision requires:

Table 38: Requirements

| Requirement | Approach |
|--------------------------------------|--|
| <i>Private investment [...]</i> | Private investment could be defined as consisting of private know how and expertise, and, more closely to the nature and understanding of “investments” to invest an asset management plan, hard and software, etc into the PPP project; this is just an example, this scope could be widened to whatever is traditionally sourced but financed through the public in an Operations and Management Contract. This could even cover expansions of the networks, access to new water resources, etc. as long as an investment component can be defined, the requirement of “private investment” can be satisfied and therefore an Operation and Management Contract modeled around this. |
| <i>[...] increase the quality or</i> | These points can be fulfilled, since a professional private |

| Requirement | Approach |
|---|--|
| <i>level of service or reduce the time to implement [...]</i> | operator would, per se, be better placed to increase the quality of service delivery, and would do this, again, per se, more efficiently and therefore quicker than the public side. |
| <i>[...] compared to what the government could accomplish on its own.</i> | See above. |

373. **Guarantee.** There are some options and combinations at hand.

- (i) Standard sovereign guarantee
- (ii) Guarantee through the PPPTAF Fund
- (iii) Commercial payment guarantee (Escrow Account)

374. **Sovereign Guarantee.** A sovereign guarantee means the government guarantees to the banks the repayment of the project debt raised by the investor consortium. While this type of guarantee used to be a standard requirement, modern PPP structures no longer revert to sovereign guarantees for a number of reasons, one being that it shifts risks back to the public and is therefore not in line with modern understanding of PPP projects.

375. **Guarantee through the PPPTA Fund.** The PPP office has a PPPTA Fund (PPPTAF) available to finance and support certain activities pertaining to PPP projects. These can be found in Article 3 of the Guidelines for PPP Technical Assistance Financing, 2012. This article refers to activities “till signing of the contract”. This, per se, would exclude any post signature support to a PPP project from the PPPTA Fund. However, Article 3 second paragraph mentions that the PPPTA Fund may also be used for activities as stipulated in the PPP Policy 2010.

376. The PPP Policy 2010 offers an entry point for securing ongoing payment obligations of the public side to a PPP. Article 10 of the Policy, last sentence reads: “The incentives may be in the areas [...] protection of return to the private investor”. This provision strongly indicates that “the protection of private investors return” could be seen as an “activity” as mentioned in Article 3 of the Guidelines for PPPTAF.

377. Since Article 3 of Annex 1 to the PPPTAF Guidelines lays out that the fund be administered and used by the PPP Office. Therefore, a guarantee of the public payment obligations can be almost certainly be covered by the PPPTA Fund. For this, close involvement of the PPP office into this discussion is required in the transaction advisory phase, when the PPP contracts will be drafted.

378. **Escrow Account.** An escrow account secures the public payment obligation to the private consortium that is undisputed due for the provision of the services, the delivery of treated water to the off-take, the interconnector.

379. This escrow account would be sourced by the public party to the PPP, most likely DWASA, and would be a simple interest bearing current account. The private party could only access this account if and to the extent a number of events (trigger events) have occurred. These would be defined when the transaction documents are drafted, but traditionally, the trigger events are:

- (i) Services delivered, invoice/s issued

- (ii) Non-payment of undisputed (parts of) invoices
- (iii) Certain period of time
- (iv) Bank or escrow account manager (lawyer, accountant, etc) has confirmed the trigger events

380. The private party could then access the escrow account and satisfy itself over an amount equal to the invoice/s due and interest (if this will be foreseen). The questions regarding the escrow account are:

- (i) Initial funding
- (ii) Replenishment, when and who guarantees that the escrow account will be replenished
- (iii) Duration

381. Initially, the escrow account would either be a multiple of monthly revenues of the operator, or a lump sum. This would be a condition precedent to contract effectiveness for the public party to the PPP. Once the escrow account drops under a certain percentage of its original value, the public will be obliged to replenish it fully.

382. A letter of credit can back up the escrow account, in the event the public side is unable to replenish it, or there could be a secondary guarantee from the PPPTAF Fund (which, by nature, is a recurring fund).

383. The escrow account could be reduced in value over time, for example, if it has not been used for a certain period, its overall value can also be reduced.

384. **Recommendation.** The establishment of an escrow account should be discussed and established, conveying comfort to the private sector for the payment obligation of the public party to the PPP. This escrow account should cover 3 to 6 months payment obligations of the public side and would be a condition precedent for contract effectiveness or a condition subsequent starting with the commercial operation date. The escrow account will need to be replenished fully once it drops beyond a certain threshold, for example under 50% of its applicable (maximum) value. The PPPTAF Fund or a letter or credit would guarantee the replenishment obligation of the public, ensuring the escrow account is a sustainable security mechanism.

385. As to the fall back option of an Operations and Management Contract, with an investment component, if the financial burden for the public through a PPP / BOT type contract is deemed too high, and linked component, infrastructure and viability gap financing cannot bridge this gap and reduce the public burden to an acceptable level, then an Operation and Management Contract can be considered, with an integrated investment component, allowing classification as a PPP and in due course all other benefits provided for by the (draft) PPP Law, assuming it is signed into force in the near future. In the event the PPP Law is not in force at the time of tendering this project, then the PPP Office would, in its role to design PPP projects, allocate the benefits deemed appropriate into the PPP structure (this can include tax breaks, etc.).

1.3. Ownership of assets

386. **Issue.** Ownership of assets is an issue in many aspects. The owner of the assets can use the assets as collateral with banks. Then, the owner can write the assets off. And, the owner enjoys an absolutely protected constitutional right.

387. If the asset ownership remains with the public, then using these assets as collaterals for project financing purposes is difficult. If the asset ownership is with the private party, then financing might be easier, but (re)gaining ownership for the public can be difficult and burdensome. The public could, in extreme cases, only revert to nationalization.

388. The question as to who, or which organization, institution, company holds which title at different times and the associated regimes is important.

389. **Analysis.** The common law principle of fixtures and fittings stipulates that all assets that are irreversibly connected with land will share the ownership of the land. This principle can be effectively enforced by expressly defining fixtures that are irrevocably connected to the land as part of the land asset in the Concession Agreement.

