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

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

FINAL REPORT
VOLUME II

SUPPORTING REPORT
&
DATA BOOK

MARCH 2013

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO., LTD.

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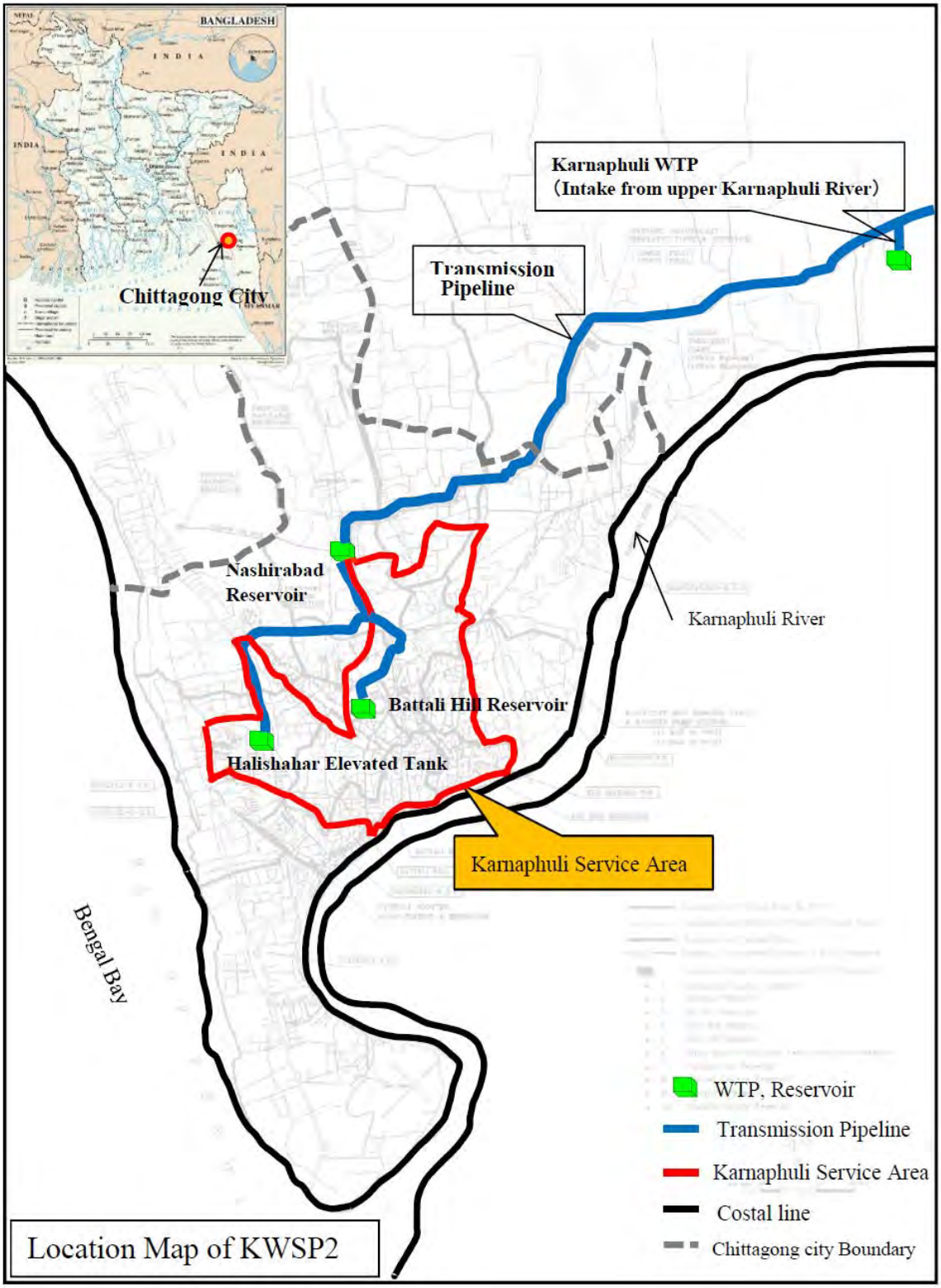
13-037

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

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


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

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THE PEOPLE'S REPUBLIC OF BANGLADESH

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TABLE OF CONTENTS

Chapter 5 ESTABLISHMENT OF KSA

Chapter 6 DISTRIBUTION SYSTEM

Chapter 7 PRELIMINARY DESIGN OF THE WATER SUPPLY FACILITIES

Chapter 8 CONSTRUCTION PLAN OF WATER SUPPLY FACILITIES

Chapter 10 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

PART 2 DATA BOOK

I. Drawings

II. Soil Investigation

PART 1

SUPPORTING REPORT

CHAPTER 1

BACKGROUND AND OUTLINE OF THE SURVEY

CHAPTER 1 BACKGROUND AND OUTLINE OF THE SURVEY

1.1 The Minutes of Meeting of the Preparatory Survey (January 22nd, 2012)

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THE MINUTES OF MEETINGS
ON
THE PREPARATORY SURVEY
ON
CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH
AGREED UPON BETWEEN
THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
AND
THE JAPAN INTERNATIONAL COOPERATION AGENCY

Dhaka, January 22nd, 2012

The Government of the People's Republic of Bangladesh (hereinafter referred to as "GOB") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") have made several preliminary discussions and confirmed the necessity of the Chittagong Water Supply Improvement Project (hereinafter referred to as "the Project") from 26 November to 2 December, 2011. Accordingly, JICA dispatched a mission on the Project headed by Mr. Ueki Masahiro, Advisor, Water Resources Management Division I, Global Environment Department, JICA (hereinafter referred to as "the JICA Mission") to Bangladesh from January 14 to January 24, 2012 in order to develop scope and implementation arrangements of the Preparatory Survey on Chittagong Water Supply Improvement Project (hereinafter referred to as "the Preparatory Survey") which will study feasibility of the Project.

The main points discussed during the mission are described in the Annex 1. The scope and implementing arrangements of the Preparatory Survey are described in the Annex 2.

Conduct of the Preparatory Survey is subject to the approval by the competent higher authorities of both sides. It should be noted that implementation of the Preparatory Survey does not imply any decision or commitment by JICA to extend its loan for the Project at this stage.

Annex 1: Main Points Discussed
Annex 2: Scope and Implementing Arrangements of the Preparatory Survey

1

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For
Japan International Cooperation Agency

Ueki Masahiro
Leader
The JICA Mission

For Economic Relations Division, Ministry of Finance

Mohammad Shafiqul Azam
Additional Secretary

For Local Government Division, Ministry of Local Government, Rural Development and Co-operatives

Zuena Aziz
Joint Secretary (WS)

For
Chittagong Water Supply
and Sewerage Authority

A.K.M. Fazlullah
Managing Director

Annex 1

MAIN POINTS DISCUSSED

(1) The effective use of the results of previous studies
The study team of the Preparatory Survey shall, upon verification, utilize the results of the previous studies conducted by various donors (such as population and water demand projections and the concepts of facilities planning except for distribution network), so that the Preparatory Survey can be implemented effectively within a relatively short period.

(2) Expansion of Karnaphuli water treatment plant
The Project will expand the production capacity of the Karnaphuli water treatment plant by 136,000 cu m/d,

(3) Improvement of distribution network
1. The Project will improve the distribution network which is located within the projected Karnaphuli Service Area. The target year for the improvement of distribution network will be 2030.
2. Karnaphuli Service Area proposed by Special Assistance for Project Formulation (SAPROF) will be reviewed in the Preparatory Survey taking the important aspects into consideration such as water demand in the target year, water supply capacity and priority supply areas.
3. The entire model area (Zones I-IV) of PANI Project will be included in Karnaphuli Service Area in the Preparatory Survey.
4. Karnaphuli Service Area will be self-contained and physically separated from other service areas. Accordingly, the planning of distribution network in the Preparatory Survey will be limited to only within the Karnaphuli Service Area.

(4) Other donors
The Preparatory Survey should be carried out without waiting for holistic mapping, modeling and detailed planning of distribution network in the entire CWASA area, which may be assisted by World Bank.

(5) Development Project Proposal (DPP) Approval Process
EIA and DPP approval are needed if both Governments decide to sign a Loan Agreement. Both sides confirmed that the EIA and DPP approval process is expected as follows and take necessary procedure to follow the schedule.

<EIA Approval Process>
- August 2012 : No Objection Certificate from Deputy Commissioner of Chittagong District for land use
- August 2012 : Submission of IEE to DOE from CWASA.
- September 2012 : DOE's approval of Site Clearance Certificate(SCC) (30 days in DOE)
- November 2012: Submission of EIA to DOE from CWASA
- December 2012: DOE's approval of Environmental Clearance Certificate(ECC) (15 days in DOE)

<DPP Approval Process>
- November 2012 : Submission of DPP to LGD from CWASA
- Deliberation on DPP (LGD : 30days, Planning Commission : 30 days、Decision by PEC : 10 days)
- February 2013 : DPP approval by ECNEC

The JICA Mission explained to the Bangladeshi side that JICA would tentatively schedule to dispatch the mission team on Yen Loan as follows;

<JICA Mission Team>
- August 2012: Fact Finding Mission

3

- December 2012: Appraisal Mission

(6) Organizational Aspects

Improvement of CWASA's management capacity will not be included in the scope of the Preparatory Survey because it is included in the consulting service in Karnaphuli Water Supply Project which is currently being implemented. However, study on the organizational aspects related to the operation and maintenance of the facilities to be constructed under the Project will be included in the scope of the Preparatory Survey.

Annex 2

SCOPE AND IMPLEMENTING ARRANGEMENTS OF THE PREPARATORY SURVEY

I. BACKGROUND AND OBJECTIVE OF THE PREPARATORY SURVEY

Chittagong City, the second largest city of Bangladesh, has a present total population of 2.7 million with a population growth rate of 3.3 % per year from 1991 to 2001 in the CWASA's administrative area of about 200 sq.km. While a rapid growth of population corresponding to expansion of economic activities has been observed, provision of basic infrastructure including water supply service has always been inadequate. Water supply service in Chittagong is operated by Chittagong Water Supply and Sewerage Authority (CWASA), but its supply capacity (168,000 cu.m/day) is far smaller than water demand in the existing service area and narrowing this gap is deemed urgent task of CWASA.

CWASA has availed of a Japanese ODA Loan to implement "Karnaphuli Water Supply Project" to increase the CWASA's supply capacity by 136,000 cu.m/day in line with the recommendations of SAPROF (2005). This project is expected to be completed by year 2014.

Although significant increase of water supply capacity is expected in the near future, there are several key issues to be resolved, such as improvement of transmission and distribution system and further expansion of the Karnaphuli water treatment plant to meet the future demand. In order to address these key issues, both sides agreed to conduct the Preparatory Survey on "Chittagong Water Supply Improvement Project."

II. OBJECTIVES OF THE PROJECT

The objective of the Project is to increase the supply of water for consumer and industrial use by constructing new water supply facilities (intake, water treatment plant, transmission pipelines, reservoirs and distribution network), thereby contributing to the improvement of the living environment of the local residents and the investment environment in Chittagong city area

III. SCOPE OF THE PROJECT

1. Outline of the Project

- The second phase of Karnaphuli water treatment plant (136MLD) and related facilities (intake, water treatment plant, transmission pipelines, reservoirs and distribution networks, including its rehabilitation and expansion)
- Engineering consulting services (D/D, Construction supervision, etc.)

Outline of the Project might be subject to change based on the results of the Preparatory Survey.

2. Executing Agency

Chittagong Water Supply and Sewerage Authority (CWASA)

IV. SCOPE OF THE PREPARATORY SURVEY

The objective of the Preparatory Survey is to conduct a feasibility study of the proposed Project for consideration of project financing by JICA.

5

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1. Survey Area

The Preparatory Survey will cover the jurisdiction area of Chittagong City Corporation as shown in Attachment 1, and its surrounding areas (for planning of intake, water treatment plant and transmission pipelines).

2. Terms of reference

(1) Basic Study

1-1 Collection and analysis of existing data and information on water supply sector in Bangladesh (including National Policy and Plan etc.)

1-2 Collection and analysis of present conditions of the Survey Area through existing data, information and field survey

1) Natural Conditions (meteorology, topography, hydrology, hydro-geology, etc.)
2) Socio-economic conditions and trends (population, industries, land use, social infrastructure, economic conditions, etc.)
3) Environment conditions (environmental laws and regulations, public health, etc.)

1-3 Collection and analysis of present conditions of water supply in the Survey Area through existing data and field survey;

1) Water demand and supply
2) Field survey,
   - Existing water supply facilities
   - Current conditions of non-revenue water
   - Water sources
3) Water right and water quality,
4) Willingness-to-pay and affordability for water supply service,
5) On-going studies, plans and projects related to the Preparatory Survey (Karnaphuli Water Supply Project, Institutional Development Consultancy Service of CWASA etc.), and
6) Evaluation of present water supply conditions and identification of problems

(2) Chittagong Water Supply Improvement Project

2-1 Planning of the Project

1) Review of existing surveys (population/demand projection)
2) Identification of priority supply area from Karnaphuli water treatment plant
3) Identification of Karnaphuli Service Area
4) Planning of intake, raw water supply pipe and water treatment plant
5) Planning of transmission mains
6) Planning of primary distribution mains (zoning/sectorization)
7) Planning of secondary and tertiary distribution mains (District Meter Area)

2-2 Preliminary design of the Project

1) Topographic and route survey, geotechnical survey, and river cross-section survey if necessary
2) Project scope and preliminary design of the facilities (intake, water treatment plant, transmission pipelines, service reservoirs, distribution network)
3) Development of operation and maintenance plan related to the facilities to be constructed under the Project
4) Preliminary cost estimation
5) Comparison of the estimated project cost with other similar projects, to verify the appropriateness of the project cost
6) Project implementation schedule and confirmation of necessary procedures for the approval of project implementation (EIA, DPP, land acquisition etc.)

7) Procurement plan, method and contract packages of the Project
8) Financing plan of the Project
9) Economic and Financial analysis of the Project
10) Consideration of pro-poor components
11) Environmental and Social Assessment (preparation of Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA), Environmental Monitoring Plan (EMP) and Resettlement Action Plan (RAP)
12) Recommendation on TOR for consulting services (detailed design, construction supervision)
13) Project evaluation for the project implementation;
    - Technical evaluation
    - Economic and financial evaluation
    - Environmental and social evaluation
    - Institutional evaluation
14) Selection of key operation and effect indicators, setting up baseline and target data
15) Preparation of the institutional set-up for the Project implementation
16) Conclusions and recommendations

2. Required Expertise

JICA will select a survey team to carry out the Preparatory Survey. The team will be comprised of the following engineers and specialists:

- Team leader/Water supply planning
- Water supply A (intake facility/transmission/water treatment plant design)
- Water supply B (distribution network design)
- Mechanical/Electrical engineer
- Procurement planning/Cost estimation
- Economic and financial analysis
- Facility operation and maintenance
- Environmental and social consideration/Public hygiene

The assignment of engineers and specialists may be subject to change. The survey team may engage local consultants.

3. Steering Committee

The steering committee will be established by LGD comprising the representatives from ERD, LGD, Planning Commission, Implementation Monitoring and Evaluation Division (IMED), CWASA, JICA and its survey team.

V. SCHEDULE OF THE PREPARATORY SURVEY

The Preparatory Survey will be carried out in accordance with the tentative schedule attached in the Attachment 2. The schedule may be subject to change during the preparation and the course of the survey.

VI. REPORTS

The survey team will prepare and submit following reports in English to the GOB.

1. Inception Report

Twenty copies will be submitted at the commencement of the first work period in Bangladesh. This report will cover basic approaches, plan of operation, work schedule, staffing, organization and others of the survey.

7

2. Interim Report:
Twenty copies will be submitted around three months after the commencement of the Preparatory Survey. This report will cover the results of the first half survey.

3. Draft Final Report:
Twenty copies will be submitted at the end of the last work period in Bangladesh. The member organization of the steering committee shall submit its comments within one month after the receipt of the Draft Final Report.

4. Final Report:
Thirty copies including electronic data will be submitted within one month after the receipt of the comments on the Draft Final Report.

VII. UNDERTAKING OF THE GOVERNMENT OF BANGLADESH

CWASA shall act as the counterpart agency to the survey team and also as a coordinating body with other organizations concerned for the smooth implementation of the Preparatory Survey.

CWASA shall, at its own expense, provide the survey team with the following items in cooperation with other organizations concerned:

1. security-related information as well as measures to ensure the safety of the survey team;
2. information as well as support in obtaining medical service.
3. data and information related to the Preparatory Survey
4. counterpart personnel from related organizations with the Chief Engineer of CWASA being a focal person;
5. authorization letters;
6. entry permits necessary for the survey team members to conduct field surveys;
7. support in making transportation arrangements such as providing a guide to destination and making appointments
8. support in obtaining other privileges and benefits if necessary; and
9. assistance to the team in customs clearance, exemption from any duties with respect to equipment, instruments, tools and other articles to be brought into and out of Bangladesh in connection with the implementation of the survey (provided by GOB).

GOB shall bear claims, if any arises, against the members of the survey team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in implementation of the Preparatory Survey, except when such claim arise from gross negligence or willful misconduct on the part of the member of the survey team.

VIII. CONSULTATION

JICA and GOB shall consult with each other in respect of any matter that may arise from or in connection with the Preparatory Survey.

IX. INFORMATION DISCLOSURE

The JICA Mission explained to GOB the JICA's policy of information disclosure as follows:

1. Based on the Information Disclosure Law of Japan, JICA has a policy to disclose information to the public. However, confidential information will be kept undisclosed, such as bidding information to secure fairness of tender procedures and other issues to be

8

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mutually agreed.

2. Under the policy, the final report will be disclosed excluding confidential information to the public as soon as practical.

The JICA Mission and GOB agreed that such information related to bidding for procurement of goods and services such as cost estimate, B/Q, TOR and person-months should be kept confidential until a relevant contract agreement is concluded.

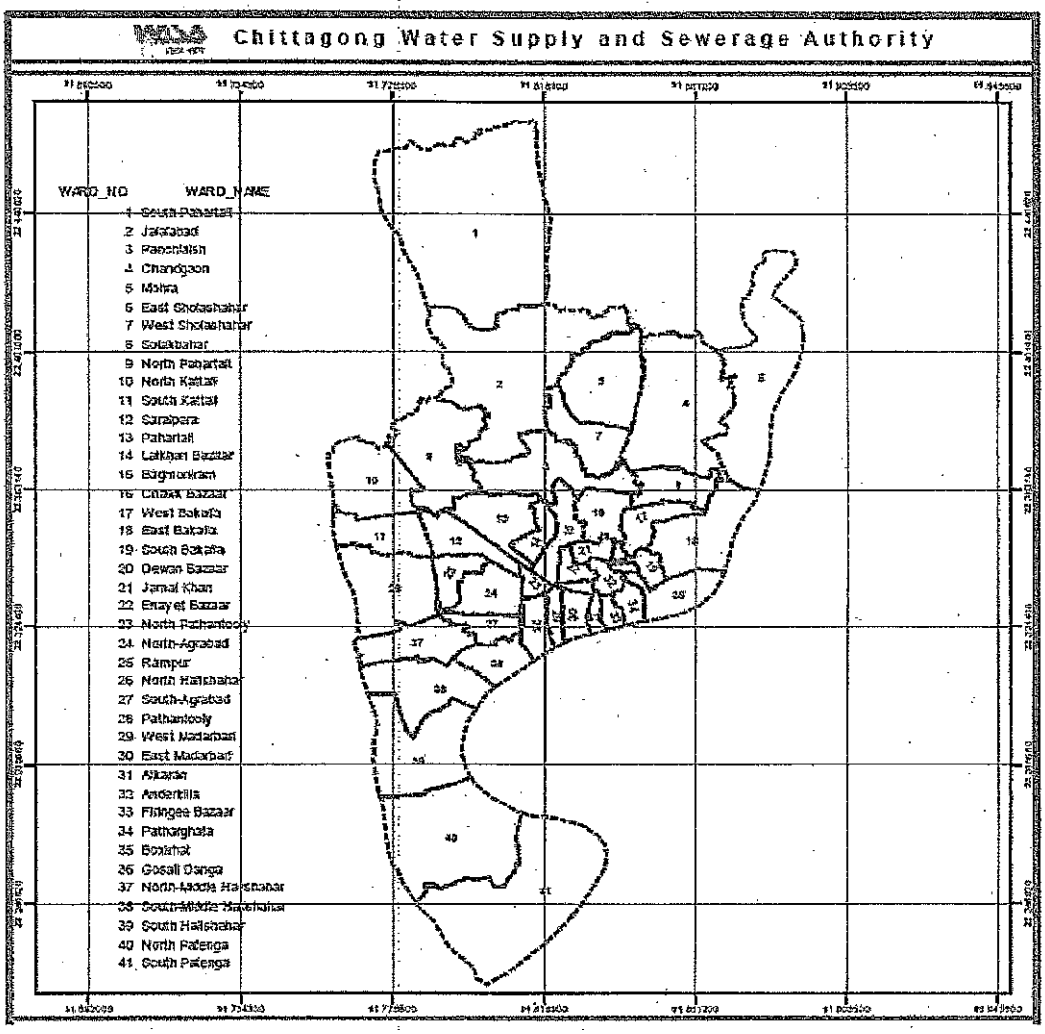
Other information which GOB requests to keep undisclosed, if any, will be so kept based on the mutual agreement between GOB and JICA. GOB agreed to submit a list of such information, if any, together with timing of disclosure to JICA by the time of the draft final report submission.

X. OTHERS

The JICA Mission and GOB confirmed that GOB expressed the possibility of making an official request to the Government of Japan for financing the Project after scrutinizing outcomes and recommendations of the Preparatory Survey.

Attachment 1

Map Showing Ward Boundary of Chittagong City Corporation



Attachment 2

Tentative Schedule

Year	First Year							
Month	1	2	3	4	5	6	7	8
Work in Japan	□			□		□	□	
Work in Bangladesh	▬	▬	▬	▬	▬	▬		
Report	▲ IC/R			▲ IT/R		▲ DF/R		▲ F/R

IC/R: Inception Report,
IT/R: Interim Report
DF/R: Draft Final Report
F/R: Final Report

1.2 (1) The Minutes of Meeting of the Steering Committee (May 24th, 2012)

THE MINUTES OF MEETING
OF
THE FIRST STEERING COMMITTEE MEETING
ON
THE PREPARATORY SURVEY
OF THE
CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT
IN
THE PEOPLES` REPUBLIC OF BANGLADESH
AGREED UPON BETWEEN
THE GOVERNMENT OF THE PEOPLES` REPUBLIC OF BANGLADESH
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

The first Steering Committee Meeting of the Preparatory Survey of the Chittagong Water Supply Improvement Project was held on May 24th, 2012, chaired by Ms. Zuena Aziz, Additional Secretary of the Local Government Division in presence of the Steering Committee members from the Government of Bangladesh (hereinafter referred to as "GOB") and Japan International Cooperation Agency (hereinafter referred to as "JICA").
Main points discussed and agreed in the meeting between the Bangladesh side and the Japanese side are presented in Annex 1.

Dhaka, May 24th, 2012

For Government of Bangladesh

Shams Uddin Ahmed
Deputy Secretary (Water Supply)
Local Government Division, Ministry of Local Government, Rural development and Co-operatives

For Japan International Cooperation Agency

Masatoshi Momose
Team Leader
Survey Team for Chittagong Water Supply Improvement Project

Witnessed by

A.K.M. Fazlullah
Managing Director
Chittagong Water Supply And Sewerage Authority

Witnessed by

Sadanobu Sawara
Senior Advisor
JICA

Annex 1

Main Points Discussed in the Steering Committee Meeting

1. The Preparatory Survey Team, by referring to Annex 2, informed the Steering Committee about the outcome of the preliminary discussion held on May 21st,2012 between the Survey Team and CWASA on the contents of the Inception Report.
2. The Preparatory Survey Team explained the contents of the Inception Report to the Steering Committee and the scope of the Survey and the basic approaches presented in the Report were agreed in principle by the Steering Committee.
3. The Steering Committee confirmed that the capacity of the Karnaphuli water treatment plant had been changed from 136,000m3/day to 143,000m3/day during the detailed design stage of the Karnaphuli Phase 1 Project, and therefore that the capacity of the plant will be expanded by another 143,000m3/day under the Karnaphuli Phase 2 Project.
4. The Steering Committee confirmed the tentative schedule of the survey and related issues (IEE/EIA and DPP) as follows. The schedule is also shown in Annex 3.

<EIA Approval Process>

- August 2012 : No Objection Certificate from Deputy Commissioner of Chittagong District for land use
- August 2012 : Submission of IEE to DOE from CWASA.
- September 2012 : DOE's approval of Site Clearance Certificate(SCC) (30 days in DOE)
- November 2012: Submission of EIA to DOE from CWASA
- December 2012: DOE's approval of Environmental Clearance Certificate (ECC) (15 days in DOE)

<DPP Approval Process>

- October 2012 : Submission of DPP to LGD from CWASA
- Deliberation on DPP (LGD : 30days, Planning Commission : 30 days、Decision by PEC : 10 days)
- February 2013 : DPP approval by ECNEC

Annex 2

Memorandum of Discussions between JICA and CWASA on Inception Report for the Preparatory Survey on Chittagong Water Supply Improvement Project

Date: May 21st, 2012

Venue: CWASA Conference Room 1st Floor

Attendees:

1. Mr. A.K.M Fazlullah, CWASA, Managing Director
2. Mr. M.A. Karim Chy, CWASA, KWSP, CE/PD
3. Mr. A.K.M Nazrul Haque, CWASA, Executive Engineer
4. Mr. Muhamad Zahurul Hoque, CWASA, KWSP, Executive Enginner
5. Mr. Ratan Kumar Sarker, CWASA, DMD/Engineering
6. Mr. Sadanobu Sawara, JICA, Senior Technical Advisor
7. Mr. Kentaro Yokota, JICA, Deputy Director, South Asia Department
8. Mr. Asaoka Shogo, JICA, Global Environment Department
9. Mr. Tomonori Wakabayashi, JICA, Global Environment Department
10. Mr. Saki Md Zial Islam, JICA Bangladesh, Senior Program Officer
11. Mr. Masatoshi Momose, NJS, Team Leader, Survey Team
12. Mr. Takao Ochiai, NJS, Water Supply Engineer, Survey Team
13. Mr. Patrik Takeuchi, NJS, Financial Specialist, Survey Team
14. Mr. George B. Young Jr., NJS Team Leader, Phase I Project
15. Mr Md Shafiullah, NJS, Deputy Team Leader, Phase I Project
16. Mr. Maximo Bugarin, NJS, Construction Engineer, Phase I Project
17. Mr. Md Ohidul Islam, NJS, Quantity Surveyor, Phase I Project

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1. The Inception Report was explained by Mr. Masatoshi Momose, Team Leader of Preparatory Survey Team for Chittagong Water Supply Improvement Project. All participants understood and in principle accepted the general approach and methodology proposed for the implementation of the Preparatory Survey, especially the approach to set up the Karnaphuli Service Area.

2. Other issues discussed were as follows:

2.1. CWASA will try to provide the Survey Team with the official results of the 2011 population census conducted in 2011 for the CCC area by ward before June 1, 2012. It was agreed that if the official results are not available by the time, the KOICA's projection will be adopted in the Preparatory Survey.

2.2. It was confirmed that the sectorization of water distribution network in Karnaphuli Service Area will allow monitoring and control of flow and pressures in the area.

2.3. Ground water use through deep wells shall not be considered for the water supply plan in 2030. Groundwater sources that are used at present may be used in the future as the emergency reserve or as the point supply source for low income people.

2.4. The counterparts from CWASA for the Survey Team: Administration, Financial, Engineering and Environmental shall be designated by CWASA and informed to the Survey Team before May 24, 2012.

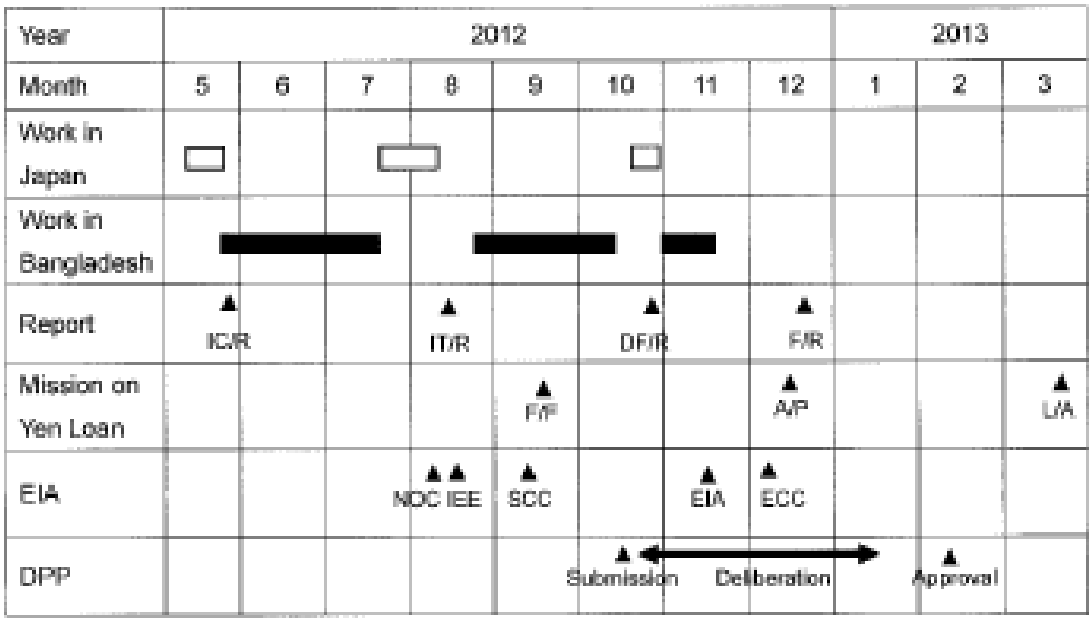
2.5. Counterpart for institutional improvement shall also be assigned and discussions shall be made on the developments so far made by CWASA by referring to the agreement for institutional improvement made November 2011 between JICA and CWASA.

2.6. CWASA will provide the Survey Team a copy of official documents which define the CWASA's responsibility area so that both sides can confirm the definition.

2.7. CWASA will confirm the necessary procedure on IEE/EIA and provide related information immediately after the commencement of the study.

Annex 3

Tentative Schedule



IC/R: Inception Report IT/R: Interim Report
DF/R: Draft Final Report F/R: Final Report

F/F: Fact Finding A/P: Appraisal L/A: Loan Agreement

NOC: No Objection Certificate IEE: Initial Environment Evaluation
SCC: Site Clearance Certificate EIA: Environment Impact Assessment
ECC: Environmental Clearance Certificate

1.2 (2) The Minutes of Meeting of the Steering Committee (July 18th, 2012)

THE MINUTES OF MEETING
OF
THE SECOND STEERING COMMITTEE MEETING
ON
THE PREPARATORY SURVEY
OF THE
CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT
IN
THE PEOPLES' REPUBLIC OF BANGLADESH
AGREED UPON BETWEEN
THE GOVERNMENT OF THE PEOPLES' REPUBLIC OF BANGLADESH
AND
SURVEY TEAM FOR PREPARATORY SURVEY ON CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT

The second Steering Committee Meeting of the Preparatory Survey for the Chittagong Water Supply Improvement Project was held on July18th, 2012, chaired by Ms. Zuena Aziz, Additional Secretary of the Local Government Division in the presence of the Steering Committee members from the Government of Bangladesh (hereinafter referred to as "GOB") and Preparatory Survey Team for Preparatory Survey for Chittagong Water Supply Improvement Project (hereinafter referred to as "Preparatory Survey Team").
Main points discussed and agreed in the meeting between the Bangladesh side and the Preparatory Survey Team are presented in Annex 1.

Dhaka, July 18th, 2012

For Government of Bangladesh	For Preparatory Survey Team
Shams Uddin Ahmed Deputy Secretary (Water Supply) Local Government Division, Ministry of Local Government, Rural development and Co-operatives	Masatoshi Momose Team Leader Survey Team for Chittagong Water Supply Improvement Project

Annex 1

Main Points Discussed in the Steering Committee Meeting

1. The Preparatory Survey Team, by referring to Annex 2, informed the Steering Committee about the outcome of the discussions held on July 15th, 2012 between the Preparatory Survey Team and CWASA on the study results of the first field work with issues and problems for implementation of Phase 2 Project.

2. The Preparatory Survey Team explained the study results of first field work with issues and problems for implementation of Phase 2 Project to the Steering Committee. The framework for the projection of water demand, Karnaphuli service area selected and the manner of planning for water supply facilities presented by Preparatory Survey Team were agreed by the Steering Committee.

3. The Steering Committee confirmed the following issues and problems to solve them timely.

   (1) Subsidiary Loan Agreement (SLA)
   The agreement between Bangladesh Government and CWASA shall be made at one time for Phase 1 and Phase 2 SLAs after financial study for the two (2) Phase through this preparatory survey.
   (2) Environmental approval for Phase 2 Project from DoE
   It was confirmed that renewal of existing ESC and EIA for Phase 2 Karnaphuli Water Supply Project (Chittagong Water Supply Improvement Project) will be made timely by CWASA according to the instructions from DoE. All concerned parties for the Project will support CWASA to complete renewal on time before the dispatch of Japanese Fact Finding mission which is scheduled in September, 2012.
   (3) Right of way for construction of conveyance and transmission pipelines
   Concurrence from RHD for the construction of the conveyance and transmission pipelines in the Kaptai road for Phase 2 Project shall be obtained before the dispatch of Japanese Fact Finding mission.
   (4) Cooperation needs by all concerned parties to achieve the plan for the improvement of Chittagong Water supply System
   It was confirmed by all participants that contributions by concerned parties are important to achieve the plan under limited water sources and initial stage of operation

in comprehensive water supply. The major improvement and cooperation needs include the following:

1) Change of the attitude of customers in use of water and promotion of willingness to pay for improved level of service that will be provided upon completion of the Project
2) Proper Capacity Building of CWASA including human resources management, customer management, and budgetary and financial planning
3) Financial arrangements including tariff structure
4) Further improvement on NRW reduction, building on the successes of the PANI Project, as well as taking into account of the lessons learned in the Project
5) Cooperation by all concerned governmental agencies to improve the above mentioned items

Annex 2

Memorandum of Discussions between Preparatory Survey Team and CWASA on the results of first field work with issues and problems for implementation of Phase 2 Project

Date: July 15th, 2012

Venue: CWASA Conference Room 1st Floor

Attendees:

1. Mr. A.K.M Fazlullah, CWASA, Managing Director
2. Mr. Ratan Kumar Sarker, CWASA, DMD/Engineering
3. Mr. ATM Hamunur Rashid, CWASA, DMD/finance
4. Mr. Md. Abdul Awd, CWASA, DMD/admin.
5. Mr. M.A. Karim Chy, CWASA, KWSP, CE/PD
6. Jane, Alam Shsisjam, CWASA, PD, CWSIP
7. Mr. Muhamad Zahurul Hoque, CWASA, KWSP-1, Executive Engineer
8. Mr. A.K.M Nazrul Haque, CWASA, KWSP-2,Executive Engineer
9. Mr. Quazi. Yeakub. Simly, CWASA, KWSP-3,Executive Engineer
10. Mr. Masatoshi Momose, Team Leader, Preparatory Survey Team
11. Mr. Kevin Anthony Holroyd, Water Supply Engineer, Preparatory Survey Team
12. Mr. Takao Ochiai, Water Supply Engineer, Preparatory Survey Team
13. Mr.Yasuaki Konda, Mechanical Engineer, Preparatory Survey Team
14. Mr. Akira Miura, Electrical Engineer, Preparatory Survey Team
15. Mr. Hirotatsu Koike, Procurement Planning/Cost Estimate, Preparatory Survey Team
16. Mr. Patrik Takeuchi, Financial Specialist, Preparatory Survey Team
17. Mr. Satoshi Ohmoto., O&M Specialist, Preparatory Survey Team
18. Mr Md Shafiqul Islam, Water Supply Engineer, Local Consultants
19. Mr. Nazrul Islam, Water Supply Engineer, Local Consultants

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1. The results of the first field work with issues and problems for implementation of Phase 2 Project were explained by the Preparatory Survey Team for the Chittagong Water Supply Improvement Project. All participants understood and agreed on the following frame work for planning water supply facilities.
   (1) Population projection by ward for CCC area in 2030.

(2) Major factors to project water demand include domestic water consumption, other water consumption by commercial, institutional and industrial users, NRW and leakage percentages.

Proposed Karnaphuli service area was also agreed as a self-contained water supply system to be served by Karnaphuli Water Treatment Plant through Phase I and Phase 2 projects.

Manner of study to come up with distribution system after sectorization in the Karnaphuli service area was agreed as well as plan of water supply facilities as the expansion of Phase 1 Project.

2. Other major issues discussed and agreed are as follows:

2.1. Subsidiary Loan Agreement (SLA): The procedure for Phase 1 SLA is on-going in the Bangladesh government. However, the agreement between the Bangladesh government and CWASA shall be made at one time for Phase 1 and Phase 2 SLA.

2.2. Environmental approval for Phase 2 Project from DoE: It was confirmed that the renewal of existing Environmental Site Clearance (ESC) and EIA approval by DoE for Karnaphuli water Supply Project will be the requirement for Phase 2 Project. In this connection the following are required.

(1) CWASA will arrange renewal of ESC immediately.

(2) Official description on the responsible DoE office for renewal of the EIA approval shall be obtained by CWASA.

(3) Action plan to cope with the instructions from DoE after renewal of ESC will be prepared. CWASA will submit required documents supported by Preparatory Survey Team according to the action plan. CWASA will discuss with JICA Dhaka Office on the arrangements upon receipt of the comments and instructions from DoE.

2.3. Right of way for construction of conveyance and transmission pipelines along Kaptai road: Discussions for Phase 1 project among concerned parties are under way to get concurrence from RHD to install the pipelines in the road.

Approval from RHD for the construction of pipelines in the same road for Phase 2 Project shall be obtained before the appraisal of the proposed loan project by the fact finding mission from Japan which is scheduled in September, 2012.

2.4. Data/ information on the cost of similar projects as Phase 2 Project: Preparatory Survey Team will conduct comparative study on the construction cost of water supply facilities for Phase 2 Project with similar projects in Bangladesh. In this connection CWASA will arrange to collect date/information from Dhaka WASA.

2.5. DPP approval process

CWASA will prepare required documents to meet the schedule as agreed at the first Steering Committee Meeting with support by Preparatory Survey Team.

1.2 (3) The Minutes of Meeting of the Steering Committee (September 03th, 2012)

THE MINUTES OF MEETING
OF
THE THIRD STEERING COMMITTEE MEETING
ON
THE PREPARATORY SURVEY
OF THE
CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT
IN
THE PEOPLES` REPUBLIC OF BANGLADESH
AGREED UPON BETWEEN
THE GOVERNMENT OF THE PEOPLES` REPUBLIC OF BANGLADESH
AND
SURVEY TEAM FOR PREPARATORY SURVEY ON CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT

The third Steering Committee Meeting for the Preparatory Survey for the Chittagong Water Supply Improvement Project which was held on September 3rd, 2012, was chaired by Ms. Zuena Aziz, Additional Secretary of the Local Government Division in the presence of the Steering Committee members from the Government of Bangladesh (hereinafter referred to as "GOB") and the Preparatory Survey Team for Preparatory Survey for Chittagong Water Supply Improvement Project (hereinafter referred to as "Preparatory Survey Team").
The main points, which were discussed and agreed in the meeting between the Bangladesh side and the Preparatory Survey Team, are presented in Annex 1.

Dhaka, September 3rd, 2012

For Government of Bangladesh	For Preparatory Survey Team
Shams Uddin Ahmed Deputy Secretary (Water Supply) Local Government Division, Ministry of Local Government, Rural development and Co-operatives	Masatoshi Momose Team Leader Survey Team for Chittagong Water Supply Improvement Project

Annex 1

Main Points Discussed in the Steering Committee Meeting

1. The Preparatory Survey Team, by referring to Annex 2, informed the Steering Committee about the outcome of the discussions held on August 30th, 2012 between the Preparatory Survey Team and CWASA on the Interim Report for the Preparatory Survey of the Chittagong Water Supply Improvement Project (KWSP Phase 2).

2. The Preparatory Survey Team explained the contents of the Interim Report to the Steering Committee. The framework for the projection of water demand, Karnaphuli service area, distribution system, environmental and social conditions and overall schedule for completion of the Survey Work, as presented by the Preparatory Survey Team were re-confirmed by the Steering Committee.

3. The Steering Committee confirmed the following issues and problems to solve them timely.

   (1) Right of way for construction of conveyance and transmission pipelines
   Approval from RHD for the construction of the conveyance and transmission pipelines in the Kaptai road for KWSP Phase 2 is urgent. In this regard, Bangladesh side shall make all efforts to obtain the concurrence from RHD before the dispatch of the Japanese Fact Finding mission.

   (2) DPP approval process
   CWASA will prepare required documents for the submission to the Government of Bangladesh by the middle of October. Concerned parties will support CWASA to get approval from the Government timely.

(3) Distribution System
(4) Plan of water supply facilities
(5) Environmental and social conditions
(6) Overall schedule for completion of Survey Work

2. Other major issues discussed and re-confirmed are as follows:

2.1. Environmental approval for KWSP Phase 2 from DoE: It was confirmed that the renewal of existing Environmental Site Clearance (ESC) and EIA approval by DoE for Karnaphuli water Supply Project will be the requirement for Phase 2 Project. Then, renewal of ESC was made by CWASA. CWASA needs to submit quarterly monitoring report for on-going Phase 1 project according to the conditions in the approval letter on EIA from DoE.

(1) Official description on the responsible DoE office for renewal of the EIA approval shall be obtained by CWASA. In addition, CWASA shall confirm with DoE, whether presentation on the changes in the scope of work for Phase 2 Project from the time approved by DoE on EIA, is required or not.
(2) CWASA will submit required documents supported by Preparatory Survey Team to meet the request from DoE.

2.2. Right of way for construction of conveyance and transmission pipelines along Kaptai road: Discussions for Phase 1 project among concerned parties are under way to get concurrence from RHD to install the pipelines in the road.

CWASA shall make all efforts to get approval from RHD for the construction of pipelines in the same road for KWSP Phase 2 before the appraisal of the proposed loan project by the fact finding mission from Japan.

2.3. DPP approval process

CWASA will prepare required documents for the submission to the Government of Bangladesh by the middle of October

Approval from RHD for the construction of pipelines in the same road for Phase 2 Project shall be obtained before the appraisal of the proposed loan project by the fact finding mission from Japan which is scheduled in September, 2012.

2.4. Data/ information on the cost of similar projects as Phase 2 Project: Preparatory Survey Team will conduct comparative study on the construction cost of water supply facilities for Phase 2 Project with similar projects in Bangladesh. In this connection CWASA will arrange to collect date/information from Dhaka WASA.

2.5. DPP approval process

CWASA will prepare required documents to meet the schedule as agreed at the first Steering Committee Meeting with support by Preparatory Survey Team.

Annex 2

Memorandum of Discussions between Preparatory Survey Team and CWASA on the Interim Report for the implementation of Phase 2 Project

Date: August 30th, 2012
Venue: CWASA Conference Room 1st Floor
Attendees:

1. Mr. A.K.M Fazlullah, CWASA, Managing Director
2. Mr. Ratan Lumar Sarker, CWASA, DMD/Engineering
3. Mr. ATM Mamunur Rashid, CWASA, DMD/finance
4. Mr. Md. Abdul Awal, CWASA, DMD/admin
5. Mr. M.A. Karim Chy, CWASA, KWSP, CE/PD
6. Mr. Jane, Alam Bhuiyan, CWASA, PD, CWSIP
7. Mr. Muhamad Zahurul Hoque, KWSP-1,Executive Engineer
8. Mr. A.K.M Nazrul Haque, CWASA, KWSP-2,Executive Engineer
9. Mr.Quazi. Yeakub. Shirajudowla, CWASA, KWSP-3, Executive Engineer
10. Mr. Masatoshi Momose, Team Leader, Preparatory Survey Team
11. Mr. Takao Ochiai, Water Supply Engineer, Preparatory Survey Team
12. Ms.Yasumi Tsutsui Environmental Specialist, Preparatory Survey Team
13. Mr Md Shafiqul Islam, Water Supply Engineer, Local Consultants
14. Mr. Nazrul Islam, Water Supply Engineer, Local Consultants

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1. The contents of the Interim Report, which was prepared based on the findings and study results from the first field work for the KWSP Phase 2, were explained by the Preparatory Survey Team. All participants re-confirmed the following frame work for preliminary design of water supply facilities and schedule for completion of Survey Work.

   (1) Water demand projection up to year 2030 including population projection and concerned factors, such as per capita water consumption, NRW and leakage percentages.
   (2) Karnaphuli service area as a self-contained water supply system to be served by Karnaphuli Water Treatment Plant through Phase I and Phase 2 projects.
   (3) Distribution System

(4) Plan of water supply facilities
(5) Environmental and social conditions
(6) Overall schedule for completion of Survey Work

2. Other major issues discussed and re-confirmed are as follows:

2.1. Environmental approval for KWSP Phase 2 from DoE: It was confirmed that the renewal of existing Environmental Site Clearance (ESC) and EIA approval by DoE for Karnaphuli water Supply Project will be the requirement for Phase 2 Project. Then, renewal of ESC was made by CWASA. CWASA needs to submit quarterly monitoring report for on-going Phase 1 project according to the conditions in the approval letter on EIA from DoE.

(1) Official description on the responsible DoE office for renewal of the EIA approval shall be obtained by CWASA. In addition, CWASA shall confirm with DoE, whether presentation on the changes in the scope of work for Phase 2 Project from the time approved by DoE on EIA, is required or not.
(2) CWASA will submit required documents supported by Preparatory Survey Team to meet the request from DoE.

2.2. Right of way for construction of conveyance and transmission pipelines along Kaptai road: Discussions for Phase 1 project among concerned parties are under way to get concurrence from RHD to install the pipelines in the road.

CWASA shall make all efforts to get approval from RHD for the construction of pipelines in the same road for Phase 2 Project before the appraisal of the proposed loan project by the fact finding mission from Japan.

2.3. DPP approval process

CWASA will prepare required documents for the submission to the Government of Bangladesh by the middle of October.

1.2 (4) The Minutes of Meeting of the Steering Committee (November 15th, 2012)

THE MINUTES OF MEETING
OF
THE FOURTH STEERING COMMITTEE MEETING
ON
THE PREPARATORY SURVEY
ON
CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH
AGREED UPON BETWEEN
THE GOVERNMENT OF THE PEOPLES' REPUBLIC OF BANGLADESH
AND
THE PREPARATORY SURVEY TEAM OF
JAPAN INTERNATIONAL COOPERATION AGENCY

The fourth Steering Committee Meeting of the Preparatory Survey on Chittagong Water Supply Improvement Project (hereinafter referred to as "the Preparatory Survey") was held on November 15th, 2012, chaired by Ms. Zuena Aziz, Additional Secretary of the Local Government Division in the presence of the Steering Committee members from the Government of Bangladesh (hereinafter referred to as "GOB") and the Team for Preparatory Survey on Chittagong Water Supply Improvement Project (hereinafter referred to as "the Team").

The main points discussed in the meeting between the Bangladeshi side and the Japanese side are presented in Annex 1.

Dhaka, November 15th, 2012

For Government of Bangladesh

Shams Uddin Ahmed
Deputy Secretary (Water Supply)
Local Government Division, Ministry of Local Government, Rural development and Co-operatives

For Preparatory Survey Team

Masatoshi Momose
Team Leader
Team for Preparatory Survey on Chittagong Water Supply Improvement Project

Witnessed by

A.K.M. Fazlullah
Managing Director
Chittagong Water Supply and Sewerage Authority (CWASA)

植木 雅浩

Masahiro Ueki
JICA Mission Leader
JICA Global Environment Department

Annex 1

Main Points Discussed in the Steering Committee Meeting

1. The Team, by referring to Annex 2, reported the outcome of the discussions held on November 12th, 2012 between the Team and CWASA on the Draft Final Report (hereinafter referred to as "DF/R") on the Preparatory Survey.

2. The Team explained the outline of the DF/R on the Preparatory Survey with the materials shown in Annex 3. In addition, The Team, by referring to Annex 2, reported the outcome of the discussions held on November 12th, 2012 between the Team and CWASA on DF/R. All participants attended in the Steering Committee understood and in principle accepted the contents of DF/R.

3. The progress on the actions to be taken, which were discussed and confirmed between the Follow- up Mission of JICA and Bangladesh side are as follows:
   (1) DPP
   DPP will be presented at the Board Meeting of CWASA scheduled on November 17, 2012. After the approval by the Board Members, DPP will be submitted to GOB.
   (2) ESC
   CWASA received ESC for KWSP 1 and 2 from DOE on November 13, 2012.
   (3) Permission for the installation of the pipelines along Kaptai Road
   The MOU between RHD and CWASA about road cutting covered Karnaphuli Water Supply Project (Phase 1 and 2) and it should be mentioned in the DPP.

4. Discussions made in the Steering Committee on the actions to be taken by concerned stakeholders.

   (1) CWASA
   CWASA will prepare and submit required documents as attached in Annex 2.

   (2) For the implementation of KWSP 2, CWASA will not be financially sustainable. In this regard, three options; 1) a drastic increase in water tariff, 2) a substantial relaxation of lending terms of the GOB's subsidiary loan and 3) the intermediate countermeasures between 1) and 2) were discussed. As a result of discussions, it

was confirmed that the on-lending terms applied for KWASA should be also applied to CWASA for both Phase 1 and Phase 2, and that appropriate level of tariff should be studied on that basis.

(3) The approval of the organogram of CWASA should be ensured by GOB before signing of the loan agreement.

(4) Timely approval by GOB on the procurement of Consultants and contractors KWSP 1 is scheduled to complete by the year 2015 to increase supply volume. It is very important to construct distribution network in KSA as early as possible. KWSP 2 covers the component for the construction of the distribution network. In this regard, timely approval by GOB for the procurement of Consultants and contractors are required. Bangladesh side will prepare to expedite the procedure for the procurement needs.

5. Both parties agreed that Bangladesh side shall send comments on DF/R to the Team through JICA Bangladesh office, if any, on or before November 30, 2012. The Team will reflect the comments from the Bangladeshi side to DF/R and finalize it as the Final Report (F/R). It will be delivered through JICA Bangladesh Office.

Annex 2

Memorandum of Discussions between the Team and CWASA on the Draft Final Report for the Preparatory Survey on Chittagong Water Supply Improvement Project (KWSP 2)

Date: November 12th, 2012
Venue: CWASA Conference Room 5st Floor
Attendees:

1. Mr. A.K.M Fazlullah, CWASA, Managing Director
2. Mr. Ratan Lumar Sarker, CWASA, DMD/Engineering
3. Mr. ATM Mamunur Rashid, CWASA, DMD/finance
4. Mr. Md. Abdul Awal, CWASA, DMD/admin
5. Mr. M.A. Karim Chy, CWASA, KWSP, CE/PD
6. Mr. Jane, Alam Bhuiyan, CWASA, PD, CWSIP
7. Mr. Muhamad Zahurul Hoque, KWSP-1,Executive Engineer
8. Mr. A.K.M Nazrul Haque, CWASA, KWSP-2,Executive Engineer
9. Mr.Quazi. Yeakub. Shirajudowla, CWASA, KWSP-3, Executive Engineer
10. Mr. Masahiro Ueki, JICA Mission Leader, JICA Global Environment Department
11. Mr. Sadanobu Sawara, JICA Global Environment Department
12. Mr. Tomonori Wakabayashi, JICA Global Environment Department
13. Mr. Masatoshi Momose, Team Leader, Preparatory Survey Team
14. Mr. Takao Ochiai, Water Supply Engineer, Preparatory Survey Team
15. Mr Patric Takeuchi, Financial Specialist, Survey Team

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1. The contents of the Draft Final Report, which was prepared based on the findings and study results, were explained by the Preparatory Survey Team. All participants understood and in principle accepted its contents.

2. As for Karnaphuli Service Area (KSA) proposed in the Preparatory Survey, some issues were raised by CWASA in advance of the dispatch of the Team. To justify the establishment of KSA, the Japanese side explained the concept and key issues regarding KSA. As a result of the discussion afterward, the following issues are agreed and confirmed by both sides.

   2.1. Basic concept of KSA

a. Great urgency of KSA

Since KWSP-1 will start water transmission in 2014, the existing network, where KWSP-1 will supply water, should be improved and expanded as soon as possible. So KSA must be set up without waiting for holistic mapping, modeling and detailed planning of distribution network in the entire CCC area.

b. KSA as self-contained and physically separated

Since KWSP-1&2 cannot satisfy water demand in entire CCC area, KSA is needed to supply water with enough pressure, continuous supply & minimum water losses. And to maintain this situation, KSA must be self-contained and physically separated. Similar examples can be found in Japan as this idea is quite common in Japan.

c. KSA boundary

KSA is set to cover high priority area, not based on any hydraulic considerations, so that KSA boundary doesn't have to follow ward boundary.

d. New and old network in KSA

To install new network ensures low leakage & less interruption of supply service while to utilize and rehabilitate existing network force CWASA to work hard and spend a lot of time without remarkable outcomes. However, existing distribution mains, which run through KSA and deliver water outside KSA, remain as they are. (e.g. Mohara-Patenga)

2.2. Major issues regarding KSA

a. Difference between KSA and proposed service area in SAPROF report (2005)

Current situation is different from what was planned in SAPROF as follows;

- It is not likely that WTPs are materialized as scheduled in SAPROF report except for Karnaphuli 1&2, and
- CCC's Water demand in 2030 is 1.65 times as much as that in 2020 while the production volume of KWSP-1&2 is almost same. It makes KSA smaller than that in SAPROF.

As for priority area to be covered, it is considered to include areas where water demand is high & urgent measures are needed in KSA. On the other hand, no consideration is given to priority area in SAPROF as Its service area is simply set at hillside area.

Two reservoirs (Nashirabad & Batali Hill) are included in Karnaphuli system even in SAPROF. However, the capacity of two reservoirs isn't still sufficient for KSA even though KSA doesn't receive Madunaghat water.

b. GIS data and maps on existing distribution network

Currently all data & information necessary for hydraulic simulation rehabilitation works for existing network aren't made available, such as location, material, diameter and condition. Against this situation, the best way to improve distribution network in KSA is to abandon all existing network, then design completely brand-new network.

c. Contribution toward improving water supply services outside KSA

After completion of KWSP-2 (Year 2020), water from Mohara (currently around 100,000m3/d of water from Mohara is supplied into KSA) will not be consumed in KSA and will be diverted 100% outside KSA. In addition, KWSP-1&2 can even supply water to neighboring areas of KSA until 2030, KSA & the areas outside KSA will be connected with emergency pipelines, of which spec & location can be identified only after World Bank study, which is supposed to target the distribution network outside KSA.

d. Different water supply quality inside and outside KSA

Water supply service will be significantly improved even outside KSA after completion of KWSP-1&2 as mentioned above. The supply conditions outside KSA can be further improved if additional supply from the Madunaghat WTP is materialized. On the other hand, service boundary will have to be established and unavoidable anyway unless supply capacity can satisfy the entire water demand of whole CCC area. To overcome this, CWASA has to make effort to establish the appropriate water supply areas outside KSA with support from GOB and/or donors.

e. Provisions to reduce the leakage in KSA until KWSP-2 is completed

According to the implementation schedule of KWSP-2, all the construction work will be completed at the end of Year 2020. However, distribution network will be newly constructed step by step after Year 2016. The sectors, which are the parts of PANI Project area and need most urgent improvement, will be completed at first, followed by other sectors. Time gap between the completion of KWSP1 and these prioritized sectors are expected to be around 2 years or less.

In addition, until KWSP-2 is completed, the pressure of Karnaphuli water will be reduced before the injection into existing network to minimize the leakage,

3. Other major issues discussed and re-confirmed are as follows:

3.1. DPP approval process

DPP will be presented at the Board Meeting of CWASA scheduled on November 17, 2012. After the approval by the Board Members, DPP will be submitted to GOB.

3.2. Extension of ESC for KWSP 2

CWASA has already submitted the application letter on the extension of ESC last month. CWASA confirmed with Chittagong DOE that DOE will issue ESC for KWSP 2 by November 15, 2012.

3.3 EOI

Draft EOI will be submitted by CWASA to JICA immediately and after concurrence from JICA, CWASA will advertise it within a week before December, 2012.

Annex 3 Presentation materials for Steering Committee

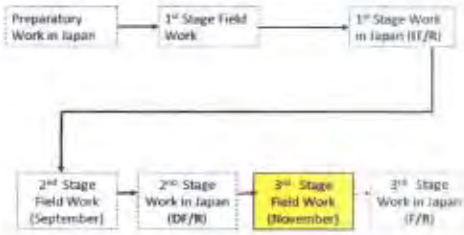
Preparatory Survey on Chittagong Water Supply Improvement Project

Draft Final Report (DF/R)

November 2012

JICA Study Team

1. Schedule and Present situation of the Survey



2. Water Demand

(1) Population Projection (CCC Area)

a. M/P conducted by KOICA in August 2009

	Population in Census		Population Projection			
	1991	2001	2007	2011	2021	2031
CCC	1,392,860	2,095,850	2,700,000	2,900,000	3,800,000	4,700,000
Average Rate (%)		4.2	4.3	1.80	2.74	2.15

b. Population Projection in the Preparatory Survey (KWSP2)

	2015	2020	2025	2030
CCC	3,226,900	3,697,000	4,135,000	4,600,000

Note) The Total population is projected as a sum of ward population

(2). Water Demand Projection(CCC Area)

(m³/d)

	2011	2015	2020	2025	2030
Daily Average	408,900	515,400	580,900	693,800	880,800
Daily Maximum	470,400	592,500	668,200	797,800	1,012,900

Conditions in **2030**; Phase 2 Project is planned to be completed by 2020

- Per capita water consumption; **120lpcd** (daily average)
- Housing types ; Pucca, Semi-Pucca, and Kutcha
- Served population; House Connection (**100%**), Hydrant (0%)
- Other water demand;
  Commercial, Institutional, Industrial (about 20% of domestic demand)
  and Leakage: **Leakage = 10%** (2030)
  NRW = 15% (2030)

➢Daily maximum : Daily average =1.15 : 1.0
➢Hourly maximum : Daily maximum =1.5 : 1.0

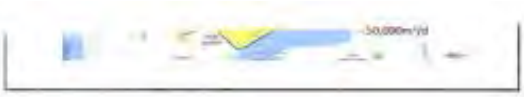
3. Establishment of Self-contained Karnaphuli Service Area (KSA)

(1) Priority Areas included in KSA

Priority Areas
a.PANI Project area
b.KWSP 1 area (Area where distribution mains are laid by KWSP 2)
c.High water demand area (high density population areas adjacent to PANI area)

⟷ Total Supply volume from Karnaphuli WTP 286,000m³/d (KWSP 1 and KWSP 2)

(2) Karnaphuli Service area



5. Sectors are grouped by Service Reservoir/E.T

Supply Source	Group	Sector	Total Daily Max. Water Demand (mld/d)
Elevated Tank at Nasirabad Reservoir	North	A, B, C	78,300
Battali Hill Reservoir	Central	D, E,F, G	138,000
Elevated Tank at Halishahar	West	H,I,J	78,700
		Total	295,000

6. Outline of Karnaphuli Water Supply Project

7. Environment Management Plan in Construction Stage

Nuisance and/or disturbance of business activities and living conditions affected by the construction work. In particular work for laying pipelines along existing roads may cause traffic congestion, resulting in nuisance and/or disturbance to business activities and living conditions in the project area.

Identification of possible impacts

Public health condition	Hydrological condition
Working condition	Air pollution
Accidents	Water pollution
Surface soil erosion	Noise and vibration
	Solid waste disposal

8. Implementation Plan/Schedule and Project Cost

(1) Contract Packages

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

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

Package 3:Primary, Secondary and Tertiary Distribution Pipelines, Service Connections in DMAs; and Optical fiber cable to each Sector

Package 4:Procurement of Equipment and Vehicles (Several lots)

(2) Procurement method

Procurement	Scope of Work	Manner of Procurement with required process/ events
Consultants	One consultancy package: D/D & C/S for all packages of work	ICB (PQ, Bid, Approval)
Contractors	Construction of facilities (Package 1,2,3, respectively)	ICB (PQ, Bid, Approval)
Procurement	Procurement of Equipment and Vehicles (Package 4; several lots)	ICB (PQ, Bid, Approval)

(3) Tentative Implementation Schedule

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

Tentative Implementation Schedule

(4) Project Cost

Summary of Project Cost

	F.C (Mil.JPY)	L.C (Mil.BDT)	Total (Mil.BDT)
A. Eligible Portion			
· Construction/Procurement (Packages 1 to 4)*	16,048	13,998	30,714
· Consulting Services*	2,024	1,219	3,327
Sub-total A	18,072	15,217	34,042
B. Non-Eligible Portion (Administration, VAT, Import Tax, Banking Charge)	0	10,301	10,301
C. Interest During Construction	2,232	0	2,325
GRAND TOTAL	20,303	25,518	46,667
JICA Finance	20,303	15,217	96,367

* Including price escalation and physical contingency

9. Financial and Economic Evaluation of KWSP2

(1) FIRR & FNPV

Description	FIRR	FNPV
Base Case		
1) Domestic tariff in 2021 9.71 BDT/m³	7.00%	-26,583.68
2) Non-Domestic tariff in 2021 27.51 BDT/m³		

Note) Base Case; Based on 5% increase of water tariff rates to 2021 prices. All inputs are in terms of 2021 constant prices.

(2) EIRR & ENPV

EIRR : 11.50%

ENPV: BDT 2,864 million at 10% discount rate
(BDT 28,640 Lahk)

(Option 3)

unless any external conditions change.

LGD&CWASA have to consider if this proposed water tariff is affordable to people in Chittagong city

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

1)To provide grant and/or equity participation for the whole amount of the funds required for the Phase 1 Project, which is equivalent to about 30% of the total fund requirements for KWSP 1 and KWSP 2.

2) For the KWSP 2 Project, relaxing the lending terms as follows:
   a. Repayment of loan with 30 years installments after a 10 years grace period
   b. Interest rate at 1% per annum for both the Foreign and Local Loan Portions
   c. Capitalize interest accrued during the initial 10 years so that annual payment of interest can be released during these years

LGD&ERD have to take necessary measures to subsidize CWASA

10. Operation and Maintenance of Karnaphuli Water Supply System

1. Sectorization (Sectors and DMAs) and SCADA system will ensure equitable water distribution and effective control of NRW/leakage within KSA
2. KWS organization for O&M: Two Major Functional requirements;
   (1) Production (intake, WTP, transmission, reservoir/elev. tank) and
   (2) Distribution Pipeline

11. Environmental and Social Considerations

(1) An IEE report and an EIA report submitted to the Department of Environment (DOE) at the time of KWSP 1 project preparation effectively cover both KWSP 1 and KWSP 2 of the Project.

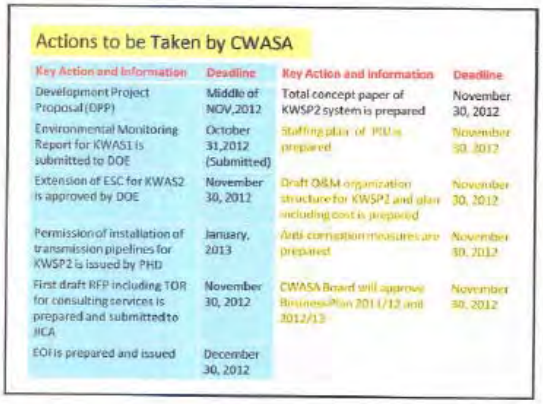
(2) DOE Chittagong informed CWASA of the need for the site clearance certificate for KWSP 2 of KWSP.

(3) CWASA submitted the requisites to obtain the ESC for the KWSP 2 , expecting that **DOE Chittagong will issue the ESC in November 2012.**

12. Recommendations

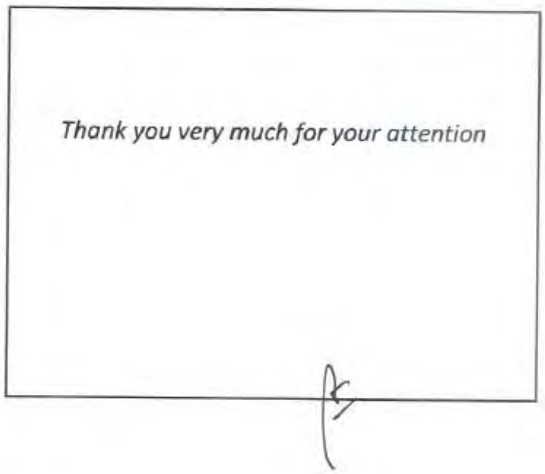
For the smooth implementation of KWSP2, the following actions are to be taken by respective stakeholders.

