APPENDIX-5

SOFTWARE COMPONENT (TECHNICAL ASSISTANCE) PLAN

Appendix-5　Software Component Plan

The Project for Improvement of Water Supply in Bahir Dar City in Ethiopia

Soft Component Plan

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The Project for Improvement of Water Supply in Bahir Dar City in Ethiopia

Soft Component Plan

1. Background

The water supply facilities in the eastern part of Bahir Dar City (Zone 2), which is the capital city of Amhara National Regional State, will be expanded and improved in the main part of this project. More specifically, the main part includes the development of production wells (including two for reserve) by equipping nine boreholes (having sufficient yield) with submergible pumps, etc., the construction of a new booster pump station to transmit water from the production wells to distribution reservoirs, the extension of the two existing and abuilt distribution reservoirs (Gabriel Reservoir and Diaspora Reservoir) and the installation of transmission and distribution pipes, chlorine dosing equipment (mixing tank of calcium hypochlorite, lifting pump and dosing tank), water level gauges and bulk meters for monitoring water distribution at the distribution reservoirs to be extended. Moreover, the distribution network of Zone 2 will be divided into two distribution zones for each distribution reservoir. Each distribution zone will be further divided into two distribution blocks for efficient operation and maintenance (O&M).

These facilities to be constructed in the main part of this project will be operated and maintained by Bahir Dar City Water Supply and Sewerage Service (BDWSSS). However, there is a concern about its current technical capability for appropriate O&M of these facilities. For example, chlorine dosing using calcium hypochlorite powder is currently conducted by hand work at exiting distribution reservoirs. The dosing continues during night time at only one of the reservoirs (Kotita Reservoir in Zone 1 which is outside of the project target area). Chlorine dosing is not carried out at the existing reservoirs within the target area of this project, which results in frequent detection of coliform in the water supplied to the customers. In addition, the inappropriate operation of pumps causes frequent overflows at Gabriel Reservoir. Moreover, the monitoring of groundwater level over years has not been carried out at the existing production wells. These problems have roots in the lack of technical skills and knowledge among facility operators and maintenance technicians. Therefore, the strengthening of their technical capacity is necessary. On the other hand, although the financial conditions of BDWSSS will be improved shortly by implementing this project, it is important to keep working on the reduction of Non-Revenue Water (NRW) for a long-term improvement of company management. However, currently, the knowledge of BDWSSS staff regarding NRW management is limited. Moreover, equipment required for NRW management such as bulk meter is insufficient, which cause difficulties in appropriate measurement/calculation of NRW ratio.

This project will support BDWSSS in solving these technical problems in its soft component so that BDWSSS can appropriately operate and maintain the water supply facilities to be constructed in this project. Specifically, the improvement of BDWSSS's chlorine disinfection and the optimization of the new booster (transmission) pump station in consideration of the water level at the reservoirs, etc. will be supported. In addition, a basic capacity development for NRW management will be carried out, which includes the measurements for calculating NRW ratios for long-term improvement of company management. The equipment to be installed in the main part of this project will be utilized in the soft component.

2. Goal of Soft Component

BDWSSS will properly and sustainably operate and maintain the water supply facilities to be expanded in Zone 2 in this project.

3. Outcomes

The following shows the five outcomes to achieve in the soft component of this project. Technical supports will be provided to the BDWSSS staff involved in the O&M of the water supply facilities in Zone 2 to achieve these outcomes.

Outcome 1 : Chlorine disinfection is conducted appropriately and sustainably at the distribution reservoirs.

Outcome 2 : Water level data is properly measured and recorded at the distribution reservoirs and the operation of transmission pumps at the booster pump station is carried out based on the data.

Outcome 3 : Appropriate adjustment of pumping discharge based on groundwater level monitoring is understood.

Outcome 4 : Basics regarding NRW and NRW reduction measures are understood.

Outcome 5 : The measurements for calculating NRW ratios in Zone 2 is started.

4. Measures for Confirming the Achievement of Outcomes

The table below shows the measures set for confirming the achievement of each of the five outcomes listed above.

Table-1. Measures for Confirming the Achievement of Each Outcome

Outcome	Indicator	Confirmation Measures
Outcome 1：Chlorine disinfection is conducted appropriately and sustainably at the distribution reservoirs.	90% or higher in achievement rate of operational water quality standards for chlorine concentration and fecal coliform Note 1)	・Results of Water Quality Test Based on the results of BDWSSS's water quality tests for residual chlorine and fecal coliform, 90% or higher achievement ratio of operational water quality standards (out of the all water samples taken from customers in Zone 2) will be confirmed. Regarding residual chlorine concentration, the achievement ratio was 49% out of 163 samples taken by BDWSSS at distribution reservoirs and customers from February to March, 2016. Regarding fecal coliform, available recent water quality test results are limited. However, according to the staff of BDWSSS, around a half of water samples do not meet its standard. Moreover, the review of water quality monitoring plan including the decision on the sampling sites will be supported. BDWSSS currently tests about 10 samples per week on average. Sampling of a similar number is assumed in this soft component and the achievement ratio of the operational standards will be confirmed monthly.
	Two thirds or more of the staff who have joined in the training is considered to understand the periodical maintenance and repair of the chlorine dosing equipment.	・Interview and confirmation on the level of understanding after the training. After the training, the Japanese expert and local supporting staff of Outcome 1 (Equipment Management) will confirm the level of understanding through the interview to each participant of the training. Technical demonstration such as assembling parts will be requested to engineers. Based on their results, the Japanese expert and the local staff will evaluate whether the participants understand mostly or their understanding is insufficient. Based on the evaluation, additional training will be held if required.
Outcome 2：Water level data is properly measured and recorded at the distribution reservoirs and the operation of transmission pumps at the booster pump station is carried out based on the data.	The transmission pumps are operated based on their operational schedule optimized in reference to the records of water level at the distribution reservoirs, etc.	・Operational Records of Transmission Pumps. Documents on the optimization of transmission pump operation based on the continuous records of water level at the distribution reservoirs, etc., the pump operation schedule in use and their pump operation records will be collected from BDWSSS for the confirmation of their contents.
Outcome 3：Appropriate adjustment of pumping discharge based on groundwater level monitoring is understood.	The measurement of groundwater level and pump discharge are conducted at all the production wells.	・Result of Analyzing the Operation Records of Production Wells Pump operators' accurate measurements of static and hydrodynamic groundwater levels and pump discharge at all the production wells at Charchara and Ashraf (based on the monitoring plan of production wells) will be confirmed with the operation records of the production wells. The frequency of the

Outcome	Indicator	Confirmation Measures
		measurements is assumed to be once every two weeks for groundwater level and every day for pump discharge, which will be decided in consideration of the monitoring plan, available operators, etc. Japanese expert will help in assessing the adequacy of measured pump discharge, in consideration of all the water supply from the distribution reservoirs and assumed level of leakage, etc.
	Measures to adjust pump discharge at the production wells are prepared.	・ Measures to Adjust Pump Discharge at the Production Wells The measures to adjust discharge at the all nine production wells including the two reserves will be discussed and put into a document based on the results of the training on the analysis of monitoring results and the management of production wells.
Outcome 4：Basics regarding NRW and NRW reduction measures are understood.	Draft policies for the measurements of NRW ratios and the reduction of NRW are prepared.	・Draft Policies for NRW Management The draft policies (including the preparation of a list of countermeasures, allocation of required staff and budget and schedule) for measuring NRW ratios and reducing NRW, which will be prepared by BDWSSS based on discussions on the current conditions and necessity of planned approaches for NRW management, will be confirmed.
Outcome 5：The measurements for calculating NRW ratios in Zone 2 is started.	Trials of calculating NRW ratios of whole Zone 2 and its two distribution zones are conducted.	・Results of the Measurement of NRW Ratios The results of trial measurements and calculation of NRW ratios in whole Zone 2 and the distribution zones will be confirmed.

Note 1: At the beginning of this soft component, the appropriateness of operational standards needs to be confirmed with C/Ps for water quality management in reference to the Compulsory Ethiopian Standard, Drinking Water – Specification issued by Ethiopian Standards Agency in 2013 and the operational water quality standards currently used by BDWSSS. The drinking water quality standards issued in 2013 include no-detection of coliform colony in 100ml of drinking water and 0.5mg/l as the upper limit of residual chlorine concentration. The operational water quality standards currently used by BDWSSS include on-detection of fecal coliform and 0.2mg/l as the lower limit of residual chlorine. Based on these standard values, the water quality targets for measuring the achievement of Outcome 1 are currently assumed to be the range from 0.2 to 0.5mg/l in residual chlorine concentration and the no-detection of fecal coliform in 100mg/l. The use of these standards needs to be confirmed with C/Ps

5. Activities（Input Plan）

The table below shows the current conditions of BDWSSS, required technical skills and activities, required equipment, targeted staff of BDWSSS, deliverables and implementation resources (trainers to be dispatched and their periods in man-month (M/M)).

Table-2. Input Plan of Activities

Outcome	Current Conditions of BDWSSS	Required Technical Skills	Activities	Required Equipment	Staff of BDWSSS mainly targeted	Deliverables	Personnel (M/M)
Outcome 1 : Chlorine disinfection is conducted appropriately and sustainably at the distribution reservoirs.	【Water Quality Management】 Calcium hypochlorite is currently dissolved with water by hand and dosed in at distribution reservoirs and a pump station. This manual practice is not safe and cause health issues. Dosing technicians are not controlling water quality at distribution reservoirs, etc. (the water quality control should be based on the measurement of residual chlorine concentration). Therefore, the residual chlorine concentration is not stable and coliform and fecal coliform are often detected at customer taps.	【Water Quality Management】 Cooperation between dosing technicians and staff of the water quality laboratory is required for adequate chlorine dosing which ensure sufficient residual chlorine at customer taps. Moreover, technical skills to optimize the sampling locations and frequency for water quality tests (based on the data management and analysis of water quality test results with MS Excel by the staff in charge of water quality tests themselves) are required.	・Preparation of training materials for the operation of chlorine dosing equipment, water quality control, periodical maintenance and repair. ・Implementation of the trainings below using the training materials described above. 【Common in Water Quality Management and Equipment Management】 1. Training on chlorine dosing at site ([1] control of the stored amount in chlorine dosing tanks and lifting pumps, [2] control of chlorine concentration at dosing, etc.) 【Water Quality Management】 2. Training for improving the water quality management plan 3. Training on water quality test and the analysis of the test results.	Installation in the Construction: mixing and dosing tanks, lifting pumps, etc. Equipment Provision: portable residual chlorine meters, and spare parts of lifting pumps Preparation by BDWSSS: Incubator for fecal coliform, PC with MS Office	【Water Quality Management】 Main Office：Deputy manager (top position of technical staff), Head of Water Quality and O&M sub process, two chemists and two field workers (in charge of water sampling) of the water quality laboratory and eight dosing technicians at the distribution reservoirs within the project target area (16 persons in total)	【Water Quality Management】 ・Training materials prepared for the operation of chlorine dosing equipment and water quality management ・Results of the water quality tests on the water disinfected with chlorine, which are tabulated and analyzed with MS Excel	【Water Quality Management】 Expert 0.90 M/M and Local Staff 0.90 M/M
	【Equipment Management】 Chlorine dosing systems using pumps will be introduced in this project(*1). BDWSSS installed a similar chlorine dosing system using calcium hypochlorite at Kotita Distribution Reservoir about 15 years ago with help of the Bureau of Water, Irrigation and Energy (BoWIE) of Amhara State. However, the chlorine dosing could not continue because	【Equipment Management】 Prevention measures against break down of chlorine dosing equipment (*2), repair methods, additional procurement of spare parts need to be learnt.	【Equipment Management】 4. Training on periodical maintenance and repair methods for the chlorine dosing equipment (including flashing while suspending its operation)		【Equipment Management】 Main Office：Deputy Manager (top position of technical staff), Head of Water Quality and O&M sub process, one electrical engineer partly involved in the maintenance of pump facilities, four electricians, one mechanic servicing cars (eight persons in total)	【Equipment Management】 ・Records of the maintenance of chlorine dosing equipment ・Training materials on the repair work	【Equipment Management】 Expert 0.57 M/M and Local Staff 0.57 M/M

(*1) In this project, the solution of calcium hypochlorite will be transmitted to the dosing tank installed on the top of receiving basin by using lifting pump. The planned dosing system doses the solution into the receiving basin. The transmission of the solution will be turned off automatically when the water level of the dosing tank becomes high while the lifting pump will be turned on manually when the water level becomes low. The skills to manage the stored volume in the tank and to operate the lifting pump needs to be acquired. Moreover, the concentration of the solution should be adjusted to the pre-decided level and the dosing amount of the solution needs to be decided based on the amount of water distribution and residual chlorine.

(*2) Flashing while suspending its operation is required to avoid deposition of chemicals (washing away pump head, inside of inlet and outlet valves and pipes with water).

Outcome	Current Conditions of BDWSSS	Required Technical Skills	Activities	Required Equipment	Staff of BDWSSS mainly targeted	Deliverables	Personnel (M/M)
	there was no supplier in Ethiopia which was handling spare parts of the dosing pumps broken down after a while. Therefore, BDWSSS does not have enough experiences in handling the troubles happened to chlorine dosing system, repairing and procuring spare parts. Currently, spare parts can be procurement in Ethiopia.				and new staff to be employed for maintaining pumps and generators.		
Outcome 2 : Water level data is properly measured and recorded at the distribution reservoirs and the operation of transmission pumps at the booster pump station is carried out based on the data.	At all the distribution reservoirs of BDWSSS, the water level gauges are broken or not installed. Moreover, the water level of distribution reservoirs is not controlled well due to the lack of understanding on the hourly fluctuation of water demand and proper operation of pumps among BDWSSS staff. Especially, the flow of water transmission to Gabriel Reservoir increases significantly from afternoon to night, which has been causing overflow during the night when dosing technician is not there but only security guard is there.	Skills are required to understand the hourly fluctuations of water distribution (water demand) during weekdays and weekend. Moreover, skills to optimize the schedule of pump operation based on the understood hourly fluctuation and the capacity and water level of distribution reservoir are also required.	▪ Preparation of training materials on the operation of transmission pumps. ▪ Implementation of the following trainings using the materials described above. 1. Training on the measurement and recording of the water level of distribution reservoirs. 2. Training on the analysis of hourly fluctuation of water distribution 3. Training of the optimization of the operation schedule of transmission pumps	Installation in the Construction: Water level gauges and bulk meters at distribution reservoirs (Gabriel Reservoir and Diaspora Reservoir) and the bulk meters and pressure gauges at the booster pump station. Preparation by BDWSSS: PC with MS Office	Main Office: Deputy Manager, Head of Water Quality and O&M, eight dosing technicians at the two distribution reservoirs within the project target area and four pump operators to be employed for the new booster pump station (14 persons in total)	▪ Training materials on the operation of transmission pumps ▪ Document showing the hourly fluctuation of water distribution ▪ Document showing the optimized operation schedule of transmission pumps	Equipment Management: Expert 0.70 M/M and Local Staff 0.70 M/M

Outcome	Current Conditions of BDWSSS	Required Technical Skills	Activities	Required Equipment	Staff of BDWSSS mainly targeted	Deliverables	Personnel (M/M)
Outcome 3 : Appropriate adjustment of pumping discharge based on groundwater level monitoring is understood.	The importance of having basic knowledge on groundwater and monitoring of groundwater level is not sufficiently recognized. BDWSSS has not being conducting any long-term monitoring of groundwater level at production wells. Moreover, the existing wells at Charchara and Ashraf were not equipped with observation pipes which were required for groundwater level monitoring. Observation pipes were installed at wells in Charchara and Ashraf when drawdown tests were conducted at test wells in this survey. Although the monitoring of groundwater level started already in May 2016 at the existing wells in Charchara under the supervision of the survey team, continuous monitoring requires planning and development of skills including how to adjust pump discharge based on the data collected through the monitoring.	Skills for measuring and recording static and hydrodynamic groundwater levels, analyzing measured data with MS Excel and maintaining bulk meters (e.g. installation of strainers and check of abnormal flow changes)	・Preparation of training materials for groundwater level monitoring. ・Preparation of training materials on the operation of transmission pumps. ・Implementation of the following trainings using the materials described above. 1. Training on the analysis of groundwater recharge during rainy season and changes in groundwater level over years based on the data of groundwater level and pump discharge being captured since May 2016 (including the theory of groundwater) 2. Training for the improvement of groundwater monitoring (including the improvement of monitoring plan and measurement/recording) 3. Training on the maintenance of production wells (including bulk meters) 4. Training on the adjustment of pump discharge at production wells based on changes in groundwater level	Development in the Construction: 9 production wells Preparation by BDWSSS: Observation well at each well field, observation pipes for groundwater level measurement at production wells, dip-type level gauge and PC with MS Office	Main Office：Deputy Manager, Head of Water Quality and O&M Sub-process, Head of Study, Design, Supervision Sub-process, 24 pump operators at the production wells for Zone 2 (27 persons in total)	・Training materials on groundwater level monitoring ・Documents showing the results of groundwater monitoring, maintenance of bulk meters at production wells and policy for adjusting pump discharge at production wells.	Equipment Management: Expert 0.73 M/M and Local Staff 0.73 M/M
Outcome 4 : Basics regarding NRW and NRW reduction measures are understood.	There is no personnel dedicated to NRW management, underground leakage detection, mapping, etc. Moreover, basic knowledge and policies for NRW reduction are not shared among the staff of BDWSSS.	Basic knowledge on NRW management and skills for mapping water pipes, detecting underground leakage and accuracy control of water meters.	・Basic training materials on overall NRW management ・Implementation of the following trainings using the materials described above. 1. Lecture on overall NRW management 2. Discussion on the existing conditions of BDWSSS regarding NRW and the necessity of planning NRW reduction activities (listing of activities, allocation of personnel, securing budget and scheduling, etc.) 3. Demonstration on the use of listening sticks, the simple check of customer meters using containers and the	Equipment Provision: Listening Stick Preparation by BDWSSS：Laptop PC, GPS and container for checking the accuracy of customer meters in a simple way	Main Office：General Manager, Deputy Manager, Head of Finance, Administrator of Billing System, Head of Public Relation, Head of Water Quality and O&M, Head of Study, Design and Supervision, Head of Planning, Water Meter Technician and new staff for mapping and leakage detection (11 persons in total). Hidar 11 Branch Office：Branch Manager, Head of Customer Services, Head of Water Distribution,	・Training materials on NRW management ・Draft policies on the measurement of NRW ratios and NRW reduction activities, which should be based on the discussion on BDWSSS's existing conditions regarding NRW and the necessity of planning NRW reduction	NRW Management: Expert 1.47 M/M and Local Staff 1.47 M/M

Outcome	Current Conditions of BDWSSS	Required Technical Skills	Activities	Required Equipment	Staff of BDWSSS mainly targeted	Deliverables	Personnel (M/M)
			mapping of water supply pipes.		meter readers, water meter technician, plumbers and new staff for leakage detection (around 20 persons in total)	activities (including listing of activities, allocation of personnel, securing budget and scheduling, etc.) The findings from Outcome 5 should be incorporated in the draft policies.	
Outcome 5 : The measurements for calculating NRW ratios in Zone 2 is started.	The NRW ratio of whole service areas of BDWSSS is not calculated accurately at present because there are problems with the bulk meters for water intake. Moreover, NRW ratio of each distribution zone cannot be figured out because distribution zone of each distribution reservoir are not hydraulically isolated.	Skills are required for confirming the hydraulic isolation for each of the distribution zones and blocks to be established in this project, sorting of customers for each block in billing system and adjustment of meter reading schedules for bulk meters and customer meters. Moreover, skills for calculating NRW ratio based on water balance analysis on distributed water including data analysis on billed water consumption.	▪ Training materials on the calculation of NRW ratio and monitoring of NRW ▪ Implementation of the following trainings using the materials described above (Calculate NRW ratios of the two distribution zones and whole Zone 2 based on flow measurements) 1. Confirmation of the hydraulic isolation of distribution zones, etc. 2. Sorting of customers for each distribution zone, etc. in billing system. 3. Adjustment of meter reading schedules for customer meters and bulk meters. 4. Calculation of NRW ratio with MS Excel based on water balance analysis.	Installation in the Construction : Expansion of distribution Reservoirs (Gabriel Reservoir and Diaspora Reservoir) and installation of bulk meters for distribution blocks Preparation by BDWSSS: PC with MS Office	Main Office: Deputy Manager, Administrator of Billing System, Head of Water Quality and O&M, Head of Study, Design and Supervision, Water Meter Technician and new staff for mapping and leakage detection (around 7 persons in total). Hidar 11 Branch Office : Branch Manager, Head of Customer Services, Head of Water Distribution and new staff for leakage detection (around 5 persons in total)	▪ The trial results of calculating NRW ratio for each distribution zone, etc.	NRW Management: Expert 1.57 M/M and Local Staff 1.57 M/M
Total					In total, around 50 staff of Main Office including dosing technicians and pump operators in the target area and around 20 staff of Hidar 11 Branch.	Documents, etc. prepared in the activities described above and completion report (in English for the client and in Japanese for JICA)	Expert 5.94 M/M and Local Staff 5.94 M/M

6. Procurement Measures of Implementation Resources

This soft component will be mainly implemented by dispatching Japanese experts due to the following reasons.

- There is no company of engineering consultants having enough technical strength in the O&M of water supply facilities in Bahir Dar City. Therefore, subcontracting the work to a consulting company based in Bahir Dar City is not possible.
- Consulting companies based in Addis Ababa have more experiences. However, their technical strength on NRW management is considered to be not sufficient to train the staff of BDWSSS in charge of O&M for more effective O&M.
- In Ethiopia, local consulting companies having a lot of experiences in NRW management are limited because there has not been a long time since the full-scale NRW management started in relatively large regional cities such as Bahir Dar City

Types of trainers expected to be allocated for this soft component are as follows:

1) Water Quality Management (Japanese)

Main Tasks: preparation of training materials on the operation of chlorine dosing equipment and water quality management in English and provision of training on the improvement of water quality management plan, the optimization of chlorine dosing and the analysis of water quality test results.

Required Skills: experiences and knowledge on the operation of chlorine dosing equipment and water quality management

2) Equipment Management (Japanese)

Main Tasks: preparation of training materials on the periodical maintenance and repair of chlorine dosing equipment, the operation of transmission pumps and the monitoring of groundwater level in English and implantation of training on the periodical maintenance of chlorine dosing equipment, etc.

Required Skills: experiences and knowledge on the O&M of equipment and hydraulic geology

3) NRW Management (Japanese)

Main Tasks: preparation of training materials on overall NRW management and the calculation and monitoring of NRW ratios in English, lecturing NRW management, discussion on the implementation of NRW management, demonstrating the use of listening sticks and the preparation of pipe network mapping, and implementation of training on the calculation of NRW ratios in distribution zones and blocks and continuous measurements for the monitoring.

Required Skills: experiences and knowledge on NRW

Requirements on the local staff, which will be employed to support the Japanese experts, are as follows:

1）Water Quality Management (Local Staff)

Main Tasks: supporting in the collection of information for the preparation of training materials on the operation of chlorine dosing equipment and water quality management, partial translation of the training materials into Amhara, arranging venues for the training, informing trainees, confirming their participation and interpretation during the training.

Required Skills: knowledge on water supply system, coordination skills, translation and interpretation skills (English).

2）Equipment Management (Local Staff)

Main Tasks: supporting in the collection of information for the preparation of training materials on the periodical maintenance and repair of chlorine dosing equipment, the operation of transmission pumps and the monitoring of groundwater level, partial translation of the training materials into Amhara, arranging venues for the training, informing trainees, confirming their participation and interpretation during the training.

Required Skills: knowledge on water supply system, coordination skills, translation and interpretation skills (English).

3）Water Supply Operation (NRW Management) (Local Staff)

Main Tasks：Supporting the Japanese expert (NRW Management）regarding overall NRW management and periodical measurements for calculating NRW ratio. Supporting in the collection of information for the preparation of training materials, partial translation of the training materials into Amhara, arranging venues for the training, informing trainees, confirming their participation and interpretation during the training.

Required Skills: knowledge on water supply system, coordination skills, translation and interpretation skills (English).

7. Implementation Schedule

The table below shows the implementation schedule of the soft component of this project.

Table-3. Implementation Schedule of the Soft Component (Draft)

Project Component		2018	2019	2020		Input of Japanese Experts (M/M)
				Jan. - Jul.	Aug. to Mid of Nov.(to be implemented for 3.5 months after the test operation starts)	
Facility Construction						
Soft Component					Submission of Implementation Status Report; Submission of Completion Report	Total 5.94
Breakdown	Outcome 1 : Chlorine disinfection is conducted appropriately and sustainably at the distribution reservoirs.					Water Quality Management 0.90 Equipment Management 0.57
	Outcome 2 : Water level data is properly measured and recorded at the distribution reservoirs and the operation of transmission pumps at the booster pump station is carried out based on the data.					Equipment Management 0.70
	Outcome 3 : Appropriate adjustment of pumping discharge based on groundwater level monitoring is understood.					Equipment Management 0.73
	Outcome 4 : Basics regarding NRW and NRW reduction measures are understood.					NRW Management 1.47
	Outcome 5 : The measurements for calculating NRW ratios in Zone 2 is started.					NRW Management 1.57

8. Deliverables

The input plan in Table-2 shows deliverables for each activity, which include the materials used for the training, the water quality test results of residual chlorine concentration, etc., the document on the optimization of pump operation and the trial results of measuring and calculating NRW ratios for each distribution zones and blocks. In addition to these deliverables, the completion report (in English for the client and in Japanese for JICA) will be prepared.

Since the turnover of staff is high in BDWSSS, the periodical training for new staff at the frequency of around once or twice a year, using the training materials prepared for the soft component, will be promoted to the human resource department of BDWSSS. The training materials to be prepared will include a simple training plan after the end of soft component. Moreover, considerations will be given to the file name and file type of the training materials so that the materials can be easily reused by the staff of BDWSSS. Moreover, the training materials will be handed over to multiple main C/Ps to avoid the loss of the training materials when some of them leave BDWSSS in the future.

9. Responsibilities of the Ethiopian Side

The following shows the expected responsibilities of the Ethiopian side which are considered to have relatively large influence on effects of the soft component.

Outcome 1 to 3 (Acquirement of O&M Skills):

- Completion of the staffing of dosing technician and pump operators at each distribution reservoir, production well and booster pump station within the target area (including night shift)
- Filling of the maintenance-related posts currently being vacant such as mechanical engineer and mechanics
- Maintenance of chlorine dosing equipment, water quality test instruments, bulk meters and level gauges

Outcome 4 to 5 (NRW Management):

- Allocation of sufficient staff for NRW reduction activities
- Maintenance of bulk meters and other equipment related to NRW reduction activities
- Update of the customer data in billing system

Throughout the soft component, long leaves of the BDWSSS staff mainly targeted for the trainings should be avoided during the periods when Japanese experts come to Bahir Dar. Since the duration of soft component is especially limited, the adjustment between leaves and training periods is important. Moreover, in order to facilitate the participation of staff in the trainings without being obstructed by their daily work, understandings of their superiors including adjustment of their daily work schedule are required.

Part of the C/Ps of this project should be involved in the preparation and implementation of the trainings as future trainers so that they can improve their capacity effectively. The future trainers should be able to use PCs, printer, etc. for preparing materials, analyzing data and sharing information with others during this soft component with a sense of ownership on this project. The future trainers need opportunities to actively discuss with the experts and their superiors on the implemented trainings to enhance their understanding and motivation for continuous training in the future.

APPENDIX-6

REFERENCES

Appendix 6 References

No.	Name	Data Source	Format	Publishers	Year
1	Topographic Map in Bahir Dar (1/50,000)	Map	Document	Ethiopian Mapping Agency	2004
2	Water Supply Design Guideline	Data	Word	Amhara Water Resources Development Bureau (AWRDB)	2012
3	Urban Water Supply Design Criteria	Data	Word	Water Resources Administration	2006
4	Contour in Bahir Dar (@10m)	Data	CAD	Ministry of Economy, Trade and Industry & NASA	2011
5	Bahir Dar Integrated Development Plan	Data	PDF	Federal Urban Planning Institute and Bahir Dar City Administration (BDCA)	2006
6	Bahir Dar Diaspora Site Base Map	Data	CAD	Anmhara National Regional State (ANRS) Urban Planning Institute	2014
7	Hidar 11 Kebele Land Development Map	Data	CAD	BDCA	2015
8	Anmhara National Regional State (ANRS) Rural Land Administration and Use System Improvement Regulation (No.51 of 2007)	Data	PDF	Bureau of the Environmental Protection, Land Administration and Use Authority (BoEPLAUA)	2007
9	ANRS BoEPLAU General EIA Guideline 2011-2012	Data	PDF	BoEPLAUA	2011
10	Draft of 2012 Amhara Re-orgnization Regulation	Data	Word	AWRDB	2011
11	Guidelines for Tariff based on 2012 Re-organization Regulation	Data	Word	AWRDB	2013
12	Guidelines for Community Water Administration	Data	Word	AWRDB	2015
13	BBWSSS 2008 Plan and Report	Data	PDF	BDWSSS	2008
14	Ethiopian Water Resources Management Policy	Data	PDF	Ministry of Water Resources	1999
15	EIA Guideline Document	Data	PDF	Federal Envionmental Protection Authority (EPA)	2000
16	Ethiopian Water Resources Management Proclamation (No.197 of 2000)	Data	PDF	Federal Government of Ethiopia	2000
17	Ethiopian Water Sector Policy	Data	Word	Ministry of Water Resources	2001
18	Ethiopian Water Sector Strategy	Data	Word	Ministry of Water Resources	2001
19	Ethiopia Environmental Protection Organs Establishment Proclamation (No. 295 of 2002)	Data	PDF	Federal Government of Ethiopia	2002
20	Environmental Pollution Control Proclamation	Data	PDF	Federal Government of Ethiopia	2002
21	Ethiopia EIA Procedural Guideline Series 1	Data	PDF	EPA	2003
22	Guideline Series Documents for Reviewing Environmental Imapt Study Reports	Data	PDF	EPA	2003
23	Ethiopia EPA Integrated Environmental and Social Impact Water supply	Data	PDF	EPA	2004
24	Ethiopian Water Resources Management Regulations (No.115 of 2005)	Data	PDF	Ethiopian Government	2005
25	Standards for Industrial Pollution Control in Ethiopia	Data	PDF	EPA	2008
26	BDWSSS Customer Data (August, 2015)	Data	Excel	Bahir Dar Water Supply and Sewerage Service (BDWSSS)	2015
27	BDWSSS Sample of Water Tarif Invoice	Data	PDF	BDWSSS	2015
28	Data of Annual Consumption and Water Tarif Demand	Data	Excel	BDWSSS	2015

29	BDWSSS Revenue, Expenditure and Capital Investment for 2013-14	Data	PDF	BDWSSS	2014
30	BDWSSS Revenue, Expenditure and Capital Investment for 2014-15	Data	PDF	BDWSSS	2015
31	BDWSSS Tender Documents Draft for External Accounting Audit 2015	Data	PDF	BDWSSS	2015
32	2007 Census Report of The Amhara Region	Data	PDF	Central Statistics Authority of Ethiopia	2010
33	Bahir Dar City Population Projection	Data	Excel	BDCA Finance and Economic Department	2010
34	Bahir Dar City Population Projection (By Kebele)	Data	Excel	BDCA Finance and Economic Department	2015
35	Hidar 11 Sub-city Population Counts	Data	PDF	Hidar 11 Kebele Office	2015
36	Solid Waste Charaterisation and Quantification of Bahir Dar City (2010)	Data	PDF	UNEP	2010
37	Result of Water Quality Test at Charchar No.3: Physical Parameters	Data	PDF	BDWSSS Laboratory	2015
38	Result of Water Quality Test at Charchar No.1	Data	PDF	BDWSSS Laboratory	2015
39	Result of Water Quality Test at Hidar 11 Health Centre	Data	PDF	BDWSSS Laboratory	2015
40	Result of Water Quality Test: Free Residual Cl and Turbidity	Data	PDF	BDWSSS Laboratory	2015
41	Secnod Growth and Transformation Plan (GTP-2)	Data	PDF	Ministry of Finance and Economic Development (MoFED)	2015
42	Universal Acess Plan	Data	PDF	Ministry of Water and Energy	2011
43	Charchara No.5 Drilling Report	Report	Word	Amhara Water Well Drilling Enterprise (AWWDE)	2014
44	Charchara No.5 Pumping Test Report	Report	Word	AWWDE	2014
45	Charchara No.6 Drilling Report	Report	Word	AWWDE	2015
46	Charchara No.6 Pumping Test Report	Report	Word	AWWDE	2015
47	Charchara No.2 Drilling Report	Report	Word	AWWDE	2012
48	Charchara No.2 Pumping Test Report	Report	Word	AWWDE	2012
49	Charchara No.3 Pumping Test Report	Report	Word	AWWDE	2012
50	Well Completion Report, Amhara Plastic Factory	Report	Word	AWWDE	2005
51	Lake Tana Water Quality	Data	Excel	Abay Basin Authority	-
52	Bahir Dar Weather Report	Data	Excel	Bahir Dar Meteorological Bureau	-
53	The Establishment of Abay Riverside Park (Draft)	Report	PDF	ANRS BoCT	2007
54	Ethiopia Building Code Standard 1～8	Data	PDF	Ministry of Works & Urban Development	1995
55	Well completion Reort Plastic Factory	Report	PDF	WWDE	2005
56	Well Completion Report of Bahir Dar city Water Supply Well Driling Report	Report	PDF	AMDSWE	2006
57	Local Development Plan Manual	Data	PDF	Ministry of Works And Urban Development	2006
58	Urban Transport Planning Manual	Data	PDF	Ministry of Works And Urban Development	2006
59	Guidelines for Finance	Guideline	MS Word	BDWSSS	2008
60	Regulation No.59-2008 The Bahir Dar Nile River Milennium Park Demacation and Administrative Determination	Regulations	PDF	The Council of ANRS	2008

61	Pump Test Data (Ashraf No.1)	Data	PDF	AWWCE	2009
62	Bahir Dar Abay (Blue Nile) River Millennium - Strategic Plan for 2010-2014 (Draft)	Report	PDF	BDCA	2010
63	Drinking Water and Other Similar Services Rent and Tariff Setting Manual	Manual	PDF	Bahir Dar City Council	2011
64	Proclamation No.188-2011 - A Revised Proclamation Issued to Provide for the Re-organization of the ANRS Water Supply and Sewerage Services	Regulations	MS Word	The Council of ANRS	2011
65	The State of African Utilities - Performance Assessment and Benchmarking Report	Report	PDF	Water Operators' Partnerships	2011
66	Welfare Monitoring Survey 2011 Volume 1	Report	PDF	CSA	2011
67	Welfare Monitoring Survey 2011 Volume 2	Report	PDF	CSA	2011
68	Drilling and Pumping Test Report of Charchara Well	Data	PDF	AWWCE	2012
69	Ethiopia's Progress towards Eradicating Proverty - An Interim Report on Poverty Analysis Study (2010-11)	Report	PDF	MoFED	2012
70	Pumping Test Data (Charchara No.3)	Data	PDF	AWWCE	2012
71	Pumping Test Report of Charchara Well (Charchara No.4)	Report	PDF	AWWDE	2012
72	Regulation No. 94-2012 The Revised ANRS Urban and Rural Potable Water Supply and Sewerage Services' Reorganizing Proclamation Implementation	Regulations	PDF	The Council of ANRS	2012
73	Revised Standards for Structure Plan Preparation and Implementation	Regulations	PDF	Ministry of Urban Development and Construction (MoUDC)	2012
74	Well completion Report of Charchara No.4 Deep Well	Report	PDF	AWWCE	2012
75	Compulsory Ethiopian Standard - Drinking Water - Specifications	Guideline	PDF	Ethiopian Standards Agency	2013
76	Guidelines for Tariff Setting	Guideline	MS Word	AWRDB	2013
77	Peda Pumping Test Data sheet	Data	PDF	WWDE	2014
78	Regulation No.125-2014 Lake Tana Biosphere Reserve Delineation and Administration Determination	Regulations	PDF	The Council of ANRS	2014
79	Well Completion Reort (Charchara No.5)	Report	オリジナル	WWDE	2014
80	Standards For 1. Urban Land Use Classification, Code, Standard Area, Served Population and Locations Of Activities	Data	PDF	ANRS Urban Planning Institute	2014
81	A0 Size Map of Lake Tana Biosphare Reserve	Map	PDF	NABU	2015
82	Charchara Pumping Test Data Sheet （Charchara No.6)	Data	オリジナル	WWDE	2015
83	Charchara Well Completion Report （Charchara No.6)	Report	オリジナル	WWDE	2015
84	EC 2008 1st Quater O&M Report	Report	MS Word	BDWSSS	2015
85	Five-Year Strategic Plan for 2015-16 to 2019-20	Report	PDF	BDWSSS	2015
86	Lake Tana Biosphere Reserve Managment Plan (Draft)	Report	PDF	NABU	2015
87	Notification on EIA	Regulations	PDF	ANRS EFWPA	2015
88	Pumping Test Report of Charchara Well No.3	Report	PDF	AWWDE	2015
89	Unaudited Financial Statement 2013-2014	Report	PDF	BDWSSS	2015