390. Therefore, any structures either buried in, or put onto the land, that cannot easily be removed, without “reducing significantly” its value, will share the same ownership as does the land. In other words, whoever owns the land will also have the title to these assets. These are: houses, other buildings, assets submerged into the subsoil (such as pipelines, cables, etc). Other assets are vehicles, machinery, computers, etc. etc.

391. An easy way of handling various assets is to classify assets along a number of criteria. These criteria could include:

- (i) Movable or immovable;
- (ii) Essential or non-essential for operations and maintenance;
- (iii) Privately or publicly owned; and
- (iv) New (book value) or old (written off).

392. Along these criteria, regimes can be introduced. For example, all essential assets are to be in public ownership. This would include all structures built. Non-essential assets, such as vehicles would be owned by the purchaser and this could be both, the public or private side. Assets have a certain value and once written off will need replacement. But, experience shows that not all assets are replaced once they are written off.

393. To illustrate this, there could be a movable asset, not essential, written off and privately owned (a vehicle for example). At the end of term, the private sector can remove this asset. There could be a movable, essential and also privately owned asset with a book value attached; for example a turbine. This asset is needed and will therefore be subjected to a “hand over” procedure at the end of term, against adequate compensation (book value).

394. There might be assets that are immovable, non-essential and written off where the public has little interest in “receiving” it, for example a disused structure, pumping station, dead-ended pipelines, etc. and there could be movable, non-essential and publicly owned assets, for example some building and construction equipment and material.

395. **Recommendation.** Upon completion of the land acquisition, the land should be given to DWASA, so that DWASA is the owner of the land and therefore becomes owner of the immovable assets automatically.

396. An asset transfer regime should be designed, where all essential assets, at the end of term, are handed over to DWASA; compensation should be considered if the respective assets are still in use and have a book-value. Otherwise, the private consortium will not invest into the facilities in the last couple of years.

1.4. Spatial planning

397. **Issue.** The area where the water treatment plant and other structures and facilities are to be built will require correct spatial planning permits. Without the appropriate spatial planning, any **building**, excavation etc activity could be challenged. Therefore, the areas where building and construction activities take place will need to be industrial land.

398. **Analysis.** The land is owned by DAWSA and a land record establishing ownership is available. Upon obtaining a Land Use Clearance, another application must be made to RAJUK under Rule 13 of the 2008 Rules for obtaining Building Permit for the purpose of constructing the water treatment plant.

399. **Recommendation.** The spatial planning should be completed as soon as reasonably possible and well before the tender for this project is launched. Efforts should be diverted to this issue and the future land-owning institution DWASA should monitor the efforts to this end, as regards the land acquisition process. RAJUK should be included in the project implementing steering committee at an early stage.

400. If and to the extent the spatial planning is completed at the stage when the tender is launched, respective information (clearance) should be included in the Information Memorandum. If at the stage of the launching the tender, this process is still ongoing, then support of RAJUK should be conveyed by a kind of “Governmental Support Agreement”.

1.5. PPP Corporate Structure

401. **Issue.** This concerns the corporate structure of the desired investor consortium. In both cases, the BOT PPP and the O&M PPP will require a local legal entity assuming the contractual obligations vis-à-vis DWASA.

402. The shareholders' agreement (or equivalent) will lay out some vital provisions which are of interest to the public side and therefore should be predetermined. These are the freeze-in of the initial shareholding structure and the issues pertaining to the so-called non-recourse financing.

403. The public side has a legitimate interest that the consortium is actually assuming its obligations as per the TOR, the technical and financial proposal and the PPP contract. Thus, until such time the main obligations are met, or major milestones are achieved, the consortium should not be allowed to significantly change the shareholding structure of the consortium and the (to be established) local company. So, there is an interest that the Joint Venture remains in place, with the companies from abroad bound into and committed to the project just as if it was a local company.

404. At the same time, international companies cannot endanger or risk their mother company's standing by the success or failure of a single project. There is, therefore, a legitimate wish of these international players, to reduce the financial impact of a project to

the consolidated finances, in particular if the mother company is a publicly traded legal entity. The so-called no-recourse financing reduces or limits the financial impact a failed project has on the consolidated finances of international companies.

405. Therefore, a balance has to be found, by the public wish to bind these international companies into the projects, yet, at the same time allowing sufficient flexibility in the financial engineering.

406. **Analysis.** The commercial law applicable in Bangladesh resembles the regulatory environment applicable in the United Kingdom. Section 5 of the Companies Act 1994 allows for the incorporation of traditional forms of corporate legal entities, i.e. private companies and public companies limited by shares/guarantee, reference is made to the Legal Review submitted under cover of the Interim Report.

407. Because of the freedom commercial entities enjoy, a transfer of shares of a private limited company or public limited company not listed in stock exchange is not restricted by the Companies Act 1994. The only means to restrict the free transfer of shares is by the contract, imposing a contractual penalty and even entailing contract termination in extreme cases or by special legislations (e.g. Bank Companies Act 1991 which restricts share transfer of a borrower company without approval of lender). The restrictions to consider contractually are:

- (i) Absolute restriction of share transfer;
- (ii) Temporary (initial) restriction of share transfer;
- (iii) External restriction of share transfer (shares can be transferred internally amongst consortium partners);
- (iv) Floating restriction of share transfer (over time, shares can be transferred, externally and internally);
- (v) Free transfer of shares, provided a certain minimum shareholding remains with the leading consortium partner.

408. **Recommendation.** The above listed share restriction options can be combined and a market sounding prior to the PPP transaction will help to tailor this system according to legitimate demands of the potential investors and financing institutions.

409. With respect to the non-recourse financing, this is possible under applicable legislation. Again, it is suggested to identify appropriate parental guarantees following the market sounding and to define an appropriate level of mother company commitment for the **project** implementation phases.

1.6. Expatriation of profits

410. **Issue.** Investors expect free and unhindered expatriation of dividends and/or profits. Any regime putting undue burdens to such free and unhindered expatriation will attract two unwanted issues: (i) there will be a risk premium on the financing, if and to the extent there would appear to be question marks on the expatriation of profits; and (ii) corporations will revert to other methods in repatriating their funds. Examples could be inter-consortium loans, high management, administration and back office support fees, cost items being inflated etc.