(1)CWASA	(2)LGD&ERD	(3)JICA
- to certainly execute Actions to be Taken (refer to next slide)	-to relax lending terms of GOB's subsidiary loan for CWASA to keep sound financial condition -to timely approve selection results for the procurement of Consults and Contractors -to approve Organogram of CWASA (PIU and O&M)	-to assist CWASA for the institutional improvement through PANI and IDC's activities -To provide CWASA with OJT during detailed design and construction supervision



Actions to be Taken by CWASA

Key Action and Information	Deadline	Key Action and Information	Deadline
Development Project Proposal (DPP)	Middle of NOV,2012	Total concept paper of KWSP2 system is prepared	November 30, 2012
Environmental Monitoring Report for KWAS1 is submitted to DOE	October 31,2012 (Submitted)	Staffing plan of PIU is prepared	November 30, 2012
Extension of ESC for KWAS2 is approved by DOE	November 30, 2012	Draft O&M organization structure for KWSP1 and plan including cost is prepared	November 30, 2012
Permission of installation of transmission pipelines for KWSP2 is issued by PHD	January, 2013	Anti-corrosion measures are prepared	November 30, 2012
First draft RFP including TOR for consulting services is prepared and submitted to JICA	November 30, 2012	CWASA Board will approve Business Plan 2011/12 and 2012/13	November 30, 2012
EOI is prepared and issued	December 30, 2012		



CHAPTER 3

EXISTING WATER SUPPLY AND ON-GOING WATER SUPPLY PROJECT

CHAPTER 3 EXISTING WATER SUPPLY AND ON-GOING WATER SUPPLY PROJECT

3.4.1 Depreciation Rates

Category of Property, Plamt and Equipment	Annual Depreciation Rates (%)
Building	2%
Mohara Water Treatment Plant	2%
Trunk & Distribution Main	2%
Pump & Booster	5%
Pump House	2%
Water Main (PVC Line)	2%
Meter Repairing Workshop	2%
Booster Station	2%
Water Reservoir	5%
Staff Quarter & Other Building	2%
Civil Work & Boundary Wall	10%
House Service Connection	2%
Meter Installation, Pump & Transformer	10%
Computers	10%
Electric Line Installation	15%
Transportatiopn & Equipment	20%
Pipeline	2%
Other Constructions	6%
Sundries Assets	2%
Loose Tools & Equipment	10%
Intercom System	10%
Medical Equipment	10%
Vehicles	20%
Furniture & Fixtures	10%
Materials of Pump	6%
Tube Well	6%

3.4.2 Depreciation Schedule FY 2006/07

		Particulars	Dep. Rate (%)	Asset Value			Depreciation Amount			Remaining Assets Value
				As At 01/07/06	Addition during the Year	As At 30/06/07	As At 01/07/06	Charged during the Year	As At 30/06/07	
SUMMARY										
A.		**LAND AND LAND DEVELOPMENT**		43,938,607	149,311	44,087,918	-	-	-	44,087,918
B.		**BUILDING & CIVIL WORKS**		169,022,603	-	169,022,603	87,041,323	4,476,679	91,518,002	77,504,601
C.		**PLANT & MACHINERY**		1,684,607,978	71,365,512	1,755,973,490	742,064,784	44,264,846	786,329,630	969,643,860
D.		**VEHICLES**		30,492,020	-	30,492,020	29,452,468	424,800	29,877,268	614,752
E.		**FURNITURE**		7,970,610	2,099	7,972,709	6,248,942	303,156	6,552,098	1,420,611
F		**TRANSPORTATION & EQUIPMENT**		4,510,034	-	4,510,034	4,509,997	-	4,509,997	37
		TOTAL		1,940,541,852	71,516,922	2,012,058,774	869,317,514	49,469,481	918,786,995	1,093,271,779
A.		**LAND AND LAND DEVELOPMENT**								
	1.	Land & Land Development (1st Phase)	0%	17,490,030	-	17,490,030	-	-	-	17,490,030
	2	Land for 5 tubewells	0%	245,908	-	245,908	-	-	-	245,908
	3	Land & Land Development (2nd Phase)	0%	20,432,542	-	20,432,542	-	-	-	20,432,542
	4	Land & Land Development (2nd Phase)	0%	4,351,204	-	4,351,204	-	-	-	4,351,204
	5	Land & Land Development (3rd/IWSRP)	0%	693,290	149,311	842,601	-	-	-	842,601
	6	Land & Land Development (Non Projet)	0%	725,633	-	725,633	-	-	-	725,633
		Sub-total (A)		43,938,607	149,311	44,087,918	-	-	-	44,087,918
B.		**BUILDING & CIVIL WORKS**								
	1	Street Hydrant (1st Phase)	0%	8,761	-	8,761	8,759	-	8,759	2
	2	Water Reservoir (1st Phase)	0-5%	19,169,000	-	19,169,000	18,845,298	53,950	18,899,248	269,752
	3	Staff Quarter & Other Building (1st Phase)	0-2%	21,087,378	-	21,087,378	12,141,747	384,193	12,525,940	8,561,438
	4	House Service Connection (1st Phase)	0-2%	204,676	-	204,676	199,812	99	199,911	4,765
	5	Building (2nd Phase)	2%	31,334,919	-	31,334,919	12,844,969	626,700	13,471,669	17,863,250
	6	Water Reservoir Tank (2nd Phase)	0-5%	35,402,939	-	35,402,939	16,647,997	946,194	17,594,191	17,808,748
	7	Civil Work & Boundary Wall (2nd Phase)	0-5%	14,996,713	-	14,996,713	9,937,645	216,615	10,154,260	4,842,453
	8	Other Construction Work (1st/IWSRP)	2%	224,666	-	224,666	44,930	4,493	49,423	175,243
	9	House Service Connection (1st /IWSRP)	10%	1,714,806	-	1,714,806	514,443	171,481	685,924	1,028,882
	10	House Service Connection (2nd /IWSRP)	10%	5,432,740	-	5,432,740	2,670,420	543,274	3,213,694	2,219,046
	11	Other Construction Work (2nd /IWSRP)	6%	1,144,014	-	1,144,014	155,745	68,645	224,390	919,624
	12	Functional Building (2nd /IWSRP)	2-10%	17,512,065	-	17,512,065	4,731,672	410,044	5,141,716	12,370,349
	13	Residential Building (2nd/IWSRP)	2%	11,142,820	-	11,142,820	1,888,970	222,858	2,111,828	9,030,992
	14	Other Building (2nd /IWSRP)	2-10%	8,955,016	-	8,955,016	6,133,399	793,527	6,926,926	2,028,090
	15	Road Construction (2nd /IWSRP)	5%	692,090	-	692,090	275,517	34,606	310,123	381,967
		Sub-total (B)		169,022,603	-	169,022,603	87,041,323	4,476,679	91,518,002	77,504,601
C.		**PLANT & MACHINERY**								
	1	Pump House - A (1st Phase)	0-2%	710,360	-	710,360	673,086	4,435	677,521	32,839
	2	Pump House - B (1st Phase)	0-2%	1,377,239	-	1,377,239	900,543	16,450	916,993	460,246
	3	Deep Tubewell A (1st Phase)	0-6%	1,516,612	-	1,516,612	1,450,686	24,720	1,475,406	41,206
	4	Deep Tubewell B (1st Phase)	0-6%	1,686,541	-	1,686,541	1,623,734	23,550	1,647,284	39,257
	5	Water Main Line PPC (1st Phase)	0-2%	173,973,865	-	173,973,865	140,945,725	3,393,898	144,339,623	29,634,242
	6	Meter Repair Working (1st Phase)	0%	331,000	-	331,000	330,997	-	330,997	3
	7	Booster Station Door (1st Phase)	0-5%	25,350,267	-	25,350,267	20,241,137	381,323	20,622,460	4,727,807
	8	Meter Instralltion & Pump Door (1st Phase)	0-6%	315,351	-	315,351	315,000	342	315,342	9
	9	Deep Tubewell (1st Phase)	0-5%	3,075,209	-	3,075,209	2,500,076	24,434	2,524,510	550,699
	10	Mohara Water Treatment Plant (2nd Phase)	2%	526,868,945	-	526,868,945	197,731,213	10,537,379	208,268,592	318,600,353
	11	Booster Station (Kalurghat 2nd Phase)	0-2%	61,082,082	-	61,082,082	57,756,036	1,402,165	59,158,201	1,923,881
	12	Tank & Distribution (Kalurghat 2nd Phase)	2%	417,402,857	-	417,402,857	154,614,021	8,348,057	162,962,078	254,440,779
	13	Pump & Booster at Potenga (Kalurghat 2nd Phase)	0-5%	9,617,732	-	9,617,732	8,582,513	188,220	8,770,733	846,999
	14	Pump & Booster at DT Road (Kalurghat 2nd Phase)	0-5%	10,135,337	-	10,135,337	9,477,388	506,767	9,984,155	151,182
	15	Deep Tubewell (Kalurghat 2nd Phase)	0-6%	13,070,926	-	13,070,926	13,031,258	25,986	13,057,244	13,682
	16	Pump House (Kalurghat 2nd Phase)	2%	13,268,902	-	13,268,902	5,172,336	265,379	5,437,715	7,831,187
	17	Sundries	5%	500,393	-	500,393	425,340	25,020	450,360	50,033
	18	Tubewell (1st IWSRP)	6%	35,371,427	-	35,371,427	23,901,669	2,122,285	26,023,954	9,347,473
	19	Pump House (1st IWSRP)	0-2%	39,485,780	-	39,485,780	8,950,151	805,438	9,755,589	29,730,191
	20	Pipe Line (1st IWSRP)	2%	108,966,072	-	108,966,072	22,967,617	2,179,314	25,146,931	83,819,141
	21	Installation of Pump & Trans (1st IWSRP)	0-10%	22,763,454	-	22,763,454	7,402,889	2,158,750	9,561,639	13,201,815
	22	Computer (1st IWSRP)	10%	1,359,800	-	1,359,800	271,960	135,980	407,940	951,860
	23	Tubewell & Generator (1st IWSRP)	6%	1,472,872	-	1,472,872	1,027,940	88,372	1,116,312	356,560
	24	Materials of Pumps (1st IWSRP)	10%	1,555,809	-	1,555,809	1,406,208	149,595	1,555,803	6
	25	Tubewell (2nd IWSRP)	6%	20,145,841	-	20,145,841	8,783,485	1,208,755	9,992,240	10,153,601
	26	Pump House (2nd IWSRP)	0-10%	12,902,362	-	12,902,362	1,713,678	359,938	2,073,616	10,828,746
	27	Pipe Line (2nd IWSRP)	2%	59,774,999	-	59,774,999	7,109,545	1,195,497	8,305,042	51,469,957
	28	Tubewell Re Generation (2nd IWSRP)	6%	1,454,262	-	1,454,262	739,352	87,256	826,608	627,654
	29	Installation of Pump Machinery (2nd IWSRP)	0-10%	13,515,038	-	13,515,038	9,017,800	1,341,502	10,359,302	3,155,736
	30	Loose Tools (2nd IWSRP)	10%	620,569	-	620,569	377,343	62,057	439,400	181,169
	31	Computer Equipment (3rd IWSRP)	10%	1,730,858	-	1,730,858	89,088	173,086	262,174	1,468,684
	32	Meter Installation & Pump (3rd IWSRP)	2-10%	17,828,403	63,591,523	81,419,926	910,856	904,040	1,814,896	79,605,030
	33	Pipeline Installation (Non Project)	2%	19,735,840	1,450,381	21,186,221	3,384,683	394,716	3,779,399	17,406,822
	34	Tubewell (Non Project)	0-6%	17,376,402	-	17,376,402	4,737,945	984,741	5,722,686	11,653,716
	35	Pump House (Non Project)	2-10%	4,469,567	-	4,469,567	201,840	93,042	294,882	4,174,685
	36	Tools & Equipment (Non Project)	0-10%	6,370,997	472,236	6,843,233	4,296,243	234,277	4,530,520	2,312,713
	37	Meter Installation at Pump Station (Non Project)	0-10%	2,900,334	435,781	3,336,115	1,055,679	250,758	1,306,437	2,029,678
	38	Computer Installationn (Non Project)	0-10%	6,496,984	1,025,504	7,522,488	3,607,452	568,369	4,175,821	3,346,667
	39	Pump & Motor (Non Project)	0-10%	10,711,599	4,390,087	15,101,686	6,309,291	807,391	7,116,682	7,985,004
	40	Intercom System (Non Project)	10%	642,694	-	642,694	447,223	64,270	511,493	131,201
	41	Electronic Line Installation (Non Project)	0-15%	7,753,881	-	7,753,881	5,815,410	1,163,082	6,978,492	775,389
	42	Sundry Assets UAWMP	2%	1,173,266	-	1,173,266	258,108	23,465	281,573	891,693
	43	Mohara Water Supply Project	20%	7,662,200	-	7,662,200	1,510,240	1,532,440	3,042,680	4,619,520
	44	Digital Camera	10%	24,029	-	24,029	-	2,403	2,403	21,626
	45	Hunai Type Video Camera	10%	25,562	-	25,562	-	2,556	2,556	23,006
	46	Office Equipment	0-10%	33,459	-	33,459	-	3,346	3,346	30,113
	47	Pump (Mohara &Kalurghat Rehabilitation Project								
		Sub-total (C)		1,684,607,978	71,365,512	1,755,973,490	742,064,784	44,264,846	786,329,630	969,643,860
D.		**VEHICLES**								
	1	1st IWSRP	0-20%	7,416,000	-	7,416,000	7,415,997	-	7,415,997	3
	2	2nd IWSRP	0%	6,994,749	-	6,994,749	6,994,730	-	6,994,730	19
	3	Non Project	20%	14,571,771	-	14,571,771	13,532,261	424,800	13,957,061	614,710
	4	Common Fixed Assets	0%	1,509,500	-	1,509,500	1,509,480	-	1,509,480	20
		Sub-total (F)		30,492,020	-	30,492,020	29,452,468	424,800	29,877,268	614,752
E.		**FURNITURE**								
	1	3rd IWSRP	10%	26,989	-	26,989	8,097	2,699	10,796	16,193
	2	Non Project	10%	2,944,632	2,099	2,946,731	1,391,639	267,491	1,659,130	1,287,601
	3	Medical Equipment	10%	307,078	-	307,078	175,995	30,705	206,700	100,378
	4	Common Fixed Assets	0-10%	4,691,911	-	4,691,911	4,673,211	2,261	4,675,472	16,439
		Sub-total (G)		7,970,610	2,099	7,972,709	6,248,942	303,156	6,552,098	1,420,611
F		**TRANSPORTATION & EQUIPMENT**	0%	4,510,034	-	4,510,034	4,509,997	-	4,509,997	37

3.4.3 Depreciation Schedule FY 2007/08

Particulars			Dep. Rate (%)	Asset Value			Depreciation Amount			Remaining Assets Value
				As At 01/07/'07	Addition during the Year	As At 30/06'08	As At 01/07/'07	Charged during the Year	As At 30/06/'08	
SUMMARY										
A.	**LAND AND LAND DEVELOPMENT**			44,087,918	-	44,087,918	-	-	-	44,087,918
B.	**BUILDING & CIVIL WORKS**			169,022,673	9,536	169,032,209	91,518,002	4,396,878	95,914,880	73,117,329
C.	**PLANT & MACHINERY**			1,755,973,490	1,945,682	1,757,919,172	786,329,630	46,003,267	832,332,897	925,586,275
D.	**VEHICLES**			30,492,020	-	30,492,020	29,877,268	424,799	30,302,067	189,953
E.	**FURNITURE**			7,972,709	59,000	8,031,709	6,552,098	275,246	6,827,344	1,204,365
F	**TRANSPORTATION & EQUIPMENT**			4,510,034	-	4,510,034	4,509,997	-	4,509,997	37
	TOTAL			2,012,058,844	2,014,218	2,014,073,062	918,786,995	51,100,190	969,887,185	1,044,185,877
A.	**LAND AND LAND DEVELOPMENT**									
	1.	Land & Land Development (1st Phase)	0%	17,490,030	-	17,490,030	-	-	-	17,490,030
	2	Land for 5 tubewells	0%	245,908	-	245,908	-	-	-	245,908
	3	Land & Land Development (2nd Phase)	0%	20,432,542	-	20,432,542	-	-	-	20,432,542
	4	Land & Land Development (2nd Phase)	0%	4,351,204	-	4,351,204	-	-	-	4,351,204
	5	Land & Land Development (3rd/IWSRP)	0%	842,601	-	842,601	-	-	-	842,601
	6	Land & Land Development (Non Projet)	0%	725,633	-	725,633	-	-	-	725,633
		Sub-total (A)		44,087,918	-	44,087,918	-	-	-	44,087,918
B.	**BUILDING & CIVIL WORKS**									
	1	Street Hydrant (1st Phase)	0%	8,761	-	8,761	8,759	-	8,759	2
	2	Water Reservoir (1st Phase)	0-5%	19,169,000	-	19,169,000	18,899,248	53,950	18,953,198	215,802
	3	Staff Quarter & Other Building (1st Phase)	0-2%	21,087,378	-	21,087,378	12,525,940	378,697	12,904,637	8,182,741
	4	House Service Connection (1st Phase)	0-2%	204,676	9,536	214,212	199,911	99	200,010	14,202
	5	Building (2nd Phase)	2%	31,334,919	-	31,334,919	13,471,669	626,698	14,098,367	17,236,552
	6	Water Reservoir Tank (2nd Phase)	0-5%	35,402,939	-	35,402,939	17,594,191	946,194	18,540,385	16,862,554
	7	Civil Work & Boundary Wall (2nd Phase)	0-5%	14,996,713	-	14,996,713	10,154,260	216,368	10,370,628	4,626,085
	8	Other Construction Work (1st/IWSRP)	2%	224,666	-	224,666	49,423	4,493	53,916	170,750
	9	House Service Connection (1st /IWSRP)	10%	1,714,806	-	1,714,806	685,924	171,481	857,405	857,401
	10	House Service Connection (2nd /IWSRP)	10%	5,432,740	-	5,432,740	3,213,694	543,274	3,756,968	1,675,772
	11	Other Construction Work (2nd /IWSRP)	6%	1,144,084	-	1,144,084	224,390	68,645	293,035	851,049
	12	Functional Building (2nd /IWSRP)	2-10%	17,512,065	-	17,512,065	5,141,716	357,155	5,498,871	12,013,194
	13	Residential Building (2nd/IWSRP)	2%	11,142,820	-	11,142,820	2,111,828	222,856	2,334,684	8,808,136
	14	Other Building (2nd /IWSRP)	2-10%	8,955,016	-	8,955,016	6,926,926	772,363	7,699,289	1,255,727
	15	Road Construction (2nd /IWSRP)	5%	692,090	-	692,090	310,123	34,605	344,728	347,362
		Sub-total (B)		169,022,673	9,536	169,032,209	91,518,002	4,396,878	95,914,880	73,117,329
C.	**PLANT & MACHINERY**									
	1	Pump House - A (1st Phase)	0-2%	710,360	-	710,360	677,521	4,432	681,953	28,407
	2	Pump House - B (1st Phase)	0-2%	1,377,239	-	1,377,239	916,993	16,450	933,443	443,796
	3	Deep Tubewell A (1st Phase)	0-6%	1,516,612	-	1,516,612	1,475,406	24,720	1,500,126	16,486
	4	Deep Tubewell B (1st Phase)	0-6%	1,686,541	-	1,686,541	1,647,284	23,550	1,670,834	15,707
	5	Water Main Line PPC (1st Phase)	0-2%	173,973,865	-	173,973,865	144,339,623	3,388,216	147,727,839	26,246,026
	6	Meter Repair Working (1st Phase)	0%	331,000	-	331,000	330,997	-	330,997	3
	7	Booster Station Door (1st Phase)	0-5%	25,350,267	-	25,350,267	20,622,460	381,323	21,003,783	4,346,484
	8	Meter Instralltion & Pump Door (1st Phase)	0-6%	315,351	-	315,351	315,342	-	315,342	9
	9	Deep Tubewell (1st Phase)	0-5%	3,075,209	-	3,075,209	2,524,510	24,434	2,548,944	526,265
	10	Mohara Water Treatment Plant (2nd Phase)	2%	526,868,945	-	526,868,945	208,268,592	10,537,380	218,805,972	308,062,973
	11	Booster Station (Kalurghat 2nd Phase)	0-2%	61,082,082	-	61,082,082	59,158,201	62,030	59,220,231	1,861,851
	12	Tank & Distribution (Kalurghat 2nd Phase)	2%	417,402,857	-	417,402,857	162,962,078	8,348,057	171,310,135	246,092,722
	13	Pump & Booster at Potenga (Kalurghat 2nd Phase)	0-5%	9,617,732	-	9,617,732	8,770,733	470,548	9,241,281	376,451
	14	Pump & Booster at Potenga (Kalurghat 2nd Phase)	0-5%	10,135,337	-	10,135,337	9,984,155	151,180	10,135,335	2
	15	Deep Tubewell (Kalurghat 2nd Phase)	0-6%	13,070,926	-	13,070,926	13,057,244	13,653	13,070,897	29
	16	Pump House (Kalurghat 2nd Phase)	2%	13,268,902	-	13,268,902	5,437,715	265,378	5,703,093	7,565,809
	17	Sundries	5%	500,393	-	500,393	450,360	25,020	475,380	25,013
	18	Tubewell (1st IWSRP)	6%	35,371,427	-	35,371,427	26,023,954	2,122,286	28,146,240	7,225,187
	19	Pump House (1st IWSRP)	0-2%	39,485,780	-	39,485,780	9,755,589	785,785	10,541,374	28,944,406
	20	Pipe Line (1st IWSRP)	2%	108,966,072	-	108,966,072	25,146,931	2,179,322	27,326,253	81,639,819
	21	Installation of Pump & Trans (1st IWSRP)	0-10%	22,763,454	-	22,763,454	9,561,639	2,061,742	11,623,381	11,140,073
	22	Computer (1st IWSRP)	10%	1,359,800	-	1,359,800	407,940	135,980	543,920	815,880
	23	Tubewell & Generator (1st IWSRP)	6%	1,472,872	-	1,472,872	1,116,312	88,372	1,204,684	268,188
	24	Materials of Pumps (1st IWSRP)	10%	1,555,809	-	1,555,809	1,555,803	-	1,555,803	6
	25	Tubewell (2nd IWSRP)	6%	20,145,841	-	20,145,841	9,992,240	1,208,750	11,200,990	8,944,851
	26	Pump House (2nd IWSRP)	0-10%	12,902,362	-	12,902,362	2,073,616	359,968	2,433,584	10,468,778
	27	Pipe Line (2nd IWSRP)	2%	59,774,999	-	59,774,999	8,305,042	1,195,499	9,500,541	50,274,458
	28	Tubewell Re Generation (2nd IWSRP)	6%	1,454,262	-	1,454,262	826,608	87,256	913,864	540,398
	29	Installation of Pump Machinery (2nd IWSRP)	0-10%	13,515,038	-	13,515,038	10,359,302	1,158,372	11,517,674	1,997,364
	30	Loose Tools (2nd IWSRP)	10%	620,569	-	620,569	439,400	62,057	501,457	119,112
	31	Computer Equipment (3rd IWSRP)	10%	1,730,858	-	1,730,858	262,174	173,086	435,260	1,295,598
	32	Meter Installation & Pump (3rd IWSRP)	2-10%	81,419,926	481,390	81,901,316	1,814,896	4,341,484	6,156,380	75,744,936
	33	Pipeline Installation (Non Project)	2%	21,186,221	-	21,186,221	3,779,399	423,724	4,203,123	16,983,098
	34	Tubewell (Non Project)	0-6%	17,376,402	-	17,376,402	5,722,686	974,661	6,697,347	10,679,055
	35	Pump House (Non Project)	2-10%	4,469,567	-	4,469,567	294,882	88,478	383,360	4,086,207
	36	Tools & Equipment (Non Project)	0-10%	6,843,233	181,135	7,024,368	4,530,520	281,501	4,812,021	2,212,347
	37	Meter Installation at Pump Station (Non Project)	0-10%	3,336,115	34,237	3,370,352	1,306,437	293,757	1,600,194	1,770,158
	38	Computer Installationn (Non Project)	0-10%	7,522,488	429,920	7,952,408	4,175,821	670,917	4,846,738	3,105,670
	39	Pump & Motor (Non Project)	0-10%	15,101,686	-	15,101,686	7,116,682	1,170,032	8,286,714	6,814,972
	40	Intercom System (Non Project)	10%	642,694	-	642,694	511,493	64,270	575,763	66,931
	41	Electronic Line Installation (Non Project)	0-15%	7,753,881	-	7,753,881	6,978,492	775,387	7,753,879	2
	42	Sundry Assets UAWMP	2%	1,173,266	-	1,173,266	281,573	23,465	305,038	868,228
	43	Mohara Water Supply Project	20%	7,662,200	-	7,662,200	3,042,680	1,532,440	4,575,120	3,087,080
	44	Digital Camera	10%	24,029	-	24,029	2,403	2,403	4,806	19,223
	45	Hunai Type Video Camera	10%	25,562	-	25,562	2,556	2,556	5,112	20,450
	46	Office Equipment	0-10%	33,459	-	33,459	3,346	3,346	6,692	26,767
	47	Pump (Mohara &Kalurghat Rehabilitation Project			819,000	819,000	-	-	-	819,000
		Sub-total (C)		1,755,973,490	1,945,682	1,757,919,172	786,329,630	46,003,267	832,332,897	925,586,275
D.	**VEHICLES**									
	1	1st IWSRP	0-20%	7,416,000	-	7,416,000	7,415,997	-	7,415,997	3
	2	2nd IWSRP	0%	6,994,749	-	6,994,749	6,994,730	-	6,994,730	19
	3	Non Project	20%	14,571,771	-	14,571,771	13,957,061	424,799	14,381,860	189,911
	4	Common Fixed Assets	0%	1,509,500	-	1,509,500	1,509,480	-	1,509,480	20
		Sub-total (F)		30,492,020	-	30,492,020	29,877,268	424,799	30,302,067	189,953
E.	**FURNITURE**									
	1	3rd IWSRP	10%	26,989	-	26,989	10,796	2,699	13,495	13,494
	2	Non Project	10%	2,946,731	59,000	3,005,731	1,659,130	250,319	1,909,449	1,096,282
	3	Medical Equipment	10%	307,078	-	307,078	206,700	19,967	226,667	80,411
	4	Common Fixed Assets	0-10%	4,691,911	-	4,691,911	4,675,472	2,261	4,677,733	14,178
		Sub-total (G)		7,972,709	59,000	8,031,709	6,552,098	275,246	6,827,344	1,204,365
F	**TRANSPORTATION & EQUIPMENT**		0%	4,510,034	-	4,510,034	4,509,997	-	4,509,997	37

3.4.4 Depreciation Schedule FY 2008/09

	Particulars	Dep. Rate (%)	Asset Value			Depreciation Amount			Remaining Assets Value
			As At 01/07/'08	Addition during the Year	As At 30/06/'09	As At 01/07/'08	Charged during the Year	As At 30/06/'09	
SUMMARY									
A.	**LAND AND LAND DEVELOPMENT**		44,087,918	76,319,667	120,407,585	-	-	-	120,407,585
B.	**BUILDING & CIVIL WORKS**		169,032,209	5,334,639	174,366,848	95,914,880	3,838,645	99,753,525	74,613,323
C.	**PLANT & MACHINERY**		1,757,919,172	38,802,215	1,796,721,387	832,332,897	45,018,559	877,351,456	919,369,931
D.	**VEHICLES**		30,492,020	-	30,492,020	30,302,067	189,799	30,491,866	154
E.	**FURNITURE**		8,031,709	280,824	8,312,533	6,827,344	237,102	7,064,446	1,248,087
F	**TRANSPORTATION & EQUIPMENT**		4,510,034	-	4,510,034	4,509,997	-	4,509,997	37
	TOTAL		2,014,073,062	120,737,345	2,134,810,407	969,887,185	49,284,105	1,019,171,290	1,115,639,117
A.	**LAND AND LAND DEVELOPMENT**								
	1 Land & Land Development (1st Phase)	0%	17,490,030	-	17,490,030	-	-	-	17,490,030
	2 Land for 5 tubewells	0%	245,908	-	245,908	-	-	-	245,908
	3 Land & Land Development (2nd Phase)	0%	20,432,542	-	20,432,542	-	-	-	20,432,542
	4 Karnaphuli Project (A/C No. 2090)	0%	-	75,974,143	75,974,143				
	5 Land & Land Development (2nd Phase)	0%	4,351,204	-	4,351,204	-	-	-	4,351,204
	6 Land & Land Development (3rd/IWSRP)	0%	842,601	345,524	1,188,125	-	-	-	1,188,125
	7 Land & Land Development (Non Projet)	0%	725,633	-	725,633	-	-	-	725,633
	Sub-total (A)		44,087,918	76,319,667	120,407,585	-	-	-	120,407,585
B.	**BUILDING & CIVIL WORKS**								
	1 Street Hydrant (1st Phase)	0%	8,761	-	8,761	8,759	-	8,759	2
	2 Water Reservoir (1st Phase)	0-5%	19,169,000	-	19,169,000	18,953,198	53,950	19,007,148	161,852
	3 Staff Quarter & Other Building (1st Phase)	0-2%	21,087,378	-	21,087,378	12,904,637	378,617	13,283,254	7,804,124
	4 House Service Connection (1st Phase)	0-2%	214,212	885,400	1,099,612	200,010	290	200,300	899,312
	5 Building (2nd Phase)	2%	31,334,919	-	31,334,919	14,098,367	626,700	14,725,067	16,609,852
	6 Water Reservoir Tank (2nd Phase)	0-5%	35,402,939	-	35,402,939	18,540,385	545,757	19,086,142	16,316,797
	7 Civil Work & Boundary Wall (2nd Phase)	0-5%	14,996,713	-	14,996,713	10,370,628	189,830	10,560,458	4,436,255
	8 Other Construction Work (1st/IWSRP)	2%	224,666	-	224,666	53,916	4,493	58,409	166,257
	9 House Service Connection (1st /IWSRP)	10%	1,714,806	-	1,714,806	857,405	171,481	1,028,886	685,920
	10 House Service Connection (2nd /IWSRP)	10%	5,432,740	-	5,432,740	3,756,966	543,274	4,300,242	1,132,498
	11 Other Construction Work (2nd /IWSRP)	6%	1,144,084	-	1,144,084	293,035	68,645	361,680	782,404
	12 Functional Building (2nd /IWSRP)	2-10%	17,512,065	4,449,239	21,961,304	5,498,871	299,698	5,798,569	16,162,735
	13 Residential Building (2nd/IWSRP)	2%	11,142,820	-	11,142,820	2,334,684	222,856	2,557,540	8,585,280
	14 Other Building (2nd /IWSRP)	2-10%	8,955,016	-	8,955,016	7,699,289	698,449	8,397,738	557,278
	15 Road Construction (2nd /IWSRP)	5%	692,090	-	692,090	344,728	34,605	379,333	312,757
	Sub-total (B)		169,032,209	5,334,639	174,366,848	95,914,880	3,838,645	99,753,525	74,613,323
C.	**PLANT & MACHINERY**								
	1 Pump House - A (1st Phase)	0-2%	710,360	-	710,360	681,953	3,722	685,675	24,685
	2 Pump House - B (1st Phase)	0-2%	1,377,239	-	1,377,239	933,443	16,450	949,893	427,346
	3 Deep Tubewell A (1st Phase)	0-6%	1,516,612	-	1,516,612	1,500,126	16,466	1,516,592	20
	4 Deep Tubewell B (1st Phase)	0-6%	1,686,541	-	1,686,541	1,670,834	15,675	1,686,509	32
	5 Water Main Line PPC (1st Phase)	0-2%	173,973,865	-	173,973,865	147,727,839	3,401,548	151,129,387	22,844,478
	6 Meter Repair Working (1st Phase)	0%	331,000	-	331,000	330,997	-	330,997	3
	7 Booster Station Door (1st Phase)	0-5%	25,350,267	-	25,350,267	21,003,783	381,320	21,385,103	3,965,164
	8 Meter Instralltion & Pump Door (1st Phase)	0-6%	315,351	-	315,351	315,342	-	315,342	9
	9 Deep Tubewell (1st Phase)	0-5%	3,075,209	-	3,075,209	2,548,944	24,434	2,573,378	501,831
	10 Mohara Water Treatment Plant (2nd Phase)	2%	526,868,945	-	526,868,945	218,805,972	10,537,379	229,343,351	297,525,594
	11 Booster Station (Kalurghat 2nd Phase)	0-2%	61,082,082	-	61,082,082	59,220,231	62,030	59,282,261	1,799,821
	12 Tank & Distribution (Kalurghat 2nd Phase)	2%	417,402,857	-	417,402,857	171,310,135	8,348,057	179,658,192	237,744,665
	13 Pump & Booster at Potenga (Kalurghat 2nd Phase)	0-5%	9,617,732	-	9,617,732	9,241,281	376,443	9,617,724	8
	14 Pump & Booster at Potenga (Kalurghat 2nd Phase)	0-5%	10,135,337	-	10,135,337	10,135,335	-	10,135,335	2
	15 Deep Tubewell (Kalurghat 2nd Phase)	0-6%	13,070,926	-	13,070,926	13,070,897	-	13,070,897	29
	16 Pump House (Kalurghat 2nd Phase)	2%	13,268,902	-	13,268,902	5,703,093	265,379	5,968,472	7,300,430
	17 Sundries	5%	500,393	-	500,393	475,380	25,012	500,392	1
	18 Tubewell (1st IWSRP)	6%	35,371,427	-	35,371,427	28,146,240	2,122,286	30,268,526	5,102,901
	19 Pump House (1st IWSRP)	0-2%	39,485,780	-	39,485,780	10,541,374	785,785	11,327,159	28,158,621
	20 Pipe Line (1st IWSRP)	2%	108,966,072	-	108,966,072	27,326,253	2,179,318	29,505,571	79,460,501
	21 Installation of Pump & Trans (1st IWSRP)	0-10%	22,763,454	-	22,763,454	11,623,381	2,061,741	13,685,122	9,078,332
	22 Computer (1st IWSRP)	10%	1,359,800	-	1,359,800	543,920	135,980	679,900	679,900
	23 Tubewell & Generator (1st IWSRP)	6%	1,472,872	-	1,472,872	1,204,684	88,372	1,293,056	179,816
	24 Materials of Pumps (1st IWSRP)	10%	1,555,809	-	1,555,809	1,555,803	-	1,555,803	6
	25 Tubewell (2nd IWSRP)	6%	20,145,841	-	20,145,841	11,200,990	1,208,753	12,409,743	7,736,098
	26 Pump House (2nd IWSRP)	0-10%	12,902,362	-	12,902,362	2,433,584	359,968	2,793,552	10,108,810
	27 Pipe Line (2nd IWSRP)	2%	59,774,999	-	59,774,999	9,500,541	1,195,499	10,696,040	49,078,959
	28 Tubewell Re Generation (2nd IWSRP)	6%	1,454,262	-	1,454,262	913,864	87,256	1,001,120	453,142
	29 Installation of Pump Machinery (2nd IWSRP)	0-10%	13,515,038	-	13,515,038	11,517,674	609,417	12,127,091	1,387,947
	30 Loose Tools (2nd IWSRP)	10%	620,569	-	620,569	501,457	59,555	561,012	59,557
	31 Computer Equipment (3rd IWSRP)	10%	1,730,858	-	1,730,858	435,260	173,086	608,346	1,122,512
	32 Meter Installation & Pump (3rd IWSRP)	2-10%	81,901,316	8,455,635	90,356,951	6,156,380	4,370,368	10,526,748	79,830,203
	33 Pipeline Installation (Non Project)	2%	21,186,221	-	21,186,221	4,203,123	423,724	4,626,847	16,559,374
	34 Tubewell (Non Project)	0-6%	17,376,402	-	17,376,402	6,697,347	970,987	7,668,334	9,708,068
	35 Pump House (Non Project)	2-10%	4,469,567	-	4,469,567	383,360	86,343	469,703	3,999,864
	36 Tools & Equipment (Non Project)	0-10%	7,024,368	757,900	7,782,268	4,812,021	289,203	5,101,224	2,681,044
	37 Meter Installation at Pump Station (Non Project)	0-10%	3,370,352	67,709	3,438,061	1,600,194	290,839	1,891,033	1,547,028
	38 Computer Installationn (Non Project)	0-10%	7,952,408	273,551	8,225,959	4,846,738	665,242	5,511,980	2,713,979
	39 Pump & Motor (Non Project)	0-10%	15,101,686	2,065,280	17,166,966	8,286,714	1,140,443	9,427,157	7,739,809
	40 Intercom System (Non Project)	10%	642,694	-	642,694	575,763	64,269	640,032	2,662
	41 Electronic Line Installation (Non Project)	0-15%	7,753,881	24,531,640	32,285,521	7,753,879	-	7,753,879	24,531,642
	42 Sundry Assets UAWMP	2%	1,173,266	-	1,173,266	305,038	23,465	328,503	844,763
	43 Mohara Water Supply Project	20%	7,662,200	2,650,500	10,312,700	4,575,120	2,062,540	6,637,660	3,675,040
	44 Digital Camera	10%	24,029	-	24,029	4,806	2,403	7,209	16,820
	45 Hunai Type Video Camera	10%	25,562	-	25,562	5,112	2,556	7,668	17,894
	46 Office Equipment	0-10%	33,459	-	33,459	6,692	3,346	10,038	23,421
	47 Pump (Mohara &Kalurghat Rehabilitation Project	0-10%	819,000	-	819,000	-	81,900	81,900	737,100
	Sub-total (C)		1,757,919,172	38,802,215	1,796,721,387	832,332,897	45,018,559	877,351,456	919,369,931
D.	**VEHICLES**								
	1 1st IWSRP	0-20%	7,416,000	-	7,416,000	7,415,997	-	7,415,997	3
	2 2nd IWSRP	0%	6,994,749	-	6,994,749	6,994,730	-	6,994,730	19
	3 Non Project	20%	14,571,771	-	14,571,771	14,381,860	189,799	14,571,659	112
	4 Common Fixed Assets	0%	1,509,500	-	1,509,500	1,509,480	-	1,509,480	20
	Sub-total (F)		30,492,020	-	30,492,020	30,302,067	189,799	30,491,866	154
E.	**FURNITURE**								
	1 3rd IWSRP	10%	26,989	-	26,989	13,495	2,699	16,194	10,795
	2 Non Project	10%	3,005,731	284,204	3,289,935	1,909,449	218,504	2,127,953	1,161,982
	3 Medical Equipment	10%	307,078	-	307,078	226,667	13,976	240,643	66,435
	4 Common Fixed Assets	0-10%	4,691,911	(3,380)	4,688,531	4,677,733	1,923	4,679,656	8,875
	Sub-total (G)		8,031,709	280,824	8,312,533	6,827,344	237,102	7,064,446	1,248,087
F	**TRANSPORTATION & EQUIPMENT**	0%	4,510,034	-	4,510,034	4,509,997	-	4,509,997	37

3.4.5 Details Long-Term Loans

	Name of Loans	FY2006/07				FY2007/08			FY2008/09		
		Opening Balace as at 01.07.'06	Loan received during the Period	Loan Payment during the Period	Closing Balace as to 30.06.'07	Loan received during the Period	Loan Payment during the Period	Closing Balace as to 30.06.'08	Loan received during the Period	Loan Payment during the Period	Closing Balace as to 30.06.'09
1.	1st IWSRP *1)	248,725,000	-		248,725,000			248,725,000			248,725,000
2	3rd IWSRP *1)	244,459,000	60,000,000		304,459,000	44,000,000	12,252,000	336,207,000	100,000,000	84,629,000	351,578,000
3	IDA Loan (1st Phase)	12,691,523		2,115,255	10,576,268		2,115,255	8,461,013		2,115,255	6,345,758
4	IDA Loan (2nd Phase)	331,755,913		57,854,645	273,901,268		60,361,103	213,540,165		56,907,561	156,632,604
5	Madunaghat Project	-			-			-			-
6	Reimbursement Loan for Sewerage	2,700,000			2,700,000			2,700,000			2,700,000
7	UAWMP *2)	5,329,000			5,329,000			5,329,000			5,329,000
8	Karnaphuli Water Supply P`roject (JICA Loan)	-			-	48,881,315		48,881,315	142,310,250		191,191,565
9	Mohara & Kalurghat Rehabilitation Project	-			-	10,000,000		10,000,000			10,000,000
10	Mohara Water Supply Extension Project	51,722,000	137,500,000	37,500,000	151,722,000		52,187,000	99,535,000			99,535,000
11	Karnaphuli Water Supply P`roject (GOB)	-	12,500,000		12,500,000	180,000,000	1,053,000	191,447,000	50,000,000	129,316,000	112,131,000
	Total	897,382,436	210,000,000	97,469,900	1,009,912,536	282,881,315	127,968,358	1,164,825,493	292,310,250	272,967,816	1,184,167,927
	(Note) *1) IWSRP: Water Supply & Rehabilitation Project										
	*2) UAWMP: Unaccounted For Water Management Program										
	(Source: CWASA Financial Statements)										

3.4.6 Change in Equity fund

	Particulars	Capital Fund	Asset Revaluation Reserve	Excess Value of Assets due to Physical Verification	Retained Earnings	Total Equity Fund
FY 2006/07						
a.	Balance as at 01.07.2006	1,070,287,680	45,473,332	280,067	(619,125,193)	496,915,886
b.	Net income for the year				84,420,080	84,420,080
c.	Payment to National Exchequer				(5,000,000)	(5,000,000)
d.	Income tax paid				(6,000,000)	(6,000,000)
e.	Loan transferred to equity/grant*1)	600,000				600,000
f.	Loan paid from Equity					
g.	Balance as at 30.06.2007	1,070,887,680	45,473,332	280,067	(545,705,113)	570,935,966
FY 2007/08						
a.	Balance as at 01.07.2007	1,070,887,680	45,473,332	280,067	(545,705,113)	570,935,966
b.	Net income for the year				107,449,237	107,449,237
c.	Payment to National Exchequer				(5,000,000)	(5,000,000)
d.	Income tax paid					
e.	Loan transferred to equity					
f.	Loan paid from Equity*2)	(10,779,000)				(10,779,000)
g.	Balance as at 30.06.2008	1,060,108,680	45,473,332	280,067	(443,255,876)	662,606,203
FY 2008/09						
a.	Balance as at 01.07.2008	1,060,108,680	45,473,332	280,067	(443,255,876)	662,606,203
b.	Net income for the year				100,643,839	100,643,839
c.	Payment to National Exchequer					
d.	Income tax paid					
e.	Loan transferred to equity/grant*3)	176,874,097				176,874,097
f.	Loan paid from Equity*4)	(12,260,000)				(12,260,000)
g.	Balance as at 30.06.2009	1,224,722,777	45,473,332	280,067	(342,612,037)	927,864,139

(Note) *1) Madunaghat Project Loan transferred to equity: increased from BDT83,265,000 as at the opening of FY2005/06 to BDT83, 865,000 as at the closing of FY2006/07

*2) Madunaghat Project Loan transferred to equity: decreased from BDT83,865,000 as at the opening of FY2006/07 to BDT73,086,000 as at the closing of FY2007/08 with repayment of BDT10,779,000 from equity during FY2007/08

*3) Grant for Mohara & Kalurghat Rehabilitation Project in an amount of BDT74,339,097 and Equity for Mohara Water Supply Project in an amount of BDT102,535,000, thus amounting to BDT176,874,097 in total

*4) Madunaghat Project Loan transferred to equity: decreased from BDT73,086,000 as at the opening of FY2008/08 to BDT60,826,000 as at the closing of FY2008/09 with repayment of BDT12,260,000 from equity during FY2008/09

(Source: Audited Financial Statements for FY2006/07 to FY2008/09)

3.4.7 Details of Retained Earnings

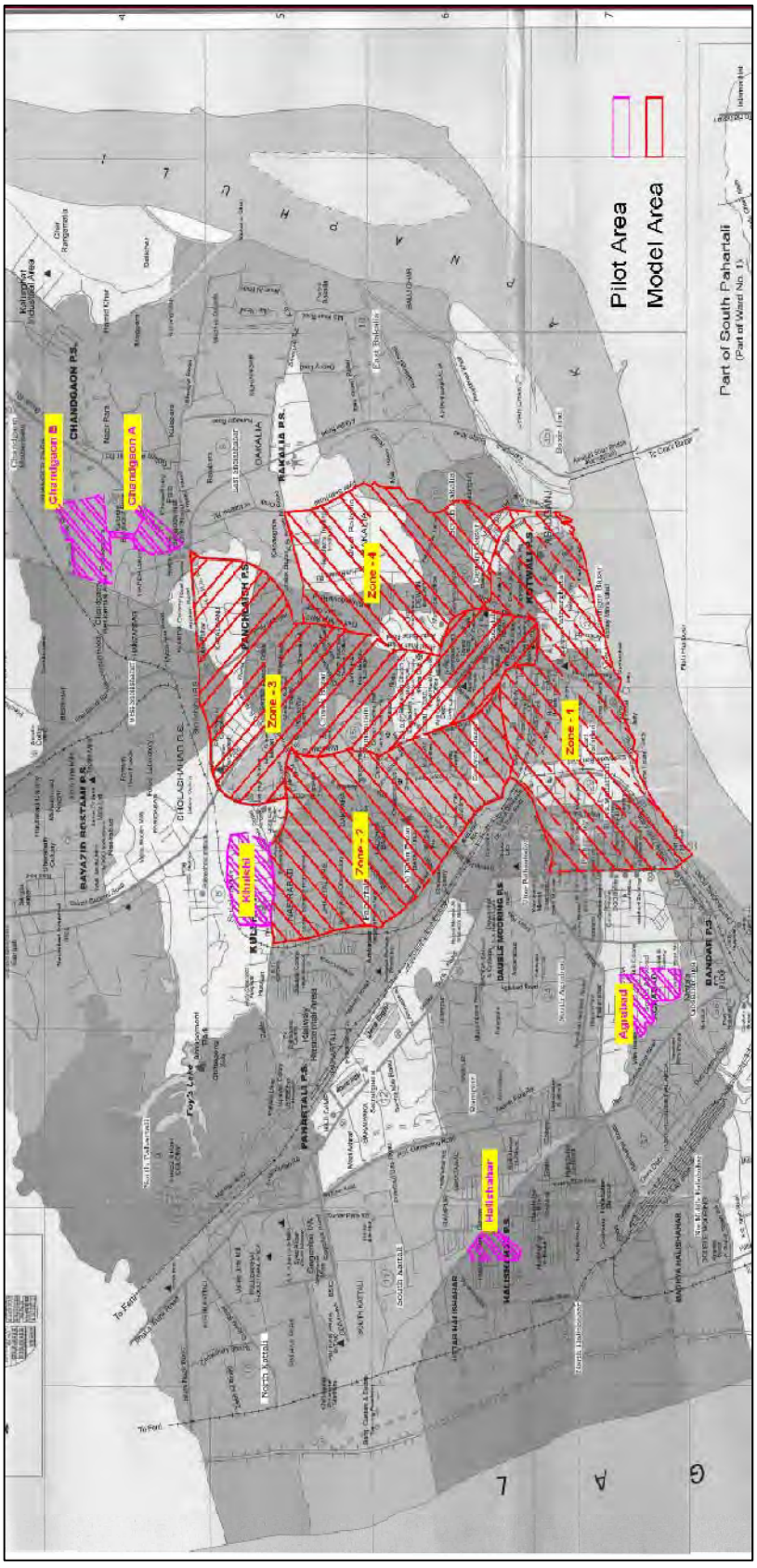
	Particulars	As at Closing of FY2006/07 (30.06. 2007)	As at Closing of FY2007/08 (30.06. 2008)	As at Closing of FY2008/09 (30.06. 2009)
a.	Opening ratained earnings as restated**	(619,125,193)	(545,705,113)	(443,255,876)
b.	Net income for the year (see Income Statements)	84,420,080	107,449,237	100,643,839
c.	Income tax paid	(6,000,000)	-	-
d.	Payment to National Exchequer	(5,000,000)	(5,000,000)	-
e.	Retained Earnings	(545,705,113)	(443,255,876)	(342,612,037)
	(Note) **Accumulated Retained Earnings was recored as BDT619,125,193 as at the opening of FY2006/07 (01.07.2006)			
	(Source: Audited Financial Statements for FY2006/07 to FY2008/09)			

CHAPTER 4

WATER DEMAND PROJECTION IN THE SURVEY AREA

Chapter 4 WATER DEMAND PROJECTION IN THE SURVEY AREA

4.2.1 (a) Location of the Survey Points



4.2.1(b) Survey Results by the PANI

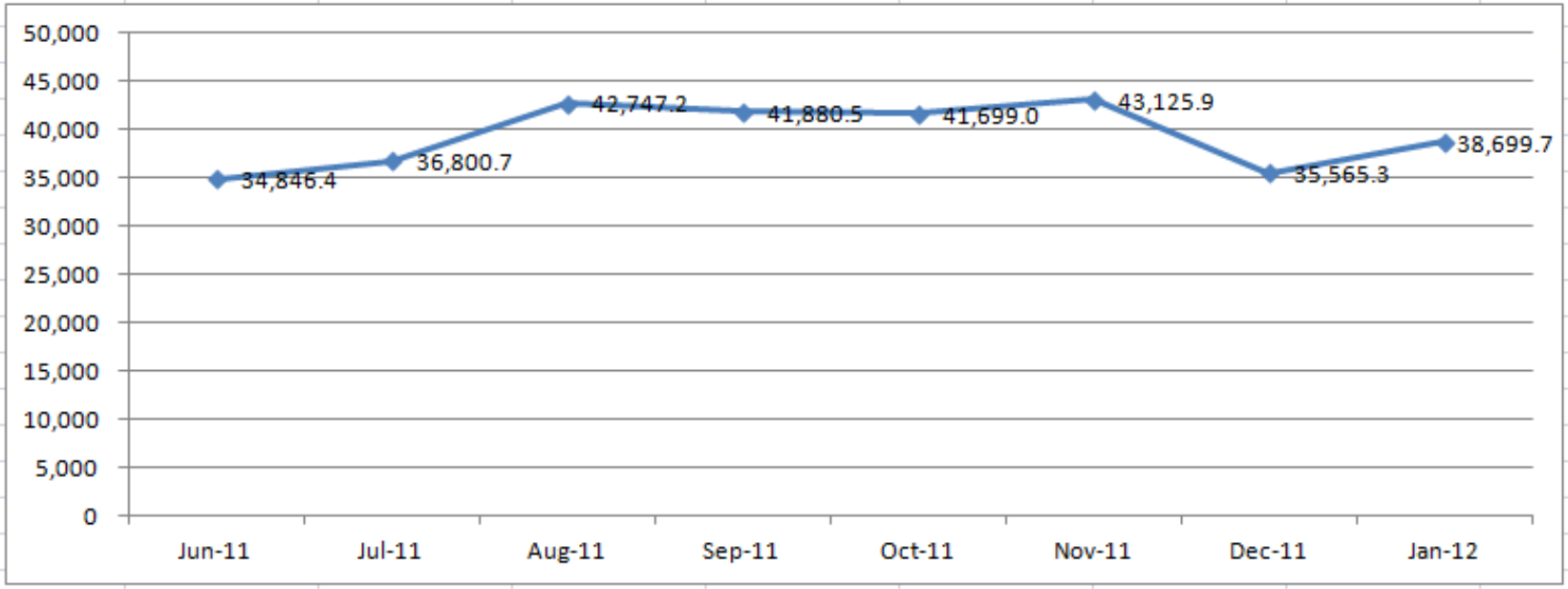
Account	Pilot_Area	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12
120315	Chandgaon A	102.4	123.8	178.4	116.8	124.8	175.2	89.7	97.7
120333	Chandgaon A	205.7	316.3	398.4	327.4	223.3	438.7	244.7	287.5
120389	Chandgaon A	109.3	110.7	110.0	109.3	110.7	106.3	106.1	109.1
120420	Chandgaon A	37.2	42.1	39.9	33.2	37.0	42.4	21.2	21.0
120472	Chandgaon A	26.2	34.6	41.8	32.3	26.2	24.8	21.2	28.0
120473	Chandgaon A	226.1	267.8	352.6	151.6	36.9	43.1	163.2	114.3
120520	Chandgaon A	257.8	330.3	398.4	303.4	241.5	244.5	220.3	227.8
120587	Chandgaon A	134.5	102.6	139.4	210.9	213.9	235.2	212.1	226.0
120627	Chandgaon A	419.5	479.4	479.4	496.9	304.8	198.4	130.5	184.3
120629	Chandgaon A	81.3	119.8	138.1	123.1	104.6	139.4	73.4	78.5
120632	Chandgaon A	99.0	146.0	160.0	135.0	147.0	149.0	89.7	136.4
120633	Chandgaon A	185.9	223.7	275.8	230.5	229.5	234.5	203.9	123.5
120640	Chandgaon A	269.1	301.9	308.1	308.0	465.2	606.8	97.9	120.0
120644	Chandgaon A	57.0	27.2	182.3	146.6	130.8	145.2	106.1	109.1
120645	Chandgaon A	45.5	60.4	181.9	120.6	80.5	174.5	212.1	241.4
120653	Chandgaon A	412.6	553.8	759.4	490.8	519.5	524.5	416.1	481.0
120656	Chandgaon A	182.5	232.3	269.0	212.7	217.4	242.6	212.1	202.7
120667	Chandgaon A	239.4	370.6	458.4	323.0	308.0	330.0	81.6	250.7
120671	Chandgaon A	198.5	263.8	215.5	342.7	334.1	331.9	171.3	216.7
120674	Chandgaon A	160.6	183.2	109.4	113.4	128.8	125.2	130.5	161.1
120680	Chandgaon A	243.8	251.9	252.4	240.9	249.6	238.4	252.9	250.7
120691	Chandgaon A	491.9	559.7	434.8	813.4	732.4	631.6	538.4	578.4
120701	Chandgaon A	45.7	85.6	115.2	79.2	78.5	75.5	53.0	66.2
120712	Chandgaon A	75.4	94.6	100.0	95.4	87.5	101.5	97.9	91.8
120718	Chandgaon A	162.0	242.0	284.2	248.1	225.4	232.6	179.5	210.8
120719	Chandgaon A	107.0	42.4	22.5	92.1	66.4	40.6	21.2	31.9
120748	Chandgaon A	238.2	330.5	291.0	310.5	378.5	305.5	220.3	266.5
120762	Chandgaon A	207.9	138.4	289.4	191.9	193.3	80.7	24.5	237.8
120776	Chandgaon A	49.9	50.0	49.9	49.9	50.0	47.0	48.4	49.9
120781	Chandgaon A	242.8	475.4	560.3	430.3	531.6	538.4	399.7	446.4
120784	Chandgaon A	59.5	75.5	92.1	74.4	78.5	85.5	54.9	83.4
120785	Chandgaon A	77.0	109.0	100.3	98.9	129.1	34.2	106.6	50.9
120800	Chandgaon A	109.0	116.8	168.4	146.8	149.0	149.0	114.2	111.0
120801	Chandgaon A	204.3	207.4	274.5	264.1	261.7	330.3	277.4	333.6
120805	Chandgaon A	26.8	20.9	52.5	39.6	51.4	60.6	53.0	62.3
120810	Chandgaon A	154.8	175.2	268.7	248.1	201.2	266.8	203.9	169.9
120826	Chandgaon A	51.7	49.1	106.1	91.2	84.7	126.3	114.2	95.5
120830	Chandgaon A	386.5	311.9	541.9	572.1	501.1	452.9	334.5	493.6
120831	Chandgaon A	79.6	78.8	73.2	117.9	90.5	60.5	97.9	76.3
120866	Chandgaon A	228.6	239.3	207.7	166.7	177.2	174.8	138.7	73.9
120869	Chandgaon A	209.5	149.4	155.6	118.9	118.8	103.2	89.7	97.7
120884	Chandgaon A	21.5	21.0	21.0	24.8	39.5	31.3	30.0	21.3
120891	Chandgaon A	83.7	108.8	113.9	253.3	195.1	202.9	146.8	172.5
120895	Chandgaon A	181.0	58.9	165.4	106.7	77.5	84.5	65.3	138.6
120907	Chandgaon A	154.8	54.2	344.5	225.3	173.1	152.9	122.4	167.0
120913	Chandgaon A	366.3	244.4	184.4	177.6	196.9	228.7	203.9	193.1
120914	Chandgaon A	252.1	98.8	471.3	454.3	247.3	78.7	48.9	88.5
120947	Chandgaon A	176.6	243.7	324.5	233.8	251.7	270.3	179.5	195.4
120950	Chandgaon A	168.1	237.7	286.3	293.2	297.0	216.0	129.6	99.6
120956	Chandgaon A	37.7	67.3	99.7	48.3	36.6	107.1	106.1	256.2
120960	Chandgaon A	103.4	93.3	90.0	121.4	78.4	97.6	89.7	105.4
120977	Chandgaon A	83.2	119.8	105.8	155.4	130.8	113.2	97.9	115.0
120992	Chandgaon A	541.7	531.5	711.3	593.2	394.3	177.7	978.9	639.1
120997	Chandgaon A	100.8	108.1	142.3	125.0	136.9	157.1	122.4	93.4
121006	Chandgaon A	180.8	124.7	101.9	243.4	193.1	212.9	130.5	168.8
121010	Chandgaon A	34.3	37.5	34.8	26.6	36.5	37.5	29.4	29.9
121016	Chandgaon A	168.4	175.2	236.5	248.4	275.8	284.2	269.2	324.0
121033	Chandgaon A	176.9	197.3	151.6	115.1	66.4	26.6	21.2	175.1
121071	Chandgaon A	81.1	105.1	101.9	123.4	100.2	82.8	61.2	75.8
121081	Chandgaon A	24.7	32.7	34.9	54.3	39.6	21.3	47.5	22.8
121082	Chandgaon A	359.1	495.4	344.5	626.1	601.7	560.3	440.5	494.3
121106	Chandgaon A	94.3	146.1	184.3	140.4	147.0	169.0	155.0	166.6
121120	Chandgaon A	21.8	30.7	29.1	38.6	42.9	21.4	35.8	21.5
121123	Chandgaon A	70.6	84.0	113.8	88.0	96.8	113.4	77.5	94.9
121134	Chandgaon A	115.1	110.7	166.5	146.8	149.0	199.0	212.1	195.0
121144	Chandgaon A	323.5	372.3	540.6	429.1	451.0	469.0	367.1	315.2
121145	Chandgaon A	210.1	270.8	380.9	300.4	346.3	339.7	252.9	281.6
121146	Chandgaon A	104.8	146.0	208.4	202.6	193.2	166.8	32.6	208.7
121147	Chandgaon A	20.0	21.0	21.0	20.0	21.0	20.7	21.3	21.0
121149	Chandgaon A	76.7	54.3	78.2	76.5	67.4	47.6	57.1	90.3
121184	Chandgaon A	50.8	81.8	106.5	85.3	76.5	77.5	81.6	34.7
121204	Chandgaon A	134.7	187.8	206.2	176.0	179.2	144.8	24.5	21.8
121205	Chandgaon A	222.8	213.8	164.9	158.0	162.2	231.1	130.5	130.1
121226	Chandgaon A	388.2	238.9	683.9	450.8	283.7	540.3	383.4	318.8
121243	Chandgaon A	135.2	64.3	153.9	162.8	193.3	138.7	407.9	432.8

121270	Chandgaon A	20.1	21.1	20.9	20.0	20.9	20.1	21.2	21.0
121272	Chandgaon A	56.4	108.2	90.6	89.9	81.4	35.6	95.9	97.0
121285	Chandgaon A	325.8	511.0	559.9	589.1	450.6	459.4	285.5	304.5
121289	Chandgaon A	103.2	132.1	140.7	115.3	126.8	135.2	106.1	116.9
121314	Chandgaon A	226.7	230.8	181.6	224.9	225.4	242.6	130.5	199.8
121389	Chandgaon A	24.4	36.3	64.2	36.7	46.9	29.9	114.2	149.7
121424	Chandgaon A	22.4	23.4	32.9	22.8	20.9	20.1	31.0	23.3
121433	Chandgaon A	168.6	213.0	217.1	185.8	205.4	270.6	220.3	212.3
121444	Chandgaon A	38.6	50.1	54.4	48.1	50.5	48.9	40.8	47.9
121464	Chandgaon A	170.6	273.9	437.1	395.0	317.9	558.1	114.2	265.8
121504	Chandgaon A	85.2	103.7	61.6	169.7	96.5	173.5	114.2	111.0
121510	Chandgaon A	224.9	169.0	190.3	206.7	195.2	186.8	187.6	189.5
121511	Chandgaon A	29.8	32.6	36.2	27.2	33.2	26.8	36.7	24.5
121525	Chandgaon A	196.8	241.6	306.5	261.9	243.5	266.5	220.3	266.5
121554	Chandgaon A	190.5	253.7	229.7	202.6	217.4	222.6	122.4	167.0
121555	Chandgaon A	180.8	221.5	310.6	151.9	134.9	167.1	179.5	133.4
121602	Chandgaon A	265.5	394.8	462.3	379.0	370.4	341.6	293.7	329.5
121674	Chandgaon A	542.8	320.3	383.5	358.2	303.9	286.1	220.3	243.3
121679	Chandgaon A	38.6	47.3	58.1	55.6	83.6	47.4	38.3	41.9
121695	Chandgaon A	46.1	21.9	79.1	21.9	40.3	40.3	41.7	41.0
121705	Chandgaon A	192.4	294.6	344.1	267.3	291.9	328.1	220.3	282.0
121714	Chandgaon A	92.0	95.0	95.0	92.0	95.0	92.4	97.9	95.7
121756	Chandgaon A	275.0	280.8	312.3	341.9	360.3	379.7	163.2	191.7
121770	Chandgaon A	277.7	318.1	233.2	440.6	333.9	296.1	203.9	216.4
121786	Chandgaon A	51.6	44.5	23.5	92.0	70.4	27.6	77.5	52.3
121816	Chandgaon A	20.6	21.0	21.0	46.1	25.8	20.8	21.3	21.0
121819	Chandgaon A	100.7	104.0	104.0	100.7	41.9	33.2	24.5	32.6
121844	Chandgaon A	20.0	21.0	21.0	20.0	21.0	20.7	21.3	21.0
121878	Chandgaon A	281.4	227.4	582.9	409.7	481.3	498.7	326.3	422.1
121948	Chandgaon A	218.3	205.8	222.6	235.6	217.4	310.6	252.9	250.7
121986	Chandgaon A	258.1	348.4	394.2	349.4	382.5	455.5	301.8	339.1
121987	Chandgaon A	302.5	576.6	454.5	319.4	334.2	345.8	277.4	217.5
121988	Chandgaon A	111.2	118.8	120.0	111.2	118.8	113.2	116.3	116.4
122005	Chandgaon A	123.1	153.3	143.4	131.3	155.0	171.0	122.4	167.0
122012	Chandgaon A	26.0	22.0	44.5	33.3	42.3	45.7	39.2	39.8
122031	Chandgaon A	65.4	75.7	136.3	94.6	68.8	97.6	106.1	109.1
122044	Chandgaon A	95.4	98.5	94.5	94.2	98.8	95.2	97.9	98.8
122062	Chandgaon A	91.6	76.5	61.9	67.6	94.6	109.4	81.6	95.8
122063	Chandgaon A	182.7	208.4	199.4	262.2	241.5	254.5	171.3	216.7
122080	Chandgaon A	36.5	41.3	42.2	38.5	57.6	72.0	61.2	68.0
122082	Chandgaon A	20.1	20.9	21.0	20.1	20.9	20.1	21.2	97.7
122125	Chandgaon A	201.3	173.1	113.5	283.4	243.4	212.6	28.6	238.7
122140	Chandgaon A	285.7	347.1	357.8	309.1	318.1	341.9	261.1	291.2
122242	Chandgaon A	21.5	31.7	30.1	20.3	67.4	22.2	30.0	21.3
122256	Chandgaon A	126.0	100.4	109.8	84.2	104.3	101.3	71.0	76.4
122350	Chandgaon A	88.5	89.3	87.6	84.1	87.0	83.8	86.5	148.8
122356	Chandgaon A	165.7	93.0	166.5	130.5	185.3	168.7	122.4	151.5
122420	Chandgaon A	49.9	45.1	57.1	51.6	58.4	56.6	32.6	38.3
122512	Chandgaon A	271.9	280.9	277.3	269.3	279.8	274.2	277.4	279.4
122562	Chandgaon A	35.4	176.4	125.8	83.4	94.4	114.0	89.7	89.9
122621	Chandgaon A	399.4	416.2	413.8	400.0	410.6	399.4	416.1	411.4
122626	Chandgaon A	252.0	209.3	369.4	383.4	326.0	380.0	244.7	287.5
122647	Chandgaon A	178.9	184.9	184.9	178.9	246.3	243.3	171.3	193.5
122686	Chandgaon A	109.7	93.6	159.7	152.7	110.6	199.4	97.9	138.2
122723	Chandgaon A	320.8	459.2	564.5	472.3	509.4	500.6	448.7	426.5
122763	Chandgaon A	164.8	112.6	87.9	368.5	265.4	232.6	106.1	202.0
122789	Chandgaon A	109.5	127.4	155.6	126.9	120.8	153.2	89.7	151.9
122808	Chandgaon A	122.8	151.0	176.1	138.8	163.1	152.9	97.9	115.0
122847	Chandgaon A	188.5	229.5	280.3	224.1	259.7	262.3	187.6	166.2
122931	Chandgaon A	208.4	221.0	200.8	214.2	221.4	262.6	171.3	193.5
123019	Chandgaon A	56.7	68.1	94.4	79.4	83.5	76.5	36.7	50.9
123044	Chandgaon A	200.6	209.4	210.0	200.6	209.4	200.6	212.1	210.5
123048	Chandgaon A	20.1	20.9	21.0	20.1	20.9	20.1	21.2	21.0
123054	Chandgaon A	212.3	272.8	331.8	265.5	259.7	240.3	163.2	276.8
123306	Chandgaon A	329.8	341.9	338.7	329.5	340.2	325.8	334.5	338.8
123319	Chandgaon A	214.2	257.7	310.3	245.9	215.4	270.6	228.4	237.4
123344	Chandgaon A	133.1	149.5	150.0	207.8	239.3	62.7	193.8	151.4
123349	Chandgaon A	351.4	447.3	191.6	389.1	380.3	379.7	310.0	348.7
123362	Chandgaon A	232.1	328.5	421.9	331.6	352.3	369.7	285.5	320.0
123366	Chandgaon A	190.2	179.2	252.6	236.3	207.3	258.7	228.4	260.6
123370	Chandgaon A	23.8	49.1	50.0	20.9	21.0	23.7	21.3	21.0
123377	Chandgaon A	36.0	28.8	56.6	39.8	43.3	53.7	48.9	53.6
123378	Chandgaon A	180.5	251.7	245.8	270.5	241.5	264.5	228.4	280.0
123435	Chandgaon A	43.1	20.9	21.0	20.1	165.3	358.7	155.0	166.6
123457	Chandgaon A	115.1	110.7	174.5	140.8	138.9	177.1	155.0	135.6
123499	Chandgaon A	20.1	28.2	22.7	20.1	20.9	20.1	22.8	23.7
123590	Chandgaon A	42.2	21.8	21.0	20.0	21.0	20.7	21.3	21.0
123620	Chandgaon A	557.8	277.4	655.4	737.7	776.6	1,001.0	375.3	417.6
123679	Chandgaon A	20.0	21.0	21.0	20.0	21.0	20.7	21.3	21.0
123710	Chandgaon A	184.4	235.6	322.6	225.8	281.9	328.1	236.6	208.3

123767	Chandgaon A	43.6	68.3	83.3	64.4	76.5	85.5	62.8	39.7
123862	Chandgaon A	40.0	23.5	32.3	22.8	28.2	55.8	44.9	75.9
123996	Chandgaon A	197.0	300.6	311.4	212.0	82.4	160.6	33.4	139.2
124102	Chandgaon A	472.2	344.4	92.3	119.7	173.2	354.8	342.6	379.3
124201	Chandgaon A	189.7	199.2	240.3	233.0	226.3	219.1	228.4	229.6
124231	Chandgaon A	206.5	255.5	214.5	208.0	243.6	188.4	163.2	207.2
124313	Chandgaon A	198.7	221.0	192.6	196.4	201.3	238.7	171.3	209.0
124381	Chandgaon A	258.3	215.8	271.7	246.5	257.7	250.3	179.5	195.4
124459	Chandgaon A	321.3	197.9	668.4	471.6	469.1	452.9	342.6	371.6
124536	Chandgaon A	236.3	304.1	142.6	523.4	400.2	325.8	163.2	114.3
124562	Chandgaon A	53.3	79.6	101.4	85.6	97.0	99.4	83.3	66.7
125066	Chandgaon A	400.0	265.5	407.4	407.1	386.5	393.5	416.1	411.4
125130	Chandgaon A	51.9	73.3	82.2	72.1	78.5	75.5	57.1	71.0
125312	Chandgaon A	20.1	21.1	20.9	20.6	221.7	251.8	179.5	203.1
125329	Chandgaon A	22.8	36.3	44.0	36.7	37.6	38.4	29.4	33.7
125364	Chandgaon A	229.9	300.6	385.0	292.4	312.1	331.9	212.1	218.2
125486	Chandgaon A	221.7	355.7	234.2	162.1	353.7	121.6	251.9	163.0
125539	Chandgaon A	68.5	84.0	83.2	82.3	94.8	108.8	89.7	97.7
125713	Chandgaon A	20.1	20.9	21.0	20.1	20.9	20.1	21.2	21.0
125793	Chandgaon A	154.8	134.8	130.0	145.2	126.8	153.2	21.2	97.7
125883	Chandgaon A	20.2	21.0	447.6	122.5	20.9	54.1	600.6	996.0
126014	Chandgaon A	180.8	181.2	236.5	232.4	158.9	287.1	220.3	204.6
126032	Chandgaon A	318.0	400.8	325.2	306.1	562.0	540.0	310.0	302.3
126182	Chandgaon A	430.6	428.8	325.2	642.1	565.4	660.6	579.2	665.0
126198	Chandgaon A	244.8	181.0	151.9	133.0	171.2	254.8	212.1	195.0
126256	Chandgaon A	20.1	20.9	21.0	20.1	20.9	20.1	32.6	23.6
126268	Chandgaon A	360.0	161.5	114.2	811.4	681.9	516.1	375.3	433.1
126283	Chandgaon A	351.1	316.0	449.1	370.9	392.6	487.4	375.3	378.9
126346	Chandgaon A	20.1	20.9	21.0	24.1	29.2	21.8	21.2	21.0
126381	Chandgaon A	41.2	55.6	51.9	53.7	47.3	52.7	33.4	30.8
126694	Chandgaon A	20.1	20.9	24.2	20.8	20.9	24.1	21.2	28.0
126775	Chandgaon A	453.5	580.0	273.2	354.1	410.4	392.3	490.0	620.0
126846	Chandgaon A	327.1	390.6	514.8	376.5	390.6	487.4	318.2	327.3
126872	Chandgaon A	36.1	40.3	44.0	28.7	61.5	55.5	47.3	57.1
127045	Chandgaon A	91.2	93.6	123.2	113.2	110.7	91.3	57.1	55.5
127054	Chandgaon A	31.9	21.0	28.7	20.3	36.5	21.2	31.0	21.3
127056	Chandgaon A	22.3	21.0	21.0	20.0	21.0	20.7	21.3	21.0
127057	Chandgaon A	24.2	21.0	21.0	21.0	29.7	21.0	21.3	21.0
127082	Chandgaon A	20.7	29.7	21.3	20.0	21.0	20.7	21.3	21.0
127309	Chandgaon A	24.1	37.3	50.5	70.3	87.6	157.4	155.0	127.9
127443	Chandgaon A	333.2	441.3	461.6	457.1	446.8	405.2	261.1	337.7
127542	Chandgaon A	215.6	165.0	208.4	162.6	191.3	238.7	163.2	129.7
127590	Chandgaon A	544.7	332.7	366.0	632.7	946.5	1,293.5	1,468.4	1,183.2
127910	Chandgaon A	22.9	21.0	21.0	29.7	21.3	20.7	21.3	21.0
127918	Chandgaon A	20.8	20.9	21.0	20.1	294.3	174.2	135.0	138.9
300140	Chandgaon A	550.0	600.0	550.0	700.0	800.0	420.0	650.0	650.0
320363	Chandgaon A	20.0	21.0	21.0	23.0	22.0	20.0	21.0	21.0
320364	Chandgaon A	120.0	50.0	60.0	90.0	100.0	130.0	120.0	120.0
320425	Chandgaon A	70.0	60.0	60.0	70.0	75.0	70.0	70.0	70.0
320427	Chandgaon A	330.0	300.0	310.0	330.0	320.0	380.0	370.0	400.0
320444	Chandgaon A	209.0	216.0	216.0	209.0	200.0	190.0	160.0	150.0
320449	Chandgaon A	950.0	680.0	630.0	700.0	700.0	700.0	800.0	700.0
320455	Chandgaon A	74.0	21.0	85.0	140.0	150.0	150.0	150.0	150.0
320475	Chandgaon A	110.0	100.0	110.0	120.0	130.0	110.0	110.0	110.0
320505	Chandgaon A	96.0	60.0	42.0	43.0	27.0	48.0	80.0	75.0

4.2.2 Seasonal fluctuation in daily water consumption

Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Average
34,846.4	36,800.7	42,747.2	41,880.5	41,699.0	43,125.9	35,565.3	38,699.7	39,420.6
0.88	0.93	1.08	1.06	1.06	1.09	0.90	0.98	1.00

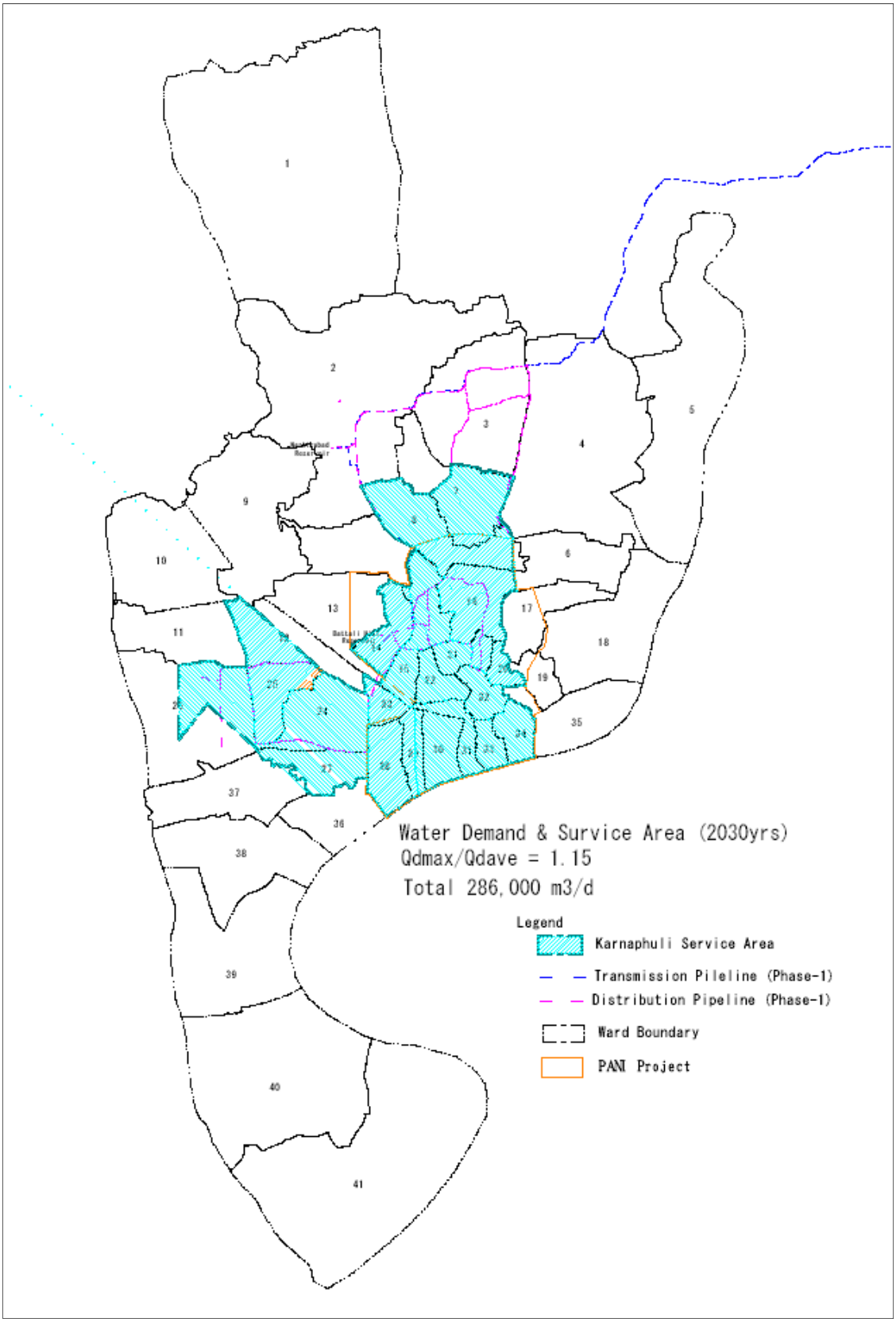


CHAPTER 5

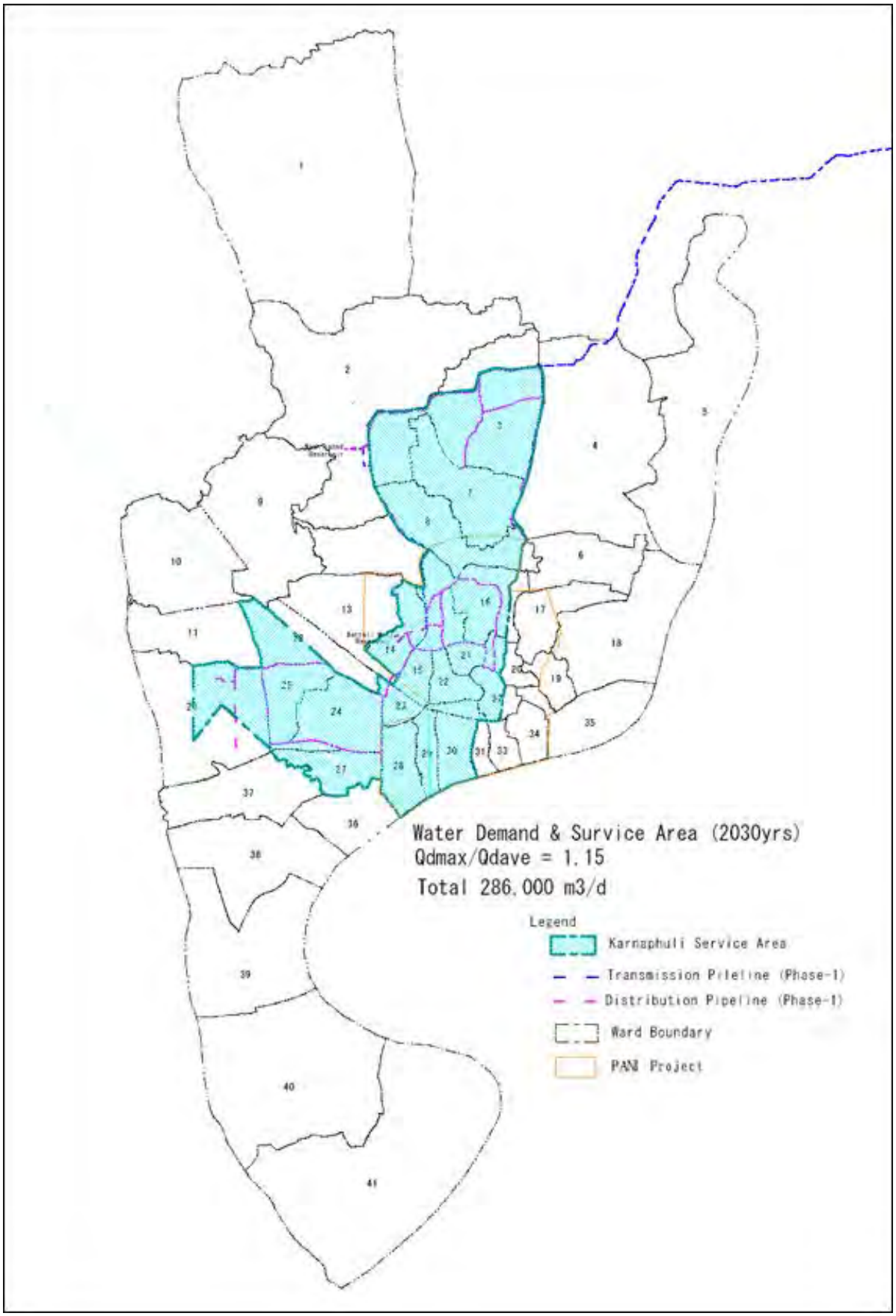
ESTABLISHMENT OF KARNAPHULI SERVICE AREA