90	Unaudited Financial Statement 2014-2015	Report	PDF	BDWSSS	2015
91	Lot-1 Supply of Submersible Pumps	Specification	PDF	BDWSSS	2015
92	3rd Quarter Achievement Report	Report	PDF	BDWSSS	2016
93	Draft Interim Audit Report on the Financial Statements for the Last 8 Years	Report	MS Word	BDWSSS	2016
94	Earthquake distribution map in Ethiopia	Thesis	PDF	Addis Ababa University	2016
95	EC 2008 2nd Quater O&M Report	Report	MS Word	BDWSSS	2016
96	EC 2008 3rd Quater O&M Report	Report	MS Word	BDWSSS	2016
97	Effect of Bahir Dar Municipal Effluents on Water Quality of the Head of Blue Nile River	Thesis	PDF	Bahir Dar University	2016
98	Land Aquistion Tariff (not authorized by the Reginoal Government)	Regulations	PDF	BDCA	2016
99	Permits of Water Uses for BDWSSS	Permit certificate	PDF	Abbay Basin Authority	2016
100	Population in Hidar 11 Kebele as of February 2016	Data	PDF	Hidar 11 Kebele Office, BDCA	2016
101	Pump Operation Records	Data	PDF	BDWSSS	2016
102	Results of Water Quality Tests	Data	PDF	BDWSSS	2016
103	Temporary Licence for Water Work (BDWSSS, Test Boreholes)	Permit certificate	PDF	Abbay Basin Authority	2016
104	TOR for the Integrated Management Systems Implementation Project	Instruction	MS Word	BDWSSS	2016
105	Water Production Data	Data	MS Excel	BDWSSS	2016
106	B.Dar (Weather Report)	Data	PDF	Bahir Dar Meteolological Bureau	-
107	Lake Tana Water Quality	Data	PDF	ABA	-

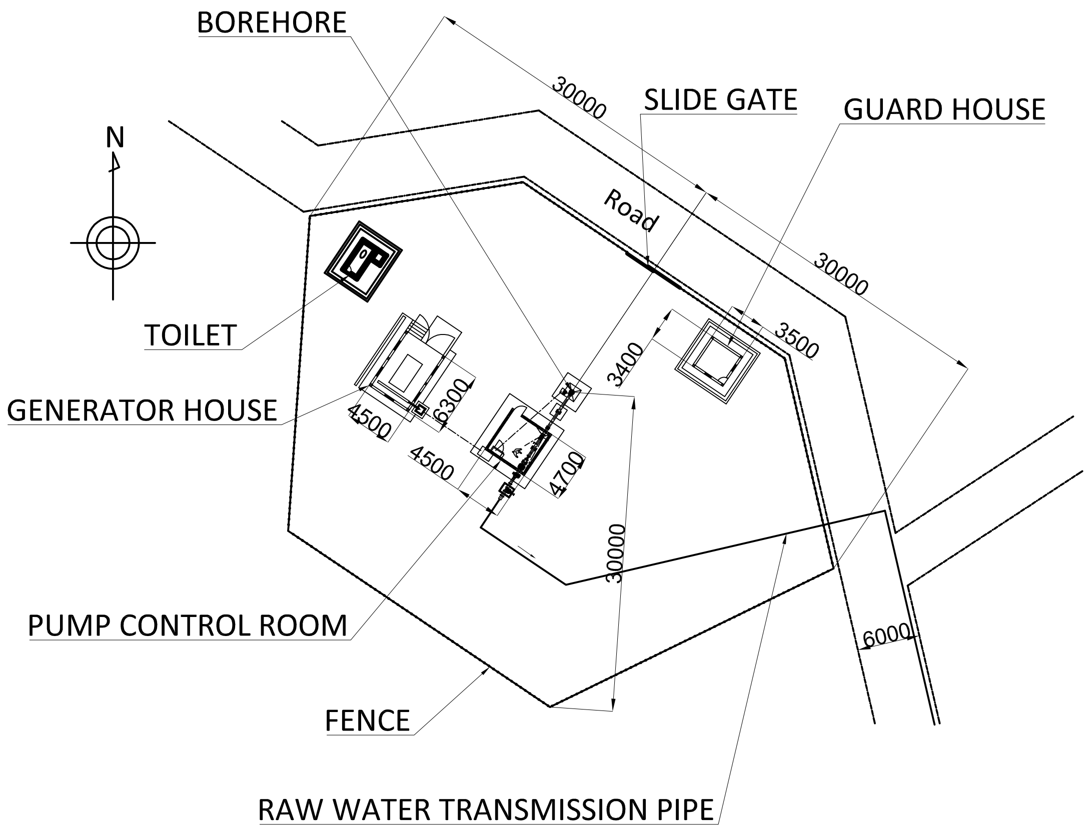
APPENDIX-7

OTHER RELEVANT DATA

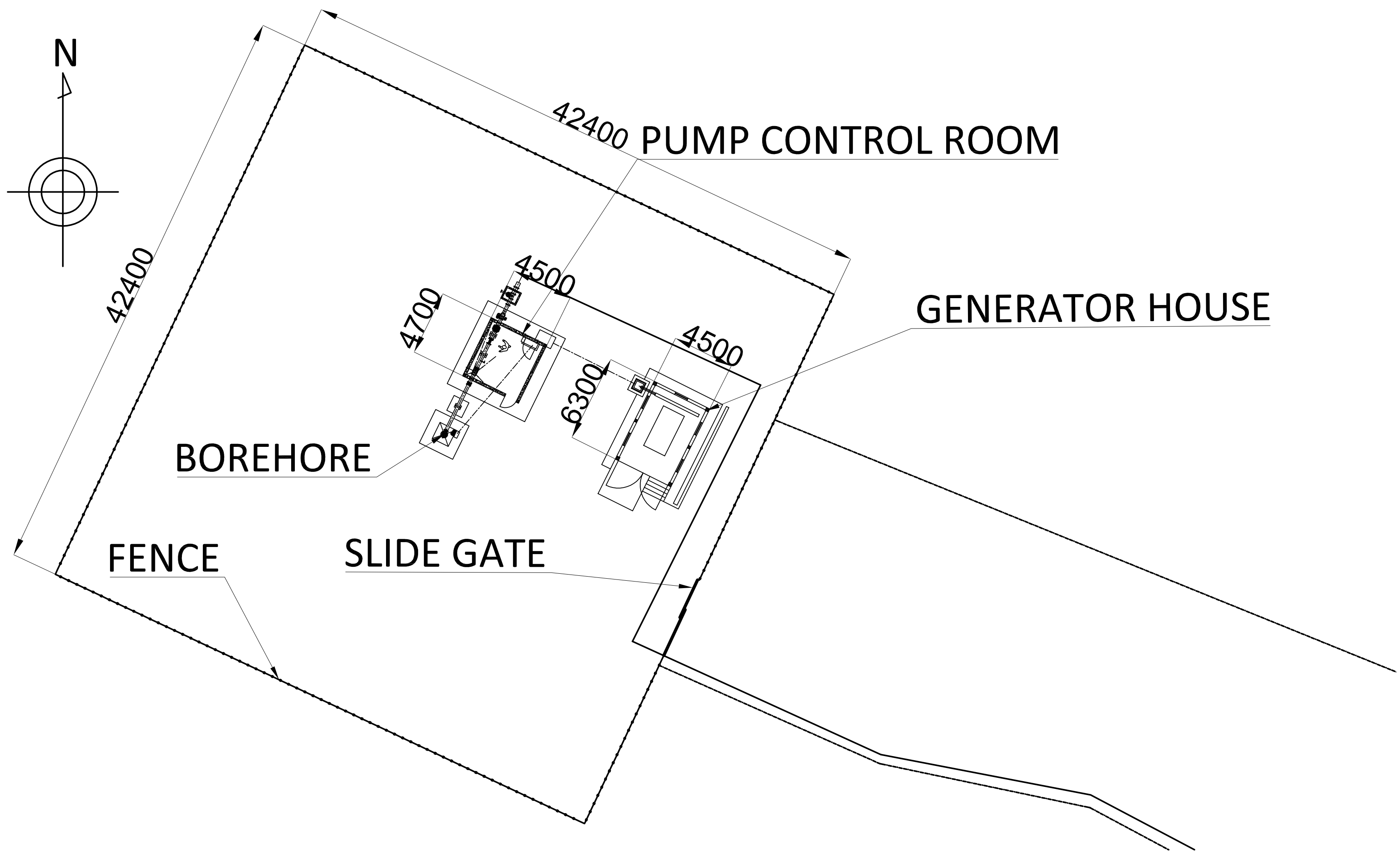
7（1） Outline Design Drawing
7（2） Results of Pumping Test of Existing Wells
7（3） Geology and Hydrogeology of The Survey Target Area
7（4） Geophysical Survey
7（5） Test Well Drilling
7（6） Results of Pumping Test of Test Wells
7（7） Multiple Well Pumping Test
7（8） Results of Water Quality Test
7（9） Results of Socio-economic Survey
7（10） Socio-economic Information of Affected Households
7（11） Minutes of the Stakeholders Meeting
7（12） EIA Certificate
7（13） Project Monitoring Sheet

Appendix-7 (1) Outline Design Drawing

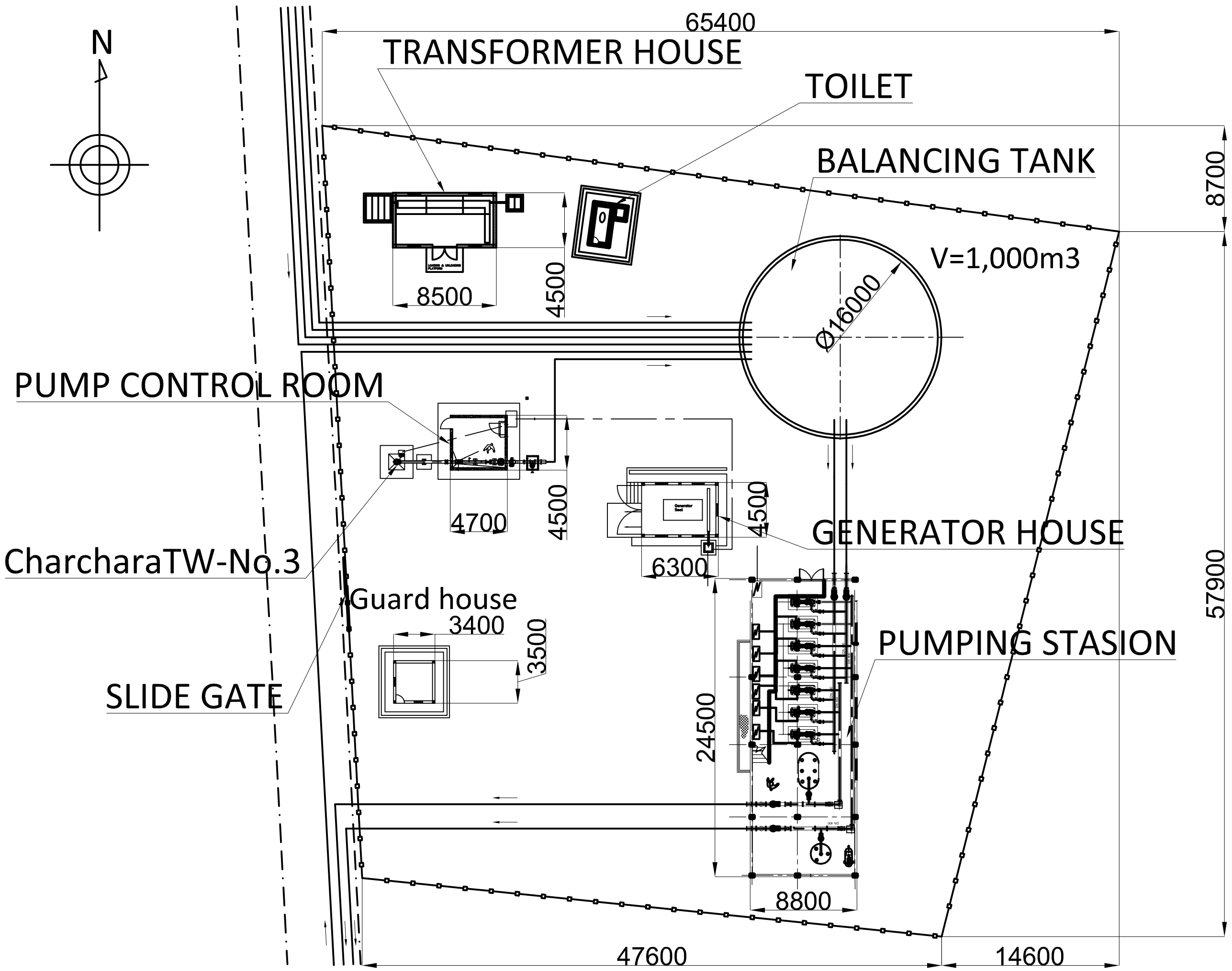
No.	Name of Drawings
1	Layout drawing of Charchara TW NO.1
2	Layout drawing of Charchara TW NO.2
3	Layout drawing of Charchara TW NO.3
4	Layout drawing of Charchara NO.3
5	Layout drawing of Charchara NO.4
6	Layout drawing of Charchara NO.5
7	Layout drawing of Charchara NO.6
8	Layout drawing of Ashraf NO.1, 2
9	Layout drawing of Ashraf TW NO.2
10	Layout drawing of Ashraf TW NO.3
11	Layout drawing of new Booster Pump Station
12	Structural drawing of Balancing Tank (1,000m^3), new Booster Pump Station
13	Layout drawing of Diaspora Water Distribution Station
14	Structural drawing of Receiving Pit (200m^3), Diaspora Water Distribution Station
15	Structural drawing of Reservoir (1,000m^3), Diaspora Water Distribution Station
16	Layout drawing of Gabriel Water Distribution Station
17	Structural drawing of Receiving Pit (700m^3), Gabriel Water Distribution Station
18	Structural drawing of Reservoir (4,000m^3), Gabriel Water Distribution Station
19	Structural drawing of Guard House
20	Structural drawing of Pump Control Room
21	Structural drawing of Toilet
22	Structural drawing of Generator Room
23	Structural drawing of Substation
24	Structural drawing of Flowmeter Pit
25	Structural drawing of Chemical Plant
26	Layout drawing of Distribution Pipe Network



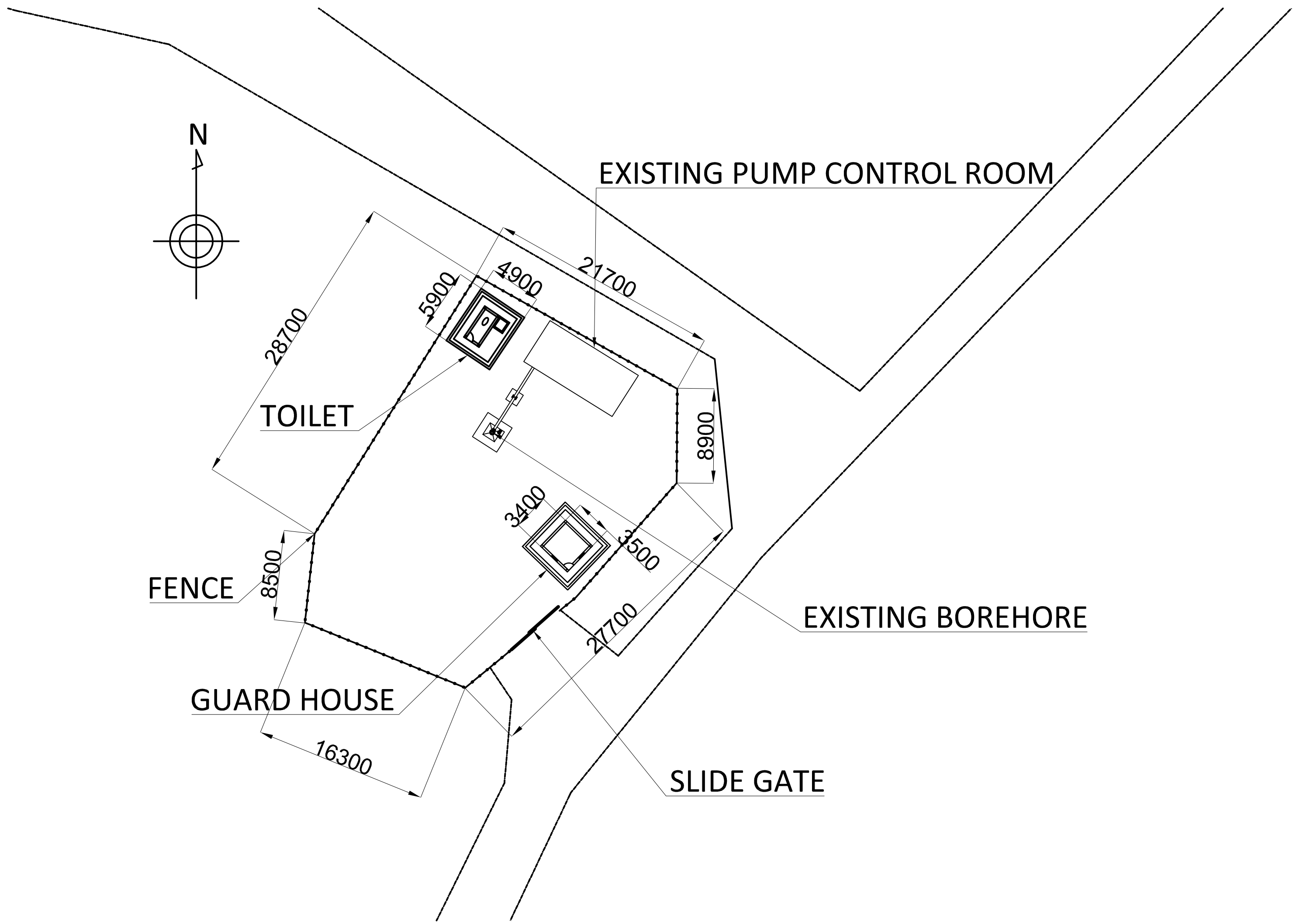
Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia
Title	Layout drawing of Charchara TW NO.1
Scale	1/1000
Consultant	JAT JAPAN TECHNO
Drawing No.	1



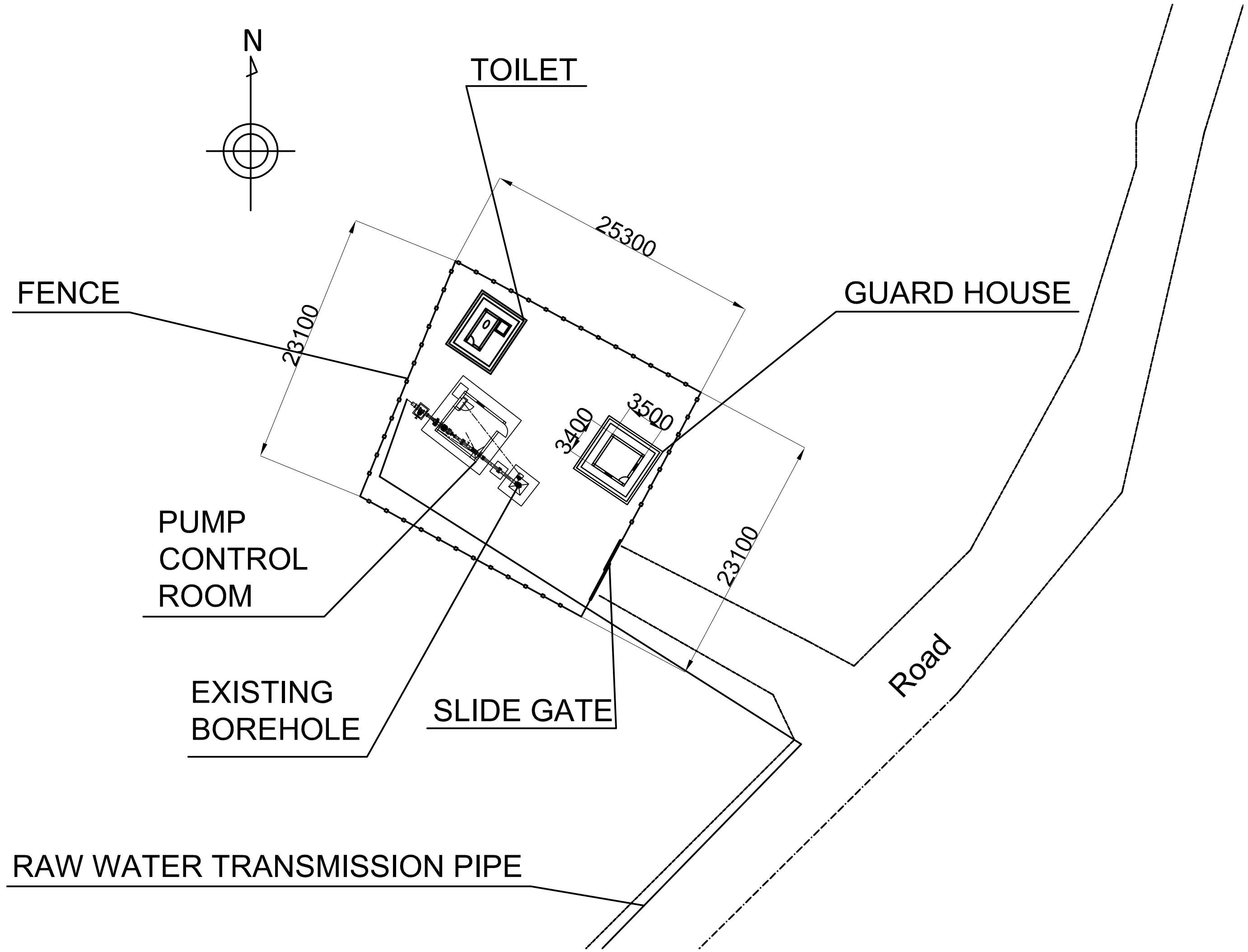
Project Name The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title Layout drawing of Charchara TW NO. 2		
Scale 1/500	Consultant JAPAN TECHNO	Drawing No. 2



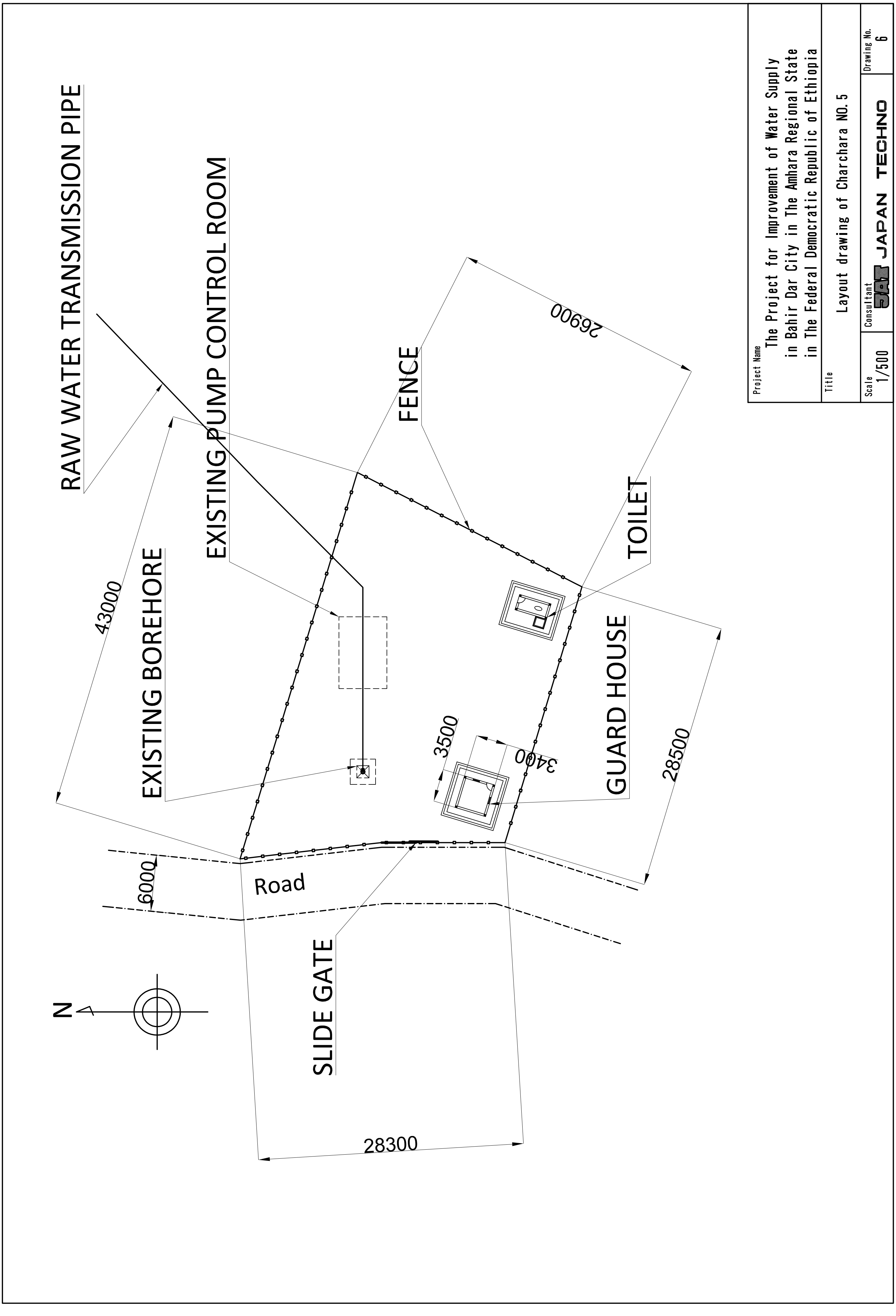
Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia	
Title	Layout drawing of Charchara TW NO.3	
Scale 1/1000	Consultant JAPAN TECHNO	Drawing No. 3



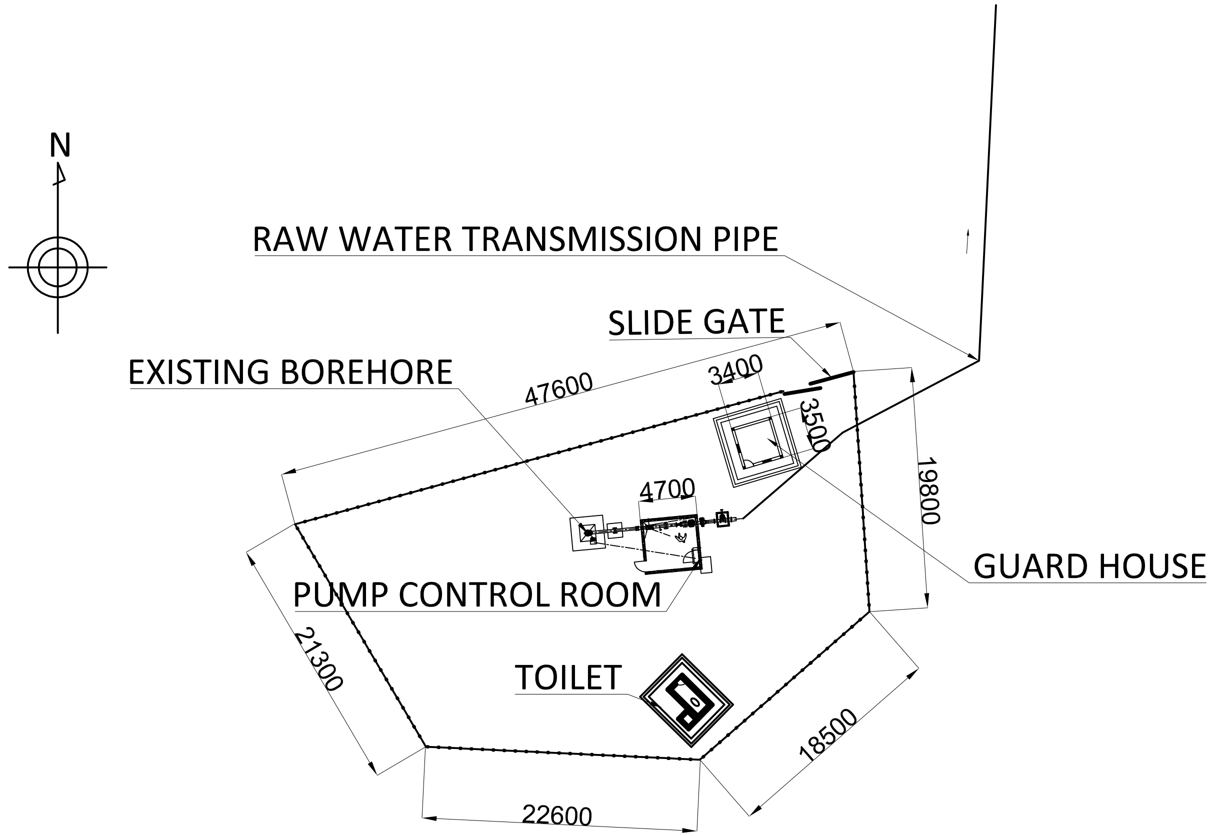
Project Name: The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title: Layout drawing of Charchara NO.3		
Scale: 1/500	Consultant: JAT JAPAN TECHNO	Drawing No. 4



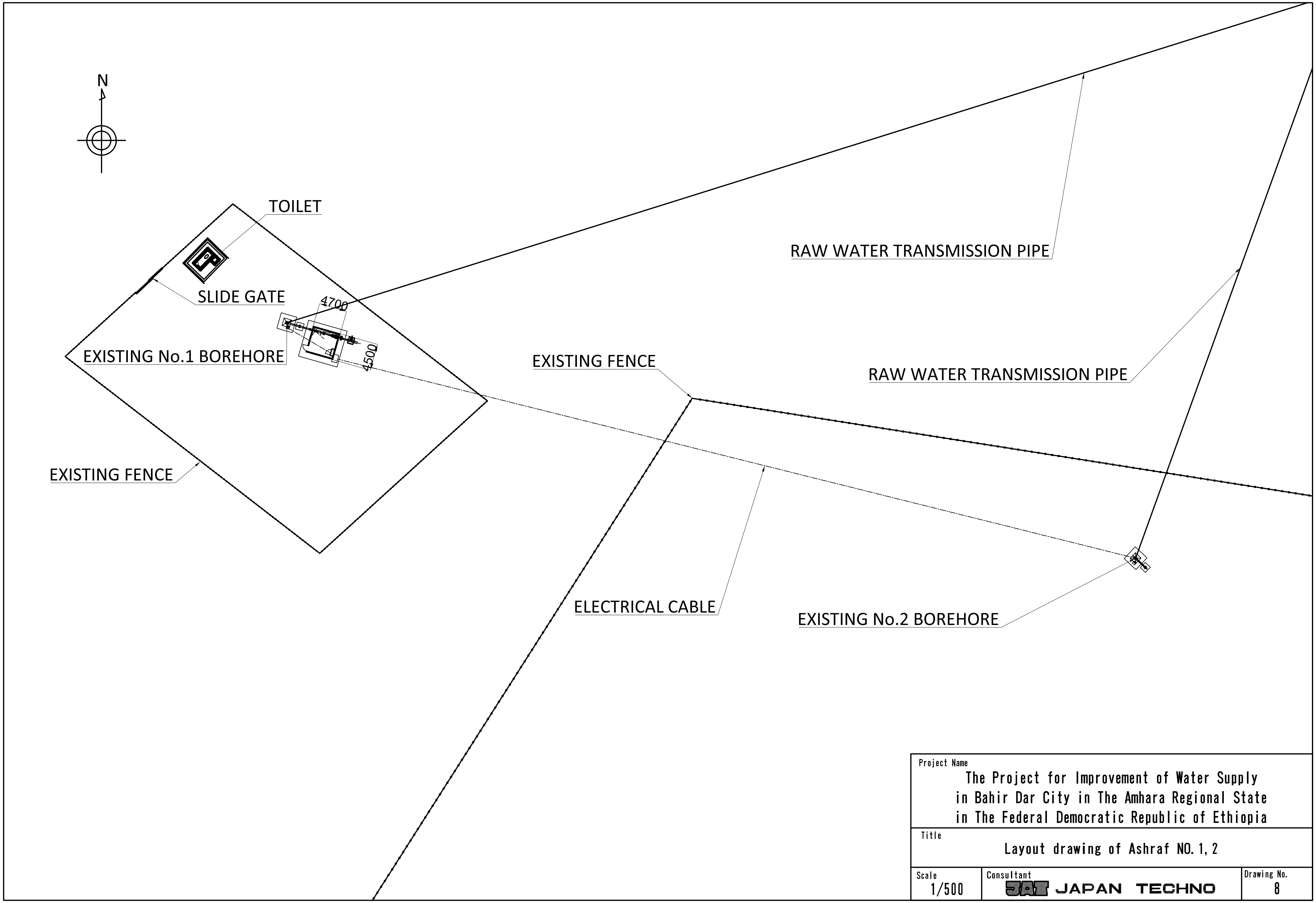
Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia
Title	Layout drawing of Charchara NO.4
Scale	1/500
Consultant	JAT JAPAN TECHNO
Drawing No.	5



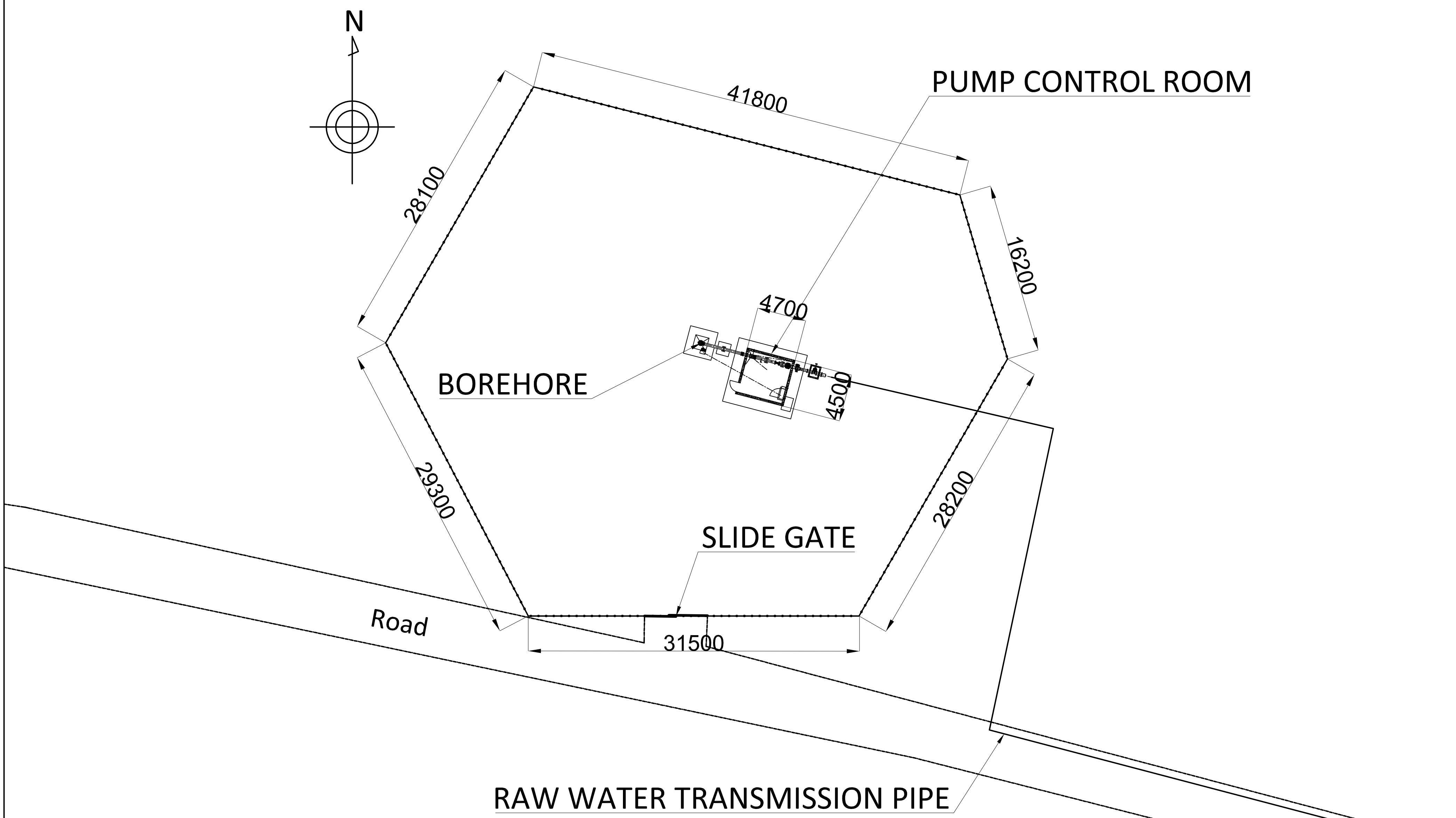
RAW WATER TRANSMISSION PIPE
EXISTING PUMP CONTROL ROOM
FENCE
26900
TOILET
43000
EXISTING BOREHORE
GUARD HOUSE
3500
3400
28500
6000
Road
SLIDE GATE
N
28300
Project Name
The Project for Improvement of Water Supply
in Bahir Dar City in The Amhara Regional State
in The Federal Democratic Republic of Ethiopia
Title
Layout drawing of Charchara NO.5
Scale
1/500
Consultant
JAPAN TECHNO
Drawing No.
6