411. It is always better to allow for free and unhindered expatriation of profits and / or dividends and to convey comfort to this end, thereby encouraging transparency than the alternative. Investor consortia are more experienced in handling these situations than normally governments are. Recent example in the UK show that politicians found

themselves in an uncomfortable situation, because transparency was missing and big companies made legitimately use of legal loopholes. These loopholes are not necessary, if the regime is predictable and free from any unnecessary burdens.

412. **Analysis.** Article 10 of the 2010 PPP policy sets out the Incentives to the Private Investor, these can be of (directly) fiscal and non-fiscal nature and concern direct subsidies, waiver or exemption from import duties, applicable tax regimes, etc. The expatriation of funds was not explicitly mentioned in this provision and it is likely that, by way of analogy, this was not included by the intent of the drafters; whether this was an oversight or deliberately is not relevant.

413. The Government of Bangladesh however, being “*keen to provide fiscal and non-fiscal incentives to the private investor*” may also consider “*incentives in the areas [...] of protection of return*” (Article 10 Water Policy 2010). This is a general entitlement for the Government to take measure “protecting the return”. This is an interesting provision, it sounds, *per se*, like an enabling clause that would entitle Government to override otherwise applicable laws.

414. Step by step: does *protection of return* cover the expatriation of profits? A return (of investment) would primarily mean a flow of funds that were invested or in compensation for investments “returning” to source. The sources for these types of investment are either local or from abroad. So, both, local and foreign investment must be covered; otherwise there would need to be a disclaimer to this end, suggesting that foreign investment not be covered by this provision. Then, a return can necessarily only mean that (legitimate) funds arrive abroad, at source, “protected” from undue interference. The returns as such are some kind of profit, whether a dividend or a declared profit should make no difference. So, it is safe to assume that “protection of return” covers the expatriation of profits, otherwise, *a contrario*, if it was not covered, then where would the protection of returns be? It could only mean that local investments are concerned, but the provision does not limit the scope. This is rather unlikely.

415. Then, does the “*protection of return*” actually mean free and unhindered expatriation of profits (or dividends)? The first question would need to address “protection” from what? This will allow defining the scope of the protection. Since this is a public policy, it can only mean public policy implementation and Article 10 PPP Policy actually stipulates that benefits are to be granted through the “appropriate agencies”. This means that all relevant public institutions, organizations, administration etc within the sphere of competencies of the Government of Bangladesh are concerned. Otherwise this provision would, *a contrario*, not make sense. So the “protection” would address undue interference of any public body and the Government will do its part in “protecting” the return (and, above, the expatriation). But, this does not necessarily mean that all interference is undue. If, for example, there are ongoing disputes and the investor consortium is attempting to drain their funds in Bangladesh, then the Government has a legitimate interest that the investors are tangible within the country. So, some restrictions are certainly acceptable.

416. On the other hand, if there are no significant potential liabilities and the investor just need to repay their banks or equity investors, then there should be as little bureaucratic as possible. Thus, if there are too many formalities, permits, approvals and loops an investor consortium has to go through each and every time before it sends funds abroad, then this certainly would not be in the spirit of “protection of returns”.

417. The detailed legal review, submitted as part of the Interim Report and updated with the findings at this final stage (included in Appendix 15 Annex 1 to the legal report), has shown the steps an investor consortium has to go through in order to expatriate profits. For dividends, according to Paragraph 31, Chapter 10 of the Bangladesh Bank Foreign Exchange Guidelines of Bangladesh, the Authorized Dealers (banks) are permitted to remit dividends (both interim and final) to the non-resident shareholders on receipt of an application in the prescribed form from the company duly certified by its auditor filed along with some supporting documents.

418. **Recommendation.** In order to convey the necessary comfort to investors to be able to expatriate profits (or dividends), the Information Memorandum should contain a chapter addressing this issue, together with a statement from the Central Bank of Bangladesh either in the Information Memorandum, or a “Governmental Support Agreement” that these “approvals” for the expatriation of dividends will be issued as soon as possible and practicable. This Central Bank of Bangladesh approval can take from 2 weeks up to 3 months.

1.7. VAT regime

419. **Issue.** The Khilkhet WTP project will require plant and machinery, goods, works and services, sourced locally and from abroad. While the imports are traditionally less problematic, because those are usually VAT exempt, the provision of local goods, works and services, can make up a significant part of the overall investment required.

420. Therefore, the extent local VAT can be waived for the sourcing and provision of local goods, works and services will have a direct impact on project financing and ultimately the burden for the public to carry through the tariff.

421. **Analysis.** According to section 3 of the VAT Act 1991 all locally bought goods, works and services, save and except the goods mentioned in Schedule 1 of the VAT Act and services mentioned in Schedule 2 of the VAT Act, are subject to VAT. Whilst there might be a VAT exemption applicable to the implementation of the consortium directly, this does not, per se, extend to local subcontractors and works since the services expected to be supplied on account of the same, including, without limitation consultancy, advisory, engineering, legal etc do not fall within the purview of Schedule 2 of the VAT Act and as such shall attract VAT

422. But, there is a possibility that local goods, works and services too are VAT exempt. According to Rule 31(Ka) of the VAT Rules 1991 read with SRO No 1 (5) VAT (redemption)/99 (part-2)/133 dated 17.10.2004, any manufacturer or service provider with a VAT Registration who provides a goods/services pursuant to a local or international tender called by any person for the purpose of a development project in Bangladesh funded by foreign donation or loan, shall be deemed to be exporting their goods/ services. Any local subcontractors, suppliers, etc falling within this category shall be exempt from payment of VAT by operation of section 3 read in conjunction with Schedule 2 of the VAT Act 1991, which exempts all exports from payment of VAT.