CHAPTER 5 ESTABLISHMENT OF KARNAPHULI SERVICE AREA

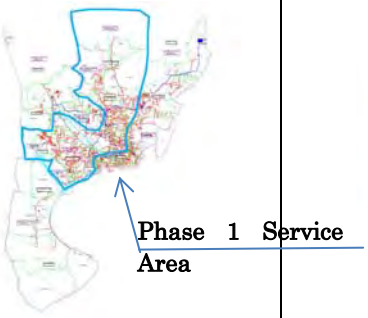
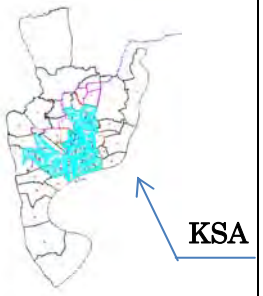
5.2.1 (a) KSA (Case-1)



5.2.1 (b) KSA (Case-2)



5.3.1 Comparison of Basic Conditions among SAPROF, Phase 1Project and Phase 2 Projects

	SAPROF		KWSP (Phase 1)	KWSP (Phase 2)
	Phase 1	Phase 2		
Target Year	2010	2020	2010	2030
Water Source (m^3/d)	Karnaphuli WTP = 136,000 Madunaght WTP = 45,500 Total = 181,500	Karnaphuli WTP = 272,000 Madunaght WTP = 45,500 Total = 317,500	Karnaphuli WTP = 143,000 Madunaght WTP = 45,500 Total = 188,500	Karnaphuli WTP =286,000
Service Area	CCC area and its surrounding area	CCC area and its surrounding area	CCC area and its surrounding area	Priority area (KSA)
				
Major Facilities				
1)Conveyance Pipe	DN 1200mm	DN1200mm	DN1200mm	DN1200mm
2)Transmission Pipe	DN 1200mm	DN1200mm	DN1200mm	DN1200mm
3)Reservoir and Elevated Tank	3no. (2R + 1ET) -Nashirabad Reservoir (17,500m^3) and Elevated Tank (1,750m^3) -BattaliHill Reservoir=27,300m^3	8no. (4R + 4ET) -Nashirabad Reservoir (17,500m^3) and Elevated Tank (1,750m^3) -Battali Hill Reservoir =27,300m^3 -Salimpur (Reservoir + E.T) -Halishahar (Reservoir + E/T) -Kulshi E.T	3no. (2R + 1ET) -Nashirabad Reservoir (26,300m^3) and Elevated Tank (2,200m^3) -Battali Hill Reservoir =8,500m^3	5no (3R + 2ET) -Nashirabad Reservoir (26,300m^3+24,800m^3) and Elevated Tank (2,200m^3) -Battali Hill Reservoir =8,500m^3 - Halishahar E.T= 2,400m^3
4)Booster P.S	Kulshi (rehabilitation)	-	Kulshi (rehabilitation)	-
Distribution System	Use existing distribution network (connected by main distribution pipeline)		Use existing distribution network (connected by main distribution pipeline)	All distribution pipeline are constructed, establishing Sectors and DMAs

Note) R; Reservoir, ET; Elevated Tank

5.3.2 Conditions and Events from SAPROF to KWSP2 with reference to the Change of Service Area to be covered

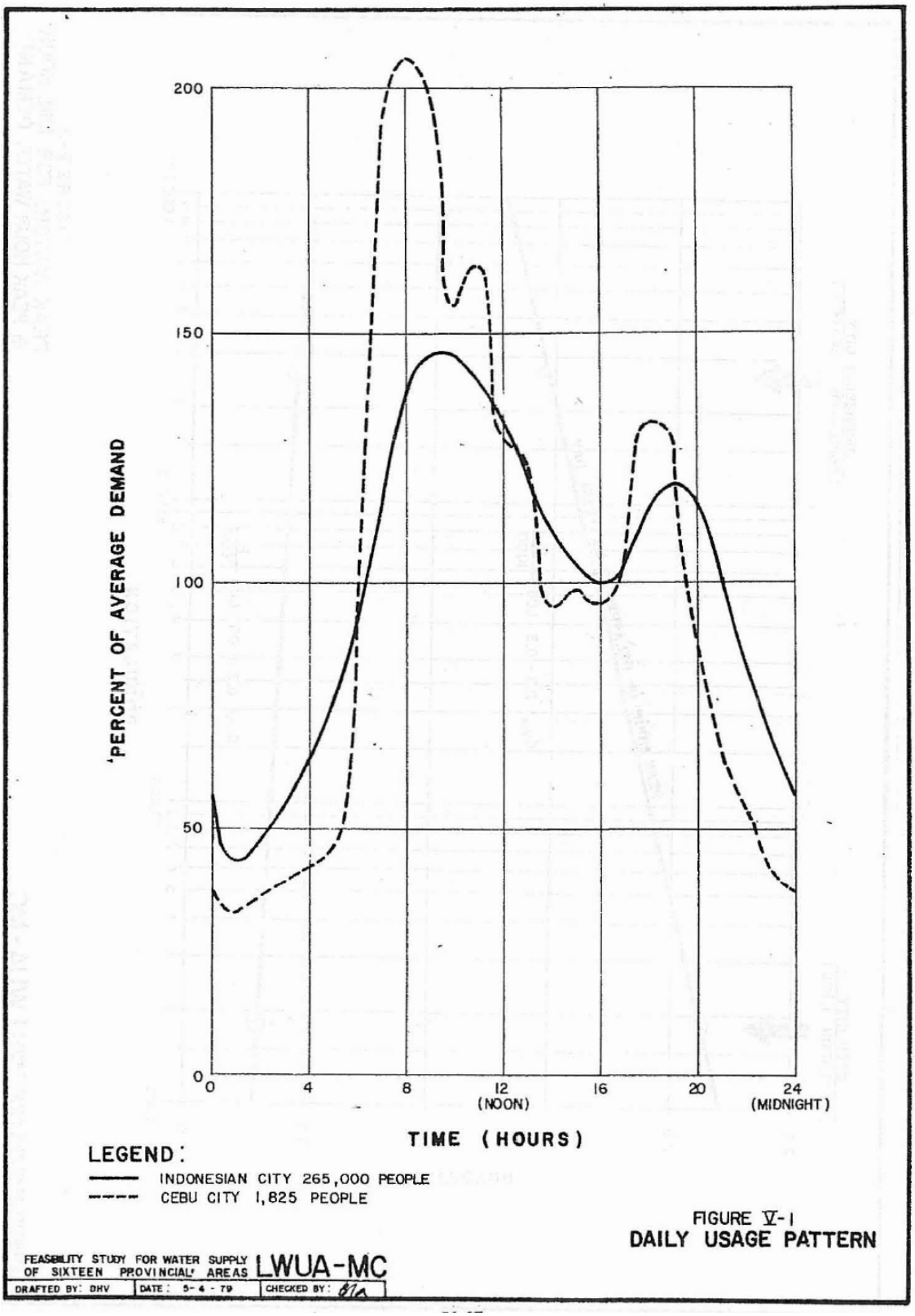
Project	Target Year	Service Area	Water Source/Construction of Distribution network	Construction Plan
SAPROF (prepared in 2005)	Phase 1: 2010	Service area covers entire CCC area, which is divided into two by provision of different water source. (1) Western part of the city (hilly area including KSA) (2) Eastern part of the city	KWSP 1 & Madunaghat WTPs Mohara & Kalurghat WYPs	- Plan of Madunaghat Phase 1 WTP - Expansion Plan of Mohara WTP
	Phase 2: 2020	(1) Western part of the city: Partial increase provided by additional supply from KWSP 2 (2) Eastern part of the city: Partial decrease, but almost same area as Phase 1	KWSP 1 & 2 and Madunaghat WTPs Mohara & Kalurghat WTPs	- Plan of KWSP 1& 2 and Madunaghat WTPs (Concerned projects were not decided) - Expansion Plan of Mohara WTP
KWSP 1	2010 (D/D started on May,2008)	The part of western service area of the city in SAPROF including highly populated and Halishahar areas. The area along western seashore is planned for next phase project.	- KWSP 1 and Madunaghat WTPs (same as Phase 1 SAPROF) - Construct main pipelines to connect to existing distribution network	-In 2008, Construction of Madunaghat Phase 1WTPs was planned financed by Italy (to be constructed in 2015), but the plan was canceled. Then,WB succeeded the project after project appraisal on May 2010. -Technical assistance by JICA (PANI) started in 2010.
KWSP 2	2030 (Preparatory Survey started on May 2012)	The KSA was identified to supply water from KWSP 1&2 WTPs, because the urgency to construct distribution pipelines to connect to main pipelines to be constructed by KWSP 1 and the delay of construction of Madunaghat WTP. The KSA is reduced from that in	-KWSP 1 & 2 WTPs -All distribution pipelines are to be newly constructed.	-Construction plan for Madunaghat WTP was postponed for long time -KSA was determined to establish self-contained water supply system.

CHAPTER 6

DISTRIBUTION SYSTEM

CHAPTER 6 DISTRIBUTION SYSTEM

6.2.1 Fluctuation Pattern of Hourly Water Use in Cirebon City, Indonesia and Philippines



6.2.2 Calculation of Battali Hill Reservoir

Caluculation of Reservoir Volume (Battali Hill)

1 Daily Maximum Demand 128,000 m3/d

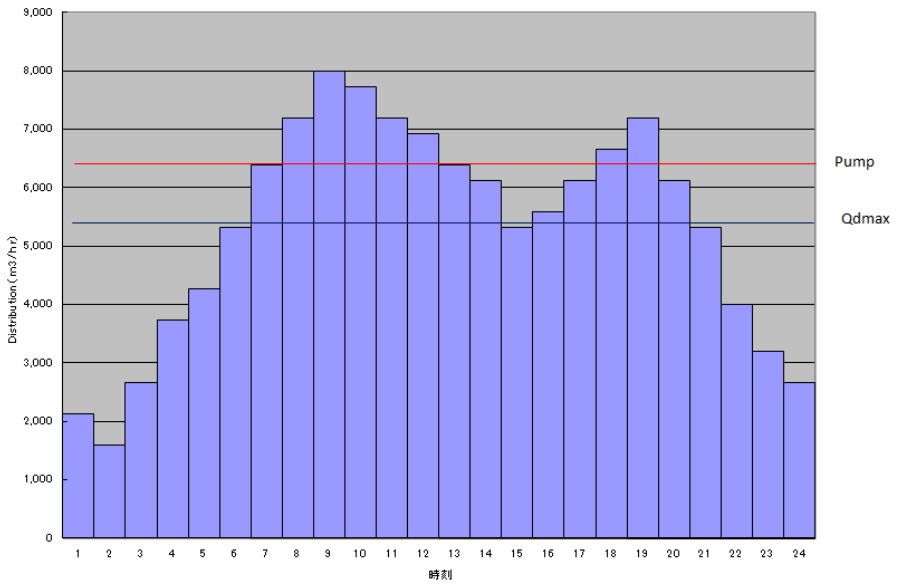
2 Hourly average distribution
128,000 m 3/d÷ 24 hr/d = 5,330 m3/hr

3 Pump 1.15 = 6,130 m3/hr

1.15 →1.2

Hourly fluctuation and Distribution

Hr	Fluctuation	WD (m3/hr) ①	Accum. WD Σ①	Hourly average distribution ②	Insufficient Volume ②-①	Cumulative Volume Σ(②-①)	Actual pump rate ③	Balance ③-①	Reserved Water Σ(③-①)	Number of Operation Pump
1	0.400	2,132	2,132	6,130	0	0	6,130	3,998	3,998	3
2	0.300	1,599	3,731	6,130	0	0	4,090	2,491	6,489	2
3	0.500	2,665	6,396	6,130	0	0	4,090	1,425	7,914	2
4	0.700	3,731	10,127	6,130	0	0	3,070	-661	7,253	1.5
5	0.800	4,264	14,391	6,130	0	0	4,090	-174	7,079	2
6	1.000	5,330	19,721	6,130	0	0	6,130	800	7,879	3
7	1.200	6,396	26,117	6,130	266	266	6,130	-266	7,613	3
8	1.350	7,196	33,313	6,130	1,066	1,332	6,130	-1,066	6,548	3
9	**1.500**	7,995	41,308	6,130	1,865	3,197	6,130	-1,865	4,683	3
10	1.450	7,729	49,036	6,130	1,599	4,795	6,130	-1,599	3,084	3
11	1.350	7,196	56,232	6,130	1,066	5,861	6,130	-1,066	2,019	3
12	1.300	6,929	63,161	6,130	799	6,660	6,130	-799	1,220	3
13	1.200	6,396	69,557	6,130	266	6,926	6,130	-266	954	3
14	1.150	6,130	75,686	6,130	0	6,926	6,130	1	954	3
15	1.000	5,330	81,016	6,130	0	6,926	6,130	800	1,754	3
16	1.050	5,597	86,613	6,130	0	6,926	6,130	534	2,288	3
17	1.150	6,130	92,742	6,130	0	6,926	6,130	1	2,288	3
18	1.250	6,663	99,405	6,130	533	7,458	6,130	-533	1,756	3
19	1.350	7,196	106,600	6,130	1,066	8,524	6,130	-1,066	690	3
20	1.150	6,130	112,730	6,130	0	8,524	6,130	1	691	3
21	1.000	5,330	118,060	6,130	0	8,524	6,130	800	1,491	3
22	0.750	3,998	122,057	6,130	0	8,524	3,070	-928	563	1.5
23	0.600	3,198	125,255	6,130	0	8,524	3,070	-128	435	1.5
24	0.500	2,665	127,920	6,130	0	8,524	2,250	-415	20	1.1
計	24.000	127,920			1.6	8,500	**127,940**			
		≒128,000			Volume (Phase-1) =	8,500				



CHAPTER 7

PRELIMINARY DESIGN OF THE WATER SUPPLY FACILITIES

CHAPTER 7 PRELIMINARY DESIGN OF THE WATER SUPPLY FACILITIES

7.7.1 Water Quality Test

Conditions on river water quality examination of Karnaphuli River near intake point are summarized in Table 7.5.1 (a)

Table 7.5.1 (a) Conditions for Water Quality Test

Item	Conditions	Remarks
Sampling Period	July 17th to Sep. 30th (Normally every Sunday, 10:00 – 14:00)	Total 15 times of sampling was executed
Sampling Point	3 points (right side, center line and left side of the river) just upstream of Godown Bridge	See Figure 7.5.1 (a) and 7.5.1 (b)
Parameter to be analyzed	• Turbidity • Electro-conductivity • water temperature	Turbidity and EC are measured at Mohara WTP Laboratory
Other meteorological data	• rain condition of sampling day and a few days before sampling day • Tide	

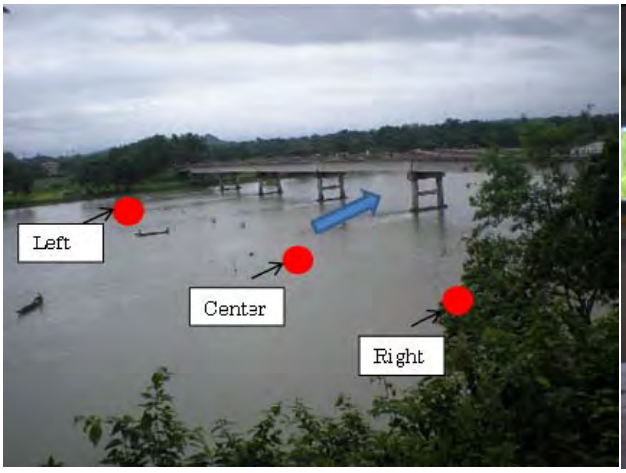


Figure 7.5.1 (a) Sampling Points

Figure 7.5.1 (b) Collected Samples

Water Quality Test results are summarized in Table 7.5.1 (b) to 7.5.1 (d) and the results of turbidity are presented in figure 7.5.1 (c). It is noted that turbidity in right side is much higher than that in left side only on June.24. About 3 km upstream of the intake point, a tributary joins to the main river at the right bank side. Turbidity of this tributary seemed to have affected to the main river by the heavy rain. This phenomenon occurred only in very heavy rain day, while other data show that turbidity is not different by the location of sampling point, right, left and center, in no-rain or not-heavy rainy days.

From the examination results, it is concluded that turbidity goes up over 200 during heavy rain, especially in case that rainy days have continued, while rain fall only in the sampling day does not affect to the turbidity so much.

Table 7.5.1 (b) Water Quality Test Results (1/3)

Sampling Date		17-Jun	24-Jun			28-Jun	1-Jul			8-Jul			17-Jul		
Sampling Time		10-40 am	1-10 pm			1-50 pm	11-00 am			10-40 am			11-00 am		
Rain Condition	Sampling Day	No Rain	Rain			No Rain	No Rain			No Rain			No Rain		
	FewDay Ago	Rain	Heavy Rain			Heavy Rain	Heavy Rain			Rain			Rain		
Tidal Condition		Medium	High			Medium	Medium			Low			Low		
Location		Center	Right	Center	Left	Center	Right	Center	Left	Right	Center	Left	Right	Center	Left
Turbidity (NTU)		80.0	380.0	290.0	220.0	124.0	200.0	186.0	220.0	92.0	87.0	80.0	40.0	44.0	50.0
Electro Conductivity (EC)μS/cm		112.3	94.3	81.5	84.4	119.9	103.1	104.3	104.2	100.0	97.0	95.2	94.2	92.2	90.6
Water Temperature (0°)		27.0	29.0	28.5	29.0	30.0	24.6	24.4	26.4	29.3	29.1	29.3	28.5	28.0	28.0
Date of Test		17-Jun	27-Jun			28-Jun	1-Jul			8-Jul			17-Jul		

Table 7.5.1 (c) Water Quality Test Results (2/3)

Sampling Date		22-Jul			29-Jul			5-Aug			12-Aug			4-Sep		
Sampling Time		10-40 am			11-00 am			10-30 am			10-40 am			11-30 am		
Rain Condition	Sampling Day	No Rain			No Rain			No Rain			Rain			Rain		
	Few Day Ago	Rain			Rain			Rain			Rain			No Rain		
Tidal Condition		Low			Low			Low			High			Low		
Location		Right	Center	Left	Right	Center	Left	Right	Center	Left	Right	Center	Left	Right	Center	Left
Turbidity (NTU)		36.0	32.0	43.0	22.0	24.0	34.0	16.0	18.0	20.0	190.0	230.0	180.0	80.0	40.0	60.0
Electro Conductivity (EC)μS/cm		92.0	106.0	90.0	95.4	86.8	93.4	93.9	88.9	96.4	105.8	91.0	93.8	107.7	108.9	105.9
Water Temperature		28.5	28.5	28.5	28.5	28.5	28.0	28.6	28.4	28.4	25.9	26.0	25.9	27.5	28.3	28.0
Date of Test		22-Jul			29-Jul			5-Aug			12-Aug			4-Sep		

Table 7.5.1 (d) Water Quality Test Results (3/3)

Sampling Date		9-Sep			16-Sep			24-Sep			30-Sep		
Sampling Time		10-50 am			10-30 am			10-40 am			10-30 am		
Rain Condition	Sampling Day	No Rain			No Rain			Rain			No Rain		
	FewDay Ago	No Rain			No Rain			No Rain			No Rain		
Tidal Condition		Low			Low			Low			Low		
Location		Right	Center	Left	Right	Center	Left	Right	Center	Left	Right	Center	Left
Turbidity (NTU)		50.0	35.0	40.0	24.0	24.0	25.0	22.0	18.0	20.0	20.0	18.0	18.0
Electro Conductivity (EC)μS/cm		91.0	88.2	72.0	103.5	99.9	97.9	108.4	103.5	103.1	101.3	101.5	102.1
Water Temperature		28.5	27.5	28.3	28.1	28.3	28.5	28.6	28.4	28.3	27.8	28.0	28.5
Date of Test		9-Sep			16-Sep			24-Sep			30-Sep		

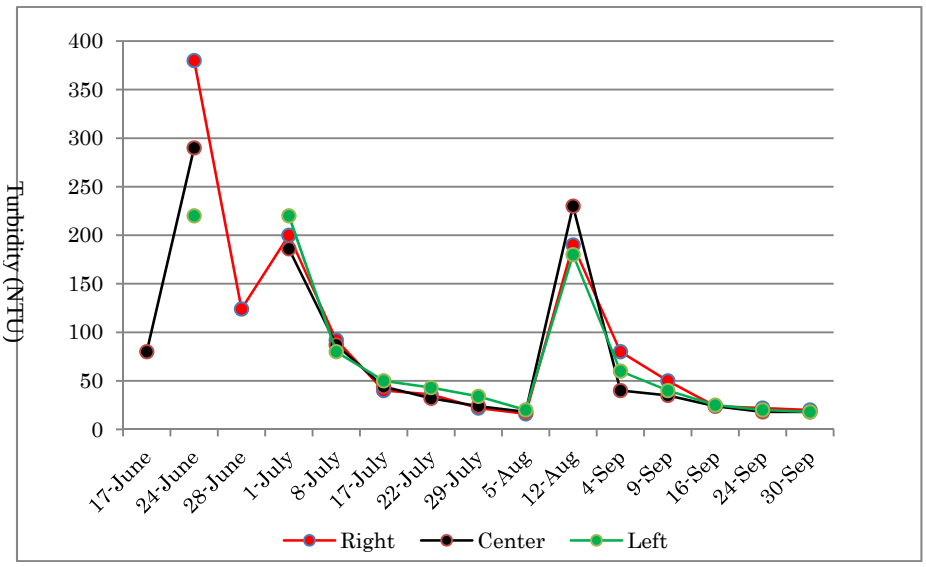
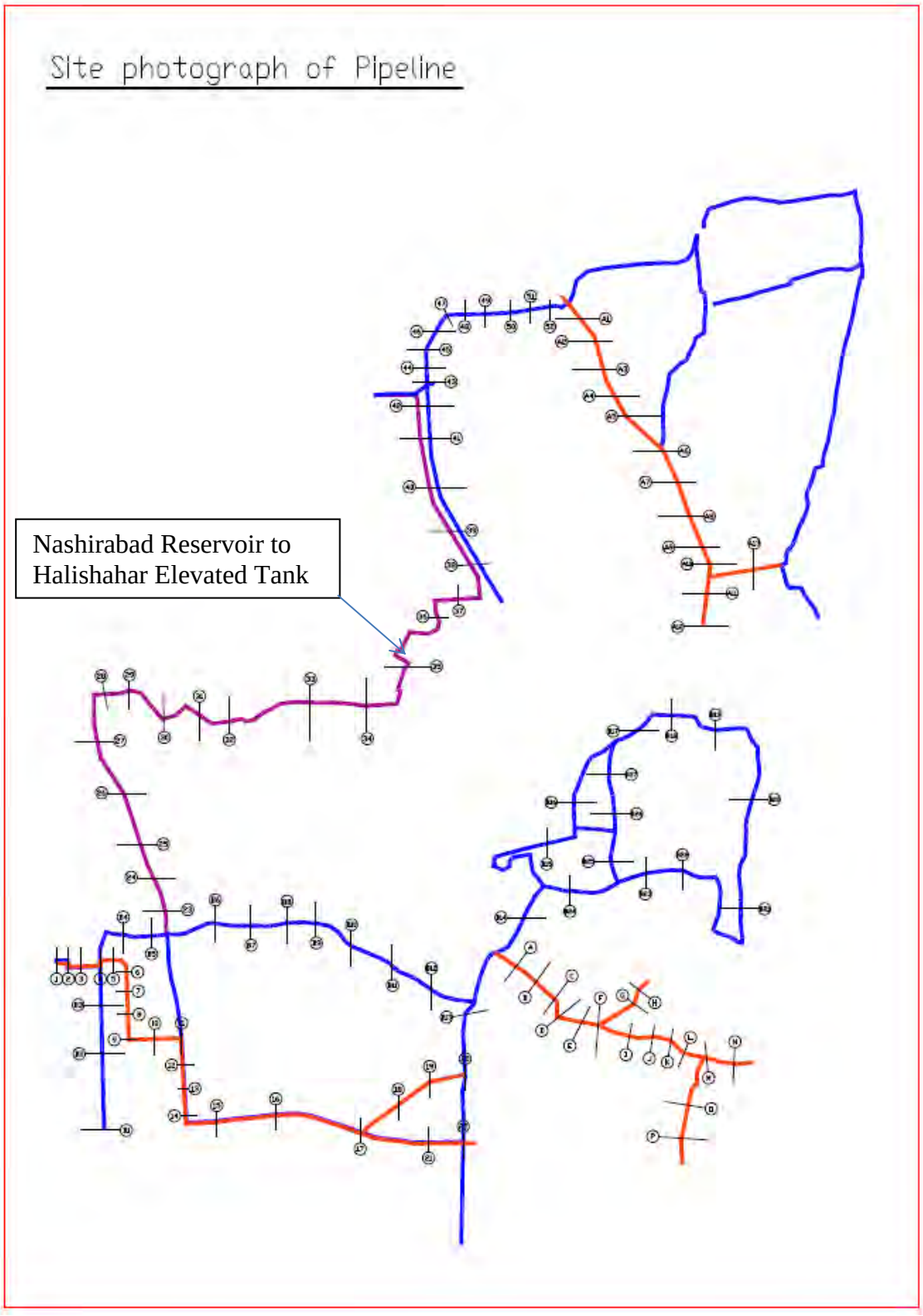


Figure 7.5.1 (c) Turbidity Test Results

The turbidity of Karnaphuli River is much lower than that of Halda River from which Mohara WTP takes water. Pre-sedimentation basin is used at the WTP intermittently during rainy season. In this regard, pre-sedimentation basin designed for Phase 1 can be commonly used for both Phase 1 and 2.

7.8.1 Route Conditions from Nashirabad Reservoir to Halishahar Elevated Tank



Chittagong Polytechnic Institute to Bayezid Bostami main road up to the KDS steel. No. of photographs have been taken on Purple colour pipe line route from 23 to 42.

It is also mention here that Alongkar circle RHD main road to A.K.Khan road circle, road pavement width is (15.00m+15.00m) & road shoulder is (3.00m+ 3.00m) approximately. i,e, Right of Way is 36.00m approximately.
From A .K .Khan road circle to USTC(University of Science & Technology, Chittagong) Chittagong Veterinary & Animal Science university gate to Rail gate, pavement width is 10.00m & shoulder is (2.00m+2.00m) approximately. So total Right of Way is 14.00m approximately.

Start from Rail gate to Chittagong Polytechnic Institute to Bayezid Bostami main road, pavement width is 6.00m & shoulder is (2.00m+2.00m) approximately. So total Right of Way is 10.00m approximately
From Bayezid Bostami main road up to the KDS steel. , pavement width is (6.00m+6.00m) & road shoulder is (3.00m+ 3.00m) approximately. i,e, Right of Way is 18.00m approximately.

Purple colour pipe line route photograph no. is 23 to 42 given below:

Photo-23

Photo-24

Photo-25

Photo-26

Photo-27

Photo-28

Photo 29

Photo-30

Photo-31

Photo-32

Photo-33

Photo-34

Photo-35

Photo-36

Photo-37

Photo-38

Photo-39

Photo-40

Photo-41

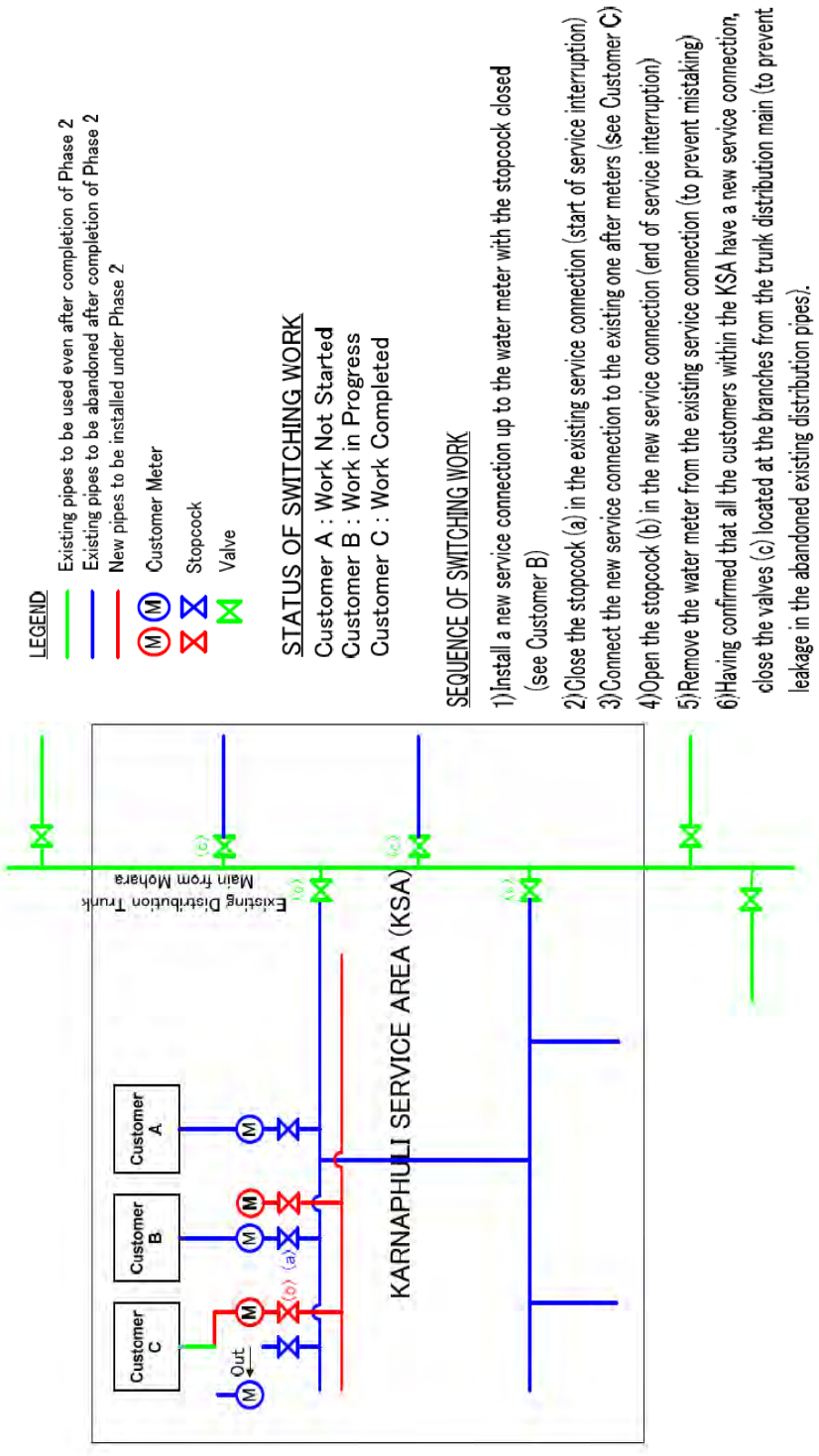
Photo-42

CHAPTER 8

CONSTRUCTION PLAN OF WATER SUPPLY FACILITIES

CHAPTER 8 CONSTRUCTION PLAN OF WATER SUPPLY FACILITIES

8.5.3 Manner of Connection of Pipes between CWASA Pipe and Private Pipe



CHAPTER 10

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

CHAPTER 10 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

10.1.1 Standard for Inland Surface Water

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

Note:

1) In water used for fish culture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.
2) Electrical conductivity for irrigation water – 2250 μ mho ms/cm (at a temperature of 25°C); Sodium less than 26%; boron less than 0.2%.

Source: Schedule -3 (A) of Environmental Conservation Rules, 1997

10.1.2 Standard for Drinking Water

Parameter	Unit	Standards	Parameter	Unit	Standards
1. Aluminum	mg/L	0.2	26. Hardness (as $CaCO_3$)	mg/L	200 – 500
2. Ammonia (NH3)	mg/L	0.5	27. Iron	mg/L	0.3 – 1.0
3. Arsenic	mg/L	0.05	28. Kjeldhl Nitrogen (total)	mg/L	1
4. Balium	mg/L	0.01	29. Lead	mg/L	0.05
5. Benzene	mg/L	0.01	30. Magnesium	mg/L	30 – 35
6. BOD_5 20°C	mg/L	0.2	31. Manganese	mg/L	0.1
7. Boron	mg/L	1.0	32. Mercury	mg/L	0.001
8. Cadmium	mg/L	0.005	31. Manganese	mg/L	0.1
9. Calcium	mg/L	75	32. Mercury	mg/L	0.001
10. Chloride	mg/L	150-600*	33. Nickel	mg/L	0.1
11. Chlorinated alkanes			34. Nitrate	mg/L	10
carbontetrachloride	mg/L	0.01	35. Nitrite	mg/L	<1
1.1 dichloroethylene	mg/L	0.001	36. Odor	mg/L	Odorless
1.2 dichloroethylene	mg/L	0.03	37. Oil and grease	mg/L	0.01
tetrachloroethylene		0.03	38. pH	-	6.5-8.5
trichloroethylene		0.09	39. Phenolic compounds	mg/L	0.002
12. Chlorinated phenols			40. Phosphate	mg/L	6
pentachlorophenol	mg/L	0.03	41. Phosphorus	mg/L	0
2.4.6 trichlorophenol	mg/L	0.03	42. Potassium	mg/L	12
13. Chlorine (residual)	mg/L	0.2	43. Radioactive materials (gross alpha activity)	Bq/L	0.01
14. Chloroform	mg/L	0.09	44. Radioactive materials (gross beta activity)	Bq/L	0.1
15.Chromium (hexavalent)	mg/L	0.05	45. Selenium	mg/L	0.01
16. Chromium (total)	mg/L	0.05	46. Silver	mg/L	0.02
17. COD	mg/L	,, 4	47. Sodium	mg/L	200
18. Coliform (fecal)	n/100ml	0	48. Suspended particulate matters	mg/L	10
19. Coliform (total)	n/100 ml	0	49. Sufide	mg/L	0
20. Color	Hazen unit	15	50. Sulfate	mg/L	400
21. Copper	mg/L	1	51. Total dissolved solids	mg/L	1000
22. Cyanide	Mg/L	0.1	52. Temperature	°C	20-30
23. Detergents	mg/L	0.2	53. Tin	mg/L	2
24. DO	mg/L	6	54. Turbidity	JTU	10
25. Fluoride	mg/L	1	55. Zinc	mg/L	5

*In coastal area 1000. Reference: Bangladesh Gazette, Addendum, August 28, 1997
Source: Schedule -3 (B) of Environmental Conservation Rules, 1997

10.1.3 Standards for Ambient Air Quality

Unit: Microgram/m^3

Sl. No.	Area	Suspended Particulate Matters (SPM)	Sulfur Dioxide (SO_2)	Carbon Monoxide (CO)	Oxides of Nitrogen (NOx)
a.	Industrial and mixed	500	120	5000	100
b.	Commercial and mixed	400	100	5000	100
c.	Residential and rural	200	80	2000	80
d.	Sensitive	100	30	1000	30

Notes:

1) At national level, sensitive area includes monuments, health center, hospital, archaeological site, educational institution, and government designated areas (if any).
2) Industrial units located in areas not designated as industrial areas shall not discharge pollutants which may contribute to exceeding the standard for air surrounding the areas specified at Sl. nos. c and d above.
3) Suspended Particulate Matter means airborne particles of a diameter of 10 micron or less.
4) Source: Schedule – 2 of Environmental Conservation Rules, 1997

10.1.4 Standards for Sound (Noise)

SI. No.	Area Category	Standards Values (all values in dBA)	
		Day	Night
a.	Silent zone	45	35
b.	Residential area	50	40
c.	Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60	50
d.	Commercial area	70	60
e.	Industrial area	75	70

Note:

1) Daytime is reckoned as the time between 6 a.m. to 9 p.m.
2) Night time is reckoned as the time between 9 p.m. to 6 a.m.
3) Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited

Source: Schedule – 4 of Environmental Conservation Rules, 1997

10.1.5 Standards for Odor

Parameters	Unit	Values
Acetaldehyde	ppm	0.5-5
Ammonia	ppm	1-5
Hydrogen Sulfide	ppm	0.02-0.2
Methyl Disulfide	ppm	0.009-0.1
Methyl Sulfide	ppm	0.01-0.2
Styrene	ppm	0.4-2.0
Trimethylamine	ppm	0.005-0.07

Note:

1) Regulatory standards at emission/discharge outlets (apply to those outlets which are higher than 5 meters): $Q = 0.108 \times He^2$ cm, Where Q – gas emission rate (Nm^3/hour), He – effective height of the outlet (m), Cm – above mentioned standard (ppm)
2) Where there is a range given for a parameter, the lower value will be used for warning and the higher value for initiation of legal procedure or punitive measures.

Source: Schedule – 8 of Environmental Conservation Rules, 1997

10.1.6 Standards for Sewage Discharge

Parameters	Unit	Values
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended Solids (SS)	mg/l	100
Temperature	^{o}C	30
Coliforms	number/100ml	1000

Note:

1) This limit shall be applicable to discharges into surface and inland waters bodies.
2) Chlorination is to be done before final discharge

Source: Schedule - 9 of Environmental Conservation Rules, 1997

10.1.7 Standards for Industrial and Project Effluent

Sl. No.	Parameters	Unit	Discharge To		
			Inland Surface Water	Public sewerage system connected to treatment at second stage	Irrigated Land
1	Ammonical nitrogen (as elementary N)	mg/l	50	75	75
2	Ammonia (as free ammonia)	mg/l	5	5	15
3	Arsenic (as As)	mg/l	0.2	0.05	0.2
4	BOD_5 at 20^{o}C	mg/l	50	250	100
5	Boron	mg/l	2	2	2
6	Cadmium (as Cd)	mg/l	0.05	0.5	0.5
7	Chloride	mg/l	600	600	600
8	Chromium (as total Cr)	mg/l	0.5	1.0	1.0
9	COD	mg/l	200	400	400
10	Chromium (as hexavalent Cr)	mg/l	0.1	1.0	1.0
11	Copper (as Cu)	mg/l	0.5	3.0	3.0
12	Dissolved oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
13	Electro-conductivity (EC)	µsiemens /cm	1200	1200	1200
14	Total dissolved solids	mg/l	2100	2100	2100
15	Fluoride (as F)	mg/l	2	15	10
16	Sulfide (as S)	mg/l	1	2	2
17	Iron (as Fe)	mg/l	2	2	2
18	Total Kjeldahl nitrogen (as N)	mg/l	100	100	100
19	Lead (as Pb)	mg/l	0.1	1	0.1
20	Manganese (as Mn)	mg/l	5	5	5
21	Mercury (as Hg)	mg/l	0.01	0.01	0.01
22	Nickel (as Ni)	mg/l	1.0	2.0	1.0
23	Nitrate (as elementary N)	mg/l	10.0	Not yet set	10

Sl. No.	Parameters	Unit	Discharge To		
			Inland Surface Water	Public sewerage system connected to treatment at second stage	Irrigated Land
24	Oil and grease	mg/l	10	20	10
25	Phenolic compounds (as C_6H_5OH)	mg/l	1.0	5	1
26	Dissolved phosphorus (as P)	mg/l	8	8	15
27	Radioactive substance	(to be specified by Bangladesh Atomic Energy Commission)			
28	PH		6-9	6-9	6-9
29	Selenium (as Se)	mg/l	0.05	0.05	0.05
30	Zinc (as Zn)	mg/l	5	10	10
31	Total dissolved solids	mg/l	2100	2100	2100
32	Temperature	^oC (summer) ^oC (winter)	40 45	40 45	40 45
33	Suspended solids	mg/l	150	500	200
34	Cyanide	mg/l	0.1	2.0	0.2

Note:

1) These standards shall be applicable to all industries or projects other than those specified under the heading "Standards for sector-wise industrial effluent or emission."
2) Compliance with these standards shall be ensured from the moment an industrial unit starts trial production, and in other cases, from the moment a project starts operation.
3) These standards shall be inviolable even in case of any sample collected instantly at any point of time. These standards may be enforced in a more stringent manner if considered necessary in view of the environmental conditions of a particular situation.
4) Inland Surface Water means drains/ponds/tanks/water bodies/ ditches, canals, rivers, springs and estuaries.
5) Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
6) Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.
7) Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes 5 and 6 above.
8) Source: Schedule - 10 of Environmental Conservation Rules, 1997

10.1.8 Standards for Gaseous Emission from Industries or Projects

Sn. No.	Parameters	Values (in mg/Nm^3)
1	Particulates (a) Power station of capacity of 200 MW or more (b) Power station of capacity of less than 200 MW	 150 350
2	Chlorine	150
3	Hydrochloric acid vapor and mist	350
4	Total fluoride (as F)	25

Sn. No.	Parameters	Values (in mg/Nm^3)
5	Sulfuric acid mist	50
6	Lead particulates	50
7	Mercury particulates	10
8	Sulfur dioxide (a) Sulfuric acid production (DCDA* process) (b) Sulfuric acid production (SCSA* process) (* DCDA : Double conversion, double absorption, SCSA : Single conversion single absorption) Lowest height of stack for sulfur dioxide dispersion : (a) Coal based power plant (1) 500 MW or more (2) 200 MW – 500 MW (3) Less than 200 MW (b) Boiler (1) Steam per hour – up to 15 tons (2) Steam per hour – more than 15 tons (Q = SO_2 emission in kg/hour)	kg/ton acid 4 100 275 m 220m $14(Q)^{0.3}$ 11m $14(Q)^{0.3}$
9	Oxides of nitrogen (a) Nitric acid production (b) Gas based power stations 500 MW or more 200 – 500 MW Less than 200 MW (c) Metallurgical oven	 3 kg/ton acid 50 ppm 50 ppm 40 ppm 30 ppm 200 ppm
10	Kiln soot and dust (a) Blast furnace (b) Brick kiln (c) Coke oven (d) Lime kiln	Mg/Nm^3 500 1000 500 250

Source: Schedule - 11 of Environmental Conservation Rules, 1997

10.1.9 Standards for Sound originating from Motor Vehicles or Mechanized Vessels

Category of Vehicles	Unit	Standards	Remarks
Motor Vehicles* (all types)	dBA	85	As measured at a distance of 7.5 meters from exhaust pipe.
		100	As measured at a distance of 0.5 meter from exhaust pipe.
Mechanized Vessels	dBA	85	As measured at a distance of 7.5 meters from the vessel which is not in motion, not loaded and is at two thirds of its maximum rotating speed.
		100	As measured at a distance of 0.5 meter from the vessel which is in the same condition as above.

Note: *At the time of taking measurement, the motor vehicle shall not be in motion and its engine conditions shall be as follows:

1) Diesel engine – maximum rotating speed.

2) Gasoline engine –at two thirds of its maximum rotating speed and without any load.
3) Motorcycle – If maximum rotating speed is above 5000 rpm; two-thirds of the speed, and if maximum rotating speed is less than 5000 rpm, three-fourth of the speed.

Source: Schedule - 5 of Environmental Conservation Rules, 1997

10.1.10 Standards of Emission from Motor Vehicles

Parameter	Unit	Standard Limit
Black Smoke	Hartridge Smoke Unit (HSU)	65
Carbon Monoxide	gm/k.m.	24
	percent area	4
Hydrocarbon	gm/k.m.	2
	Ppm	180
Oxides of Nitrogen	gm/k.m.	2
	Ppm	600

Note: As measured at two-thirds of maximum rotating speed.
Source: Schedule - 6 of Environmental Conservation Rules, 1997

10.2.1 Environmental Clearance

Environmental Site Certificate (rewritten from copy of original letter from DOE to CWASA. Note that in rewritten version (i) abbreviations have been used in some cases and (ii) text in italics added for clarity in terms of content of IEE report that was submitted as part of the Application.)

Government of the People's Republic of Bangladesh
Department of Environment www.doe-bd.org
Head Office, Paribesh Bhaban, E-16 Agargaon, Dhaka-1207

Memo No: DoE/Clearance/2225/2005/75
Date: 9-01-2006
Subject: Environment Site Clearance for Karnaphulli Water Supply Project.
Ref: Your Application dated 04/12/2005

With reference to the above, the Department of Environment (DOE) is pleased to award the Environmental Site Clearance in favor of Karnaphuli Water Supply Project subject to fulfilling the following terms and conditions.

1. This clearance shall only be applicable for the infrastructure of the said project.
2. Chittagong Water Supply and Sewerage Authority (CWASA) shall submit a comprehensive Environmental Impact Assessment (EIA) report considering the overall activity of the said Project in accordance with the TOR and time schedule submitted to the Department of Environment (DOE).
3. The EIA shall incorporate the following components/items in addition to the issues mentioned in the proposed TOR for EIA.
   a) In section 4.0 *(Chapter 4 Description of Existing Environment in IEE Report)* detail description of the land cover/land use with all the existing resource classes along with area coverage shall be shown in the respective maps derives from updated image of proper spatial and spectral resolution including name of satellite, date and time of acquisition with atmospheric condition, etc.
   b) Refer to section4.1; Physical Environment-Data pertaining to ambient water quality (surface as well as ground), ambient air quality and soil quality of the project area shall be included as updated and in detail. (*No data regarding ambient quality of air, water and noise were included.)*
   c) Refer to Section-7; Identification of potential impacts should be replaced with Identification and Analysis of Potential impacts; The Analysis part shall include the analysis of relevant spatial and non-special data. The outcome of the analysis shall be presented with scenarios, models, maps, graphics etc. for the cases of anticipated impacts on baseline environment as specified in section 4.1 through 4.3. Description of the project on air, water, land, vegetation-man made or natural, wildlife, socio-economic aspect shall be incorporated in detail for the project.
   d) There shall be new section on "Analysis and Description of the Mitigation measures" to be arranged in accordance with the adverse impacts for the interventions as identified in previous section.
   e) Specific formats for environmental monitoring shall be included under proposed chapter 8.0.
4. Without approval of EIA report by the Department of Environment, Chittagong Water Supply and Sewerage Authority (CWASA) shall not be able to open L/C in favor of importable machineries.
5. Without obtaining Environmental Clearance, CWASA shall not be to start the physical activity of the project.
6. Rehabilitation or compensation for any sort of activity that will incur damage or loss of public or private property shall be addressed as per Government of Bangladesh rules and regulation.
7. No activity of cutting/razing/dressing of hill or hilly land is endorsed without permission/clearance of the concerned authority of the government.
8. Appropriate permission would be required to obtain from the forest department in favor of cutting/felling of any plant/sapling forested by individual or government before doing such type of activity.
9. CWASA shall submit the EIA to the divisional office of DOE in Chittagong along with a filled-in ap-

plication for Environmental Clearance in prescribed form, the feasibility report. The No Objection Certificates (NOCs) from the local authorities. NOC from forest department (if is required in case of cutting any forested plant/trees-private or public) and NOC in favor of cutting Dressing (if it is required) of Hill/Hillock from the concerned authority.

10. A soft copy of the image data as well as the maps to be generated from the image shall be submitted to DOE Head Office along with the EIA.
11. This clearance is valid for one year from the date of issuance and CWASA shall apply for renewed to the Chittagong Divisional Office of DOE at Chittagong with a copy to Head Office at least 30 days ahead of expiry.

(Sign) **Syed Nazmul Ahsam**
Research Officer and Member Secretary, Environmental Clearance Committee

Mr. Maksumul Hakim Chaudhury
Chairman, Chittagong WASA,
WASA Office Building, Dampara, Chittagong

Copy Forwarded to:

1) The Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka
2) Director, Department of Environment, Chittagong Division, Chittagong
3) Staff Officer to the Director General, Department of Environment, Head Office, Dhaka

10.2.2 Approval of Environmental Impact Assessment (EIA) Report on Karnaphuli Water Supply Project (rewritten from copy of original letter from DOE to CWASA)

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, E-16 Agargaon
Dhaka-1207

Memo No:DOE/Clearance/2225/2005/2416 Date:13/09/2007

Subject: Approval of Environmental Impact Assessment (EIA) Report on Karnaphulli Water Supply Project

Ref: 1) Your application on 14/03/2006

With reference to the above, the Department of Environment (DOE) hereby approves Environmental Impact Assessment Report on **Karnaphulli Water Supply Project**, Chittagong. This approval authorizes and regulates the following activities:

1. Project Proponent may undertake activities for land development and infrastructural development of the project subject to conditions laid out in the Site Clearance issued from the Department of Environment on 09 January 2006 as well as the following:

1.1 During site preparation, top soil shall be kept aside and be restored after completion of the said activities.

1.2 The open areas that are grasslands can be used for construction but with appropriate safeguards to maintain materials and dump sites from contaminating haor/river waters.

1.3 Soil erosion caused by removal of vegetation cover and excavated loose soil shall be checked through repopulation with local vegetation as soon as possible; loose soil shall be covered and stored away from the edge of the haor/river.

1.4 Proper construction practices shall be followed that minimize loss of habitats and fish breeding, feeding & nursery sites.

1.5 Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project period.

1.6 In order to control noise pollution, vehicles & equipment shall be maintained regularly; working during sensitive hours and locating machinery close to sensitive receptors shall be avoided.

1.7 No solid waste can be burnt in the project area. An environment friendly solid waste management should be in place during whole the period of the project in the field.

1.8 Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora and fauna would be demolished or destructed.

1.9 All the required mitigation measures suggested in the IEE and EIA reports along with the emergency response plan are to be strictly implemented and kept operative/ functioning on a continuous basis.

1.10 To control dust vehicles and equipment to be used for this project shall be maintained properly, water trucks shall be used, stockpiles to be located away from sensitive receptors and vehicle speed limits shall be enforced.

1.11 Resettlement plan should be properly implemented and people should be adequately compensated, where necessary.

1.12 Construction material should be properly disposed off after the construction work is over.

1.13 The Environmental management Plan included in the IEE and EIA reports shall strictly be implemented and kept functioning on a continuous basis.

2. **Limit Condition for Discharges to Air and Water**: The Site Clearance Certificate must comply with schedule 2 and 10, rule 12 of the Environment Conservation Rules, 1997.
3. **Noise Limit**: The Site Clearance Certificate must comply with schedule 4, rule 5(2) of the Noise Pollution (Control) Rules, 2006.
4. **Monitoring and Recording conditions**:

M1.1 The results of any monitoring required to be conducted by this Clearance Certificate must be recorded.

M1.2 The following records must be kept in respect of any samples required to be collected for the purpose of

this Clearance certificate:

(a) The date(s) on which the sample was taken;
(b) The time(s) at which the sample was collected;
(c) The point at which the sample was taken; and
(d) The name of the person who collected the sample.

M2. Requirement to monitor concentration of pollutants discharged

M2.1 For each monitoring, the Clearance Certificate holder must monitor (by sampling and obtaining results by analysis) the following parameter; water flow, water quality, air quality (SPM), the surrounding areas for spread of invasive species, the changes in aquatic habitats before, during and after construction, fish catching during and after construction.

5. Reporting Conditions: Environmental Monitoring Reports shall be made available simultaneously to Head Quarters and respective Divisional offices of the Department of Environment on a quarterly basis during the whole period of the project.
6. Notification of Environmental Harm: The Clearance Certificate holder or its employees must notify the Department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident.
7. Project Proponent may open L/C (Letter of Credit) for importing machineries for the project which shall also include machineries relating to pollution devices;
8. Before finalizing of the design of Karnaphulli Water Treatment Plant following water quality data should be updated:
   Spatial variability of water quality along the rivers Karnaphulli and Halda. Variables to be chosen for water quality analysis should include: temperature, TSS, TDS, turbidity, conductivity, pH, DO, hardness, nutrients (NH_4-N, NO_3-N), Phosphorus), organic matter (COD, BOD), major ions (Sodium, Potassium, Calcium, Manganese, Chloride, Sulphate, other inorganic variables (Fluoride, Boron, Cyanide), trace elements, heavy metals, Arsenic, Organic contaminants (oil and petroleum products, pesticides), faecal coliform and total coliform.
   Hydrodynamic and water quality models should be used by constructing different scenarios for production and quantification of the potential impacts on water quality.
9. Based on up-to-date water quality data, model out-put as well as other scientific study WTP should be designed, installed and operated.
10. Project Proponent shall, after installation of the plant as well as other pollution control facilities and equipment apply for Environmental Clearance Certificate without which, proponent shall not start operation of the project.

(Sign) Masud Iqbal Md. Shameem
Deputy Director (Technical, Current Charge) and Member Secretary
Environmental Clearance Committee

Md. Maksumul Hakim Chaudhury
Chairman, Chittagong WASA, WASA Office Building, Dampara, Chittagong

Copy Forwarded to:

1. PS to Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka
2. Staff Officer, Director General, Department of Environment, Dhaka

10.2.3 Correspondence between CWASA and DOE Chittagong (Environmental Site Clearance)

(1) Letter from CWASA to DOE Chittagong
(2) Responding letter from DOE Chittagong

চট্টগ্রাম পানি সরবরাহ ও পয়:নিষ্কাশন কর্তৃপক্ষ
Chittagong Water Supply & Sewerage Authority
WASA Office Building, Dampara, Chittagong, Bangladesh
ফোন: ৮৮০ ৩১ ২৮৫১৮০৬ ফেক্স: ০৩১ ৬১০৪৬৫ ইমেইল: cwasa@globalctg.net

Memo no. CWSIP/PD/01/12/01 Date: 05.07.2012

পরিবেশ অধিদপ্তর, চট্টগ্রাম বিভাগ
চিঠি গৃহীত
নংঃ.....
তারিখঃ.05/07/2012
স্বাক্ষরঃ.....
গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

Director
Department of Environment
Government of the People's Republic of Bangladesh
Chittagong Division, Chittagong.

Sub: **Environmental Site Clearance for Karnaphuli Water Supply Project of Chittagong WASA**

Ref: 1. DoE/Clearance/2225/2005/75 dt. 17.01.2005
2. DoE/Clearance/2225/2005/2416 dt. 13.09.2007

Dear Sir,

Thank you very much for issuance of Environmental Site Clearance and approval of Environmental Impact Assessment (EIA) report in time on Karnaphuli Water Supply Project as referenced above.

It is my pleasure to inform you that the work of Karnaphuli Water Supply Project, Phase-1 financed by JICA and GoB are progressing fast. In the mean time, JICA started processing to finance Phase-2 project. A preparatory survey team appointed by JICA for Phase-2 is now working to formulate the project. It is to be mentioned that Karnaphuli Water Supply Project Phase-1 and Phase-2 both are included in the approved Environmental Impact Assessment (EIA) report.

It is to be mentioned that inadvertently Environmental Site Clearance is not renewed in due course as per condition laid in it.

Now, we would like to regularize the Environmental Site Clearance along with other steps pending related to environmental issues.

Please let us know how we can proceed to regularize the renewal of Environmental Site Clearance along with other pending issues related to environment.

Photocopy of the Environmental Site Clearance and approval of Environmental Impact Assessment (EIA) report on Karnaphuli Water Supply Project are enclosed herewith for your ready reference.

Your kind coopcration in this regard will be highly appreciated.

Thanking you.

Yours truly,

(Jane Alam Bhuiyan)
Project Director (CWSIP)
Chittagong WASA

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ অধিদপ্তর, চট্টগ্রাম বিভাগীয় কার্যালয়
পরিবেশ ভবন
[illegible], চট্টগ্রাম-[illegible] ।
www.doe-bd.org

স্মারক নম্বর: [illegible]

তারিখ: [illegible] বঙ্গাব্দ / [illegible]/২০১২ খ্রিষ্টাব্দ

বিষয় : পরিবেশগত ছাড়পত্র নবায়নের বিষয়ে প্রয়োজনীয় কাগজপত্র দাখিল।

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১. [illegible]

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উপপরিচালক
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[illegible] ওয়াটার সাপ্লাই প্রজেক্ট
[illegible]
[illegible], চট্টগ্রাম

To
Chairman
CWSP
Chittagong WASA.

Sub: Submission of Necessary documents for Renual of Environmental site clearance

According to Environmental conservation Act. 1995 and 1997 you are hereby requested to Submit the following documents.

1. Renual fee 5,75,000 ~~tk~~

After receiving the above ~~documents for renewal~~ necessary action will be taken for Environmental clearance.

Deputy Director.
DOE/Chittagong

10.2.4 Renewal of Environmental Site Clearance Certificate for Karnaphuli Water Supply Project of Chittagong WASA

Government of the People's Republic of Bangladesh
Department of Environment
Chittagong Division
Zakir Hossain Road
Khulshi, Chittagong
www.doe-bd.org

Memo No: DoE/CD/Clearance-18343/2012/730 Date: 31/07/2012.

Subject : Renewal of Environmental Site Clearance Certificate for karnaphuli Water Supply Project of Chittagong WASA.

Reference: Application of karnaphuli Water Supply Project of Chittagong WASA. Date: 05/07/2012,

Reference to your above mentioned application on Environmental Site Clearance Certificate issued against the karnaphuli Water Supply Project, Chittagong WASA. hereby is renewed subject to fulfilling the following terms and conditions:

1. Renewal of the site clearance certificate will be valid for a period of 1(one) year with effect from 17th January 2012 to 16th January 2013.
2. No activity of cutting/razing/dressing of hill, helloes are favored with this renewal.
3. Must submit Environmental monitoring reports as mentioned in the article 5 of the approved EIA.
4. Application along with renewal fees must be submitted to this office prior to 30 days of the expiry of the certificate.

Beside this you will also abide by the terms and conditions mentioned in the original Site Clearance Certificate and approved EIA. Violation of any of the above mentioned terms and conditions shall render this renewal void.

Project Director (CWSIP)
karnaphuli Water Supply Project of
Chittagong WASA. Chittagong.

(Md. Zafar Alam)
Director
Phone: 659379

D:\LAGEAT\Renewal of Eng\EIA Forms.doc

10.2.5 Application of Environmental Site Clearance for Phase 2 Project

চট্টগ্রাম পানি সরবরাহ ও পয়:নিষ্কাশন কর্তৃপক্ষ
Chittagong Water Supply & Sewerage Authority
WASA Office Building, Dampara, Chittagong, Bangladesh
ফোন: ৮৮০ ৩১ ২৮৫১৮০৬ ফেক্স: ০৩১ ৬১০৪৬৫ ইমেইল: cwasa@globalctg.net

Memo no. CWSIP/PD/01/12/12 Date: 20.09.2012

Director
Department of Environment
Government of the People's Republic of Bangladesh
Chittagong Division, Chittagong.
Phone: 2566696

Sub: **Environmental Site Clearance for Karnaphuli Water Supply Project-Phase II of Ctg. WASA**

Ref: 1. DoE/Clearance/2225/2005/75 dt. 17.01.2005
2. পঅ/চবি/ছাড়পত্র-১৮৪৩/২০১২/৬৭৫ তাং ১২.০৭.২০১২
3. DoE/CD/Clearance-18343/2012/730 dt. 31.07.2012

Dear Sir,

Thank you for giving us time today in your office to discuss the issue of Environmental Site Clearance for Karnaphuli Water Supply Project- Phase II of Chittagong WASA and also for issuing the renewal of Environmental Site Clearance as per above ref. 3. We sincerely appreciate your support to this important water supply projects of Karnaphuli WSP-Phase I & II.

It is my pleasure to inform you that the work of Karnaphuli Water Supply Project, Phase-I financed by JICA and GoB are progressing fast. In the mean time, JICA started processing to finance Phase-2 project. A preparatory survey team appointed by JICA for Phase-II is now working to formulate the project and a high power fact finding mission is coming on September 24, 2012. It is to be mentioned that Karnaphuli Water Supply Project Phase-I and Phase-II both are mentioned in the approved Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) report as we have shown to you and the copy of which are enclosed herewith.

As per discussion we are preparing to submit necessary prescribed forms collected from your office to get Environmental Site Clearance for Karnaphuli WSP- Phase II including amount of fee for the clearance. But in the meantime it will be highly appreciated if you can provide us a response stating that this issue is in right track and that you have no objection to go ahead with the project. This will help us to convince the JICA fact finding mission to proceed further for the project funding requirements.

Your kind cooperation in this regard will be highly appreciated.

Thanking you.

Yours truly,

(Engr. A K M Fazlullah)
Managing Director
Chittagong WASA

10.2.6 Environmental Site Certification for Phase 2 Project

Government of the People's Republic of Bangladesh
Department of Environment
Chittagong Division
Zakir Hossain Road
Khulshi, Chittagong
www.doe-bd.org

Memo no. DoE/CD/Clearance-18343/12/872 Date: 20.09.2012

Sub: **Environmental Site Clearance for Karnaphuli Water Supply Project-Phase II of Ctg. WASA**

Ref: 1. CWSIP/PD/01/12/12 dt. 20.09.2012
2. DoE/CD/Clearance-18343/2012/730 dt. 31.07.2012

Reference to above-1 we have reviewed the issue and found that Karnaphuli Water Supply Project (KWSP) has got the Site Clearance Certificate (SCC) from Department of Environment on 17.01.2006 and that has been renewed and remain valid till 16.January 2013. During issuance of SCC the committee reviewed the Initial Environment Examination (IEE) and Environmental Impact Assessment (EIA) report of the said project. We have examined the IEE and EIA again and found that both documents were prepared covering the Phase-1 and Phase-2 of KWSP. Since the location of the both phases are same and situated side by side and covered by the IEE and EIA an extension of the site clearance certificate is required under Environment Conservation Act 1995 and Environment Conservation Rules 1997.

To expedite the SCC extension issue you are requested to furnish information in the prescribed formalong with requisite fees.

After getting the application we will be very prompt to issue the SCC.

Best regards.

20/9/2012

(Md. Zafar Alam)
Director
Phne: 659379

Managing Director
Chittagong WASA
WASA office Building
Dampara, Chittagong

10.2.7 Correspondence between CWASA and DOE Chittagong (Extension of Environmental Site Clearance)

(1) Letter from CWASA to DOE Chittagong

চট্টগ্রাম পানি সরবরাহ ও পয়ঃনিষ্কাশন কর্তৃপক্ষ
Chittagong Water Supply & Sewerage Authority
WASA Office Building, Dampara, Chittagong, Bangladesh
ফোন: ৮৮০ ৩১ ২৮৫১৮০৬ ফেক্স: ০৩১ ৬১০৪৬৫ ইমেইল: cwasa@globalctg.net

Memo no. CWSIP/PD/01/12/13 Date: 26.09.2012

Director
Department of Environment
Government of the People's Republic of Bangladesh
Chittagong Division, Chittagong.
Phone: 659379

Sub: **Extension of Environmental Site Clearance for Karnaphuli Water Supply Project-Phase II**

Ref: 1. DoE/CD/Clearance-18343/2012/872 dt. 20.09.2012
2. DoE/Clearance/2225/2005/75 dt. 17.01.2006
3. DoE/Clearance/2225/2005/2416 dt. 13.09.2007

Dear Sir,

Thank you for your letter under reference-1, in which you clearly pointed out the status of the Environmental Site Clearance for Karnaphuli Water Supply Project-Phase II. Currently visiting JICA fact find mission also appreciated your prompt action in response to our letter on the subject matter. In the light of your letter we are submitting herewith Form-3 duly filled in with necessary enclosures including fees (in the form of treasury chalan) for extension of the Environmental Site Clearance for Karnaphuli Water Supply Project-Phase II.

As scheduled, the JICA fact finding mission is with us since 24th instant to formulate the Karnaphuli Water Supply Project-Phase II. They will remain with us until 30th instant and expecting to get extension of Environmental Site Clearance for Karnaphuli Water Supply Project-Phase II.

It will be highly appreciated if you can issue the extension of Environmental Site Clearance for Karnaphuli Water Supply Project-Phase II during their presence in Chittagong WASA.

Thanking you.

Yours truly,

(Engr. A K M Fazlullah)
Managing Director

Enclo : 1. Treasury Chalan 4117/01 dt. 20.09.2012 Tk. 1,00,000/-
2. Approved EIA and IEE reports- 2 sets
3. Letter of issuance of approval for IEE and EIA report as mentioned in ref. 2 & 3- 2 nos.

(2) Letter from DOE Chittagong to CWASA

Government of the People's Republic of Bangladesh
Department of Environment ,Chittagong Division
Zakir Hossain Road, Khulshi, Chittagong
www.doe-bd.org

Memo No: DoE/CD/Clearance-18343/2012/ 4265 Date: 13 /11/2012.

Subject : Renewal of Site Clearance Certificate for Karnaphuli Water Supply Project (Phase I &II) of Chittagong WASA till January 2014.
Reference: CWSIP/PD/01/12/13, Date: 26/09/2012,

In Reference to your letter for the renewal of Site Clearance Certificate(SCC) issued against the Karnaphuli Water Supply Project(KWSP), Chittagong WASA, we have examined the Environment Impact Assessment (EIA) of the project submitted earlier. During the inception of the project EIA was carried out for the both phases of KWSP and the national Environmental Clearance Committee vide its memo no. DoE/Clearance/2225/2005/2416, dated: 13.09.2007 approved the said EIA. Considering the EIA the renewal of site clearance Site Clearance Certificate is also applicable for the second phase. The existing Site Clearance Certificate will expire on 16.01.2013 and as per EIA the clearance is meant for the both phase of the project. Hence for the convenience of the Project activities of the second phase the Site Clearance Certificate of KWSP, phase I&II is hereby renewed subject to fulfilling the following terms and conditions:

1. All the terms and conditions of the original Site Clearance Certificate issued on 17/01/2006, Memo No. DoE/Clearance/2225/2005/75 will remain unchanged and will be applicable for both phases of the KWSP.
2. Renewal of the site clearance certificate will be valid for a period of 1(one) year with effect from 17th January 2013 to 16th January 2014.
3. No activity of cutting/razing/dressing of hill or hilly land is endorsed without permission/ clearance of the concerned authority of the government. If any cutting/razing/dressing of hill is required a fresh permission/clearance will be required from DoE as per section 6(B) of Bangladesh Environment Conservation Act, 1995 (Amendment 2010).
4. Must submit Environmental monitoring reports as mentioned in the article 5 of the approved EIA.
5. Application along with renewal fees must be submitted to this office prior to 30 days of the expiry of the certificate.

Beside this all the terms and conditions mentioned in the original Site Clearance Certificate and approved EIA will be applicable mutatis mutandis. Violation of any of the above mentioned terms and conditions shall render this renewal void.

Project Director (CWSIP)
karnaphuli Water Supply Project
Chittagong WASA (Phase I&II).
Chittagong.

(Md. Zafar Alam)
Director
Phone: 659379

Memo No. DoE/CD/Clearance-18343/2012/ 4265 Date: 13 /11/2012.
Copy Forwarded to:
1. Director General, Department of Environment, Dhaka.
2. Office Copy.

(Md. Zafar Alam)
Director

10.3 Specific Environmental and Social Aspects in the Project site

10.3.1 Result and analysis of Socio-Economic Survey

(1) Report of Socio-Economic Survey

1. Background of the study

Chittagong is a commercial and industrial hub and a port city in southeastern Bangladesh. Built on the bank of the Karnaphuli River the city is home to Bangladesh's busiest sea port and has a population of 2.7 million in the administrative area of about 200 square kilometer. Today, Chittagong is one of the fastest growing cities in the world, in terms of population and economy. Such expansion is pressing pressure on utility services such as water, electricity, gas. Water supply service is thoroughly taken care of by Chittagong Water Supply and Sewerage Authority (CWASA), but its capacity is limited to only 48% (168,000 m^3/day) of water demand in the existing service area and an immediate action to cater for this water gap is deemed urgent task of CWASA.

CWASA has availed of the Japan's ODA Loan to expand supply capacity of construction of Karnaphuli Water Treatment Plan. In this regard the Preparatory Survey on Chittagong Water Supply Improvement Project (herein after referred to as PSCWSIP) is intended to augment production capacity of Karnaphuli Water Treatment Plant and to rehabilitate/expand the distribution network in Karnaphuli Service Area proposed in the PSCWSISP. Social survey including water service condition and willingness to pay for water tariff etc. is needed for judging the actual present condition of water supply, decision of service area of PSCWSIP, Economic and Financial analysis etc.

PSCWSIP has therefore decided engage services of local consultants to conduct the Social Survey at the expected Karnaphuli Service Block.

So as a response of it a social survey has been conducted in the defined area and outcome and findings of the survey have been demonstrated in the existing report.

2. Study Area

The proposed Area of the Social Survey is shown in following figure.