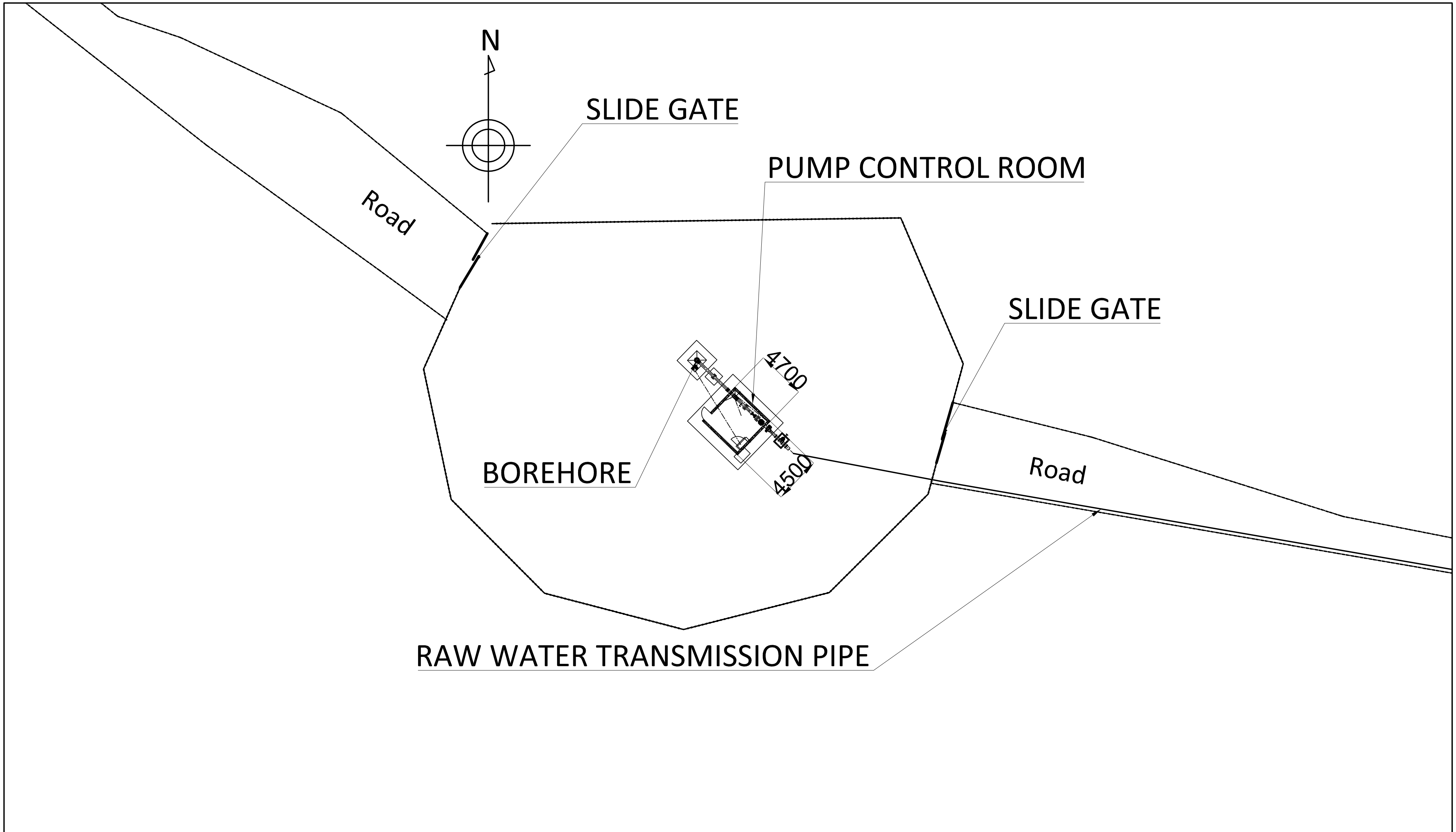
Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia
Title	Layout drawing of Charchara NO.6
Scale	1/500
Consultant	JAPAN TECHNO
Drawing No.	7



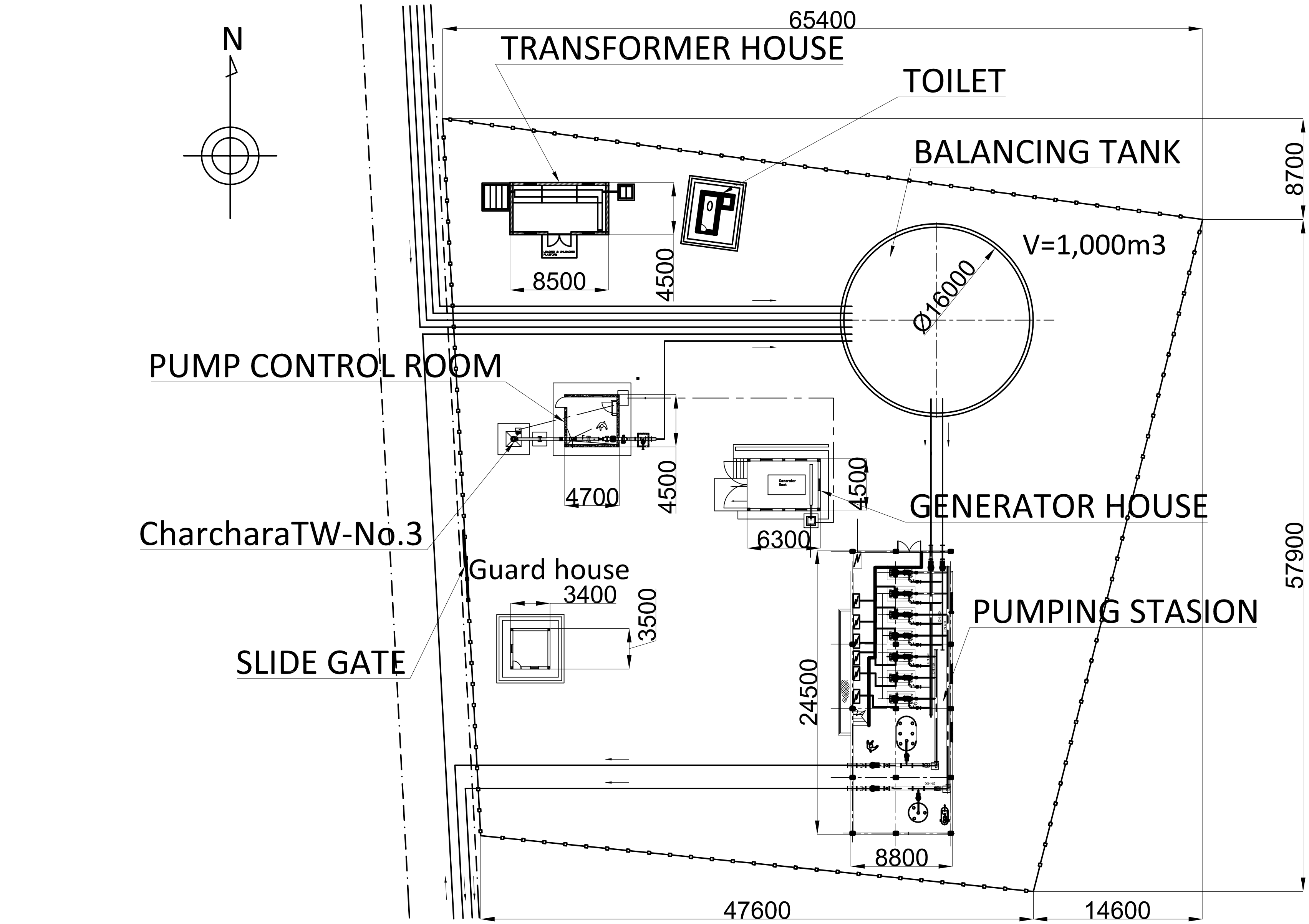
Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia
Title	Layout drawing of Ashraf NO.1,2
Scale	1/500
Consultant	JAT JAPAN TECHNO
Drawing No.	8



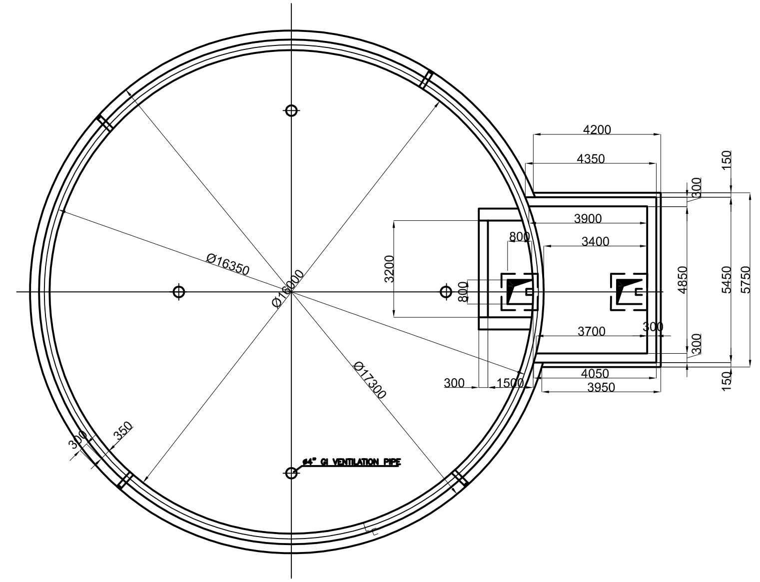
Project Name: The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title: Layout drawing of Ashraf TW NO. 2		
Scale: 1/500	Consultant: JAT JAPAN TECHNO	Drawing No.: 9

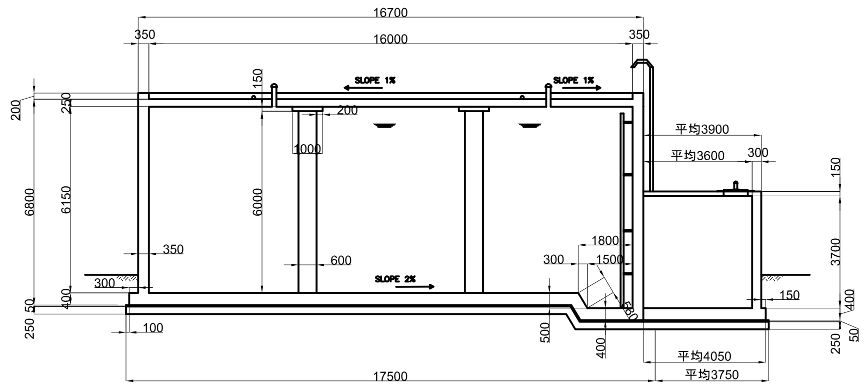


Project Name: The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title: Layout drawing of Ashraf TW NO. 3		
Scale: 1/500	Consultant: JAT JAPAN TECHNO	Drawing No.: 10



Project Name: The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title: Layout drawing of New Booster Pump Station		
Scale: 1/500	Consultant: JAPAN TECHNO	Drawing No. 11

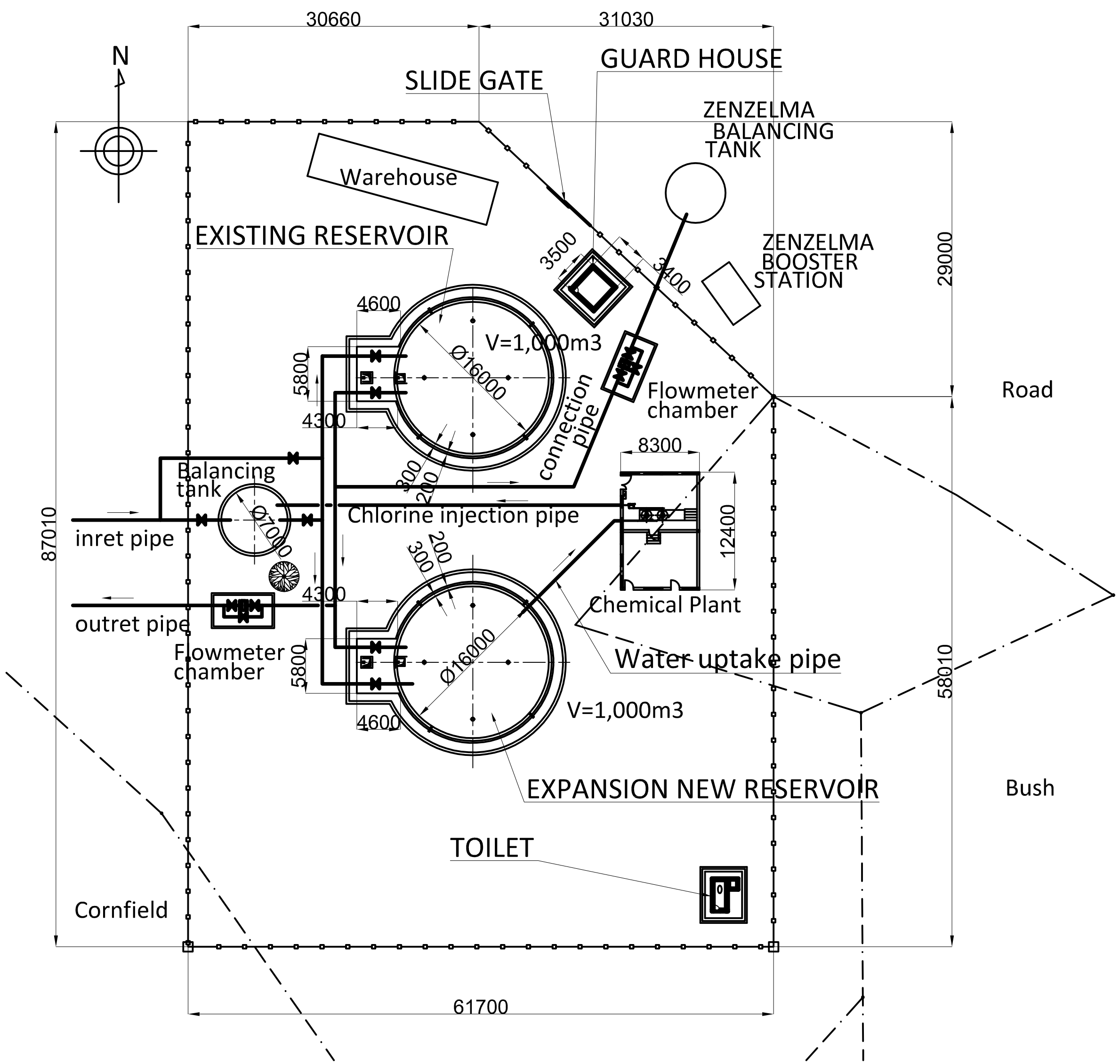




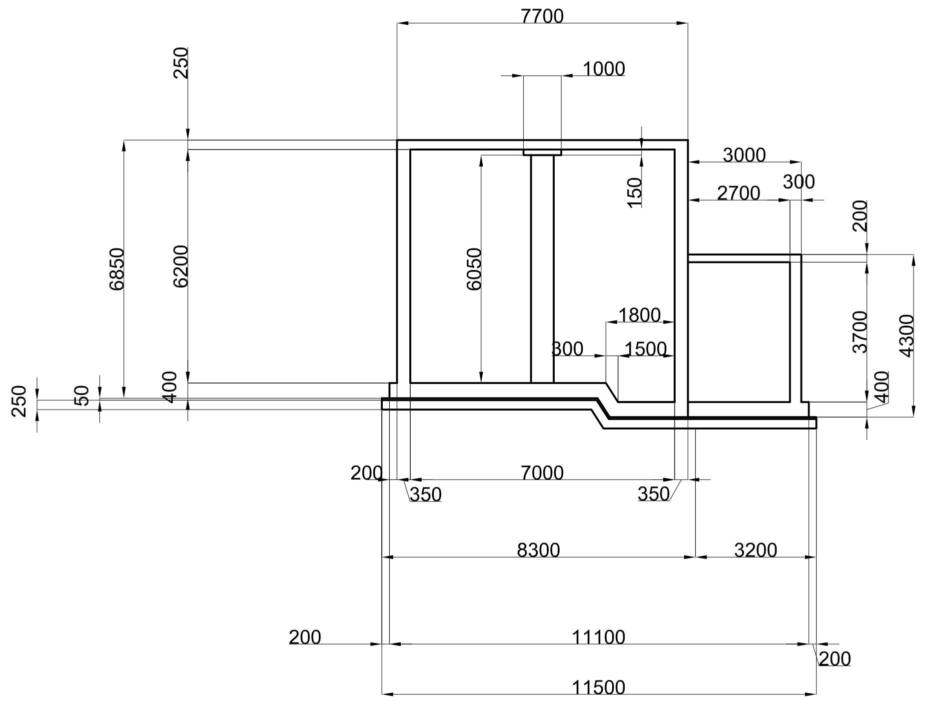
Project Name
The Project for Improvement of Water Supply
in Bahir Dar City in The Amhara Regional State
in The Federal Democratic Republic of Ethiopia

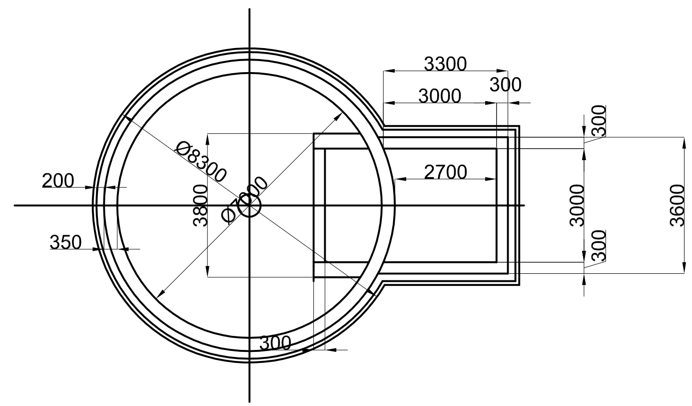
Title
Structural drawing of Balancing Tank(1000m³),
New Booster Pump Station

Scale	Consultant	Drawing No.
1/250	JAPAN TECHNO	12

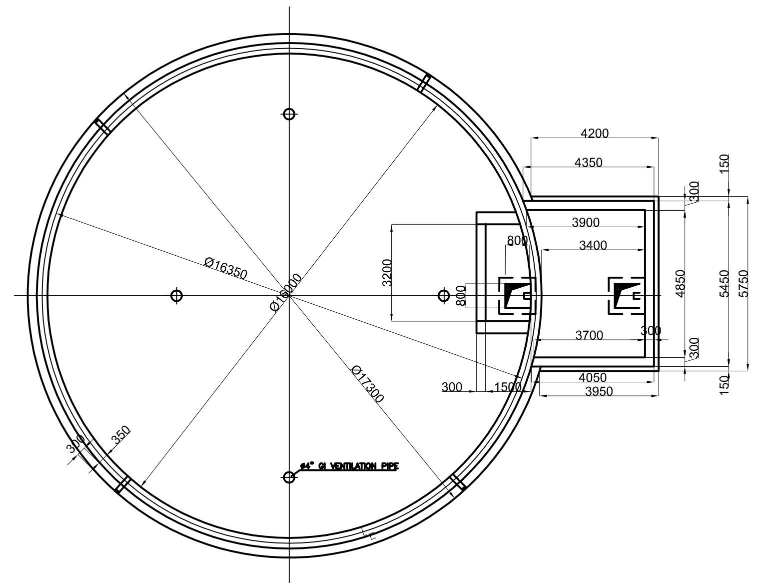


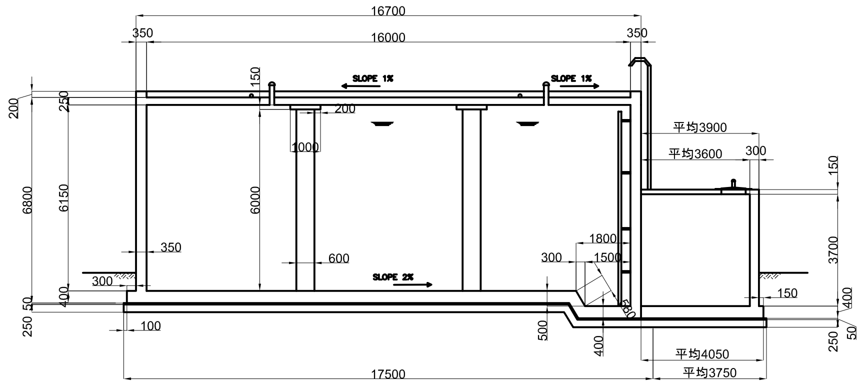
Project Name The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title Layout drawing of Diaspora Water Distribution Station		
Scale 1/750	Consultant JAPAN TECHNO	Drawing No. 13



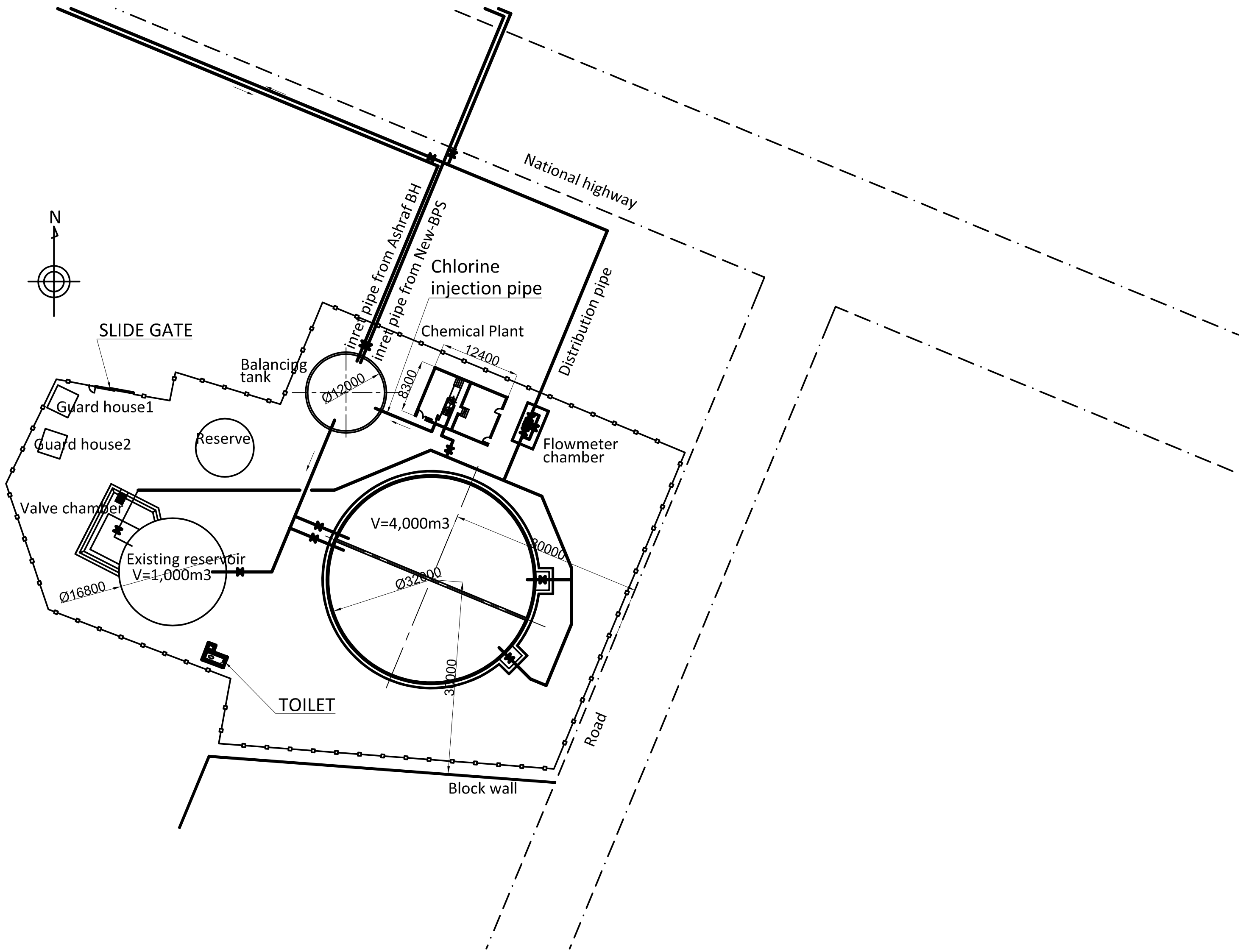


Project Name: The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title: structural drawing of Receiving Pit (200m³), Diaspola Water Distribution Station		
Scale: 1/200	Consultant: JAT JAPAN TECHNO	Drawing No. 14

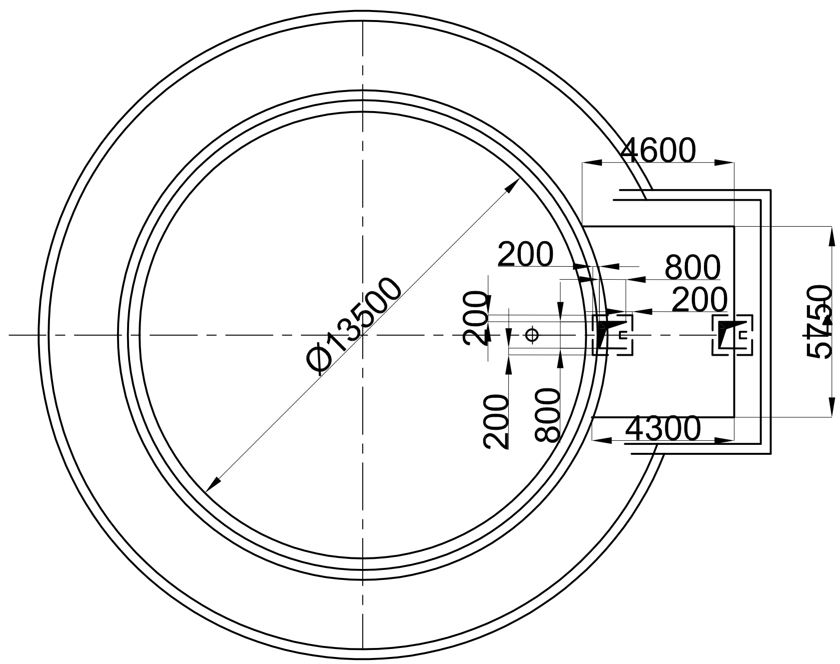


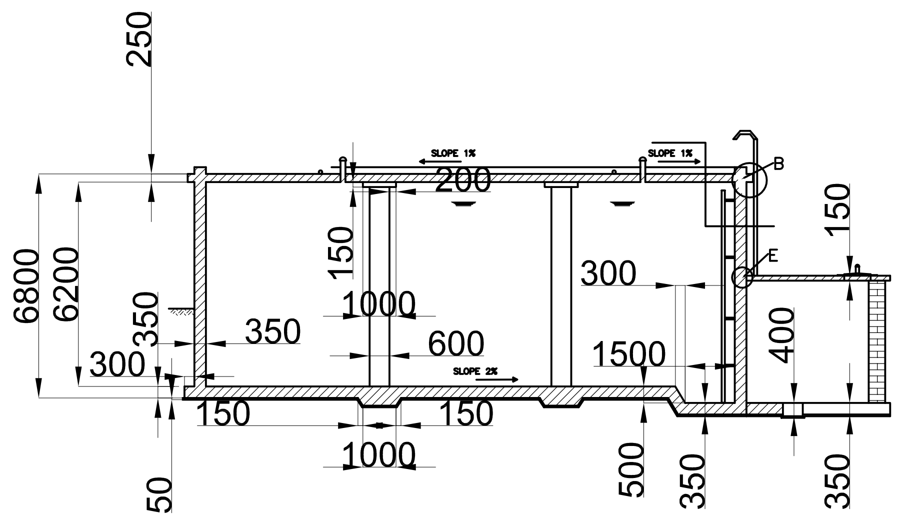


Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia
Title	Structural drawing of Reservoir(1000m³), Diaspola Water Distribution Station
Scale	1/250
Consultant	JAT JAPAN TECHNO
Drawing No.	15

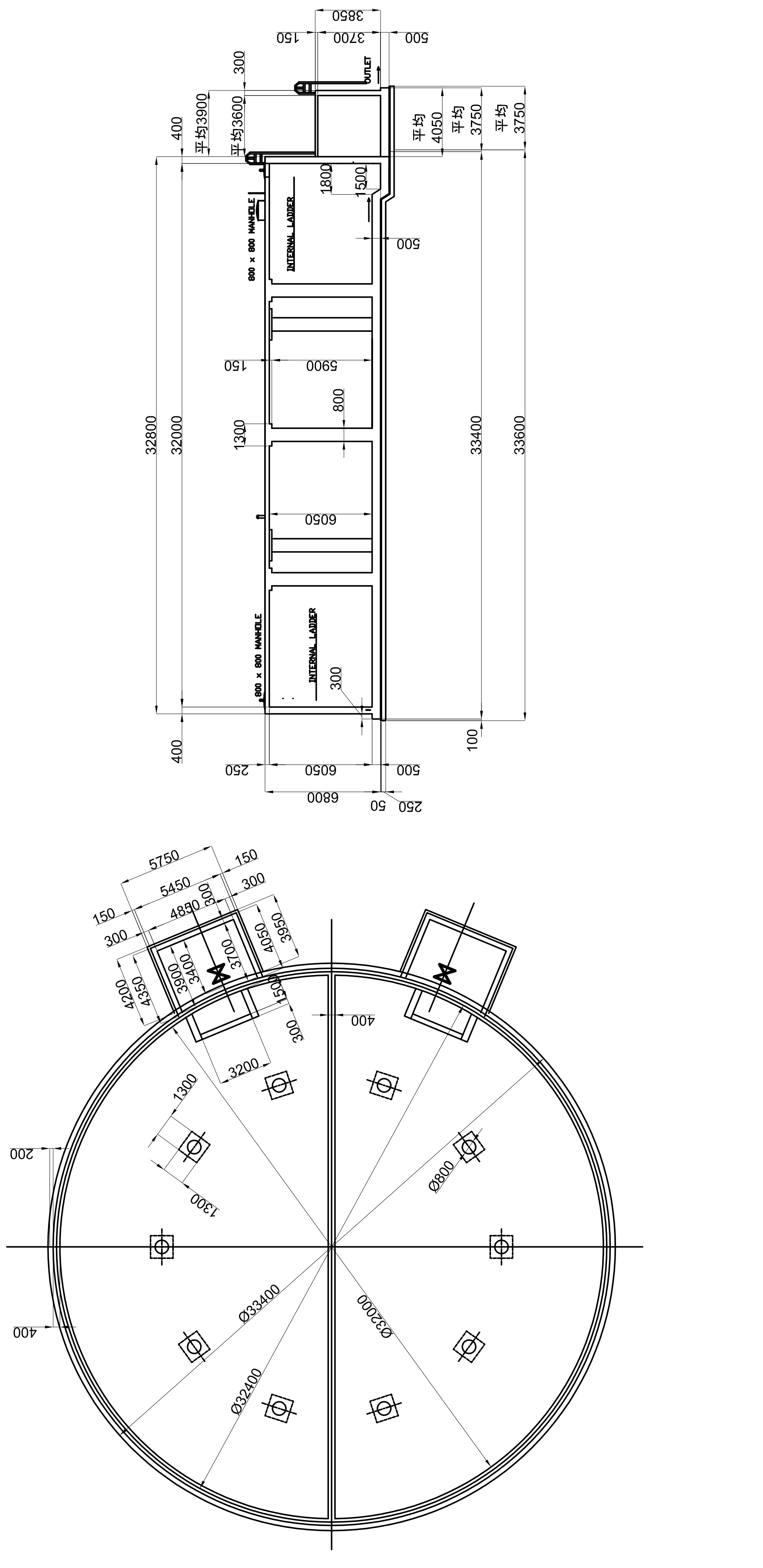


Project Name The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title Layout drawing of Gabriel Water Distribution Station		
Scale 1/1000	Consultant JAT JAPAN TECHNO	Drawing No. 16





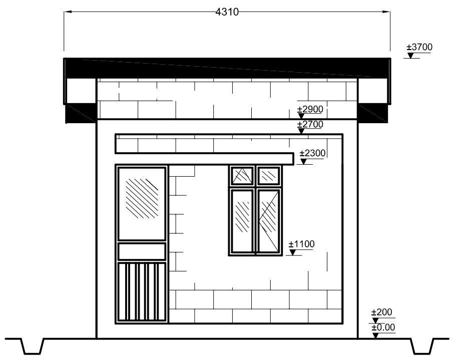
Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia
Title	Structural drawing of Receiving Pit(700m³), Gabriel Water Distribution Station
Scale	1/250
Consultant	JAPAN TECHNO
Drawing No.	17



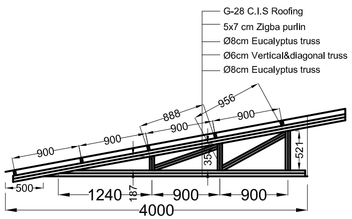
Project Name
The Project for Improvement of Water Supply
in Bahir Dar City in The Amhara Regional State
in The Federal Democratic Republic of Ethiopia

Title
Structural drawing of Reservoir(4000m³),
Gabriel Water Distribution Station

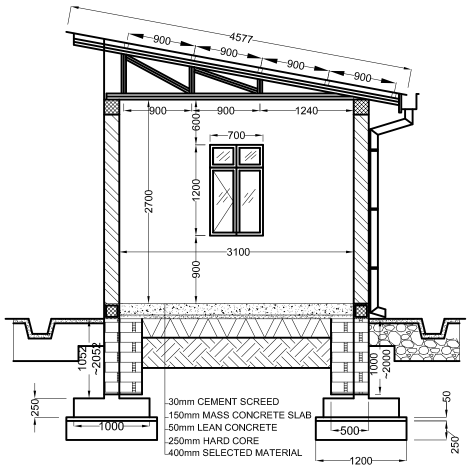
Scale 1/350
Consultant JAPAN TECHNO
Drawing No. 18



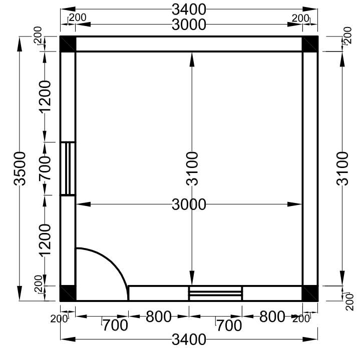
FRONT ELEVATION



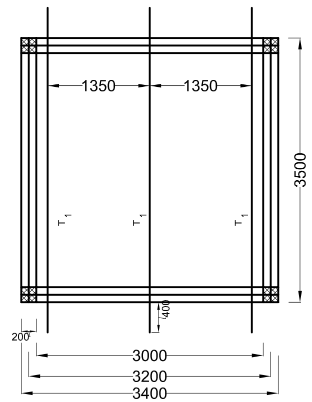
Truss Detail T1



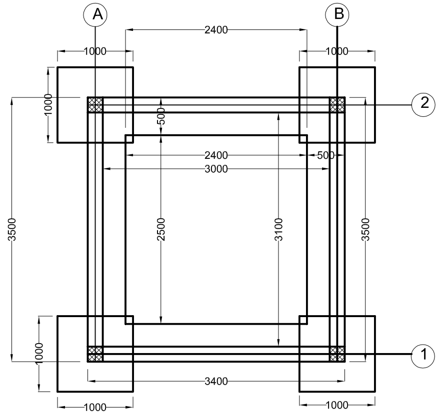
SECTION A-A



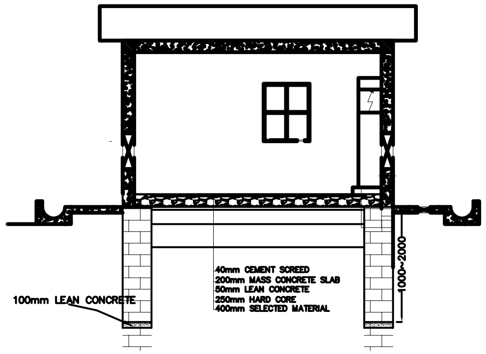
GUARD HOUSE FLOOR PLAN

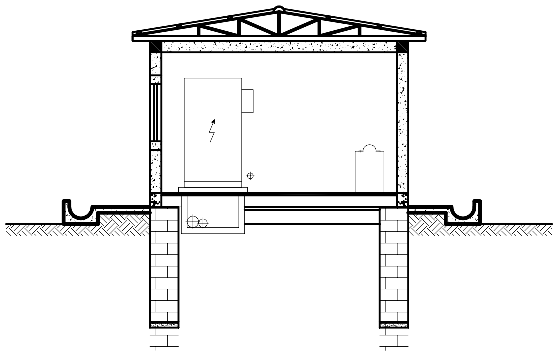


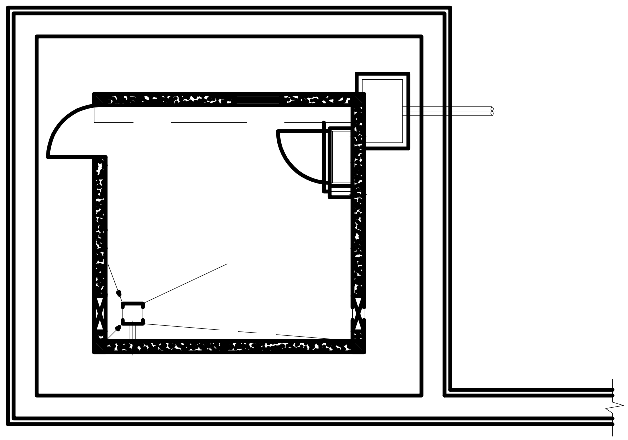
Truss Plan



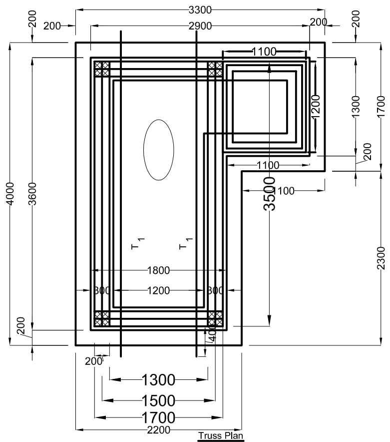
Project Name The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title Structural drawing of Guard House		
Scale 1/100	Consultant JAPAN TECHNO	Drawing No. 19



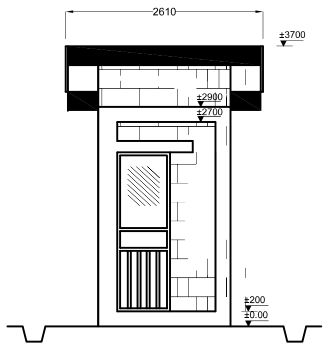




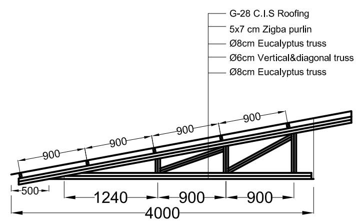
Project Name The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title Structural drawing of Pump Control Room		
Scale 1/100	Consultant JAT JAPAN TECHNO	Drawing No. 20