423. In practice however, instead of exemption of payment, such local contractors would be entitled to reclaim any VAT they might have paid. However, it is not possible to conclude whether the local sub-contractors or suppliers will qualify for the aforesaid VAT

exemption without precise information about the funding mechanism of the Project. The relevant factors for this possible exemption are:

- Local contractor provides goods/services pursuant to a local or international tender called by any person for the purpose of a development project in Bangladesh funded by foreign donation or loan;
- The local contractor is a VAT registered;
- The local contractor is Bangladeshi national/registered;
- The consideration for local contractor’s service is paid in foreign currency;
- Such consideration is remitted through normal banking channels

424. While this cannot be guaranteed, there is a possibility that such VAT exemption can be effected and if this is the case, which means local VAT will not apply to locally procured goods, works and services

425. **Recommendation.** In the following phases of this project, this issue of VAT exemption of local goods, works and services, if remunerated in foreign currency, should be discussed and taken up with the PPP Office and the Ministry of Finance. If a general waiver can be obtained, then, perhaps the respective invoices to the project can be Zero VAT invoices and therefore significantly reduce the overall financial burden.

426. Since the exemption would depend on the nature of funding of the project (and consequentially the contract arrangement with local contractor) it is highly unlikely that at this stage a conclusive view would be taken by the VAT regulators at this stage. Customary practice is that PPP/concession contracts provide for such allowances only after contract execution and such exemption applications are made to the regulators, who then take a decision looking at the executed contracts and recommendation from the procuring entities.

1.8 Summary

427. The table below provides an overview of the issues addressed and the relative applicability to the two PPP options, BOT and O&M

Table 39: Issues Addressed

| N. | Issue | BOT PPP | O&M PPP |
|----|---------------------------|---------|---------|
| 1 | Water Abstraction Rights. | √√√ | √ |
| 2 | Commercial security | √√√ | √√ |
| 3 | Ownership of assets. | √√√ | √ |
| 4 | Spatial planning. | √√ | √ |
| 5 | Corporate structure | √√√ | √ |
| 6 | Expatriation of Profits. | √√√ | √√√ |
| 7 | VAT Regime | √√√ | √√ |

428. These issues will have to be addressed in order of priority, depending on the chosen PPP option. In the event of a BOT PPP, this means all these issues will require resolution before the launch of the tender thereby establishing a favorable environment for investment and inviting investment from abroad. In the event of an O&M PPP the most important issues pertain to the commercial security and profitability issues (tax and expatriation of profits).

3. Definition of Additional Requirement

429. For this project to include a PPP component, either as a BOT or Operation and Maintenance PPP, additional support is required. This can be summarized as traditional transaction advisory, with two phases; the pre-tender and preparatory phase and the tender assistance phase leading up to the PPP contract signature.

1.9 Pre-Tender Phase

430. In this phase the tender documents and the PPP contract should be drafted. The associated documents are:

- (i) Procurement plan, outlining the entire (planned) procurement;
- (ii) Expression of Interest; together with the prequalification criteria;
- (iii) Request for Proposal, together with the financial and technical bid evaluation criteria;
- (iv) Time schedule for award;
- (v) Draft PPP contract for the design, construction, operation, maintenance and ultimate transfer of the intake, transmission pipeline, the water treatment plant and interconnector for the BOT PPP and the Operation and Maintenance of all these facilities and the investment component for the O&M PPP;
- (vi) The off-take agreement with between the BOT Operator and DWASA together with a commercial mechanism allowing remuneration of the BOT Operator and a support type agreement, where the public side commits to the project.

431. All these documents will need to be drafted, in principle agreed upon by the main public stakeholders and financial institutions (such as the ADB) and cleared for the tender phase, ensuring a swift and efficient tender process.

1.8. Tender Phase

1. In the tender phase, assistance should be provided for the following actions:

- (i) Prequalification evaluation
- (ii) Shortlisting
- (iii) Questions and answerer
- (iv) Bidders meetings
- (v) Bid evaluation
- (vi) Negotiation assistance

F. Contract Types & Packaging

The main issues and alternatives considered before arriving at recommendations are summarized below:

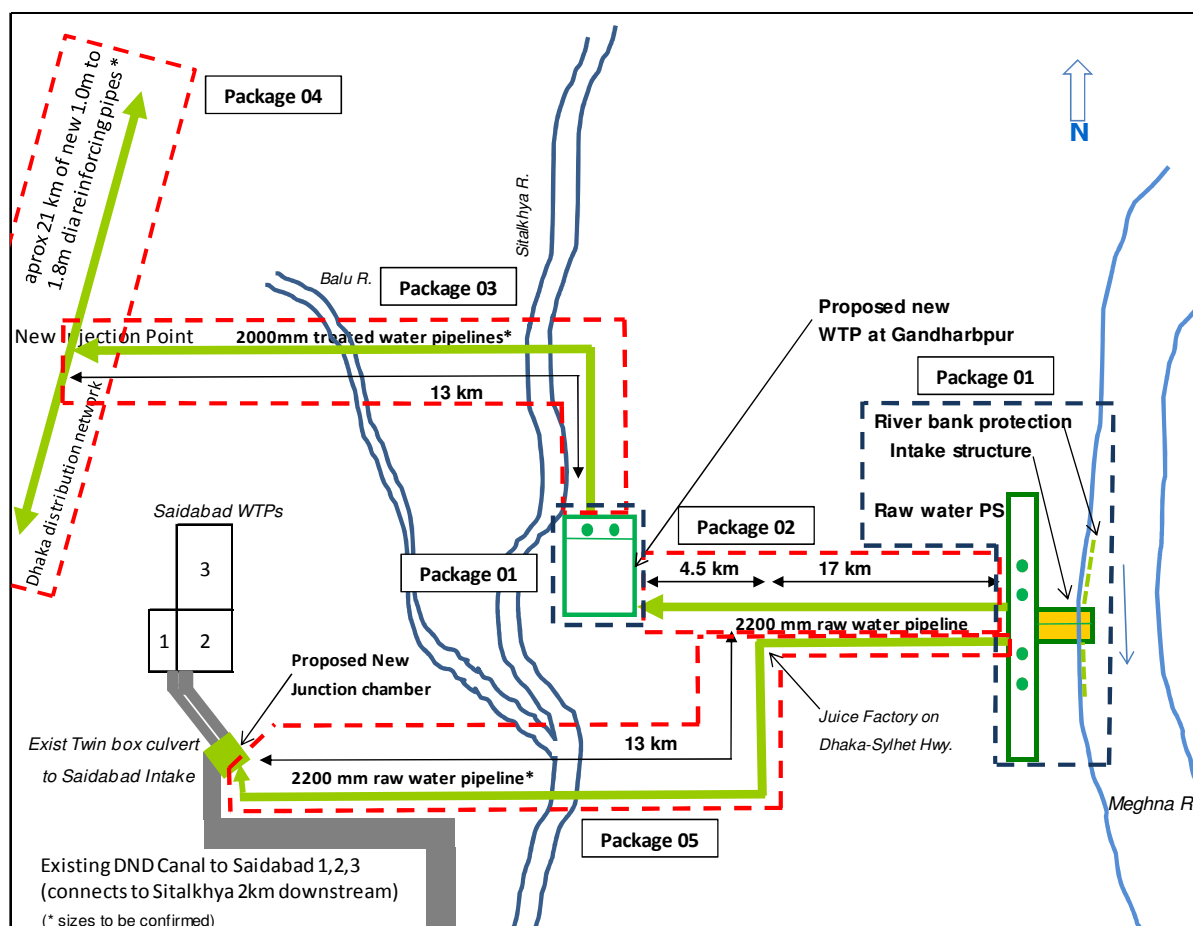


Figure 21: Contract Packages Schematic

1.0 Contract Packaging Considerations

Table 40: Contract Packaging Considerations

| Ref. | Question/Issue | Response | Date |
|------|------------------------|--|------------|
| 1 | What to include in DBO | A “large DBO” is not necessarily best. It has a cost, and the right choice is not straightforward. It is expected that “the contractor” feels accountable from intake to WTP if there’s only one large contract, but it might be more complex. There will be a consortium (maybe a JV, maybe a joint and several consortium, maybe a | 13/06/2013 |

| | | | |
|---|--|---|------------|
| | | <p>lead contractor with sub-contractors).</p> <p>One company may be in charge of pipes (supply + laying) and civil engineering, and another one in charge of the water treatment process + intake. If the intake is very complex (and it certainly is), it may actually be left to a 3rd, specialized company.</p> <p>The “civil engineering” will have the lion’s share during the works phase (all pipes + 50% of WTP cost + xx % of intake), maybe 80% of the total cost. Then, during operations, the water treatment specialist will certainly be the one in charge (pipe maintenance will be minimal). That means that the structure of the consortium will have to change between these 2 phases (e.g. in a JV, the share of equity of each company will have to be modified), responsibilities will change, specific interest of each partner will differ along the project’s life, etc. So it’s not so easy.</p> <p>An independent, competent engineer to do detailed design could instead promote an unbiased approach.</p> | |
| 2 | Saidabad pipeline | <p>1. The original project plan for a parallel pipe from intake to Saidabad needs to be changed, considering the complication (and additional cost) of having two contractors from juice factory to Saidabad at the same time.</p> <p>2. Having a partial pipeline from intake to juice factory under this project (which will continue to Saidabad under a future project) is not supported by any party.</p> <p>3. So the most plausible option for this project is just one pipe from intake to Gandharbpur. Condition will be made that Contractor 2 (under Saidabad) will come to intake-juice factory section only after Contractor 1 (under this project) will complete the section.</p> | 13/06/2013 |
| 3 | Is it possible to construct two trenches | <ul style="list-style-type: none"> It will be impossible to manage | 12/06/ |

| | | | |
|----------|---|---|-------------------|
| | <p>simultaneously from intake to juice factory in case the pipe contracts for Gandharbpur and Saidabad are by different contractors at the same time?</p> | <p>/coordinate 2 contractors working simultaneously in the same pipe corridor.</p> <ul style="list-style-type: none"> • The access road is long and narrow and will frequently be blocked by one contractor, which will cause claims for disruption /delay by the other. • It is impossible to have 2 separate open trenches adjacent to each other. Access problems + accident risk. • It is expensive, risky and inefficient to excavate a deep trench close to another existing pipe, so it is avoided whenever possible. Pipe 1 must have careful protection from trench 2 e.g. Sheet piled trench support which is expensive, to protect its compacted bedding. Pipe 1 risks being damaged by construction plant working on pipe 2. Compared to placing 2 pipes simultaneously in 1 trench, the cost for 2 separate trenches is approximately 2 x the full installation cost (which is ~30% of total pipe cost) e.g. 2x the working time; 1.5x the excavated waste to be removed; 2x the dewatering cost; 2x trench support costs; 2x environmental impact. Hence ~ 30% increase in pipe costs. | <p>2013</p> |
| <p>4</p> | <p>While we need to see when exactly the construction of each package will start and end, there is a possibility that Saidabad 3 construction will start before the completion of construction under Gandharbpur.</p> | <p>If financing constraints and commitment delays dictate that both raw water pipes from Intake to Juice, cannot be installed under 1 contract at the same time, then the extra cost, risk and inefficiency of sequential construction must be accepted.</p> <p>To make this work, we agree it will be best to either:</p> <p>1. Impose a construction schedule on Contractor 2, to avoid interference with Contractor 1. That means persuading contractor 1, during award negotiations, to commit to a programme which finishes substantial independent sections of the pipe route as early as possible, which can be accessed without using the project access road (probably new roads will have to be built)</p> <p>Or :</p> | <p>12/06/2013</p> |

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| | | 2. Find a different alignment for Saidabad (1+2+3). | |
| 5 | Having two different contractors to work in the same site (both from intake to juice factory and from juice factory to Saidabad) may sound difficult (and costly), but how can this be avoided? | <p>Having two different contractors to work in the same pipe reservation will be a disaster. Installing 1 big pipe right next to another, which has just been laid and backfilled is very risky, difficult, much more expensive and very bad planning.</p> <p>If you want to build 2 Saidabad pipes within 2 years of each other, the only technically acceptable way to do it is :-</p> <p>Contract 1 = Supply + lay triple pipe* from Intake Pump station to Juice Factory (+ single pipe onward to WTP). This should be part of the DBO contract.</p> <p>Contract 2 = Supply + lay double pipe from Juice Factory to Saidabad.</p> <p>*Actually, it is economically indefensible to lay 3 pipes at the same time next to each other. Two pipes is OK because they provide security of supply, but 3 is a waste of money and bad planning.</p> <p>Therefore, it is much better if :-</p> <p>Contract 1 = Supply + lay 2 pipes in same trench from Intake Pump station to Juice Factory: dia ~2200 for Gandharbpur + dia 3500 (aprox) for Saidabad.</p> <p>These 'big + small' pipes will have cross connection at Juice F (for emergency supply). After the Juice Factory, the big Saidabad pipe should revert to twin ~2200 dia for security of supply</p> <p>While technically most logical, this proposal will not be accepted by financiers unless there is very firm commitment from the government and financiers of Saidabad 3 that Contact 2 will come without delay.</p> | 11/06/2013 |
| 6 | Comment from Lionel Goujon | Regarding pipe diameter: leaving the diameter undecided would without a doubt add | 07/06/ |