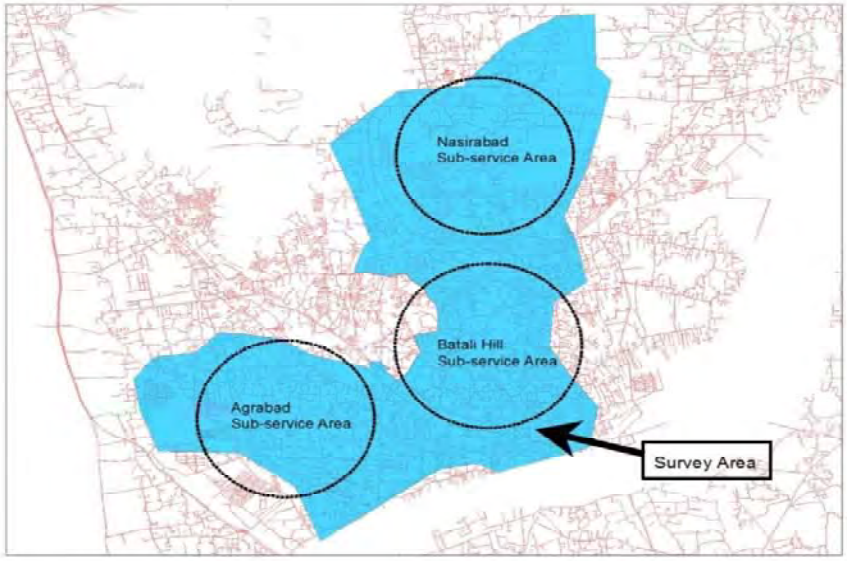


Figure 01: Study Area

3. Scope of Work

Numbers of Social Survey are described below

Land Use	Structure Type/Use Category	No. of Sample
Residential	Pucca	385
	Semi Pucca	312
	Kutcha/Slum	242
Industrial	Factory	9
Commercial	Office	23
	Hotel	11
	Restaurant	7
	Shop	11
Educational	High School	4
	Elementary School	9
	College / University	10
Community Service	Community	23
Total		1046

Table 01: Sample distribution

4. Methodology

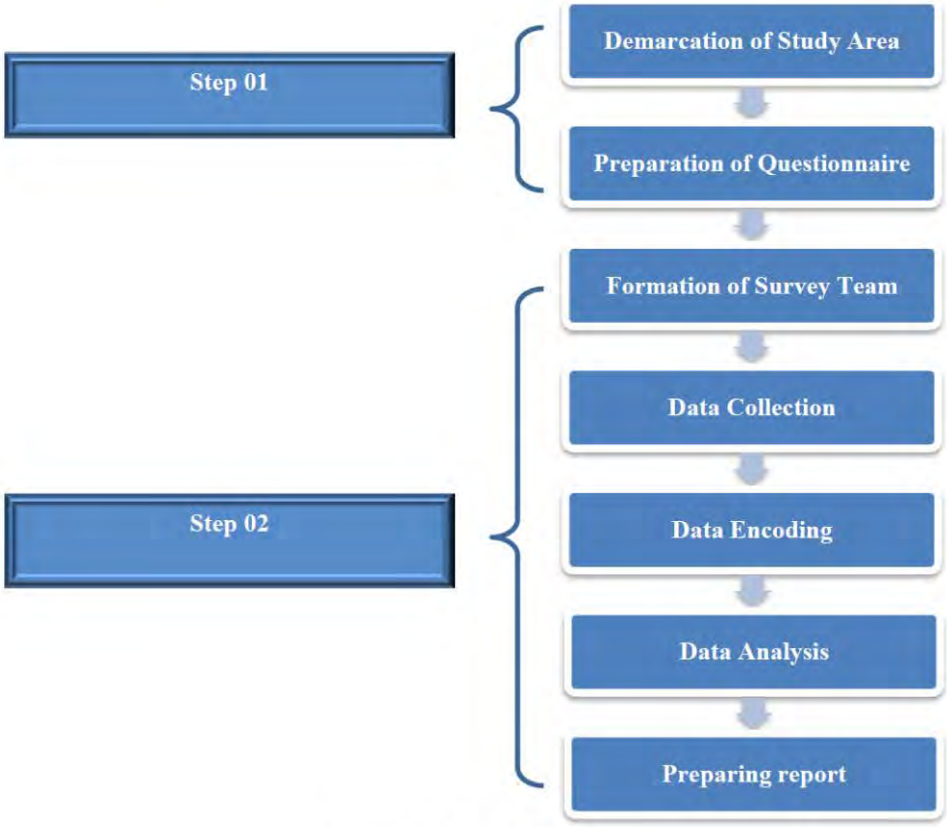


Figure 02: Methodology

Step 01:

In this step some preliminary work regarding social survey has done by PSCWSIP. Demarcations of study area which are illustrated in the study area are determined by the clients along with questionnaire which are given in ***Annex-01***.

Step 02:

This step is carried on by local consultants. In the following the different stages of step 02 are discussed.

Formulation of survey team: Survey teams have been formed including one female supervisor and 8 surveyors among them one was female. They were well trained and having previous experience of questionnaire survey

Data Collection: Data collection method was direct interview to the household head or any members of the household. Questionnaires were filled by the surveyors according to the response of interviewee. Some photos taken during data collection process are given in ***Annex-02.***

Data Encoding: Data encoding has done in using 'Microsoft Access'. A survey form has been created in access where data from a questionnaire are being documented. A picture of survey form in attached in ***Annex-03.*** With entry of each questionnaire in the survey form they get arranged in a table format in 'Microsoft Access'. After entry of all the data we get a total table where all the information's are arranged. A final table including all the data is given in ***Annex-04.***

Data Analysis: A final table then has analyzed using 'SPSS' a statistical software. Several tables has been created describing different aspects regarding income structure, water supply quality, availability of water supply, consumers' willingness to pay, drainage facility etc.

Preparing Report: A report has been prepared describing all the analysis using different chart, table using table created from 'SPSS' and detailing all the process regarding social survey activity.

5. Survey Findings:

According to the data collected from the survey there are several findings which are discussed under the following 7 categories.

1. Structure use
2. Economic Condition
3. Water supply condition
4. Consumer's expectation and willingness to pay
5. Sanitation and waste water disposal
6. Drainage Facility
7. Water Related Hygiene Conditions

5.1. Structure Use

Table 02 show the number of different category of structure use and their respective percentages which are surveyed.

From the table it can be easily seen that residential use is the dominant and it is almost 89.8% of the total surveyed household. Then community as same as office use is 2.2%, hotel and shop is 1.1% each, college is 1%, factory and elementary school are similar 0.9%. High school is lowest 0.4%.

Structure Use		
Type	**Number**	**Percent**
Residential	939	89.8
Hotel	11	1.1
High School	4	0.4
Shop	11	1.1
Factory	9	0.9
Community	23	2.2
Office	23	2.2
Restaurant	7	0.7
Elementary School	9	0.9
College / University	10	1.0
Total	**1046**	**100**

Table 02: Number of different structure use

Among the residential use there are there types of structure. In the following pie chart structure types are shown.

In the pie chart it shows that about 41% houses are pucca structure where semi pucca and kutcha houses are 33% and 26% respectively.

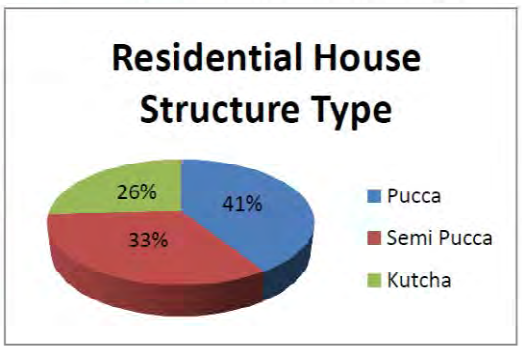


Chart 01: Residential House Built Type

5.2. Economic Condition

Source of income are mainly independent Business and Private Job. Almost 90% of the people in the study area are doing either independent business or private job. Very few amounts of people only 5% are engaged in Government job. Being a port city and for other infrastructure facility Chittagong city emerged as a commercial capital of the country. And this also affected the professional behavior of the inhabitants. Lots of factory and privatized industry, company play a vital for the economic stability of this reason.

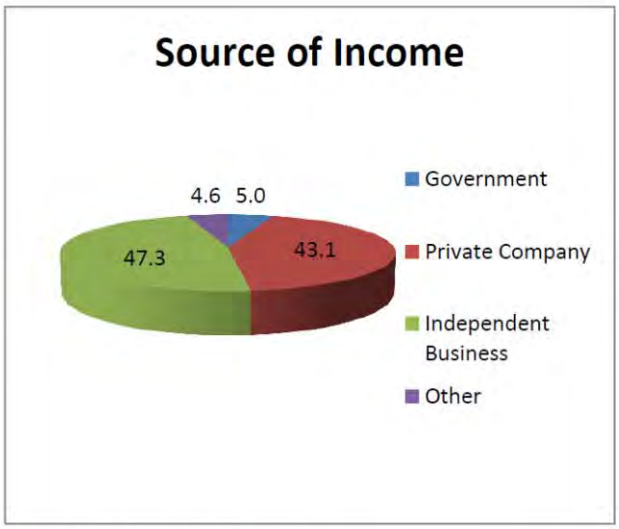


Chart 02: Source of Income

In the following monthly income chart is given to show the income distribution of the study area.

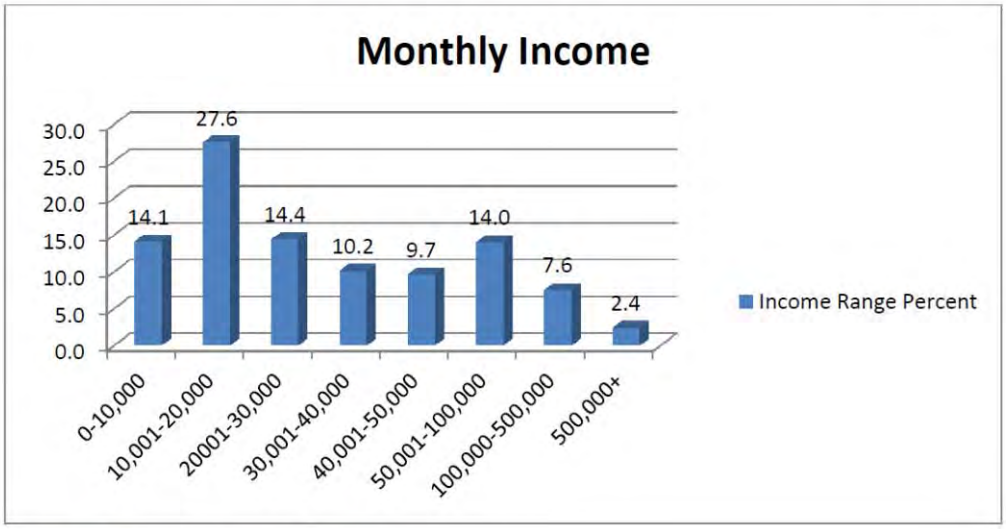


Chart 03: Monthly Income distribution

Almost 27.6% of the people's monthly income is between 10000-2000. Where 14% people's monthly income are in the 40,000-50,000 range. Low income people are 14.1%

So we can say that on the basis of monthly income economic condition is quite good compared to others parts of the country.

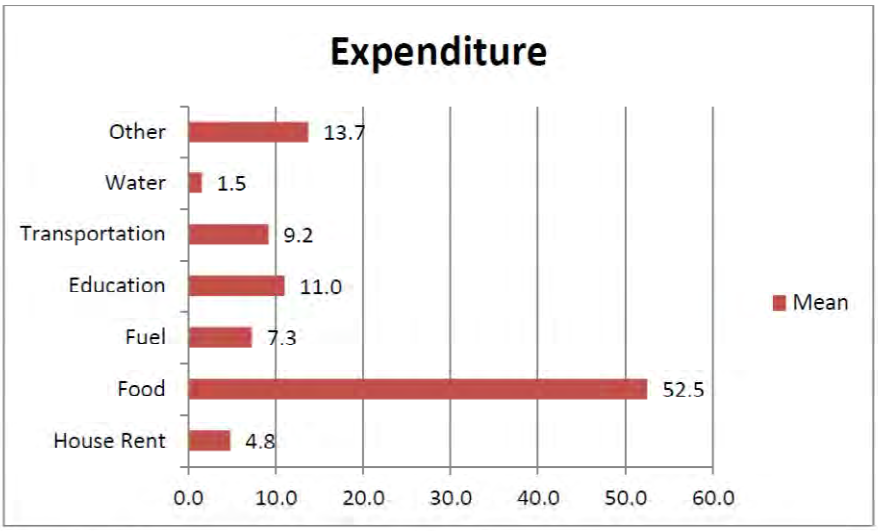


Chart 04: Monthly expenditure pattern in different sector

From the above bar chart it is seen that the spending in food is very high (52.5%) where expense in education and transportation are 11.0% and 9.2% respectively.

Expense in water is only 1.5% which is not very significant. Cheap tariff of CWASA and existence of alternative water sources such as tube well, pond is possibly the main reason behind it.

5.3. Water Supply Condition

Water supply conditions are illustrated in the table.

According to it almost 74.6% household has CWASA connections while others having alternative water sources such as private shallow tube well and deep tube well. Most of the CWASA connections are very recent.

In the following pie chart water meter installation period are revealed.

Source of Water Supply					
Source		**Frequency**		**Percent**	
CWASA	**House Connection**	**789**	**755**	**74.6**	**96.9**
	Hydrant Connection		**24**		**3.1**
Other	**Private STW**	**265**	**218**	**25.4**	**82.3**
	Other (DTW)		**47**		**17.7**
Total		**1045**		**100**	

Table 03: Number of different structure use

From the pie chart we can assume that substantial amount of meter (40.9%) installed after 2000 on the other hand 27.8% and 23% meter installed in 1991-2000 and 1981-1990 period correspondingly. Only 8.3% meter installed in before 1980. So we can see that number of meter installation in increasing by time to time which indicates the growing dependency to CWASA water supply.

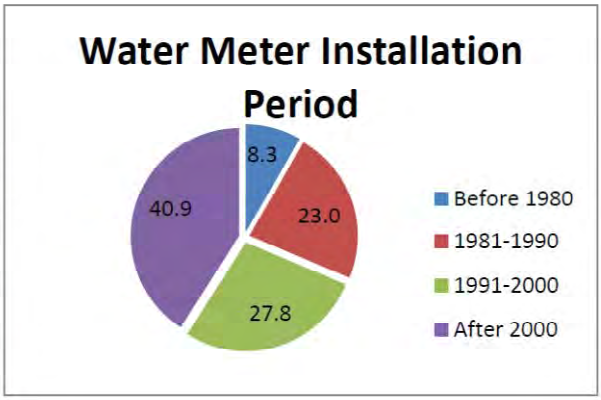


Chart 05: Water Meter Installation Period

Water supply per week and water supply per day illustrates the supply availability of CWASA. Almost 30.7% household get water every days of the week where 18.8%, 17.4% and 18.6% household get once, twice and thrice in a week respectively.

In the following per day water supply chart we find that almost 30% house hold get 2 hour supply in a day where 22% and 15.8% households get 1 hour and 3 hour supply respectively. There are 47% household which get more than 12 hour supply in a day.

Water Supply per Week	
Day	***Percent***
0	*0.4*
1	*18.8*
2	*17.4*
3	*18.6*
4	*7.6*
5	*5.8*
6	*0.6*
7	*30.7*
Total	***100***

Table 04: Water supply day per week

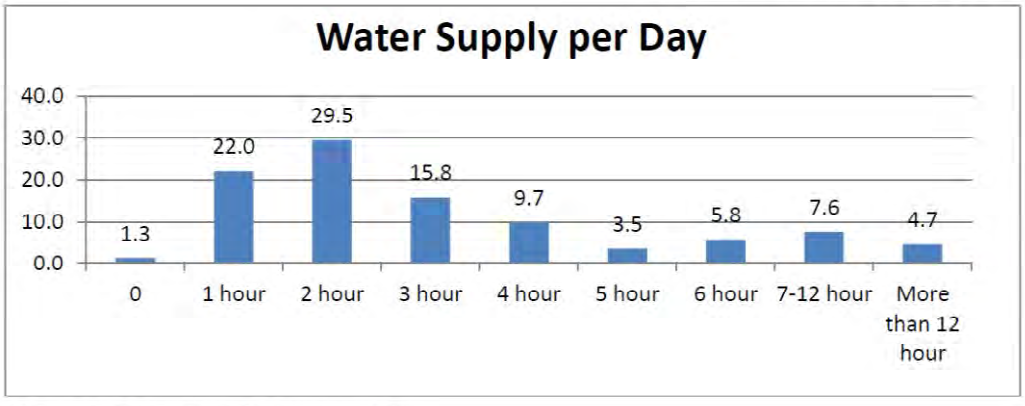


Chart 06: Water Supply hour per day

CWASA water supply condition varies from place to place. But overall in planned residential area water supply condition seems to be good.

5.4. Consumer's expectation and willingness to pay

The following column chart is showing the expectation of the people in the study area regarding CWASA water supply.

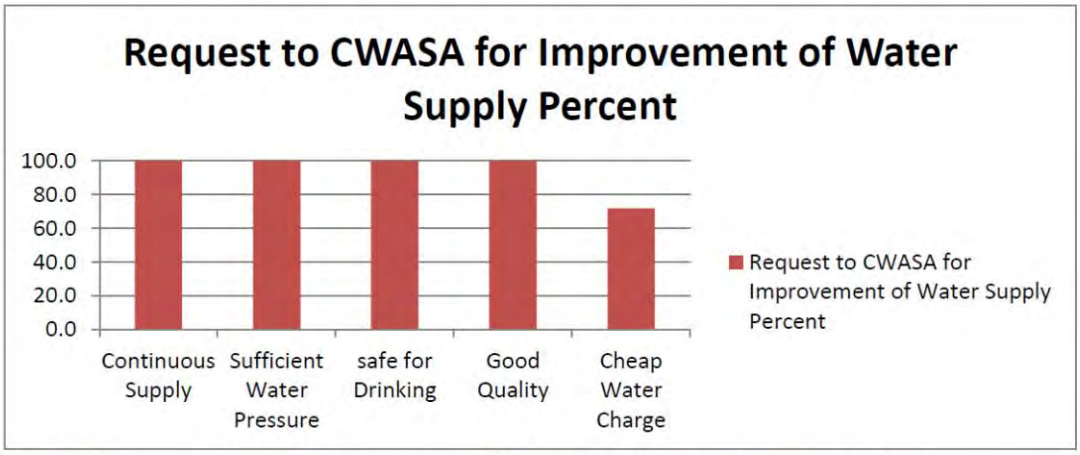


Chart 07: Consumer's different request to CWASA regarding supply quality and rate

Almost 100% respondents want continuous, safe and good quality water supply along with sufficient water pressure. 65% of the people want cheap water price.

To improve the water supply quality it will require the improvement of service in CWASA thus extra cost in water production and maintenance resulting increase in water charge.

In the study we find that almost 54.7% respondents willing to pay up to 1.5 times of present where 20.5% up to 2.0 times. 24.65% people want to stay in present rate. This is the indication that there is a scope for CWASA to increase its revenue if it can improve its water supply condition.

Willingness to Pay after Improvement		
Willingness	***Frequency***	***Percent***
Only Present Charge	*186*	*24.6*
Up to 1.5 times	*413*	*54.7*
Up to 2.0 times	*155*	*20.5*
Up to 2.5 times	*1*	*0.1*
Total	***755***	***100.0***

Table 05: Willingness to pay after improvement

In the previous part we illustrated the economic condition of the studied area which is quite good regarding other parts of the country. And we also found that expenditure in water is not very significant. So it can be implied that people can spend more than present rate for better quality water supply which become evident in the previous table.

5.5. Sanitation and waste water disposal

Almost 100% household has sanitary latrine. 37% households have pour flash latrine while 30.9% have latrine flushed by tape water and 30.9% have pit latrine.

Type of Toilet		
Type	**Frequency**	**Percent**
Flushing by tape water	336	32.1
Pour flash	387	37.0
Pit latrine	323	30.9
Total	**1046**	**100**

Table 06: Type of Toilet

Most of the household (94.2%) use septic tank for waste water disposal from toilet while 4.5% household disposed waste water from toilet directly to drain. In the following the disposal place of waste water from toilet are shown in bar chart.

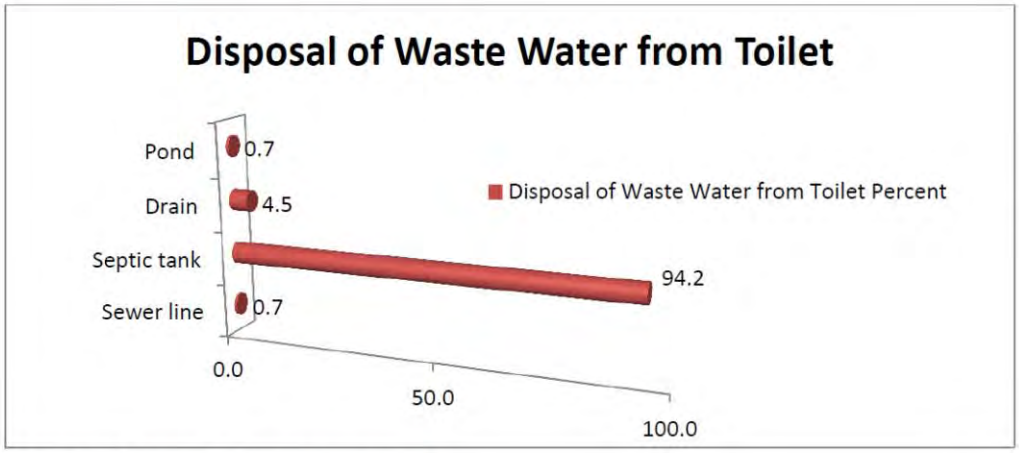


Chart 08: Disposal of water from toilet

On the other hand 97.4% household use drains for the disposal of waste water from kitchen.

So we find that for waste water disposal drain is playing a vital role though CWASA is not the concerned authority for management of the drainage facility.

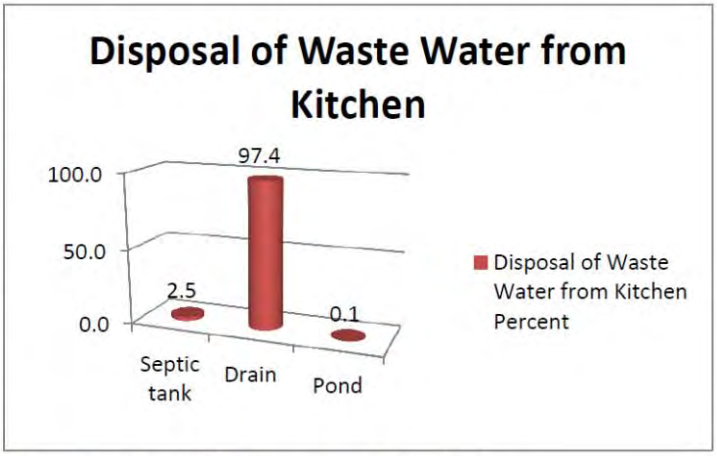


Chart 09: Disposal of waste water from kitchen

5.7. Water Related Hygiene Condition

Water related hygiene condition in the study area is very good. Approximately 95.45% of the household's experiencing no sickness due to water quality.

Because of improve hygiene sanitation system and medical facility. Using of ground water in the form of private STW (shallow tube well), DTW (deep tube well) make it happen.

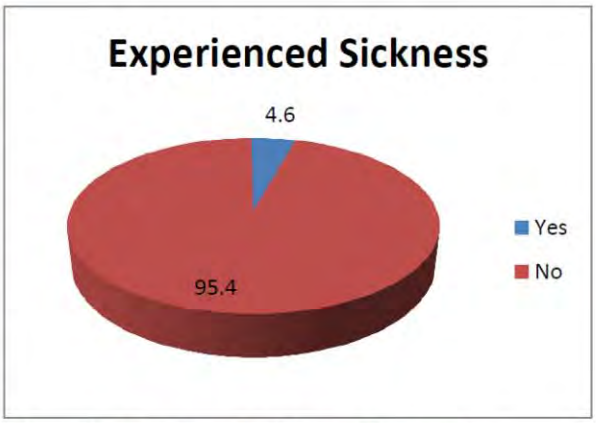


Chart 09: Experienced Sickness due to water

But we should keep in mind that the study area is the core Chittagong city area, where economic condition of the people is good though all of them are not getting good quality water supply but they are using alternative sources. But situation is deteriorating with increasing number of population there is now high demand of water where CWASA is failed to meet this demand. Dependency on ground water is increasing environmental vulnerability. Several studies show that ground water level depletion is very alarming. So it is the right time to take immediate otherwise situation will get worse day by day.

6. Conclusion

From the social survey we can conclude that despite the progressive socio-economic condition and growing demand of water, CWASA is not yet updated as required which hindering the expected growth of the area though people are willing to pay if they get better service. On the other hand drainage system being a vital for waste water disposal is not yet treated in systematic approach or managed by any authority causing overflow and water stagnation in some parts of the city after heavy rain. Situation may get even worse after 10 years if current state continuous.

In the CWASA jurisdiction area almost 25.4% of areas are out of CWASA water supply where as an alternative people use STW (Shallow Tube Well) which are prone to arsenic contamination and in some case DTW (Deep Tube Well). Dependency on ground water is environmentally hazardous causing depletion in water level. Concentration should be given on surface water treatment CWASA should also be increased because city area is expanding and several housing projects are ongoing.

In such a case immediate steps should be taken to improve the water supply condition which will not only contribute in the economy of the region but can make CWASA a profitable organization.

(Annex of Socio-Economic Survey)

Preparatory Survey on Chittagong Water Supply Improvement Project

Questionnaire form

To the People of Chittagong

This Social Survey is intended to obtain information on awareness, willingness and affordability, as well as actual conditions of Chittagong people for improvement of existing water supply conditions in the City of Chittagong being undertaken by the joint effort of the Japan International Cooperation Agency (JICA) and Chittagong Water Supply and Sewerage Authority (CWASA)

Any answer to this questionnaire survey will not used other than the above-mentioned purpose

Thank you,
JICA Study Team and CWASA

1. Location of Residence

   Name of Street, Ward and Thana

   Street ,_____Ward No._____, Thana No,_____

2. Housing

   2.1 Housing Type; ☐ Pucca, ☐ Semi-Pucca, ☐ Kutcha,
   ☐ Hotel, ☐ School, ☐ Shop, ☐ factory, ☐ Community(Mosque etc)

   2.2 Construction Year

   ☐ Built before 1980, ☐ Built between 1981 to 1990. ☐ Built between 1991 to 2000
   ☐ Built after 2001

3. Family

   3.1 General/Income

   (1) Number of inhabitant; _____persons
   (2) Number of family; _____families
   (3) Number of income earners; _____persons
   (4) Sum of income; _____TK/Year, _____TK/month
   (5) Main income source;
   ☐ Government, ☐ Private Company, ☐ Independent business,
   ☐ Other; Specify _____

   3.2 Expenditure

   Total Expenditure; _____TK/month (100%)

1)	Housing	_____TK (%)	5)	Transportation/Communication	_____TK (%)
2)	Food	_____TK (%)	6)	Water	_____TK (%)
3)	Fuel and Electricity	_____TK (%)	7)	Sewerage	_____TK (%)
4)	Education	_____TK (%)	8)	Others	_____TK (%)

4. Water Supply Condition

4.1 Source of Drinking Water; Are you supplied the tapped water from CWASA?

☐ Yes,

☐ a) By house connection; How many people use the house connection? _____ persons

☐ b) By hydrant; How many people use the hydrant? _____ pesons

☐ No, if No.

1) Where is the source for your drinking water?

☐ Private shallow well, ☐ Other; Specify_____

2) Where is the source for your washing clothes?

☐ Private shallow well, ☐ Stream water/pond water, ☐ Other; Specify_____

4.2 Metering (in case you have water supply service by CWASA)

(1) Do you have a water meter at your resident? ☐ Yes, ☐ No

If yes, is it functioning? ☐ Good, ☐ Not Correct

(2) When was it installed? ☐ Before 1980, ☐ 1981-1990, ☐ 1991- 2000, ☐ 2001-

4.3 Awareness/Willingness/Affordability (in case you have water supply service by CWASA)

(1) Are you interrupted in water supply? ☐ Yes, ☐ No.

If Yes, how many hours a day can you get the tap water?

_____ Hours a day at; ☐ day-time or ☐ evening/night time

(2) Do you have request to CWASA for the improvement/provision of Water Supply Conditions?

(more than one answer is available)

☐ Continuous supply (no interruption when you want)

☐ Sufficient water pressure

☐ Safe for drinking

☐ Good quality for water supply

(Have you experienced iron content or offensive smell/taste? ☐ Yes, ☐ No)

☐ Cheap water charge

☐ Other; Specify _____

(3) Upon improvement/provision of Water Supply conditions, are you willing to pay water charge which may be required for CWASA's investment program, as you consume water based on the water meter reading?

☐ No, present water charge is maximum to pay. How much is it now? _____TK

☐ Up to 1.5 times of present (up to _____TK/month)

☐ Up to 2.0 times of present (up to _____TK/month)

☐ Up to 2.5 times of present (up to _____TK/month)

☐ Up to3.0 times of present (up to _____TK/month)

☐ More than 3.0 times of present (more than _____TK/month)

5. Sanitary Condition

5.1 Toilet Facility; Type of toilet

☐ Flushing by tap water, ☐ Pour flush, ☐ Pit latrine, ☐ No toilet

5.2 Disposal

(1) Disposal of wastewater from toilet

☐ to Sewer line, ☐ to Septic tank, ☐ to Drainage, ☐ to road/pond

(2) Disposal of wastewater from kitchen and bath room

☐ to Sewer line, ☐ to Septic tank, ☐ to Drainage, ☐ to road/pond

(3) Have you experienced overflowing or flooding from sewer pipeline or drainage facility nearby your house?

☐ Yes, ☐ No

If yes, how often and how long does it happen?

_____Time/s a year, and _____days for every flooding

6. Water Related Hygiene Conditions

(1) Have your family member experienced sickness (e.g. diarrhea, dysentery, skin disease) by the usage of tap water? ☐ Yes, ☐ No

(2) Do you know the occurrence of health hazard being caused by unsanitary water source (e.g. shallow well nearby septic tank) or by polluted tap water? ☐ Yes, ☐ No

(2) Analysis of Willingness to pay of Household

Table (1): Situation of Household and Connection to Water Supply Services

Type of House	N. of Respodent Household		Average of N. of Families in a House	Average of N. of Family Members	Average of Monthly Income (Tk)	Monthly Income The Lowest (Tk)	Monthy Income The Highest (Tk)	N. of Household Connected to Water Supply by CWASA	% of Connected Household	N. of Household regarding Water Meter Possession	% of Water Meter Possession in Connected Household	N. of Household that Water Meter is working accurately	% of Accurate Water Mater Working
Kutcha	242	26%	1.00	5.90	14,716	5,000	100,000	57	24%	36	63%	35	97%
Pucca	385	41%	1.02	5.98	63,182	10,000	550,000	376	98%	373	99%	371	99%
Semi-Pucca	312	33%	1.03	5.51	25,186	5,000	100,000	263	84%	258	98%	255	99%
Total	939	100%	1.01	5.80	38,051			696	74%	667	96%	661	99%

Table (2): Willingness to pay

Type of House	Whether Water Tarriff can be paid higher or not							Amount of Willigness to Pay				% of Average of Willingness to pay in Average of Monthly Income
	N. of Respndent	Only Present Charge	More than Present Charge	% of "More than Present Charge"	Detail of "More than Present Charge"			N. of Respondent	Average (Tk)	The Lowest (Tk)	The Highest (Tk)	
					Up to 1.5 times	Up to 2 times	Up to 2.5 times					
Kutcha	37	21	16	43%	16	0	0	35	198	86	867	1.35%
Pucca	376	66	310	82%	218	91	1	376	442	72	4,000	0.70%
Semi-Pucca	259	73	186	72%	135	51	0	259	246	65	2,000	0.98%
Total	672	160	512	76%	369	142	1	670	353			0.93%

Table (3): Duration of Water Supply

Type of House	N. of Respodent	Average of Supply Hours	Range of Water Supply Hours				
			No Supply (0 hour)	1-3hours	4 hours	5-23hours	24hours
Kutcha	37	4.27	3	21	7	4	2
Pucca	370	3.78	4	255	31	67	13
Semi-Pucca	213	3.86	1	151	23	29	9
Total	620	3.84	8	427	61	100	24

10.6.1 Bangladesh Environmental Checklist of Karnaphuli Water Supply Project Phase 2

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
Ⅰ Pre-Construction (Planning) Stage						
1. Secure land for Intake, Water Treatment Plant (WTP) and Distribution Reservoir; Right of way for transmission and distribution pipelines.	Land acquisition and resettlement	×				Any involuntary resettlement is not expected because of following reasons: a) All the necessary land and space for the project related facilities have been secured by land acquisition and relocation of people during Phase 1, b) new ly constructed Halishahar Elevated Tank is within property of CWASA, c) The right of way for pipeline construction will be ensured with concerned authorities (Roads and Highways Department (RHD), Ministry of Communication).
II Construction Stage						
II-1 Social Environment						
1. Temporary occupancy of space for construction related facilities (office, worker's camp, material storage, waste disposal)	may cause nuisance to the community and people.		x			Plan to avoid or minimize nuisance to residents and local communities and disturbance of road transport.
2. Construction works, especially laying pipelines along existing roads and Halda river bridge	Traffic congestion, disturbance of navigation and nuisance to business activities and living conditions.			x		1) In case of pipe laying work along roads and Halda river bridge, permission from concerned authorities should be obtained before start of construction works (and in the case of construction along Kaptai Road in the planning stage), by submission of drawings of pipe laying works in the roads, schedules, safety traffic control plan, etc. 2) To avoid or minimize traffic congestion and navigation disturbance and nuisance to local people and communities, consideration should be given to pipe laying in one lane of a two way road (to allow vehicular access to be maintained), as well as providing construction signs and post with color taping, temporary fences and using watchmen.3) In addi-

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
						tion, at night time, the Contractor shall provide electric lighting/signal equipment indicating the location of the construction site to ensure safe traffic control and management.
3. Construction work as a whole	health conditions of residents and workers			x		Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project period. Measures to minimize dust, noise and traffic congestion shall be taken, as mentioned in other items.
4. Construction workers and construction vehicle drivers are in some cases considered as having a high potential for the spread of sexually transmitted diseases (STDs) and HIV/AIDS virus due to their mobility.	Infection of HIV/AIDS and other diseases			x		1) Education of and campaign of prevention and cure of HIV/AIDS to residents and construction workers. 2) Monitoring of cases of HIV/AIDS before, during and after the construction stage. 3) Migration of workers should be minimized by giving local people preferences as construction workers.
5. Construction work as a whole	Worker's health			x		1) Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project period. 2) Medical check for workers, as required.
6. Migration and staying construction workers	Risk of security and crime			x		(1) Consult with police and local government, and establish vigilantes composed of CBOs and residents, if necessary. 2) Education of workers to keep manners and obey community rules. 3) Monitoring of cases and causes of hazard risks.
7. Traffic congestion and disturbance by the work laying pipelines along roads and the Halda river bridge.	An increase in number of traffic accidents			x		1) Suitable planning and management of construction work to prevent the number and minimize the consequences of accidents. 2) Monitoring cases and causes of accidents.
II-2 Natural Environ-						

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
ment						
1. Topography and Geology	Deterioration of topographic/geological features	x				No large scale alteration of ground, which may give rise to a change in topography and geology, is expected.
2. Excavation, cutting and filling of earthmoving work and removal of vegetation cover	Soil erosion		x			1) Soil erosion caused by removal of vegetation cover and excavated loose soil shall be checked and replantation with local vegetation carried out as soon as possible, as necessary. 2) Loose soil shall be covered and stored away from the edge of the hoar/river.
3. Groundwater will be used for some construction work subject to permission being received from the concerned authorities.	groundwater pollution		x			Measures to prevent infiltration of polluted water to the ground and groundwater shall be implemented.
4. Tree cutting Removal and/or transplantation of road side trees and greens are expected due to earthmoving and construction works.	Loss of trees and vegetation		x			1) To get permit of cutting from concerned authorities in advance. 2) proper plantation and/or forestation to replace cut trees under the instruction of the authorities.
5. Construction work as a whole	Global warming/Climate change	x				The amount of greenhouse gases such as CO_2, which are generated due to construction vehicles and machines, is expected to be negligible.
II-3 Environmental Pollution						
1. Emission of air pollutants (dust, NOx, etc.) from vehicles and equipment during construction works is expected.	Air pollution due to dust, NOx, etc.			x		1) Vehicles, machines and plant shall be properly and regularly maintained. 2) Water trucks shall be used and material stockpiles shall be located away from sensitive receptors. 3) Vehicle speed limits shall be enforced.
2. Discharge of wastewater from construction work and worker's camps is expected.	Water pollution			x		1) Wastewaters should be collected in reservoir tank and discharged to water bodies after treatment by sedimentation and/or flocculation process to comply with wastewater quality standards. 2) Sludge and/or sediment including clay and silt etc. should be reused or disposed to waste storage site.
3. Toxic materials such as lubricant oil and asphalt	Soil contamination by toxic materials			x		In order to prevent spillover or leakage of toxic materials such

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
emulsifiers for construction works may give rise to soil contamination.						as lubricant oil and asphalt emulsifiers into soil, following measures should be implemented: (i) To keep clean storage sites of construction equipment, (ii) To install storage tank for preventing spill and leakage of lubricating oil and grease, etc., (iii) Training of workers for proper handling of toxic materials.
4. Generation of construction waste and garbage from worker's camp.	Solid waste		x			1) Consider ways to minimize waste generation in the construction work plan. 2) Proper treatment and disposal of waste generated from construction work. 3) The open areas that are grasslands can be used for construction but with appropriate safeguards to maintain materials and dump sites from contaminating watercourses/river waters.
5. Asbestos cement pipes are used for existing distribution pipes in some parts of the project area.	Exposure to hazardous fine asbestos fibers			x		1) If asbestos cement pipes are found, they should be abandoned and replaced by pipes made of other materials, which are safe enough. 2) At present in Bangladesh there is no clear provision regarding regulation of asbestos waste. Therefore, at first to consult measures for safe treatment and disposal asbestos cement water pipes and asbestos debris with DOE and other responsible organizations. In this regards Japanese laws and manuals such as Waste Management and Public Cleansing Law, Industrial Safety and Health Law, and “Manual for asbestos treatment and disposal of asbestos containing wastes” (Ministry of Environment, 2007.3. In Japanese) will be useful. 3) To confirm the existence of asbestos cement water pipes for water pipes replacement lines. 4) The replacement work of old asbestos cement pipes should be treated carefully taking in to

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
						consideration possible health effect to workers by inhaling and adhering scattered fine fibers. Thus, the workers should be equipped with helmets, masks, shoes and wears to prevent inhalation and adhesion of asbestos fibers. All the equipped materials should be separately stored and safely disposed after replacement work. 5) While loading, unloading and transport, dug out asbestos cement water pipes should be covered with plastic sheets and/or packed with closed containers or bags marking a sign of hazardous asbestos. 6) Collected asbestos pipes should be solidified with cement and/or transferred to secured final disposal site.
6. Generation of noise and vibration from construction vehicles, machines and plant.	Ambient noise and vibration			x		1) Vehicles, machines and plant shall be properly and regularly maintained. 2) Working during sensitive hours and locating machinery close to sensitive receptors shall be avoided. 3) Use equipment with low-noise and vibration. 4) Installation of soundproof walls/acoustic enclosures and provision of buffer zones.
III Post Construction Phase (Operation and Maintenance) Stage						
III-1 Social Environment						
1. Existing social infrastructure and services -1 Water supply	water supply improvement in both quality and quantity	x				The project may contribute to easier access of safe drinking water and improvement in sanitary conditions, as well as a decrease in the number of cases of water-borne diseases.
III-2 Natural Environment						
1. Spatial occupancy of water supply related facilities	Deterioration of natural landscape	x				No negative impact on the landscape is expected in view of the location, scale and design of water supply facilities.
2. Operation activities as a whole	Change of local climate	x				No major infrastructure development and reclamation, which may give rise to a change in the micro-climate is expected.
3. Operation activities as a whole	Global warming/climate change	x				The amount of greenhouse gas emissions from diesel genera-

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
						tors used for water supply facilities is expected to be negligible.
III-3 Environmental Pollution						
1. Emission of air pollutants from diesel generators at the water treatment plant and other facilities	Dust and NOx pollution	x				1) Emission of air pollutants from diesel generators at the water treatment plant and other facilities is expected to be negligible.
2. Chlorine gas emission from leakage of chlorination facility	Hazardous chlorine gas exposure		x			1)In ordinary handling, chlorine gas emission is hardly expected from stored utilities and automatic injec-tion equipment of chlorination. 2) However, following measures should be considered: a) Handing personnel should be properly trained and cautioned, b) Use of good quality nozzles for injection, c) Installation of warning signs.
3. The increase in the quantity of water supply	Increase in the quantity of wastewater and sludge.		x			1) Sludge generated from water treatment plant should be dried and reused. 2) Supernatant water separated from sludge will be sent back to water treatment process and and some portion of will be overflown to Karnaphuli river through drain. Water quality of the supernatant water complies with Bangladesh wastewater standards (such as SS 150 mg/l and BOD 50 mg/l) by flocculation, sedimentation and sand filtration process.
4. Generation of sludge from water treatment plants.	Sludge waste problem		x			Sludge generated from water treatment plants will be dried and utilized.
5. Generation of noise and vibration from water supply facilities (pumps, diesel generator, etc.)	Ambient noise and vibration		x			1) Vehicles, machines and plant shall be properly and regularly maintained. 2) Working during sensitive hours and locating machinery close to sensitive receptors shall be avoided. 3) Use equipment with low noise and vibration. 4) Installation of soundproof walls/acoustic en-closures and provision of buffer zones.
6. Leakage of chlorine gas	Offensive odor		x			1) Strict management for use of chlorine. 2) Monitoring of leakage of chlorine. 3) Good maintenance/ storage and injec-

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
						tion facilities.
IV General (Mostly Overall Stages)						
IV-1 Social Environment						
1. Water supply project activities as a whole	Local economy	x				Beneficial impacts are expected on the local economy, such as creation of employment opportunity for public works during construction and easier access to drinking water will contribute to the reduction of the burden on women and children to collect water and improvement, thus improving living conditions.
2. Water supply project activities as a whole	Making urban socio-economic conditions worse	x				1) The influence of migration may be minimal as increase in workers is limited to the construction period. 2) Migration of workers should be minimized by giving local people preferences as construction workers.
3. Water supply project activities as a whole	Anxieties and complaints may spread amongst the people and communities.			x		Information disclosure and public participation should be fully considered for all the stake-holders from early stage of planning in order to obtain a thorough understanding of the project and consensus of the people and communities.
4. Water supply project activities as a whole	Misdistribution of benefit and damage			x		Consultation with stakeholders, including residents and community organizations should be planned from an early stage to obtain understanding and consent amongst the stakeholders in order to share equally benefits and damage.
5. Water supply project activities as a whole	Local conflict of interests			x		Consultation with stakeholders, including residents and community organizations, should be planned from early stage to obtain understanding and consent amongst the stakeholders in order to avoid or minimize local conflict of interests.
IV-2 Natural Environment						
1. Water supply project activities as a whole	Salt intrusion and change of river regime	x				1) Karnaphuli River discharges into the Bay of Bengal. It is a tidal river and the tidal flow was observed to take place up to about 10 km upstream of the confluence with the Halda River

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures
						However, the rising tide cannot come up to the intake point and no salinity problem was reported due to salt intrusion from the rising tide. 2) The impact on the river regime is expected to be negligible considering the size of the rivers and the flow discharge.
2. Water supply project activities as a whole	Coastal erosion	x				River mouth of Karnaphuli river is located in coastal zone of the Bay of Bengal. However, the project sites including the water intake are more than about 40 km upstream from the river mouth. Therefore, effects related to coastal erosion and sedimentation of sand are not expected.
3. Water supply project activities as a whole	Deterioration of flora, fauna and ecosystem		x			No rare, endangered or endemic terrestrial plant or animal species are expected in the project area. However, planted trees along the road contribute to the greenery and visual amenity providing relaxation and recreation area to local residents.
4. Water supply project activities as a whole	Loss of fishery resources	x				The project area being estuarine is rich in fish resources as both marine and freshwater fish roam the area. There are 76 species and 35 families of fishes. Out of the 76 species 49 species are either endangered or threatened. Both Karnaphuli and Halda rivers are rich in fish and good location for hatcheries. River fishing is active in both rivers. However, the project would not involve any direct interference with water bodies and water resources. Thus, effect on fishery resources activity is not expected.
5. Water supply project activities as a whole	Protected zone	x				There are no sites of protected areas such as National Parks, Wildlife Sanctuaries and Game reserves in the project area.

Activities	Impact	Confirmation of Environmental Considerations*				
		None	Minor	Moderate	Major	Reasons/Mitigation Measures

Note: * (1) In general, both positive and negative impacts are expected by the project activities. However, negative impacts only is considered. (2) Ratings of "Major, Moderate, Minor and None" are almost similar to those of "Significant or serious impact (A), Not significant but some impact (B), Little impact or extent of impact is unknown/not clear (C) and Negligible or no impact (D)" in JICA Guidelines, respectively

10.6.2 JICA Environmental Checklist - Preparatory Survey on Chittagong Water Supply Improvement Project

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Countermeasures)</th></tr>
<tr><td rowspan="2">1 Permits and Explanation</td><td>(1) EIA and Environmental Permits</td><td>(a) Have EIA reports been already prepared in official process?
(b) Have EIA reports been approved by authorities of the host country's government?
(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?
(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?</td><td>(a) Y
(b) Y
(c) N
(d) N</td><td>(a) IEE report (December 2005) and EIA reports (June 2007), the descriptions of which cover Phase 1 and 2 of the Karnaphuli Water Supply Project were prepared and submitted to DOE to obtain necessary approvals.
(b) CWASA received approvals with conditions from DOE as follows:
(1) Environmental Site Clearance issued on January 9, 2006 (Memo No. DoE/Clearance/2225/2005/75). ESC for Phase 2
(2) Approval of Environmental Impact Assessment (EIA) Report issued on September 13, 2007 (Memo No. DoE/Clearance/2225/2005/2416)
Renewal of the ESC for Phase 1 was issued by DOE Chittagong on July 31, 2012, and will be issued by the end of November 2012 for Phase 2.
(c) Approval of the EIA included conditions relating to proper mitigation countermeasures and monitoring for site preparation, construction and operation stages and resettlement plan. It is also pointed out that CWASA shall apply for Environmental Clearance Certificate (ECC) after installation of the plant as well as other pollution control facilities and equipment.
(d) No need of permits</td></tr>
<tr><td>(2) Explanation to the Local Stakeholders</td><td>(a) Have contents of the project and the potential impacts been adequately explained to the local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the local stakeholders?
(b) Have the comments from the stakeholders (such as local residents) been reflected in the contents of the project?</td><td>(a) Y
(b) Y</td><td>(a). Information disclosure was carried out for the public occasionally from the early stage of the project implementation for Phase 1 in accordance with appropriate procedures.
Public consultation was conducted at four places as shown in the table below. Participants of public consultation were local leaders, women groups, representatives of professional groups like farmers, businessman, teachers, local representatives, etc.
<table>
<tr><th></th><th>Date</th><th>Place</th><th>No. of Participants</th></tr>
<tr><td>1</td><td>12-08-2005</td><td>Shantir Hat of Rangunia</td><td>20</td></tr>
<tr><td>2</td><td>12-09-2005</td><td>Godown of Rangunia</td><td>24</td></tr>
<tr><td>3</td><td>13-09-2005</td><td>Ward No.14 of Double Mooring Thana</td><td>18</td></tr>
<tr><td>4</td><td>13-09-2005</td><td>Ward No.8 of Khulsi Thana</td><td>20</td></tr>
</table>
The participants in general welcomed the project. Concerns expressed by the people were as follows:
(i) Agricultural products including vegetation may be affected during</td></tr>
</table>

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Countermeasures)
				movement of transport and equipment, (ii) Assembly of people during project activities may damage crops and other trees, (iii) Noise pollution from vehicles and equipment may cause socio-economic and ecological disruption, (iv) Environmental pollution through sanitation and waste materials as well as other social nuisance should be controlled, (v) Local personnel should be employed in different activities of the project on a priority basis, (vi) Compensation payment in any form, should be properly distributed so that the actual people get his full share, (vii) Affected property should be assessed properly. (b) The comments of the local residents have been reflected in the contents of and design of the project.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative plans were studied for the alignment of major facilities including right of way for pipeline installation and the location of distribution reservoirs/elevated tank.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating countermeasures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) N (b) Y	(a) Chlorine from chlorine storage facilities and chlorine injection facilities will not cause air pollution. Mitigation measures such as use of automatic injection equipment, safe operation and maintenance practices and provision of training to O&M personnel will be incorporated in the design of the facilities (as for Phase 1) and lessons learned from Phase 1 will be included in Phase 2. In addition, the existing Mohara water treatment which includes chlorination has been operated safely since commencement of operation. (b) Thus, the automatic injection system will comply with the country's occupational health and safety standards. However, to make ready against leakage accidents of chlorine gas by any possibility, Emergency Responsible Plan (10.5.3) including training of workers and preparation of safety protection masks and manuals will be prepared.
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a) Y	(a) 1) By the water treatment plant operation river water is purified for use of water supply. 2) Supernatant separated from sludge will be sent back to water treatment process, some portion of which will be overflown to Karnaphuli river through nearby canal. Water quality of the supernatant complies with Bangladesh wastewater standards (such as SS 150

Category	Environ-mental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Countermeasures)
				mg/l and BOD 50 mg/l) by flocculation, sedimentation and sand filtration process.
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) 1) Sludge generated by water treatment plant operation will be separated by sedimentation and filtration process and dried for reuse as manure and land reclamation. 2) There is a possibility that hazardous asbestos cement pipes are used in some portion. (1) If asbestos cement pipes are found, they should be abandoned and replaced by pipes made of other materials, which are safe enough. (2) At present in Bangladesh there is no clear provision regarding regulation of asbestos waste. Therefore, at first to consult measures for safe treatment and disposal of asbestos cement pipes and asbestos debris with DOE and other responsible organizations. (3) To confirm the existence of asbestos cement pipes. (4) The replacement work of old asbestos cement pipes should be treated carefully taking into consideration possible health effect to workers by inhaling and adhering scattered fine fibers. Thus, the workers should be equipped with helmets, masks, shoes and wears to prevent inhalation and adhesion of asbestos fibers. All the equipped materials should be separately stored and safely disposed of after replacement work. (5) While loading, unloading and transport, dug out asbestos cement pipes should be covered with plastic sheets and/or packed with closed containers or bags marking a sign of hazardous asbestos. (6) Collected asbestos pipes should be solidified with cement and/or transferred to secured final disposal site.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) Y	(a) 1) Vehicles, machines and plant shall be properly and regularly maintained. 2) Working during sensitive hours and locating machinery close to sensitive receptors shall be avoided. 3) Use equipment with low noise and vibration. 4) Installation of soundproof walls/acoustic enclosures and provision of buffer zones.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) The water source is a river, so no subsidence will be caused by the extraction of groundwater.

Category	Environ-mental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Countermeasures)
3 Natural Envi-ronment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There is no protected area located in and in the vicinity of the project sites.
3 Natural Envi-ronment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, and ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection countermeasures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate countermeasures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) N (d) N	(a) The project site does not encompass primeval forests, tropical rain forests, and ecologically valuable habitats. (b) The project site does not encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions. (c) No significant ecological impacts are anticipated; however adequate countermeasures will be taken to reduce the impacts on the ecosystem in case such impacts are identified during the later stages of the project, including detailed design. (d) The water used by the project does not adversely affect aquatic environments. The amount used for water supply is not large in comparison with the total river flow.
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a) N	(a) The water used by the project does not adversely affect aquatic environments. The amount used for water supply is not large in comparison with the total river flow. In addition drinking water has top priority among all the purposes of water uses.
4 Social Envi-ronment	(1) Resettle-ment	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compen-	(a) N (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A	(a) Necessary land for the facilities for Karnaphuli Water Supply Project was already secured by CWASA for the two phases. (b) to (j) Any involuntary resettlement is not expected. Therefore, items from (b) to (j) will be not applicable.

Category	Environ-mental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Countermeasures)
		sation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous people? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Is a plan developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(i) N/A (j) N/A	
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate countermeasures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect the existing water uses and water area uses?	(a) N (b) N	(a) There is no possibility that the project will adversely affect the living conditions of inhabitants. However, adequate countermeasures will be considered to reduce the impacts, if necessary. (b) There is no possibility that the project will adversely affect any other existing water uses and users.

Category	Environ-mental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Countermeasures)
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate countermeasures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There are no local archaeological, historical, cultural, and religious heritage sites to be affected by the project.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary countermeasures taken?	(a) N	(a) The project will not adversely affect the local landscape.
	(5) Ethnic Minorities and Indigenous People	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous people? (b) Are all of the rights of ethnic minorities and indigenous people in relation to land and resources respected?	(a) N (b) N	(a) The project does not violate any of the country's laws for rights of ethnic minorities and indigenous peoples. (b) There are no impacts on culture and lifestyle of ethnic minorities and indigenous people by the project.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country, which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents from labor accidents, and management of toxic substances? (c) Are tangible safety education for labors and the formulation of safety sanitary practices (in-	(a) Y (b) Y (c) Y (d) Y	(a) Project will be carried out in compliance with prevailing legislation, including Labour Act 2006, Factories Act 1965. (b) Project will be designed considering the needs for safety equipment and measures for the safe management of toxic substances. In addition, Emergency Response System including emergency situation, emergency response system and procedure, alarm systems and training, etc. will be established. (c) Tangible safety education for labors and the formulation of safety sanitary practices will be planned and implemented for concerned persons in the project. (d) Appropriate countermeasures will be taken to ensure that security guards involved in the project do not violate the safety of local residents

Category	Environ-mental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Countermeasures)
		cluding traffic control and public health) to concerned persons in the project planned and conducted? (d) Are proper countermeasures taken not so as to threaten the safety of the local residents and concerned persons in the project by security guards employed by the project?		and concerned persons in the project.
5 Others	(1) Impacts during Con-struction	(a) Are adequate mitigation countermeasures considered to reduce adverse impacts during construction (e.g., noise, vibrations, turbid wa-ter, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate mitigation countermeasures considered to re-duce impacts? (c) If construction activities adversely affect the social environment, are adequate mitigation countermeasures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate countermeasures considered to reduce such impacts?	(a) Y (b) N (c) N (d) Y	(a) Adequate countermeasures to reduce adverse impacts (noise, turbidity of effluent, waste disposal, etc) during construction will be included in the design and Contract Documents. (b) Construction activities will not adversely affect the natural environ-ment. (c) Construction activities will not adversely affect the social environ-ment. (d) Adequate countermeasures to reduce traffic congestion will be in-cluded in the design and Contract Documents. These will include specific requirements for maintaining traffic flow on Kaptai Road along the route of the conveyance and transmission pipelines, as well as within Chit-tagong City.
5 Others	(2) Monitoring	(a) Does the proponent develop and implement a monitoring program for the environmental items that are considered to have potential impacts? (b) How are the items, methods and frequencies of the monitoring program planned? (c) Does the proponent establish an adequate monitoring system (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) The proponent will develop and implement a monitoring program for the environmental items that are considered to have potential impacts. (b) The items, methods and frequencies included in the monitoring pro-gram will be carefully planned and take full account of the conditions of the approval of the EIA. (c) The proponent will establish an adequate monitoring system (organi-zation, personnel, equipment, and adequate budget to sustain the moni-toring framework). This will be based upon and take account of the monitoring that is undertaken at existing WTPs and for Phase 1 of the project. (d) The monitoring will comply with regulatory requirements, such as the format and frequency of reports, pertaining to the monitoring report sys-tem to the regulatory authorities in due course of time.

Category	Environ-mental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Countermeasures)
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in other sectors such as in the Dam and River Projects checklist should also be referred to.	(a) N/A	(a) Not applicable.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans-boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) The nature and scale of the project are such that there will be no impacts to trans-boundary or no global issues.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is locate

CHAPTER 11

IMPLEMENTATION PLAN AND CONSTRUCTION COST ESTIMATES

CHAPTER 11 IMPLEMENTATION PLAN AND CONSTRUCTION COST ESTIMATES

11.6 Terms of Reference (TOR) for Consulting Services under Karnaphuli Water Supply Project - Phase 2 (KWSP2

Chapter 1 Background

1.1 Background

The Chittagong Water Supply and Sewerage Authority (CWASA) is in the implementation of a project constructing a 143,000 m^3/day water treatment plant including water intake facility, two water reservoirs and water transmission and distribution main pipelines (named "Karnaphuli Water Supply Project; abbreviated as KWSP") with Japanese ODA Loan provided by the Japan International Cooperation Agency (JICA) and the development funds of the Government of Bangladesh (GOB).

In order to further improve the water supply service in Chittagong, CWASA plans to undertake Karnaphuli Water Supply Project -Phase 2 (KWSP2) (hereinafter referred to as "KWSP2" or "the Project").for expanding the water treatment and supply facilities with an additional 143,000m^3/day capacity.
GOB has received a Japanese ODA Loan to finance the KWSP2. GOB intends to use part of the proceeds of the Japanese ODA Loan for eligible payments for consulting services for which this TOR is issued

1.2 Components of the Project

The Project consists of the following components:

(a) Construction of a complete package unit of Water Intake Facility having additional 150,000 m^3/day pumping capacity *1) adjacent to the Water Intake Facility being constructed under KWSP.
(b) Construction of complete package unit of WTP having a capacity of 143,000 m^3/day *2) at the site of the WTP being constructed under KWSP.
(c) Construction of an additional reservoir having a capacity of 24,800 m^3 and installation of additional pumps and electrical equipment *3) at the site of Nashirabad Water Reservoir being constructed under KWSP.
(d) Construction of a new 2,400 m^3 elevated tank at Halishahar (called "Halishahar Elevated Tank").
(e) Construction of water conveyance pipeline from Water Intake Facility to WTP in a length of approximately 3.6km.
(f) Transmission pipeline from WTP to Nashirabad Reservoir and further to Halishahar Elevated Tank in a total length of approximately 34.4km.
(g) Construction of primary distribution mains from Nashirabad Reservoir, Battali Hill Reservoir and Halishahar Elevated Tank to the respective service areas in a total length of approximately 20km, including the installation of water distribution control system.
(h) Construction of additional optical fiber cable line to extend the planned cable in KWSP1, in a length of approximately 20km.
(i) Construction of secondary/tertiary distribution network through individual service connection points in the service areas covering approximately 3,063 ha, including the laying of pipes in a total length of approximately 475km, the installation of meters at the individual service connection points and supply low income communities
(j) Procurement Package and Procedure of:
    a. Water meters to be installed for Service connections from distribution pipe, and

b. mobile ultrasonic flow meters, vehicle-mounted electromagnetic-type flow meters, pick-up cars, and backhoes to be used for O&M of networks in DMA (district metered area) and WTP.

(Remarks)

*1), *2) and *3): All construction works include the procurement and installation of mechanical and electrical equipment required.

1.3 Procurement Package and Procedure

(1) Procurement Package

The construction works will be divided into three contract packages as follows:

Package 1:
Package 2:
Package 3:
Package 4:

Non-Disclosure Information

The contractors' works for Package 1 and Package 2 will include O&M supervision and training services to be provided during the Defect Liability Period in respect of (i) WTP including Intake Facility and (ii) Water Distribution Control System.

(2) Procurement procedure

Package 1, 2 and 3 will be procured respectively through International Competitive Bidding (ICB) based on Single-Stage Two-Envelope Bidding Procedure with Pre-qualification in accordance with the JICA's Procurement Guideline (Section 2.03, Part II),

While Package 4 will be procured for each item of products through ICB or Local Competitive Bids (LCB) in accordance with the biddings set forth in the JICA Sample Bidding Documents under Japanese ODA Loans for Procurement of Goods version 1.0 issued in August 2010.

(3) Service connection with water meter including supply low income communities

For the construction of service connections, the following work shall be undertaken by different parties.

(a) Collection of information on customers including mapping on the location of water meter to be installed

CWASA staff trained by PANI will undertake the required work in the field as early as possible after loan agreement.

(b) Procurement of equipment

The selected contractor will procure the required equipment for the service connection

(c) Preparation of installation plan for service connections

The contractor to be selected for the construction of distribution pipelines will prepare plan using information collected by CWASA staff.

(d) Connection work from CWASA pipeline to each customer connection pipe

The customers will make contract with private company for the connection of pipes between CWASA pipe and private pipe.

1.4 Funding Source

GOB has received a Japanese ODA Loan to finance the KWSP2. GOB intends to use part of the proceeds of the Japanese ODA Loan for eligible payments for consulting services for which this TOR is issued.

1.5 Completion of the Project

The Project is expected to be completed by the 31th day of March 2021.

1.6 Location of the Project

The Water Intake Facility and WTP are located at the outskirt of Chittagong City, approximately 25 km far to the north-east from the city center and along the Karnaphuli River. Nashirabad Reservoir and Battali Hill Reservoir and Halishahar Elevated Tank are located in the Chittagong City. The location of the Project is shown in a location map enclosed as Attachment 1.

1.7 Executing Agency

The Execution Agency of the KWSP2 is CWASA.

1.8 Technical information

The final report on the "Preparatory Survey on Chittagong Water Supply Improvement Project[1]" as well as the results of topographic and geological surveys at the facility sites and pipeline routes conducted for the Project are available at CWASA.

Chapter 2 Objectives of Consulting Services

The consulting services shall be provided by an international consulting firm (hereinafter referred to as "the Consultant") in association with national consultants in compliance with Guidelines for the Employment of Consultants under Japanese ODA Loans (April 2012). The objective of the consulting services is to achieve the efficient and proper preparation and implementation of the Project through the following works:

(a) Detailed design
(b) Tender Assistance
(c) Construction supervision
(d) Facilitation of implementation of Environmental Management Plan (EMP), and Environmental Monitoring Plan (EMoP)
(e) Capacity Development for CWASA
(f) Guidance for Public Awareness Campaign

Chapter 3 Terms of Reference for Consulting Services

3.1 Detailed Design

The Consultant shall carry out the following works:

(a) review and verify all available primary and secondary data;
(b) carry out all the required engineering surveys and investigations such as topographical survey, hydrological survey, geotechnical survey, material availability survey and other related engineering works required for preparing basic and detailed designs, as applicable to the concerned project components;
(c) prepare detailed work plan, progress reports and implementation schedule for the Project to ensure effective monitoring and timely project outputs, and regularly update the same;
(d) prepare the detailed design of all the Project components in sufficient detail to ensure clarity and

[1] In the course of the survey, the name of the project was changed to "Karnaphuli Water Supply Project (Phase2)".

understanding by CWASA, contractors and other relevant stakeholders; All the design must be in conformity with the Bangladesh Standards (if available) or with the appropriate international standards. The detailed design shall, as a minimum, include (i) drawings and plot plants for all facilities (ii) detailed cost estimates, and (iii) necessary calculations to determine and justify the engineering details for the Project. The detailed design shall be prepared in close consultation with, and to meet the requirements of CWASA, and shall be incorporated into the detailed design report to be submitted for approval of CWASA;

(e) prepare Detailed Specifications, Bill of Quantities (BOQ) and Tender Drawings to be incorporated into Bidding Documents. Such Detailed Specifications shall contain those in relation to i) quality control of plant, materials and workmanship, ii) safety and iii) protection of the environment.

3.2 Tender Assistance

(1) Assistance in Pre-Qualification (PQ) of Bidders undertaking Construction Works

The Consultant shall:

(a) define PQ criteria: technical and financial requirements, capacity and/or experience taking into consideration technical feature of the Project;
(b) prepare PQ documents in accordance with the latest version of Standard Prequalification Documents under Japanese ODA Loans;
(c) assist CWASA in PQ announcement, addendum/corrigendum, and clarifications to the applicants' queries;
(d) evaluate PQ applications in accordance with the criteria set forth; and
(e) prepare a PQ evaluation report for approval of the PQ evaluation committee.

(2) Assistance in the Bidding for Award of Contractor(s) undertaking Construction Works

The Consultant shall

(a) prepare bidding documents in accordance with the latest version of Standard Bidding Documents under Japanese ODA Loans for Procurement of Works together with all relevant specifications, drawings and other documents;
(b) assist CWASA in issuing bid invitation, conducting pre-bid conferences, issuing addendum/corrigendum, and clarifications to bidders' queries.
(c) evaluate bids in accordance with the criteria set forth in the bidding documents. In such evaluation, the Consultant shall carefully confirm that bidders' submissions in their technical proposal including, but not limited to, site organization, mobilization schedule, method statement, construction schedule, safety plan, have been prepared in harmony each other and will meet such requirements set forth in applicable laws and regulations, specifications and other parts of the bidding documents;
(d) prepare a bid evaluation report for approval of the bid evaluation committee;
(e) assist CWASA in contract negotiation by preparing agenda and facilitating negotiations including preparation of minutes of negotiation meeting; and
(f) prepare a draft and final contract agreement.

(3) Assistance in the Bidding for Procurement of Equipment and Materials for Service Connections and Equipment and Vehicles for O&M

The Consultant shall

(a) prepare bidding documents in accordance with the latest version of Standard Bidding Documents under Japanese ODA Loans for Procurement of Goods together with all relevant specifications, drawings and other documents in respect of individual items as listed in 1.2 (j);
(b) carry out the bidding assistance works as stipulated in (b) to (f) of Paragraph (2) above.

3.3 Construction Supervision

The Consultant shall perform his duties during the construction period in accordance with the contracts to

be executed between CWASA and the contractors. It should be noted, however, House connection from meter to house etc. is out of the Consultant's scope of the works. FIDIC MDB Harmonized Edition (2010) complemented with the Specific Provisions as included in the Standard Bidding Documents under Japanese ODA Loans for Procurement of Works will be applied to the civil works of the Project. In this context, the Consultant shall:

(a) act as the Engineer to execute construction supervision and contract administration services in accordance with the power and authority delegated by CWASA ;
(b) provide assistance to the Employer concerning variations and claims which are to be ordered/issued at the initiative of CWASA;
(c) issue the commencement order to the Contractors;
(d) provide recommendation to CWASA for acceptance of the Contractor Performance security, advance payment security and required insurances.
(e) review and approve the proposals submitted by the contractors which include work program, method statements, material sources, manpower and equipment deployment. In light of **Section 3.03** of Guidelines for the Employment of Consultants under Japanese ODA Loans (April 2012), the Consultant shall pay attention, in particular, to whether such proposals will meet the safety requirements set forth in the applicable laws and regulations, the specifications or other parts of the contract;
(f) explain and/or adjust ambiguities and/or discrepancies in the Contract Documents and issue any necessary clarifications or instructions;
(g) review, verify and further detail the design of the works, approve the Contractors' working drawings and, if necessary, issue further drawings and/or give instructions to the Contractor;
(h) liaise with the appropriate authorities to ensure that all the affected utility services are promptly relocated.
(i) carry out field inspections on the contractor's setting out to ensure that the works are carried out in accordance with drawings and other design details.
(j) regularly monitor physical and financial progress against the milestones as per the contract so as to ensure completion of contract in time;
(k) supervise the works so that all the contractual requirements will be met by the contractors, including those in relation to i) quality of the works, ii) safety and iii) protection of the environment. In light of **Section 3.03** of Guidelines for the Employment of Consultants under Japanese ODA Loans (April 2012), the Consultant shall confirm that an accident prevention officer proposed by contractor is duly assigned at the project site and that construction works are carried out according to the requirements set forth in the applicable laws and regulations, the specifications or other parts of the contract ;
(l) supervise field tests, sampling and laboratory test to be carried out by the contractors;
(m) inspect the construction method, equipment to be used, workmanship at the site, and attend shop inspection and manufacturing tests in accordance with the specifications;
(n) survey and measure the work output performed by the contractors and issue payment certificates such as interim payment certificates and final payment certificate as specified in the contract;
(o) coordinate the works among different contractors employed for the Project;
(p) modify the designs, technical specifications and drawings, relevant calculations and cost estimates as may be necessary in accordance with the actual site conditions, and issue variation orders (including necessary actions in relation to the works performed by other contractors working for other projects, if any);
(q) carry out timely reporting to CWASA for any inconsistency in executing the works and suggesting appropriate corrective measures to be applied;
(r) inspect, verify and determine claims issued by CWASA in accordance with the civil works contract;
(s) perform the inspection of the works and to issue certificates such as the Taking-Over Certificate, Performance Certificate as specified in the civil works contract, ;
(t) supervise testing and commissioning;

(u) provide periodic and/or continuous inspection services during defects liability period (Defect Notification Period defined in FIDIC Conditions of Contract) and if any defects are noted, instruct the contractor to rectify;
(v) check and certify as-built drawings submitted by the contractors; and prepare and submit reports to CWASA, which are detailed in **Chapter 6** in relation to the implementation of the Project.

(Note)

The Consultant's supervision duties as set out above shall include those for the procurement of meters, saddles, pipes, etc. to be used for house connections and also for the procurement of equipment to be used for O&M of DMA distribution networks as required.

3.4 Safety Measures

The Consultant shall:

(a) When preparing or reviewing bidding documents for procurement of work and those for procurement of supply and installation of plant, make sure to meet the requirements for safety measures.
(b) Review the safety plans submitted by the bidders from the point of view of securing the safety during the construction. (Refer to *Paragraph (2), Section 4.02 Scope of the Project and of the Consulting Services of the Guidelines for the Employment of Consultants under Japanese ODA Loans, April 2012*).
(c) Review the Programme (the programme stipulated in the relevant clause of *the Standard Bidding Documents under Japanese ODA Loans (Procurement of Works) 2012*) submitted by the contractors from the point of view of securing the safety during the construction and require them to submit further details, if necessary.
(d) During the supervision of the construction work, confirm that an accident prevention officer proposed by the contractor is duly assigned at the project site and that the construction work is carried out according to the safety plan as well as the safety measures prescribed in the Programme. If consultants recognize any questions regarding the safety measures in general including the ones mentioned above, the consultants shall require the contractors to make appropriate improvements.

3.5 Facilitation of implementation of Environmental Management Plan (EMP), and Environmental Monitoring Plan (EMoP)

The Consultant shall:

(a) update and review EMP submitted by the contractor, as appropriate; incorporate necessary technical specifications with design and contract documentation;
(b) during the preparation of bidding documents, clearly identify environmental responsibilities as explained in the environmental impact assessment/initial environmental examination report and EMP;
(c) prepare EMoP for monitoring implementation of EMP;
(d) supervise EMP implementation and undertake regular compliance monitoring according to EMoP to ensure that the civil works are implemented in accordance with the EMP; and
(e) assist CWASA in the capacity building of CWASA staff on environmental management through on-the-job training on environmental assessment techniques, mitigation measure planning, supervision and monitoring, and reporting.

3.6 Capacity Development for CWASA

(a) The Consultant shall transfer the technology in design and supervision works through OJT. The Consultant shall provide the opportunity to CWASA officers and staffs to be involved in the working team of the Consultant during the design, contract administration and supervision works for their capacity building wherever possible.
(b) The Consultant shall develop the capacity of the CWASA's staff to enhance the expertise and skills of key staff, as well as identified group(s) of personnel with the competencies required to

manage, operate and maintain the new facilities/system thereby transforming organizational and individual potentials into actuality.

The contractors will be required to provide O&M supervision and/or training services for one year during the Defect Notification Period in respect of WTP including Water Intake Facility and Distribution Control System.

In this context, the Consultant shall:

1) prepare manuals for overall O&M of the following facilities constructed under the Project for the contractor's activities.:
   i) Intake Facility and WTP
   ii) Conveyance/ Transmission Pipelines
   iii) Primary, Secondary and Tertiary Distribution Networks

2) In particular, prepare specific operation manual in respect of:
   i) WTP sludge treatment
   ii) Overall distribution control based on SCADA system
   iii) Distribution system, including:
      - Water pressure monitoring and control as sector inlet chambers
      - Leakage investigation and repairs at DMA in let chambers

3) provide specific training for the aspects stated in Paragraph 3.6 (b) 2) ii) above (SCADA system), supplement to the training provided by the contractor.