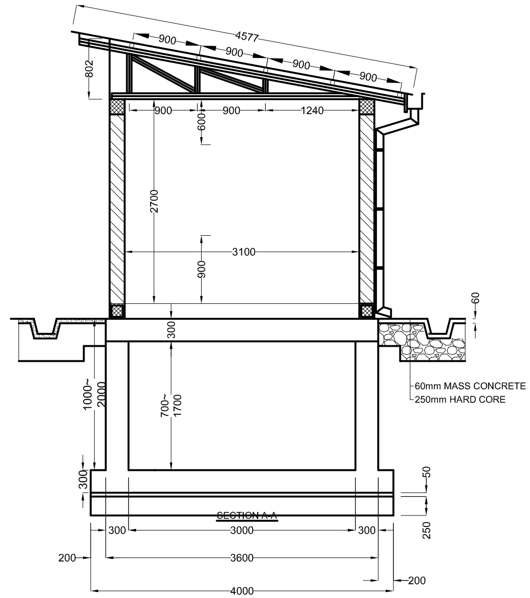
Truss Plan



FRONT ELEVATION



Truss Detail T1

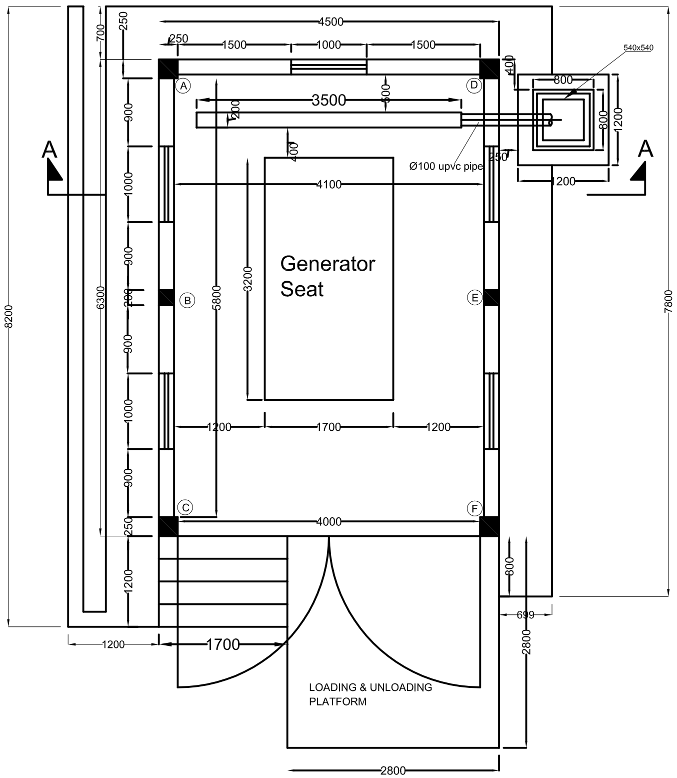


SECTION A-A

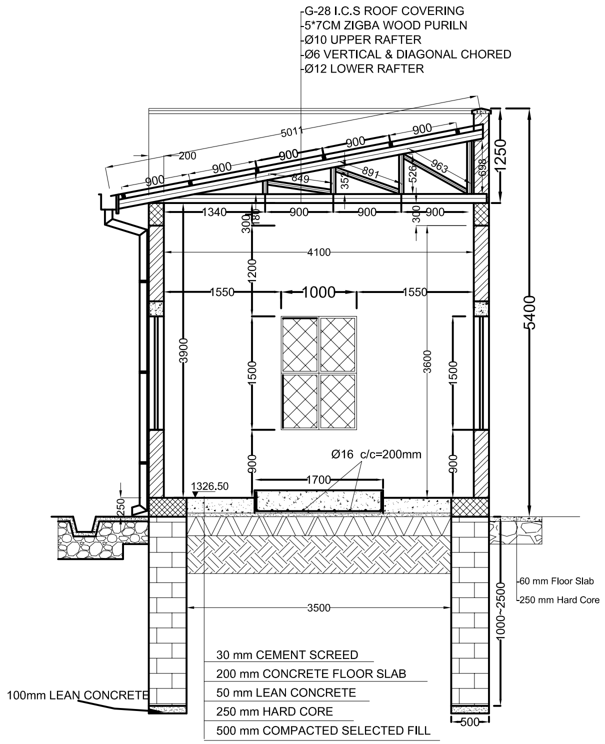
Project Name
The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia

Title
Structural drawing of Toilet

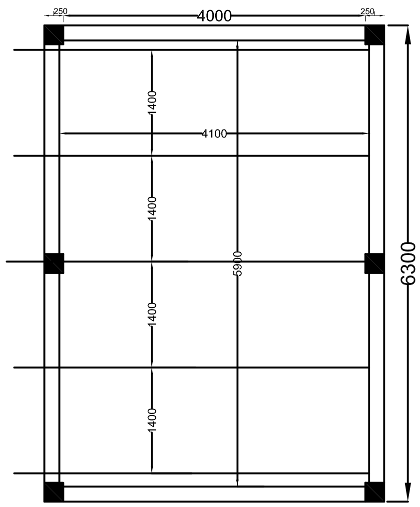
Scale	Consultant	Drawing No.
1/100	JAPAN TECHNO	21



PLAN

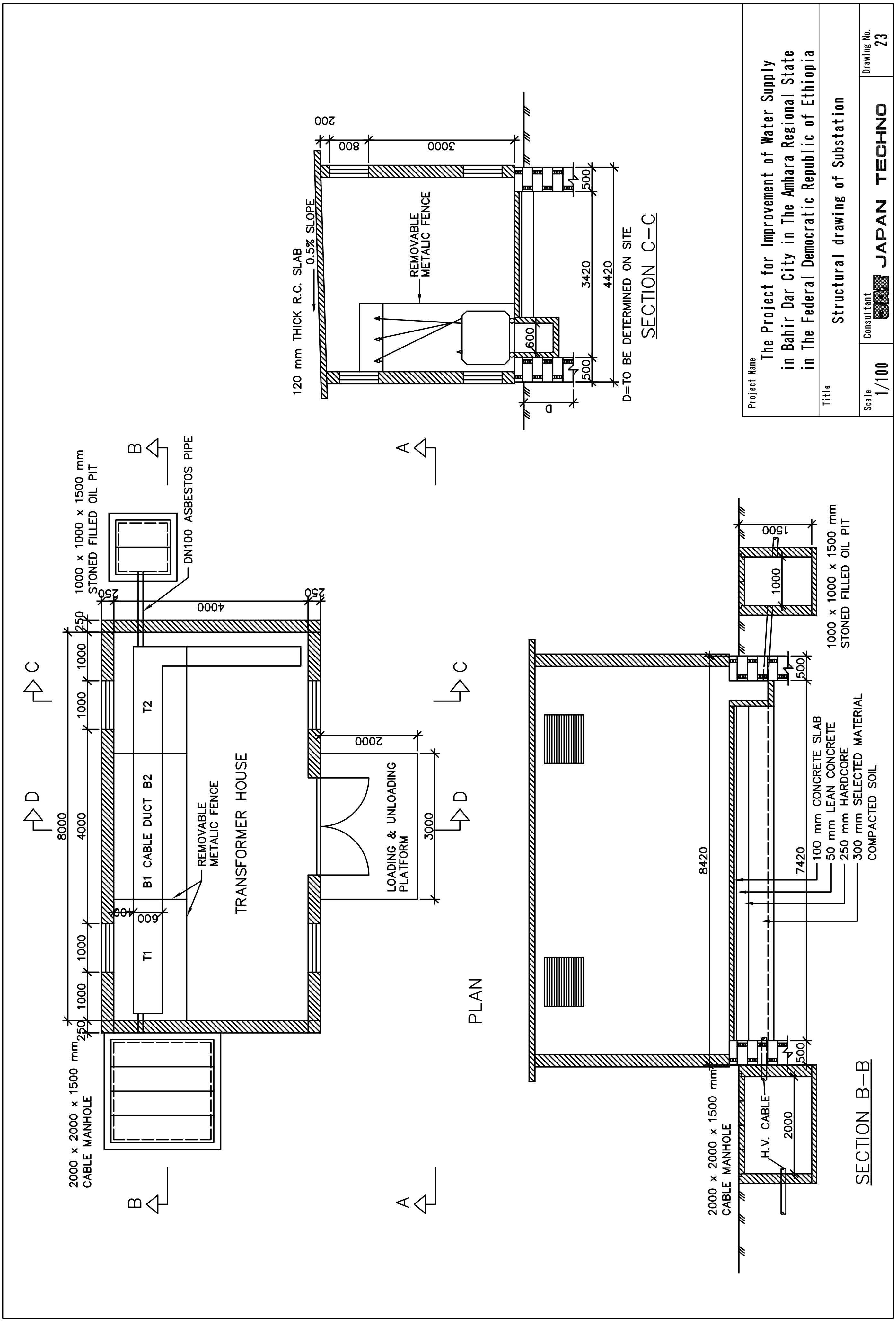


Section A-A

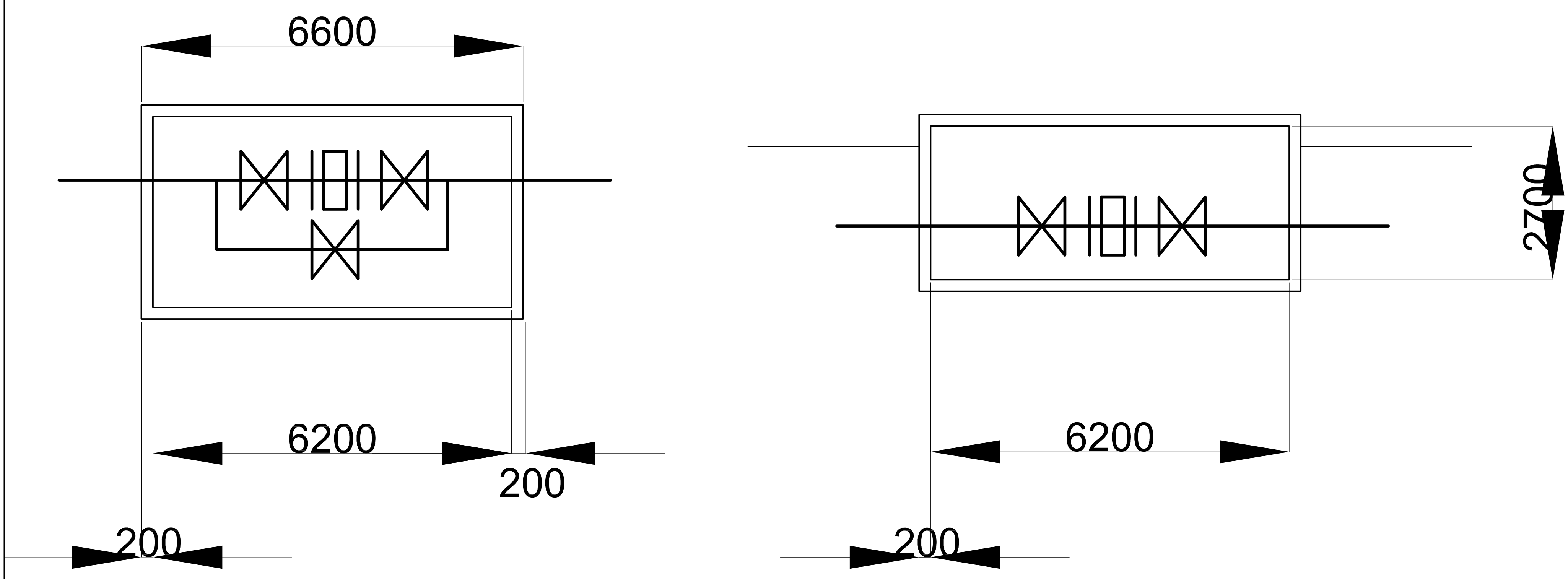


TRUSS PLAN

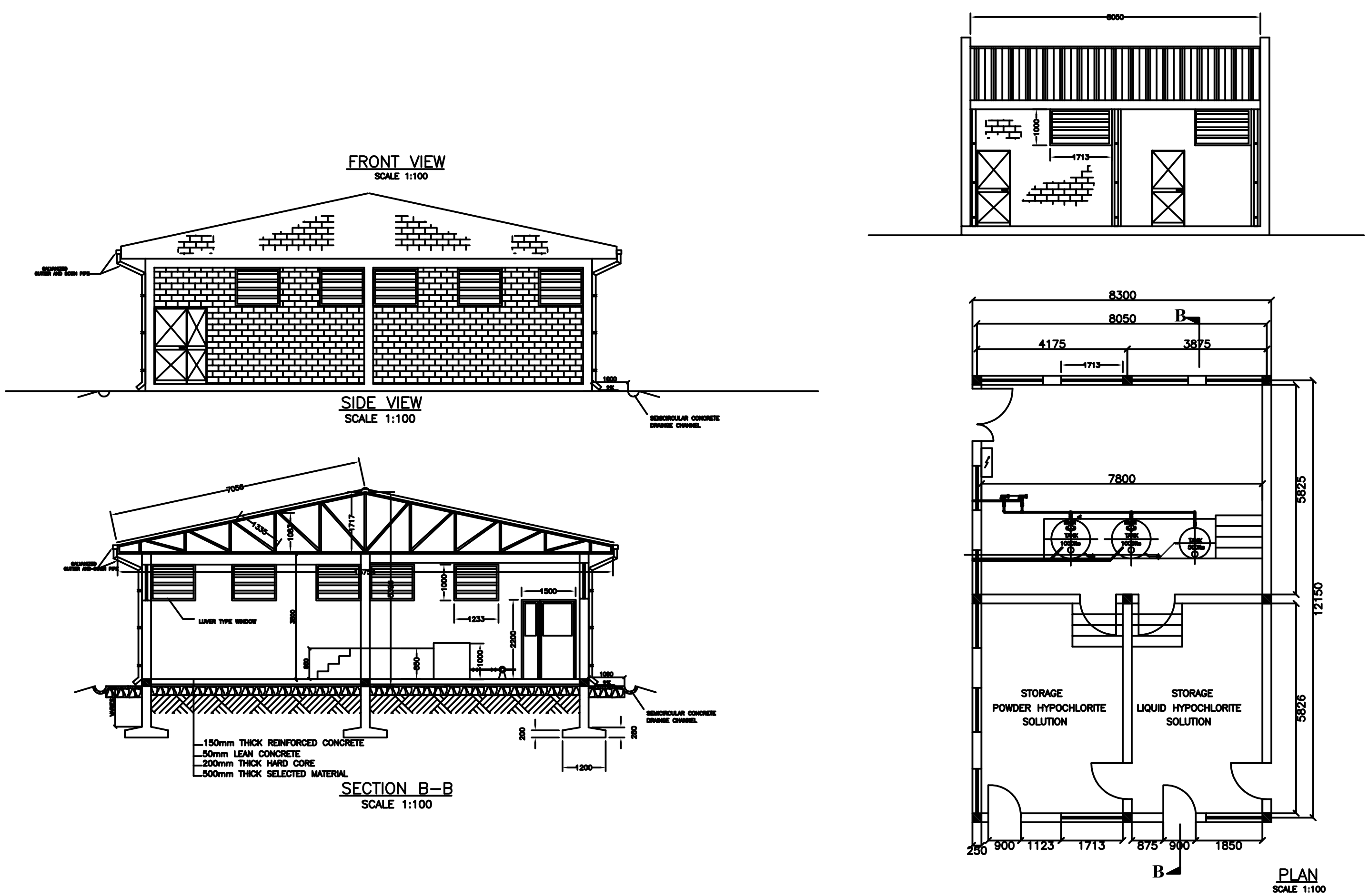
Project Name The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia		
Title Structural drawing of Generator Room		
Scale 1/100	Consultant JAT JAPAN TECHNO	Drawing No. 22



Project Name
The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia
Title
Structural drawing of Substation
Scale 1/100
Consultant JAPAN TECHNO
Drawing No. 23
PLAN
TRANSFORMER HOUSE
T1
T2
B1 CABLE DUCT B2
REMOVABLE METALIC FENCE
LOADING & UNLOADING PLATFORM
2000 x 2000 x 1500 mm CABLE MANHOLE
1000 x 1000 x 1500 mm STONED FILLED OIL PIT
DN100 ASBESTOS PIPE
8000
4000
250
1000
2000
3000
600
400
SECTION B–B
8420
7420
100 mm CONCRETE SLAB
50 mm LEAN CONCRETE
250 mm HARDCORE
300 mm SELECTED MATERIAL
COMPACTED SOIL
H.V. CABLE
1500
500
SECTION C–C
120 mm THICK R.C. SLAB
0.5% SLOPE
REMOVABLE METALIC FENCE
D=TO BE DETERMINED ON SITE
3420
4420
3000
800
200



Project Name	The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia	
Title	Structural drawing of Flowmeter Pit	
Scale 1/100	Consultant JAPAN TECHNO	Drawing No. 24



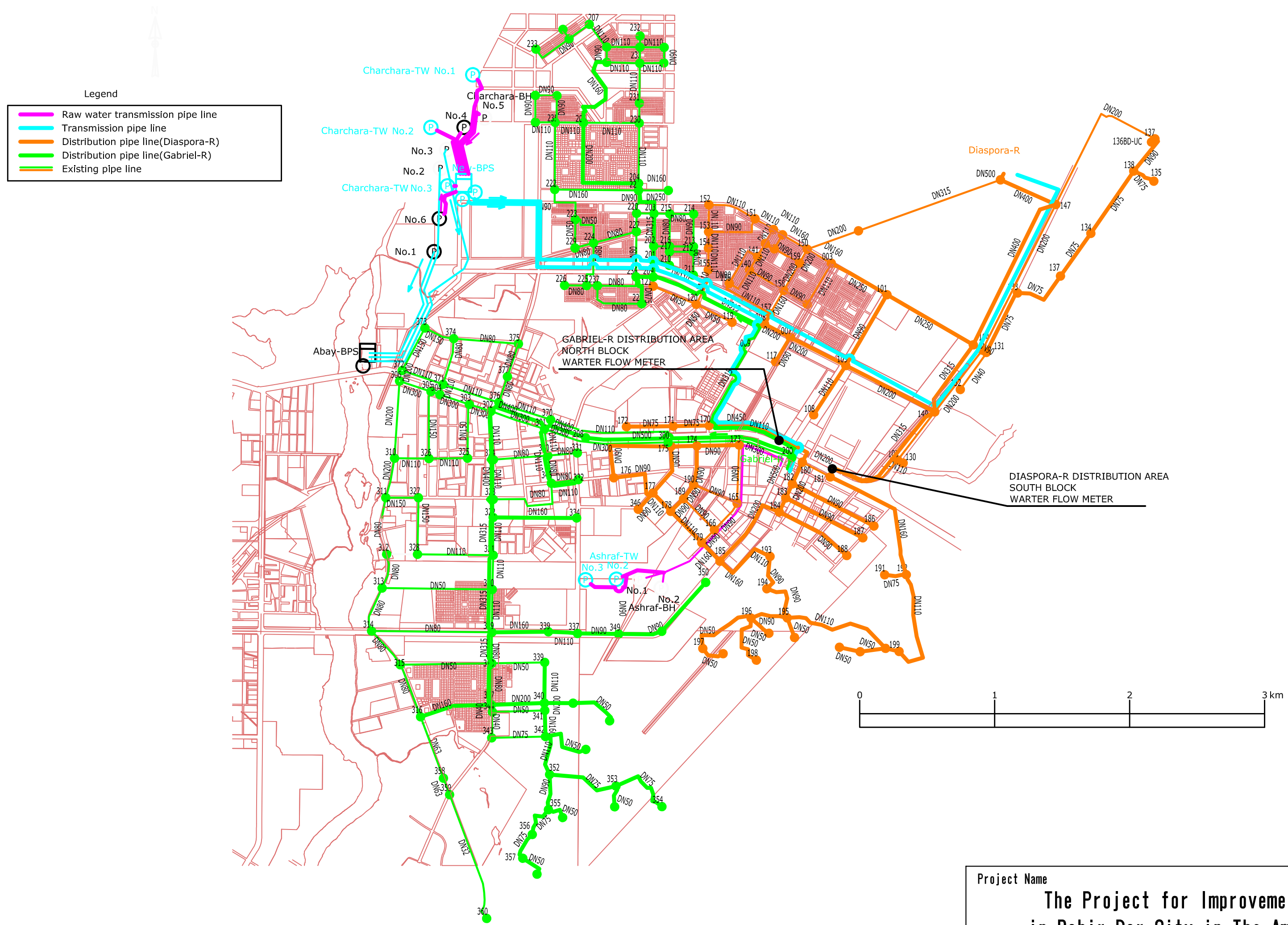
Project Name

The Project for Improvement of Water Supply
in Bahir Dar City in The Amhara Regional State
in The Federal Democratic Republic of Ethiopia

Title

Structural drawing of Chemical Plant

Scale	Consultant	Drawing No.
1/200	JAPAN TECHNO	25



Project Name

The Project for Improvement of Water Supply in Bahir Dar City in The Amhara Regional State in The Federal Democratic Republic of Ethiopia

Title

Layout drawing of Distribution Pipe Network

Scale	Consultant	Drawing No.
	JAT JAPAN TECHNO	26

APPENDIX-7 (2)　RESULTS OF PUMPING TEST OF EXISTING WELLS

(1)　Data of Pumping Test Conducted by Amhara Side

The existing data of pumping tests conducted by the Amhara side are summarized in Table 1.　No step drawdown test was conducted in any of these pumping tests, and only constant drawdown tests were carried out at the maximum rate of available pumps for 8 to 48 hours. The capacities of the existing well are estimated from these data except from Ashraf No.1 well as described below

Table-1　Data of Pumping Test of Existing Well

Well No.	Year of execution	Discharge rate (L/sec)	Pumping time (hours)	SWL (GL-m)	DWL (GL-m) / drawdown (m)
Charchara No.3	2011	40	12	2.70	3.09 / 0.39
	2015	32	24	2.85	3.70 / 0.85
Charchara No.4	2012	40	8	2.73	3.05 / 0.32
Charchara No.5	2014	57.5	24	1.40	24.74 / 23.34
Charchara No.6	2015	72	24	1.04	4.78 / 3.74
Ashraf No.1 *1	2009	18	48	40.85	48.05 / 7.20

*1 : pumping capacity determined from the results of pumping test carried out by the Survey Team

1)　Charchara No.3well

This well was drilled in 2008 and pumping test was carried out in 2011 and 2015 and according to the results of the pumping test carried out in August 2015, the drawdown was 85cm with a discharge rate of 32 L/sec and 24 hours of constant discharge. As a result of recovery test, the water level recovered 100% within 1 minute. The pumping test data of nearby wells are shown as follows,

Table-2　Data of Recovery Test of Existing Wells

Well No.	Actual discharge (L/sec)	Drawdown (m)	Optimum yield (L/sec)
Charchara No2	9.9	0.32	8.4
Charchara No.4	31.3	0.11	40.0
Charchara No.5	57.5	23.34	41.0
	(35.0) *1	(4.50)	41.0
Charchara No.6	75.0	3.74	52.50
	(65.0) *1	(3.23)	52.50

*1 : figures in brackets were measured at the time of interference tests

In Charchara No. 3 well, no significant change in dynamic water level was observed from the actual discharge rate measurement result and comparing with the pumping test of 2015 with discharge rate of 32 L/sec and drawdown of 85 cm, it can be considered that 32 L / sec can be regarded as the optimal yield for this well.

2) Charchara No.4 well

Charchara well was drilled in March 2013 and according to the record of the pumping test carried out by AWWCE, it was pumped with a constant discharge of 40 L/sec for eight hours with a relatively small drawdown of 32cm and in the recovery test, the water level recovered 100% within 1.5 minutes. Considering that the drawdown of Charchara No.3 well was 85cm with discharge rate of 32 L/sec and the drawdown of Charchara No.5 well was 4.51m with discharge rate of 35 L/sec, it is concluded that it is appropriate to consider the actual discharge rate of 31.3 L/sec as a optimum yield of Charchara No.4 well.

3) Charchara No.5well

In Charchara No.5 well, a pumping test was carried out in 2014 for 24 hours with a constant discharge rate of 57.5 L/sec and the drawdown was 23.43m, reaching to the equilibrium. Comparing with other neighboring wells, the drawdown amount is too big so that it can be considered as a critical yield. Thus, the optimum yield could be determined to be 40 L/sec.

4) Charchara No.6 well

In Charchara No.6 well, a pumping test was carried in 2015 for 24 hours with a constant discharge rate of 75 L/sec and the drawdown was 3.74m, reaching to the equilibrium.

Results of pumping test of newly drilled test well carried out in Charchara aquifer are shown below.

Table-3 Pumping Test Data in Charchara Aquifer

Well No.	Critical yield (L/sec)	Drawdown (m)	Optimum yield (L/sec)
Charchara TW No.1	93.0	1.28	65.1
Charchara TW No.2	85.0	4.29	59.5
Charchara TW No.3	91.0	4.98	63.7

Comparing the values of discharge rates above with the discharge rate of 75 L/sec of Charchara No.6, it is appropriated to consider this discharge rate as the critical yield and the optimum yield as $75 \times 0.7 = 52.5$ L/sec.

(2) Result of the Pumping Test of Charchara No.1 well

1) Preparation

The measured depth of the well was GL- 45 m (no available drilling record). The 11 kw pump was installed at the depth of GL- 24.7 m, and 3 inch riser pipes were set. The static water level was GL- 1.02 m before starting the provisional test. The provisional test was conducted at the pumping rate of 12.0 L/s when the valve was fully open.

2) Step Drawdown Test

The step drawdown test was conducted by 5 steps at the pumping rates of 8, 9, 10, 11 and 12 L/sec and pumped for 2 hours at each step. Figure-1 shows the Drawdown – Time graph at 5 steps and Figure-2 shows Discharges – Drawdown logarithmic graph.

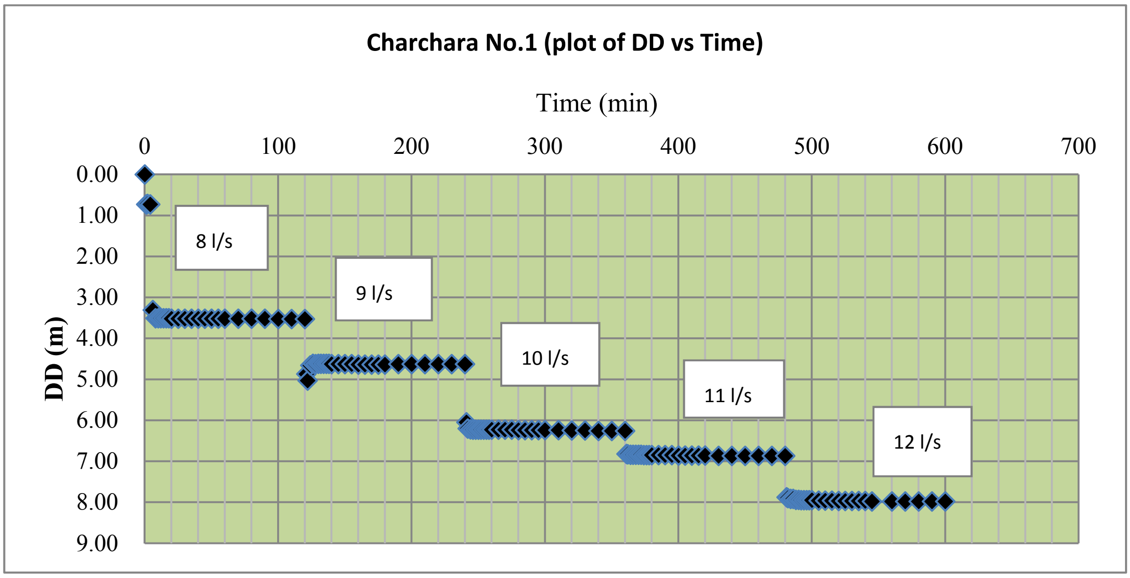
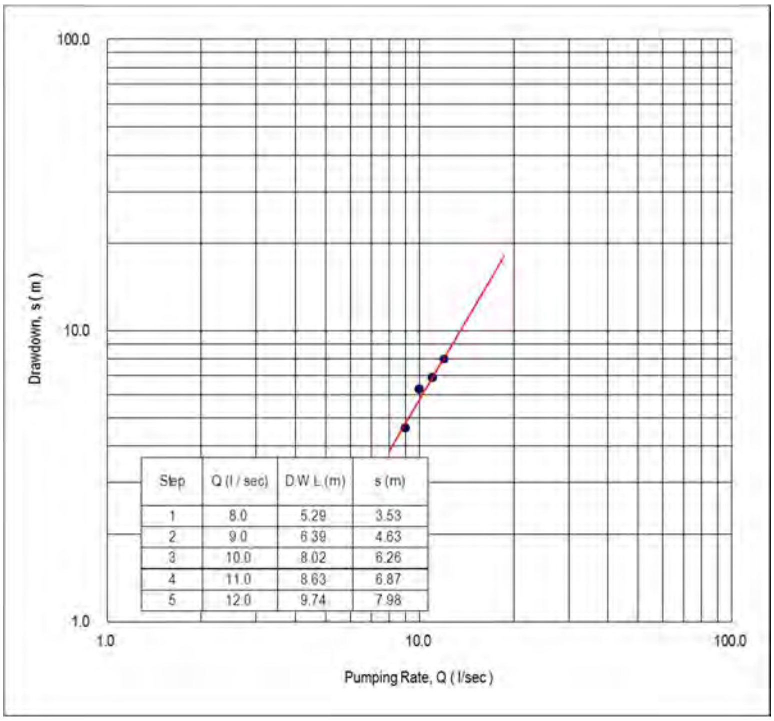


Figure-1 Result of Step Drawdown Test



Step	Q (l / sec)	D.W.L (m)	s (m)
1	8.0	5.29	3.53
2	9.0	6.39	4.63
3	10.0	8.02	6.26
4	11.0	8.63	6.87
5	12.0	9.74	7.98

Figure-2　Discharge－Drawdown logarithmic graph

As it is indicated in the Figure-2, the critical yield would be recognized to be higher than 12.0 L/sec. However there is no available bigger capacity pump in the site, so that 12.0 L/sec could be regarded to be the critical yield. Thus 70 % of the maximum yield, i.e. 8.7 L/sec was determined to be the optimal yield. Very large amount of well loss was assumed from the result of the step drawdown test.

3) Constant Discharge Test

The constant discharge test was conducted for 24 hours with the discharge rate of 12.0 L/sec. The result is shown in Figure-3. The maximum drawdown was 8.23 m.

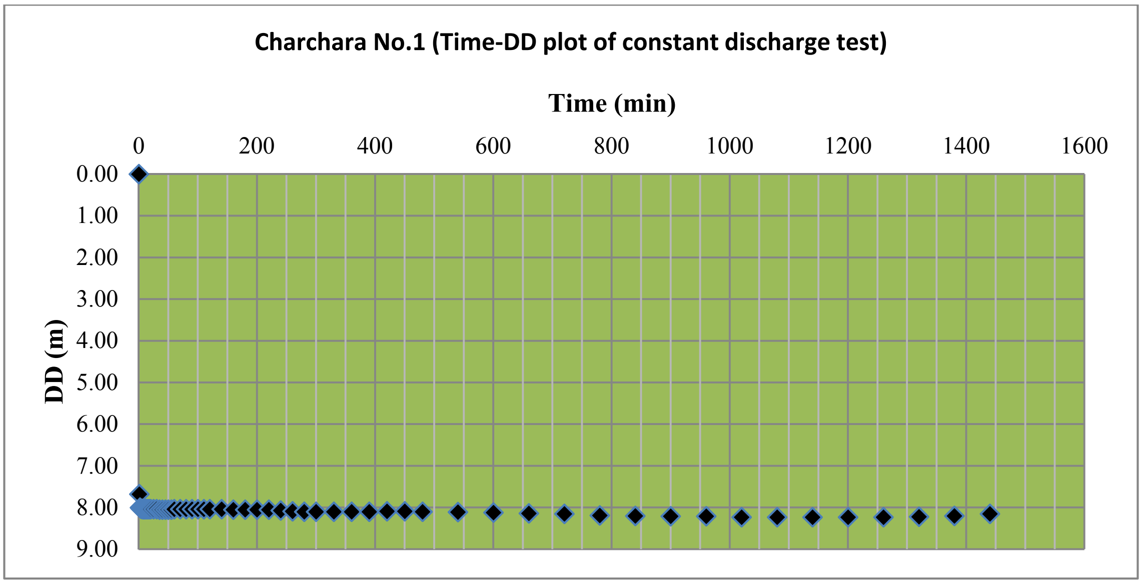


Figure-3 Result of Constant Discharge Test

The water level became almost in equilibrium 4 hours after starting the constant discharge test, but the water level lowered at most 18 cm. This might be assumed that as the depression cone of Charchara No.1 well was expanding, it reached to the edge of the depression cone of Charchara No.2, No.3 and No.4 wells successively and due to the interferences with these wells amount of drawdown became slightly bigger.

4) Recovery Test

After the constant discharge test, the recovery of the water level was very fast, and in 6 minutes time 100 % was recovered.

5) Accuracy Test of water Meter

The accuracy test of the water meter installed at the Charchara No.1 well was carried out using the V notch. When the water meter reading was 14.5 L/sec, the V notch indicated 12.0 L/sec. Assuming that the V notch indicates the correct figure, the accuracy of the water meter becomes 12.0 / 14.5 = 0.827 ≈ 0.83. According to the actual discharge measurement carried out for a period of 15 day, the average discharge rate was 8.5 L/sec, so that the actual discharge becomes as 8.50 × 0.83 = 7.05 ≈ 7.1 L/sec.

(3) Result of the Pumping Test of Charchara No.2 well

1) Preparation

Although the depth of the well was 51m by verbal information, the measured depth was 47.8 m (drilling report not available). The depth of the well could become shallower by siltation, as it is indicated that the surface of riser pipes retrieved from the lower portion of the well were covered with thin crust of silt.

In the well 22 kw pump was installed at the depth of GL- 43.1 m, but in the control box the three phased 340 voltage electricity lines were connected erroneously to the reverse position and the pumping rate was 3.3 L/s. After connect correctly the electricity lines the pumping rate increase to 12.0 L/sec.

The pumping test was carried out using the same production pump, and installed it at the depth of 37.1 m. The static water level before the provisional test was GL- 2.40 m. In the provisional test the amount of drawdown after 1 hour was GL- 10.22m at the pumping rate of 12.0 L/s with fully opened valve. 40 minutes after the commencement of the provisional test at Charchara No.2 well, the dynamic water level of Charchara No.3 well lowered from GL- 4.28 to 4.31 m, which might indicate that as the depression cone of Charchara No.2 was expanding, it reached to the edge of that of Charchara No.3 and due to the interference dynamic water level of Charchara No.3 was lowered by 3 cm

2) Step Drawdown Test

The step drawdown test was carried out at the discharge rates of 10.0, 10.5, 11.0, 11.5 and 12.0 L/s. Drawdown – Time graph is shown in Figure-4 and Discharge – Drawdown logarithmic graph is shown in Figure-5.

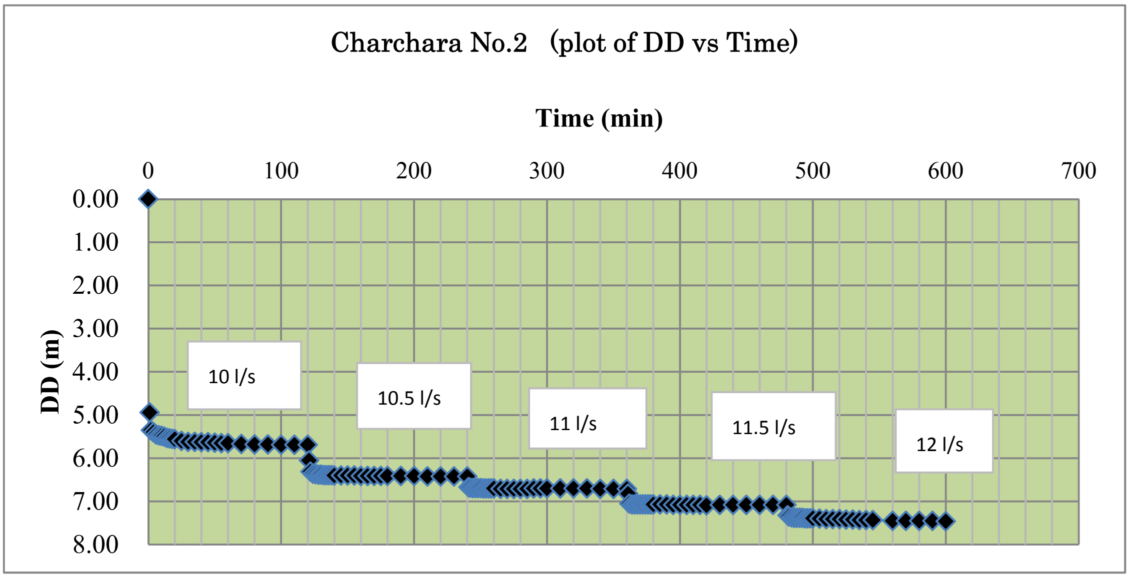


Figure-4 Result of Step Drawdown Test

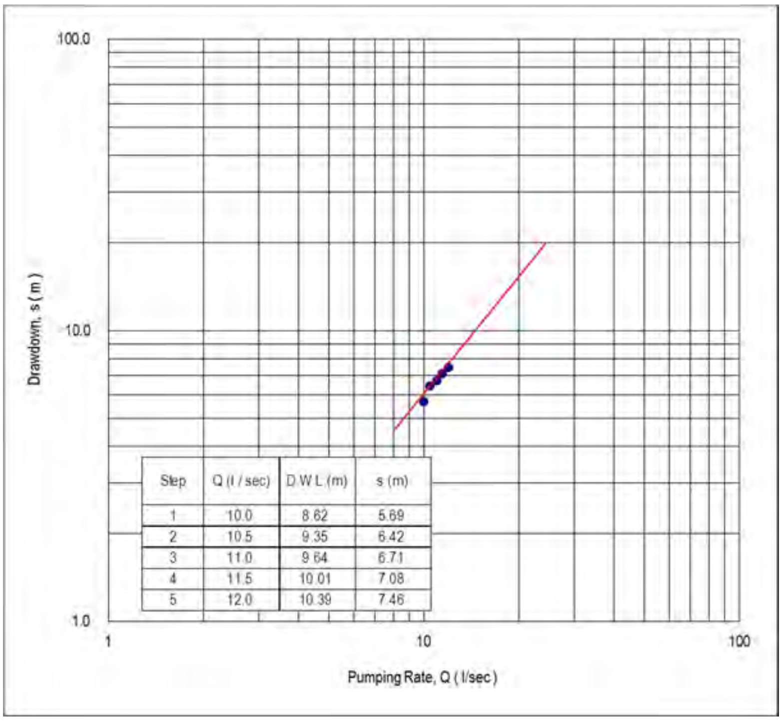


Figure-5. Discharge－Drawdown logarithmic graph

As shown in the Figure-5, the critical yield might be higher than 12.0 L/sec, however due to the no availability of bigger capacity pump in the site, so that 12.0 L/sec could be regarded as the critical yield. Thus 70 % of the maximum yield, i.e. 12.0 x 0.7 = 8.4 L/sec was determined to be the optimum yield.