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| | | complexity to the cfps. So, if a proper NPV analysis can be performed during the bid document preparation, and prove that the optimal choice is clear and/or that enforcing a diameter will not have a real impact on the NPV (compared to a pipe one size larger or smaller), I fully agree that it is better. | 2013 |
| 7 | Phasing | We propose the following: (i) intake + WTP + interconnecting raw water pipework: DBO, with 15-20 years operation (ii) another raw water pipework to Saidabad (from junction): DB (whether this will be consolidated with (i) will be determined through market sounding) (iii) treated water pipework: DB, possibly split into 2: Rural/Urban, (to be determined through market sounding) | 07/06/2013 |
| 8 | Is the following a plausible option (i) DBO for intake and WTP and (ii) only Build for pipes, with Design to be made by the loan consultants? | (i) Yes but we still recommend the interconnecting raw pipework is included (ii) This is technically the better, lower risk way to do it, but takes longer.. Usually it results in project cost savings. | 07/06/2013 |
| 9 | Only if B duration of pipe laying is much shorter than DB duration of intake and WTP, the above option would make sense. But pipe laying would take longer than WTP? | Not necessarily. This depends on how many pipe laying teams the contractor mobilises to work concurrently. With sufficient plant and management a good, well financed contractor can squeeze his construction time down to fit a shorter deadline by working in many places at once, but the risk of overrun increases (which becomes an extra bid cost). | 07/06/2013 |
| 10 | Split contract for T.W. pipeline | We recommend (from technical perspective) to split Package 3 (treated water from WTP to Dhaka) because the rural 2m dia pipe route is quite different contracting work from laying smaller DI pipes under congested asphalt roads within urban Dhaka. It would suit different contractors. | 03/06/2013 |
| 11 | It has been pointed out that having one single contractor would increase its accountability during the "Operate" part of the DBO. What seems important is that the (future) operator of the system participates in the pipe package acceptance (for its completion certificate), and that should be enough | Generally, whenever a contractor is allowed to bid on more than one package in a multi-package project, he would offer substantial discounts to obtain more than one or all packages. This is driven by economy of scale (e.g. mobilisation + preliminaries + management costs + risk cost will be shared across several packages). However, it may be right to say the package size is already big | 02/06/2013 |

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| | " . | enough to override any economy of scale considerations. True or not? - market sounding would confirm. | |
| 12 | These are not “small” vs. “large” packages. We’re rather talking of “very large” vs. “very very large”. We are confident that we can attract world-class companies on these tenders (and even more in the currently tough market conditions). | Others say the Bangladesh political and social environment may not be so attractive to world class contractors needing to fully commit to a project that requires procurement to move fast, transparency of bids, third party delivery /approval, supportive regulations, predictable implementation and a host of other activities and potential liabilities that deny them comfort. Without careful packaging, we may end up with only Chinese and Indian bidders. | 02/06/2013 |
| 13 | Above a certain size, economies of scale do not really apply anymore: 2 tenders of 100KUSD might lead to 160KUSD in total if grouped, but 2 tenders of 100MUSD would more probably lead to ~200MUSD if grouped. | Agreed, but unsure where that threshold is. Market sounding can check. | 02/06/2013 |
| 14 | On the other side, one large package may somehow reduce the competition. | This is a beneficial objective, to attract good DBO contractors. | 02/06/2013 |
| 15 | One key question is: can there be design-related linkages between the pipes and the intake/plant? Actually, there might be: if we procure the (raw water) pipes on “red FIDIC”, that means we will calculate ex-ante the acceptable headloss, then we will ask for pipes with the relevant diameter on one side, and for pumps adapted to this diameter on the other side.**** | Yes, possible if the bid docs :- (1) Contain minimum specifications for each allowed pipe material. (2) Ask bidders to provide supply & lay rates for several diameters (which bracket the likely optimal dia). (3) Define the economic parameters which will be used to select optimal dia. During evaluation (e.g. power tariff, pump efficiency, pipe roughness, average pipe depth, discount rate, annual (non power) opex costs, (4) Tell bidders that the final pipe size + material selection will be made by client. | 02/06/2013 |
| 16 | A design-build procurement might make sense for these pipes if it also includes the treated water pumps, so that the competitors might propose optimized solution for the investment | Agree pumps to stay with WTP, but pipe dia can be fixed after DB bidding as suggested in ***** above | 02/06/2013 |

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| | + operations (energy) cost. But can we recommend that the treated water pumps should be included in the WTP package, not in the treated water pipes package (these pumps will be located at the plant, operated by the plant manager... so they must be chosen by him)? | | |
| 17 | Alternatively, with a global “yellow FIDIC”, we can let the competitors propose an optimised “investment + operation cost” arrangement (e.g. A smaller diameter – i.e. Higher headloss – might be financially relevant with a specific pump configuration). | This only works if the operating period is long enough for opex to outweigh their capex savings from an undersized pipe - say 15 years | 02/06/2013 |
| 18 | How certain are we that 2200mm will be the optimal diameter in the end? | Not certain at all. Pipe supply + install cost is the major variable which is only known at bid evaluation. It can change the optimal diameter by 300mm. | 02/06/2013 |
| 19 | If much doubt remains on this, one global package including raw water pipes might make sense (but more for design issues than for maintenance issues, in my opinion). | Agreed | 02/06/2013 |
| 20 | Please note that if we choose design-build, we should think in terms of specifications for the “system output”, i.e. “we want that much water of that quality, with this resistance to earthquake, this xxx, etc.”, but not “we want pipes of 2200mm, DI, with this kind of pre-treatment, etc.). So it is not clear whether a “base bid” should be mentioned. | Agreed | 02/06/2013 |
| 21 | Or the “base condition” should relate to outputs (e.g. “base condition for turbidity of treated water is below 1 NTU, but alternatives up to 2 NTU can be proposed if they result in significant cost savings”). | The principle is correct, but there is a problem as we don't have enough (years of) raw water data to give them, so promising a particular t. W. Quality is a costly risk to bidder. (depending on the penalties to be defined in bid docs). Another point to be explored in market sounding. | 02/06/2013 |
| 22 | For that reason, a “red FIDIC” procurement for treated water pipes (if not for the raw water) is more favorable. The diameters, exact routes | It can still be DB with flexible bid docs demanding prices for several different pipe dias so the final decision on size + material can be made during bid evaluation and contract negotiation. This is a | 02/06/2013 |