4) monitor and evaluate the contractors' performance of O&M supervision and training services, and instruct the contractors to improve their services if necessary.

5) submit to CWASA "Evaluation Report of Contractors' Training Services" stating the evaluation of the training services provided by the contractors after completion of the contractors' training services.

3.7 Guidance for Public Awareness Campaign

The purpose of public awareness campaign is to inform and educate the general public of the present situation of health damage in the project area caused by the use of groundwater, the objectives of the proposed project, the importance of connection to a proposed water supply system under the project and payment of water tariff for sustainable operation and management of water supply facilities. These activities are essential for expediting the works for secondary/tertiary distribution network, since it is needed to increase a large numbers of house connections and also promote applications for the house connections in advance so that the meter installation locations can be fixed. These activities should primarily be carried out by CWASA.

The Consultant shall:

(a) design and formulate the campaign program to be carried out by CWASA;
(b) guide and assist CWASA on the implementation of the campaign program; and
(c) coordinate with the "Project for Advancing NRW Reduction Initiative (PANI) of CWASA" (hereinafter referred to as the "PANI") for the CWASA's performance of the campaign program.

*(Note) JICA's technical cooperation project to CWASA being carried out for technology transfer and CWASA staff capability build-up with regard to measures for identifying leakage and reducing non-revenue water.

Chapter 4 Expected Time Schedule

The total duration of consulting services will be 106 months including 12 months of Defect Notification Period. The implementation schedule expected is as shown in **Table 1**.

Table 1 Implementation Schedule Expected

Key Activities	Date	Duration in Months
Commencement of Consulting Services	1 December 2013	13
Completion of detail design, preparation of drawings and tender documents	31 December 2014	
Tender process including prequalification	1 October 2014 to 31 January 2016	16
Commencement of Works	1 February 2016	62
End of Works	31 March 2021	
Defect Notification Period	1 April 2021 to 31 March 2022	12
Final Contract Administration	1 April 2022 to 30 June 2022	3
Completion of Consulting Services	30 June 2022	-

Chapter 5 Staffing (Expertise Required)

17 of Professional (A) consultants (Foreign Persons) and 23 of Professional (B) consultants (Local Persons) will be engaged, over 102 months duration of consulting services, for a total of 505 man-months for Professional consultants (A) and 856 man-months for Professional consultants (B). Total consulting input is estimated to 1,361 man-months. A detailed schedule of consulting services and a distribution of man-months are shown in **Attachment 2**.

5.1 Consulting Input for the Respective Phase

The Consultant Team for the design, tender assistance, construction supervision and other miscellaneous consulting services consist of following key personnel together with supporting staff.
The allocation of person-month for the respective phases of consulting services, excluding local supporting staff, is as shown in **Table 2**.

Table 2 Allocation of Person-Month for the Respective Phases

Designation	No.	Phase wise input in months			Total Input in Months
		Design phase	Construction Phase	Post Construction Phase	
		December .2013- December 2014	February 2016- March 2021	April 2021 March 2022	
Professional (A): International Specialist					
Team Leader					
Water Treatment Expert					
Intake & WTP Engineer (Civil)					
Senior Pipeline Engineer					
Pipeline Engineer(1)					
Pipeline Engineer(2)/Hydrologist					
Pipeline Engineer(3)					
Pipeline Engineer(4)					
Structure Engineer					
Mechanical Engineer					
Electrical Engineer					
O&M Specialist (WTP)					

Non-Disclosure Information

Designation	No.	Phase wise input in months			Total Input in Months
		Design phase	Construction Phase	Post Construction Phase	
		December .2013- December 2014	February 2016- March 2021	April 2021 March 2022	
O&M Specialist (Distribution Control)	Non-Disclosure Information				
Specification Specialist					
Environment/Social campaign Specialist					
Costing Engineer					
Contract Specialist					
Total					
Professional (B): National Specialist					
Deputy Team Leader	Non-Disclosure Information				
Senior Engineer (Intake and WTP)					
Senior Engineer (Pipeline-1)					
Senior Engineer (Pipeline-2)					
Senior Engineer (Pipeline-3)					
Senior Engineer (Pipeline-4)					
Senior Engineer (Pipeline-5)					
Senior Engineer (Pipeline-6)					
Senior Engineer (Pipeline-7)					
Senior Engineer (Pipeline-8)					
Senior Engineer (Pipeline-9)					
Senior Engineer (Pipeline-10)					
Senior Engineer (Structure)					
Senior Engineer (Mechanical)					
Senior Engineer (Electrical)					
Senior Engineer (Architect)					
Senior Engineer (Build. Services)					
Engineer (Topographic Specialist)					
Engineer (Geotechnical Specialist)					
Environment/Social Campaign Specialist					
Engineer (Specification Specialist)					
Quantity Surveyors					
Total					

5.2 Qualification of Key Team Members

The qualification of Key Team Members of Professional (A) is shown in **Table 3**.

Table 3 Qualification of Key Team Members

Designation	Qualification
Professional (A) International Specialist	
Team Leader	Should have at least 15 years' experience in urban water supply and water related projects. Should have handled at least one urban comprehensive water supply project involving planning, process design, detail design, detailed engineering, construction supervision, monitoring and commissioning. Should have handled at least one Japanese ODA Loan project.
Water Treatment Expert	Should have at least 10 years' experience in urban water supply and water related projects. Should have handled at least one urban water supply project involving progress design, detailed engineering, construction supervision, monitoring and commissioning.
Civil Engineer (Intake Facility & Water Treatment Plant)	Should have at least 7 years' experience in urban water supply and water related projects. Should have handled at least one urban water supply project involving process design, detailed engineering, construction supervision, monitoring and Commissioning.
Senior Pipeline Engineer	Should have at least 7 years' experience in detailed engineering in water conveyance system and distribution network analysis for a minimum length of 50 km and minimum diameter 100 mm. Should have handled at least one urban water supply project.
Mechanical Engineer	Should have at least 10 years' experience in design/detailed engineering of mechanical works and piping in water/waste water treatment plant, pump system and water hammer analysis. Should have handled at least one urban water supply project.
Electrical Engineer	Should have at least 10 years' experience in detailed Engineering of HT/LT installations and pumping machineries in water supply and water related projects with instrumentation with SCADA system. Should have handled at least one urban water supply project.
Professional (B) National Specialist	
Deputy Team Leader	Qualification: • Licensed or Registered Civil Engineer and Graduate (B.Sc.) in Civil Engineering/ construction management and/or related field Experience: • More than 15 years in water supply projects in similar area

Consultant may propose other experts and supporting staff required to accomplish the tasks outlined in the TOR. It is the Consultant's responsibility to select the optimum team and to propose the professionals which he believes best meets the needs of CWASA.

5.3 Scope of Works for the Respective Personnel

Detailed information on the major tasks and duties to be performed by the members of the detailed engineering design team and the construction supervision team is shown in **Table 4**.

Table 4 Major Tasks and Duties of Team Members

Designation	Major Tasks and Duties
Professional (A) (International Specialist)	
Team Leader	Pre-Construction Stage: • General coordination • Supervises the Consultant's services • Assumes direct responsibility for day-to-day consulting services • Represents the Consultant's Team in all matters relating to the performance of services Construction Stage: • General coordination • Supervises the Consultant's services • Assumes direct responsibility for day-to-day consulting services • Represents the Consultant's Team in all matters relating to the performance of services
Water Treatment Expert	Pre-Construction Stage • Review existing designs and specifications • Prepare the basic design and detailed design of the water treatment plant including water intake facilities and other related facilities • Direct the foreign and local engineers attending the detailed designs of the water treatment plant including water intake facilities
Civil Engineer (Intake Facility & Water Treatment Plant)	Pre-Construction Stage • Review structural designs • Assist the water supply expert in preparing the basic design and detailed design of the water treatment plant including water intake facilities • Direct the local engineers attending the detailed designs of the water treatment plant including water intake facilities • Prepare Technical Specifications • Prepare Bills of Quantities Construction Stage • Coordinate and supervise contractors' works for civil engineering of Intake Facility and WTP • Review and approve Shop Drawings/ Construction Drawings for these works submitted by the contractors. • Review and approve test reports for materials submitted by the contractors • Inspect the contractors' works
Senior Pipeline Engineer	Pre-construction stage • Review structural designs • Prepare the basic design and detailed design of water transmission and distribution pipelines and facilities and secondary/tertiary distribution network • Direct the foreign and local engineers attending the detailed designs of water transmission and distribution pipelines and facilities and secondary/tertiary distribution network • Prepare Technical Specifications • Prepare Bills of Quantities ・Direct the local pipeline engineers Construction stage ・Coordinate and supervise the contractor's works ・Review and approve shop drawings submitted by the contractors ・Inspect the contractor's works
Pipeline Engineer (1)	Pre-construction stage • Assist Senior Pipeline Engineer in preparing detailed design, specifications and drawings for conveyance and transmission pipelines and primary distribution mains. Construction stage • Assist Senior Pipeline Engineer in reviewing shop drawings for the above works. • Supervise day-to-day contractors' work performance for the above works.

Designation	Major Tasks and Duties
Pipeline Engineer (2) to (4)	Pre-construction stage • Assist Senior Pipeline Engineer in preparing detailed design, specifications and drawings for secondary/tertiary distribution networks. Construction stage • Assist Senior Pipeline Engineer in reviewing shop drawings for the above works. • Supervise day-to-day contractors' work performance for the above works.
Structure Engineer	Pre-construction stage • Assist Senior Pipeline Engineer in preparing detailed design, specifications and drawings for civil structures. Construction stage • Assist Senior Pipeline Engineer in reviewing shop drawings for the above works.
Mechanical Engineer	Pre-construction stage • Review existing designs • Prepare the basic design of mechanical equipment for the water treatment plant including water intake facilities / water transmission and distribution facilities • Direct the local mechanical engineers attending the detailed designs of mechanical works for the water treatment plant including water intake facilities / water transmission and distribution facilities • Prepare Specifications for mechanical works • Prepare Bill of Quantities for mechanical works Construction stage • Check the shop drawings submitted by the contractors • Assess the substitution of products proposed by the contractors • Supervise the installation work of mechanical equipment • Attend the factory inspection together with CWASA's engineer, if requested • Attend the trial operation of mechanical equipment
Electrical Engineer	Pre-construction stage • Review existing designs • Prepare the basic design of electrical equipment for the water treatment plant including water intake facilities / water transmission and distribution facilities • Direct the local electrical engineers attending the detailed designs of the water treatment plant including water intake facilities / water transmission and distribution facilities • Prepare Specifications for electrical works • Prepare Bill of Quantities for electrical works Construction stage • Check the shop drawings submitted by the contractors • Assess the substitution of products proposed by the contractors • Supervise the installation work of electrical equipment • Attend the factory inspection together with CWASA's engineer, if requested • Attend the trial operation of mechanical equipment
O&M Specialist (Water Treatment Plant)	Construction stage • Review and contractors' proposed O&M supervision work program and training programs for WTP including Intake Facility and Reservoirs • Coordinate the contractor's commissioning works • Coordinate the contractor's O&M supervision and training for WTP, Intake Facility and Reservoirs, including SCADA system • Monitor and assess the effect of training and instruct any improvement of training services if necessary • Prepare O&M manuals on WTP sludge treatment and SCADA system management • Provide training on the above and any other particular aspects supplement to the contractors' training services
O&M Specialist (Distribution Control System)	Construction stage • Review and contractors' proposed O&M supervision work program and training programs for Distribution Control System • Coordinate the contractor's commissioning works

Designation	Major Tasks and Duties
	• Coordinate the contractor's O&M supervision and training for Distribution Control System • Monitor and assess the effect of training and instruct any improvement of training services if necessary • Prepare O&M manuals on water pressure monitoring and control at Sector inlet chambers and leakage investigation and repairs at DMA inlet chambers • Provide training on the above and any other particular aspects, supplement to the contractors' training services
Specification Specialist	Pre-construction stage • Review and formalize all specification documents to be incorporated in the Bidding Documents
Environment/Social campaign Specialist	Pre-construction stage/ construction stage • Prepare environmental monitoring program to be carried out by CWASA • Assist CWASA in initial set-up of environmental monitoring program • Prepare the CWASA's campaign program and action program for public education and awareness of public water supply and beneficiaries' obligations and promotion of applications for house connections to be carried out by CWASA • Guide and assist CWASA 's in initial set-up of these action programs • Assist CWASA in carrying out these actions. • Monitor the effect of these campaign programs and improve programs if necessary.
Costing Engineer	Pre-construction stage • Prepare the Engineer's Cost Estimates for the Project • Assist the Civil Engineer and Senior Pipeline Engineer in finalizing Bill of Quantities
Contract Specialist	Pre-construction stage • Prepare Bidding Documents and Evaluation Criteria • Assist CWASA in conducting bidding process • Coordinate consultant's bid evaluation and prepare bid evaluation reports • Assist Team Leader in presentation to and discussion with CWASA as well as liaison with JICA on the bid evaluation Construction stage • Assist CWASA in contract administration • Assist Team Leader in presentation to and discussion with CWASA as well as liaison with JICA on contractual matters
Professional (B) (National Specialist)	
Deputy Team Leader	• Assist Team Leader in carrying out all tasks and duties of Team Leader • Represent the Consultant's team during absence of the Team Leader • Perform specific issues/aspects delegated by Team Leader
Senior Engineer (Intake and WTP)	Pre-construction stage • Assist Professional (A) Civil Engineer (Intake Facility & Water Treatment Plant) in carrying out site survey/investigation and collecting local data and information related to civil works for Intake Facility, WTP and Reservoirs • Assist Professional (A) Civil Engineer (Intake Facility & Water Treatment Plant) in carrying out detailed design of civil structure and buildings • Prepare drawings for these facilities Construction stage • Assist Professional (A) Civil Engineer (Intake Facility & Water Treatment Plant) in carrying out day-to-day supervision of the contractors' works for Intake Facility, WTP and Reservoir/Elevated Tank construction
Senior Engineer (Pipeline – 1 & 2)	Pre-construction stage • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out the pipeline route survey/investigation and collecting local data and information related to Conveyance and Transmission Pipelines and Primary Distribution Mains • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out detailed design of Conveyance and Transmission Pipelines and Primary Distribution Mains • Prepare drawings for these pipelines

Designation	Major Tasks and Duties
	Construction stage • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out day-to-day supervision of the contractors' works for these Pipelines
Senior Engineer (Pipeline – 3, 4 & 5)	Pre-construction stage • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out the pipeline route survey/investigation, trial digging and collecting local data and information related to Secondary/Tertiary Distribution Networks • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out detailed design of Secondary/Tertiary Distribution Networks • Prepare drawings for these pipelines Construction stage • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out day-to-day supervision of the contractors' works for these pipelines and relevant facilities
Senior Engineer (Pipeline – 6 & 7)	Pre-construction stage • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out the pipeline route survey/investigation and collecting local data and information related to Conveyance and Transmission Pipelines and Primary Distribution Mains • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out detailed design of Conveyance and Transmission Pipelines and Primary Distribution Mains • Prepare drawings for these pipelines
Senior Engineer (Pipeline – 8, 9 & 10)	Pre-construction stage • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out the pipeline route survey/investigation, trial digging and collecting local data and information related to Secondary/Tertiary Distribution Networks • Assist Professional (A) Senior Pipeline Engineer and Pipeline Engineers in carrying out detailed design of Secondary/Tertiary Distribution Networks • Prepare drawings for these pipelines
Senior Engineer (Structure)	Pre-construction stage • Assist Professional (A) Structure Engineer in detailed design of civil structures Construction stage • Assist Professional (A) Structure Engineer in carrying out day-to-day supervision of the contractors' civil structure works
Senior Engineer (Mechanical)	Pre-construction stage • Assist Professional (A) Mechanical Engineer in detailed design of mechanical works Construction stage • Assist Professional (A) Mechanical Engineer in carrying out day-to-day supervision of the contractors' mechanical works
Senior Engineer (Electrical)	Pre-construction stage • Assist Professional (A) Electrical Engineer in detailed design of electrical works Construction stage • Assist Professional (A) Electrical Engineer in carrying out day-to-day supervision of the contractors' electrical works
Senior Engineer (Architect)	Pre-construction stage • Assist Professional (A) Civil Engineer in architectural design of buildings • Prepare drawings for buildings Construction stage • Assist Professional (A) Civil Engineer in reviewing shop drawings for buildings • Assist Professional (A) Civil Engineer in carrying out day-to-day supervision of the contractors' building works
Senior Engineer (Build. Services)	Pre-construction stage • Assist Professional (A) Mechanical Engineer and Electrical Engineer in detailed design of building services Construction stage • Assist Professional (A) Mechanical Engineer and Electrical Engineer in reviewing shop drawings for building services • Assist Professional (A) Mechanical Engineer and Electrical Engineer in carrying out

Designation	Major Tasks and Duties
	day-to-day supervision of the contractors' works for building services • Assist Professional (A) Mechanical Engineer and Electrical Engineer in carrying out on-site inspection and installation inspection of the delivered building service equipment • Assist Professional (A) Mechanical Engineer and Electrical Engineer in carrying out on-site inspection, installation inspection and tests of the delivered building service equipment
Engineer (Topographic Specialist)	Pre-construction stage • Supervise topographic surveyors to be carried out by Topographic Surveyors • Assist Professional (A) Civil Engineer in reviewing Topographic Survey Reports submitted by the Topographic Surveys and determining topographic conditions for detailed design
Engineer (Geotechnical Specialist)	Pre-construction stage • Supervise geotechnical surveyor and investigations to be carried out by Geotechnical Surveyors • Assist Professional (A) Civil Engineer in reviewing Geotechnical Survey Reports submitted by the Geotechnical Surveys and determining geotechnical conditions for detailed design
Environment/Social Campaign Specialist	• Assist the duties and works to be carried out by Professional (A) Environment/Social Campaign Specialist
Engineer (Specification Specialist)	• Assist the duties and works to be carried out by Professional (A) Specification Specialist, in particular inputting local regulations and practices and other particular conditions in Bangladesh
Quantity Surveyors	Pre-construction stage • Assist Professional (A) Costing Specialist in collecting local cost data and information and estimating local components of works Construction stage • Assist Professional (A) Engineers and Contract Specialist in measuring quantities of contractors' works claimed for monthly payments and also assist Professional (A) Team Leader and Contract Specialist in certifying contractors' monthly bills • Assist Professional (A) Contract Specialist in contract administration, in particular variation orders and so on • Assist Professional (A) Team Leader and Contract Specialist in reviewing and certifying final measurements and accounts submitted by the contractors • Assist Professional (A) Team Leader in monitoring financial progress of works and estimating payment/disbursement amount for the coming few months • Assist Professional (A) Team Leader in preparing financial monitoring reports to be submitted to CWASA and JICA

Chapter 6 Reporting

Within the scope of consulting services, the Consultant shall prepare and submit reports and documents to Project Director/ Project Manager in charge in CWASA as shown in **Table 5**. The Consultant shall provide electronic copy of each of these reports.

Table 5 Summary of Reports to Be Submitted

Category	Type of Report	Timing	No. of Copies
Consultancy Services	Inception Report	Within 1 month after commencement of the services	10
	Monthly Progress Report	Every month	10
	Quarterly Progress Report	Every quarter	10
	Project Completion Report (for submission to JICA)	At the end of the services	10

Category	Type of Report	Timing	No. of Copies
Detailed Design	Project Definition Report	Within 3 months after commencement of the services	10
	Draft Design Report	Within 8 months after commencement of the services	10
	Cost Estimate Report	As per the Project Schedule for each Package	10
	Final Design Report	As per the Project Schedule for each Package	10
Tender Assistance	Pre-qualification Document	As per the Project Schedule for each Package	10
	Bidding Document	As per the Project Schedule for each Package	10
	Pre-qualification Evaluation Report	At appropriate timing	10
	Technical Evaluation Report	At appropriate timing	10
	Price and Commercial Evaluation Report	At appropriate timing	10
Assistance in Environment Monitoring	Environmental Monitoring Report	Every quarter after commencement of the services	10
Construction Supervision	Construction Completion Report	Within 3 months after completion of construction	10
Technology Transfer	O&M Manual	At appropriate timing in accordance with the Inception Report	10
	Evaluation Report of Contractors' Training Services	Within 1 month after completion of training	10
Other Report	Technical Report	As required or upon request	As required

Contents to be included in each report are as follows:

(1) For Inception Report
   (a) **Inception Report**: presents the methodologies, schedule, organization, etc.

(2) For Monthly and Quarterly Progress Report
   (a) **Monthly Progress Report**: describes briefly and concisely all activities and progress for the previous month by the 10th day of each month. Problems encountered or anticipated will be clearly stated, together with actions to be taken or recommendations on remedial measures for correction. Also indicates the work to be performed during the coming month.
   (b) **Quarterly Progress Report**: presents the progress status of the Project.

(3) For Detailed Design
   (a) **Project Definition Report**: presents the design criteria and standards.
   (b) **Draft Design Report**: presents detailed engineering design.
   (c) **Cost Estimate Report**: presents detailed cost estimate.
   (d) **Final Design Report**: presents final documents of detailed design and cost estimate and bid plan through the incorporation of comments on the Draft Design Report provided by the Consultant.

(4) For Tender Assistance
   (a) **Pre-qualification Document**: presents the pre-qualification documents and its evaluation criteria.
   (b) **Bidding Document**: presents the bidding documents and bid evaluation criteria.
   (c) **Pre-qualification Evaluation Report**: presents the results of the evaluation with recommendation on the selection of the qualified applicants.

(d) **Technical Evaluation Report**: presents the results of technical evaluation with recommendation on technically responsive bidders.
(e) **Price and Commercial Evaluation Report**: presents the results of the tenders with recommendation on the successful bidder for award of contract.

(5) For Assistance in Environment Monitoring
(a) **Environmental Monitoring Report**: presents the environmental impacts and implementation of environmental mitigation measures during and after the construction stage. Environmental monitoring forms attached as **Appendix 1** shall be filled and attached to the Report.

(6) For Construction Supervision
(a) **Construction Completion Report**: comprises outline of all facilities completed and construction records from the commencement through completion, together with key data and records.

(7) For Technology Transfer
(a) **O&M Manuals**: comprises the contents mentioned in 3.6 (b) (i) & (ii)
(b) **Evaluation Report of Contractors' Training Services**: presents the evaluation of contractors training services

Chapter 7 Obligations of the Executing Agency

A certain range of arrangements and services will be provided by CWASA to the Consultant for smooth implementation of the Consulting Services. In this context, CWASA will:

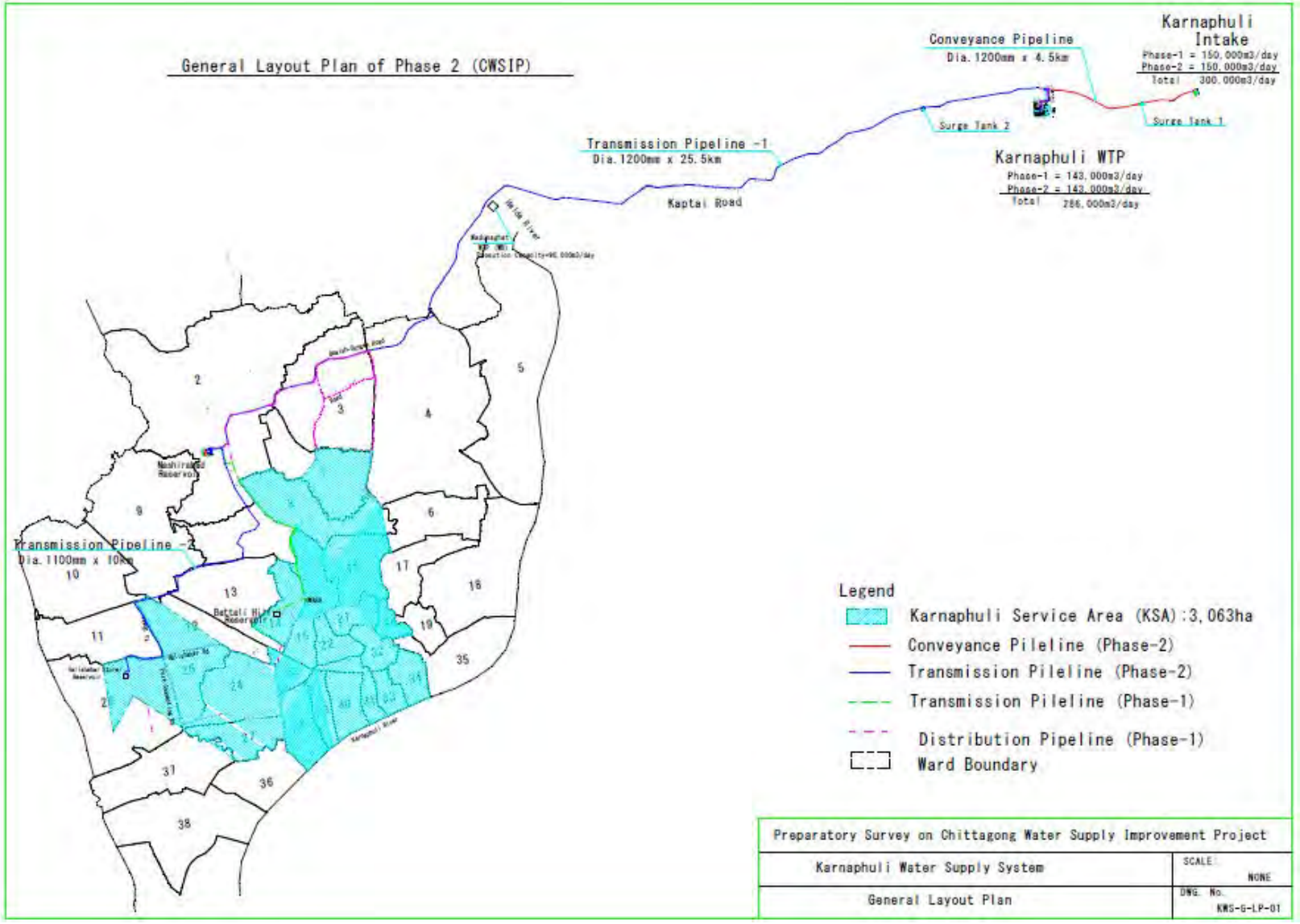
(1) Reports and data
Make available to the Consultant existing reports and data related to the Project as required.

(2) Office space
Provide an office space in CWASA with necessary equipment, furniture and utility. However, the Consultant's requirement for office space, including necessary equipment, furniture and utilities, shall be clearly stated in the proposal with its rental cost for the case where CWASA would be unable to provide such facilities;

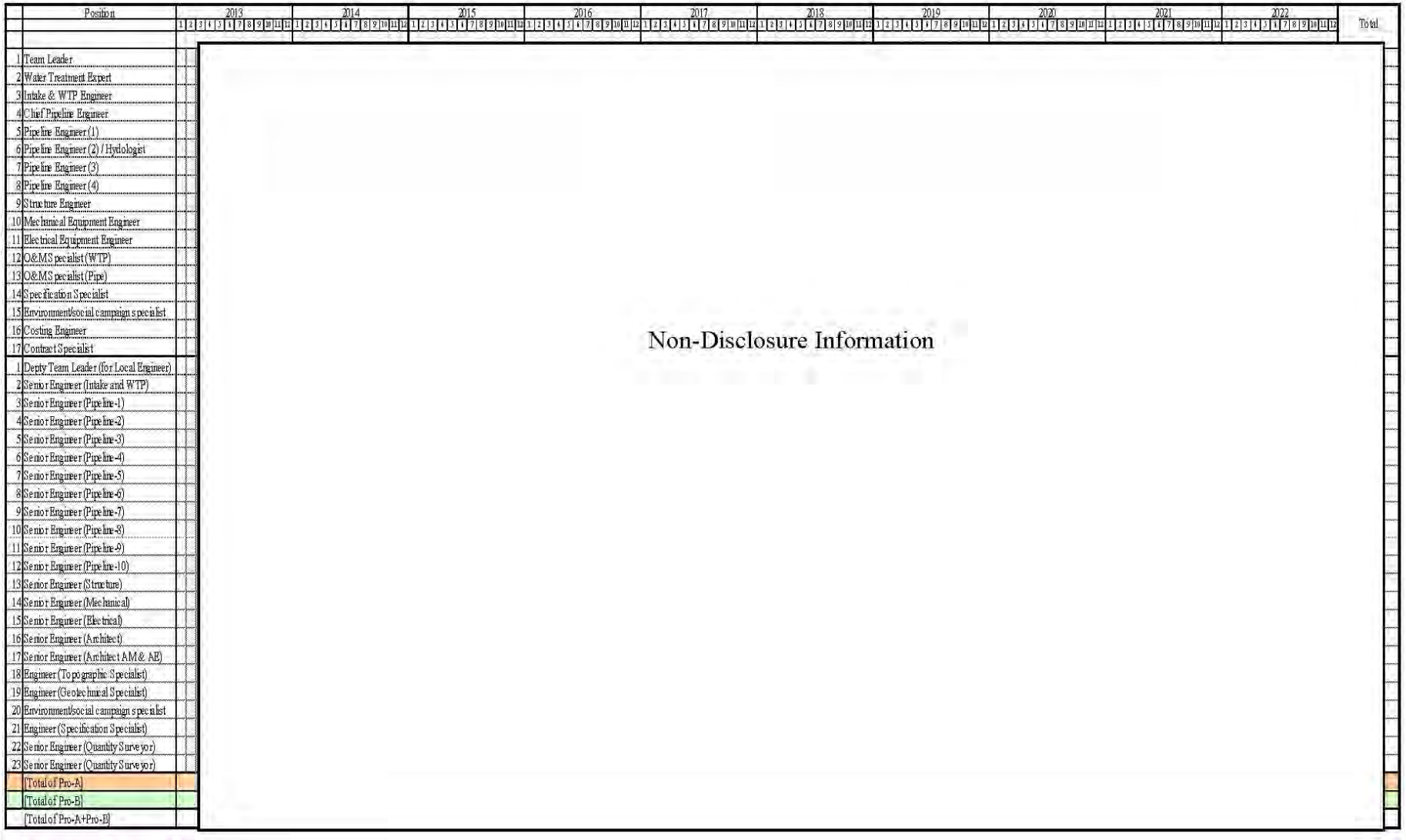
(3) Cooperation and counterpart staff
Appoint counterpart officials, agent and representative as may be necessary for effective implementation of the Consulting Services;

(4) Assistance and exemption
Use its best efforts to ensure that the assistance and exemption, as described in the Standard Request for Proposal issued by JICA, will be provided to the Consultant, in relation to:
- work permit and such other documents;
- entry and exit visas, residence permits, exchange permits and such other documents
- clearance through customs;
- instructions and information to officials, agent and representatives of the GOB;
- exemption from any requirement for registration to practice their profession;
- privilege pursuant to the applicable law in Bangladesh.

Attachment 1



Attachment 2



11.7 Basis of Cost Estimation for Construction Works of Phase 2

1. Basis of cost estimation for Phase 2

Biddings of Karnaphuli Water Supply Project (Phase 1) were conducted as bellow times;

Table 11.1 Bidding Submission Date

Contract	date
C-1 Intake and WTP	20th July, 2010
C-2 Pipeline	27th July, 2010
C-3 Reservoir	19th April,2010

Construction Cost of Phase 2 will be estimated by referring the Phase 1 because conditions of construction such as local material, labour, soil, and traffic etc. are almost same one. However, basically Price escalation should be considered during 2 or 3 years as bellow;

Foreign price; $(1+ 1\%)^3 = 1.03 =$about 1.05
Local Price; $(1+3\%)^3 = 1.09 =$ about 1.10

On the other hand, the contracted price of C-1 was discounted as bellow so that appropriate cost should be considered.

Table 11.2 Contracted Price of C-1

Description		Amounts	
		Local Currency Portion (BDT)	Foreign Currency Portion (JPY)
A.	Grand Total of BOQ Amounts**1)	Non-Disclosure Information	
B.	Less: Discount**2)		
C.	Accepted Contract Amount (A.−B.)		

2. Pipeline

2.1 Analysis of Phase 1 Project (C-2)

(1) Composition of construction cost

Construction cost of pipeline for Phase 1 was consisted of following items as shown in Table 11.3

Table 11.3 Items of Construction Cost for Pipeline in Phase 1Project

Item		Work/ Material	
1	Supply of Pipes, Valve s and Fittings	DI Pipe and Steel Pipe	Standard S/S joints
			Restrained joint system
		Air Valves and Associated pipes & Fittings	
		Washout Valve and	

		Associated Pipes & Fittings	
		Butterfly Valve and Associated Pipes & Fittings	
		Butterfly Valve and Associated Pipes & Fittings	
2	Laying and Fitting of Pipes, Valve and Fittings	Pipe works-DI Pipes	Standard S/S joints depending on excavation depth
			Restrained joint system depending on excavation depth
		Pipe works -Fittings	
		Fittings for Air Valves	
		Fittings for Washout	
		Fittings for Valves	
		Steel Pipes for over crossing	
		Steel pipes for over crossing with pile	
		Water Course/Culvert Crossings	
		Pipe Jacking	
3	Payment for permanent road reinstatement		

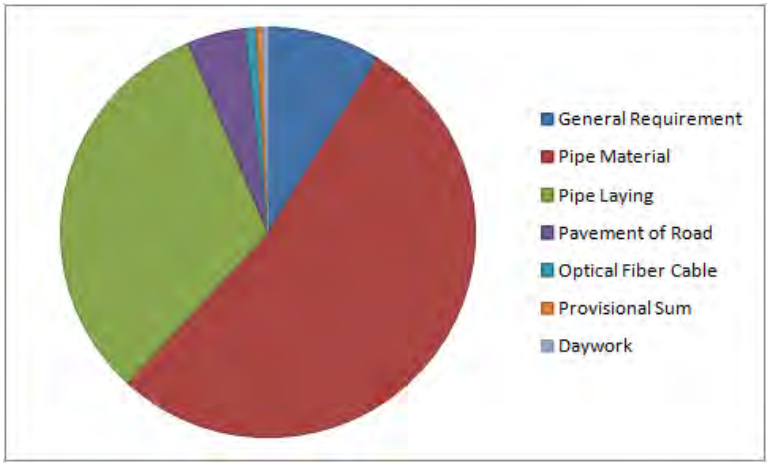
(2) Composition of the Contracted cost for C-2 in Phase 1 Project

The Contracted cost for C-2 in Phase1 Project is shown in Table 2, in which Pipe Material cost, ranging from DN300mm to DN 1200mm, cover more than 50% of Total Cost. However, Material Cost of Conveyance/Transmission Pipe from Intake/WTP, to Battali Hill Reservoir via. Nashirabad Reservoir, which are almost DN1200mm pipe, account for about 80% of total material cost.

Table 11.4 Cost Breakdown of C-2 (Pipeline) in Phase 1 Project

KMJV (Rev.)		JPY	%
Part 1	General Requirement	Non-Disclosure Information	
Part 2-1	Pipe Material		
Part 2-2	Pipe Laying		
Part 2-3	Pavement of Road		
Part 3	Optical Fiber Cable		
Part 4	Provisional Sum		
Part 5	Daywork		
Total			

Note) Revised BOQ submitted on 22nd August 2011



(3) Unit price of pipe in Phase 1 Project

<Material Cost>

According to Table 11.5, Unit price of Restrained Joint System is more than 1.5 times than Unit price of Standards S/S Joints. Compared with the published price in Japan, in case of more than DN 900mm pipes, Unit price of Standard S/S Joints are almost same as Published price in Japan (2009). However, in case of less than DN 700mm pipes imported from India, Unit price of Standard S/S Joints are almost 50% of the Published price in Japan (2009).

Table 11.5 Contracted Unit Price of pipe material in Phase1 Project

(JPY/m)

Dia.	Phase1 Project		Published Price in Japan (2009); K type
	Standard S/S Joints	Restrained Joint System	
1200mm	Non-Disclosure Information		
1000mm			
900mm			
800mm			
700mm			
500mm			
450mm			
400mm			
300mm			

Note) Unit Prices are rounded and DI Pipes of less than DN700m are imported from India.

<Pipe laying Cost by excavation depth>

Compared with pipe laying cost in Japan, Cost of Phase 1 is about 50%.

Table 11.6 Contracted Unit Price of Pipe Laying in Phase1 Project

(JPY/m)

Dia.	Phase1 Project Standard S/S Joints	Rough cost estimation in Japan
1200mm	1.5m<d<2m	Non-Disclosure Information
	2m<d<3m	
	3m<d<5m	
	d>5m	
1000mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	
900mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	
800mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	
700mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	
500mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	
450mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	
400mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	
300mm	1.5m<d<2m	
	2m<d<3m	
	3m<d<5m	
	d>5m	

Note) Pipe laying cost depends on soil condition etc.

(4) Total unit construction cost of pipeline works

Total construction cost of pipeline works in Phase1 including pipe material cost (standard S/S straight pipe, restrained joint system, air valve, washout, butterfly valve etc), and pipe laying cost (depending on excavation depth, fittings works, pipe over crossing works, under passing, pipe jacking works etc.) are summarized in Table 11.7. But road pavement is not included in this price.

Table 11.7 Total Unit Construction Cost of Pipeline Works in Phase 1

Location	Dia.	Unit Price (per m)			Reference
		Taka	JPY	Converted JPY	
Conveyance Pipeline	1200mm	Non-Disclosure Information			
Transmission Pipeline 1 (WTP to Nashirabad Reservoir)	1200mm				Including Water bridge, jacking etc
Transmission Pipeline 2 (Nashirabad Reservoir to Battali Hill Reservoir)	1200mm				
	1000mm				Including jacking
Distribution pipeline					
N 5.1	1200mm				
N5.2	900mm				
N5.3	450mm				
N5.4	300mm				
N5.5	400mm				
N5.6	300mm				
N5.7	400mm				
N5.8	300mm				
N5.9	400mm				
N5.10	700mm				
C6.6	500mm				
C6.7	400mm				
C6.8	500mm				
C6.9	400mm				
C6.10	300mm				
S7.1	900mm				
S7.2	700mm				
S7.3	500mm				
S7.4	300mm				
S7.5	400mm				
S7.7	300mm				
S7.8	400mm				
S7.9	500mm				
S7.10	700mm				
S7.11	300mm				

Note) 1 BDT = 1.2 JPY in 2010, figures are rounded.

2.2 Proposed Unit Price for Phase 2

(1) Pipeline works

Table 11.8 shows the proposed total unit construction cost of pipeline works in Phase2 including price escalation for distribution Pipeline.

Table 11.8 Proposed Total Unit Construction Cost of Pipeline Works in Phase 2

Material	Dia.	Unit Price (m)			
		Phase1 Project		Phase 2 Project	
		Taka	JPY	Taka	JPY
DIP	1200mm	Non-Disclosure Information			
	1200mm				
	1200mm				
	1200mm				
	1100mm				
	1000mm				
	900mm				
	900mm				
	800mm				
	700mm				
	700mm				
	700mm				
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	400mm				
	400mm				
	300mm				
	300mm				
	300mm				
	300mm				
	300mm				
	300mm				
	300mm				
PVC	250mm				
	200mm				
	150mm				
	100mm				
	75mm				

Note) Material cost of PVC is applied by price in Japan

(2) Sector Inlet Chamber

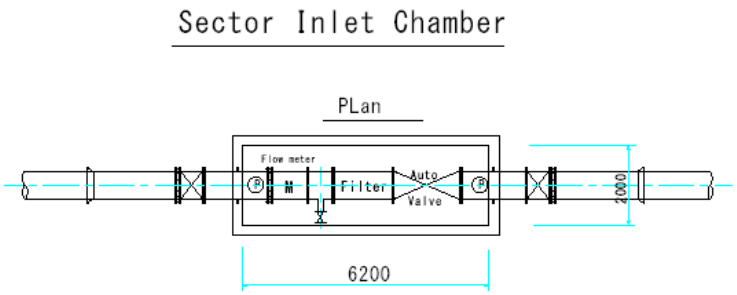


Table 11.9 Total Cost of Sector Inlet Chamber

	Unit	Quantity	Rate		Total	
			Taka	JPY	Taka	JPY
Pressure Control Valve	Set	10	Non-Disclosure Information			
Maintenance Valve	Set	20				
Distribution Flow	Set	10				
Distribution Pressure	Set	10				
Valve Control Panel	Set	10				
Telemetry System (Local)	Set	10				
Telemetry System (Central)	Set	1				
Central Monitoring System	Set	1				
Other (10%)	Ls	1				
Chamber	Nr	10				
Total						

(3) DMA Inlet Chamber

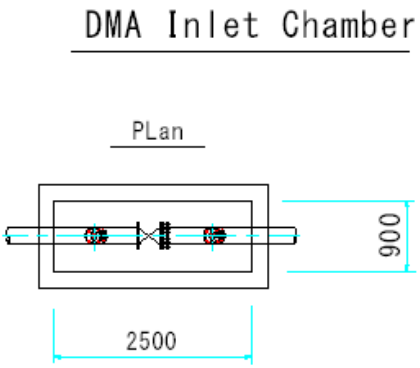
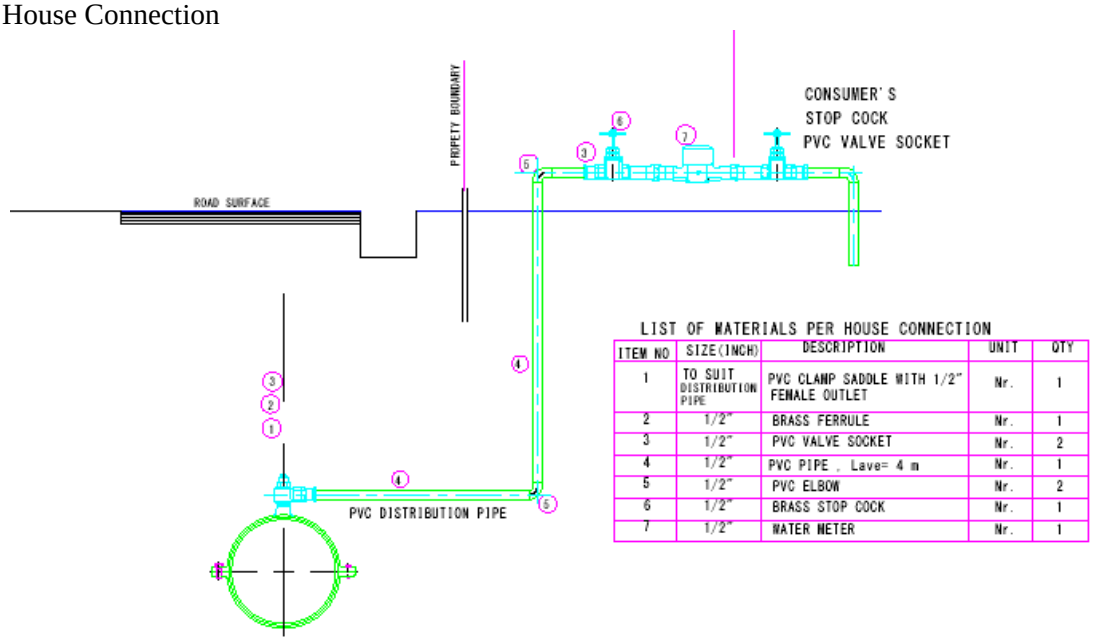


Table 11.10 Unit Cost of DMA Inlet Chamber

	Unit	Quantity	Rate		Total	
			Taka	JPY	Taka	JPY
Fire Hydrant	set	2	Non-Disclosure Information			
Valve	set	1				
Chamber	Nr	1				
Total						

(4) House Connection



LIST OF MATERIALS PER HOUSE CONNECTION

ITEM NO	SIZE(INCH)	DESCRIPTION	UNIT	QTY
1	TO SUIT DISTRIBUTION PIPE	PVC CLAMP SADDLE WITH 1/2" FEMALE OUTLET	Nr.	1
2	1/2"	BRASS FERRULE	Nr.	1
3	1/2"	PVC VALVE SOCKET	Nr.	2
4	1/2"	PVC PIPE , Lave= 4 m	Nr.	1
5	1/2"	PVC ELBOW	Nr.	2
6	1/2"	BRASS STOP COCK	Nr.	1
7	1/2"	WATER METER	Nr.	1

Table 11.11 Unit Cost of House Connection

	Unit	Quantity	Rate		Total	
			Taka	JPY	Taka	JPY
Saddle & Ferrules (100mm)	set	1	Non-Disclosure Information			
PVC Pipe (20mm)	m	6				
Valve (20mm)	set	1				
Water Meter	set	1				
Laying works	Ls	1				
Total						

3. Intake and Water Treatment Plant

Appropriate Bided price of C-1, compared with Engineer's estimates, is applied for Phase 2 Project.

Table 11.12 Bided price of Phase 1

		LC (Taka)	FC(JPY)	reference
Intake	Plant Mechanical Works	Non-Disclosure Information		Phase 1
				Phase 2
	Plant Electrical Works			Phase 1
				Phase 2
	No1. Surge Tank			Phase 1
				Phase 2 (10%up)
WTP	Sedimentation Basin			Phase 1
	ditto			Without Pile
				Phase 2 (10%up)
	Pile (1m)			Phase 1
				Phase 2 (10%up)
	Filter			Phase 1
				Phase 2 (10%up)
	Filter Drain Tank			V=6,900m^3 Without Pile

		LC (Taka)	FC(JPY)	reference
		Non-Disclosure Information		Phase 2 (10%up)
	Clear Well Reservoir			Phase 1
				Phase 2 (10%up)
	Electrical Building			Phase 1
				Phase 2 (10%up)
	Chlorine Building			Phase 1
				Phase 2 (10%up)
	Site works			10.5ha
				Road in Phase 2
	No.2 Surge Tank			Phase 1
				Phase 2 (10%up)
	Plant Mechanical Works			Phase 1
				Phase 2
	Plant Electrical Works			Phase 1
				Phase 2

<Mechanical Works for Phase 2> Intake

Item	Description	Unit	Quantity	Rate		Total Amount	
				Component		Component	
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)
	Intake Facility						
1	Intake Pump and Motor complete	Nr	2				
2	Check Valve	Nr	2				
3	Discharge Valve (HV)	Nr	2				
4	Discharge Valve (MV)	Nr	2				
5	Flow Control Valve complete	Nr	1				
6	Supply all pipe work, valves and fittings complete (excluded the above-mentioned valves)	LS	Lump Sum				
7	Installation of all pipe work, valves and fittings	LS	Lump Sum				

Non-Disclosure Information

<Electrical Works for Phase 2> Intake

Item	Description	Unit	Qt'ty	Rate		Total Amount		
				Component		Component		Custom Duty. (Taka)
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)	
	Intake facilities (Electrical) – Phase 2							
	Power Supply Facilities	lot	1					
	– 33kV VCB, 1000kVA Transformer							
	Standby Generator Facilities	lot	1					
	– 1000kVA Diesel Engine Generator							
	Control & Operation Facilities	lot	1					
	– Pump Starter Panel (3kV VFD), 400V MCC, Local Panel							
	Instrumentation facilities	lot	1					
	– Electromagnetic Flow Meter, Indication Panel							
	SCADA & Automatic Control Facilities	lot	1					
	– PCL Panel, SCADA System							
	Other Necessary Items	lot	1					
	Intake Facilities (Electrical) – Phase 2							

Non-Disclosure Information

<Mechanical Works for Phase 2> WTP

Item	Description	Unit	Quantity	Rate		Total Amount	
				Component		Component	
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)
	Mixing Chamber/ Clarifier Facility						
1	Flash Mixer complete	Nr	2				
2	Inlet Weir complete	Nr	2				
3	Inlet Gate complete	Nr	8				
4	Sludge Collector complete	Nr	8				
5	De-sludge Valve complete	Nr	32				
6	Drain Pump complete	Nr	4				
7	Polymer Tank complete	Nr	2				
8	Alum Share Box complete	Nr	1				
9	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				
10	Installation of all pipe work, valves and fittings	LS	Lump Sum				
	Filter Facility						
1	Inflow Valve complete	Nr	10				
2	Filtrated & Backwash Valve complete	Nr	10				
3	Surface-wash valve complete	Nr	10				
4	Wash Waste Valve and Franged Spigot with Puddle Dia.1000mm	Nr	10				
5	Drain Pump complete	Nr	4				
6	Surface-wash Pipe Unit complete	Nr	10				
7	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				
8	Installation of all pipe work, valves and fittings	LS	Lump Sum				

Non-Disclosure Information

Item	Description	Unit	Quantity	Rate		Total Amount	
				Component		Component	
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)
	Clear Well Facility						
1	Transmission Pump and Motor complete	Nr	5				0
2	Suction Valve -1	Nr	5				0
3	Check Valve -1	Nr	5				0
4	Discharge Valve -1(HV)	Nr	5				0
5	Discharge Valve -1(MV)	Nr	5				0
6	Surface wash Pump and Motor complete	Nr	3				0
7	Suction Valve -2	Nr	3				0
8	Check Valve -2	Nr	3				0
9	Discharge Valve -2	Nr	3				0
10	Isolation Valve	Nr	2				0
11	Drain Pump complete	Nr	4				0
12	Overhead Crane complete	Nr	1				0
13	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				0
14	Installation of all pipe work, valves and fittings	LS	Lump Sum				0
	Chemical Facility						
1	ALUM Mixer complete	Nr	2				0
2	ALUM Pump and Motor complete	Nr	4				0
3	LIME Mixer complete	Nr	2				0
4	LIME Pump and Motor complete	Nr	3				0
5	Lime Dust Collector	Nr	2				0
6	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				0
7	Installation of all pipe work, valves and fittings	LS	Lump Sum				0

Non-Disclosure Information

Item	Description	Unit	Quantity	Rate		Total Amount	
				Component		Component	
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)
	Chlorine Facility						
1	Chlorine Cylinder	Nr	18				
2	Weight Scale complete	Nr	2				
3	Chlorinator complete	Nr	3				
4	Chlorine Booster Pump and Motor complete	Nr	3				
5	Chlorine Booster Valve complete	Nr	1				
6	Chlorine Crane complete	Nr	1				
7	Exhaust Fan complete	Nr	7				
8	Chlorine Leak Detector complete	Nr	1				
9	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				
10	Installation of all pipe work, valves and fittings	LS	Lump Sum				
	Sludge Receiving Tank Facility						
1	Sludge Inlet Valve complete	Nr	4				
2	Isolation Gate complete	Nr	1				
3	Sludge Mixer complete	Nr	6				
4	De-Sludge Pump and Motor complete	Nr	4				
5	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				
6	Installation of all pipe work, valves and fittings	LS	Lump Sum				
	Sludge Thickener Facility						
1	Thickener 1 complete	Nr	2				
2	Thickener 2 complete	Nr	2				
3	Thickened Sludge Pump 1 complete	Nr	4				
4	Thickened Sludge Pump 2 complete	Nr	3				
5	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				
6	Installation of all pipe work, valves and fittings	LS	Lump Sum				
	Supernatant Tank Facility						
1	Sludge Inlet Valve complete	Nr	2				
2	Isolation Gate complete	Nr	1				
3	Supernatant Pump complete	Nr	4				
4	Supply all pipe work, valves and fittings complete (Excluded the above-mentioned valves)	LS	Lump Sum				
5	Installation of all pipe work, valves and fittings	LS	Lump Sum				

Non-Disclosure Information

<Electrical Works for Phase 2> WTP

Item	Description	Unit	Quantity	Rate Component Local (Taka)	Rate Component Foreign (Yen)	Total Amount Component Local (Taka)	Total Amount Component Foreign (Yen)	Custom Duty, (Taka)
	WTP Facilities (Electrical) -Phase2							
	Power Supply Facilities	lot	1					
	・33kV VCB, 3500kVA Transformer							
	Standby Generator Facilities	lot	1					
	・3500kVA Diesel Engine Generator							
	Control & Operation Facilities	lot	1					
	・Pump Starter Panel (3kV VFD, 3kV Soft Starter), 400V MCC, Local Panel							
	Instrumentation Facilities	lot	1					
	・Electromagnetic Flow Meter, Ultrasonic Level Sensor, Indication Panel							
	SCADA & Automatic Control Facilities	lot	1					
	・PLC Panel, SCADA System							
	Other Necessary Item	lot	1					
	WTP Facili							

Non-Disclosure Information

4. Nashirabad Reservoir and Halishahar Elevated Tank

Bided price of C-3 is applied for Phase 2 Project as shown in Table 11.12.

Table 11.12 Bided price of Phase 1

	LC (Taka)	FC(JPY)	reference
Nashirabad Reservoir	Non-Disclosure Information		V=26,300m^3
			Phase 1
			Phase 2 (10%up)
Elevated Tank			V=2,200m^3
			Phase 2 (10%up)
Guard & Electrical House			Phase 1
			Phase 2 (10%up)

Table 11.13 Construction cost for Phase 2

	LC (Taka)	FC(JPY)	reference
Nashirabad Reservoir	Non-Disclosure Information		
1) Mechanical Works			
2) Electrical Works			
Halishahar Elevated Tank			
1) Mechanical Works			
2) Electrical Works			

<Mechanical Works for Phase 2> Nashirabad Reservoir

Item	Description	Unit	Quantity	Rate (Component)		Total Amount (Component)	
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)
1	Battali Hill Transmission Pump and Motor complete (dismantlement)	Nr	5	Non-Disclosure Information			
2	Battali Hill Transmission Pump and Motor complete	Nr	5				
3	Halishar Transmission Pump and Motor complete(Reinstallation)	Nr	4				
4	Suction Valve - 3 and Discharge Valve - 3 complete	Nr	8				
5	Check Valve - 3 complete	Nr	4				
6	Inlet Valve-1 (Nashirabad Reservoir) complete	Nr	1				
7	Isolation Valve-2	Nr	2				
8	Drain Pump complete	Nr	2				
9	Supply all pipe work, valves and fittings complete (excluded the above mentioned valves)	LS	Lump sum				
10	Installation of all pipe work, Valves and fittings	LS	Lump sum				

<Mechanical Works for Phase 2> Halishahar Elevated Tank

Item	Description	Unit	Quantity	Rate (Component)		Total Amount (Component)	
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)
1	Motor Driven Discharge / Bypass Batterfly Valve complete	Nr	2	Non-Disclosure Information			

<Electrical Works for Phase 2> Nashirabad Reservoir

Item	Description	Unit	Quantity	Rate		Total Amount		
				Component		Component		Custom Duty,
				Local (Taka)	Foreign (Yen)	Local (Taka)	Foreign (Yen)	(Taka)
	Nashirabad Facilities (Electrical) -Phase2							
	Power Supply Facilities	lot	1					
	・11kV VCB, 2000kVA Transformer, LV Transformer							
	Standby Generator Facilities	lot	1					
	・1000kVA Diesel Engine Generator							
	Control & Operation Facilities	lot	1					
	・Pump Starter Panel (3kV Soft Starter), 400V MCC, Local Panel							
	Instrumentation Facilities	lot	1					
	・Electromagnetic Flow Meter, Ultrasonic Level Sensor, Indication Panel							
	SCADA & Automatic Control Facilities	lot	1					
	・PLC Panel, SCADA System							
	Other Necessary Item	lot	1					
	Nashirabad Fac							

Non-Disclosure Information

Quantity Survey of Pipeline

Upstream to Sector Valve

Primary Distribution Pipeline

Sector	Diameter (mm)										Total
	200	300	400	500	600	700	800	900	1000	1200	(m)
0 Sector	-	-	-	-	-	-	-	-	-	-	-
A Sector	0	0	0	0	0	0	0	0	0	0	0
B Sector	0	0	0	0	0	74	1,374	0	0	0	1,448
C Sector	0	0	0	0	0	0	43	0	0	0	43
D Sector	0	0	0	0	0	0	0	0	0	0	0
E Sector	0	0	0	0	0	0	0	0	0	0	0
F Sector	0	0	0	0	44	0	84	2	1,185	0	1,315
G Sector	0	0	0	0	0	0	2	0	0	0	2
H Sector	0	0	0	0	0	0	0	0	0	0	0
I Sector	0	0	0	0	0	17	925	0	1,644	0	2,586
J Sector	0	0	0	0	0	0	0	0	2,538	0	2,538
Total of KSA	0	0	0	0	44	91	2,428	2	5,367	0	7,932

Sector Valve to DMA

Secondary Distribution Pipeline

Sector	Diameter (mm)										Total
	200	300	400	500	600	700	800	900	1000	1200	(m)
0 Sector	-	-	-	-	-	-	-	-	-	-	0
A Sector	5,989	2,161	0	167	0	0	0	0	0	0	8,317
B Sector	4,065	918	385	816	867	161	0	0	0	0	7,212
C Sector	2,001	1,094	1,472	216	0	0	105	0	0	0	4,888
D Sector	5,866	2,662	167	833	0	0	0	0	0	0	9,528
E Sector	6,444	660	127	692	0	0	0	0	0	0	7,923
F Sector	5,468	3,007	0	0	559	0	0	0	0	0	9,034
G Sector	6,305	3,211	427	244	1,240	0	893	0	0	0	12,320
H Sector	5,168	1,798	1,162	0	1,581	0	60	0	0	0	9,769
I Sector	11,383	1,355	1,046	0	529	507	0	0	0	0	14,820
J Sector	22,194	1,189	270	0	0	0	0	0	0	0	23,653
Total of KSA	74,883	18,055	5,056	2,968	4,776	668	1,058	0	0	0	107,464

Tertiary Distribution Pipeline

Sector	Area			Number of DMA	Sub-Main Pipe Length	Service Pipe Length	All Pipe Length
	Actual		CCC				
	(m2)	(ha)	(ha)	(-)	(m)	(m)	(m)
A Sector	1,317,996	131.80	**192**	12	8,317	**23,040**	31,357
B Sector	1,998,710	199.87	**216**	13	8,660	**25,920**	34,580
C Sector	1,208,861	120.89	**158**	10	4,931	**18,960**	23,891
D Sector	2,666,800	266.68	**352**	22	9,528	**42,240**	51,768
E Sector	2,876,881	287.69	**216**	13	7,923	**25,920**	33,843
F Sector	2,546,988	254.70	**220**	14	10,349	**26,400**	36,749
G Sector	3,594,125	359.41	**425**	26	12,322	**51,000**	63,322
H Sector	2,390,623	239.06	**257**	16	9,769	**30,840**	40,609
I Sector	4,241,692	424.17	**356**	22	17,406	**42,720**	60,126
J Sector	5,981,981	598.20	**671**	42	26,191	**80,520**	106,711
Total of KSA	28,824,657	2,882.47	**3,063**	190	115,396	**367,560**	482,956

Area of Pilot DMA	16.15	(ha)	
Pipe Density in D Sector	120	(m/ha)	←Without Sub-Main Pipe 118m/ha
Pipe Density in DMA-D1~D3	177	(m/ha)	←Includes Sub-Main Pipe
DMA Valve	4	(N/DMA)	

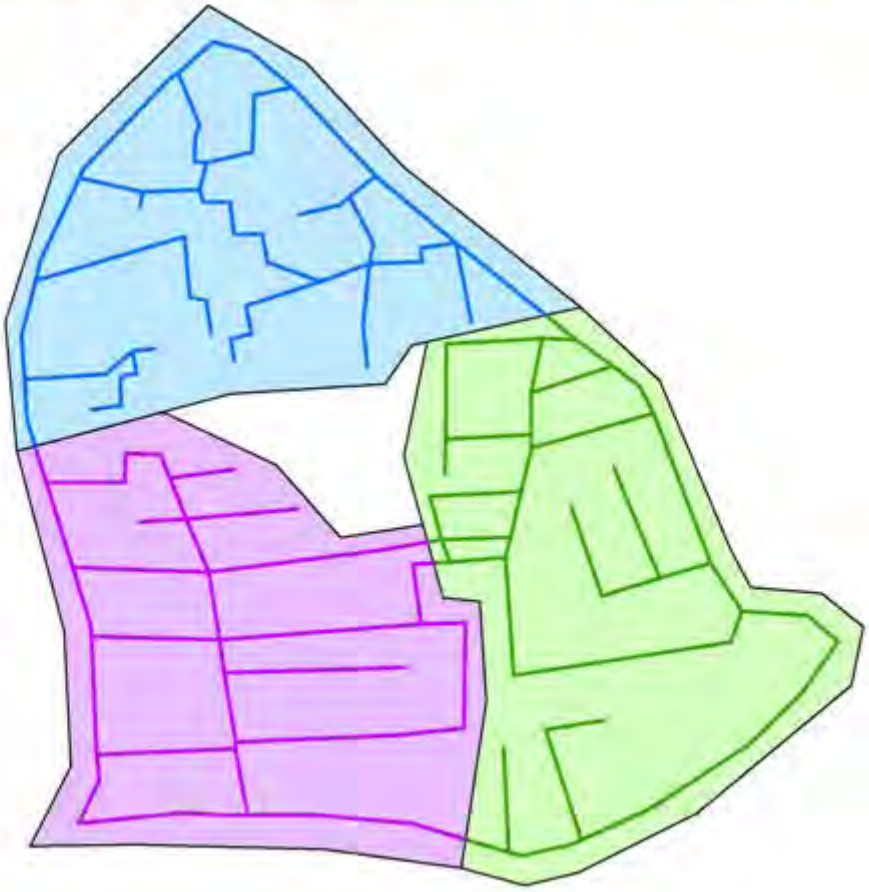
Area of D Sector	**267**	(ha)
Pipe Density in D Sector (without Sub-Main	**118**	(m/ha)

Area of DMA-D1	**13.64**	(ha)
Pipe Length in DMA-D1	**2628**	(m)
Pipe Density in DMA-D1	**193**	(m/ha)

Area of DMA-D2	**19.5**	(ha)
Pipe Length in DMA-D2	**3024**	(m)
Pipe Density in DMA-D2	**155**	(m/ha)

Area of DMA-D3	**15.32**	(ha)
Pipe Length in DMA-D3	**2939**	(m)
Pipe Density in DMA-D3	**192**	(m/ha)

Average	Area of DMA-D1～D3	**48.46**	(ha)
	Pipe Length in DMA-D1～D3 (with Sub-Ma	**8591**	(m)
	Pipe Density in DMA-D1～D3 (with Sub-Ma	**177**	(m/ha)
	Valve Density in DMA-D1～D3	**0.4**	(N/ha)



<Obstacles along the Kaptai road>

Obstacles Along the Roadway

Table: Number of Obstructions from the Centerline of Kaptai Road

SL NO	Description	20m from Centerline	10m from Centerline
1	Shop	166	117
2	House	31	19
3	Graveyard	4	9
4	School	5	2
5	Mosque	2	7
6	Pole of Electric (PDB)	278	237
7	Passenger Shed	5	1
8	Private Toilet	6	5

Note: It should be noted that there are hundred of young & old trees within the 10M and 20M zone.

Phase 2 Pipeline

Phase 1 Pipeline

11.8 Comparison of Construction Cost with Similar Projects

Notes of Meeting with Md. Serajuddin, DWASA Project Director, Saidabad Water Treatment Plant Phase II Project at DWASA (10.30 am on 10th September 2012).

Attended by: Kevin Holroyd (NJS)
Mir Towfiq Hussain (BETS Dhaka Office)

Details of Saidabad Water Treatment Plant Phase II Project as follows:

1. General Details of Project

- ✓ Production capacity of WTP: 225 MLD
- ✓ Treatment process is conventional with lamella plate settlers used. The project includes preliminary treatment to remove/reduce levels of ammonia for both Phases I and II (total production capacity of 450 MLD). Sludge is thickened in circular gravity thickeners. No new subsequent sludge treatment (i.e. dewatering) is included in the project. The Phase I sludge drying beds and lagoons will be used.
- ✓ Standby generation provided for 100% of duty equipment. Piling required.
- ✓ Sludge from the Phase I WTP has been and is being used to fill the site, which has a total area of about 30 hectares. It is intended that Phase III of the WTP, with the same capacity as each of Phases I and II will be constructed on this site. (Note that probable or definite that the Feasibility Study for Phase III will be financed by a grant from France).
- ✓ Project also includes about 10 km of transmission pipelines (about 5.5 km of DN 1,000 mm and more than 2 km each of DN 800 mm and 600 mm).
- ✓ Tenderers were provided with raw water quality and some site investigations.
- ✓ Site for Phase II had been filled by DWASA prior to contract commencing.
- ✓ Contractor is Danish with a French company 'responsible' for process design. This company used patented equipment.

2. Implementation Schedule

- ✓ Tendering Commenced approximately June 2009
- ✓ Contract Commencement Date June 2010
- ✓ Contract Completion Date December 2012
- ✓ Contract Period 30 months (including detailed design, additional site investigation, construction, commissioning and performance testing)
- ✓ Contract is FIDIC Yellow Book (Plant and Design Build), with Contractor responsible for detailed design (as stated above).
- ✓ Currently it is hoped that completion will be 15 days earlier than the contractual completion date. There have been no extensions of time given.

3. Project Cost

- ✓ Contract sum about EURO Non-Disclosure information, exclusive of taxes. Financed by Government of Denmark.

- ✓ Contribution of GOB for taxes and other items is about EURO Non-Disclosure information.
- ✓ Contract is lump sum.
- ✓ Mr. Serajuddin is reluctant to give a breakdown of costs for confidentiality reasons, but stated that if NJS sends him a schedule then he will provide some information.
- ✓ Cost of transmission pipelines is EURO Non-Disclosure information (exclusive of taxes).

4. Design Criteria and Specifications and Related Issues

- ✓ Most specifications based on British Standards. There is no requirement for a minimum % of mechanical and electrical plant and equipment to be sourced from Denmark (source of finance) and Contractor free to propose equipment from any country.
- ✓ Major items of equipment sources from various countries including France and Germany, with some equipment from China (small % of total cost I think). Equipment from France includes that which is part of the patented process.
- ✓ Transmission pipes supplied by Saint Gobain and manufactured in China.

5. Bidding Method

- ✓ ICB used with requirement that Contractor/lead partner in a Joint Venture is from Denmark. Experience of similar type of project was a requirement of the PQ/Bidding process.

6. Terms and Conditions

- ✓ Lump sum contract with provision for variations. It is understood that variations have not been significant in terms of amount.
- ✓ No provision for price escalation.
- ✓ Payment based on a schedule, with progress payments every 2 months. No detailed bill of quantities.

7. Construction Supervision

- ✓ Carried out by consultant.

CHAPTER 12

FINANCIAL AND ECONOMIC CONSIDERATIONS

CHAPTER 12 FINANCIAL AND ECONOMIC CONSIDERATIONS

12.2 Financial Forecast of Phase 1 and Phase 2 Projects based on Varied Conditions

12.2.1 Project Cost for Financial Forecast

Particulars	FC Portion (JPY mil.)	LC Portion (BDT mil.)	Combined Total (BDT mil.) *5)
Phase 1 Project	Non-Disclosure Information		
A. Financing Requirements			
B. Financing Plan			
JICA Loan *1)			
GOB Local Loan *2)			
Total			
Phase 2 Project			
A. Financing Requirements			
A-1 Eligible Portion			
a. Gross Construction Costs			
b. Consulting Services Costs			
Eligible Portion - Total			
A-2 Non-eligible Portion			
a. Administration Costs			
b. VAT			
c. Import Tax & Banking Charges			
d. Interest during Construction			
Non-eligible Portion - Total			
A-3. Grand Total			
B. Financing Plan			
JICA Loan (to be proposed)*3)			
GOB Local Loan *4)			
Total			

(Note)

Excluding costs for service connections and costs for procurement of water meters for service connections, as these costs can be covered with service connection charges.