3) Constant Discharge Test

The constant discharge test was carried out at the pumping rate of 12.0 L/sec for 24 hours (Figure-6).

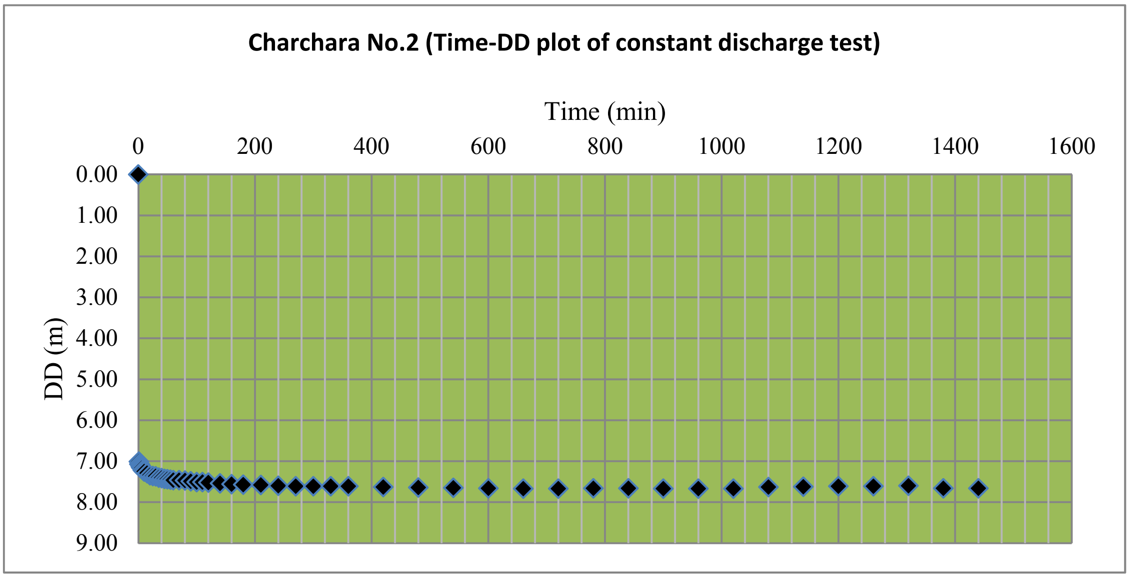


Figure-6. Result of Constant Discharge Test

The operation of Charchara No.3 well stopped 17 hours after the commencement of the constant discharge test due to the power outage and the dynamic water level of Charchara No.2 well rose immediately 4cm and increased to 7cm in 22 hours. After 23 hours, when the operation of Charchara No.3 well resumed, the water level of Charchara No.2 immediately decreased 6cm. This fluctuation of the water level of about 6 to 7cm seems to be the influence of interference with Charchara No. 3 well.

4) Recovery Test

The recovery was rather quick, recovering 99.5% in20 minutes.

5) Accuracy of water Meter

The accuracy of water meter installed in Charchara No.2 well was tested using the V notch. When the reading of the water meter was 14.28 L/sec, V notch indicated a discharge of 12.0 L/sec. Assuming that the figure indicated by the V notch is correct, the accuracy of water meter becomes as 12.0/14.28 = 0.84. According to the actual discharge measurement carried out for a period of 15 day, the average discharge rate was 11.80 L/sec, so that the actual discharge becomes as 11.80×0.84 ≈ 9.9 L/sec.

6) Well Capacity Improvement of Charchara No.2 well after the Pumping Test

It was clearly recognized that the capacity of the Charchara No.2 well rose significantly after the implementation of pumping test. During the constant discharge test, the drawdown was 7.67 m at the pumping rate of 12.0 L/sec (1,037 m^3/day), being the specific capacity of 135 m^3/day/m. While after finished the pumping test and the usual operation of the well resumed, the amount of drawdown was 0.32 m at the pumping rate of 9.9 L/sec (855m^3/day), thus the specific capacity improved to 2.673 m^3/day/m.

The possible reasons for the improvement of the capacity of the well after the pumping test is presumed to be as follows,

- Pump position was raised by 6 m, so that the well loss was reduced
- Clogged screen was cleaned by pumping a large amount of water during the test
- Hydrogeological condition around the well was improved by pumping a large amount of water during the test

(4) Result of Pumping Test of Ashraf No.1 well

1) Preparation

The depth of Ashraf No.1 well, according to the drilling report was 123m but the depth measured before of pumping test was 111m and the depth shallowed 12m. As described later, it is presumed that due to the casing being broken, the gravel of gravel packing and fragments of rock around the well entered into the well and it was buried.

An 11kw pump was installed at the depth of G.L.-85.5m and the static water level before the provisional test was G.L.-39.54m. During the provisional pumping test with the discharge rate of 8.9 L/sec, the drawdown was about 30m. And it was decided to carry out the step drawdown test with 5 steps and discharge rates of 4, 5, 6, 7 and 8.9 L/sec.

During the provisional test, dynamic water level of Ashraf No.1 was lowered by 20 cm when the Ashraf No.2 started operation. It is regarded to be the influence of the interference by the operation of the Ashraf No.2 well.

2) Result of the Step Drawdown Test

The result of the step drawdown test is shown in Figure-7 and the Discharge - Drawdown logarithmic graph is shown in Figure-8.

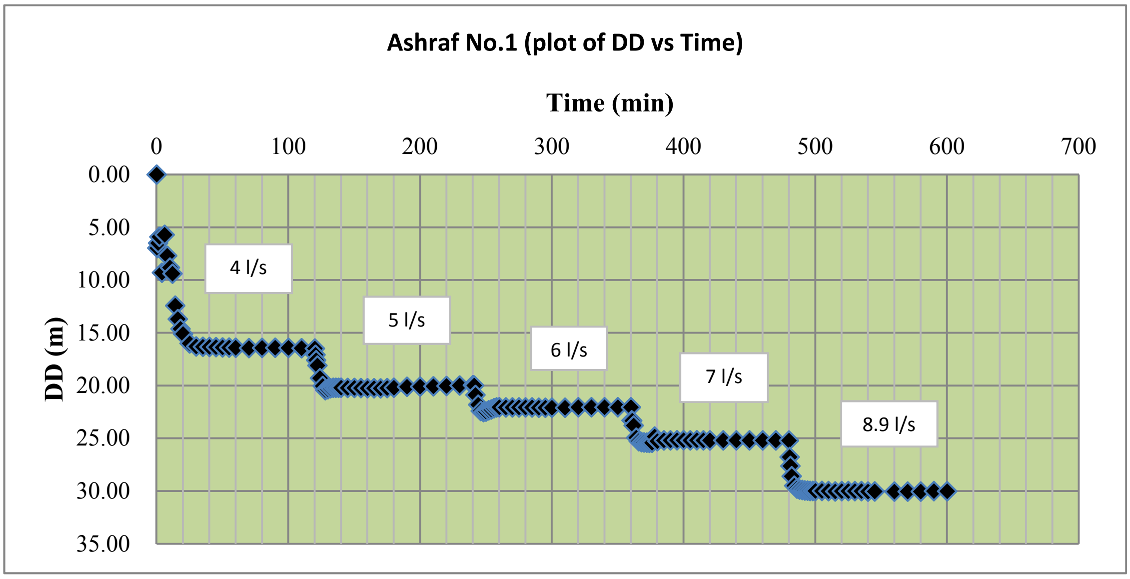
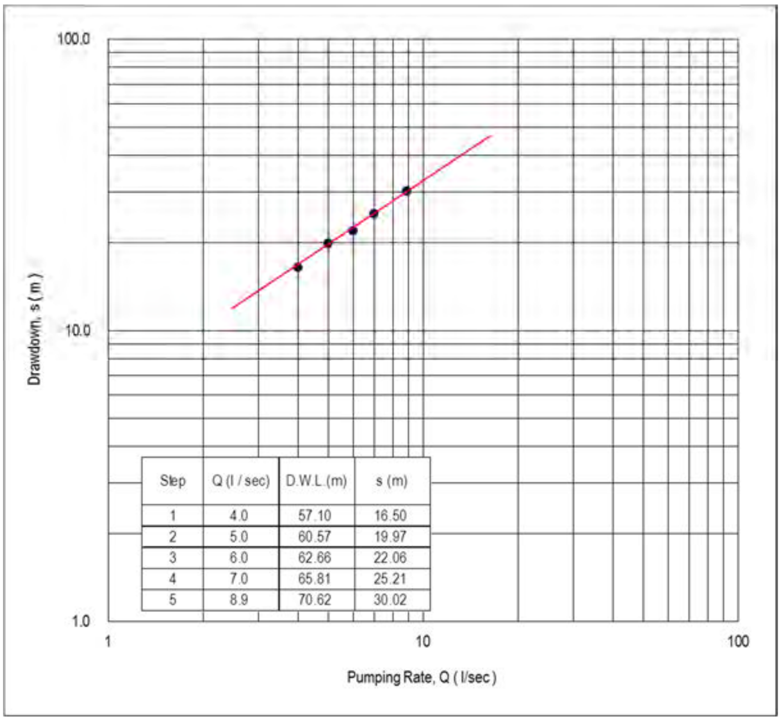


Figure-7. Result of Step Drawdown Test



Step	Q (l / sec)	D.W.L (m)	s (m)
1	4.0	57.10	16.50
2	5.0	60.57	19.97
3	6.0	62.66	22.06
4	7.0	65.81	25.21
5	8.9	70.62	30.02

Figure-8. Discharge – Drawdown logarithmic graph

As shown in Figure-8, the critical yield is regarded to be higher than 8.9 L/sec. However due to the no availability of bigger capacity pump in the site, so that 8.9 L/sec could be regarded as a critical yield. Thus, the optimum yield would be determined as 8.9 x 0.7 = 6.2 L/sec.

3) Abstention of Constant Discharge Test due to Damaged Casing

In Ashraf No.1 well, after the execution of the step drawdown test, it was observed that it has not reached the critical yield so it was decided to set a bigger capacity pump instead. During the substitution works of the pump, it was found that the casing is moving and also that a considerable quantity of backfilled gravel and fragments of rock were rolled up together with water in the V notch meaning that the PVC casing of the well is damaged and the gravel and rock fragments entered to the well from the damaged part and deposited at the bottom of the well for about 12m. Due to such circumstance, it was decided to not carry out further step drawdown and constant discharge tests in the well in order to prevent further damage to the well and pump.

(5) Result of Pumping Test of Ashraf No.2 well

1) Preparation

The measured depth of the well was 105m (no drilling report available) and the static water level before provisional pumping test was G.L.-41.79m. 55kw pump was installed at the depth of G.L.-84.2m. The provisional test indicated the drawdown was 11.66m at discharge rate of 29.0 L/sec after 2 hours. The step drawdown was decide to be carried out with 5steps with discharge rates of 20.0, 22.6, 26.3 and 29.0 L/sec each step.

2) Step drawdown Test

Figure-9 shows the result of the step drawdown test and Figure-10 Discharge – Drawdown logarithmic graph.

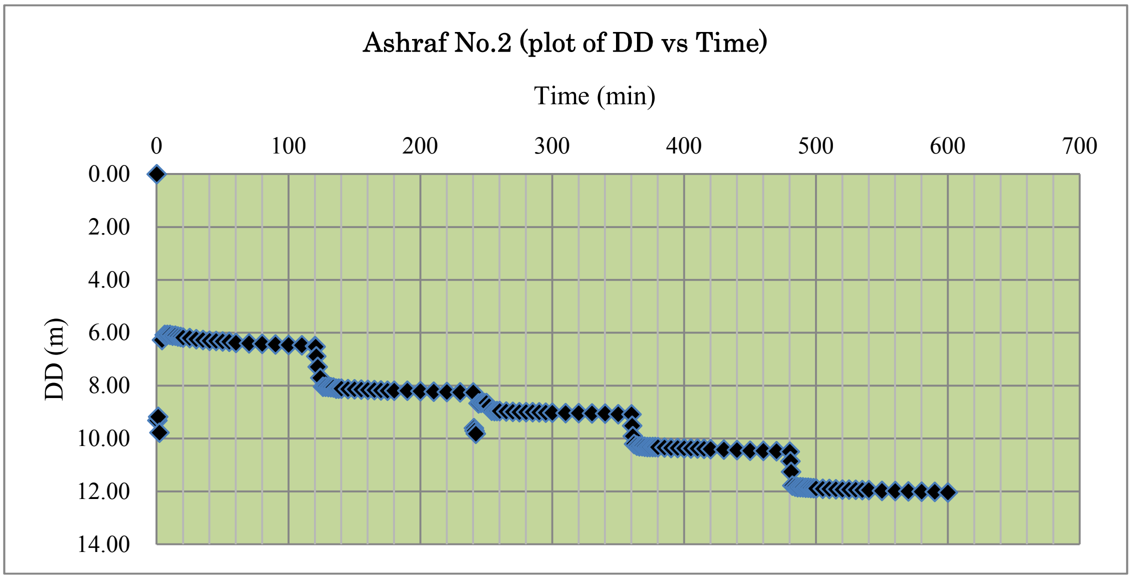
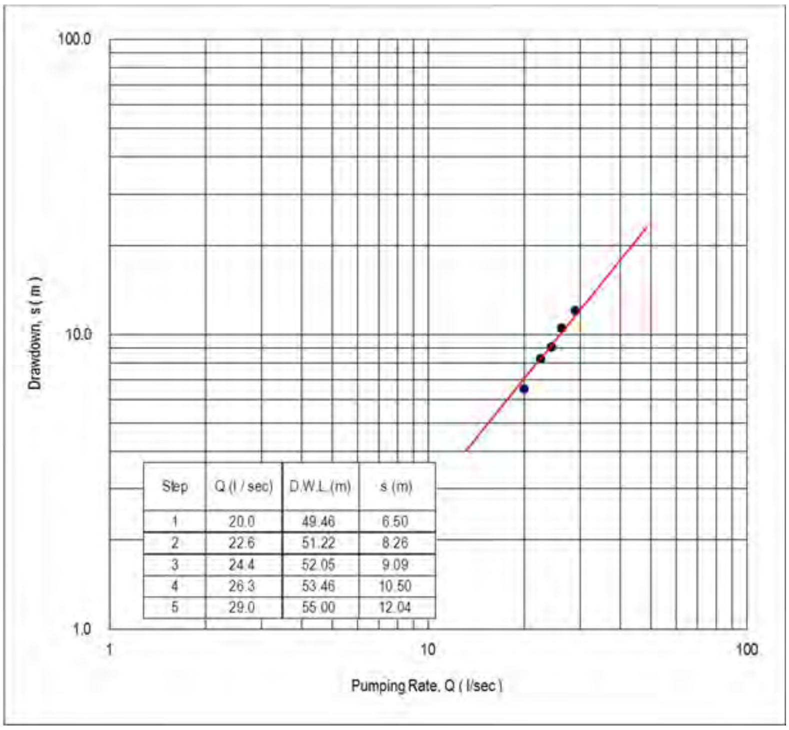


Figure-9 Result of Step Drawdown Test



Step	Q (l / sec)	D.W.L.(m)	s (m)
1	20.0	49.46	6.50
2	22.6	51.22	8.26
3	24.4	52.05	9.09
4	26.3	53.46	10.50
5	29.0	55.00	12.04

Figure-10. Discharge – Drawdown logarithmic graph

As shown in Figure-10, the critical yield is regarded to be higher than 29.0 L/sec. However due to the no availability of bigger capacity pump in the site, so that 29.0 L/sec could be regarded as a critical yield. Thus, the optimum yield would be determined as 29.0 x 0.7 = 20.3 L/sec.

3) Result of the Constant Discharge Test

The constant discharge test was carried out with discharge rate of 29 L/sec for a period of 27 hours. The result is shown in Figure-11.

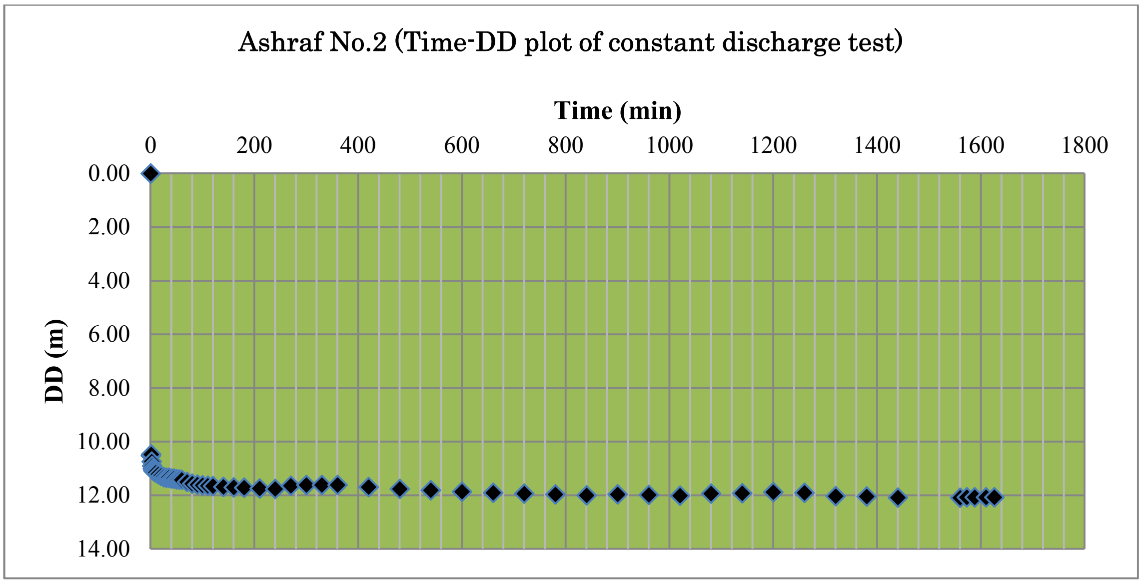


Figure-11. Result of the Constant Discharge Test

As a result of the test, it was confirmed that the drawdown was 11.90m and attained to the equilibrium after 21 hours of pumping. When Ashraf No.1 started operation after 21 hour's pumping, the dynamic water level lowered by 13cm immediately, and 3 hours later it still lowered by 17cm getting to be at the equilibrium. This 17cm lowering could be considered as interference caused by Ashraf No.1 well.

4) Accuracy of the water Meter

Accuracy test of water meter was conducted comparing the reading of water meter with that of V notch. When water meter indicated 22.22 L/s, V notch was indicating 22.30 L/s. Thus the water meter installed at the Ashraf No.2 well indicates almost correct figure.

APPENDIX-7 (3)　GEOLOGY AND HYDROGEOLOGY OF THE SURVEY TARGET AREA

The geological map of Bahir Dar city and its surrounding area is shown in Figure-1.

In the geological map, Qv1, Qv2 and Qv3 represent Quaternary volcanic rocks consisted of basaltic lava, scoria and pyroclastic rocks. The Qv1 is the oldest and become younger in order of Qv2 and Qv3.

Qv1 is consisted with massive, hard basalt with low porosity and relatively well developed joints (Photo-4). On the other hand, Qv2 and Qv3 are consisted of very porous vesicular basalts and scoria or basaltic pyroclastic rocks which are supposed to form good aquifers (Photo-1).

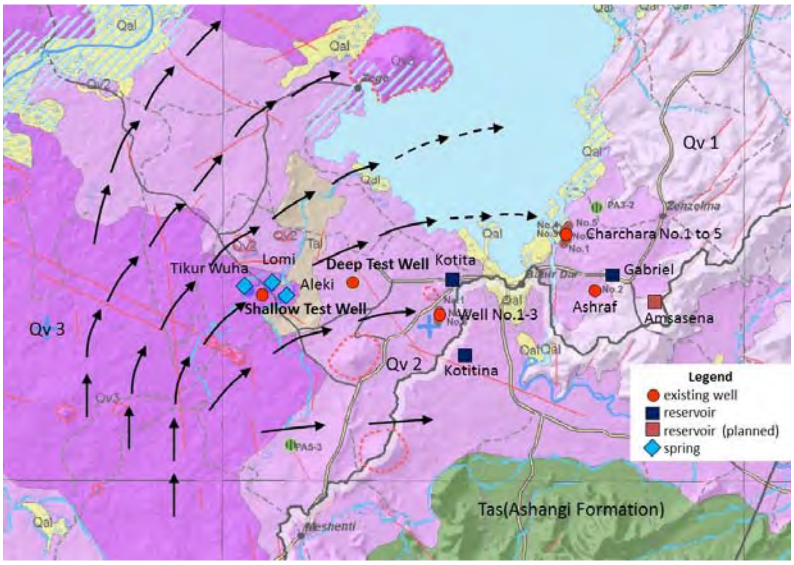


Figure-1.　Geological map of Bahir Dar city and its surrounding area. The arrows show the approximate flow direction of the Quaternary basaltic lavas (Qv1, Qv2, and Qv3). It is also assumed that the groundwater within the aquifer of the Quaternary lava formations (Qv1, Qv2, and Qv3) flows approximately same direction of the arrows underneath the bottom of Lake Tana. Red circles show existing wells (production and observation). Source: Revised after Detailed Abay Basin Groundwater Investigation Study, 2013 (MoWIE)。

It is said that Qv2 lavas flowed in the direction of the arrows shown in Fig.-6 and intercepted Abay River and thus formed the Lake Tana as a result (Abay Basin Master Plan Study, 2009). Aleke, Lomi and Tikur Wuha springs gush out from the edge of the Qv3 lava formations and are the main water source of Bahir Dar city water supply system. Three existing boreholes located in the vicinity of the Industrial Park (Gudobahir No.1, No. 2, No.3) and two private boreholes located at Amhara Pipe Factory and Agro-Stone Production enterprise are presumed to be abstracted from the aquifers in the Qv2 lava formations.

(1)　Charchara Area

As shown in Figure 2, Qv2-A lava flow layer flows across Abay River from the western side of the survey target area and it has been found that this lava flow forms a good aquifer. It has been confirmed from the past drilling data that there are mainly two aquifers and it is presumed that those aquifers are recharged from the western side of the Abay River passing through underneath the bottom of Tana Lake.

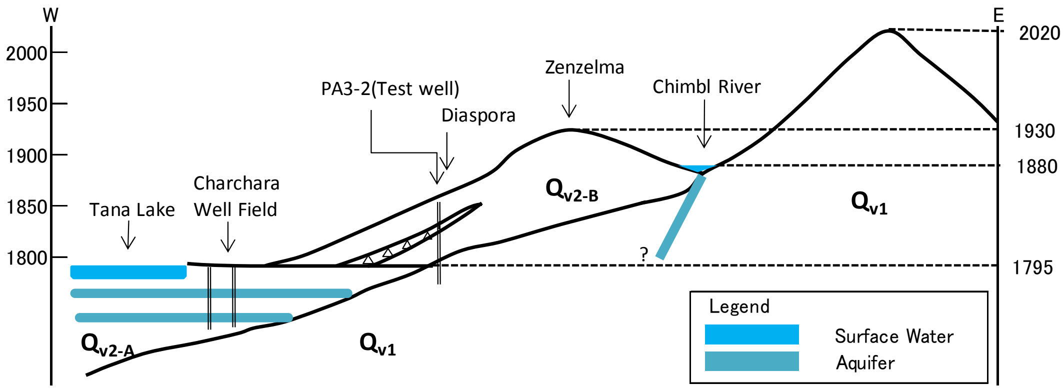


Figure-2. Schematic hydrogeological profile of Charchara area

(2) Ashraf Area

In Ashraf area, same as in Charchara area, it was supposed that this area is recharged from the western side of the Abay River passing through underneath the bottom of the river. It was presumed from the results of geophysical survey and test well drilling that Ashraf aquifer is formed by Qv2-A lava that flowed to Ashraf area from western side along the valley excavated in Qv1 lava formation. The Qv2-B lava flow flowed over the Ashraf aquifer from the eastern side and covered the aquifer (see Figure-3).

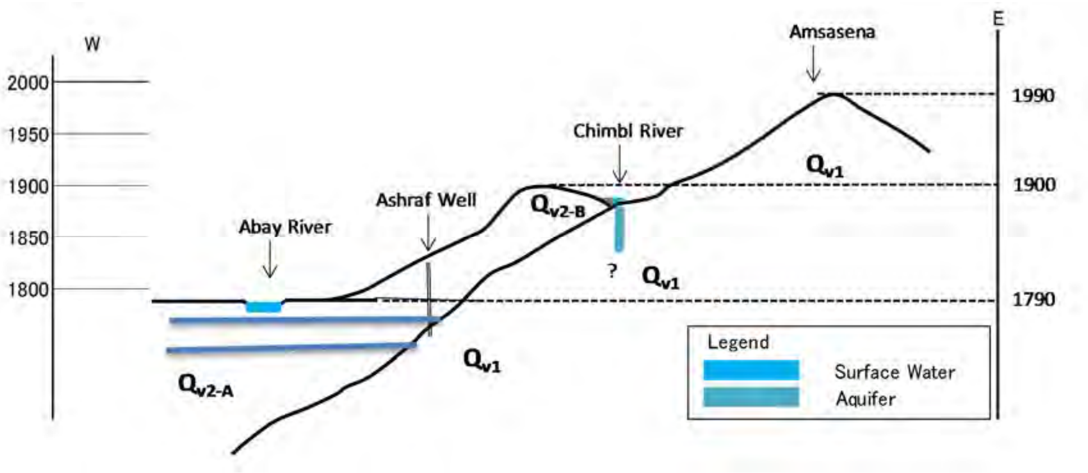


Figure-3. Schematic hydrogeological profile of Ashraf area

It is understood that Ashraf aquifer is recharged from the western area, same as Charchara aquifer, however, the static water level of Ashraf aquifer is about 6m lower than Charchara aquifer. And from the results of pumping test; it has been found that the water temperature of Ashraf aquifer is two degrees Celsius higher and the value of nitrate nitrogen is lower than those of Charchara aquifer. From these facts, the Ashraf aquifer, similarly to Charchara aquifer is an aquifer of Qv2-A lava flow formation and it is considered that the Ashraf aquifer would be the aquifer located below the Charchara aquifer.

(3) Chimbl Area

A massive Qv2-B lava formation with little pores is distributed in the vicinity of Chimbl River and its surface is covered with weathered reddish soil, so that the most of rain does not infiltrate to underground, running off from the surface. However, the existence of a fault (see photo in the right) is assumed along the Chimbl River flowing northeast to southwest direction and since it is supposed that the groundwater is recharged by infiltrating the fractured zone of the said fault, it was decided to confirm the existence of this fault by carrying out a geophysical survey.

Photo-7 Small fault along Chimbl River (gap: 2m)

		
Photo-1Vesicular basalt of Qv2-A. It is very porous and expected to be highly permeable and to form a good aquifer.	Photo-2 Basaltic lava formation of Qv2-B crops out at immediately down the stream of the Charchara Weir, at the right bank of Abay river.	Photo-3 Basalt lava formation of Qv2-B crops out on the river bed, in the upstream area of Chimbl River. A fault is assumed running along the Chimbl river valley.
		
Photo-4 Basalt lava formation of Qv1 crops out in the foothills of Wereb Michel. It is massive basalt, with little pores and partly well developed joints.	Photo-5 Volcanic mudflow deposit at the gully bottom in the western part of the Diaspora Area.	Photo-6 The site of dry test well (PA3-2). The test well was drilled in 2013 and backfilled at the northern edge of Diaspora Area. The volcanic mud flow deposit covers the surface portion of the area.

APPENDIX-7 (4)　GEOPHYSICAL SURVEY

(1)　Survey Method and Specification

The specification of the survey is as follow.

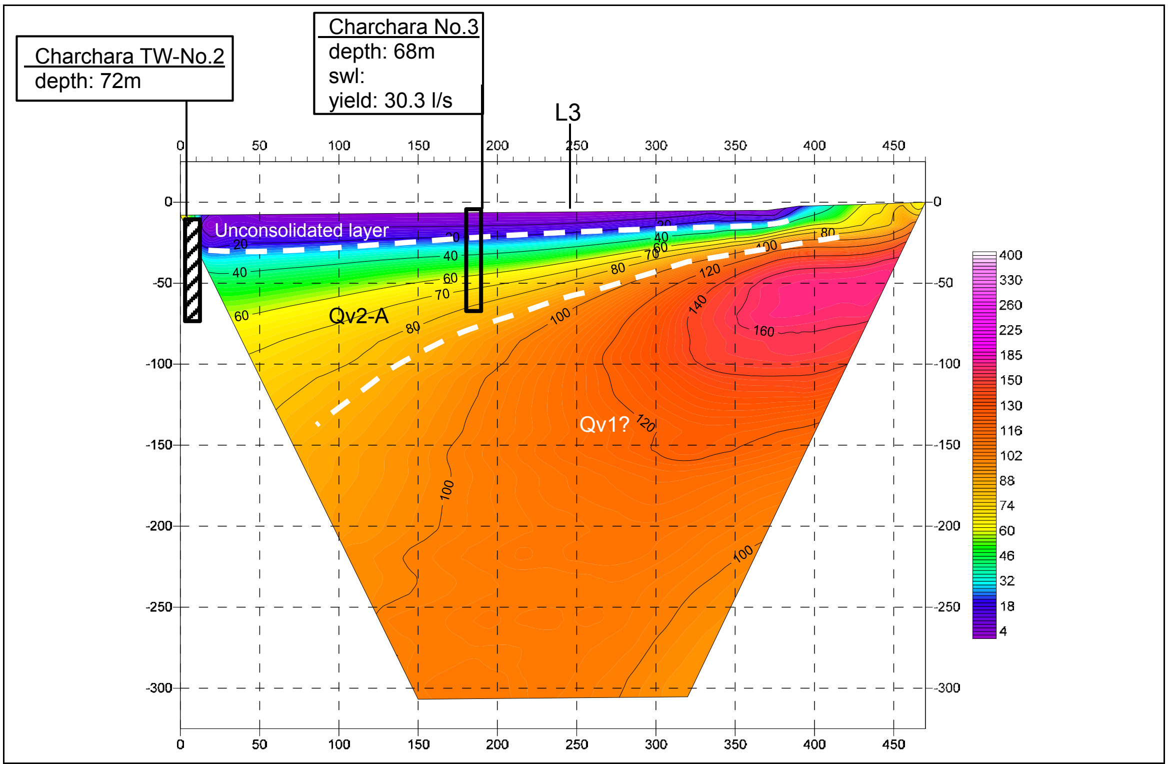
- Survey method : 2D electrical resistivity survey
- Electrode array : Pole-Pole electrode array
- Electrode spacing : 10m
- Survey depth : 300m
- Survey line length : max.1,110m
- Number of survey lines : 30 lines
- Equipment used : McOHM Profiler 4、Power Booster (OYO)
- Analysis software : ElecImager

(2)　Method of Analysis

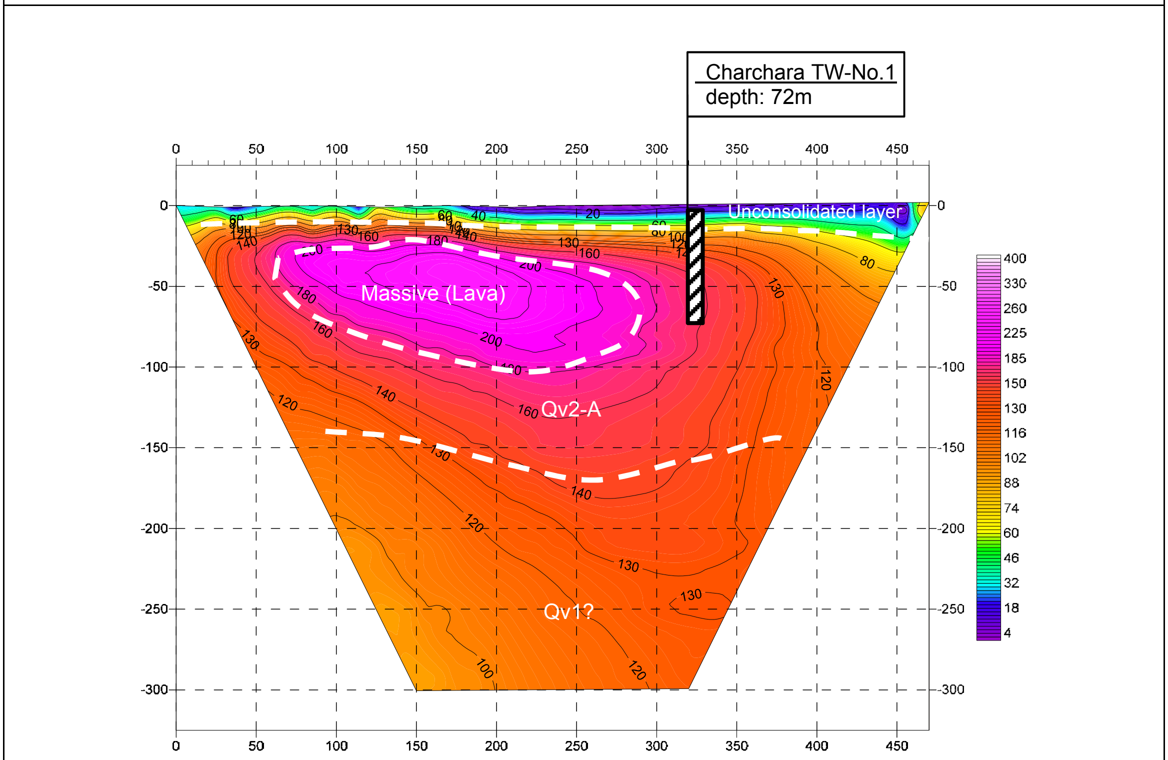
The finite element method was applied using software for the 2D electrical resistivity survey analysis.

(3)　Analysis Result

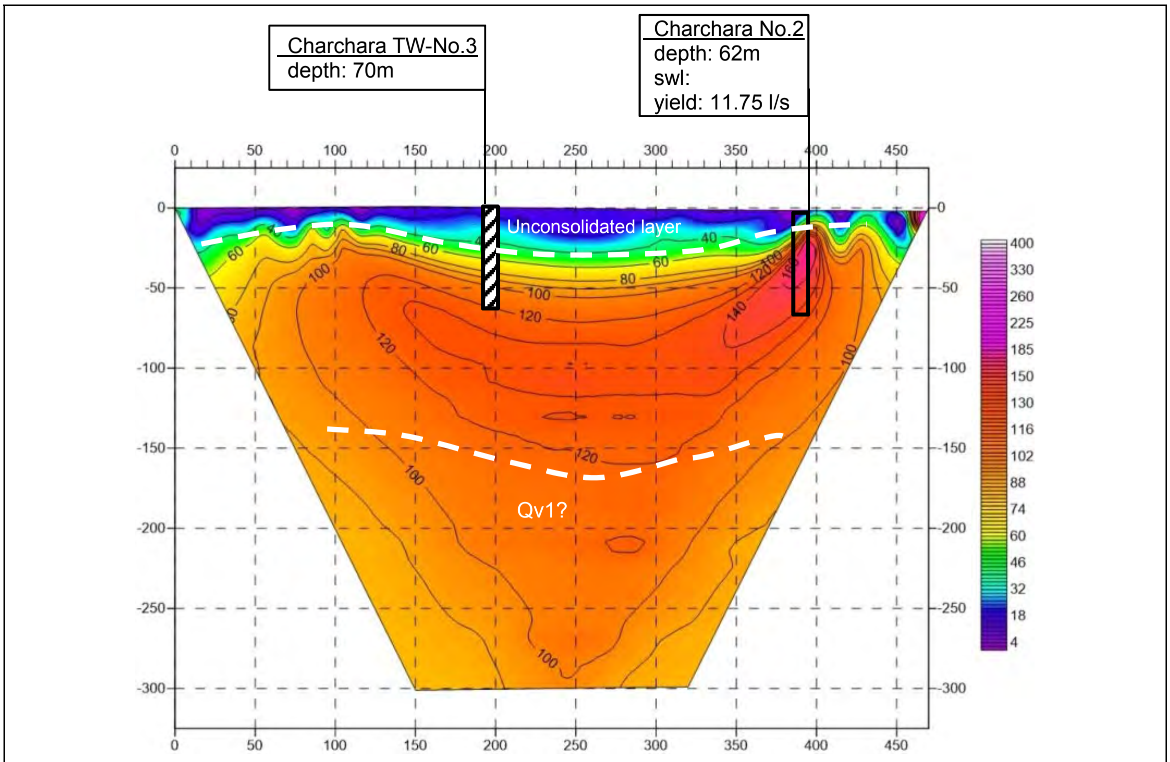
The result of the electrical resistivity survey are shown below.