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| | and allowed headloss will have to be clearly stated in the tender documentation. | workable option, not the only one. We can also consider a partial design by consultant during bid doc preparation, to analyse optimal pipe size, based on best costs available at that time and fix these pipe + pump sizes in bid docs, but guessed prices mean they might not be optimal size hence a penalty in long term discounted total cost. | |
| 23 | Even if partial pipe design is made, can bidders still propose alternatives? If so, what's the merit of partial design? | First approach above offers win-win by saving red FIDIC design time while still allowing DWASA to choose the optimal size. | 02/06/2013 |
| 24 | For pipeline construction, the key advantage of DB is time-saving. But if we do not fix the pipe diameter, how can we stop bidders proposing smaller pipes by claiming incremental pumping costs are not large? | Indeed - this is our big concern. It is the main disadvantage of DB over red book. Only the bid documents can prevent this unwanted outcome. They must be skillfully crafted to enable the client to get optimal design. It is not simple, but we suggest as follows:- Bid docs must :- (1) Contain minimum specifications for each allowed pipe material. (2) Ask bidders to provide supply & lay rates for several diameters (which bracket the likely optimal dia). (3) Define the economic parameters which will be used to select optimal dia. During evaluation (e.g. power tariff, pump efficiency, pipe roughness, average pipe depth, discount rate, annual opex costs (non power), (4) Tell bidders that the final pipe size + material selection will be made by client. | 01/06/2013 |
| 25 | Disadvantage of few/large packages | Two or three large contract packages have a risk advantage over one big one, in that if it fails, the other(s) may be in a good position to take over and finish their work. On the other hand, many packages attract small contractors, who may not have capacity to do this. | 31/05/2013 |
| 26 | As for using one single trench for both pipes (if there are two pipes) what are the expected advantages (and evaluate the cost impact compared to 2 trenches)? | Single trench for 2 pipes is assumed in DFR. The cost for 2 trenches is much higher than for one twin (2x the working time; 1.5x the excavated waste to be removed; 2x the dewatering cost; 2x trench support costs; 2x environmental | 31/05/2013 |

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| | | impact); pipe corridor space too narrow for 4 separate pipe trenches = risk damaging the installed pipe(s). Problematic for 2 different contractors to use the same access road at the same time. | |
| 27 | Size of package | <p>The bigger the package, the more attractive it is to good international contractors, who we are targeting. Small packages give them less incentive to bid and less incentive to put effort into good designs. This is a major infrastructure project on which a big portion of Dhaka will rely and breakdown would be catastrophic. It demands first class design to reduce the many technical risks inherent in a long pipeline in difficult ground conditions, with insufficient base data (geotec + water quality + river characteristics).</p> <p>Good big international contractors know that small packages mean:-</p> <ul style="list-style-type: none"> - more competition from small, cut-price contractors, - more chance that the considerable cost and effort required to prepare a winning DBO bid will be wasted, - smaller profit so less incentive to mobilise a top team to Dhaka | 30/05/2013 |
| 28 | Number of packages | <p>If package 1 + 2 are not combined, or worse, if they are split into 3 contracts, DWASA will probably :-</p> <ul style="list-style-type: none"> - get poorer design (see above). - have trouble managing the different operators because each will blame the other for any problem. | 30/05/2013 |

2.0 Operations Stage

Table 41: DBO Operations Stage

| Ref. | Question/Issue | Response | Date |
|------|--|--|------------|
| 1 | Why longer "O" duration? DWASA is expecting a DBO with "a small o", Saidabad 2: 1 year warranty + 2 years management contract. Why is 15 years++ recommended? What would be the objective? Reaching a "stabilized" performance and building the capacity of DWASA on such a large plant can be done in 3 years. | A short period operating commitment gives DB contractor no incentive to design the system and select equipment for low plant maintenance, simple operation, long term reliability etc. He could use cheap fast running pumps with short life, shallow pipes, minimal surge protection, labour intensive treatment processes, reduced stand-by capacity, low corrosion protection etc. We can try to avoid some of these with tight specifications, but contractor with short operating obligation will design system very differently to DWASA disadvantage. A long operating obligation is DWASA's guarantee for a good design. It should cover most of the expected lifespan of major equipment. | 07/06/2013 |
| 2 | What is the best duration of the DBO contract? DWASA prefer a short one as in Saidabad phase 2 (3 years). | DWASA staff were not enthusiastic for longer than 5 years operation, but we recommend DWASA should consider the benefits of longer op, unless 'Design' is separated from 'Operations', but this is not advised for the intake + WTP. | 07/06/2013 |
| 3 | Why include raw water pipe Intake to WTP in DBO? | Breakage /burst frequency depends on good design and good supervision to prevent: damage from vehicles, flotation, river erosion, failed /flooded air valves, failed thrust blocks, and surge pressures caused by intake operator. (latter can collapse or burst the pipe; if so, who is responsible - the pipe contractor or operator?). We strongly recommend keeping pipes from intake to WTP under responsibility of operator. The more pipes we can give to the operator the better the design + construction quality will be. | 31/05/2013 |
| 4 | Duration of operation | To achieve full benefits from a DBO approach, the 'O' part should preferably be nearer 20 years to capture the potential breakdown and need to replace major items of (potentially underdesigned) mechanical plant. Five years or less would be most unusual and risky for DWASA in the long term. It is the obligation to operate for a long time that | 30/05/2013 |