*1) JICA Loan provided for Phase 1 Project
*2) Remaining Balance of the Financing Requirements
*3) Eligible portion of the Financing Requirements
*4) Non-eligible portion of the Financing Requirements
*5) Exchange Rate:
- Phase 1: BDT 0.90 = JPY 1.0
- Phase 2: BDT 1 = JPY 0.966

12.2.2 Summary of Financial Forecast

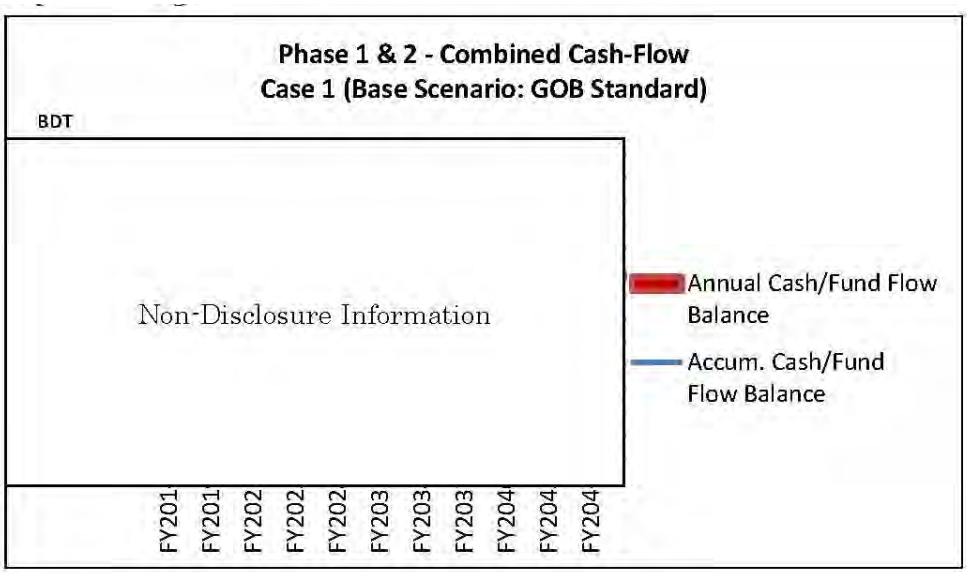
	Case 1: Base Scenario (GOB standard)	Case 2	Case 3	Case 4
Water Tariff	5% increase annually	5% increase annually	**7.5% increase annually**	5% increase annually
Proportion of Grant/Equity	0%	0%	0%	0%
Interest Rate (FC/LC)	5%/4%	2% for Phase 1&2 (Capitalize interest incurred during the grace period)	2% for Phase 1&2 (Capitalize interest incurred during the grace period)	1% for Phase 1&2 (Capitalize interest incurred during the grace period)
Grace Period/ Repayment Period	5 years/15years	10 years/ 30 years for Phase 2	10 years/ 30 years for Phase 2	10 years/ 30 years for Phase 1&2
Currency Risk	GOB	GOB	GOB	GOB
Phase 1 & 2 Combined Cash-flow	• Negative from FY2016 to FY2040 • Accumulated cash-flow negative during the whole period	• Positive until FY 2025 then turning to negative in FY 2026 onward • Accumulated cash-flow positive until FY 2030 then turning to negative in FY 2031 onward	• Positive until FY 2030 then turning to negative in FY 2031 to 2037. After FY2038 become positive. • Accumulated cash-flow positive until FY 2033 then turning to negative until FY 2044, but after 2045FY become positive.	• Positive until FY 2025 then turning to negative in FY 2026 onward excluding FY 2029 & 2030 • Accumulated cash-flow positive until FY 2031 then turning to negative in FY 2032 onward

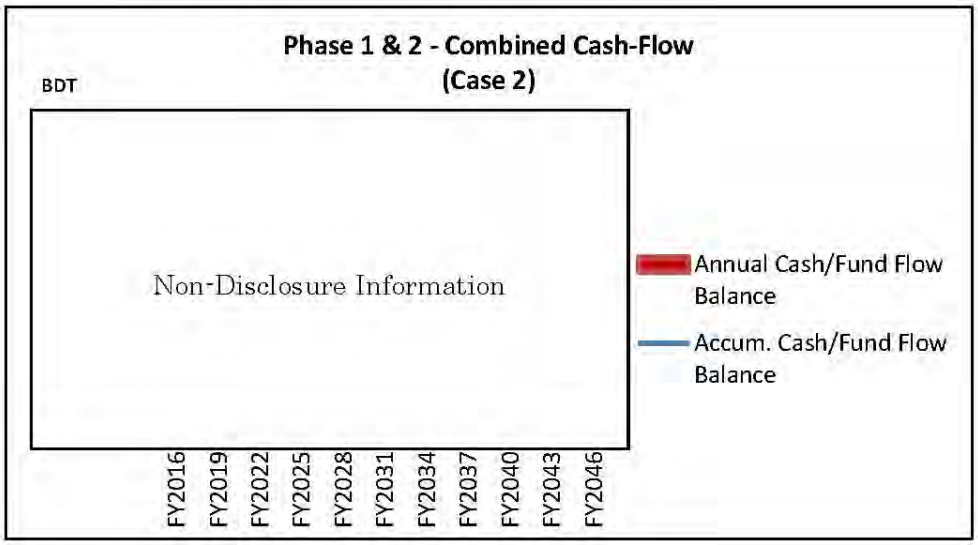
	Case 5	Case 6	Case 7	Case 8
Water Tariff	**7% increase annually**	5% increase annually based on present tariff rate	Increase as per Note 1	5% increase annually based on present tariff rate
Proportion of Grant/Equity	0%	Whole amount of Phase 1	0%	Whole amount of Phase 1
Interest Rate (FC/LC)	1% for Phase 1&2 (Capitalize interest incurred during the grace period)	1% for Phase 2 (Capitalize interest incurred during the grace period)	5%/4%	2% for Phase 2 (Capitalize interest incurred during the grace period)
Grace Period/ Repayment Period	10 years/ 30 years for Phase 1&2	10 years/ 30 years for Phase 2	5 years/15 year	17 years/ 23 years for Phase 2
Currency Risk	GOB	GOB	GOB	GOB
Phase 1 & 2 Combined Cash-flow	• Positive until FY 2030 then turning to negative in FY 2031 to 2036. After FY2037 become positive. • Accumulated cash-flow positive in whole years	• Positive from FY 2016 to FY2030 and negative from FY2031 to FY2042. After FY2043 become positive • Accumulated cash-flow positive in whole years	• Positive every year from FY2016 to FY2047, except FY2021, FY2026, FY2028 and FY2028 • Accumulated cash-flow positive in whole years	• Positive from FY2016 to FY2037 then turning to negative from FY2038 on-ward • Accumulated cash-flow positive in whole years

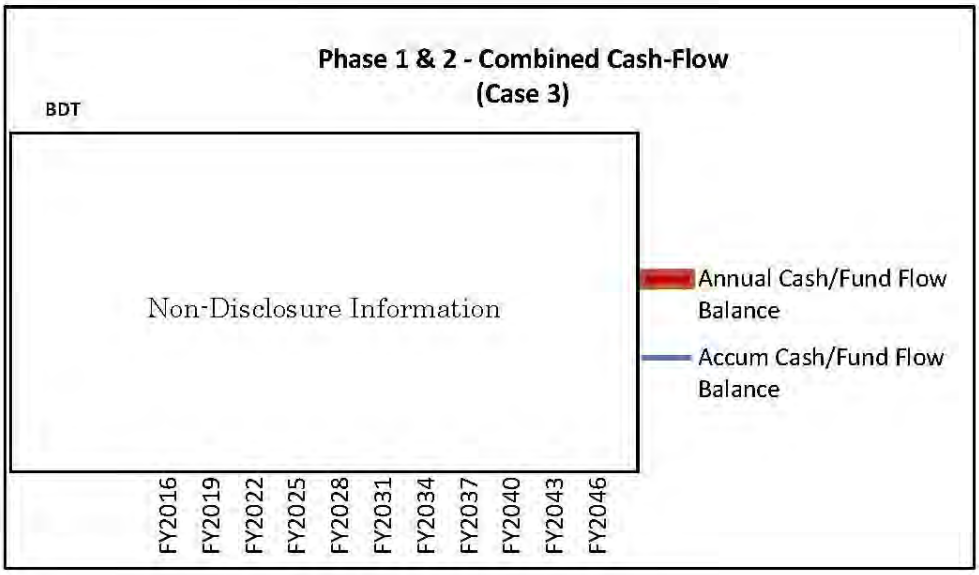
(Note) Increase in water tariff for Case 7

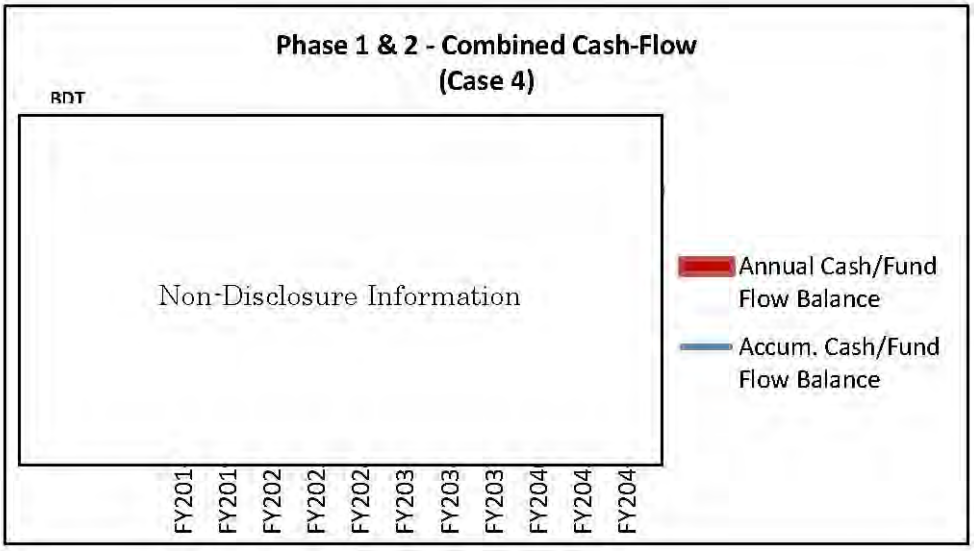
- Increase in 2016 by 4.6 times of the 2012 rates (Rate in FY2016: Tk. 24.31 for domestic; Tk. 68.86 for non-domestic)
- 3.0% increase every year (2017-2020)
- Increase in 2021 by 1.4 times of the 2020 rates
- 2% increase every year (2022-2025)
- Increase in 2026 by 10% of the 2025 rates
- No increase (2027 onward)

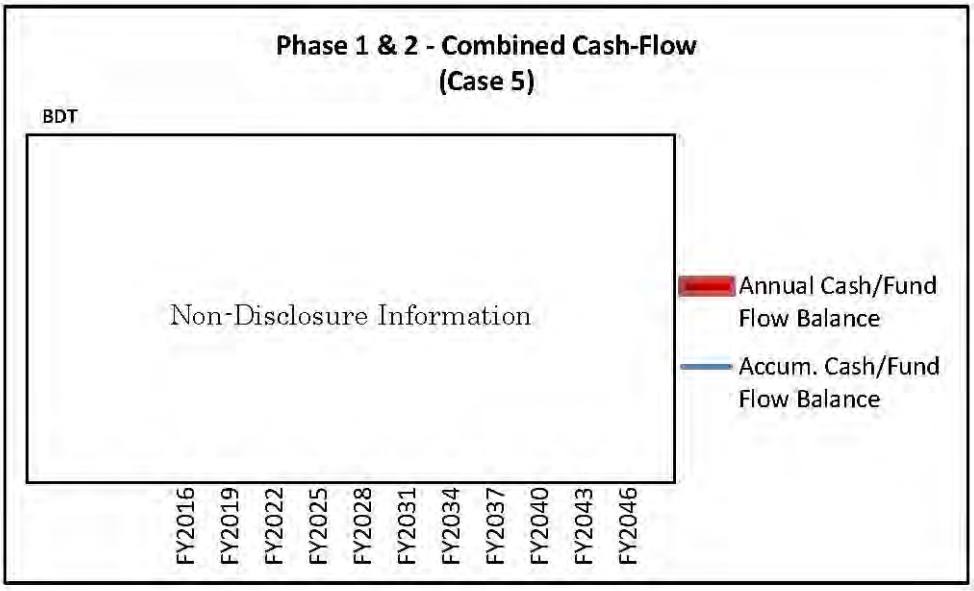
12. 2.3 Graphs showing Cash-Flow of Each Case

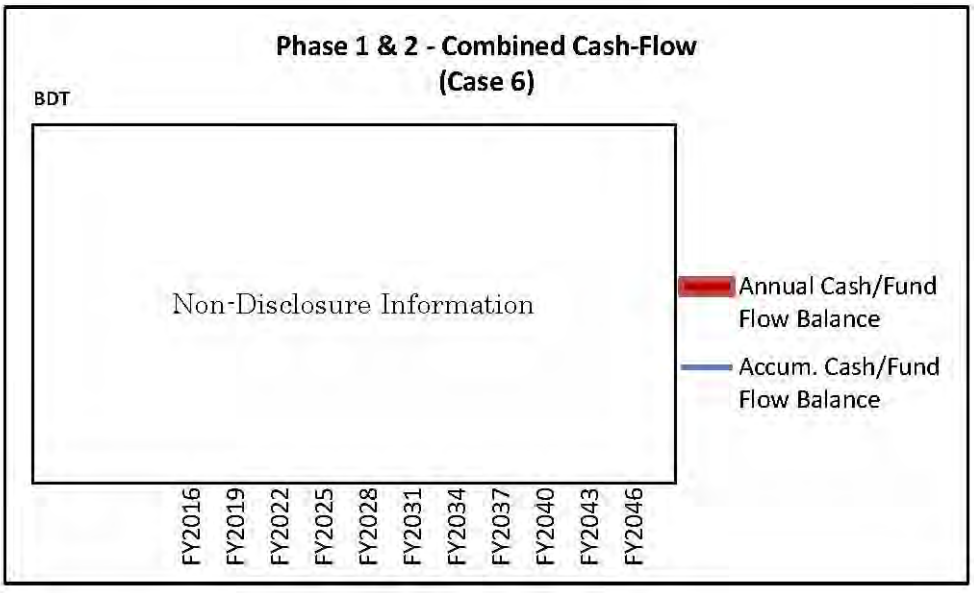


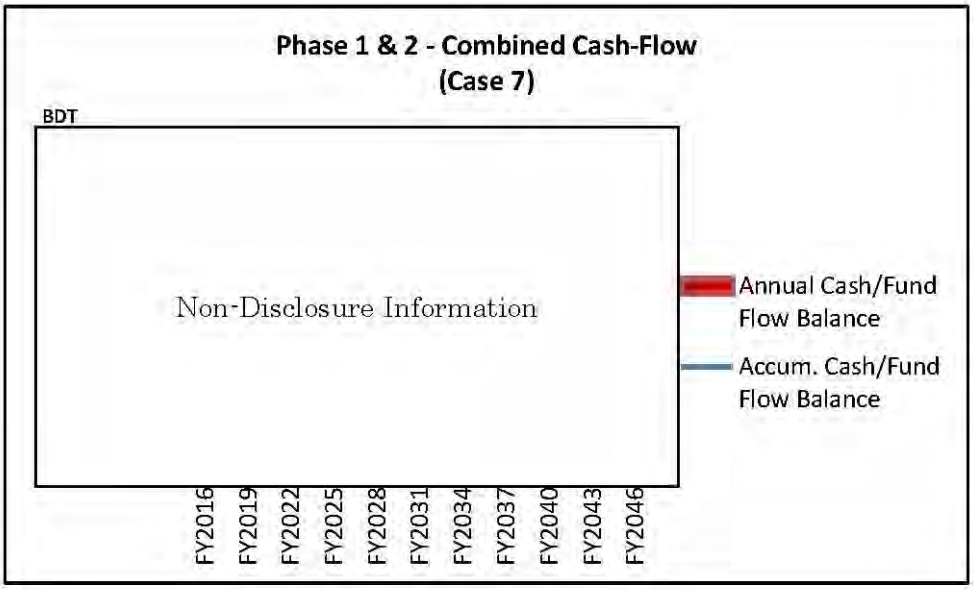


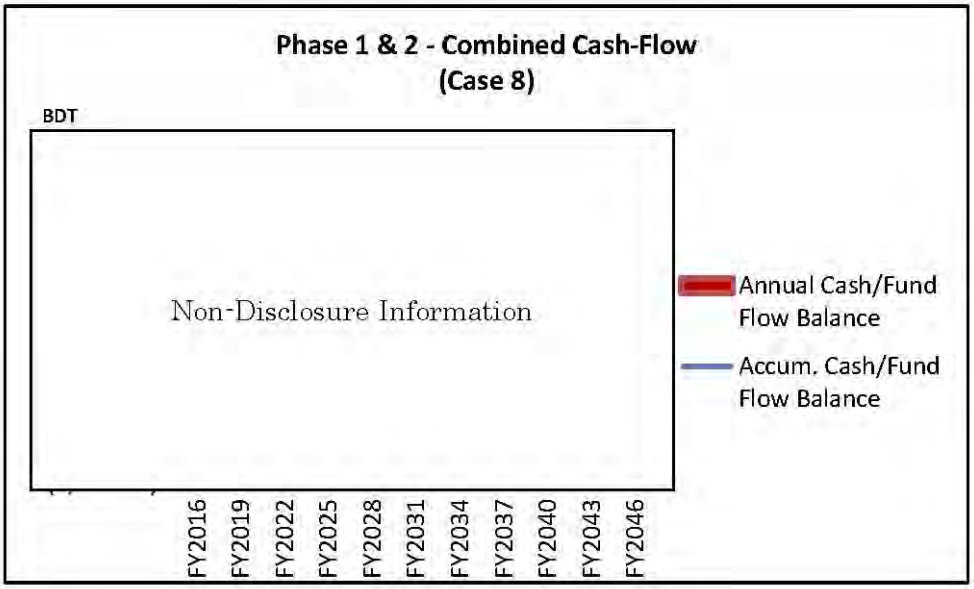



Phase 1 & 2 - Combined Cash-Flow
(Case 4)
BDT
Non-Disclosure Information
Annual Cash/Fund Flow Balance
Accum. Cash/Fund Flow Balance
FY201
FY201
FY202
FY202
FY202
FY203
FY203
FY203
FY204
FY204
FY204


Phase 1 & 2 - Combined Cash-Flow
(Case 5)
BDT
Non-Disclosure Information
Annual Cash/Fund Flow Balance
Accum. Cash/Fund Flow Balance
FY2016
FY2019
FY2022
FY2025
FY2028
FY2031
FY2034
FY2037
FY2040
FY2043
FY2046


Phase 1 & 2 - Combined Cash-Flow
(Case 6)
BDT
Non-Disclosure Information
Annual Cash/Fund Flow Balance
Accum. Cash/Fund Flow Balance
FY2016
FY2019
FY2022
FY2025
FY2028
FY2031
FY2034
FY2037
FY2040
FY2043
FY2046


Phase 1 & 2 - Combined Cash-Flow
(Case 7)
BDT
Non-Disclosure Information
Annual Cash/Fund Flow Balance
Accum. Cash/Fund Flow Balance
FY2016
FY2019
FY2022
FY2025
FY2028
FY2031
FY2034
FY2037
FY2040
FY2043
FY2046


Phase 1 & 2 - Combined Cash-Flow
(Case 8)
BDT
Non-Disclosure Information
Annual Cash/Fund Flow Balance
Accum. Cash/Fund Flow Balance
FY2016
FY2019
FY2022
FY2025
FY2028
FY2031
FY2034
FY2037
FY2040
FY2043
FY2046

12.2.4 Debt-service and Cash-flow of Each Case

(1) Case 1
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

(2) Case 2
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

(3) Case 3
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

(4) Case 4
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

(5) Case 5
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

(6) Case 6
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

(7) Case 7
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

(8) Case 8
Debt-service

Non-Disclosure Information

Cash-flow

Non-Disclosure Information

12.3 Financial Sensitivity Analysis

(1) Financial Cash Flow with 10% Decrease in O&M Cost

Non-Disclosure Information

(2) Financial Cash Flow with 5% Decrease in O&M Cost

Non-Disclosure Information

(3) Financial Cash Flow with 5% Increase in O&M Cost

Non-Disclosure Information

(4) Financial Cash Flow with 10% Increase in O&M Cost

Non-Disclosure Information

(5) Financial Cash Flow with 252% Increase in Tariff

Non-Disclosure Information

12.4 Economic Sensitivity Analysis

(1) Economic Cash Flow with 10% Decrease in O&M Cost

Non-Disclosure Information

(2) Economic Cash Flow with 5% Decrease in O&M Cost

Non-Disclosure Information

(3) Economic Cash Flow with 5% Increase in O&M Cost

Non-Disclosure Information

(4) Economic Cash Flow with 10% Increase in O&M Cost

Non-Disclosure Information

(5) Economic Cash Flow with 10% Decrease in WTP

Non-Disclosure Information

(6) Economic Cash Flow with 5% Decrease in WTP

Non-Disclosure Information

(7) Economic Cash Flow with 5% Increase in WTP

Non-Disclosure Information

(8) Economic Cash Flow with 10% Increase in WTP

Non-Disclosure Information

(9) Economic Cash Flow with 10% Decrease in Indirect Benefit

Non-Disclosure Information

(10) Economic Cash Flow with 5% Decrease in Indirect Benefit

Non-Disclosure Information

(11) Economic Cash Flow with 5% Increase in Indirect Benefit

Non-Disclosure Information

(12) Economic Cash Flow with 10% Increase in Indirect Benefit

Non-Disclosure Information

PART 2

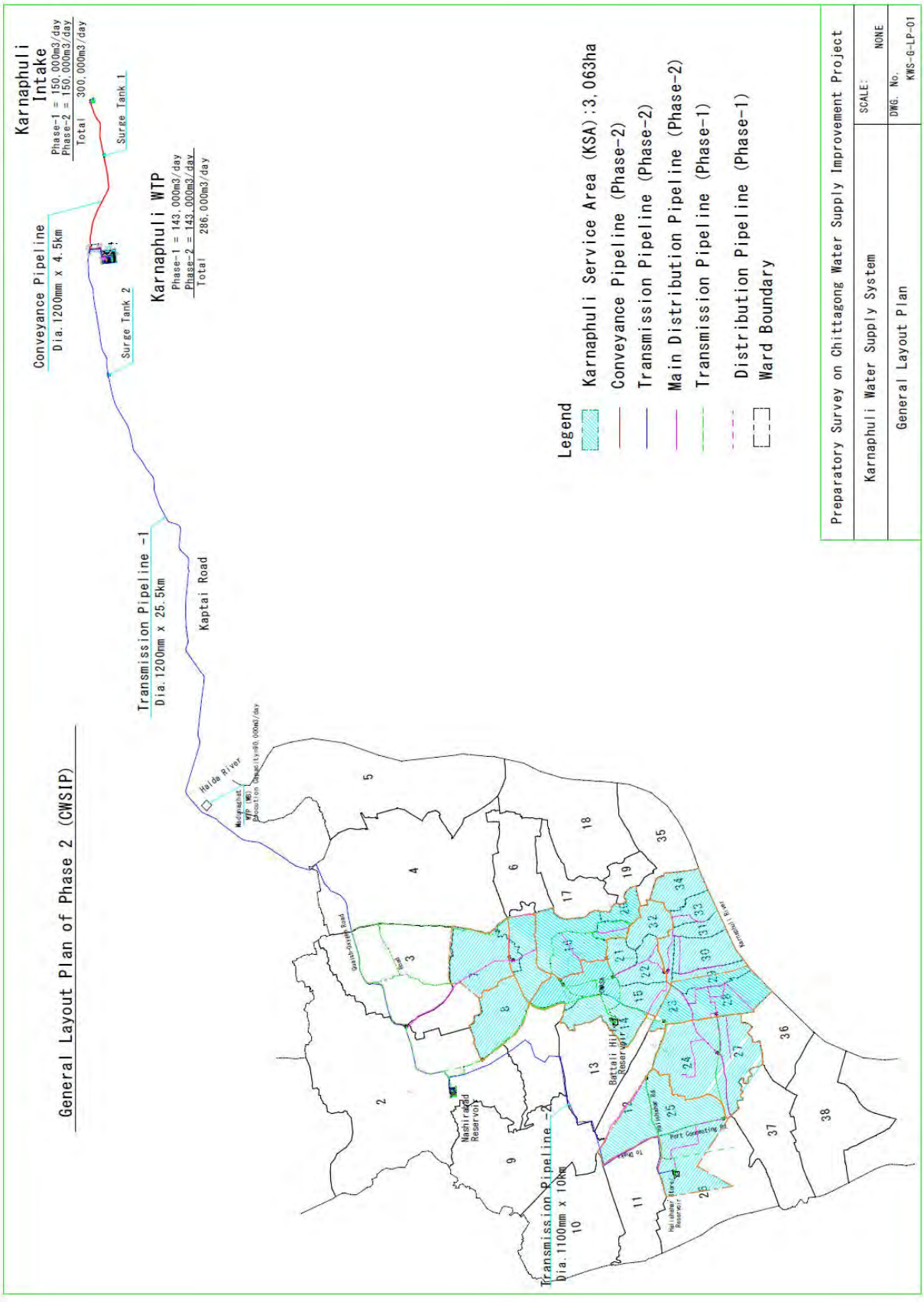
DATA BOOK

I DRAWINGS

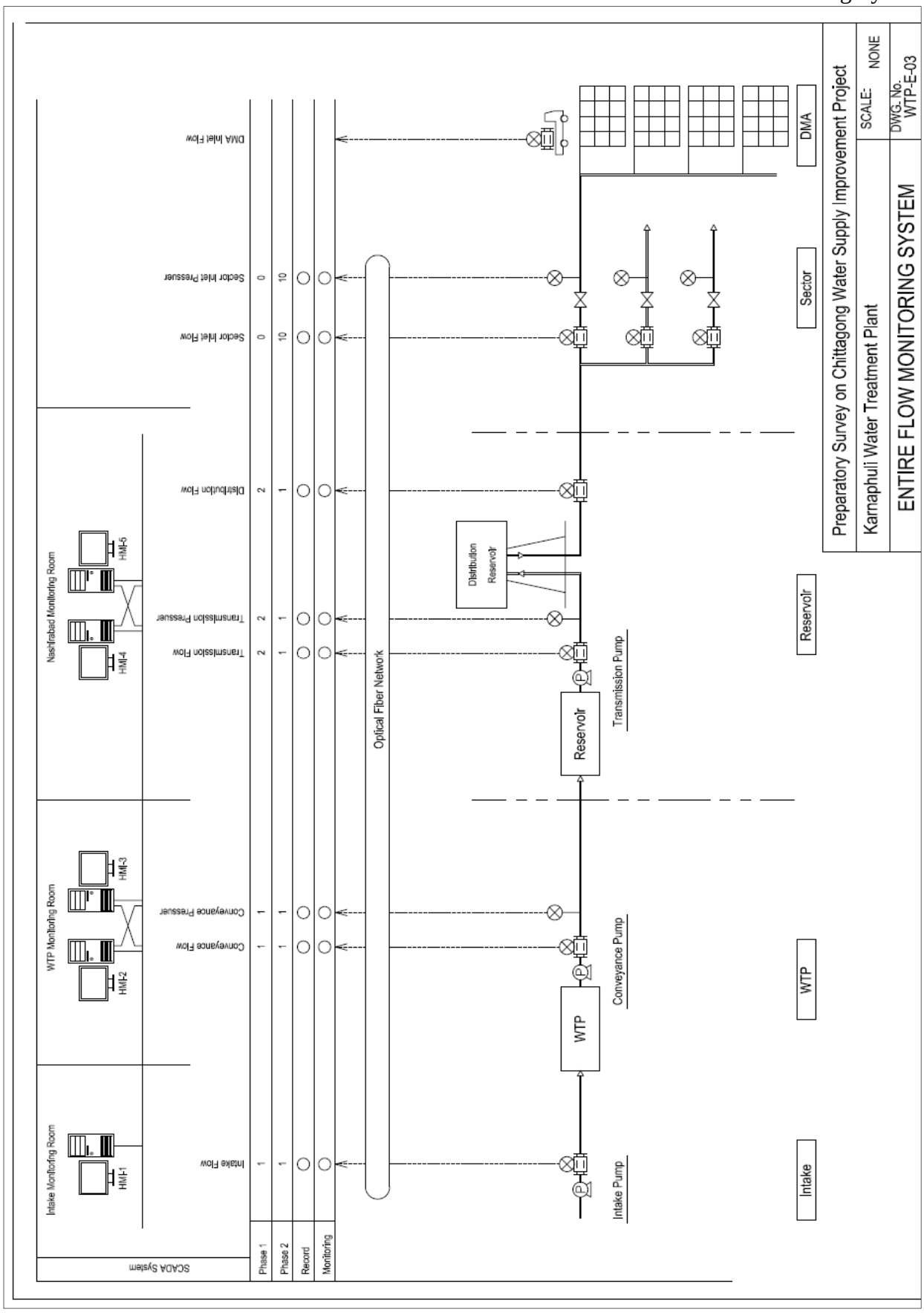
I. Drawings

1. General Layout Plan
2. Entire Flow Monitoring System
3. General Layout Plan of Optical Fiber Cable
4. Intake Facilities ; Yard Pipe (Conveyance Pipeline)
5. Intake Facilities; Process Flow Diagram
6. Intake/WTP Facilities; General Single Line
7. Surge Tank 1 (from Intake to WTP)
8. WTP; General Layout Plan
9. WTP; General Plan and Section
10. WTP; Hydraulic Profile (Phase 1 &2)
11. Surge Tank 2 (from WTP to Nashirabad Reservoir)
12. Nashirabad Reservoir; General Layout Plan
13. Nashirabad Reservoir ; Section
14. Hydraulic Profile from Nashirabad Reservoir to each Elevated Tank/Distribution Reservoir
15. Nashirabad Elevated Tank (Phase 1 Project)
16. Nashirabad Reservoir; General Single Line Diagram
17. Battali Hill Reservoir(Phase 1 Project) and Location of Sector Inlet Chamber
18. Halishahar Elevated Tank ; Plan and Section
19. General Layout Plan of KSA
20. General Layout Plan of Sector
21. Sector and DMA Inlet Chamber
22. House Connection ; Section

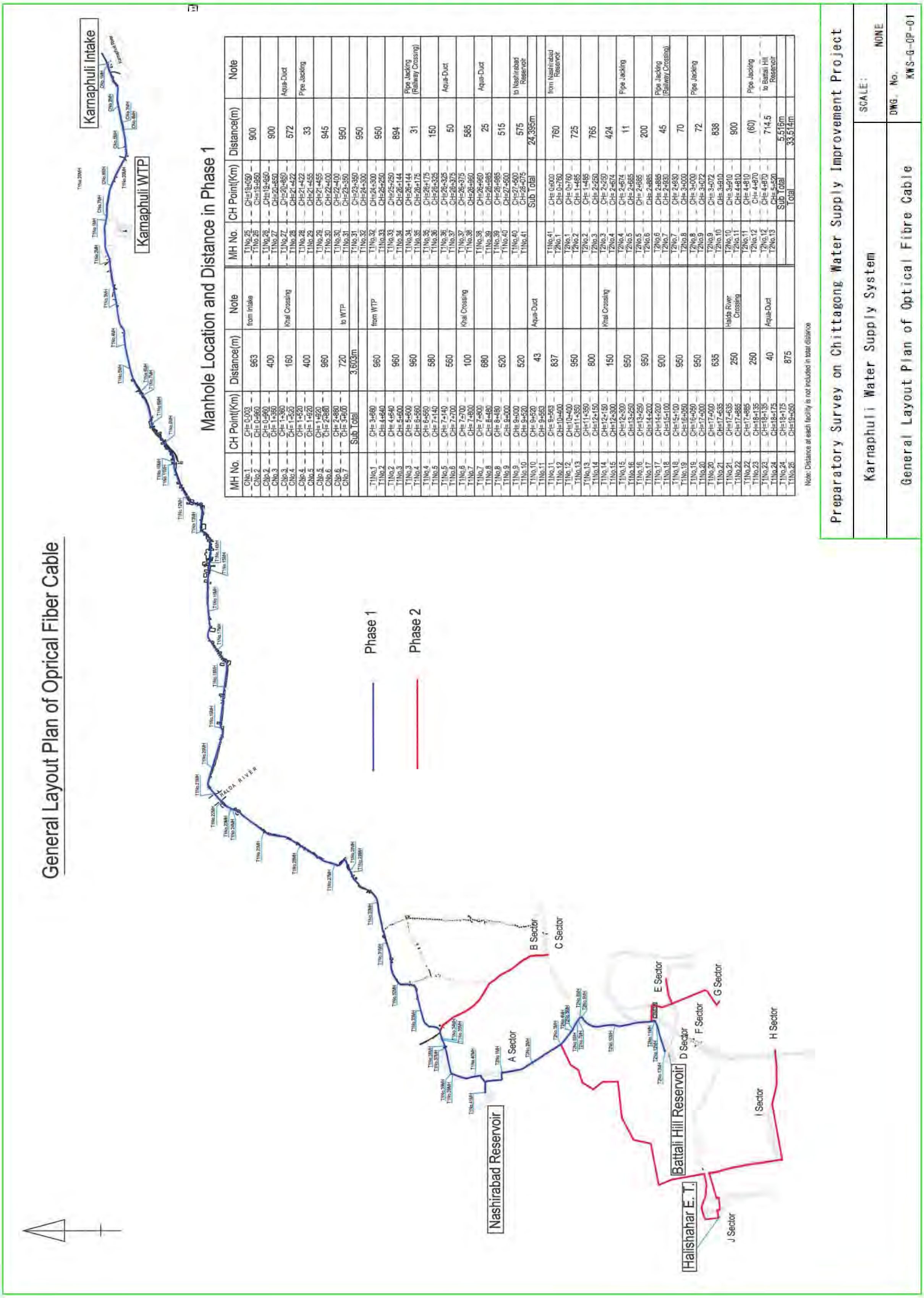
1. General Layout Plan



2. Entire Flow Monitoring System



3. General Layout Plan of Optical Fiber Cable



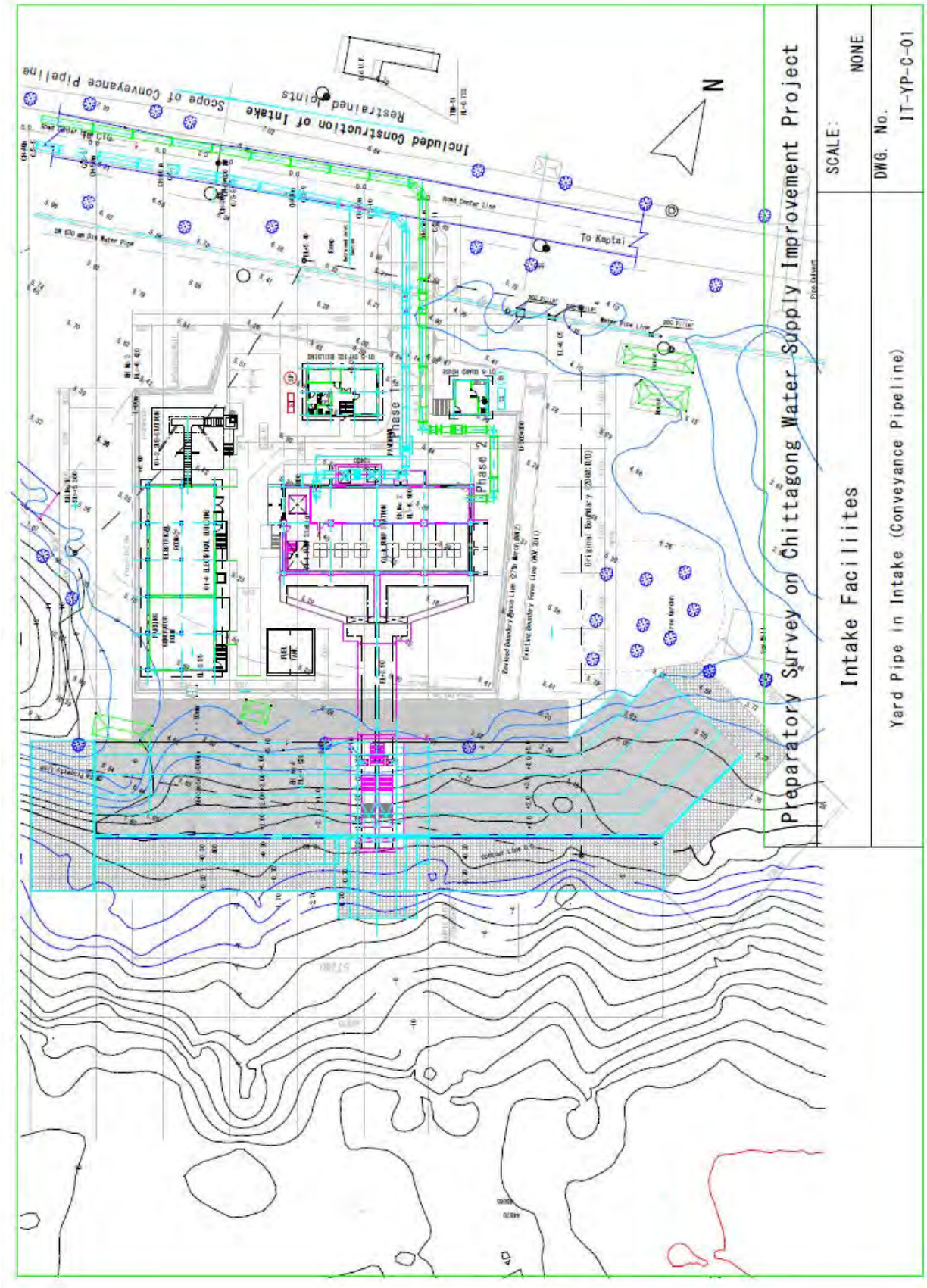
MH No.	CH Point(Km)	Distance(m)	Note
CNo.1 – CNo.2	CH= 0-003 – CH= 0+960	963	from Intake
CNo.2 – CNo.3	CH= 0+960 – CH= 1+360	400	
CNo.3 – CNo.4	CH= 1+360 – CH= 1+520	160	Khal Crossing
CNo.4 – CNo.5	CH= 1+520 – CH= 1+920	400	
CNo.5 – CNo.6	CH= 1+920 – CH= 2+880	960	
CNo.6 – CNo.7	CH= 2+880 – CH= 3+600	720	to WTP
	Sub Total	3,603m	
T1No.1 – T1No.2	CH= 3+680 – CH= 4+640	960	from WTP
T1No.2 – T1No.3	CH= 4+640 – CH= 5+600	960	
T1No.3 – T1No.4	CH= 5+600 – CH= 6+560	960	
T1No.4 – T1No.5	CH= 6+560 – CH= 7+140	580	
T1No.5 – T1No.6	CH= 7+140 – CH= 7+700	560	
T1No.6 – T1No.7	CH= 7+700 – CH= 7+800	100	Khal Crossing
T1No.7 – T1No.8	CH= 7+800 – CH= 8+480	680	
T1No.8 – T1No.9	CH= 8+480 – CH= 9+000	520	
T1No.9 – T1No.10	CH= 9+000 – CH= 9+520	520	
T1No.10 – T1No.11	CH= 9+520 – CH= 9+563	43	Aqua-Duct
T1No.11 – T1No.12	CH= 9+563 – CH=10+400	837	
T1No.12 – T1No.13	CH=10+400 – CH=11+350	950	
T1No.13 – T1No.14	CH=11+350 – CH=12+150	800	
T1No.14 – T1No.15	CH=12+150 – CH=12+300	150	Khal Crossing
T1No.15 – T1No.16	CH=12+300 – CH=13+250	950	
T1No.16 – T1No.17	CH=13+250 – CH=14+200	950	
T1No.17 – T1No.18	CH=14+200 – CH=15+100	900	
T1No.18 – T1No.19	CH=15+100 – CH=16+050	950	
T1No.19 – T1No.20	CH=16+050 – CH=17+000	950	
T1No.20 – T1No.21	CH=17+000 – CH=17+635	635	
T1No.21 – T1No.22	CH=17+635 – CH=17+885	250	Halda River Crossing
T1No.22 – T1No.23	CH=17+885 – CH=18+135	250	
T1No.23 – T1No.24	CH=18+135 – CH=18+175	40	Aqua-Duct
T1No.24 – T1No.25	CH=18+175 – CH=19+050	875	

MH No.	CH Point(Km)	Distance(m)	Note
T1No.25 – T1No.26	CH=19+050 – CH=19+950	900	
T1No.26 – T1No.27	CH=19+950 – CH=20+850	900	
T1No.27 – T1No.28	CH=20+850 – CH=21+422	572	Aqua-Duct
T1No.28 – T1No.29	CH=21+422 – CH=21+455	33	Pipe Jacking
T1No.29 – T1No.30	CH=21+455 – CH=22+400	945	
T1No.30 – T1No.31	CH=22+400 – CH=23+350	950	
T1No.31 – T1No.32	CH=23+350 – CH=24+300	950	
T1No.32 – T1No.33	CH=24+300 – CH=25+250	950	
T1No.33 – T1No.34	CH=25+250 – CH=26+144	894	
T1No.34 – T1No.35	CH=26+144 – CH=26+175	31	Pipe Jacking (Railway Crossing)
T1No.35 – T1No.36	CH=26+175 – CH=26+325	150	
T1No.36 – T1No.37	CH=26+325 – CH=26+375	50	Aqua-Duct
T1No.37 – T1No.38	CH=26+375 – CH=26+960	585	
T1No.38 – T1No.39	CH=26+960 – CH=26+985	25	Aqua-Duct
T1No.39 – T1No.40	CH=26+985 – CH=27+500	515	
T1No.40 – T1No.41	CH=27+500 – CH=28+075	575	to Nashirabad Reservoir
	Sub Total	24,395m	
T1No.41 – T2No.1	CH= 0+000 – CH= 0+760	760	from Nashirabad Reservoir
T2No.1 – T2No.2	CH= 0+760 – CH= 1+485	725	
T2No.2 – T2No.3	CH= 1+485 – CH= 2+250	765	
T2No.3 – T2No.4	CH= 2+250 – CH= 2+674	424	
T2No.4 – T2No.5	CH= 2+674 – CH= 2+685	11	Pipe Jacking
T2No.5 – T2No.6	CH= 2+685 – CH= 2+885	200	
T2No.6 – T2No.7	CH= 2+885 – CH= 2+930	45	Pipe Jacking (Railway Crossing)
T2No.7 – T2No.8	CH= 2+930 – CH= 3+000	70	
T2No.8 – T2No.9	CH= 3+000 – CH= 3+072	72	Pipe Jacking
T2No.9 – T2No.10	CH= 3+072 – CH= 3+910	838	
T2No.10 – T2No.11	CH= 3+910 – CH= 4+810	900	
T2No.11 – T2No.12	CH= 4+810 – CH= 4+870	(60)	Pipe Jacking
T2No.12 – T2No.13	CH= 4+870 – CH= 5+520	714.5	to Battali Hill Reservoir
	Sub Total	5,516m	
	Total	33,514m	

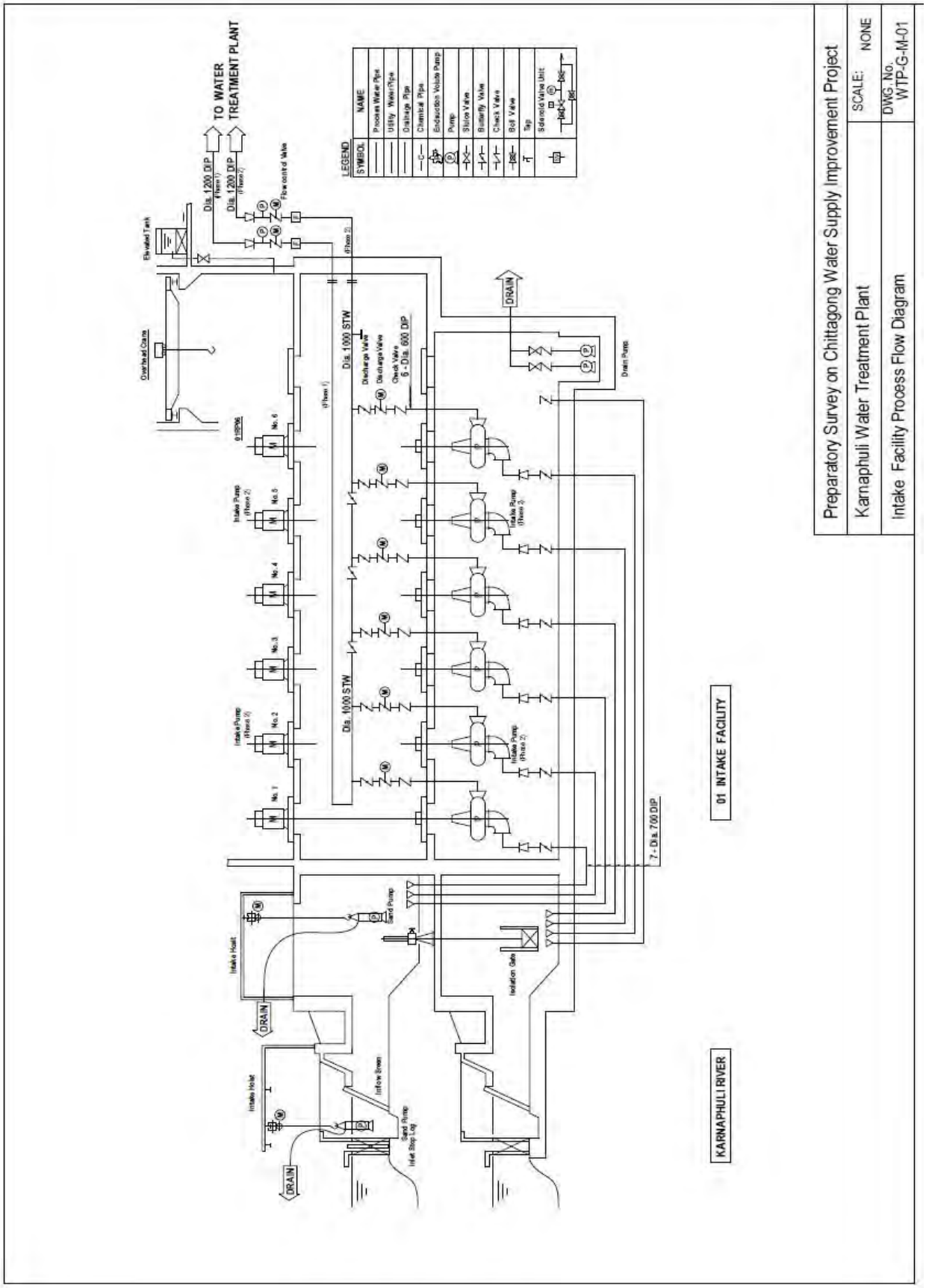
Note: Distance at each facility is not included in total distance

Preparatory Survey on Chittagong Water Supply Improvement Project	
Karnaphuli Water Supply System	SCALE: NONE
General Layout Plan of Optical Fibre Cable	DWG. No. KWS-G-OP-01

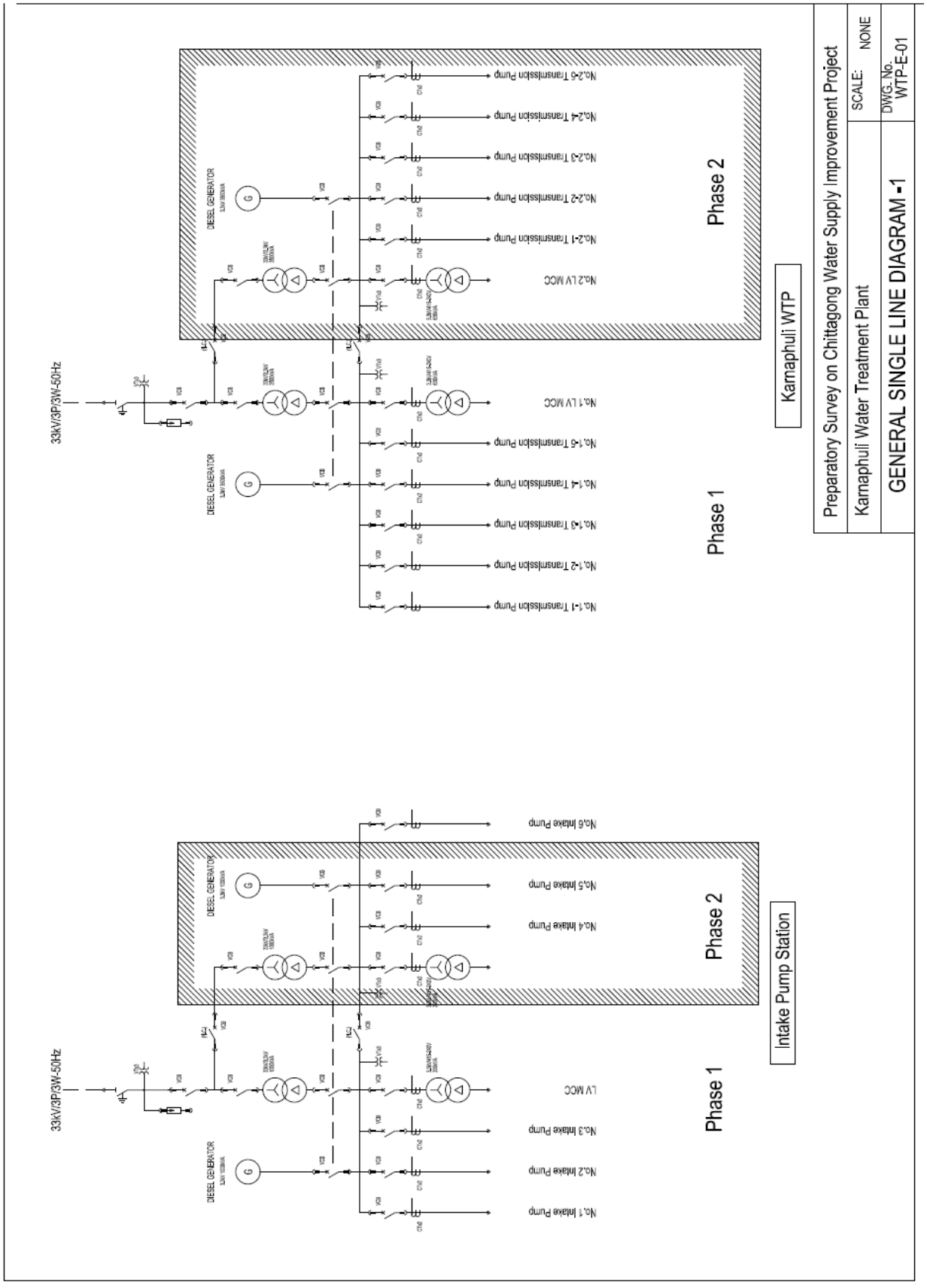
4. Intake Facilities; Yard Pipe (Conveyance Pipeline)



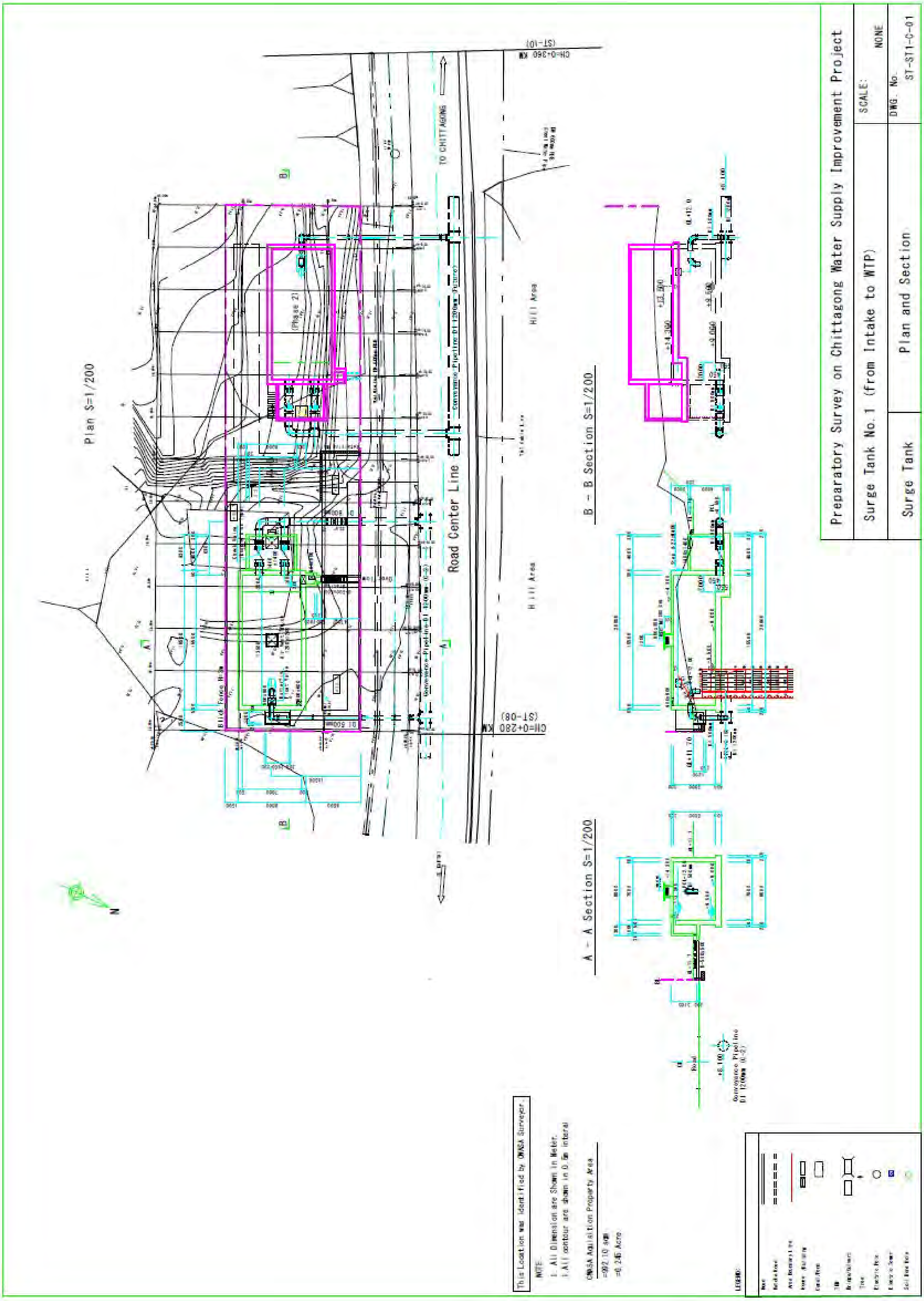
5. Intake Facilities; Process Flow Diagram



6. Intake / WTP Facilities; General Single Line

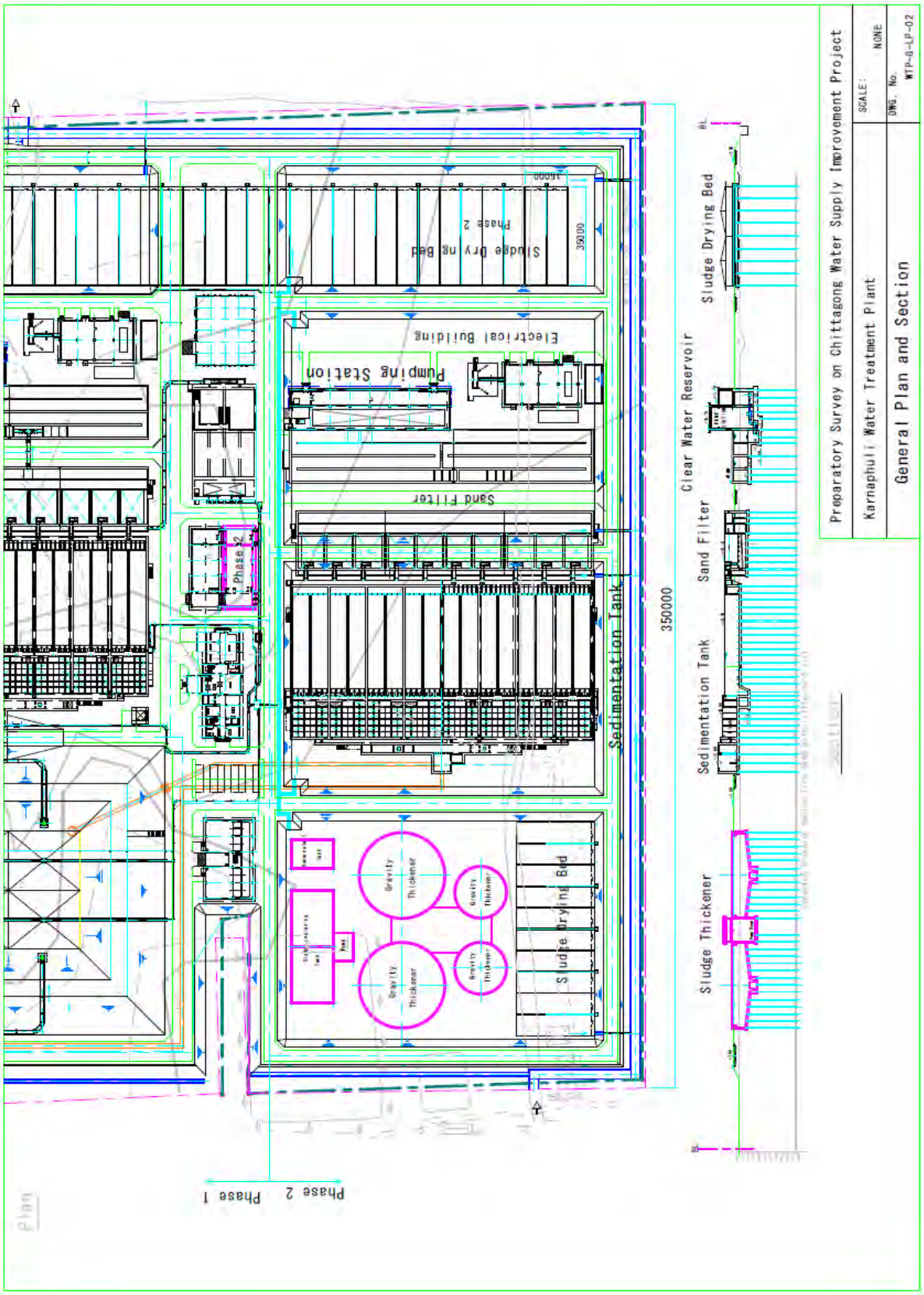


7. Surge Tank 1 (from Intake to WTP)

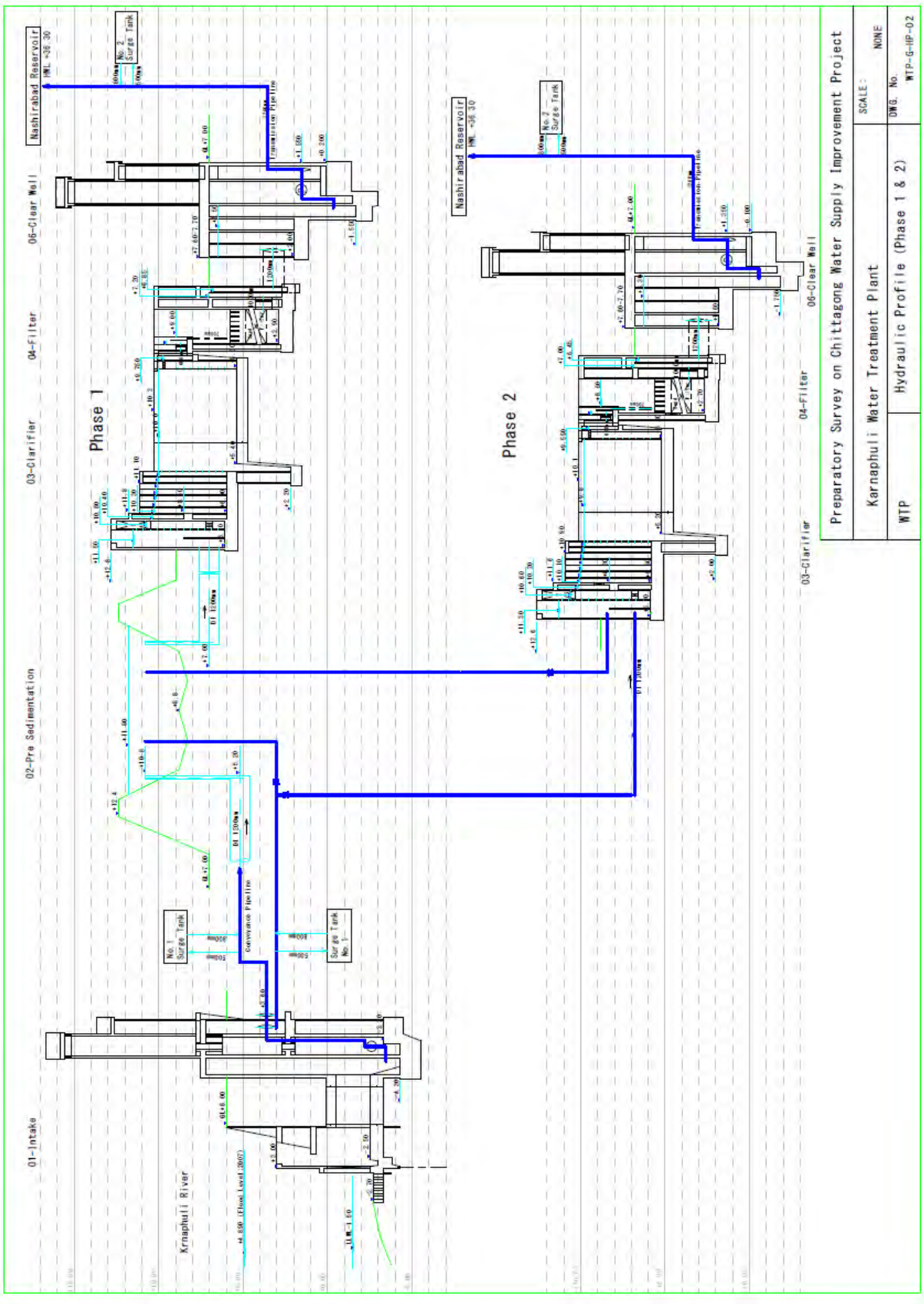


8. WTP; General Layout Plan

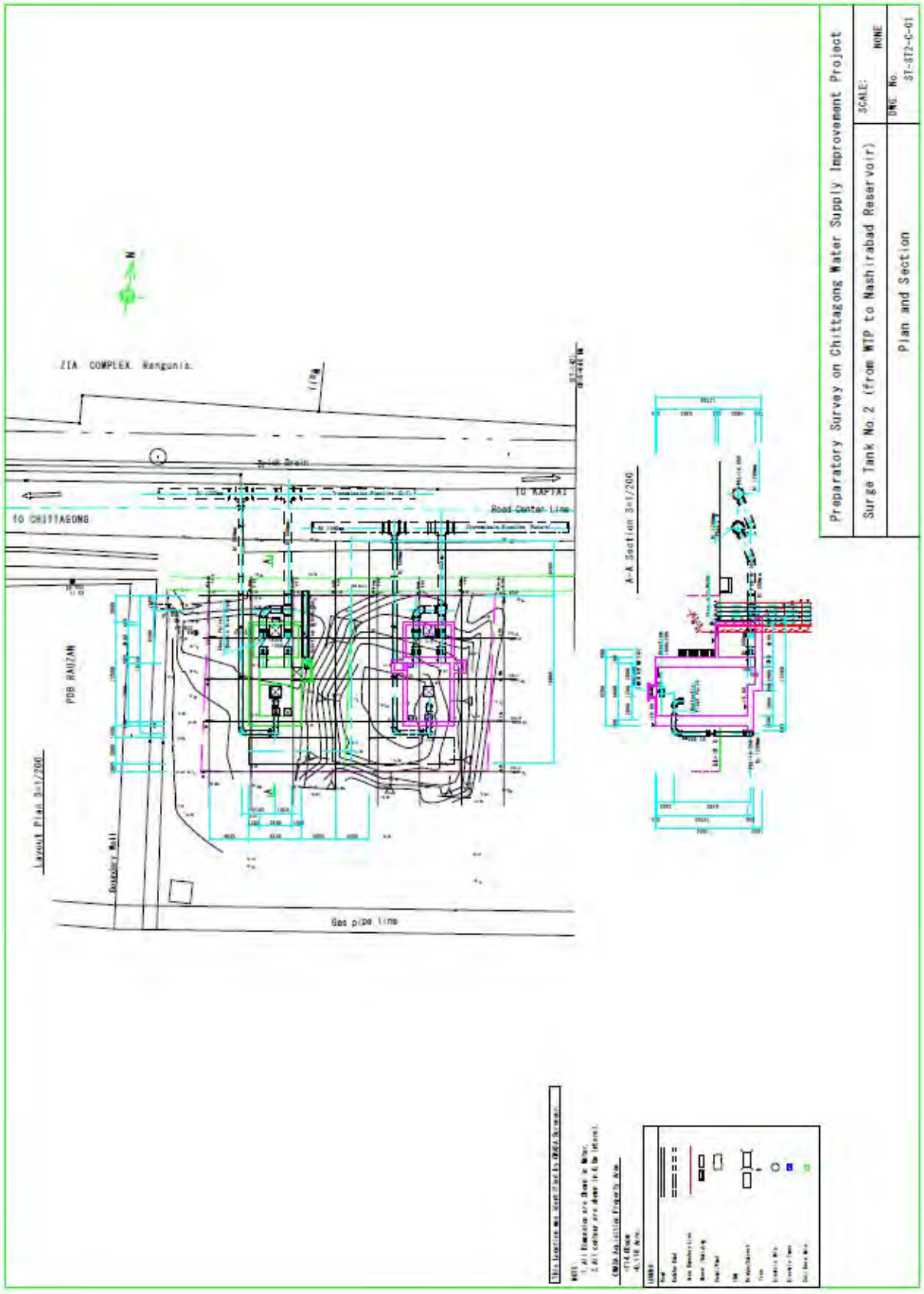
9. WTP; General Plan and Section



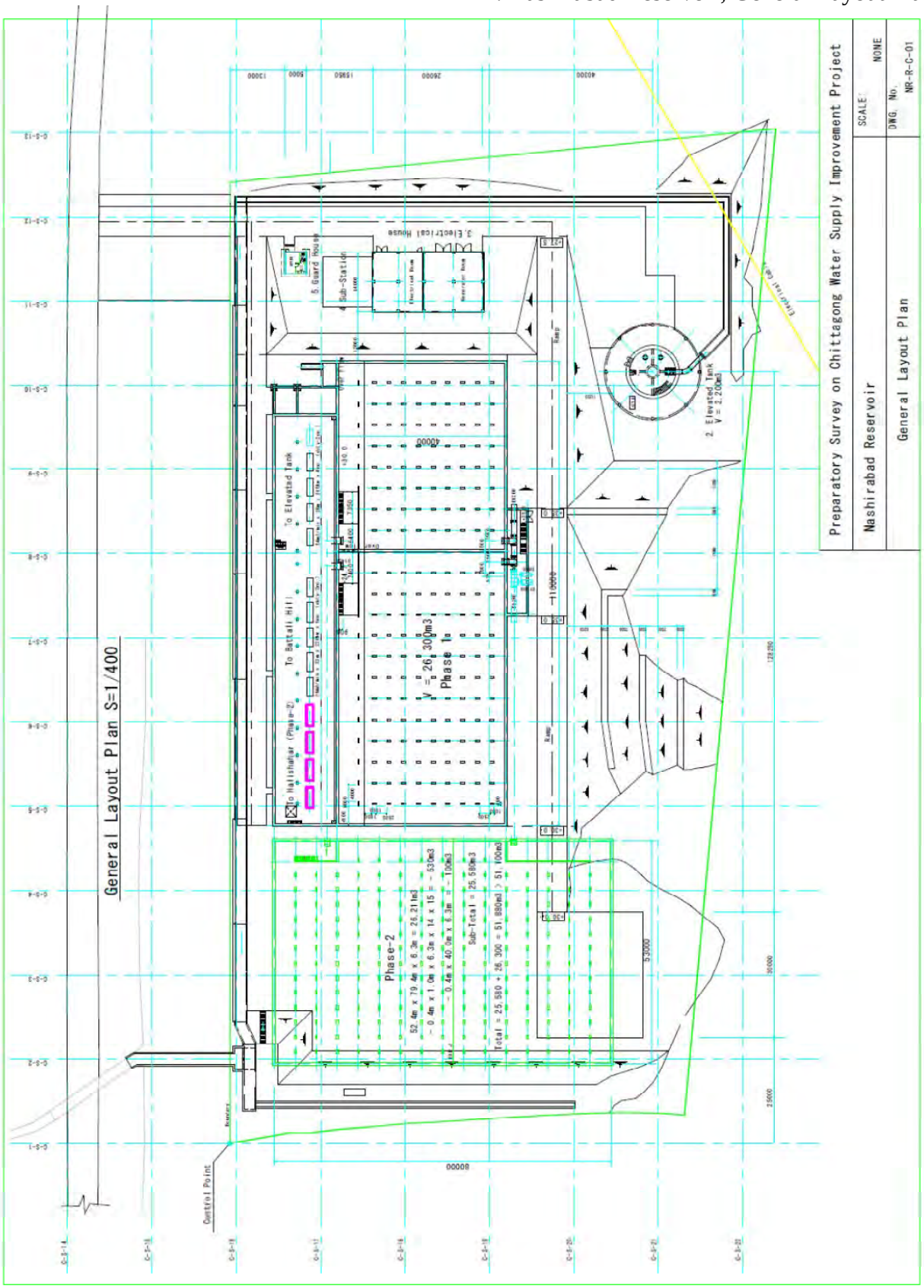
10. WTP; Hydraulic Profile (Phase 1&2)



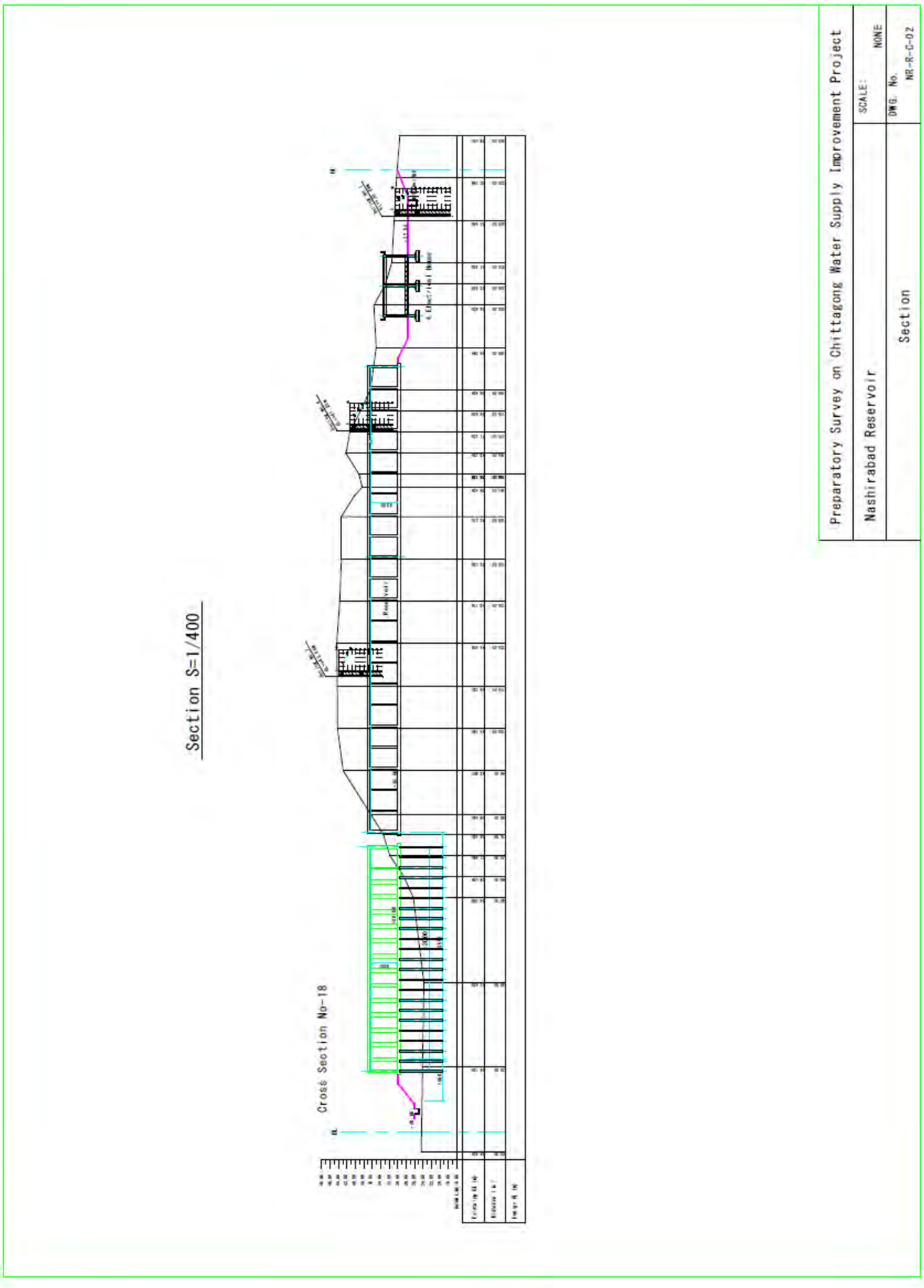
11. Surge Tank 2 (from WTP to Nashirabad Reservoir)