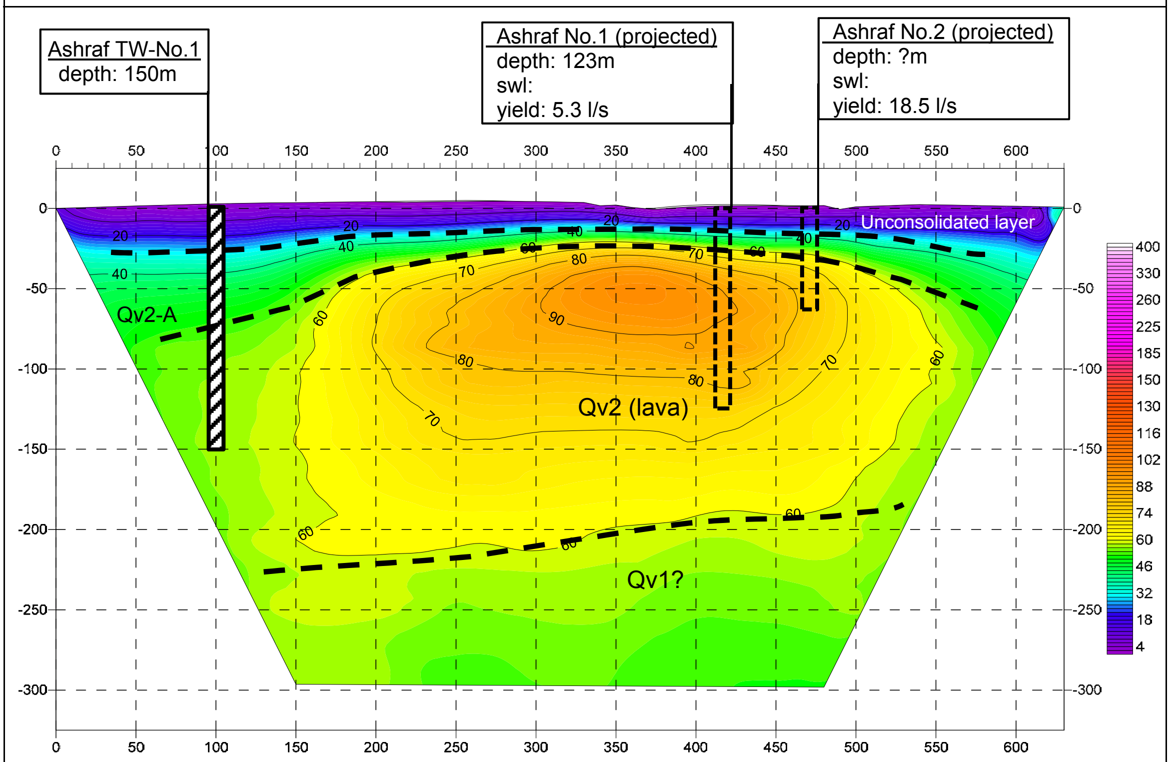
CH-L01 Line (L=470m)
Charchara TW-No.2 (depth=72m / productive)



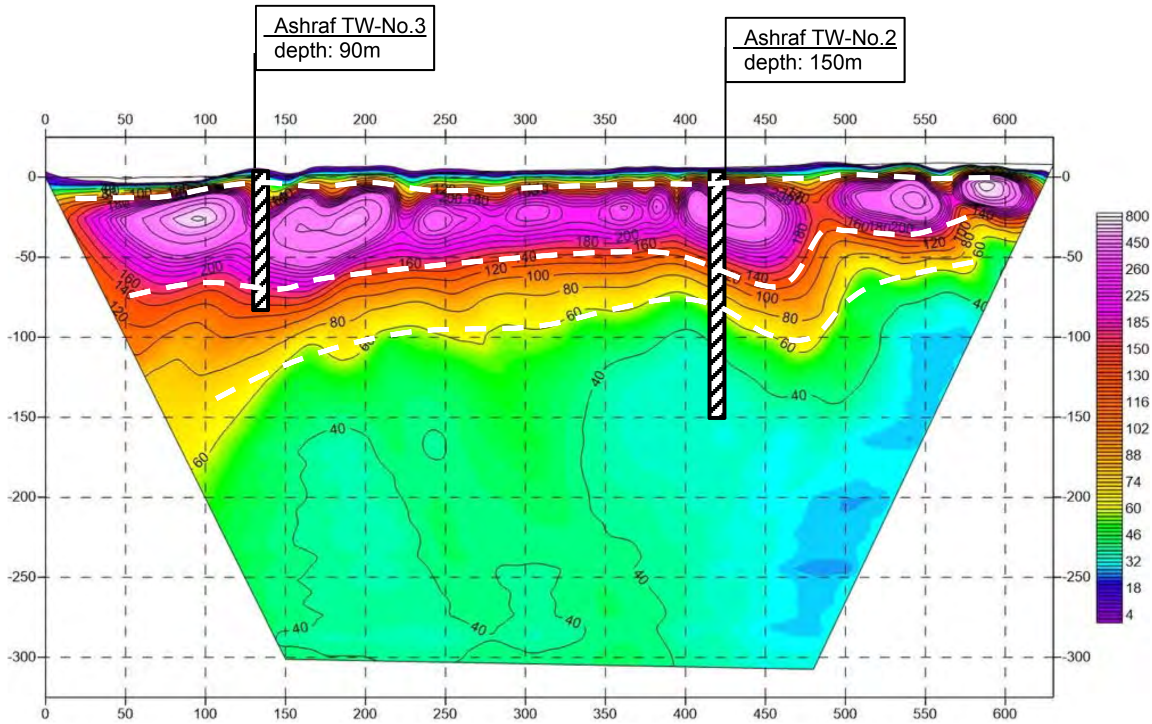
CH-L02 Line (L=470m)
Charchara TW-No.1 (depth =72m / productive)



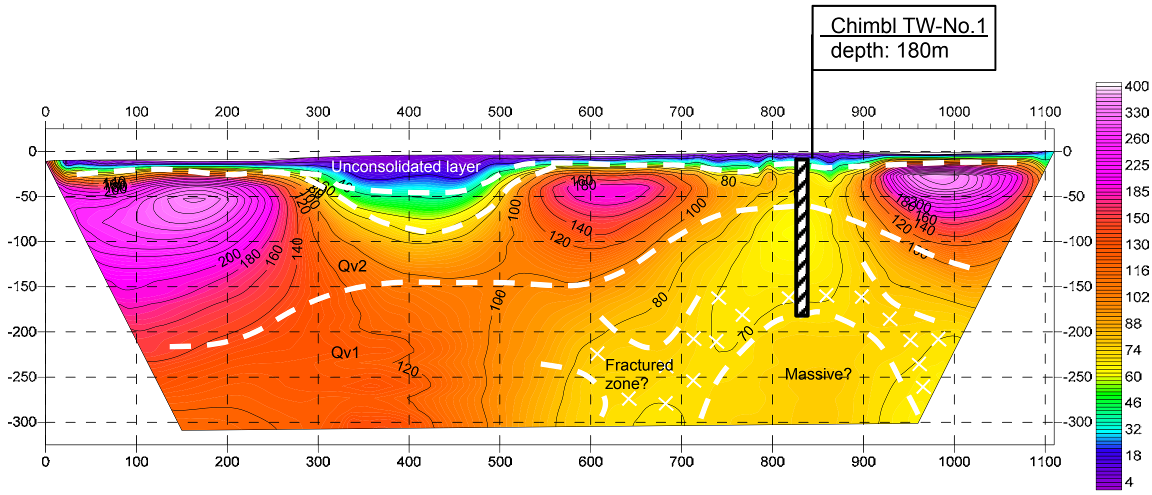
CH-L7 Line (L=470m)
Charchara TW-No.3 (depth=70m / productive)



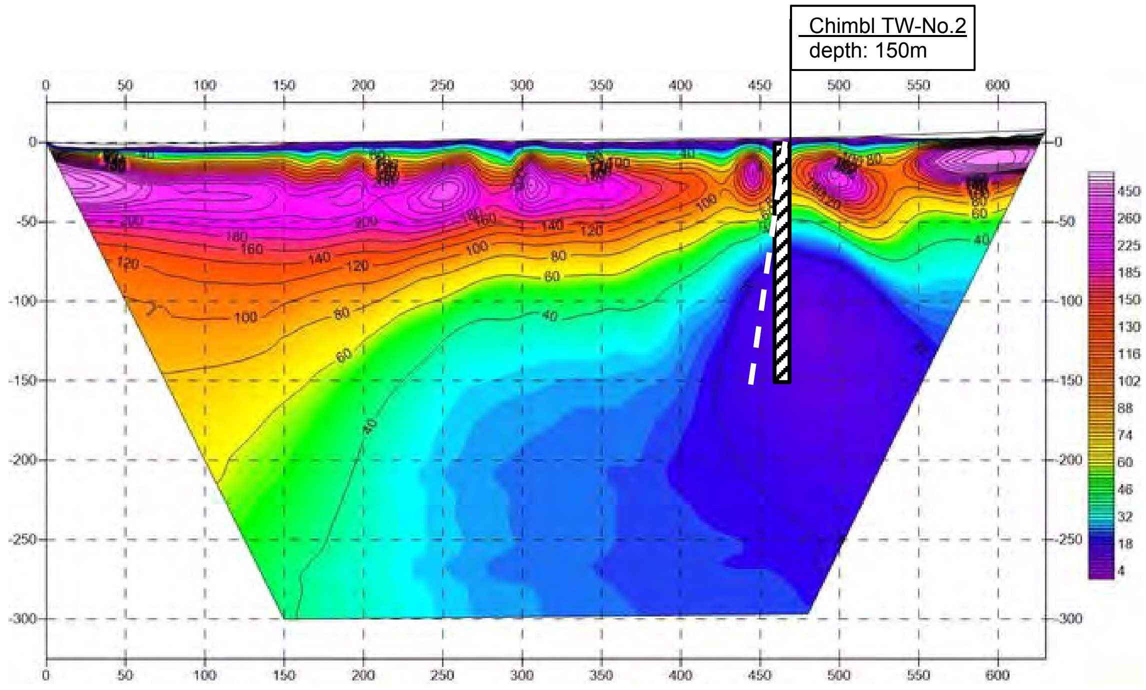
AS-L1 Line (L=630m)
Ashraf TW-No.1 (depth=150m / dry well)



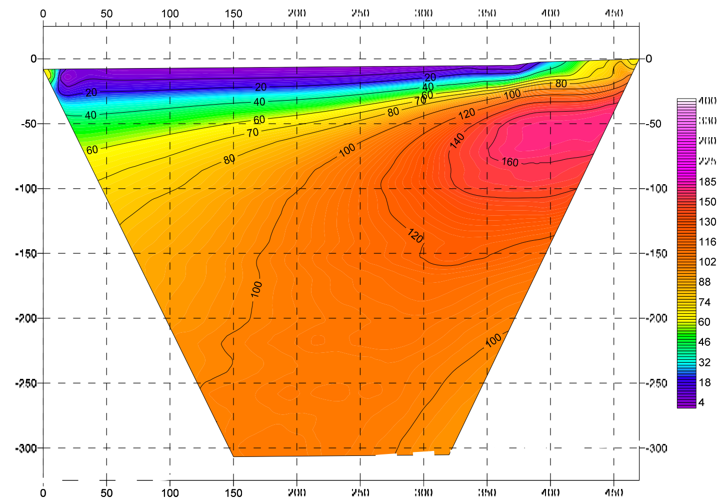
AS-L3 Line (L=630m)
Ashraf TW-No.2 (depth=150m / productive) / TW-No.3 (depth=90m / productive)



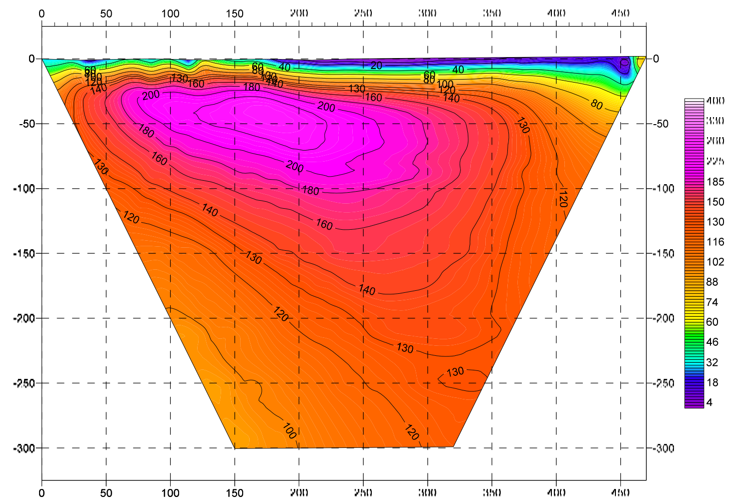
CH-L1 Line (L=1,110m)
Chimbl TW-No.1 (depth =180m / dry well)



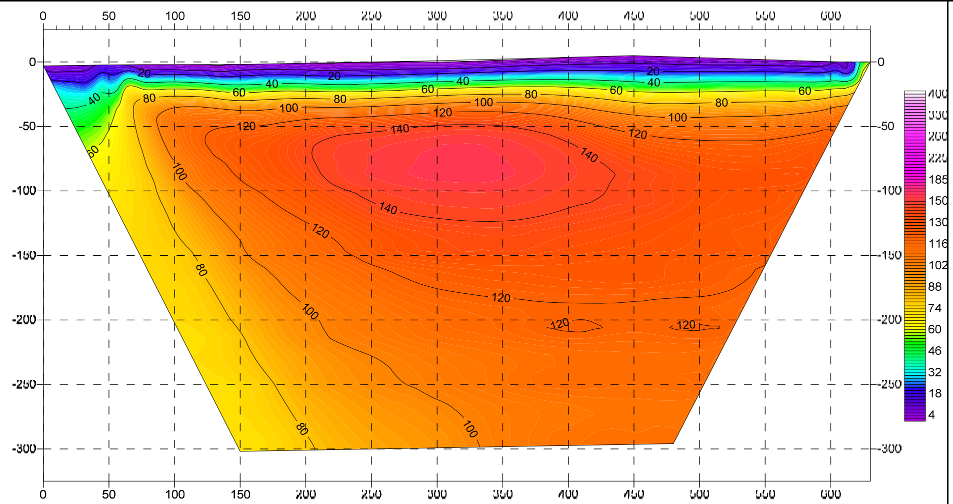
CB-L3 Line (L=630m)
Chimbl TW-No.2 (depth=150m / dry well)



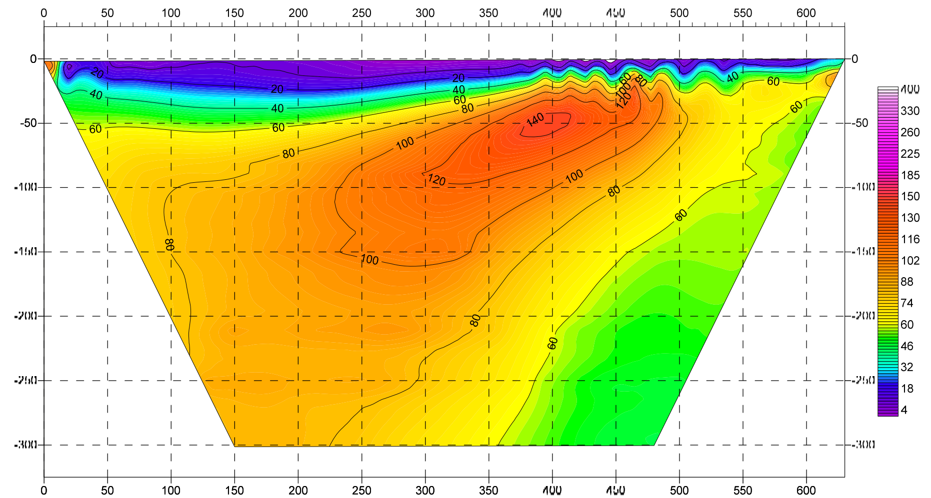
CH-L01 Line (L=470m)



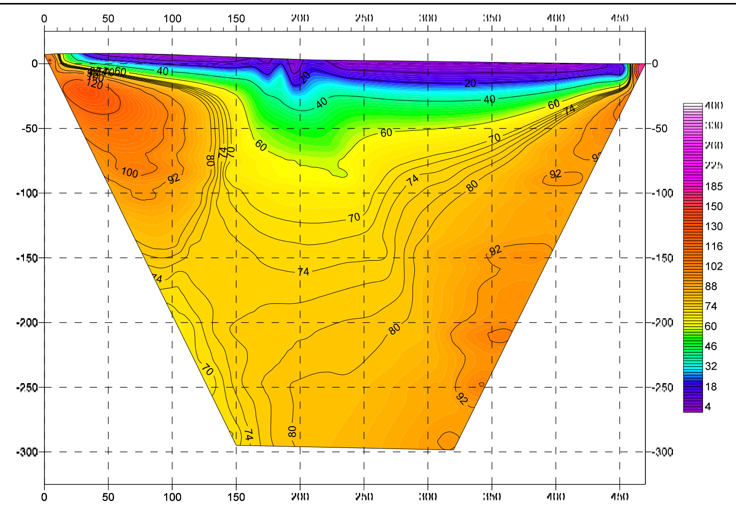
CH-L02 Line (L=470m)



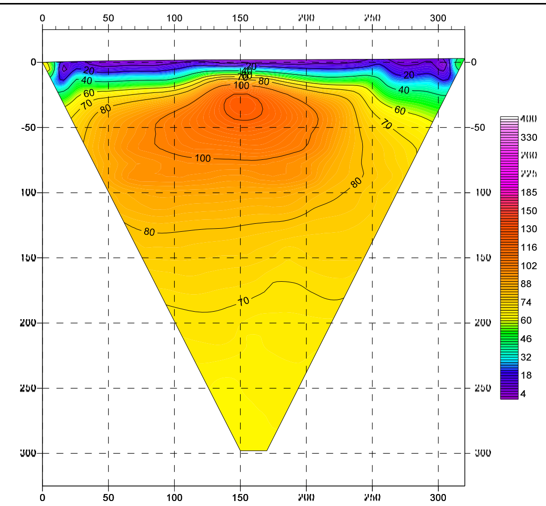
CH-L03 Line (L=630m)



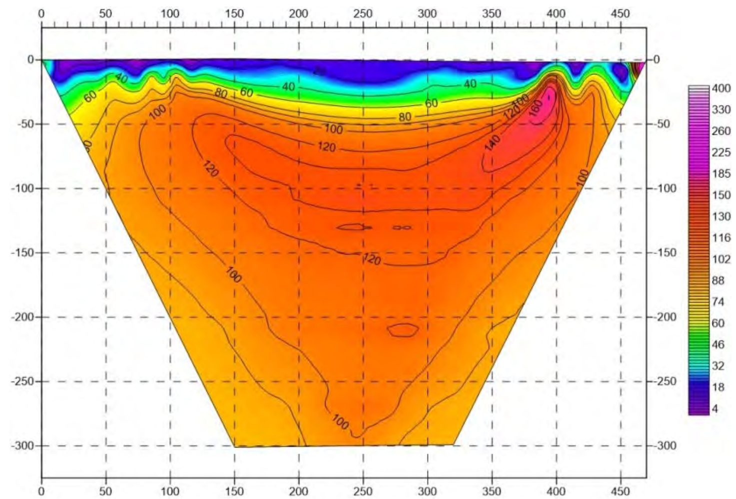
CH-L04 Line (L=630m)



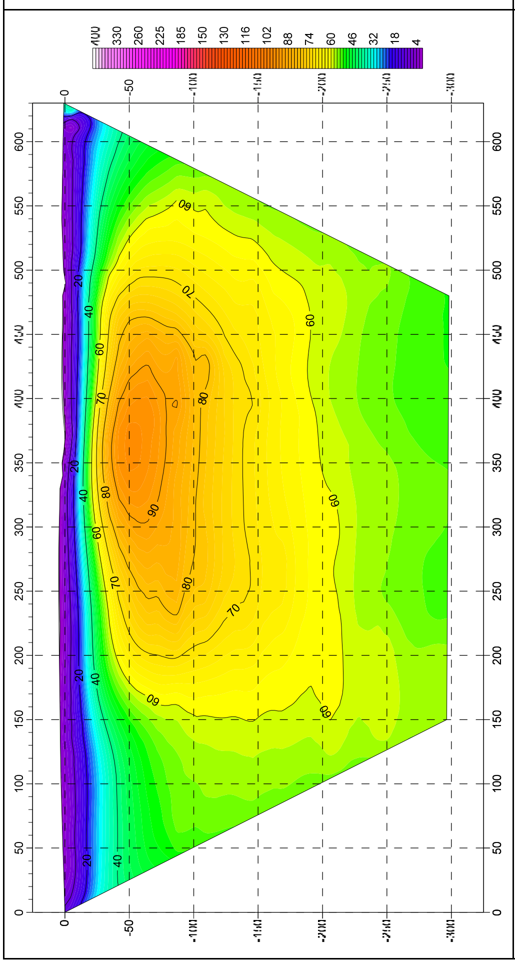
CH-L05 Line (L=470m)



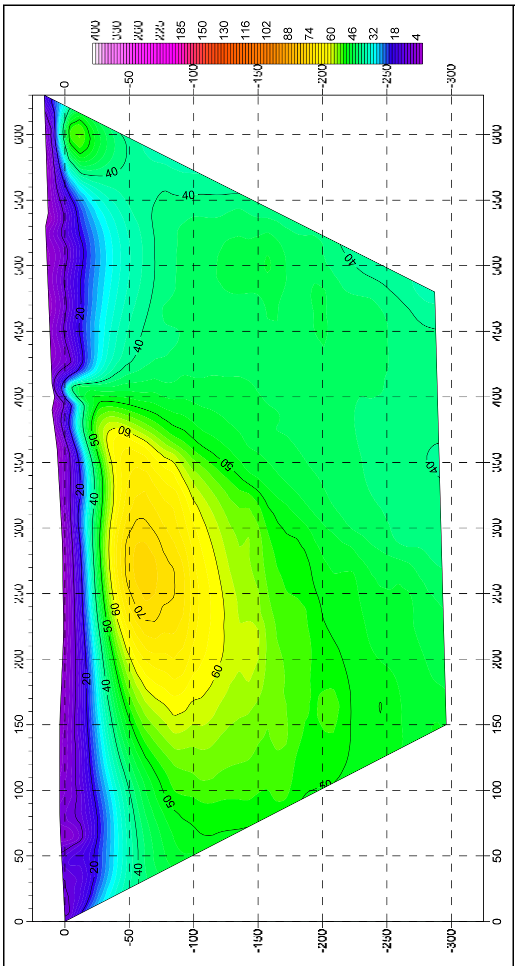
CH-L06 Line (L=320m)



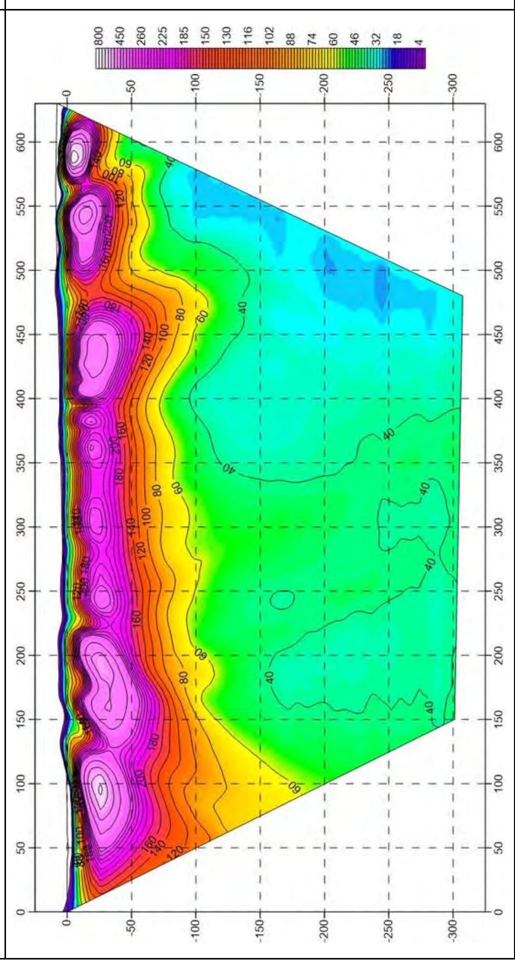
CH-L07 Line (L=470m)



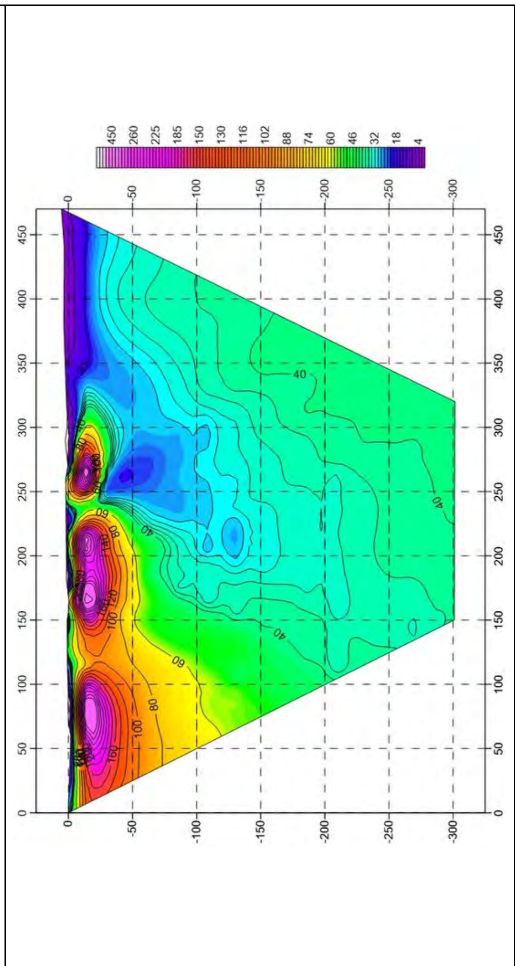
AS-L01 Line (L=630m)



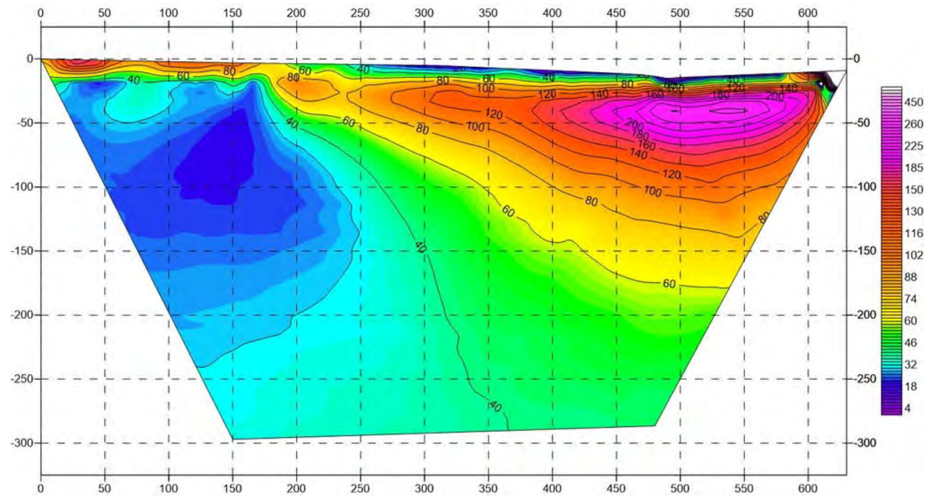
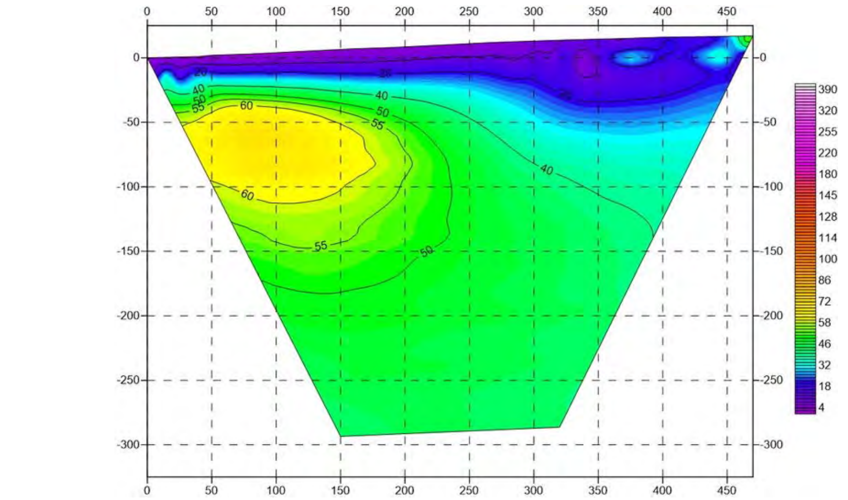
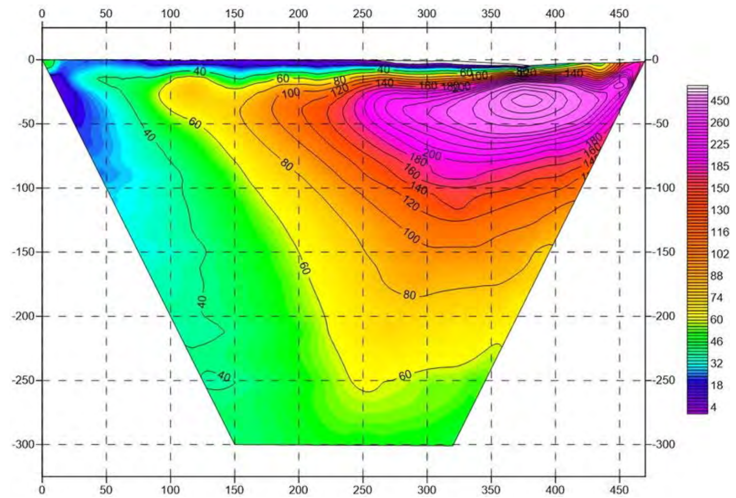
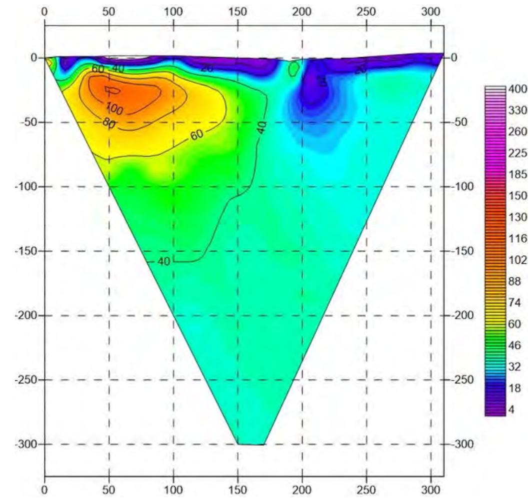
AS-L02 Line (L=630m)

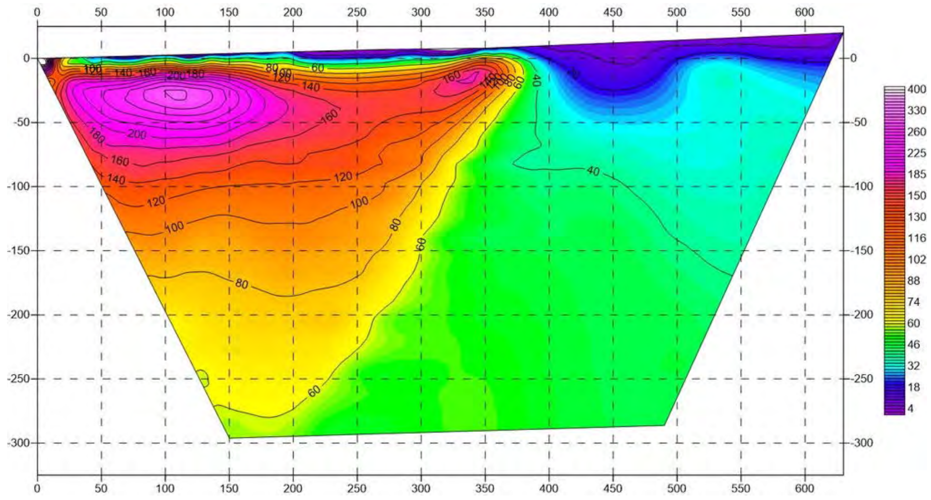


AS-L03 Line (L=630m)

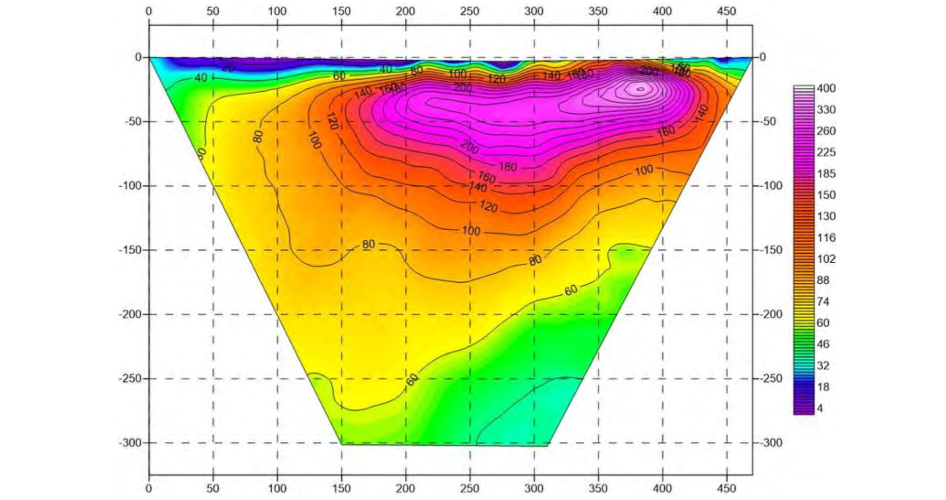


AS-L04 Line (L=470m)

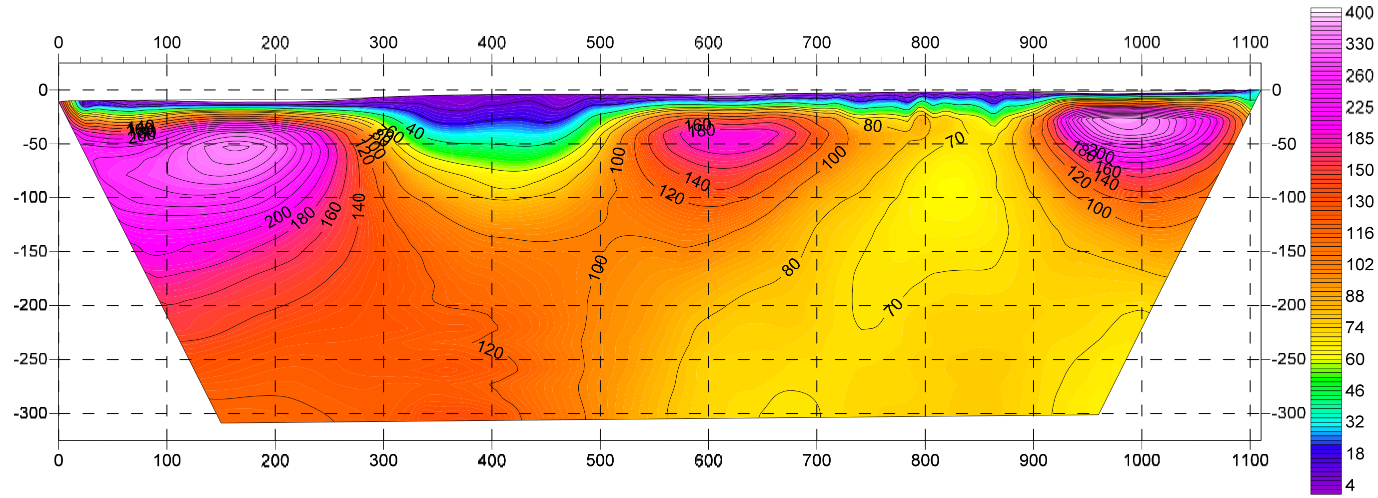
	
AS-L05 Line (L=630m)	AS-L06 Line (L=470m)
	
AS-L07 Line (L=470m)	AS-L08 Line (L=310m)



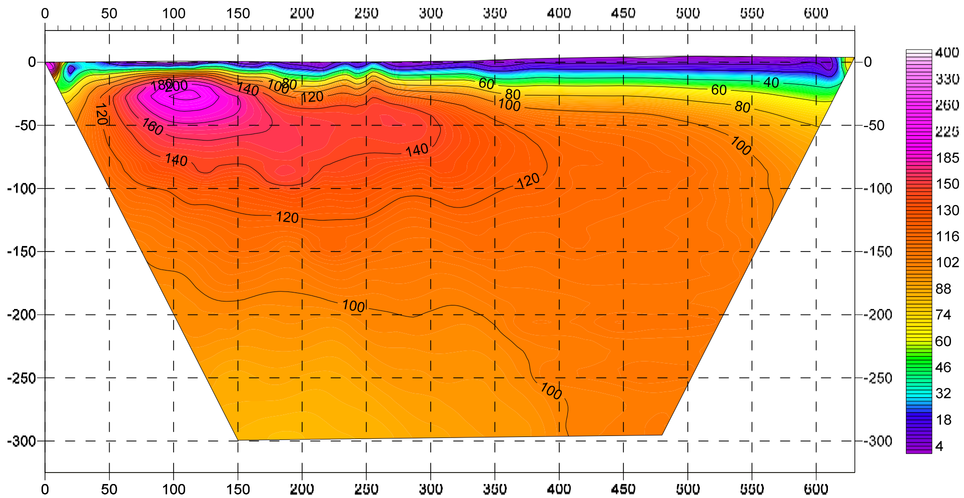
AS-L09 Line (L=630m)