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| | | forces a contractor to design & build an efficient, reliable solution that is easy + cheap to operate + maintain | |
|--|--|--|--|

3.0 Bid Documents

Table 42: Bid Documents

| Ref. | Question/Issue | Response | Date |
|------|------------------------------------|--|------------|
| 1 | Advantage of fixing pipe diameter: | <p>Leaving the diameter undecided would without a doubt add complexity to the tender evaluation. So, if a proper NPV analysis can be performed during the bid document preparation, and prove that the optimal choice is clear and/or that enforcing a diameter will not have a real impact on the NPV (compared to a pipe one size larger or smaller), we agree that it is better.</p> <p>Enforcing a pre-determined diameter reduces the “design link” between intake and raw water pipes (the characteristics of the raw water pumps will become independent from the pipes – except for the roughness, which has a small impact.</p> | 08/06/2013 |
| 2 | Starting Bidding at the same time | This allows bidders to bid for more than one package (with possible discounts), but some say discounts may be negligible when contracts are this big | 07/06/2013 |
| 3 | Concern about pipe diameter | The consultants who will prepare the bid documents should analyze optimal pipe diameter during bid document preparation. This will be done for the pipes of all packages. Long term NPV cost penalty of slightly wrong pipe size is relatively small, so this can be acceptable. Merit will be much clearer, simpler, more professional pipe bid docs with fixed sizes and only alternative pipe materials offered. Bidders may be alarmed (= extra risk costs added) to find pipe size is undecided and it would involve them in much extra work + bid time. | 07/06/2013 |
| 4 | Detail design/ Red Book vs. D&B | <p>1) A Red Book approach for the pipe contracts would likely result in better designs/quality than if implemented under a DB/Yellow Book contract</p> <p>2) A DBO contract for intake + pipe + WTP could be expected to result in higher quality pipe designs than if the pipes were implemented under a DB/Yellow Book contract. The validity of this statement will increase with the length of the O component. With a short operation period, the difference to a DB contract is less pronounced than with a long O-period.</p> | 06/06/2013 |

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| | | 3) Recruitment of consultants for Red book design of pipes would take at least a year and require more resources than funds are available for, without further delay. To avoid these delays of one year, or more, risks of inferior construction must be accepted. | |
| 5 | Advantages of FIDIC Red Book Detail Design | FIDIC Red Book may be an appropriate option for the pipe packages. This would allow a competent and objective consultant to make the final decision on e.g. pipe material and pipe dimension, rather than leaving such decisions in the hands of a price pressing contractor, less concerned about the long-term performance. This approach would facilitate the tender evaluation, but would also influence the time schedule and TA fund needs. The DBO approach for the intake and WTP in one package, eliminates the risk of intake and WTP plant contractors blaming each other for any problem. | 31/05/2013 |

Table 43: Saidabad and other Questions

| Ref. | Question/Issue | Response | Date |
|------|--|---|------------|
| 1 | <p>The DFR suggests not using the DND canal anymore to supply Saidabad 1 & 2 as this canal is considered an “open sewer” putting at risk the quality of the raw water.</p> <p>Degrémont considers the canal is dirty because the Sitalkhya water is dirty. The canal is not the source of pollution. Switching to the Meghna water will solve this issue, according to them.</p> | <p>PPTA appreciates this opinion. It could easily be verified by water quality sampling at beginning and end of canal. If Degremont + DWASA confirm that Sitalkhya raw water can be treated satisfactorily throughout the year and in future, (DWASA disagreed at ADB wrap-up) this last proposed pipe section along the canal can possibly be omitted from this current project.</p> | 12/06/2013 |
| 2 | <p>Saidabad 1 and 2 cannot receive water directly from a pipe with a pressure head.</p> | <p>This was understood by PPTA consultant who propose in DFR to pump into an open inlet box (included in costs) at start of culvert so Saidabad inlet arrangement is unchanged</p> | 12/06/2013 |
| 3 | <p>Degrémont say the DND canal capacity is not sufficient for 1000 MLD.</p> <p>This implies that the canal must be used for Saidabad 1 & 2</p> | <p>Not necessarily – see above</p> <p>But Degremont say the canal cannot be used for Saidabad 3, which should receive water directly from pipes</p> | 12/06/2013 |
| 4 | <p>The new pre-treatment currently enables Saidabad 1 and 2 to produce drinking water of good quality, from the Sitalkhya. Switching to the Meghna water will increase the cost (because water from Meghna requires more energy).</p> | <p>But expect that cost is partly offset by reduced chemical treatment cost. So it may not be relevant to switch the water supply until the Sitalkhya becomes too deteriorated.</p> | 12/06/2013 |
| 5 | <p>How is security of supply considered?</p> | <p>If we have two pipes instead of 3 from Intake to Juice, (one small for G1 and one big for S1+2+3) to save money, they will be joined at Juice with a connecting pipe + valve which is opened when one pipe has failed. This will allow the flow from the good pipe to be shared between Gandharbpur and Saidabad while repairs are made.</p> | 11/06/2013 |
| 6 | <p>Can 15% Physical contingency be reduced? A number of ADB projects' cost estimates, and contingencies are</p> | <p>15% physical contingency is not high at FS stage. I feel it is uncomfortably low.</p> | 05/06/2013 |

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| | <p>normally more or less 10%, not more than 15%.</p> | <p>10% ph contingency for this sort of project (with many unknowns) is only acceptable following a very good detail design, based on full site investigations + client and gov't approvals etc.</p> <p>Even then, many /most contracts incur variation orders for unforeseen problems, oversights and instructed extra works in excess of 10%.</p> <p>Projects where all risks are passed over to the contractor can have smaller physical contingency, but then the contractor's risk costs must be added to the contract value (works cost estimate), so the cost still has to be included.</p> <p>We cannot support reducing it from 15%.</p> | |
| 7 | <p>Why DB for pipes?</p> | <p>Having a separate d is technically the better, lower risk way to do it, but takes longer and if we wait for the loan consultants to do the design, this will be delayed by a year. If we squeeze the construction period of these contracts to compensate for the delay, bid price could go up. So it makes more sense to start all packages at the same time. By fixing the pipe diameter during bid document preparation, risk of design manipulation by prospective bidders will be less.</p> | |