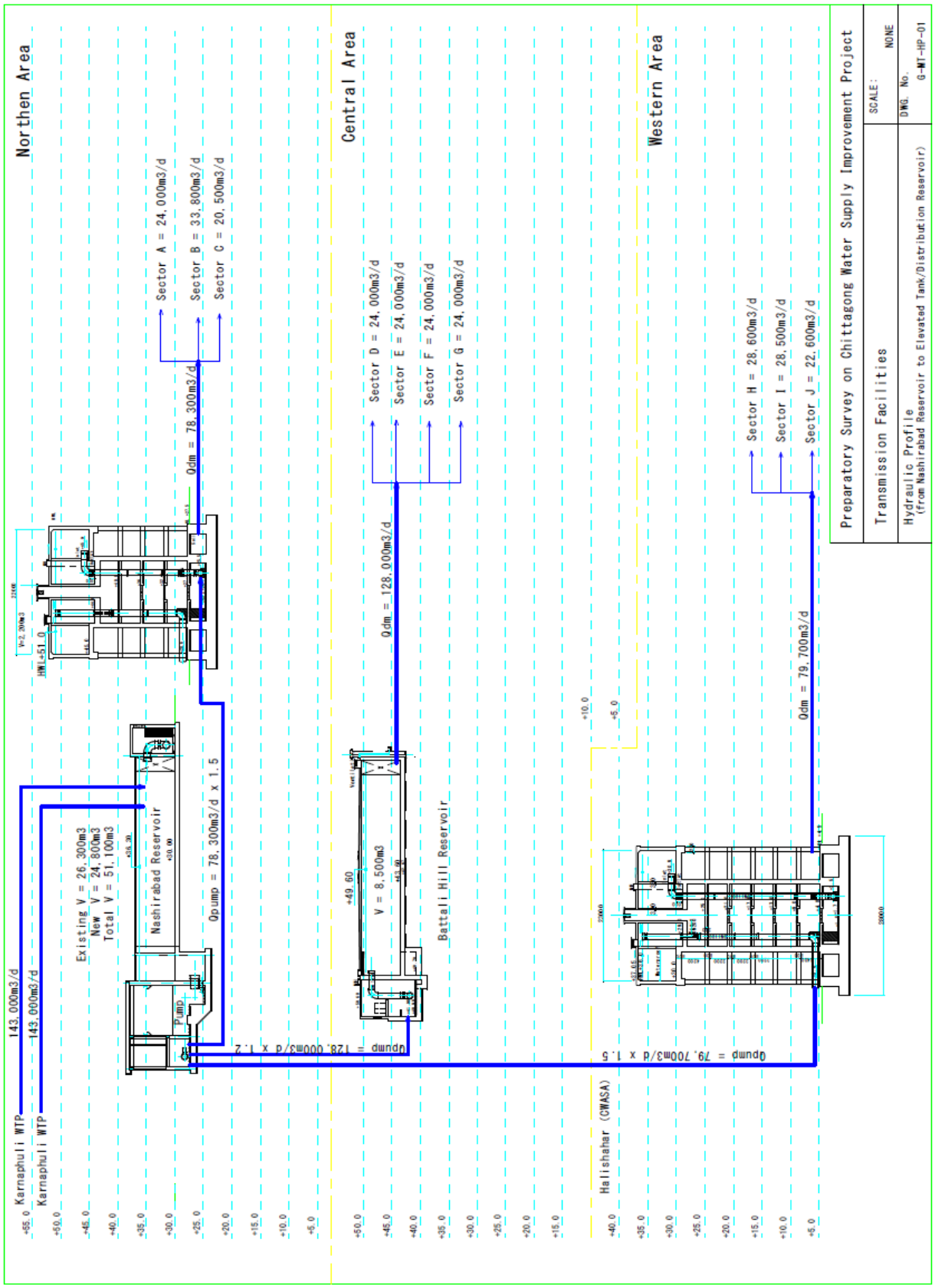
12. Nashirabad Reservoir; General Layout Plan



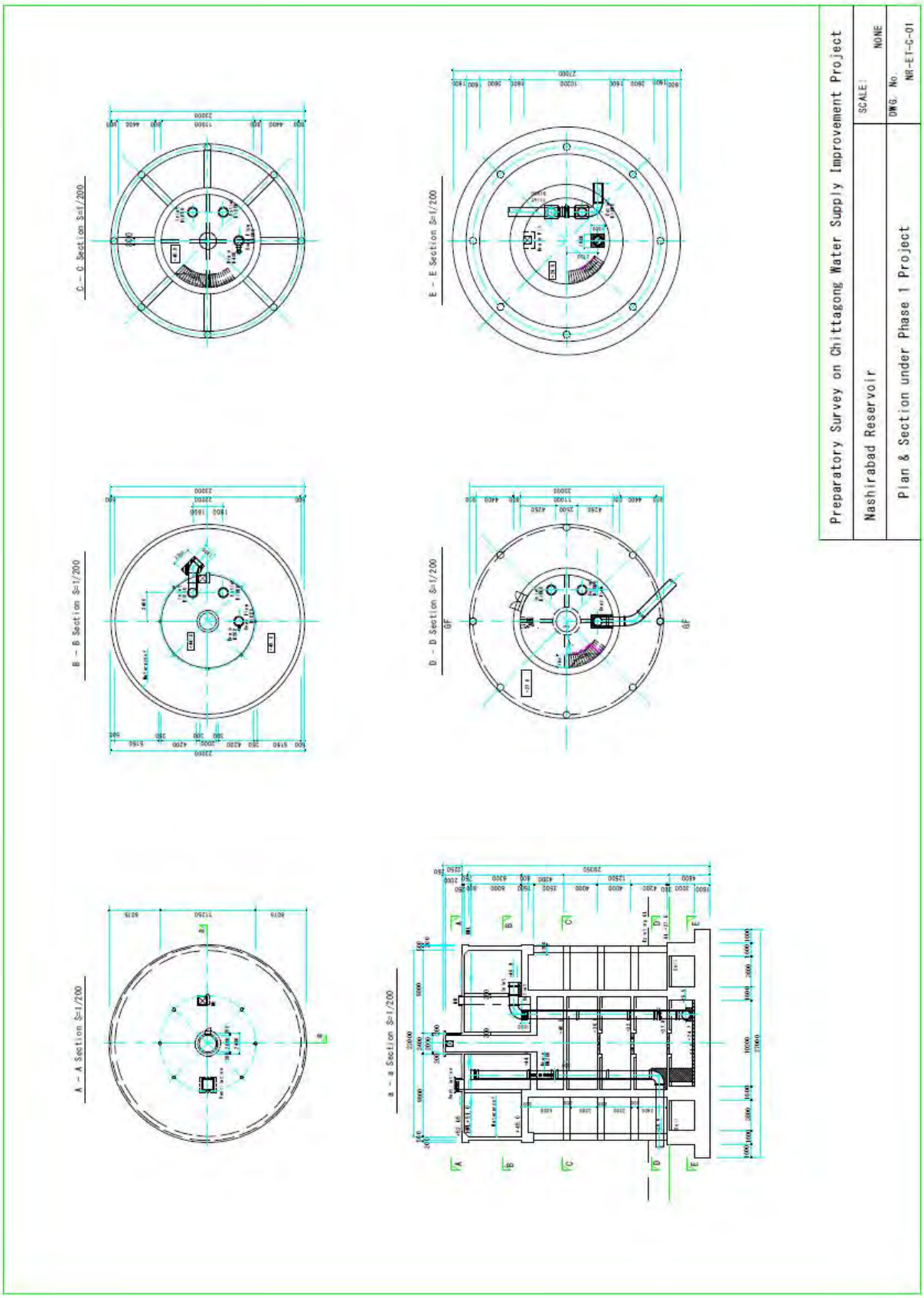
13. Nashirabad Reservoir; Section



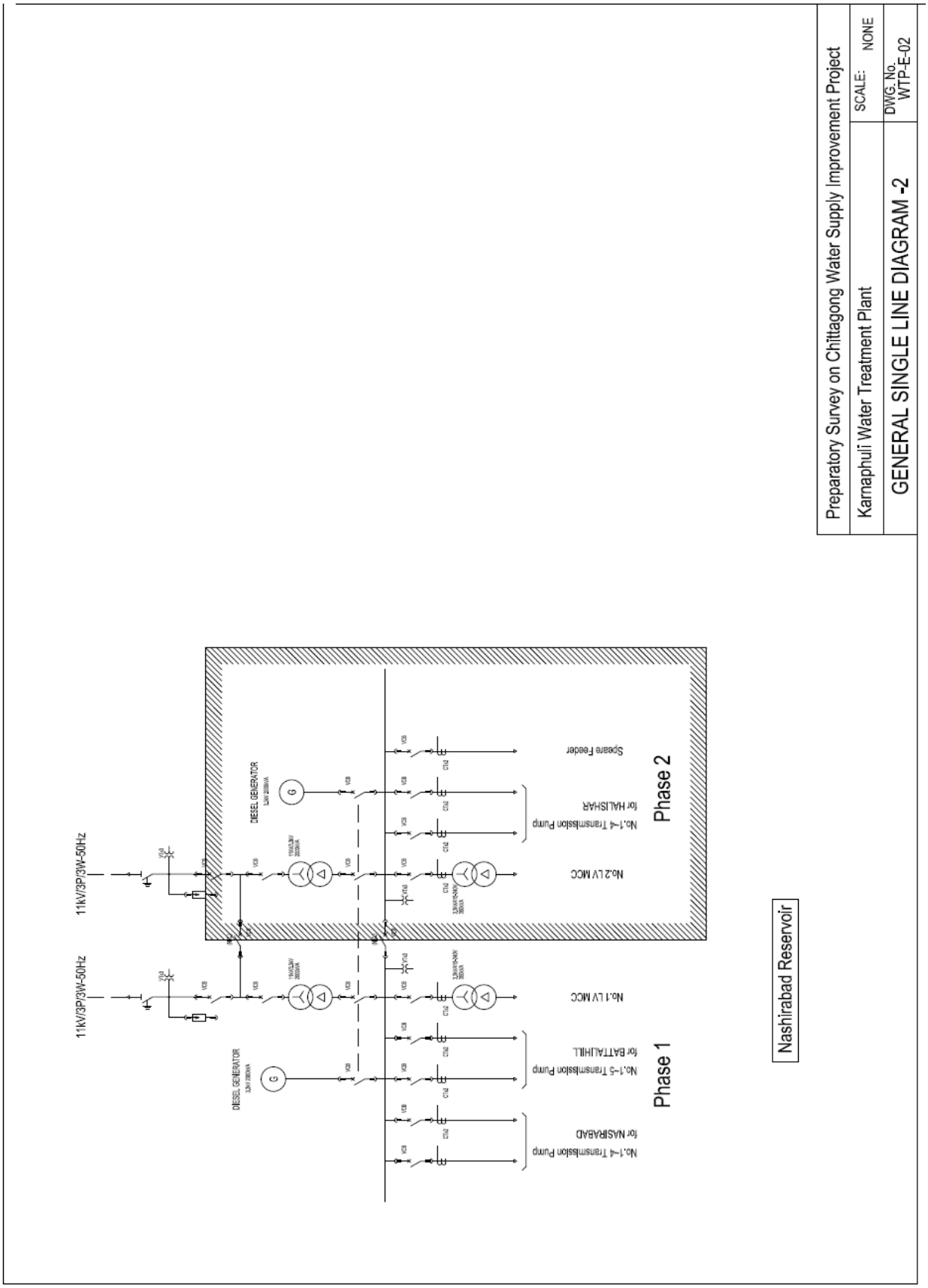
14. Hydraulic Profile from Nashirabad Reservoir to each Elevated Tank/Distribution Reservoir



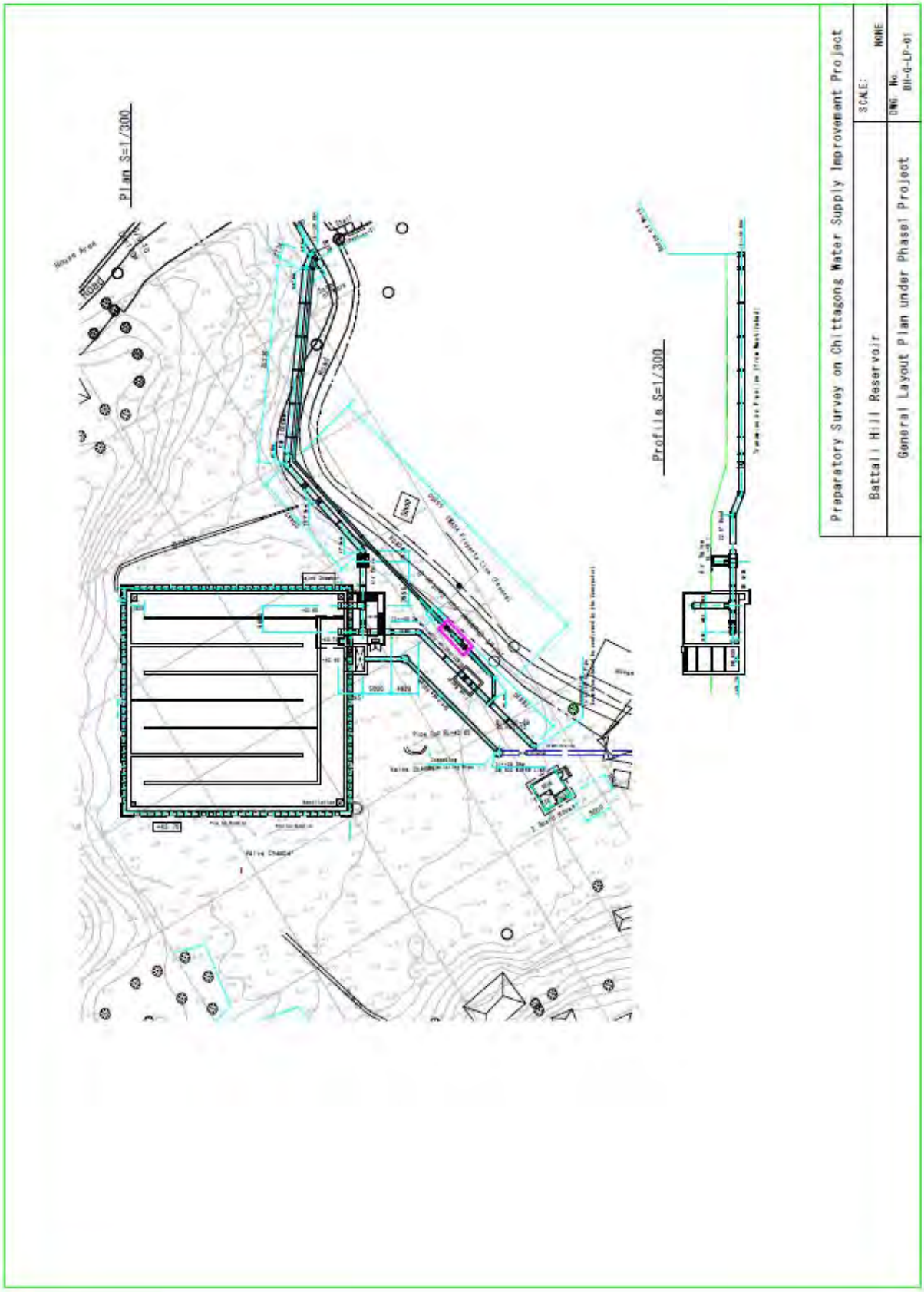
15. Nashirabad Elevated Tank (Phase 1 Project)



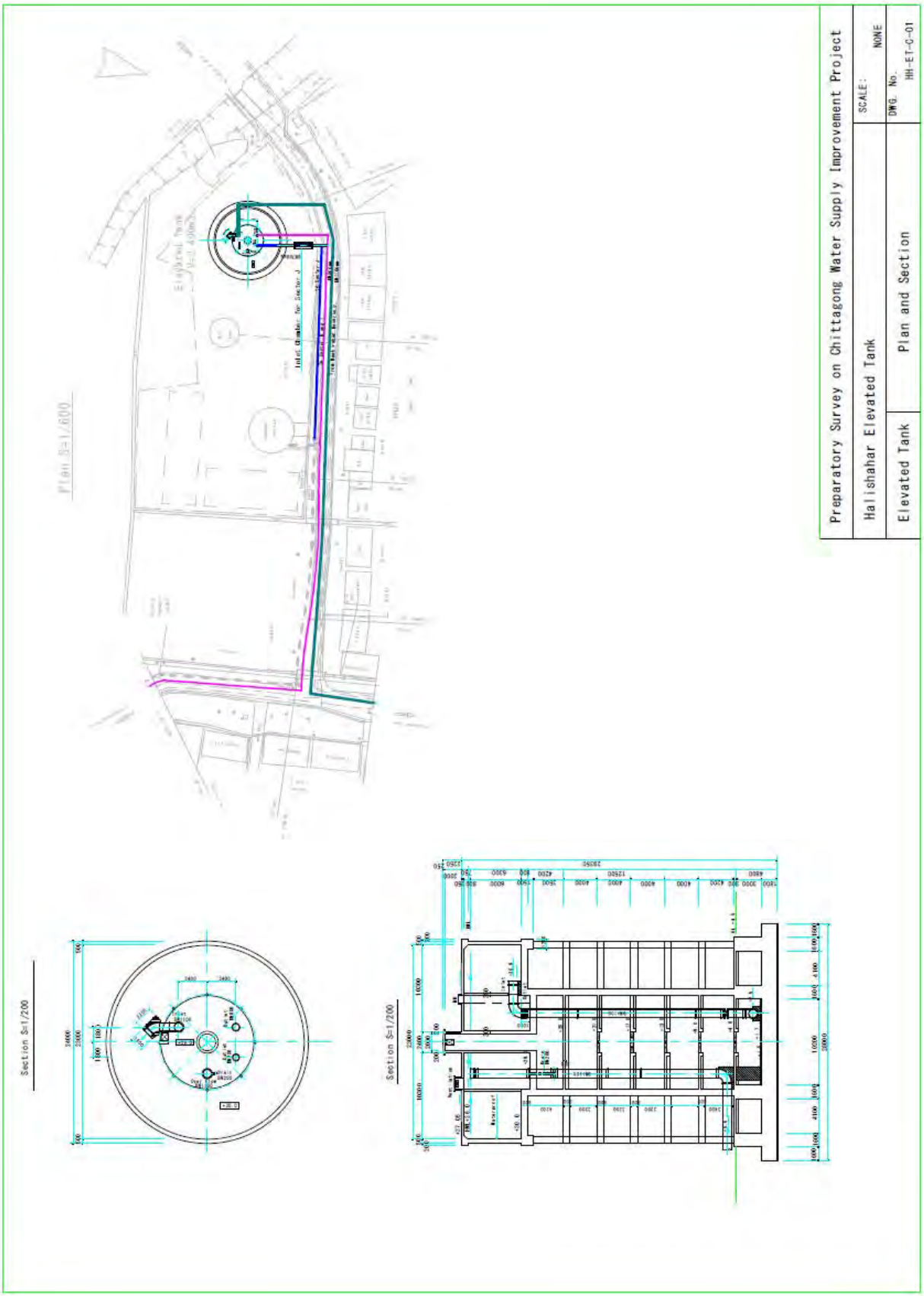
16. Nashirabad Reservoir; General Single Line Diagram



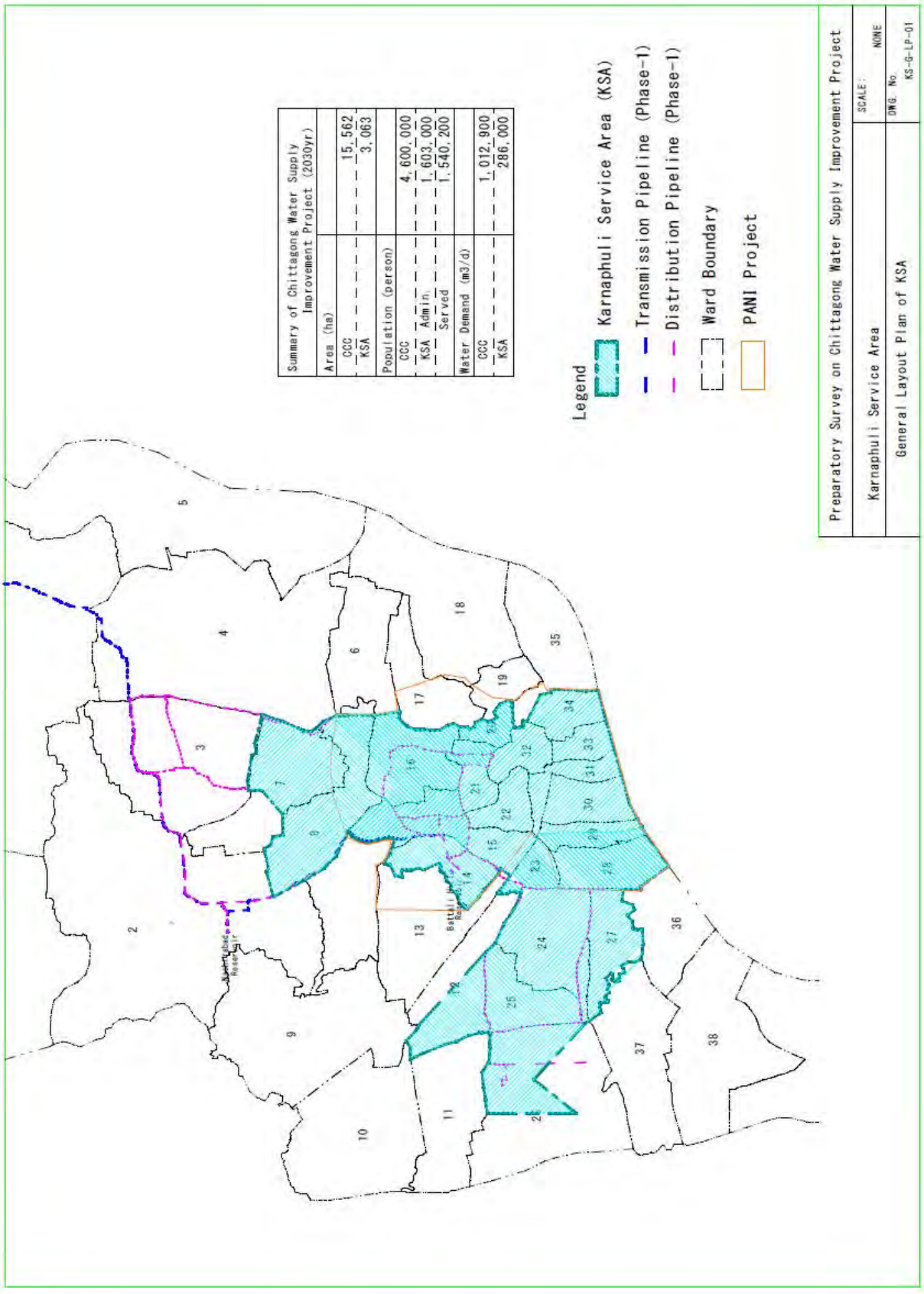
17. Battali Hill Reservoir (Phase 1 Project) and Location of Sector Inlet Chamber



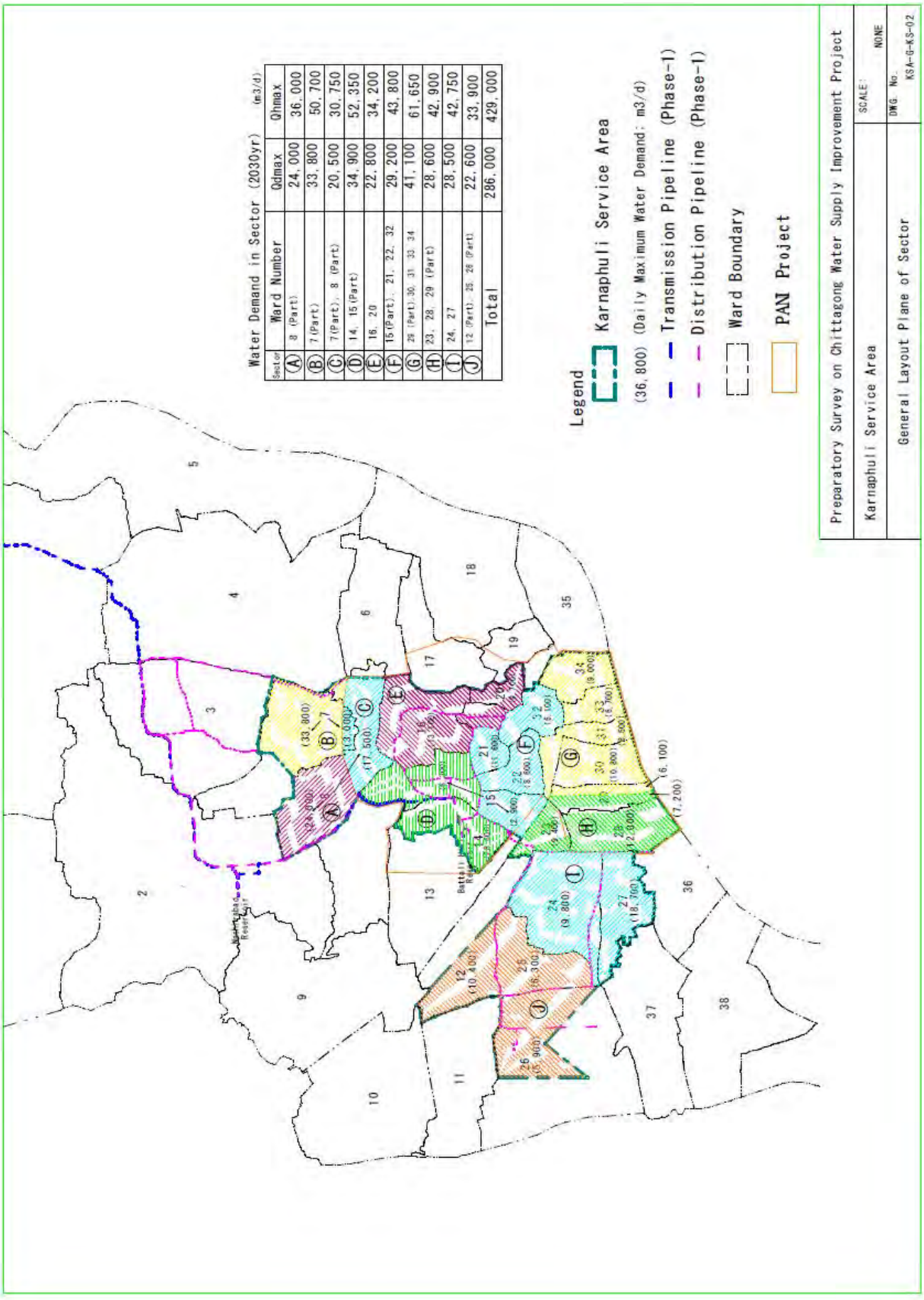
18. Halishahar Elevated Tank; Plan and Section



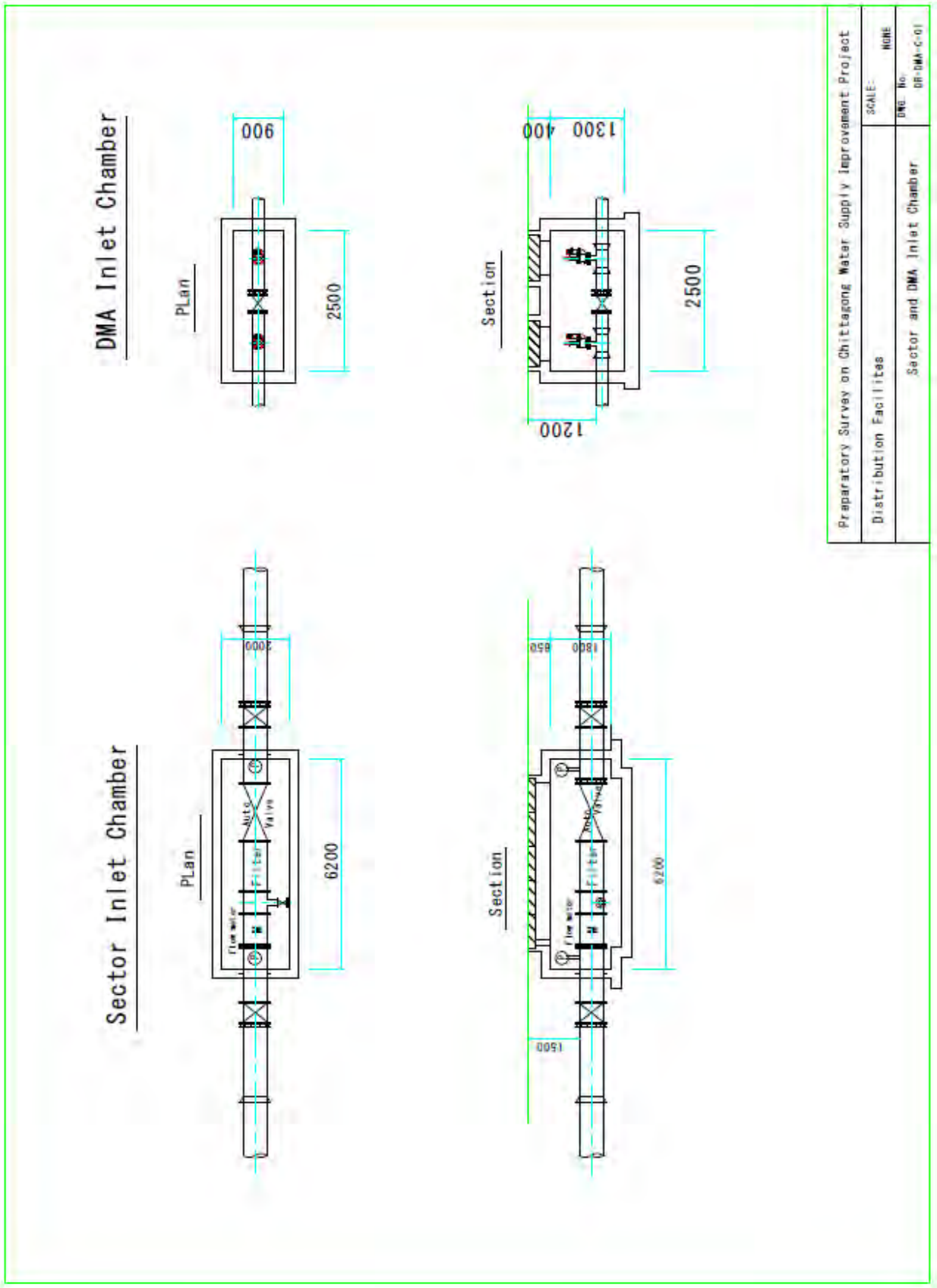
19. General Layout Plan of KSA



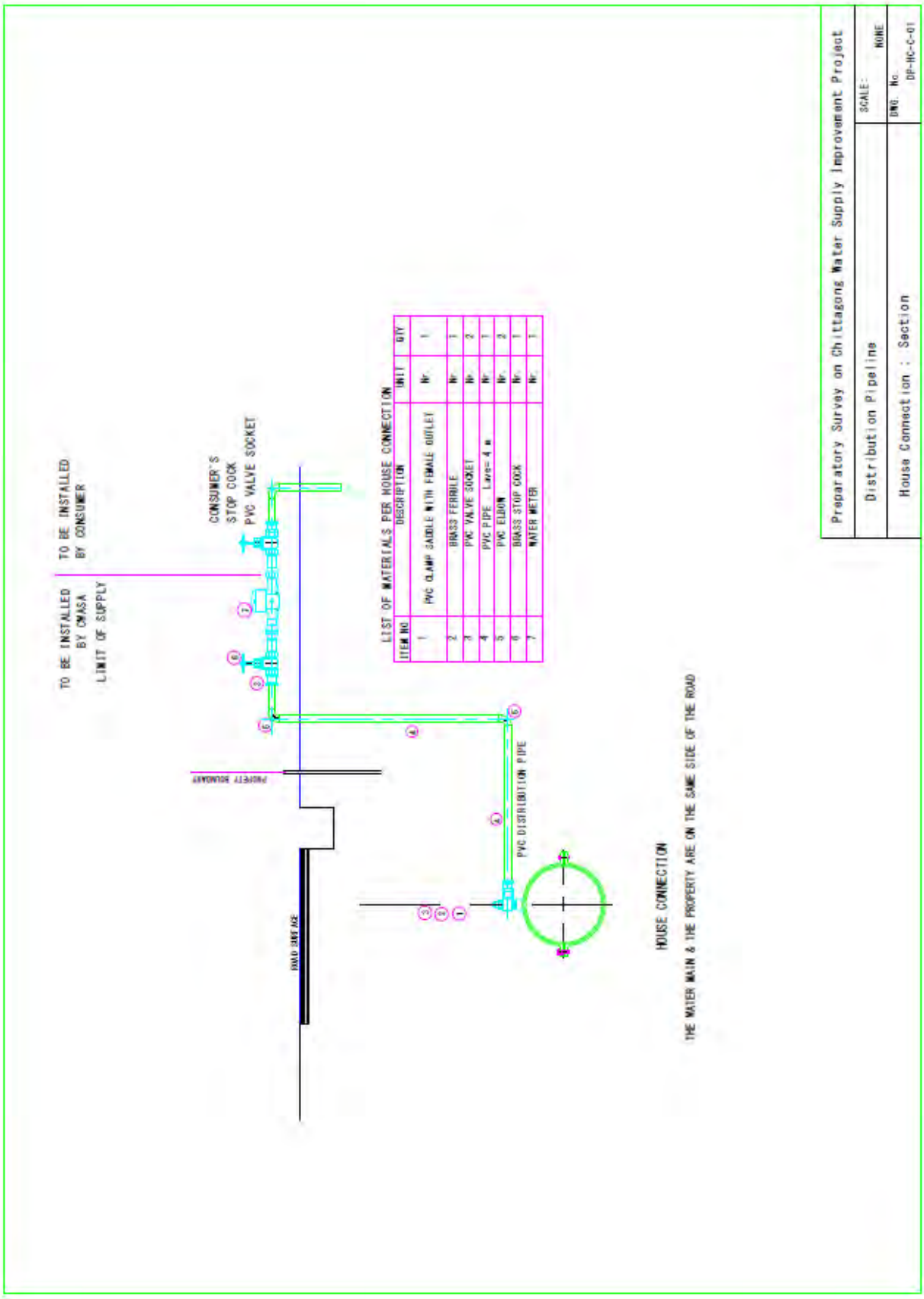
20. General Layout Plan of Sector



21. Sector and DMA Inlet Chamber



22. House Connection; Section



II SOIL INVESTIGATION

II. Soil Investigation

II.1 Halishahar Site

CLIENT:
JICA/CWASA

REPORT ON:
SUB-SOIL INVESTIGATION OF HALISHAHOR PROJECT FOR FEASIBILITY STUDY OF KARNAPHULI WATER SUPPLY PROJECT PHASE-2 AT HALISHAHOR, CHITTAGONG.

CONSULTANT:
NJS CONSULTANTS

SEPTEMBER – 2012.

REPORT ON SUB-SOIL INVESTIGATION (Halishahar Site)

1.0 INTRODUCTION:

A reasonably accurate conception about the subsoil parameters of any project site is an essential priority for proper planning and designing the foundation of the concerned structure, So that the structure after its construction would remain safe and stable throughout its service period. Paying due considerations to JICA Survey Team**,** was agreed to offer the sub-surface investigation work of the same in favour of **BETS Consulting Services Ltd.**, Engineering Consultant, a well reputed geotechnical firm in Dhaka, Bangladesh.
According to work order of representative of the client, a detailed sub-soil study comprising execution of **3 (Three)** number borings up to **19.5-21.0m**deep, including the different field and laboratory tests was carried out and results analysis, report preparation & report submission etc had been undertaken and all official correspondence carried out by BETS, during the period of **SEPTEMBER-2012.**

2.0 METHODOLOGY:

BETS sent one SPT Test team for field test at the site. According to the work order, Team Leader of SPT Test team contacted with representative of client forrecognizing the selected land and locations for field test. The location of bore holes was selected in presence of the representative of client.

3.0 CLIENT:

JICA Survey Team.
NJS CONSULTANTS

4.0 LOCATION:

HALISHAHOR, CHITTAGONG.

5.0 SCOPE OF WORK:

The main scopes of this investigation work are:

a. Execution of exploratory borings, recording of sub-soil stratification and position of ground water table.
b. Execution of standard penetration test (**SPT**) at an interval of **1.5m** depth with collection of disturbed soil samples up to final depth exploration of each boring.
c. Collection of 1 nos. undisturbed soil samples by thin walled Shelby tubes for each bore hole.
d. Preparation of final report with all works including detailed description of soil stratification sub-soil.
e. From the field tests and laboratory tests, scope of calculation for bearing capacity values for design shallow foundation.
f. For loose and soft strata, from the field test and laboratory tests, scope of calculation for skin friction and bearing values for design deep foundation.

6.0 FIELD WORKS:

All the field works and field tests were conducted as per standard procedure as laid down in ASTM specification are as follows:

6.1 EXPLORATORY BORING DRILLING:

Drilling was executed by wash boring method. A hole was started by driving vertically a 4" diameter steel casing into the ground to some depth and then the formation ground casing was broken up by repeated drops of a chopping bit attached to the lower and of drilling pipe. The upper end of the same was forced at high pressure through pressure pipe. Forced slurry or water emerges at high velocity through the pores of the chopping bit, and returns to the surface through the annular space between drilling pipe and the side of the casing or hole, carrying with it the broken-up soil. In this way drilling is advanced up to a level of 6" above the depth, where SPT has to be executed.

6.2 STANDARD PENETRATION TEST:

Standard penetration Tests have been executed in all the bore holes at 1.5m. intervals of depth up to the final depth of in this test, a split spoon sampler of 2" out diameter and 1-3/8" inner diameter, is made to penetrate 18", for boring. Into the soil by drops of a hammer weighing 140lb. failing freely for a height of 30 inches. Number of blows of hammer required for penetration of each 6" length of the sampler is recorded. The number of blows last 12" penetration of the total 18" is know as the standard penetration value (N-values) as specified by ASTM and is plotted the SPT value of the particular depth.

6.3 EXTRACTION OF SOIL SAMPLE:

The Disturbed soil samples were collected at 1.5m. intervals and at every change of soil strata split spoon sampler. These soil samples were studied visually and the soil classification were done to prepare strata chart of soils up to the explored depth. Before collection of samples, the hole is washed and cleaned the drill pipe with the help of an adapter and is lowered into the hole. The sampler is then pressed down into the ground in one rapid continuous movement until the tube, except 4inches from the top is filled with soil sample.

Undisturbed soil samples were collected at a depth where layer of soil is changed such as 8ft to 12ft.Undisturbed soil samples area collected by means of thin walled sharp ended 3inch dia.stationary piston sampler from the cohesive soil formation. The collected tubes were then labeled with detailed job designation, date and shifted the laboratory for testing.

7.0 LABORATORY TESTS:

All Laboratory Tests conducted on soil samples collected either in the disturbed or in the undisturbed state. All tests were done as per ASTM procedures, are as follows:

7.1 NATURAL MOISTURE CONTENT:

The water content of a soil sample is the ratio of the weight of the water in the sample to its dry weight. It is usually expressed as a percentage. The soil sample is weight both in natural state and in over dry state and the moisture content is calculated by dividing the loose of weight of the sample by its dry weight.

7.2 COMPLETE GRAIN SIZE ANALYSIS:

The object of grain size analysis is to determine the size of the soil grains, and the percentage by weight of soil particles of different particles size, comprising a soil sample. The process consists of either sieve analysis or hydrometer analysis or both. The hydrometer analysis is adopted for sample passing sieve No. 200. For hydrometer analysis, a 40 gms of the over dry sample, is thoroughly mixed with required quantity of water in a calibrated glass cylinder. In order to avoid flocculation, a little dispersing agent is added. The density of the suspension is measured at specified time intervals, by means of a hydrometer or special design. At any particular time the size of the largest particle remounting in suspension at the level of the hydrometer can be computed by means of stocks Law, where as he weight of the particles finer than that size, can be computed from the density of the suspension at the same level.

The mixture is washed through U.S standard sieve No. 200 and the fraction retained is dried. The fraction retained on each sieve is weighed for calculation of the percentage of different fraction. The results are represented by cumulative curves plotted on semi-logarithmic graph paper.

7.3 ATTERBERG LIMITS:

Physical properties of clay are greatly influenced by water content. A given soil behave as a fluid or a soil or, as a plastic materials, depending on how much water its contains. The water contents that correspond to the boundaries between the states of consistency are called as the Atterberg limit.
Liquid Limit is the minimum water content at which a clay soil just starts behaving like a fluid. It is determined with the help of a standard limit device which consists of brass cup and an arrangement to impart blows to cap at a uniform rate. The water content at which 25 blows are required is termed as the limit.
The plastic limit is the minimum water content at which a soil is just plastic and is determined by rolling out a soil sample at slowly decreasing water content until, the desired water content is reached, at which a thread of 3mm diameter just begins to crumble. The thread is rolled on glass plate with hand.

7.4 SPECIFIC GRAVITY TEST:

The specific gravity of soil particles (Gs) is defined as the ratio of the mass of given volume of soil particles to the mass of an equal volume of water at 40C. The specific gravity of a solid for most natural soils falls in general range of 2.60 to 2.80. To determine the specific gravity of soil sample, 25 grams of over dried soil sample is thoroughly pulverized and is placed in a calibrated psychomotor. Water is poured inside the pycnometer until its top is slightly below the calibrated mark. The mixture is then boiled thoroughly in order to eliminate all the air bubbles. More water is then added to the mixture till it over-night, the temperature is then recorded and the bottle is weighed.
The specific gravity Gs is given by:

$$Gs = \frac{Gt \cdot Ws}{Ws - W_1 + W_2}$$

Where,

Gt	=	Specific gravity of water at TOC.
W_S	=	The weight of over dry soil (25gms.)
W_1	=	Weight of flask + soil + water.
W_2	=	Weight of flask + water.

7.5 DIRECT SHEAR TEST:

Direct shear test can be performed for both cohesion less & cohesive soil to determine shear strength, angle of internal friction, cohesion c, volume change etc. The test is done in a direct shear machine which consists of a normal loading device; shearing displacement of approximately 10mm per minute is often for a sample used for a sample thickness of about 1.2cm.
The results of a direct shear test on a cohesion less & cohesive soil can be presented in a summary table & by stress-strain curve. A stress-strain curve normally consists of shear stress, various shear displacement for both the undisturbed and the remolded test under a specified normal load the normal load usually varies from 1/3kg/cm^2 to 1kg/cm^2. Another curve of normal stress verses shearing stress will give angle of internal and cohesion for cohesive soil.

7.6 UNCONFINED COMPRESSION TEST:

Unconfined compression test is a simple method for determination of shearing strength of cohesive soil which is important to determine the bearing capacity of soil. As the name implies, the lateral confining pressure in an unconfined compression test is kept zero, unsupported specimen and at failure is measured. The specimen is prepared from the undisturbed soil sample by carefully trimming it to a cylindrical shape of 7cm height and 3.5cm dia. The specimen is then placed on the level pedestal of the unconfined compression apparatus in a vertical position. The load is applied axially on the top of the specimen an is distributed uniformly over surface of the specimen with the help of

double providing ring assembly fitted with a strain gauge, fitted with the apparatus. The load is applied at such a rate that the vertical deformation of the sample is nearly 2% (two percent) per minute in order to avoid and drainage during compression. The load is kept increasing until the specimen fails along shearing plane. The maximum load at failure knows as the unconfined compressive strength of the sample the shearing strength of the sample is half of the unconfined compressive strength.

7.7 CONSOLIDATION TEST:

The gradual process of compression of soil under the action of static load and with decrease of void ratio due to expulsion of water from the soil pores is termed consolidation The phenomenon compressibility characteristics of a soil as the period and magnitude of settlement of a foundation depends on these characteristics. The test is performed on a specimen of circular shape of 6.35cm dia and 2.54cm thickness, the specimen is prepared from the undisturbed sample by carefully trimming it to the required dimension with the help of a cutting edge and wire saw.

The specimen is then placed in the consolidation ring and its top and bottom are trimmed off level with that of the ring .The specimen along with the ring on the top and the other at the bottom of the specimen. The load is then applied on porous stone and on the specimen with the help of a level arrangement with the apparatus.

Decreases in volume of specimen are read from a strain gauge attached to the consolidation unit at specified time intervals the consolidation unit is always kept full with water in order to avoid evaporation of the specimen. The load increment is allowed after each twenty four hours, The observed reading are then plotted on semi-logarithmic graph paper to give the pressure-void ratio curve from which compression index, Cc Can be calculated. Cc is important factor governing the settlement process of underlying soils.

8.0 SOIL COMPOSITION:

8.1 DESCRIPTION OF SOIL COMPOSITION:

The following terms are used in this report for description of soil composition:

Trace fine sand : 1 to 10% fine sand.
Little silt : 11 to 20% silt.
Some clay : 20 to 35% clay.
Sandy silt : 35 to 50% sand & 50 to 70% silt.
Clayey silt : 35 to 50% clay & 50 to 70% silt.
Silty sand : 35 to 50% silt & 50 to 70 % sand.

9. 0 CORRELATION TABLE OF SOILS BASED ON SPT-VALUES:

Two tables for Cohesion-less and cohesive soils based on N- Values as below:

9.1 values of Unit Weight and Angle of Internal Friction of Cohesion-less soil Based on N-Values (After K. Terzaghi and R. B. Peck):

Table No. 1.

N-Values	Condition	Relative Density	Angle of Internal Friction	Moist Unit Wt. in gm/cc.
0-4	Very loose	0.0-0.2	25^0-30^0	1.12-1.60
4-10	Loose	0.2-0.4	30^0-35^0	1.44-1.84
10-30	Medium	0.4-0.6	35^0-40^0	1.76-2.08
30-50	Dense	0.6-0.85	40^0-45^0	1.76-2.24
Over 50	Very dense	1.00	45^0	2.08-2.40

The tabulated values apply for dry/moist cohesion less sand. For silty sands the bearing capacity values must be reduced by study of grain size classification and applying judgment. Correction for water table close to bottom of foundation the bearing values should be reduced to half. The bearing values are, however, not affected by the water table at a depth greater than 1.5B below foundation level, B being least dimension of the bottom of foundation. Bearings values for intermediate position of water table may be reduced by liner interpolation.

9.2 Values of approximate Unconfined Compressive Strength Based on N-Values for Cohesive Soil (After K. Terzaghi and R.B. Peck):

Table No.- 2.

N-Values	Condition	Unconfined compressive Strength in Kg/cm^2.
Below 2	Very soft	Below 0.25
2-4	Soft	0.25-0.50
4-8	Medium	0.50-1.00
8-16	Stiff	1.00-2.00
16-32	Very stiff	2.00-4.00
Over 32	Hard	Over 4.00

In the above table the shear strength of cohesive soil is equal to 1/2 of unconfined compressive strength and the angle of shearing resistance is equal to zero. It should be remembered that the correlation for cohesive soil is always much reliable.

10.0 PHYSICAL PROPERTIES:

Physical Properties of the subsoil formation of the project area have been evaluated by the execution of **3(Three)** number borings of **19.5-21.0m** deep (firm strata). The overall physical properties may be summarized as follows:

10.1 STRATIFICATION OF SOIL:

The top soil is light brown soft to medium clay, some silt the underlying soil is grey coarse sand, trace silt.

10.2 CONSISTENCY/COMPACTNESS:

Up to the depth of EGL to 6.0m, consistency of the top soil usually varies from soft to medium consistency of soil, however, gradually increase the consistency. The subsequent deep layers stiff to medium stiff soil state.

10.3 GROUND WATER TABLE:

The position of Ground Water Table (GWT) is about (-) **0.0-0.60m** from existing ground level.

10.4 Natural Moisture Content, Unit Weight, Specific Gravity and Liquid Limit:

Table No .3 Name of the Laboratory Test:

Name of the Soil Test
Natural Moisture Content
Natural Unit Weight
Dry density
Specific Gravity
Liquid Limit
Plasticity index
Grain Size Distribution
Direct shear test
Consolidation test
Unconfined compressive test

11.0 ENGINEERING PROPERTIES:

The engineering properties of soil, including the cohesion, compressibility and the angle of internal granular friction have been determined by performing laboratory tests on the soil samples collected during field investigation. These are as follows:

11.1 COHESION: The values of cohesion, as reported from the performance of unconfined compression tests from Laboratory Test Sheet.

11.2ANGLE OF INTERNAL FRICTION:
The angle of internal friction values of the investigated of soil, as reported form the performance of direct shear test from Laboratory Test Sheet.

11.3 COMPRESSIBILITY: The top layer of plastic silty soil usually has been observed moderately compressible in nature by consolidation tests from Laboratory Test Sheet.

12. 0 EVALUATION OF BEARING CAPACITY:

12.1 BEARING CAPACITIES OF THE SHALLOW CONDITION FROM THE SPT:
The Bearing capacities of the shallow foundation particularly for the top layer of cohesive soil may be estimated from the SPT values, as suggested by Terzaghi, according to the following table.

Table No.- 4: Bearing Capacities of the shallow foundation (Values in kg/cm^2, F. S. =2.50):

SPT range	Allowable Bearing Capacity (Tsf)	
	Continuous Footing (B=4ft)	Isolated Column Footing (B=8ft)
0-2	0.00 - 0.225	0.00 - 0.30
2-4	0.225 - 0.45	0.30 - 0.60
4-8	0.45 - 0.90	0.60 - 1.20
8-15	0.90 - 1.80	1.20 - 2.40
15-30	1.80-3.60	2.40-4.80
>30	> 3.60	> 4.80

Note:
a. width = 4ft for strip footing and width = 8ft for isolated footing respectively.
b. The above values are the net allowable Bearing capacities.
c. The cohesive soil has been considered in a saturated condition.

12.2 BEARING CAPACITY OF THE SHALLOW FOUNDATION FROM THE SOIL PARAMETERS:
The bearing capacities of the shallow foundation may more appropriately be determined from the parameters of soil such as the values of cohesion and the angle of internal friction as obtained from the performance of laboratory tests. These have been done considering the general equations of the Bearing capacity of the foundation as suggested by Terzaghi. The evaluated values are provided in the following Table no. 5, and Table no.6

Table No. 5. Bearing Capacities of the Shallow Foundation from Field and Laboratory Test
(Values in kg/cm^2, F. S. = 2.50):

Bore Hole	**Depth in m**	**Field SPT**	**Cohesion kg/cm^2**	**Bearing Capacity (kg/cm^2)**	
				For strip Foundation	**For circular or square footing**
BH-01	1.5	5	0.23	0.56	0.75
	3.0	1	0.05	0.11	0.15
	4.5	4	0.18	0.45	0.60
	6.0	7	0.32	0.79	1.05

BH-02	1.5	2	0.09	0.23	0.30
	3.0	1	0.05	0.11	0.15
	4.5	1	0.05	0.11	0.15
	6.0	12	0.55	1.35	1.80
BH-03	1.5	4	0.18	0.45	0.60
	3.0	3	0.14	0.34	0.45
	4.5	2	0.09	0.23	0.30
	6.0	14	0.64	1.58	2.10

Table No.6: The Skin Friction and the End Bearing Capacities of Piles (F.S. =2.50)

Depth m	BH-01					BH-02				
	N	N_{cor}	Cu kg/cm^2	f_s kg/cm^2	f_b kg/cm^2	N	N_{cor}	Cu kg/cm^2	f_s kg/cm^2	f_b kg/cm^2
1.5	5	-	0.23	0.03	-	2	-	0.09	0.01	-
3.0	1	-	0.05	0.01	-	1	-	0.05	0.01	-
4.5	4	-	0.18	0.03	-	1	-	0.05	0.01	-
6.0	7	-	0.32	0.05	-	12	-	0.55	0.08	-
7.5	14	-	-	0.10	6.24	15	-	-	0.10	6.69
9.0	25	20	-	0.14	10.70	18	17	-	0.11	8.83
10.5	28	22	-	0.15	13.42	21	18	-	0.12	11.23
12.0	35	25	-	0.17	17.85	24	20	-	0.13	13.92
13.5	43	29	-	0.20	23.29	35	25	-	0.17	20.08
15.0	50	33	-	0.22	28.99	40	28	-	0.19	24.53
16.5	50	33	-	0.22	31.88	40	28	-	0.19	26.98
18.0	50	33	-	0.22	34.78	47	31	-	0.21	33.17
19.5	50	33	-	0.22	37.70	50	33	-	0.22	37.70
21.0						50	33	-	0.22	40.59

Depth m	BH-03				
	N	N_{cor}	Cu kg/cm^2	f_s kg/cm^2	f_b kg/cm^2
1.5	4	-	0.18	0.03	-
3.0	3	-	0.14	0.02	-
4.5	2	-	0.09	0.01	-
6.0	14	-	0.64	0.10	-
7.5	12	-	-	0.08	5.35
9.0	17	16	-	0.11	8.56
10.5	21	18	-	0.12	11.23
12.0	16	16	-	0.11	11.07
13.5	27	21	-	0.14	16.86
15.0	43	29	-	0.20	25.87
16.5	35	25	-	0.17	24.53
18.0	48	32	-	0.21	33.71
19.5	50	33	-	0.22	37.70
21.0	50	33	-	0.22	40.59

Note:

- N=Blows/ft, Cu=C
- f_s = Allowable value of the skin friction.
- f_b = Allowable value of the pile end bearing capacity.
- SPT (N) values are corrected within calculation.
- The values of f_s and f_b have been making preliminary estimate about the carrying capacity of a Bored R.C.C. pile.
- In the case of plastic silty soil, the values of the cohesion have been obtained from the SPT values.

13.0 FORMULA USED FOR COMPUTATION:

FOR COHESIVE SOIL:

The ultimate bearing capacity:

$$Q_{ult} = CN_c = \frac{Q_u . N_c}{2} \text{ (J. E. Bowles)}$$

$$q_{all} = \frac{q_u . N_c}{2X3} + \gamma D_f = \frac{q_u N_c}{6} + \gamma D_f \text{ (Factor of safety = 2.50)}$$

Where, q_u = Unconfined Compressive Strength in kg/cm^2.

N_c = Bearing Capacity Factor

= 6.8 square footing.

= 5.7 continuous footing.

FOR COHESION-LESS SOIL:

Q_{ult} = C Nc Sc + γ D_f Nq + 0.5γ BNγ Sγ (J. E. Bowles)
Where, C = Cohesion, γ = Unit weight of soil
D_f = Depth of footing, B = Width of footing
N_C, N_q & Nγ = bearing capacity factors = f (Φ) = f (N)
Sc, Sγ = Shape Factors = f (B, D_f)
$Q_{allowable}$ = q_{ult}/F.S. (F.S. = 2.5)
(Ref. Book: Foundation Analysis and Design by J. E. Bowles, page No. 213-277)

ULTIMATE SKIN FRICTION (f_s) AND END BEARING (f_b)
FOR COHESIVE SOIL :

f_s = FC_d (M. J. Tomlinson)
Where, C_d = q_u/2;
q_u = Unconfined Compressive strength of soil and
F= Bearing Capacity Factor (Ranges between 0.45 to 0.60)

FOR COHESION-LESS SOIL:

For high displacement piles, f_s = 2.0 N kN/m^2
For low displacement f_s = 1.0 N kN/m^2
Where, N average of corrected N- value along the length of the pile.
For bored piles in sand, f_b = 14 N (D_b/B) kN/m^2
Where D_b = actual penetration into the granular soil.
For bored pile in sand, the unit frictional resistance (f_s) is given by
f_s= 0.67 N kN/m^2 (K . R. Arora).

CONSOLIDATION SETTLEMENT:

S= C_c / (1+e_o) * H * log (p_o + Δp) / p_o.
(Ref. Book: Soil Mechanics and Foundation Engineering by K. R. ARORA, Page NO. - 383-450, 638-647 & 1003-1006).

STANDARD PENETRATION TEST:

N correction=15+0.5(N'-15)
Where, N correction =Corrected N- value
N'=SPT value from the field
(Ref. Book: Theory and Practice of Foundation Design by N.N. SOM & S.C. DAS. Page no-42.)

LOAD CALCULATION FOR ANY DIAMETER/ANY LENGTH OF PILE:

P= πDLf_s + $\pi D^2/4f_b$

Where,
P =Allowable working Load
f_s =Average Allowable value of the skin friction=Kg/cm^2
f_b =Allowable value of the pile end bearing capacity =Kg/cm^2
π = A constant=3.1416
D =Pile Diameter
L =Required length of pile = m

14.0 COMPUTATION FOR CONSOLIDATION SETTLEMENT:

The vertical downward movement of the base of a structure is called settlement and its effect upon the structure depends on its magnitude, its uniformity, the length of the time over which it takes place, and the nature of the clay soils. The consolidation settlement can be calculated form test result of unit weight and consolidation tests. The average settlement depends on column load of structure.

15.0 CONCLUSIONS:

On the basis of above analysis and discussions, the following conclusions may be drawn regarding the sub-soil condition of the project area.

a. The overall soil formation of the investigated site are more or less regular in between the Bore hole locations.
b. The top layers of the investigated site have been encountered with comprising light brown soft to medium clay, some silt (Ref. Bore logs).
c. The underlying soil is grey coarse sand, trace silt. (Ref. Bore logs).
d. Bearing capacities for shallow foundation including isolated column footings are may not be suitable (Ref. - Table – 5)
e. Shallow foundation as isolated column footing may not be provided at the project site.
f. **R. C. C. Cast-In-Situ Pile** may be provided for all borings at project site.

16.0 RECOMMENDATIONS:

On the basis of aforesaid conclusions, the following recommendations are suggested for **PROJECT: GEOTECHNICAL INVESTIGATION OF FEASIBILITY STUDY OF KARNAPHULI WATER SUPPLY PROJECT PHASE-2 AT HALISHAHOR, CHITTAGONG.**

R.C.C CAST-IN-SITU PILE:

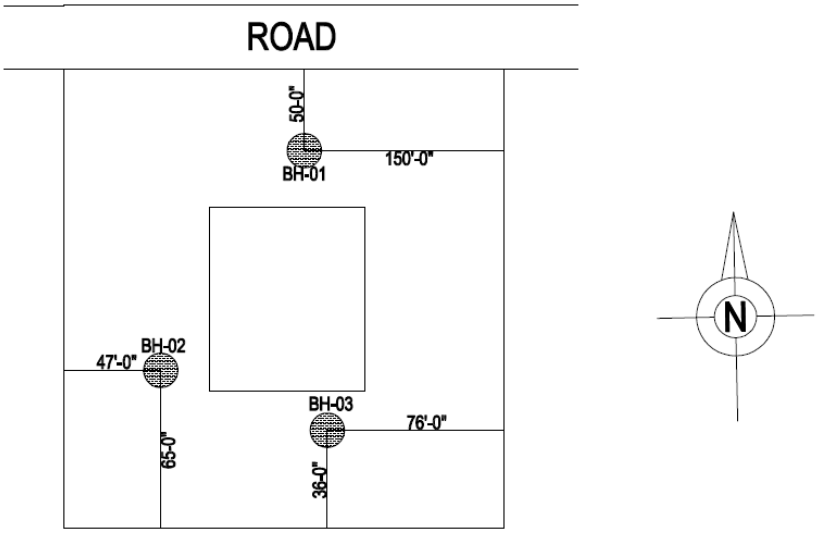
The average bearing capacities (F.S=2.50) of different or same diameter piles with embedment length up to **50.0ft or 15.0m** from **EGL** for each bore hole**,** may be considered as follows:

31.16 Ton for 400 mm or 16 inch.dia pile
37.10 Ton for 450 mm or 18 inch.dia pile
43.50 Ton for 500 mm or 20 inch.dia pile
57.67 Ton for 600 mm or 24 inch.dia pile

Note:

a. 1 Tsf = 1 kg/cm^2 = 2ksf, 1 Ton = 2000 lbs = 9.81 kN, 1m = 3.28ft, EGL = Existing Ground level & F. S. = Factor of Safety.
b. The designer may select any other alternative type, depth as well as the bearing capacity of the foundation in the light of information provided in this report.
c. Foundation base should be kept dry during construction period.

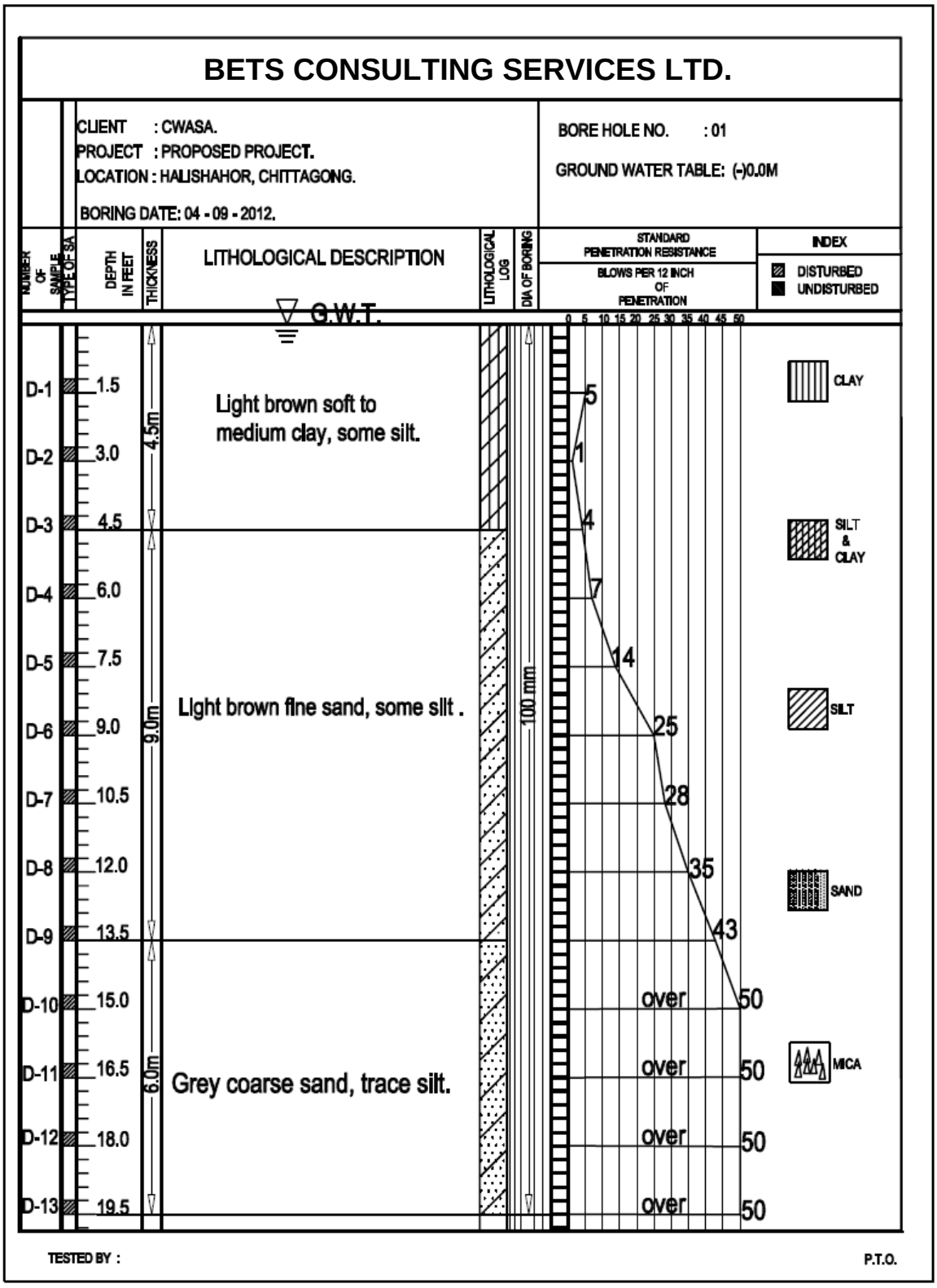
BETS	BORE HOLE LOCATION	CLIENT : CWASA. PROJECT : PROPOSED PROJECT. LOCATION : HALISHAHOR, CHITTAGONG.

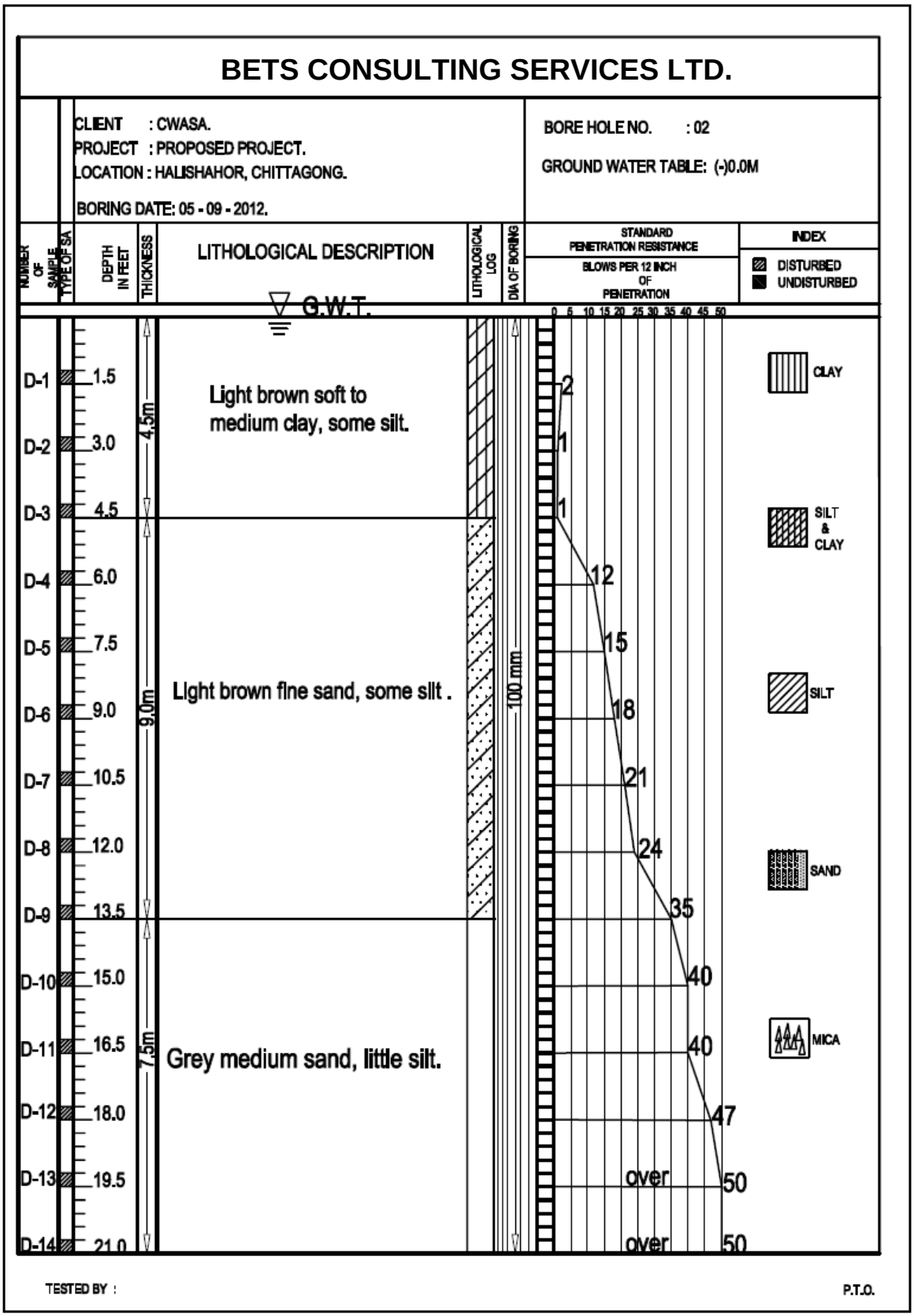


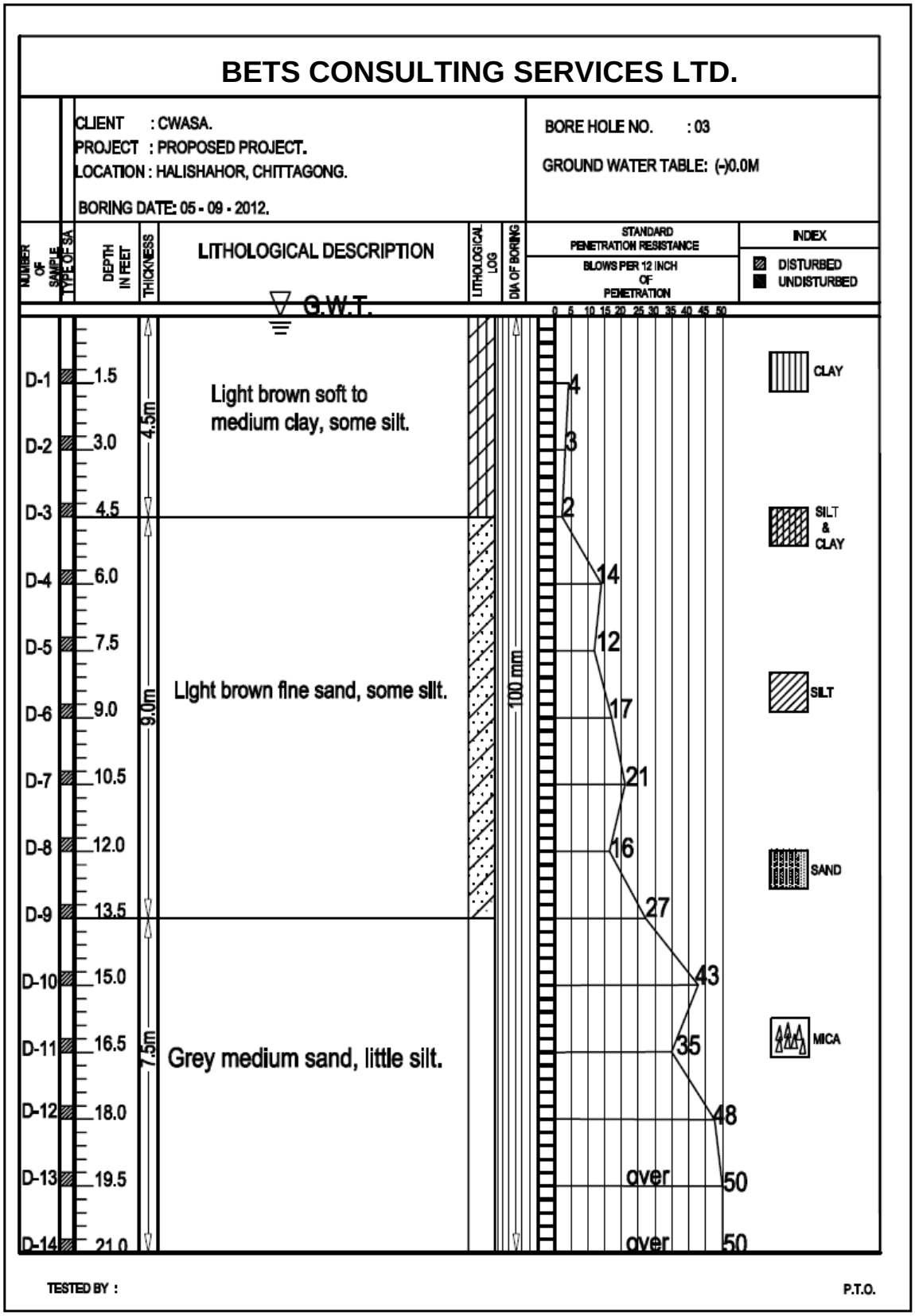
BETS	SUMMARY SHEET	CLIENT : CWASA. PROJECT : PROPOSED PROJECT. LOCATION : HALISHAHOR, CHITTAGONG.