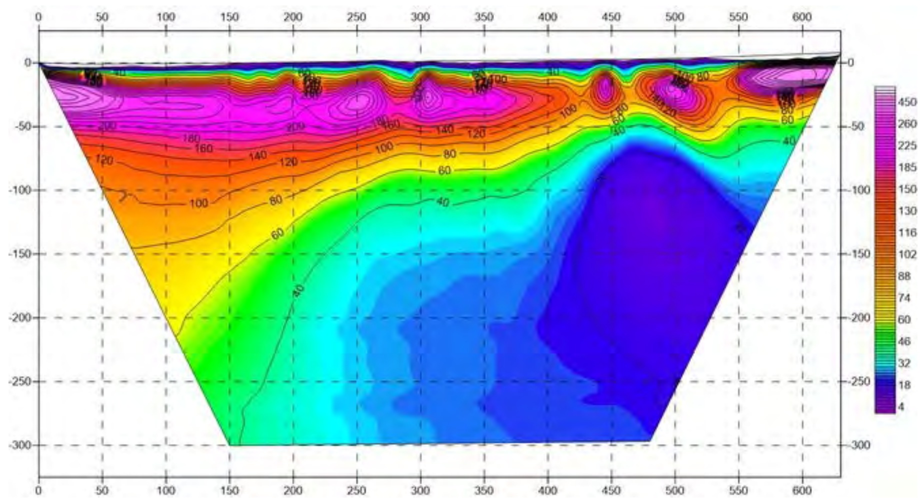
AS-L10 Line (L=470m)



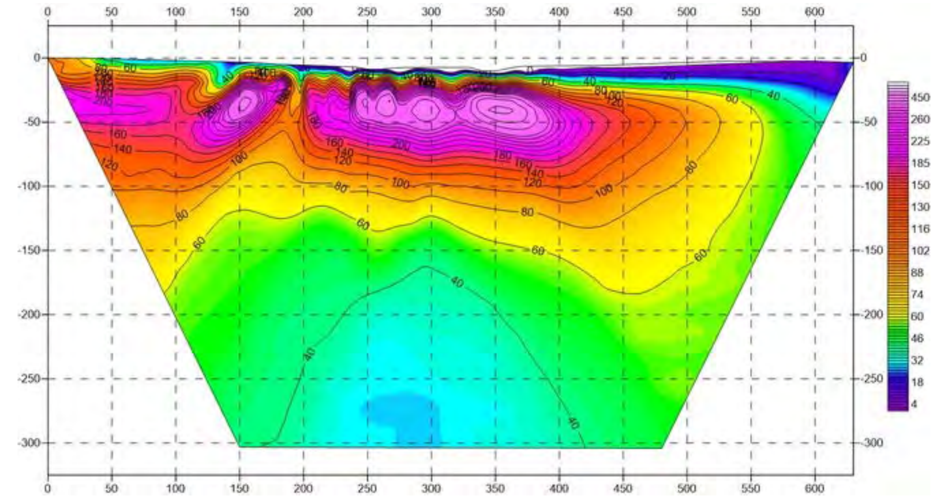
CB-L01 Line (L=1,110m)



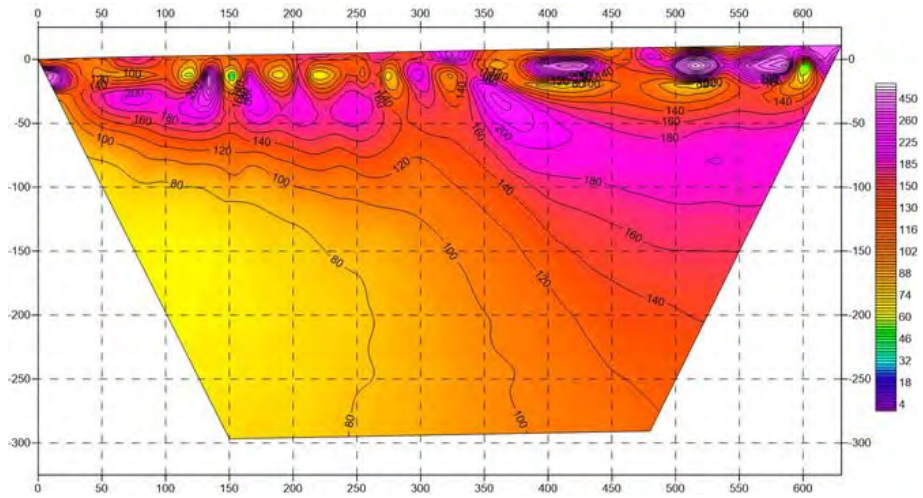
CB-L02 Line (L=630m)



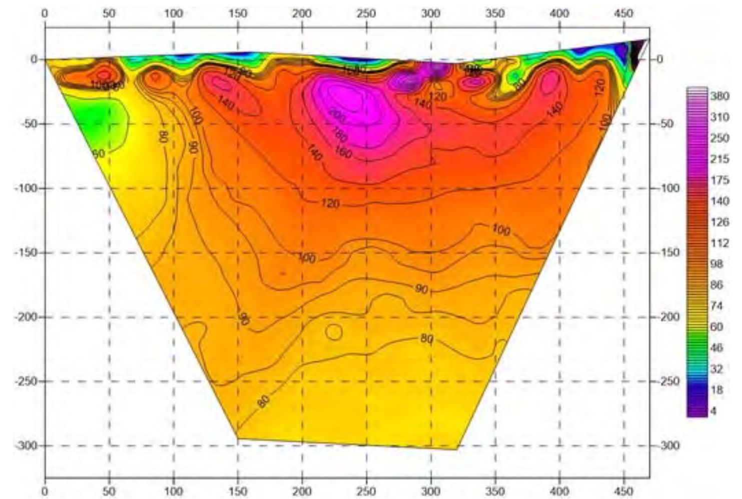
CB-L03 Line (L=630m)



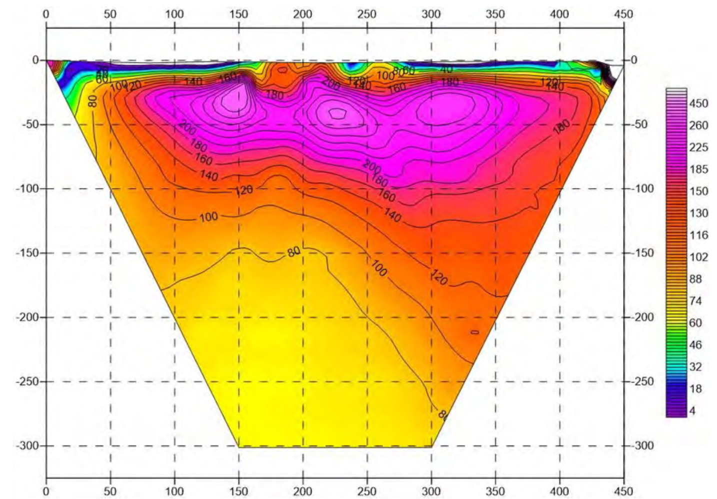
CB-L04 Line (L=630m)



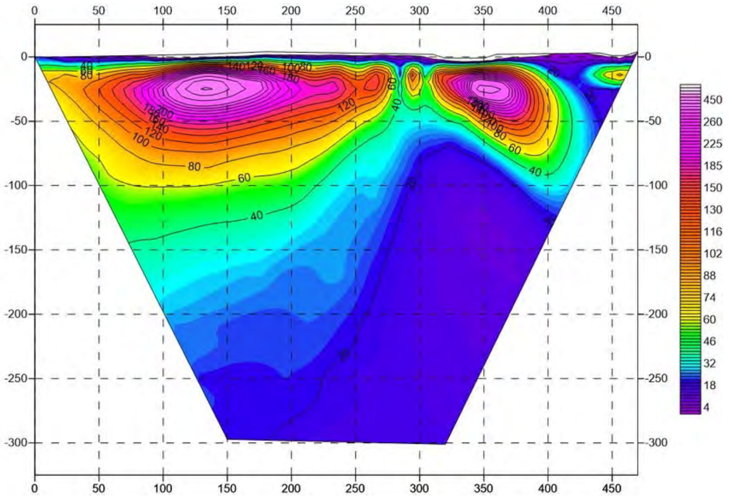
CB-L05 Line (L=630m)



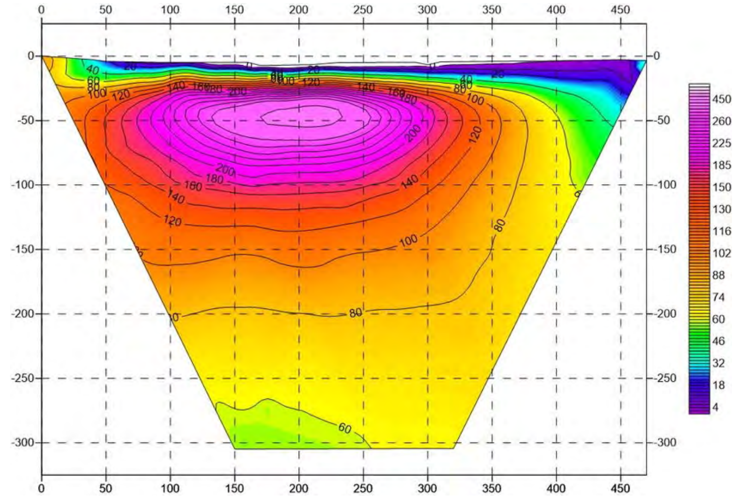
CH-L06 Line (L=470m)



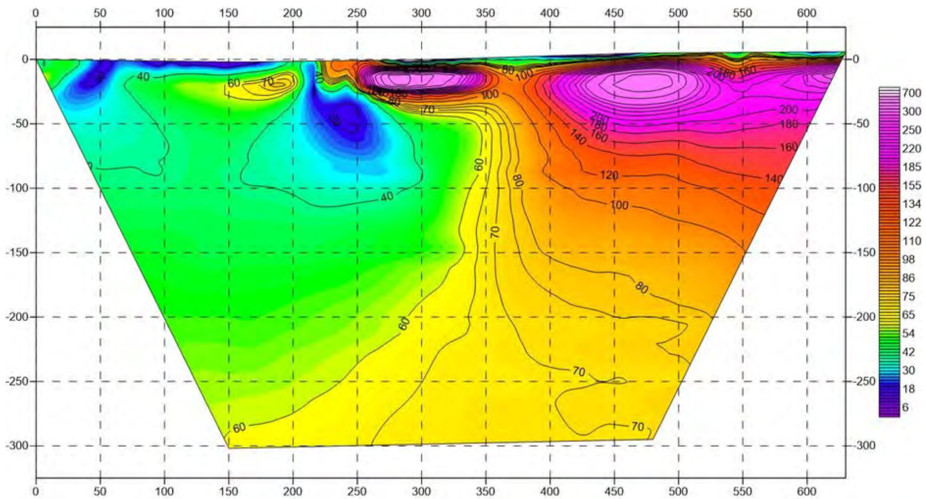
CB-L07 Line (L=450m)



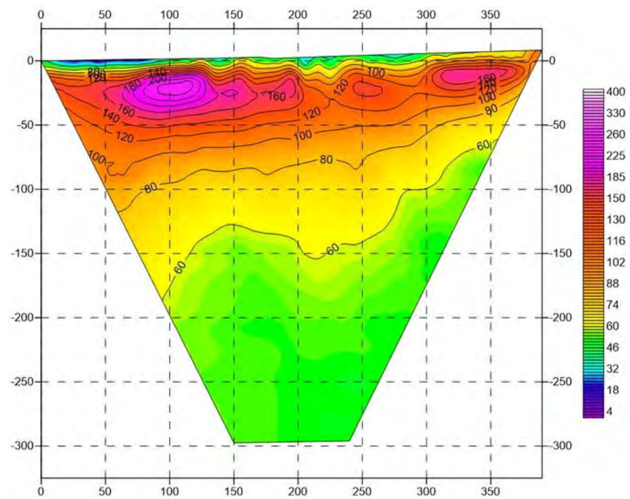
CB-L08 Line (L=470m)



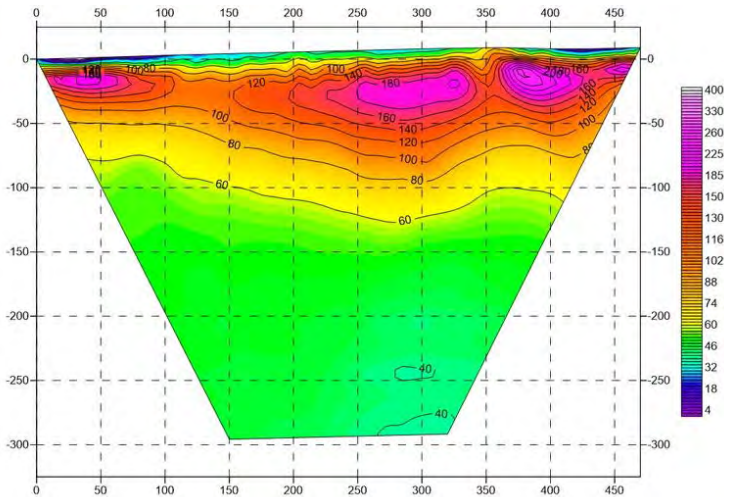
CB-L09 Line (L=470m)



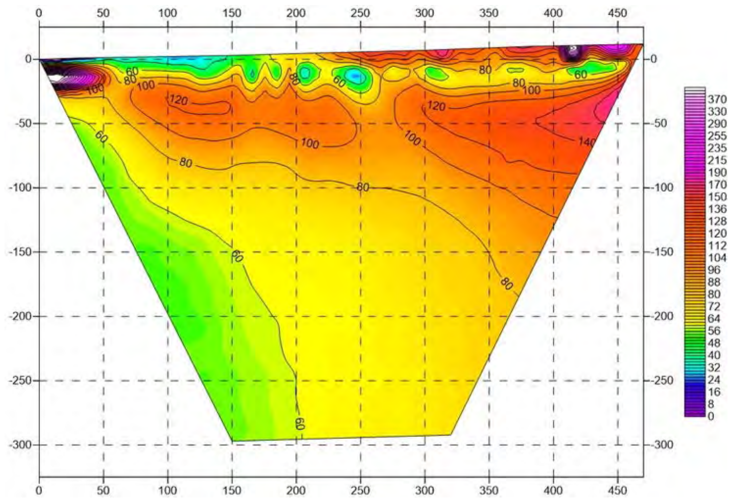
CB-L10 Line (L=630m)



CB-L11 Line (L=390m)



CB-L12 Line (L=470m)



CB-L13 Line (L=470m)

APPENDIX-7 (5) TEST WELL DRILLING

(1) Drilling of Charchara TW-No.1 Test Well

Circulation loss of drilling mud occurred at the depth of 24.3m. A large amount of mud was introduced into the well but the circulation loss could not be stopped and the drilling was continued injecting raw water. Since the drilling samples did not came up due to the circulation loss, it is assumed that the drilled formation is all basaltic lava according to the verbal information about the drilling condition (drilling speed, drilling bit condition and so) from the drilling operator.

Initially the planned drilling depth was 90m but since it was observed that sufficient amount of water can be expected from the depth deeper than G.L.-24m, very hard rock formation continues from the depth of G.L.-66.5m and taking in consideration that it will take long time to achieve the planned depth, it was decided to stop the drilling at the depth of 70m. Lithological column and casing program is shown in Figure-1.

(2) Drilling of Charchara TW-No.2 Test Well

The geology is weathered basaltic lava formation distributed throughout with few layers of fresh basalt with a maximum thickness of about 4m interbedded and since the distribution ratio of hard basalt layer is smaller in comparison with Charchara TW-No.1 site, the drilling speed was a little faster.

Planned drilling depth was initially 90m, but considering that it was possible to expect sufficient amount of water, it was decided to stop the drilling at the depth of 72m. Lithological column and casing program is shown in Figure-2.

(3) Drilling of Charchara TW-No.3 Test Well

Planned drilling depth was 90m but when reached the depth of 70m, sufficient amount of water could be expected so far and it was decided to stop the drilling at the depth of 70m. Lithological column and casing program is shown in Figure-3,

(4) Drilling of Ashraf TW-No.1 Test Well

It was observed the distribution of a weathered basalt formation between the depths of 118m to 137m and a very small amount of groundwater was confirmed and not sufficient to finalize it as a production well so it was back filled without installation of casing. Lithological column is shown in Figure-4.

(5) Drilling of Ashraf TW-No2 Test Well

The hammer drilling bit dropped inside the well when drilling the depth of 60m but it could not be recovered and the borehole was backfilled. A new well was drilled about 20m to north instead.

According to the drilling report of Ashraf No.1 well, it was expected to be confirmed at the depth of 80m, but the depth where sufficient potential of water was confirmed was 131m and the well was drilled up to 150m. Lithological column and casing program is shown in Figure-5.

(6) Drilling of Test Ashraf TW-No.3 Test Well

As result of drilling with 12 inches bit, it was confirmed the presence of a good aquifer with sufficient potential of water at the depth of 62m to 80m. In order to line the well with 12 inches casing, it was decide to ream the well to 17 inches.

However, the depth of 80m to 90m is consisted by a very hard formation and it will take long time for reaming, and considering the work efficiency, it was decided to reaming by 17 inches until the depth of 80m and install 12 inches casing. From the depth of 80 to 90m, install 8 inches casing keeping the well diameter as 12 inches. Lithological column and casing program is shown in Figure-6.

(7) Drilling of Chimbl TW-No.1 No.1

The depth from 68.5 to 83m is consisted by a weathered basalt layer. At the depth of 68.5m and 79m, the concentration of drilling mud diluted and it was supposed to be an aquifer but the estimated water potential was less than 1 L/sec. From the depth of 83m the layer become very hard and weathered basalt layer was confirmed at the depth of 129m to 134m but with no sufficient water potential as a good aquifer. The well was drilled until 180m, but the amount of water obtained was less than 1 L/sec and the static water level was deep as 75m so that it is not suitable for setting a hand pump and the well was backfilled. Lithological column is shown in Figure-7

(8) Drilling of Chimbl TW-No.2 Test Well

A fresh basalt formation with interbedded weathered basalt layer is distributed in this site as a whole. The results of electrical resistivity survey indicated the probable existence of an aquifer at the depth of 40m to 70m. However, as shown in Figure-8, it could be observed a weathered basalt formation containing fresh basalt layers from depth of 35m to 110m, but it was not found any indication of an aquifer. From depth of 110m the formation become fresh basalt and the drilling continued until depth of 150m. It was concluded that the possibility to find an aquifer in a depth deeper than depth of 150m is low, so the drilling was stopped at depth of 150m. Since it was not found an aquifer with sufficient water potential even for installation of a hand pump, this well was backfilled. The lithological column is shown in Figure-8.

Preparatory Survey for the Project for Improvement of Water Supply in Bahir Dar City					
Test Well ID:	*Charchara Test Well No.01 (CH-TW01)*			Drilled depth:	*72 m*
Drilling diameter:	*17 "*	Latitude:	*11.624884 °*	Start date:	*13-Dec-15*
Casing diameter:	*12-8 "*	Longitude:	*37.416486 °*	End date:	*29-Jan-16*

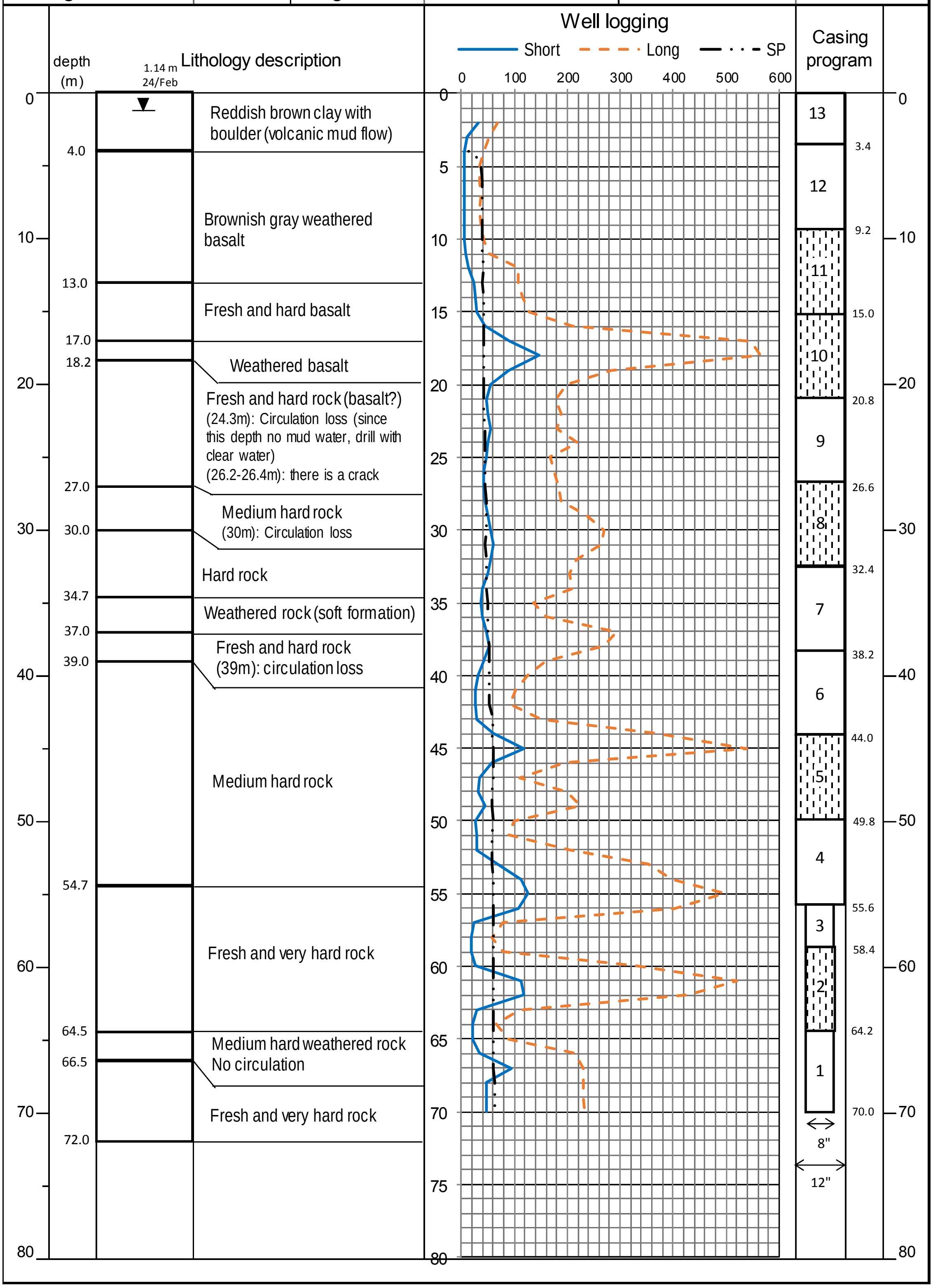


Figure-1. Charchara TW-No.1 - Lithological Column and Casing Program

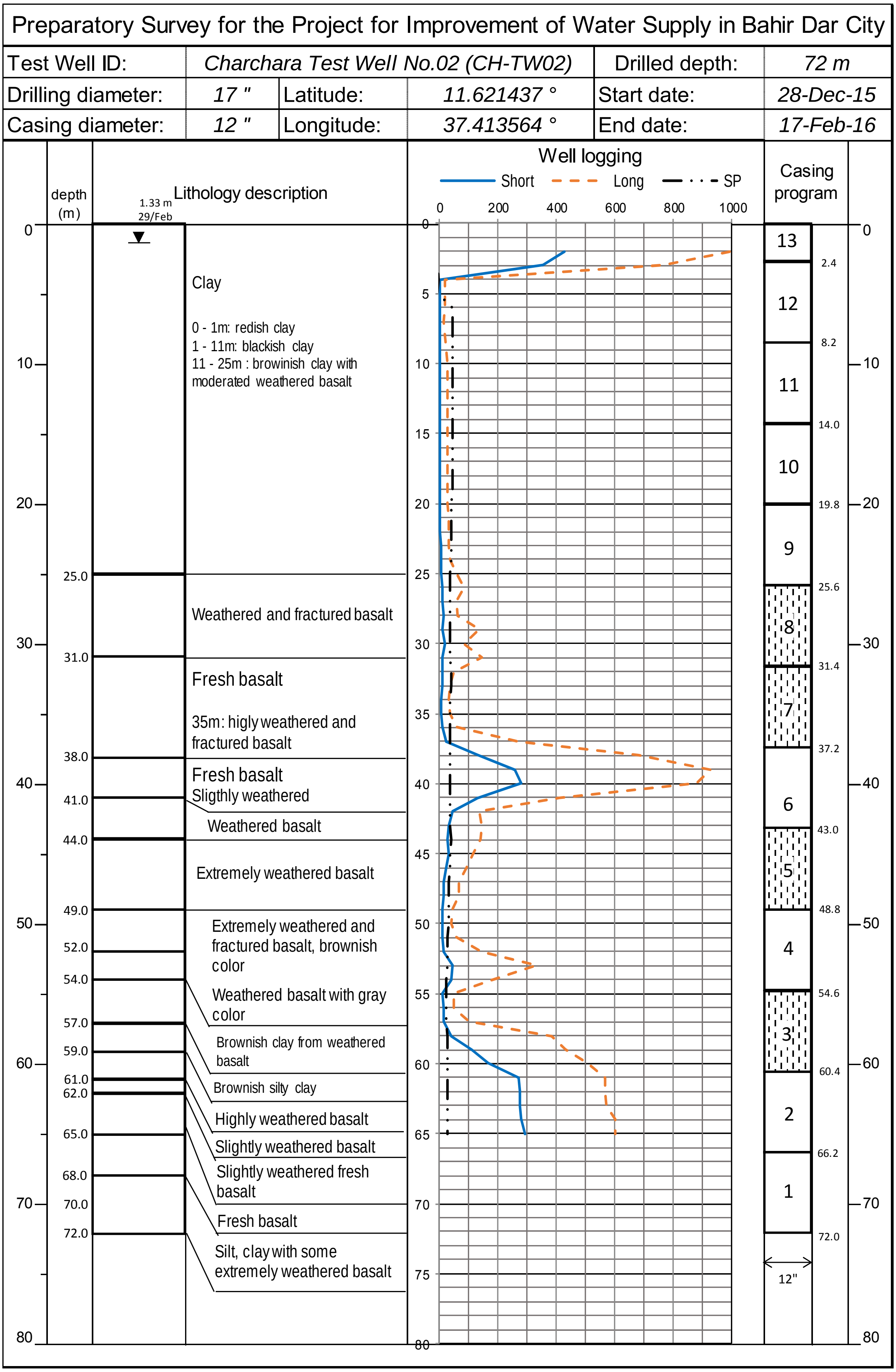


Figure-2. Charchara TW-No.2 – Lithological Column and Casing Program

Preparatory Survey for the Project for Improvement of Water Supply in Bahir Dar City					
Test Well ID:	*Charchara Test Well No.03 (CH-TW03)*			Drilled depth:	*70 m*
Drilling diameter:	*17 "*	Latitude:	*11.617451 °*	Start date:	10-Feb-16
Casing diameter:	*12 "*	Longitude:	*37.414693 °*	End date:	14-Apr-16

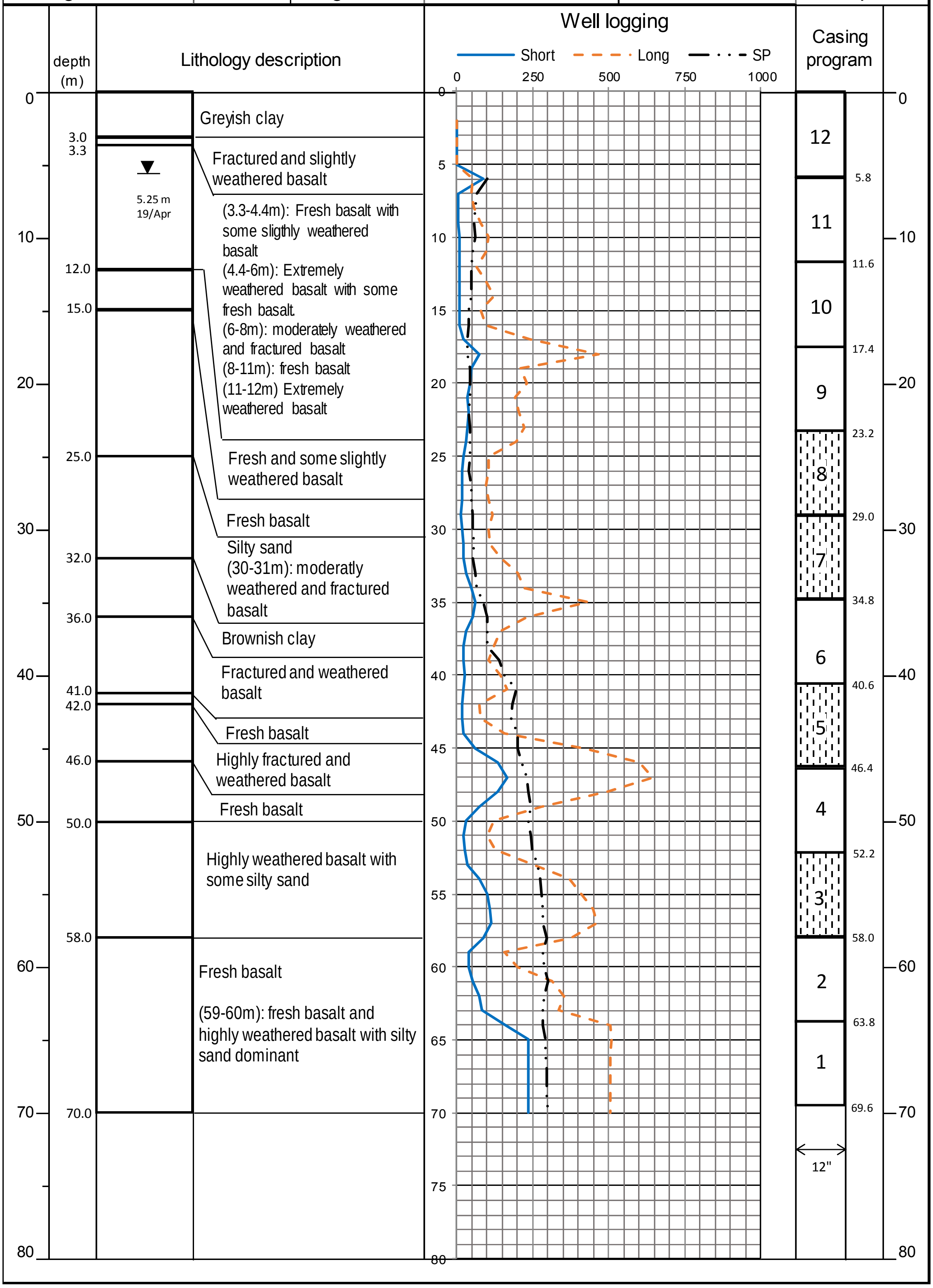


Figure-3. Charchara TW-No.3 – Lithological Column and Casing Program

Preparatory Survey for the Project for Improvement of Water Supply in Bahir Dar City					
Test Well ID:	*Ashraf Test Well No.01 (AS-TW01)*			Drilled depth:	*150 m*
Drilling diameter:	*12 "*	Latitude:	*11.588048 °*	Start date:	*25-Jan-16*
Casing diameter:		Longitude:	*37.427563 °*	End date:	*10-Feb-16*

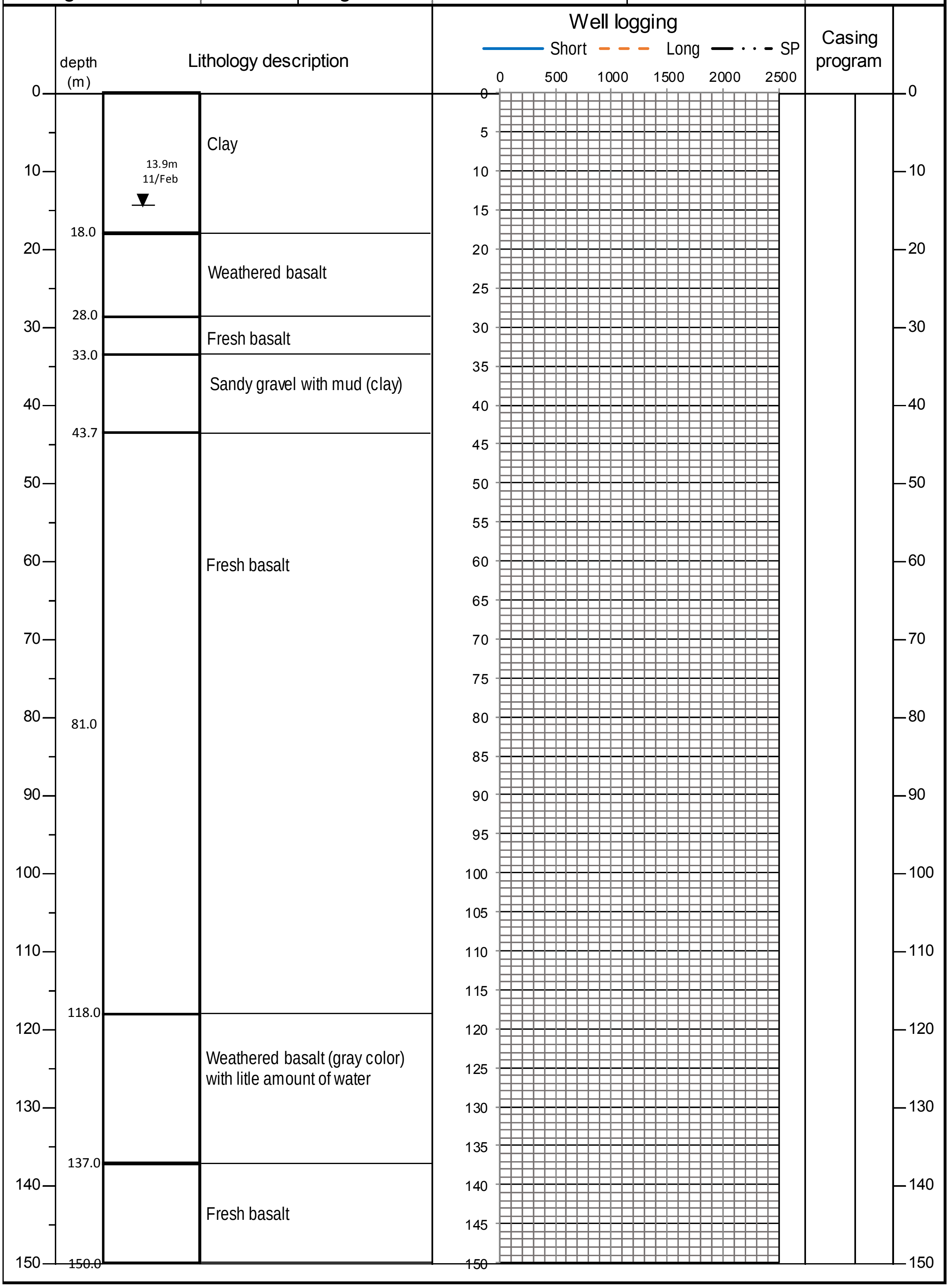


図 4.　Ashraf TW-No.1 – Lithological Column

Preparatory Survey for the Project for Improvement of Water Supply in Bahir Dar City					
Test Well ID:	*Ashraf Test Well No.02 (AS-TW02)*			Drilled depth:	*152.50 m*
Drilling diameter:	*12 "*	Latitude:	*11.591378 °*	Start date:	*26-Feb-16*
Casing diameter:	*8 "*	Longitude:	*37.427331 °*	End date:	*22-Mar-16*