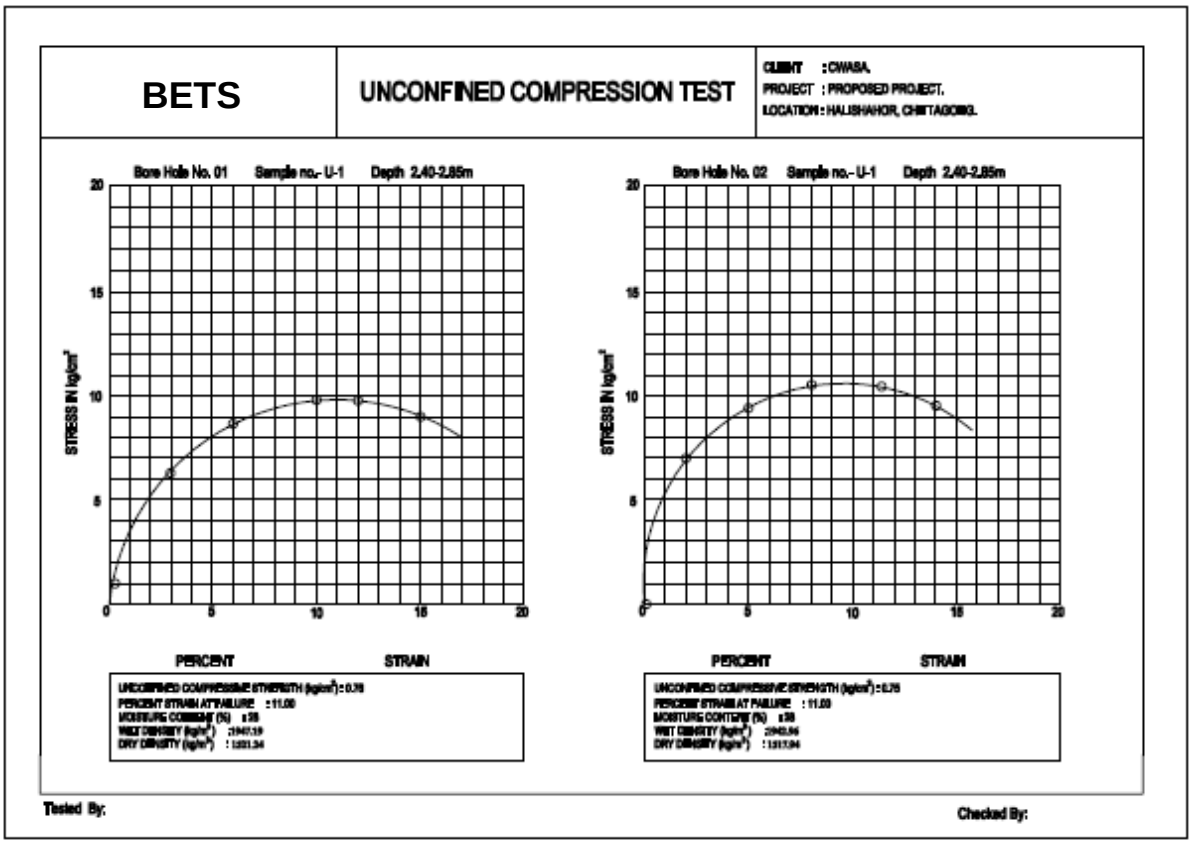
Bore Hole No.	Sample No.	Depth In m	Wet Unit Weight (kg/m³)	Dry Unit Weight (kg/m³)	Natural Moisure Content (%)	Liquid Limit (%)	Plasticity Index (%)	Unconfined Compression Test		Consolidation Test		Triaxial Shear Test		Direct Shear Test		Grain Size Test			
								Strength (kg/cm²)	Strain at failure (%)	Compression Index (cc)	Void (e_o)	ϕ°	Cohesion (kg/cm²)	ϕ°	Cohesion (kg/cm²)	SAND (%)	SILT (%)	CLAY (%)	S. P. Gravity
01	D-02	3.00	1947.19	1521.24	28						0.716			29.65	0.36	-	35	65	2.65
	D-07	10.50	-	-	27						-			32.35	0.00	61	39	-	2.66
	D-10	15.00	-	-	26						-			37.49	0.00	85	15	-	2.68
02	D-02	3.00	1942.96	1517.94	28						0.721			28.83	0.31	-	36	64	2.64
	D-07	10.50	-	-	26						-			33.12	0.00	65	35	-	2.65
	D-10	15.00	-	-	26						-			36.89	0.00	86	14	-	2.69
03	D-02	3.00	1932.99	1498.45	29						0.718			27.00	0.28				2.65
	D-07	10.50	-	-	28						-			33.45	0.00				2.66
	D-10	15.00	-	-	27						-			36.73	0.00				2.68

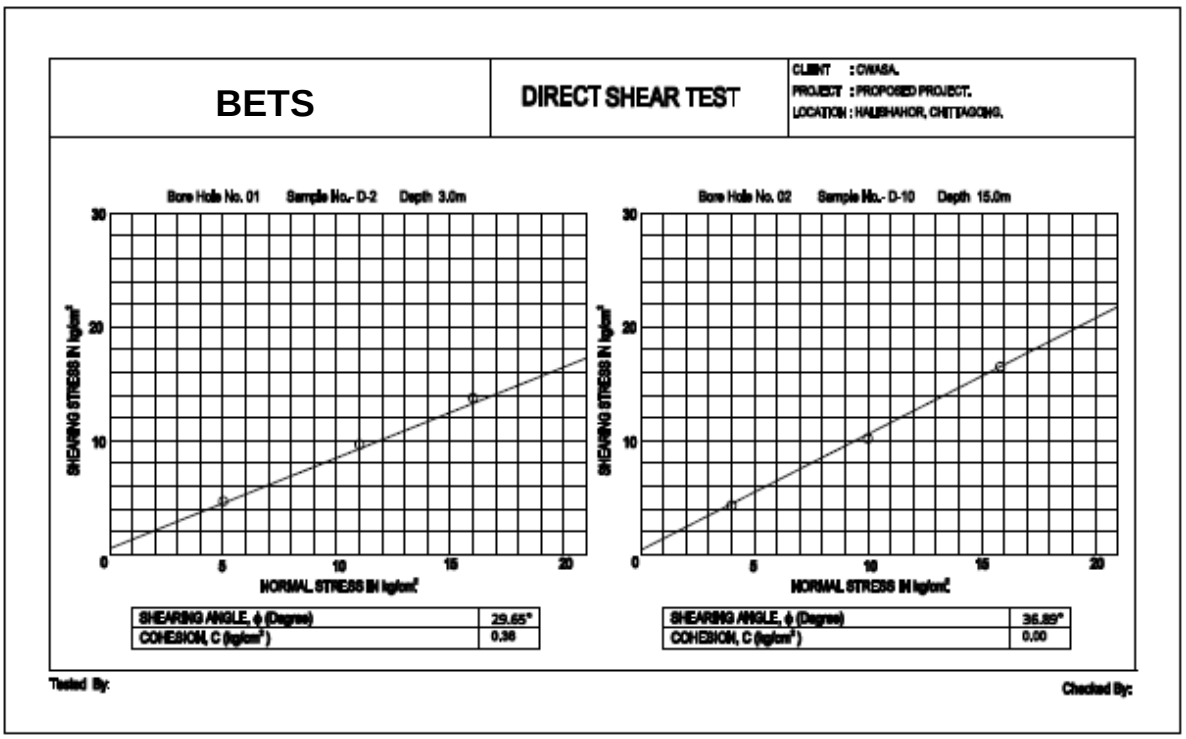
TESTED BY: CHECKED BY:


BETS CONSULTING SERVICES LTD.
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : HALISHAHOR, CHITTAGONG.
BORING DATE: 04 - 09 - 2012.
BORE HOLE NO. : 01
GROUND WATER TABLE: (-)0.0M
NUMBER OF SAMPLE
TYPE OF SA
DEPTH IN FEET
THICKNESS
LITHOLOGICAL DESCRIPTION
G.W.T.
LITHOLOGICAL LOG
DIA OF BORING
STANDARD PENETRATION RESISTANCE
BLOWS PER 12 INCH OF PENETRATION
INDEX
DISTURBED
UNDISTURBED
0 5 10 15 20 25 30 35 40 45 50
D-1 1.5
D-2 3.0
D-3 4.5
4.5m
Light brown soft to medium clay, some silt.
D-4 6.0
D-5 7.5
D-6 9.0
9.0m
Light brown fine sand, some silt .
D-7 10.5
D-8 12.0
D-9 13.5
D-10 15.0
D-11 16.5
6.0m
Grey coarse sand, trace silt.
D-12 18.0
D-13 19.5
100 mm
5
1
4
7
14
25
28
35
43
over 50
over 50
over 50
over 50
CLAY
SILT & CLAY
SILT
SAND
MICA
TESTED BY :
P.T.O.


BETS CONSULTING SERVICES LTD.
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : HALISHAHOR, CHITTAGONG.
BORING DATE: 05 - 09 - 2012.
BORE HOLE NO. : 02
GROUND WATER TABLE: (-)0.0M
NUMBER OF SAMPLE
TYPE OF SA
DEPTH IN FEET
THICKNESS
LITHOLOGICAL DESCRIPTION
G.W.T.
LITHOLOGICAL LOG
DIA OF BORING
STANDARD PENETRATION RESISTANCE
BLOWS PER 12 INCH OF PENETRATION
INDEX
DISTURBED
UNDISTURBED
0 5 10 15 20 25 30 35 40 45 50
D-1 1.5
D-2 3.0
D-3 4.5
4.5m
Light brown soft to medium clay, some silt.
D-4 6.0
D-5 7.5
D-6 9.0
D-7 10.5
D-8 12.0
D-9 13.5
9.0m
Light brown fine sand, some silt .
D-10 15.0
D-11 16.5
D-12 18.0
D-13 19.5
D-14 21.0
7.5m
Grey medium sand, little silt.
100 mm
2
1
1
12
15
18
21
24
35
40
40
47
over 50
over 50
CLAY
SILT & CLAY
SILT
SAND
MICA
TESTED BY :
P.T.O.


BETS CONSULTING SERVICES LTD.
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : HALISHAHOR, CHITTAGONG.
BORING DATE: 05 - 09 - 2012.
BORE HOLE NO. : 03
GROUND WATER TABLE: (-)0.0M
NUMBER OF SAMPLE
TYPE OF SA
DEPTH IN FEET
THICKNESS
LITHOLOGICAL DESCRIPTION
LITHOLOGICAL LOG
DIA OF BORING
STANDARD PENETRATION RESISTANCE
BLOWS PER 12 INCH OF PENETRATION
INDEX
DISTURBED
UNDISTURBED
G.W.T.
0 5 10 15 20 25 30 35 40 45 50
D-1 1.5
D-2 3.0
D-3 4.5
4.5m
Light brown soft to medium clay, some silt.
D-4 6.0
D-5 7.5
D-6 9.0
D-7 10.5
D-8 12.0
D-9 13.5
9.0m
Light brown fine sand, some silt.
100 mm
D-10 15.0
D-11 16.5
D-12 18.0
D-13 19.5
D-14 21.0
7.5m
Grey medium sand, little silt.
4
3
2
14
12
17
21
16
27
43
35
48
over 50
over 50
CLAY
SILT & CLAY
SILT
SAND
MICA
TESTED BY :
P.T.O.

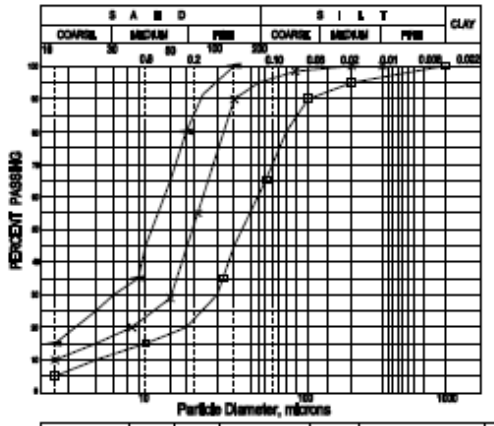

BETS
UNCONFINED COMPRESSION TEST
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : HALISHAHOR, CHITTAGONG.
Bore Hole No. 01 Sample no.- U-1 Depth 2.40-2.85m
Bore Hole No. 02 Sample no.- U-1 Depth 2.40-2.85m
STRESS IN kg/cm²
PERCENT STRAIN
PERCENT STRAIN AT FAILURE : 11.00
Tested By:
Checked By:

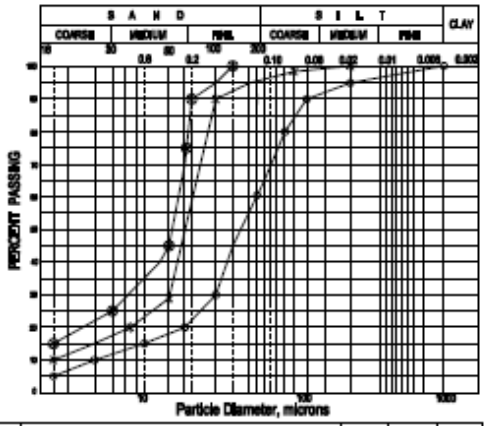

BETS
DIRECT SHEAR TEST
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : HALISHAHOR, CHITTAGONG.
Bore Hole No. 01 Sample No.- D-2 Depth 3.0m
Bore Hole No. 02 Sample No.- D-10 Depth 15.0m
SHEARING STRESS IN kg/cm²
NORMAL STRESS IN kg/cm²
SHEARING ANGLE, ϕ (Degree) 29.65°
COHESION, C (kg/cm²) 0.36
SHEARING ANGLE, ϕ (Degree) 36.89°
COHESION, C (kg/cm²) 0.00
Tested By:
Checked By:

BETS

GRAIN SIZE DISTRIBUTION

CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : HALISHAHOR, CHITTAGONG.





SYMBOLS	BORE	SAMPLES	Depth in m	N.M.C	ATTERBERG LIMIT L.L	P.L	P.I	SPECIFIC GRAVITY	SOIL CLASSIFICATION	SAND %	SILT %	CLAY %
○ ○ ○		02	3.00	28	41	27	14	2.65	Light brown soft to medium clay, some silt.	-	35	65
× × ×	BH-01	07	10.00	27	NP	NP	NP	2.69	Light brown fine sand, some silt.	61	39	-
⊣ ⊣ ⊣		10	15.00	28	NP	NP	NP	2.68	Grey coarse sand, trace silt.	85	15	-
□ □ □												
⊗ ⊗ ⊗		02	3.00	28	39	26	13	2.64	Light brown soft to medium clay, some silt	-	36	64
⊠ ⊠ ⊠	BH-02	07	10.00	29	NP	NP	NP	2.69	Light brown fine sand, some silt	69	39	-
● ● ●		10	15.00	29	NP	NP	NP	2.68	Grey coarse sand, trace silt.	86	14	-
⊣ ⊣ ⊣												

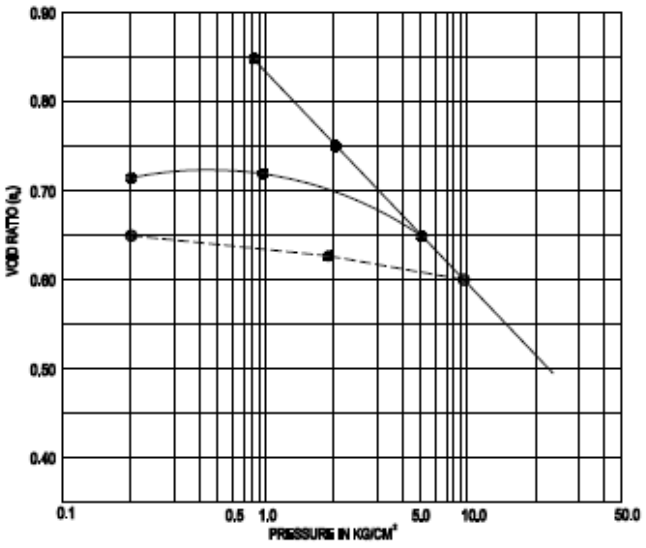
TESTED BY:

P.T.O.

BETS

CONSOLIDATION TEST
VOID RATIO—LOG PRESSURE CURVE

CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : HALISHAHOR, CHITTAGONG.



BORE HOLE NO: 01

SAMPLE DEPTH: 2.40 TO 2.85M

DIAMETER (CM) = 6.35

INITIAL HIGH (CM) : 2.04

SOLID HEIGHT (CM): 1.301

INITIAL M.C (%):28

SPECIFIC GRAVITY : 2.65

DRY DENSITY (KGM³): 1331.34

INITIAL VOID RATIO (e_0): 0.716

COMPRESSION INDEX (Cc): 0.19

Tested By:

Checked By:

II.2 Nashirabad Site

CLIENT:
JICA/CWASA

REPORT ON:
SUB-SOIL INVESTIGATION OF NASHIRABAD RESERVOIR FOR FEASIBILITY STUDY OF KARNAPHULI WATER SUPPLY PROJECT PHASE-2 AT NASHIRABAD, CHITTAGONG.

CONSULTANT:
NJS CONSULTANTS

SEPTEMBER – 2012.

REPORT ON SUB-SOIL INVESTIGATION (Nashirabad Site)

1.0 INTRODUCTION:

A reasonably accurate conception about the subsoil parameters of any project site is an essential priority for proper planning and designing the foundation of the concerned structure, So that the structure after its construction would remain safe and stable throughout its service period. Paying due considerations to JICA Survey Team**,** was agreed to offer the sub-surface investigation work of the same in favour of **BETS Consulting Services Ltd.**, Engineering Consultant, a well reputed geotechnical firm in Dhaka, Bangladesh.

According to work order of representative of the client, a detailed sub-soil study comprising execution of **4(Four)** number borings up to **13.5-19.5m**deep, including the different field and laboratory tests was carried out and results analysis, report preparation & report submission etc had been undertaken and all official correspondence carried out by BETS, during the period of **SEPTEMBER-2012.**

2.0 METHODOLOGY:

BETS sent one SPT Test team for field test at the site. According to the work order, Team Leader of SPT Test team contacted with representative of client for recognizing the selected land and locations for field test. The location of bore holes was selected in presence of the representative of client.

3.0 CLIENT:

JICA Survey Team.
NJS CONSULTANTS

4.0 LOCATION:

NASIRABAD, CHITTAGONG.

5.0 SCOPE OF WORK:

The main scopes of this investigation work are:

a. Execution of exploratory borings, recording of sub-soil stratification and position of ground water table.
b. Execution of standard penetration test (**SPT**) at an interval of **1.5m** depth with collection of disturbed soil samples up to final depth exploration of each boring.
c. Collection of 1 nos. undisturbed soil samples by thin walled Shelby tubes for each bore hole.
d. Preparation of final report with all works including detailed description of soil stratification sub-soil.
e. From the field tests and laboratory tests, scope of calculation for bearing capacity values for design shallow foundation.
f. For loose and soft strata, from the field test and laboratory tests, scope of calculation for skin friction and bearing values for design deep foundation.

6.0 FIELD WORKS:

All the field works and field tests were conducted as per standard procedure as laid down in ASTM specification are as follows:

6.1 EXPLORATORY BORING DRILLING:

Drilling was executed by wash boring method. A hole was started by driving vertically a 4" diameter steel casing into the ground to some depth and then the formation ground casing was broken up by repeated drops of a chopping bit attached to the lower and of drilling pipe. The upper end of the same was forced at high pressure through pressure pipe. Forced slurry or water emerges at high velocity through the pores of the chopping bit, and returns to the surface through the annular space between drilling pipe and the side of the casing or hole, carrying with it the broken-up soil. In this way drilling is advanced up to a level of 6" above the depth, where SPT has to be executed.

6.2 STANDARD PENETRATION TEST:

Standard penetration Tests have been executed in all the bore holes at 1.5m. intervals of depth up to the final depth of in this test, a split spoon sampler of 2" out diameter and 1-3/8" inner diameter, is made to penetrate 18", for boring. Into the soil by drops of a hammer weighing 140lb. failing freely for a height of 30 inches. Number of blows of hammer required for penetration of each 6" length of the sampler is recorded. The number of blows last 12" penetration of the total 18" is know as the standard penetration value (N-values) as specified by ASTM and is plotted the SPT value of the particular depth.

6.3 EXTRACTION OF SOIL SAMPLE:

The Disturbed soil samples were collected at 1.5m. intervals and at every change of soil strata split spoon sampler. These soil samples were studied visually and the soil classification were done to prepare strata chart of soils up to the explored depth. Before collection of samples, the hole is washed and cleaned the drill pipe with the help of an adapter and is lowered into the hole. The sampler is then pressed down into the ground in one rapid continuous movement until the tube, except 4inches from the top is filled with soil sample.

Undisturbed soil samples were collected at a depth where layer of soil is changed such as 8ft to 12ft.Undisturbed soil samples area collected by means of thin walled sharp ended 3inch dia.stationary piston sampler from the cohesive soil formation. The collected tubes were then labeled with detailed job designation, date and shifted the laboratory for testing.

7.0 LABORATORY TESTS:

All Laboratory Tests conducted on soil samples collected either in the disturbed or in the undisturbed state. All tests were done as per ASTM procedures, are as follows:

7.1 NATURAL MOISTURE CONTENT:

The water content of a soil sample is the ratio of the weight of the water in the sample to its dry weight. It is usually expressed as a percentage. The soil sample is weight both in natural state and in over dry state and the moisture content is calculated by dividing the loose of weight of the sample by its dry weight.

7.2 COMPLETE GRAIN SIZE ANALYSIS:

The object of grain size analysis is to determine the size of the soil grains, and the percentage by weight of soil particles of different particles size, comprising a soil sample. The process consists of either sieve analysis or hydrometer analysis or both. The hydrometer analysis is adopted for sample passing sieve No. 200. For hydrometer analysis, a 40 gms of the over dry sample, is thoroughly mixed with required quantity of water in a calibrated glass cylinder. In order to avoid flocculation, a little dispersing agent is added. The density of the suspension is measured at specified time intervals, by means of a hydrometer or special design. At any particular time the size of the largest particle remounting in suspension at the level of the hydrometer can be computed by means of stocks Law, where as he weight of the particles finer than that size, can be computed from the density of the suspension at the same level.

The mixture is washed through U.S standard sieve No. 200 and the fraction retained is dried. The fraction retained on each sieve is weighed for calculation of the percentage of different fraction. The results are represented by cumulative curves plotted on semi-logarithmic graph paper.

7.3 ATTERBERG LIMITS:

Physical properties of clay are greatly influenced by water content. A given soil behave as a fluid or a soil or, as a plastic materials, depending on how much water its contains. The water contents that correspond to the boundaries between the states of consistency are called as the Atterberg limit.
Liquid Limit is the minimum water content at which a clay soil just starts behaving like a fluid. It is determined with the help of a standard limit device which consists of brass cup and an arrangement to impart blows to cap at a uniform rate. The water content at which 25 blows are required is termed as the limit.
The plastic limit is the minimum water content at which a soil is just plastic and is determined by rolling out a soil sample at slowly decreasing water content until, the desired water content is reached, at which a thread of 3mm diameter just begins to crumble. The thread is rolled on glass plate with hand.

7.4 SPECIFIC GRAVITY TEST:

The specific gravity of soil particles (Gs) is defined as the ratio of the mass of given volume of soil particles to the mass of an equal volume of water at 40C. The specific gravity of a solid for most natural soils falls in general range of 2.60 to 2.80. To determine the specific gravity of soil sample, 25 grams of over dried soil sample is thoroughly pulverized and is placed in a calibrated psychomotor. Water is poured inside the pycnometer until its top is slightly below the calibrated mark. The mixture is then boiled thoroughly in order to eliminate all the air bubbles. More water is then added to the mixture till it over-night, the temperature is then recorded and the bottle is weighed.
The specific gravity Gs is given by:

$$Gs = \frac{Gt \cdot Ws}{Ws - W_1 + W_2}$$

Where,

Gt	=	Specific gravity of water at TOC.
W_S	=	The weight of over dry soil (25gms.)
W_1	=	Weight of flask + soil + water.
W_2	=	Weight of flask + water.

7.5 DIRECT SHEAR TEST:

Direct shear test can be performed for both cohesion less & cohesive soil to determine shear strength, angle of internal friction, cohesion c, volume change etc. The test is done in a direct shear machine which consists of a normal loading device; shearing displacement of approximately 10mm per minute is often for a sample used for a sample thickness of about 1.2cm.
The results of a direct shear test on a cohesion less & cohesive soil can be presented in a summary table & by stress-strain curve. A stress-strain curve normally consists of shear stress, various shear displacement for both the undisturbed and the remolded test under a specified normal load the normal load usually varies from 1/3kg/cm^2 to 1kg/cm^2. Another curve of normal stress verses shearing stress will give angle of internal and cohesion for cohesive soil.

7.6 UNCONFINED COMPRESSION TEST:

Unconfined compression test is a simple method for determination of shearing strength of cohesive soil which is important to determine the bearing capacity of soil. As the name implies, the lateral confining pressure in an unconfined compression test is kept zero, unsupported specimen and at failure is measured. The specimen is prepared from the undisturbed soil sample by carefully trimming it to a cylindrical shape of 7cm height and 3.5cm dia. The specimen is then placed on the level pedestal of the unconfined compression apparatus in a vertical position. The load is applied axially on the top of the specimen an is distributed uniformly over surface of the specimen with the help of

double providing ring assembly fitted with a strain gauge, fitted with the apparatus. The load is applied at such a rate that the vertical deformation of the sample is nearly 2% (two percent) per minute in order to avoid and drainage during compression. The load is kept increasing until the specimen fails along shearing plane. The maximum load at failure knows as the unconfined compressive strength of the sample the shearing strength of the sample is half of the unconfined compressive strength.

7.7 CONSOLIDATION TEST:

The gradual process of compression of soil under the action of static load and with decrease of void ratio due to expulsion of water from the soil pores is termed consolidation The phenomenon compressibility characteristics of a soil as the period and magnitude of settlement of a foundation depends on these characteristics. The test is performed on a specimen of circular shape of 6.35cm dia and 2.54cm thickness, the specimen is prepared from the undisturbed sample by carefully trimming it to the required dimension with the help of a cutting edge and wire saw.

The specimen is then placed in the consolidation ring and its top and bottom are trimmed off level with that of the ring .The specimen along with the ring on the top and the other at the bottom of the specimen. The load is then applied on porous stone and on the specimen with the help of a level arrangement with the apparatus.

Decreases in volume of specimen are read from a strain gauge attached to the consolidation unit at specified time intervals the consolidation unit is always kept full with water in order to avoid evaporation of the specimen. The load increment is allowed after each twenty four hours, The observed reading are then plotted on semi-logarithmic graph paper to give the pressure-void ratio curve from which compression index, Cc Can be calculated. Cc is important factor governing the settlement process of underlying soils.

8.0 SOIL COMPOSITION:

8.1 DESCRIPTION OF SOIL COMPOSITION:

The following terms are used in this report for description of soil composition:

Trace fine sand	: 1 to 10% fine sand.
Little silt	: 11 to 20% silt.
Some clay	: 20 to 35% clay.
Sandy silt	: 35 to 50% sand & 50 to 70% silt.
Clayey silt	: 35 to 50% clay & 50 to 70% silt.
Silty sand	: 35 to 50% silt & 50 to 70 % sand.

9. 0 CORRELATION TABLE OF SOILS BASED ON SPT-VALUES:

Two tables for Cohesion-less and cohesive soils based on N- Values as below:

9.1 values of Unit Weight and Angle of Internal Friction of Cohesion-less soil Based on N-Values (After K. Terzaghi and R. B. Peck):

Table No. 1.

N-Values	Condition	Relative Density	Angle of Internal Friction	Moist Unit Wt. in gm/cc.
0-4	Very loose	0.0-0.2	25^0-30^0	1.12-1.60
4-10	Loose	0.2-0.4	30^0-35^0	1.44-1.84
10-30	Medium	0.4-0.6	35^0-40^0	1.76-2.08
30-50	Dense	0.6-0.85	40^0-45^0	1.76-2.24
Over 50	Very dense	1.00	45^0	2.08-2.40

The tabulated values apply for dry/moist cohesion less sand. For silty sands the bearing capacity values must be reduced by study of grain size classification and applying judgment. Correction for

water table close to bottom of foundation the bearing values should be reduced to half. The bearing values are, however, not affected by the water table at a depth greater than 1.5B below foundation level, B being least dimension of the bottom of foundation. Bearings values for intermediate position of water table may be reduced by liner interpolation.

9.2 Values of approximate Unconfined Compressive Strength Based on N-Values for Cohesive Soil (After K. Terzaghi and R.B. Peck):

Table No.- 2.

N-Values	Condition	Unconfined compressive Strength in kg/cm^2.
Below 2	Very soft	Below 0.25
2-4	Soft	0.25-0.50
4-8	Medium	0.50-1.00
8-16	Stiff	1.00-2.00
16-32	Very stiff	2.00-4.00
Over 32	Hard	Over 4.00

In the above table the shear strength of cohesive soil is equal to 1/2 of unconfined compressive strength and the angle of shearing resistance is equal to zero. It should be remembered that the correlation for cohesive soil is always much reliable.

10.0 PHYSICAL PROPERTIES:

Physical Properties of the subsoil formation of the project area have been evaluated by the execution of **4(Four)** number borings of **13.5-19.5m** deep (firm strata). The overall physical properties may be summarized as follows:

10.1 STRATIFICATION OF SOIL:

The top soil is light brown medium clay, some silt, the underlying soil is grey coarse sand, trace silt.

10.2 CONSISTENCY/COMPACTNESS:

Up to the depth of EGL to 6.0m, consistency of the top soil usually varies from soft to medium consistency of soil, however, gradually increase the consistency. The subsequent deep layers stiff to medium stiff soil state.

10.3 GROUND WATER TABLE:

The position of Ground Water Table (GWT) is about (-) **0.0-4.50m** from existing ground level.

10.4 Natural Moisture Content, Unit Weight, Specific Gravity and Liquid Limit:

Table No .3 Name of the Laboratory Test:

Name of the Soil Test
Natural Moisture Content
Natural Unit Weight
Dry density
Specific Gravity
Liquid Limit
Plasticity index
Grain Size Distribution
Direct shear test
Consolidation test
Unconfined compressive test

11.0 ENGINEERING PROPERTIES:

The engineering properties of soil, including the cohesion, compressibility and the angle of internal granular friction have been determined by performing laboratory tests on the soil samples collected during field investigation. These are as follows:

11.1 COHESION: The values of cohesion, as reported from the performance of unconfined compression tests from Laboratory Test Sheet.

11.2ANGLE OF INTERNAL FRICTION:
The angle of internal friction values of the investigated of soil, as reported form the performance of direct shear test from Laboratory Test Sheet.

11.3 COMPRESSIBILITY: The top layer of plastic silty soil usually has been observed moderately compressible in nature by consolidation tests from Laboratory Test Sheet.

12. 0 EVALUATION OF BEARING CAPACITY:

12.1 BEARING CAPACITIES OF THE SHALLOW CONDITION FROM THE SPT:
The Bearing capacities of the shallow foundation particularly for the top layer of cohesive soil may be estimated from the SPT values, as suggested by Terzaghi, according to the following table.

Table No.- 4: Bearing Capacities of the shallow foundation (Values in kg/cm^2, F. S. =2.50):

SPT range	Allowable Bearing Capacity (Tsf)	
	Continuous Footing (B=4ft)	Isolated Column Footing (B=8ft)
0-2	0.00 - 0.225	0.00 - 0.30
2-4	0.225 - 0.45	0.30 - 0.60
4-8	0.45 - 0.90	0.60 - 1.20
8-15	0.90 - 1.80	1.20 - 2.40
15-30	1.80-3.60	2.40-4.80
>30	> 3.60	> 4.80

Note:
a. width = 4ft for strip footing and width = 8ft for isolated footing respectively.
b. The above values are the net allowable Bearing capacities.
c. The cohesive soil has been considered in a saturated condition.

12.2 BEARING CAPACITY OF THE SHALLOW FOUNDATION FROM THE SOIL PARAMETERS:
The bearing capacities of the shallow foundation may more appropriately be determined from the parameters of soil such as the values of cohesion and the angle of internal friction as obtained from the performance of laboratory tests. These have been done considering the general equations of the Bearing capacity of the foundation as suggested by Terzaghi. The evaluated values are provided in the following Table no. 5, and Table no.6

Table No. 5. Bearing Capacities of the Shallow Foundation from Field and Laboratory Test
(Values in kg/cm^2, F. S. = 2.50):

Bore Hole	Depth in m	Field SPT	Cohesion kg/cm^2	Bearing Capacity (kg/cm^2)	
				For strip Foundation	For circular or square footing
BH-01	1.5	4	0.18	0.45	0.60
	3.0	7	0.32	0.79	1.05
	4.5	12	0.55	1.35	1.80
	6.0	20	0.92	2.25	3.00

BH-02	1.5	4	0.18	0.45	0.60
	3.0	3	0.14	0.34	0.45
	4.5	41	1.88	4.61	6.15
	6.0	50	2.29	5.63	7.50
BH-03	1.5	5	0.23	0.56	0.75
	3.0	18	0.83	2.03	2.70
	4.5	9	0.41	1.01	1.35
	6.0	12	0.55	1.35	1.80
BH-04	1.5	6	0.28	0.68	0.90
	3.0	7	0.32	0.79	1.05
	4.5	11	0.50	1.24	1.65
	6.0	18	0.83	2.03	2.70

Table No.6: The Skin Friction and the End Bearing Capacities of Piles (F.S. =2.50)

Depth m	BH-01					BH-02				
	N	N_{cor}	Cu kg/cm^2	f_s kg/cm^2	f_b kg/cm^2	N	N_{cor}	Cu kg/cm^2	f_s kg/cm^2	f_b kg/cm^2
1.5	4	-	0.18	0.03	-	4	-	0.18	0.03	-
3.0	7	-	0.32	0.05	-	3	-	0.14	0.02	-
4.5	12	-	0.55	0.08	-	41	28	1.28	0.19	-
6.0	20	18	0.80	0.12	-	50	33	1.49	0.22	-
7.5	25	20	-	0.14	8.92	50	33	-	0.22	14.50
9.0	27	21	-	0.14	11.24	50	33	-	0.22	17.39
10.5	24	20	-	0.13	12.17	50	33	-	0.22	20.28
12.0	18	17	-	0.11	11.78	50	33	-	0.22	23.21
13.5	28	22	-	0.15	17.26	50	33	-	0.22	26.10
15.0	43	29	-	0.20	25.87					
16.5	50	33	-	0.22	31.88					
18.0	50	33	-	0.22	34.78					
19.5	50	33	-	0.22	37.70					

Depth m	BH-03					BH-04				
	N	N_{cor}	Cu kg/cm^2	f_s kg/cm^2	f_b kg/cm^2	N	N_{cor}	Cu kg/cm^2	f_s kg/cm^2	f_b kg/cm^2
1.5	5	-	0.23	0.03	-	6	-	0.28	0.04	-
3.0	18	17	0.76	0.11	-	7	-	0.32	0.05	-
4.5	9	-	0.41	0.06	-	11	-	0.50	0.07	-
6.0	12	-	0.55	0.08	-	18	17	0.76	0.11	-
7.5	14	-	-	0.10	6.24	21	18	-	0.12	8.03
9.0	20	18	-	0.12	9.36	27	21	-	0.14	11.24
10.5	50	33	-	0.22	20.28	40	28	-	0.19	17.16
12.0	50	33	-	0.22	23.21	50	33	-	0.22	23.21
13.5	50	33	-	0.22	26.10	50	33	-	0.22	26.10
15.0						50	33	-	0.22	28.99

Note:

- N=Blows/ft, Cu=C
- f_s = Allowable value of the skin friction.
- f_b = Allowable value of the pile end bearing capacity.
- SPT (N) values are corrected within calculation.
- The values of f_s and f_b have been making preliminary estimate about the carrying capacity of a Bored R.C.C. pile.
- In the case of plastic silty soil, the values of the cohesion have been obtained from the SPT values.

13.0 FORMULA USED FOR COMPUTATION:

FOR COHESIVE SOIL:

The ultimate bearing capacity:

$Q_{ult} = CN_c = \frac{Q_u . N_c}{2}$ (J. E. Bowles)

$q_{all} = \frac{q_u . N_c}{2X3} + \gamma D_f = \frac{q_u N_c}{6} + \gamma D_f$ (Factor of safety = 2.50)

Where, q_u = Unconfined Compressive Strength in kg/cm^2.

N_c = Bearing Capacity Factor

= 6.8 square footing.

= 5.7 continuous footing.

FOR COHESION-LESS SOIL:

$Q_{ult} = C\ Nc\ Sc + \gamma D_f\ Nq + 0.5\gamma\ BN\gamma\ S\gamma$ (J. E. Bowles)

Where, C = Cohesion, γ = Unit weight of soil

D_f = Depth of footing, B = Width of footing

N_C, N_q & $N\gamma$ = bearing capacity factors = f (Φ) = f (N)

Sc, $S\gamma$ = Shape Factors = f (B, D_f)

$Q_{allowable} = q_{ult}/F.S.$ (F.S. = 2.5)

(Ref. Book: Foundation Analysis and Design by J. E. Bowles, page No. 213-277)

ULTIMATE SKIN FRICTION (f_s) AND END BEARING (f_b) FOR COHESIVE SOIL :

$f_s = FC_d$ (M. J. Tomlinson)

Where, $C_d = q_u/2$;

q_u = Unconfined Compressive strength of soil and

F= Bearing Capacity Factor (Ranges between 0.45 to 0.60)

FOR COHESION-LESS SOIL:

For high displacement piles, $f_s = 2.0\ N\ kN/m^2$

For low displacement $f_s = 1.0\ N\ kN/m^2$

Where, N average of corrected N- value along the length of the pile.

For bored piles in sand, $f_b = 14\ N\ (D_b/B)\ kN/m^2$

Where D_b = actual penetration into the granular soil.

For bored pile in sand, the unit frictional resistance (f_s) is given by

$f_s = 0.67\ N\ kN/m^2$ (K . R. Arora).

CONSOLIDATION SETTLEMENT:

$S = C_c / (1+e_o) * H * \log (p_o + \Delta p) / p_o$.

(Ref. Book: Soil Mechanics and Foundation Engineering by K. R. ARORA, Page NO. - 383-450, 638-647 & 1003-1006).

STANDARD PENETRATION TEST:

N correction=15+0.5(N'-15)

Where, N correction =Corrected N- value

N'=SPT value from the field

(Ref. Book: Theory and Practice of Foundation Design by N.N. SOM & S.C. DAS. Page no-42.)

LOAD CALCULATION FOR ANY DIAMETER/ANY LENGTH OF PILE:

$$\mathbf{P = \pi D L f_s + \pi D^2/4 f_b}$$

Where,

P =Allowable working Load

f_s =Average Allowable value of the skin friction=Kg/cm^2

f_b =Allowable value of the pile end bearing capacity =Kg/cm^2

π = A constant=3.1416
D =Pile Diameter
L =Required length of pile = m

14.0 COMPUTATION FOR CONSOLIDATION SETTLEMENT:

The vertical downward movement of the base of a structure is called settlement and its effect upon the structure depends on its magnitude, its uniformity, the length of the time over which it takes place, and the nature of the clay soils. The consolidation settlement can be calculated form test result of unit weight and consolidation tests. The average settlement depends on column load of structure.

15.0 CONCLUSIONS:

On the basis of above analysis and discussions, the following conclusions may be drawn regarding the sub-soil condition of the project area.

a. The overall soil formation of the investigated site are more or less regular in between the Bore hole locations.
b. The top layers of the investigated site have been encountered with comprising light brown medium clay, some silt (Ref. Bore logs).
c. The underlying soil is grey course sand, trace silt. (Ref. Bore logs).
d. Bearing capacities for shallow foundation including isolated column footings are may not be suitable (Ref. - Table – 5)
e. Shallow foundation as isolated column footing may not be provided at the project site.
f. **R. C. C. Cast-In-Situ Pile** may be provided for all borings at project site.

16.0 RECOMMENDATIONS:

On the basis of aforesaid conclusions, the following recommendations are suggested for **PROJECT: GEOTECHNICAL INVESTIGATION OF FEASIBILITY STUDY OF KARNAPHULI WATER SUPPLY PROJECT PHASE-2 AT NASIRABAD, CHITTAGONG.**

R.C.C CAST-IN-SITU PILE:

The average bearing capacities (F.S=2.50) of different or same diameter piles with embedment length up to **50.0ft or 15.0m** from **EGL** for **BH-01,** may be considered as follows:

28.08 Ton for 400 mm or 16 inch.dia pile
33.42 Ton for 450 mm or 18 inch.dia pile
39.17 Ton for 500 mm or 20 inch.dia pile
51.88 Ton for 600 mm or 24 inch.dia pile

The average bearing capacities (F.S=2.50) of different or same diameter piles with embedment length up to **25.0ft or 7.5m** from **EGL** for **BH-02,** may be considered as follows:

15.58 Ton for 400 mm or 16 inch.dia pile
18.56 Ton for 450 mm or 18 inch.dia pile
21.76 Ton for 500 mm or 20 inch.dia pile
28.84 Ton for 600 mm or 24 inch.dia pile

The average bearing capacities (F.S=2.50) of different or same diameter piles with embedment length up to **35.0ft or 10.5m** from **EGL** for **BH-03 & BH-04,** may be considered as follows:

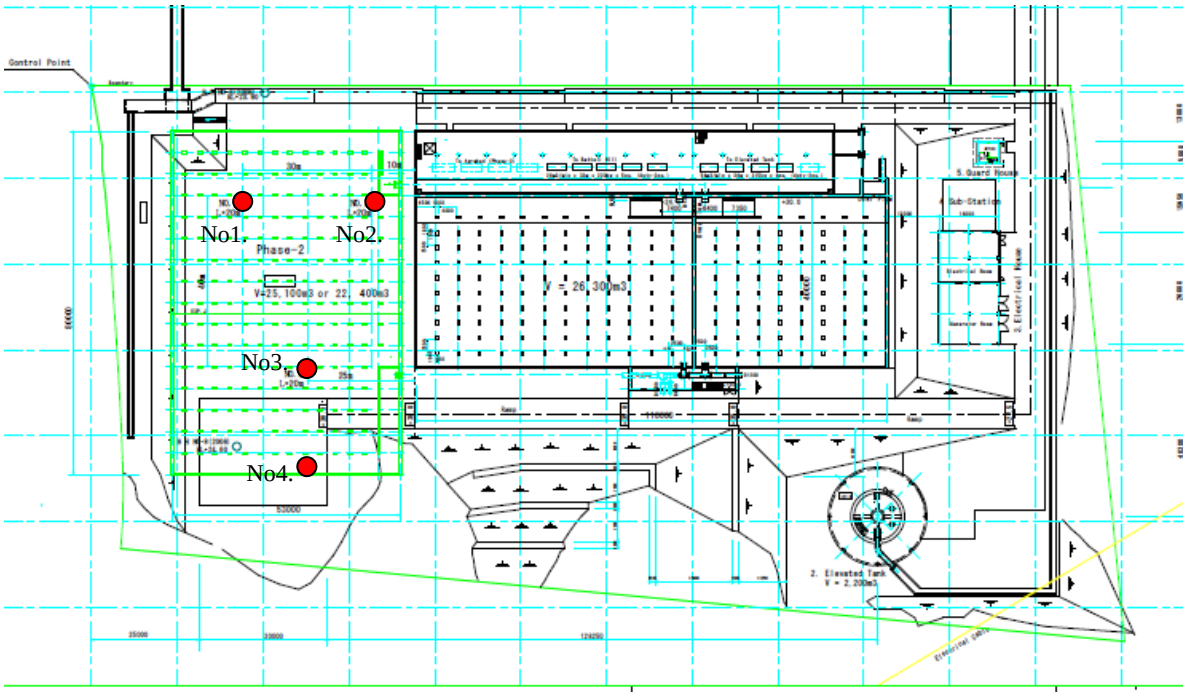
21.81 Ton for 400 mm or 16 inch.dia pile
25.96 Ton for 450 mm or 18 inch.dia pile
30.44 Ton for 500 mm or 20 inch.dia pile
40.35 Ton for 600 mm or 24 inch.dia pile

Note:

a. 1 Tsf = 1 kg/cm^2 = 2ksf, 1 Ton = 2000 lbs = 9.81 kN, 1m = 3.28ft, EGL = Existing Ground level & F. S. = Factor of Safety.

b. The designer may select any other alternative type, depth as well as the bearing capacity of the foundation in the light of information provided in this report.

c. Foundation base should be kept dry during construction period.

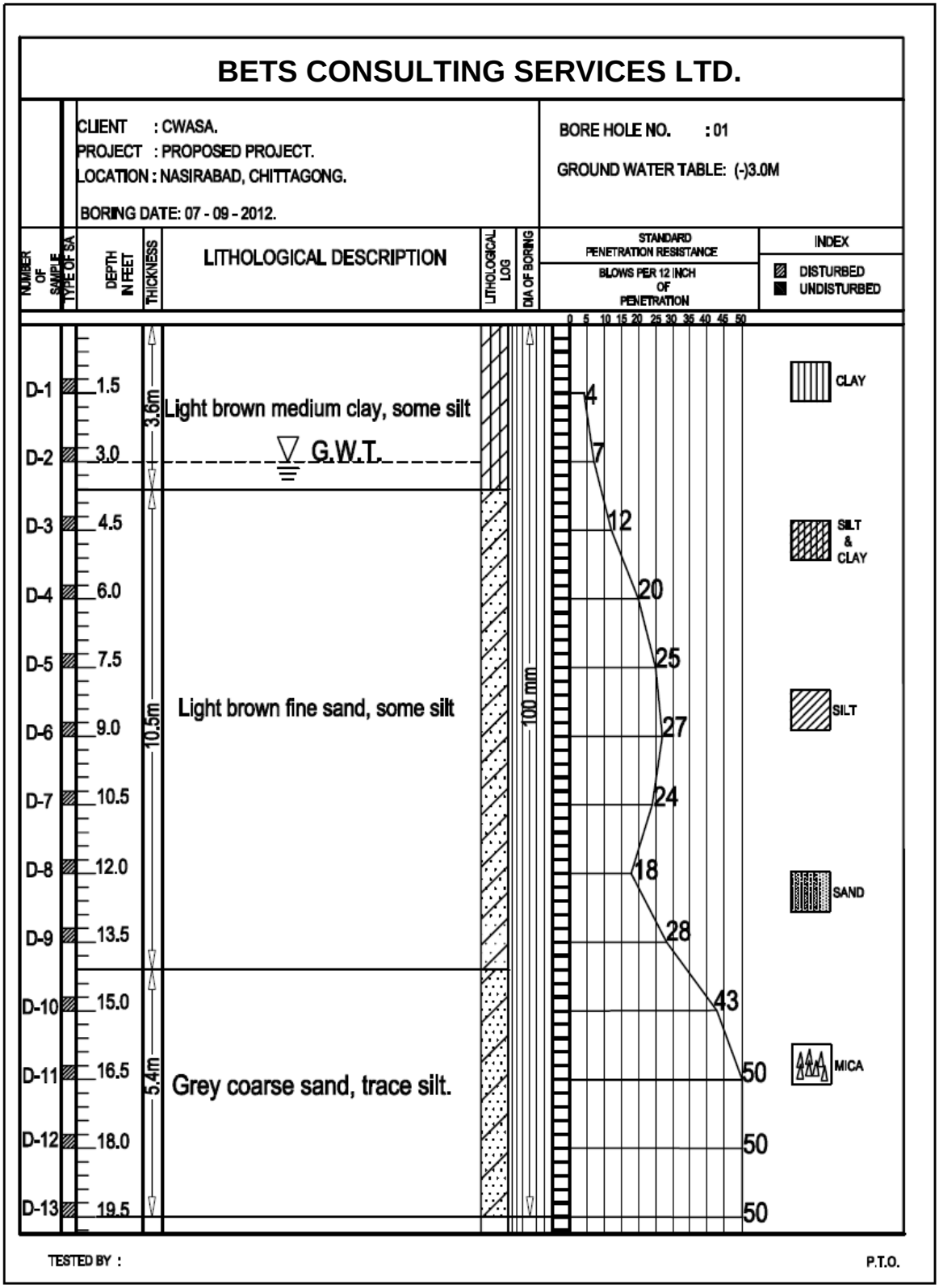


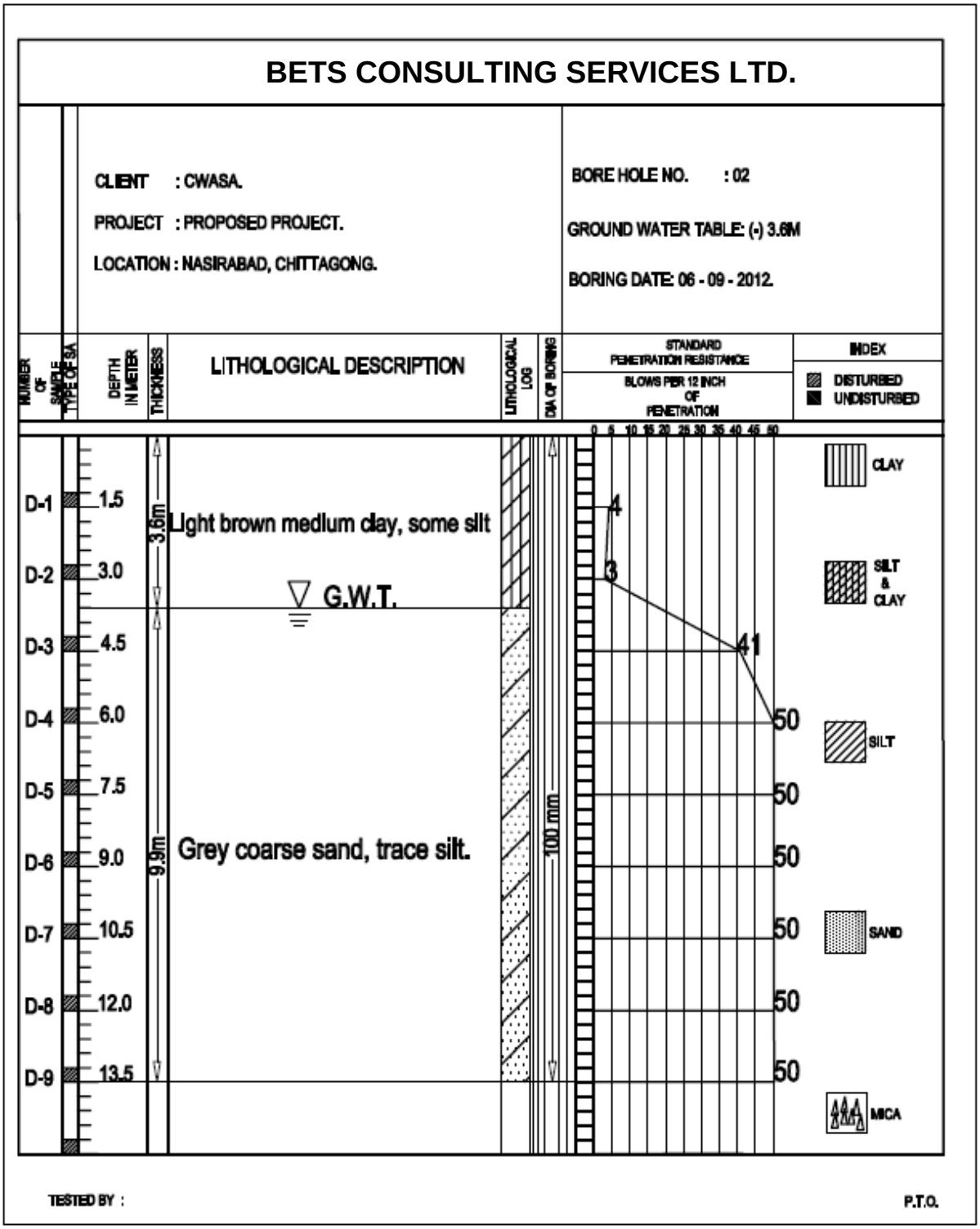
BETS | **SUMMARY SHEET**

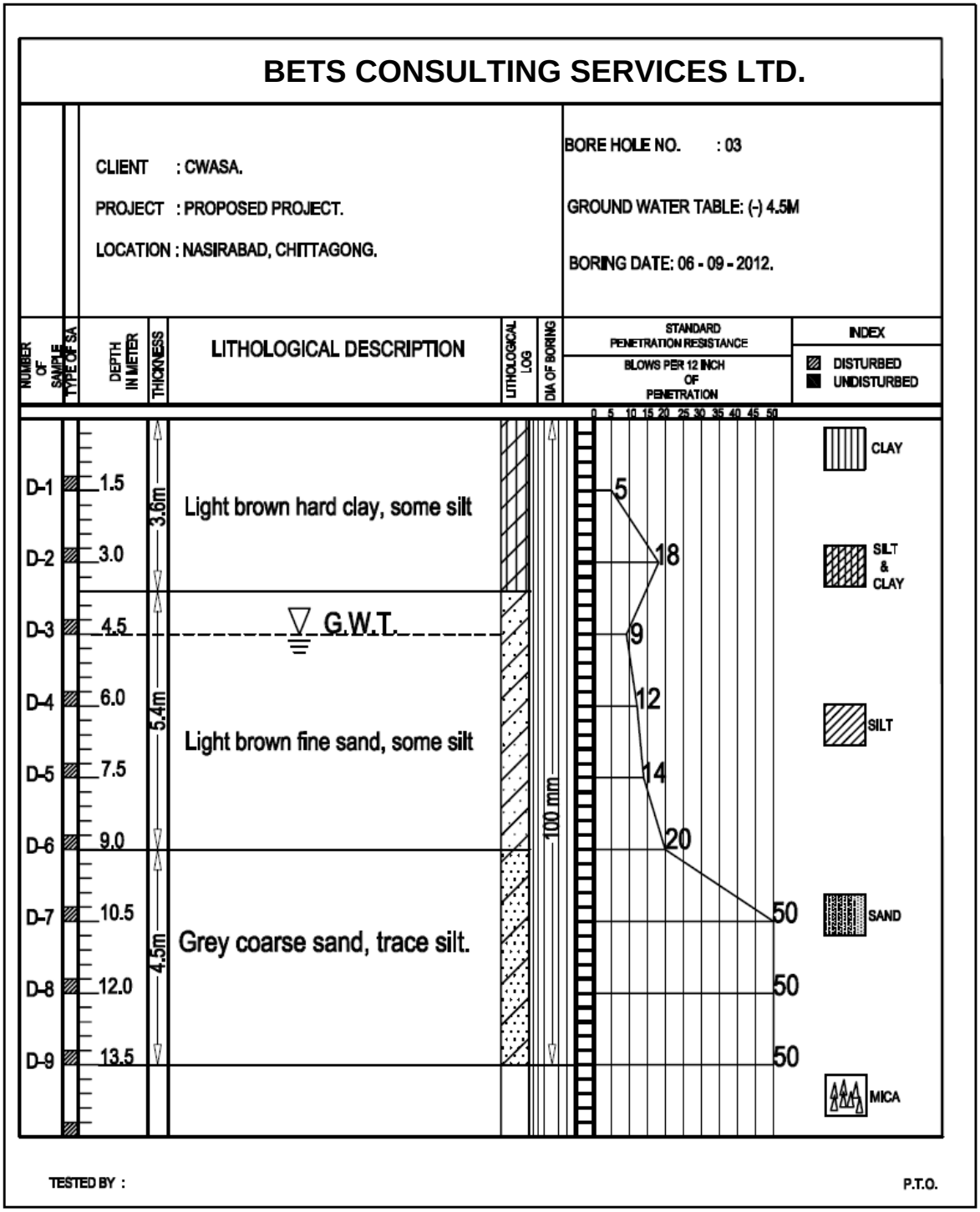
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.

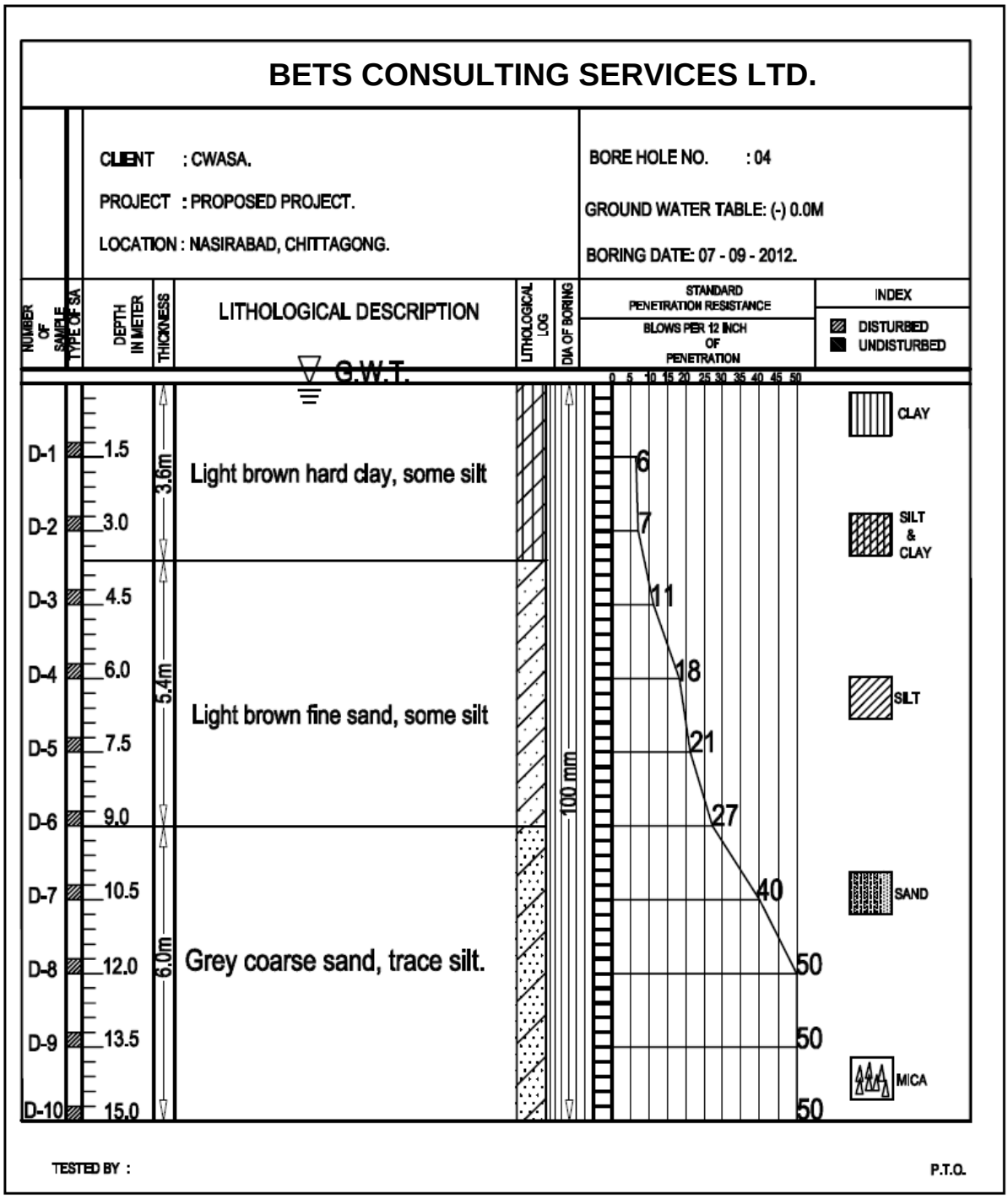
Bore Hole No.	Sample No.	Depth in m	Wet Unit Weight (kg/m³)	Dry Unit Weight (kg/m³)	Natural Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Unconfined Compression Test		Consolidation Test		Tri-axial Shear Test		Direct Shear Test		Grain Size Test			
								Strength (kg/cm²)	Strain at failure (%)	Compression Index (cc)	Void (e)	ϕ°	Cohesion (kg/cm²)	ϕ°	Cohesion (kg/cm²)	SAND (%)	SILT (%)	CLAY (%)	S. P. Gravity
01	D-2	3.00	1963.95	1534.34	28						0.720			30.47°	0.37				2.67
	D-10	15.00	-	-	27						-			34.06°	0.00				2.69
02	D-2	3.00	1959.78	1531.08	28						0.718			31.47°	0.45	-	34	66	2.66
	D-07	10.50	-	-	27						-			36.8°	0.00	65	15	-	2.68
03	D-2	3.00	1955.60	1527.81	28						0.689			29.75°	0.39				2.65
	D-07	10.50	-	-	26						-			35.86°	0.00				2.67
04	D-2	3.00	1957.50	1541.34	27						0.712			30.07°	0.41	-	32	68	2.66
	D-07	10.50	-	-	27						-			35.74°	0.00	87	13	-	2.69

TESTED BY: CHECKED BY:


BETS CONSULTING SERVICES LTD.
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.
BORING DATE: 07 - 09 - 2012.
BORE HOLE NO. : 01
GROUND WATER TABLE: (-)3.0M
NUMBER OF SAMPLE
TYPE OF SA
DEPTH IN FEET
THICKNESS
LITHOLOGICAL DESCRIPTION
LITHOLOGICAL LOG
DIA OF BORING
STANDARD PENETRATION RESISTANCE
BLOWS PER 12 INCH OF PENETRATION
INDEX
DISTURBED
UNDISTURBED
0 5 10 15 20 25 30 35 40 45 50
D-1 1.5
D-2 3.0
3.6m
Light brown medium clay, some silt
G.W.T.
D-3 4.5
D-4 6.0
D-5 7.5
D-6 9.0
D-7 10.5
10.5m
Light brown fine sand, some silt
D-8 12.0
D-9 13.5
D-10 15.0
D-11 16.5
D-12 18.0
D-13 19.5
5.4m
Grey coarse sand, trace silt.
100 mm
4
7
12
20
25
27
24
18
28
43
50
50
50
CLAY
SILT & CLAY
SILT
SAND
MICA
TESTED BY :
P.T.O.


BETS CONSULTING SERVICES LTD.
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.
BORE HOLE NO. : 02
GROUND WATER TABLE: (-) 3.6M
BORING DATE: 06 - 09 - 2012.
NUMBER OF SAMPLE
TYPE OF SA
DEPTH IN METER
THICKNESS
LITHOLOGICAL DESCRIPTION
LITHOLOGICAL LOG
DIA OF BORING
STANDARD PENETRATION RESISTANCE
BLOWS PER 12 INCH OF PENETRATION
INDEX
DISTURBED
UNDISTURBED
0 5 10 15 20 25 30 35 40 45 50
D-1
D-2
D-3
D-4
D-5
D-6
D-7
D-8
D-9
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
13.5
3.6m
9.9m
Light brown medium clay, some silt
G.W.T.
Grey coarse sand, trace silt.
100 mm
4
3
41
50
50
50
50
50
CLAY
SILT & CLAY
SILT
SAND
MICA
TESTED BY :
P.T.O.

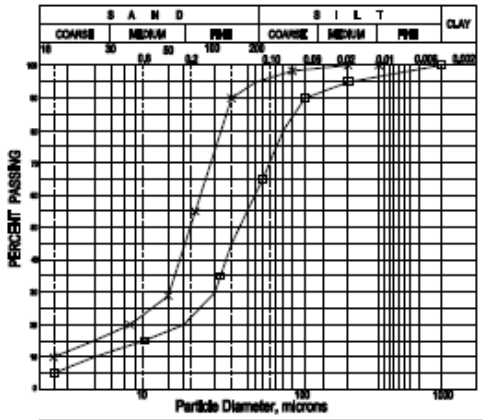

BETS CONSULTING SERVICES LTD.
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.
BORE HOLE NO. : 03
GROUND WATER TABLE: (-) 4.5M
BORING DATE: 06 - 09 - 2012.
NUMBER OF SAMPLE
TYPE OF SA
DEPTH IN METER
THICKNESS
LITHOLOGICAL DESCRIPTION
LITHOLOGICAL LOG
DIA OF BORING
STANDARD PENETRATION RESISTANCE
BLOWS PER 12 INCH OF PENETRATION
INDEX
DISTURBED
UNDISTURBED
0 5 10 15 20 25 30 35 40 45 50
D-1
D-2
D-3
D-4
D-5
D-6
D-7
D-8
D-9
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
13.5
3.6m
5.4m
4.5m
Light brown hard clay, some silt
G.W.T.
Light brown fine sand, some silt
Grey coarse sand, trace silt.
100 mm
5
18
9
12
14
20
50
50
50
CLAY
SILT & CLAY
SILT
SAND
MICA
TESTED BY :
P.T.O.

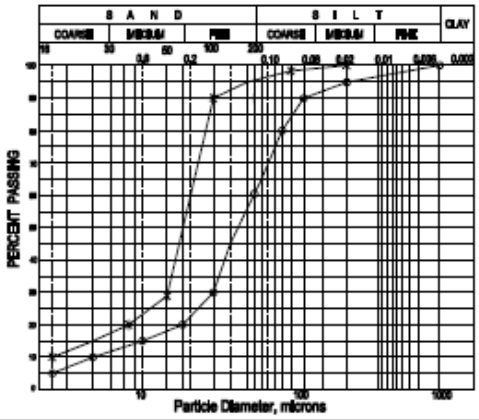

BETS CONSULTING SERVICES LTD.
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.
BORE HOLE NO. : 04
GROUND WATER TABLE: (-) 0.0M
BORING DATE: 07 - 09 - 2012.
NUMBER OF SAMPLE
TYPE OF SA
DEPTH IN METER
THICKNESS
LITHOLOGICAL DESCRIPTION
LITHOLOGICAL LOG
DIA OF BORING
STANDARD PENETRATION RESISTANCE
BLOWS PER 12 INCH OF PENETRATION
INDEX
DISTURBED
UNDISTURBED
G.W.T.
D-1
D-2
D-3
D-4
D-5
D-6
D-7
D-8
D-9
D-10
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
13.5
15.0
3.6m
5.4m
6.0m
Light brown hard clay, some silt
Light brown fine sand, some silt
Grey coarse sand, trace silt.
100 mm
0 5 10 15 20 25 30 35 40 45 50
6
7
11
18
21
27
40
50
50
50
CLAY
SILT & CLAY
SILT
SAND
MICA
TESTED BY :
P.T.O.

BETS

GRAIN SIZE DISTRIBUTION

CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.





SYMBOLS	BORE	SAMPLE	Depth in m	N.M.C	ATTERBERG LIMIT L.L.	P.L.	P.I	SPECIFIC GRAVITY	SOIL CLASSIFICATION	SAND %	SILT %	CLAY %
○ ○ ○												
× × ×	BH-02	02	3.0	28	41	27	14	2.66	Light brown medium clay, some silt	-	34	66
⊣ ⊣ ⊣		07	10.5	27	NP	NP	NP	2.68	Grey coarse sand, trace silt.	85	15	-
□ □ □												
① ② ③												
* * *	BH-04	02	3.0	27	38	26	12	2.66	Light brown hard clay, some silt	-	32	68
④ ⑤ ⑥		07	10.5	27	NP	NP	NP	2.69	Grey coarse sand, trace silt.	87	13	-
⊣ ⊣ ⊣												

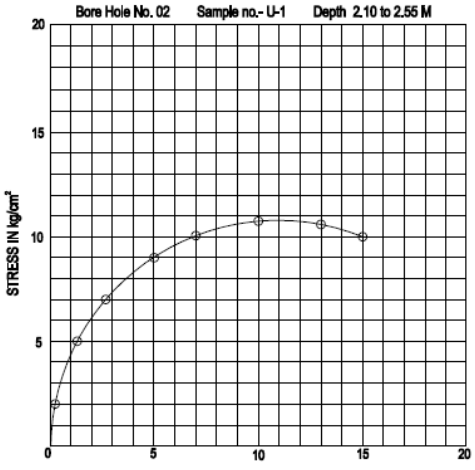
TESTED BY:

P.T.O.

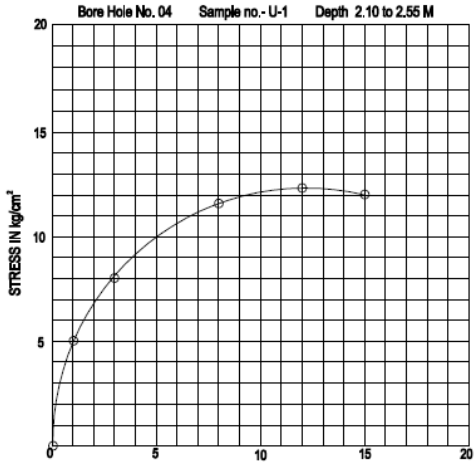
BETS

UNCONFINED COMPRESSION TEST

CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.



UNCONFINED COMPRESSIVE STRENGTH (kg/cm²) : 0.720
PERCENT STRAIN AT FAILURE : 10.80
MOISTURE CONTENT (%) : 26
WET DENSITY (kg/m³) : 1959.78
DRY DENSITY (kg/m³) : 1531.08



UNCONFINED COMPRESSIVE STRENGTH (kg/cm) : 0.716
PERCENT STRAIN AT FAILURE : 11.00
MOISTURE CONTENT (%) : 27
WET DENSITY (kg/m) : 1957.50
DRY DENSITY (kg/m) : 1541.34

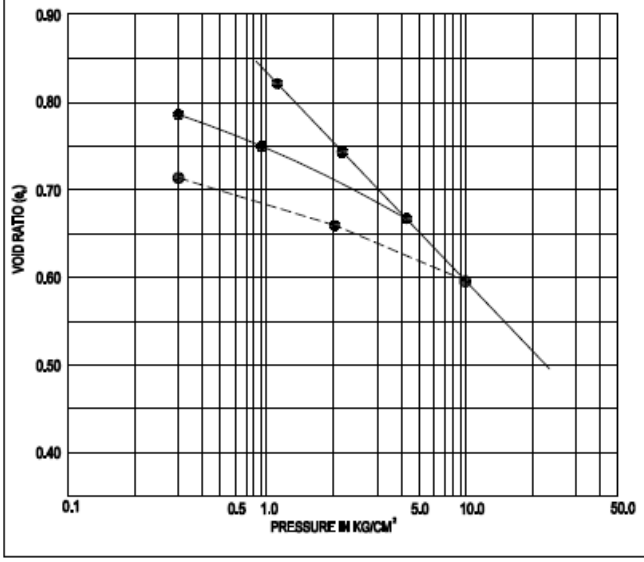
Tested By:

Checked By:

BETS

CONSOLIDATION TEST
VOID RATIO— LOG PRESSURE CURVE

CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.



BORE HOLE NO: 04.
SAMPLE DEPTH: 2.40 TO 2.85M
DIAMETER (CM) : 6.35
INITIAL HIGH (CM) : 2.54
SOLID HIGHT (CM): 1.391
INTIAL M.C (%): 27
SPECIFIC GRAVITY : 2.66
DRY DENSITY (KGM³): 1541.34
INTIAL VOID RATIO (e)=0.712
COMPRESSION INDEX (Cc): 0.17

Tested By:

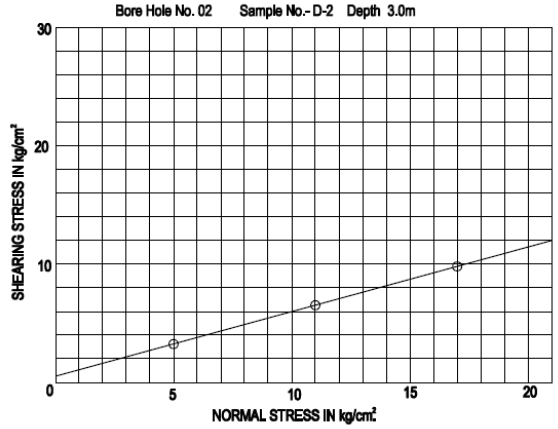
Checked By:

BETS

DIRECT SHEAR TEST

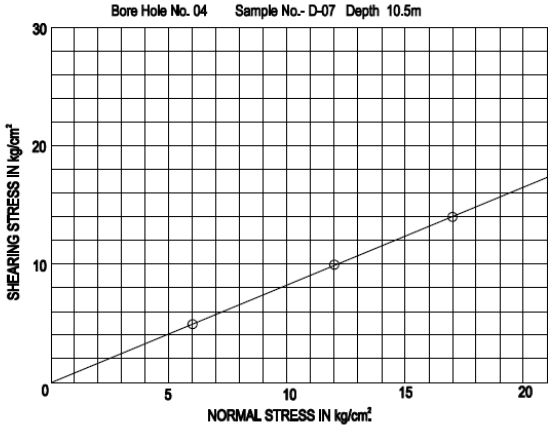
CLIENT : CWASA.
PROJECT : PROPOSED PROJECT.
LOCATION : NASIRABAD, CHITTAGONG.

Bore Hole No. 02 Sample No.- D-2 Depth 3.0m



SHEARING ANGLE, ϕ (Degree)	31.47°
COHESION, C (kg/cm²)	0.45

Bore Hole No. 04 Sample No.- D-07 Depth 10.5m



SHEARING ANGLE, ϕ (Degree)	35.74°
COHESION, C (kg/cm)	0.00

Tested By:

Checked By:

III GROUND LEVEL SURVEY

III Ground Level Survey