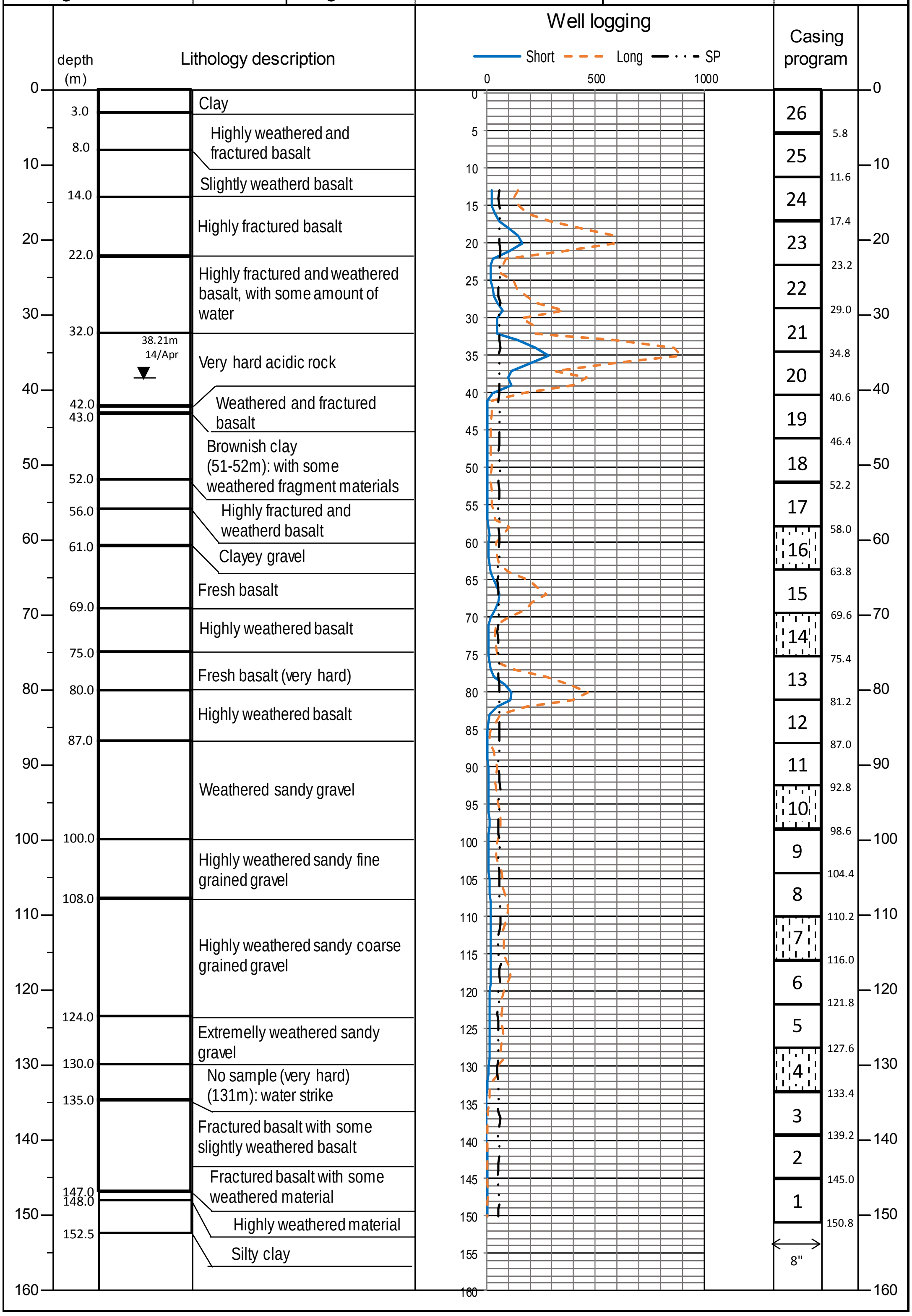


Figure-5. Ashraf TW-No.2 – Lithological Column and Casing Program

Preparatory Survey for the Project for Improvement of Water Supply in Bahir Dar City					
Test Well ID:	*Ashraf Test Well No.03 (AS-TW03)*			Drilled depth:	*90.5 m*
Drilling diameter:	*17 "*	Latitude:	*11.591628 °*	Start date:	11-Mar-16
Casing diameter:	*12 "*	Longitude:	*37.424913 °*	End date:	26-May-16

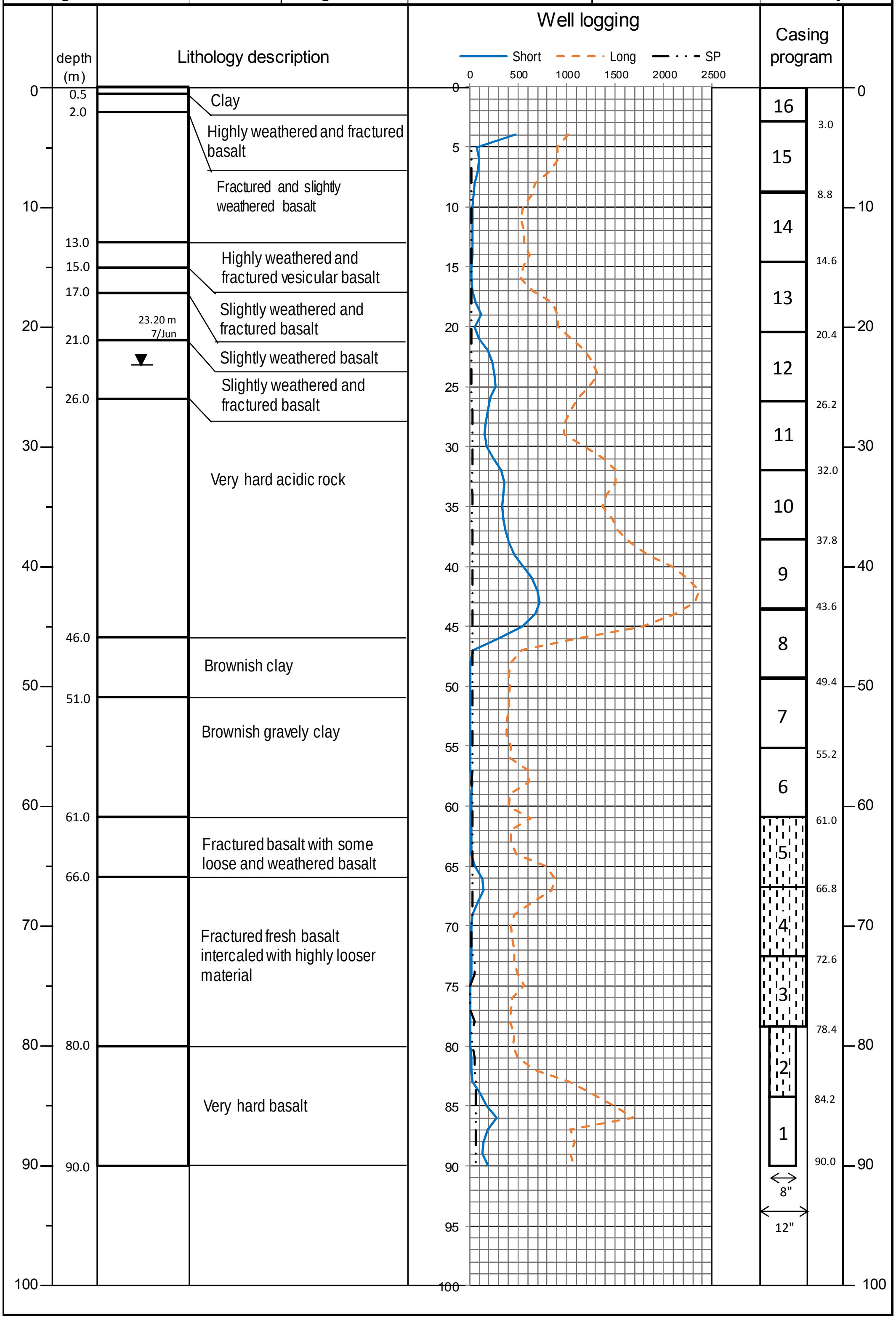


Figure-6. Ashraf TW-No.3 – Lithological Column and Casing Program

Preparatory Survey for the Project for Improvement of Water Supply in Bahir Dar City					
Test Well ID:	*Chimbl Test Well No.01 (CB-TW01)*			Drilled depth:	*180 m*
Drilling diameter:	*12 "*	Latitude:	*11.604031 °*	Start date:	*11-Dec-15*
Casing diameter:		Longitude:	*37.454436 °*	End date:	*26-Feb-16*

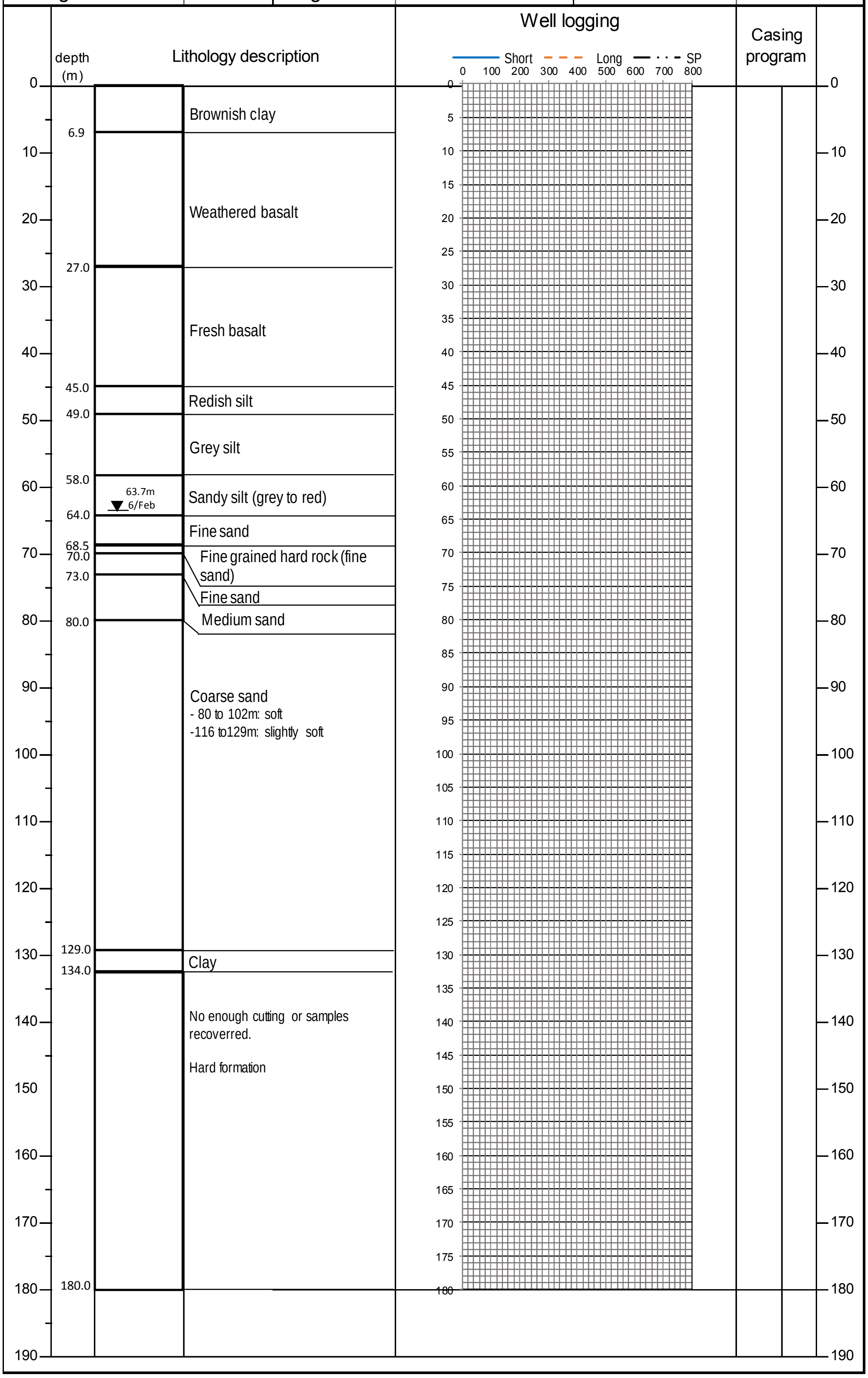


Figure-7. Chimbl TW-No.1 – Lithological Column

Preparatory Survey for the Project for Improvement of Water Supply in Bahir Dar City

Test Well ID:	*Chimbl Test Well No.02 (CB-TW02)*			Drilled depth:	*150 m*
Drilling diameter:	*12 "*	Latitude:	*11.617575 °*	Start date:	*24-Mar-16*
Casing diameter:		Longitude:	*37.464193 °*	End date:	*9-May-16*

depth (m)	Lithology description
0 – 1.0	Clayey soil with some highly weathered materials
1.0 – 5.0	Gravely clay
5.0 – 14.0	Highly weathered and fractured basalt
14.0 – 27.0	Slightly fractured and weathered basalt
27.0 – 35.0	Very hard fresh basalt
35.0 – 42.0	Fractured fresh basalt with some weathered materials
42.0 – 48.0	Greyish gravel with weathered grains
48.0 – 49.0	Very hard fresh basalt
49.0 – 65.0	Fractured fresh basalt with some weathered zones
65.0 – 80.0	Highly weathered basalt
80.0 – 110.0	Fractured adn weathered basalt
110.0 – 150.0	Slightly fractured and weathered basalt

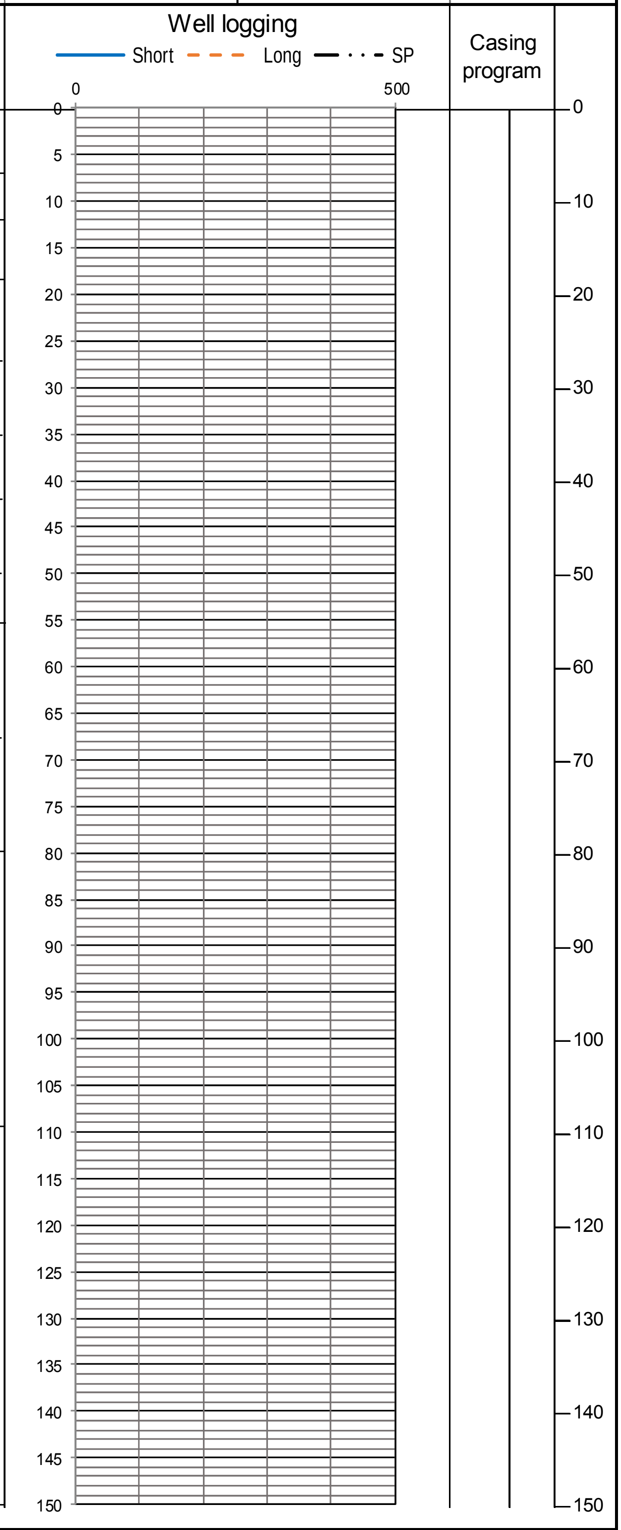


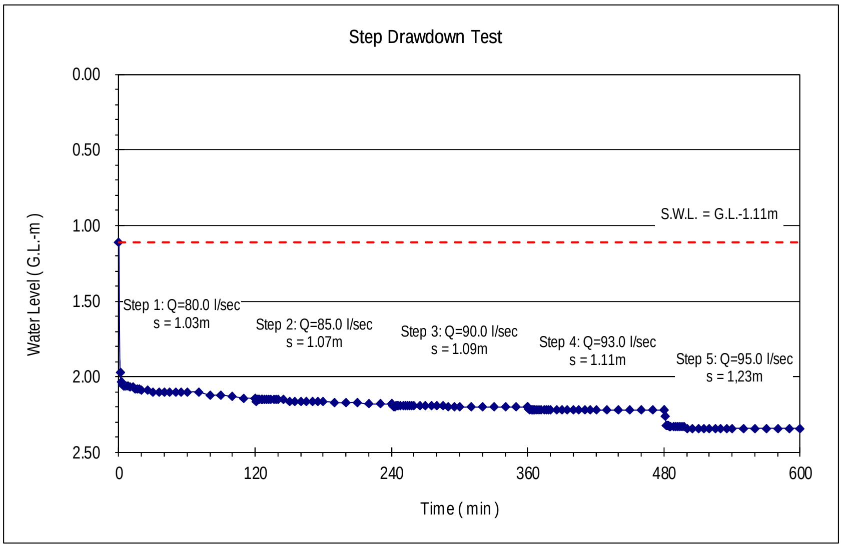
Figure-8. Chimbl TW-No.2 – Lithological Column

APPENDIX-7 (6)   RESULTS OF PUMPING TEST OF TEST WELLS

(1) Charchara Area

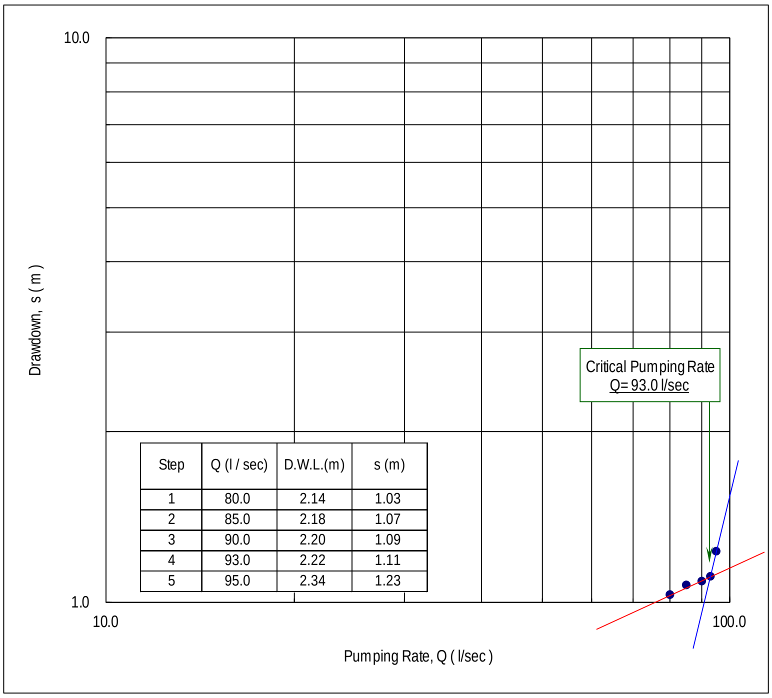
1) Results of Pumping Test of Charchara TW-No.1Test Well

① Step Drawdown Test



Step Drawdown Test Charchara TW-No.1
(Time - Water Level)

Figure-1. Result of Step Drawdown Test

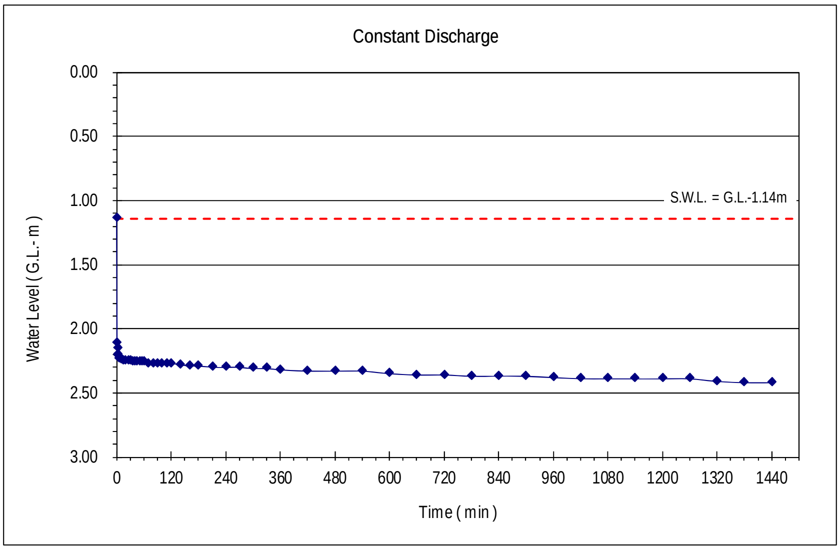


Step	Q (l / sec)	D.W.L.(m)	s (m)
1	80.0	2.14	1.03
2	85.0	2.18	1.07
3	90.0	2.20	1.09
4	93.0	2.22	1.11
5	95.0	2.34	1.23

Step Drawdown Test Charchara TW-No.1
(Pumping Rate - Drawdown)

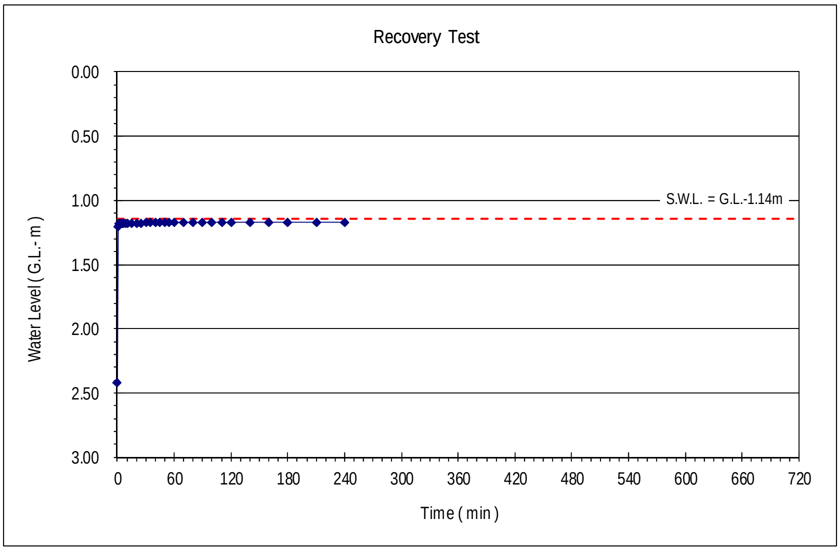
Figure-2. Discharge – Drawdown logarithmic graph

② Constant Discharge Test



Constant Discharge Test - Charchara TW-No.1
(Time - Water Level)

Figure-3. Result of Constant Discharge Test

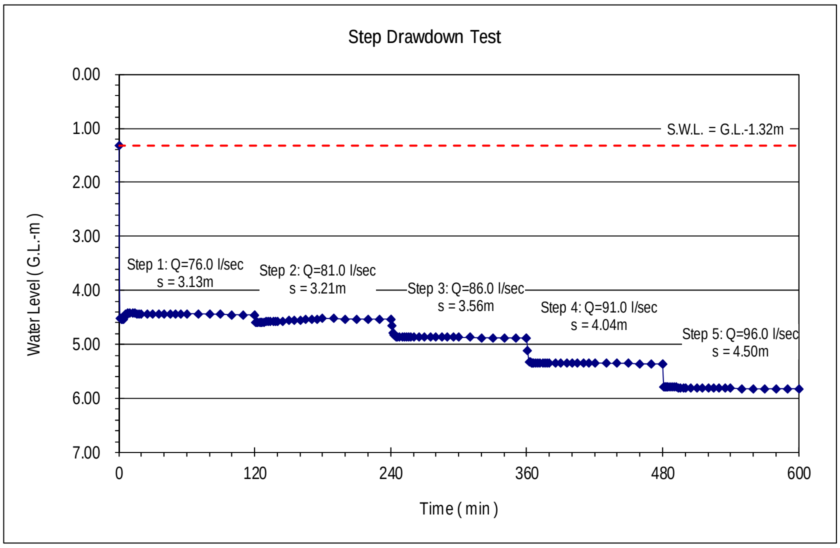


Recovery Test (Constant Discharge) - Charchara TW-No.1
(Time - Water Level)

Figure-4. Result of Recovery Test

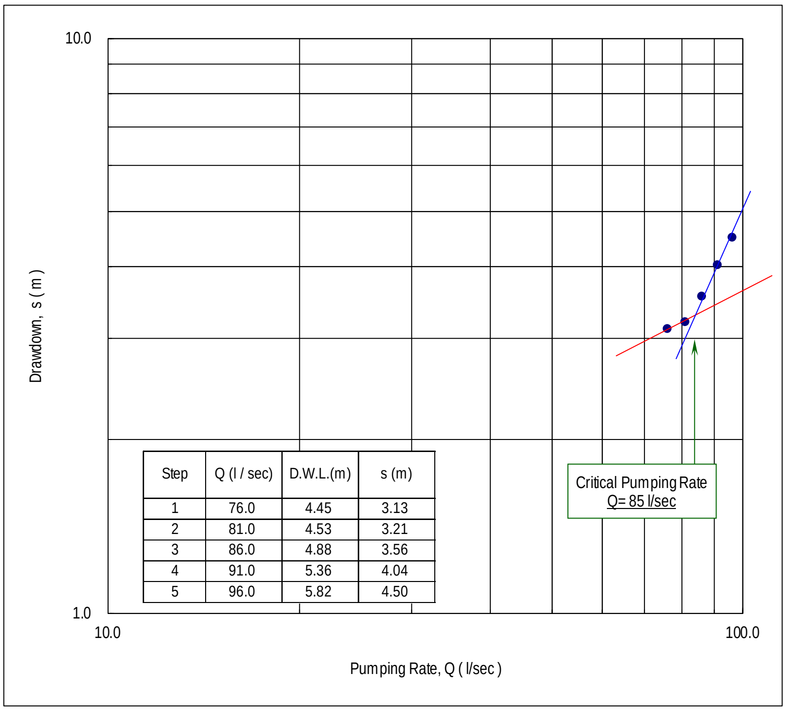
2) Results of Pumping Test of Charchara TW-No.2Test Well

① Step Drawdown Test



Step Drawdown Test Charchara TW-No.2
(Time - Water Level)

Figure-5. Result of Step Drawdown Test

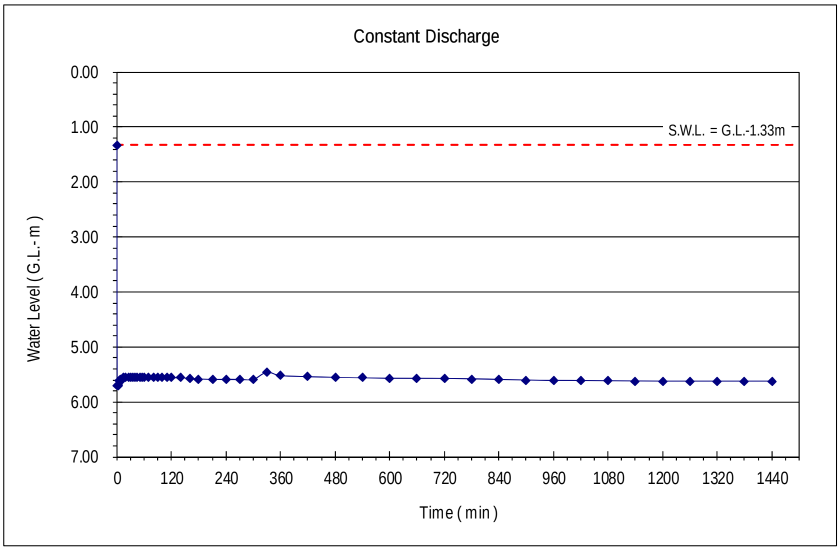


Step	Q (l / sec)	D.W.L.(m)	s (m)
1	76.0	4.45	3.13
2	81.0	4.53	3.21
3	86.0	4.88	3.56
4	91.0	5.36	4.04
5	96.0	5.82	4.50

Step Drawdown Test Charchara TW-No.2
(Pumping Rate - Drawdown)

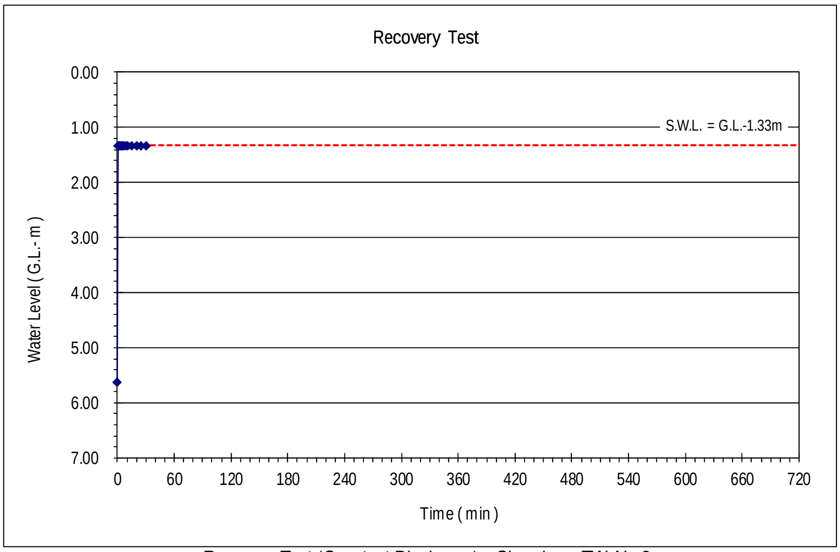
Figure-6. Discharge – Drawdown logarithmic graph

② Constant Discharge Test



Constant Discharge Test - Charchara TW-No.2
(Time - Water Level)

Figure-7. Result of Constant Discharge Test

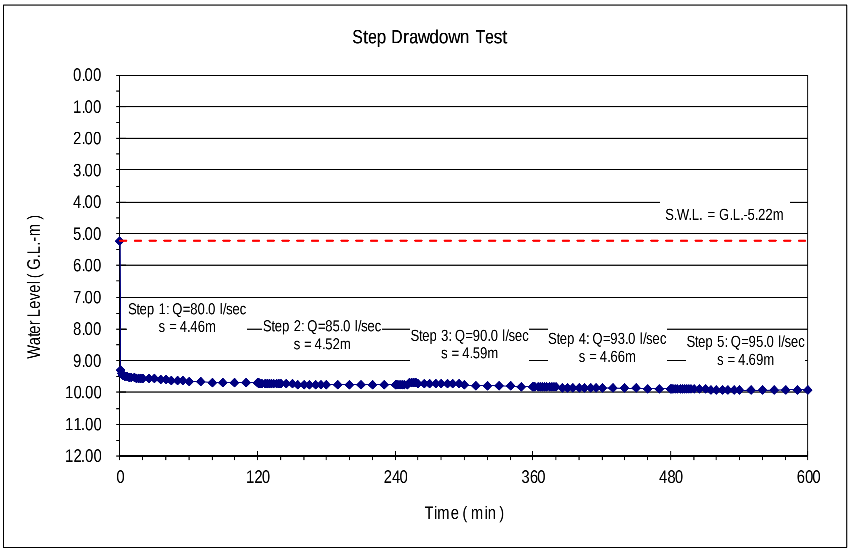


Recovery Test (Constant Discharge) - Charchara TW-No.2
(Time - Water Level)

Figure-8. Result of Recovery Test

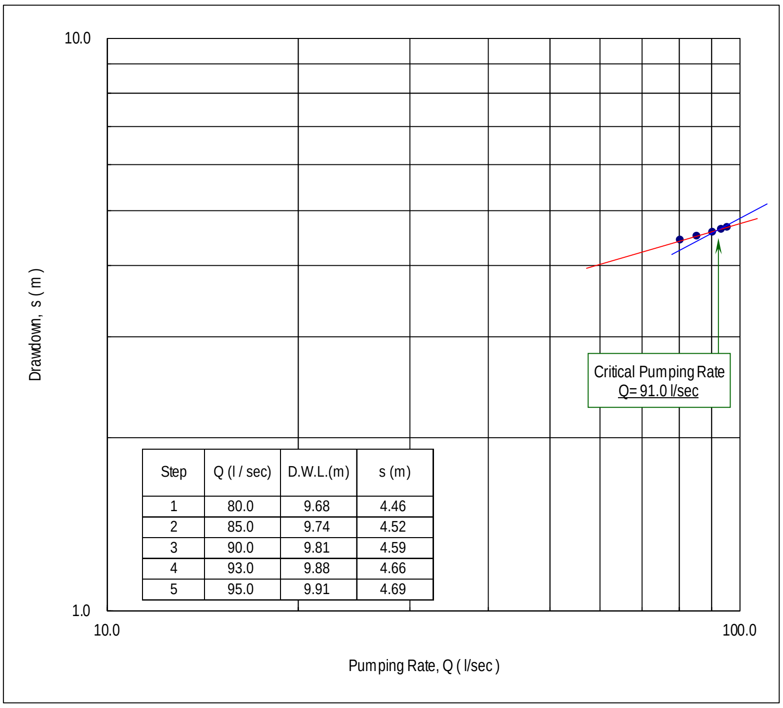
3) Result of Pumping Test of Charchara TW-No.3 Test Well

① Step Drawdown Test



Step Drawdown Test Charchara TW-No.3
(Time - Water Level)

Figure-9. Result of Step Drawdown Test

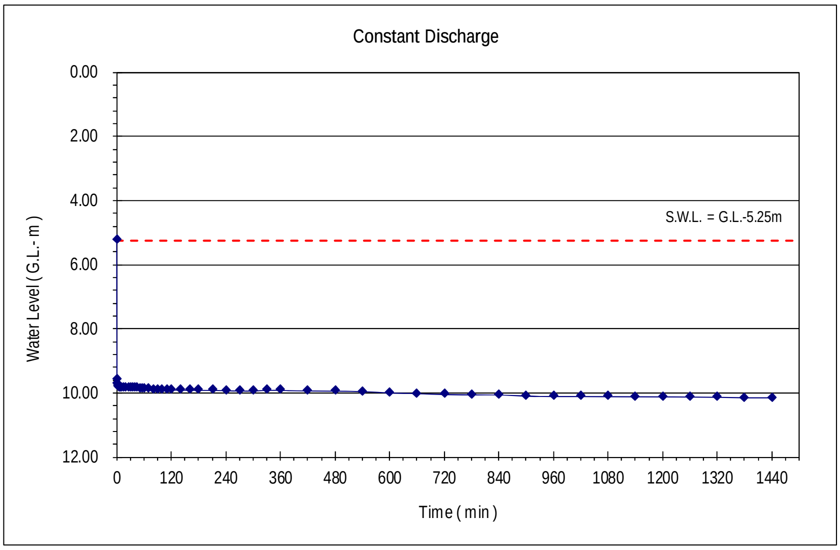


Step	Q (l / sec)	D.W.L.(m)	s (m)
1	80.0	9.68	4.46
2	85.0	9.74	4.52
3	90.0	9.81	4.59
4	93.0	9.88	4.66
5	95.0	9.91	4.69

Step Drawdown Test Charchara TW-No.3
(Pumping Rate - Drawdown)

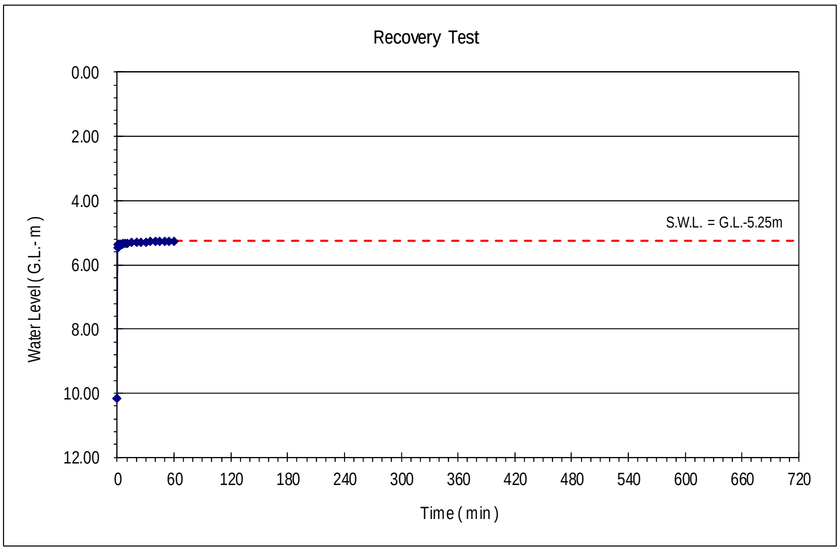
Figure-10. Discharge – Drawdown logarithmic graph

② Constant Discharge Test



Constant Discharge Test - Charchara TW-No.3
(Time - Water Level)

Figure-11. Result of Constant Discharge Test



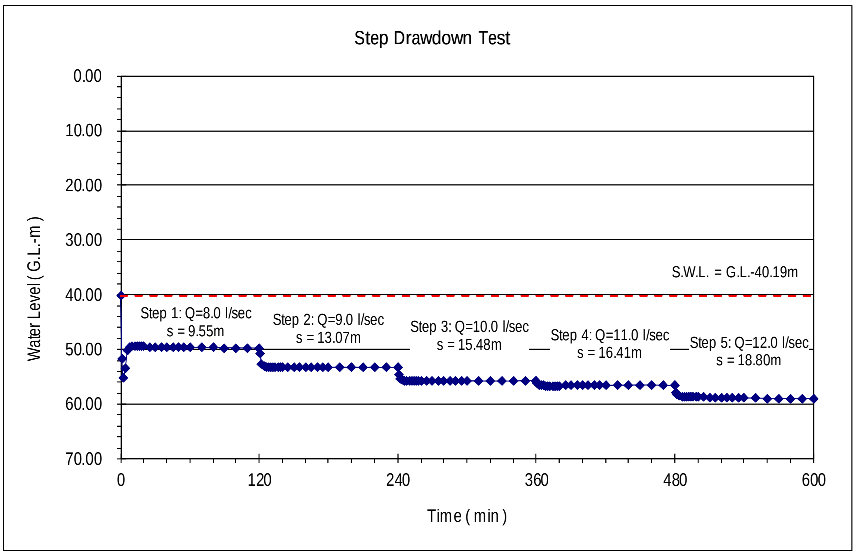
Recovery Test (Constant Discharge) - Charchara TW-No.3
(Time - Water Level)

Figure-12. Result of Recovery Test

(2) Ashraf Area

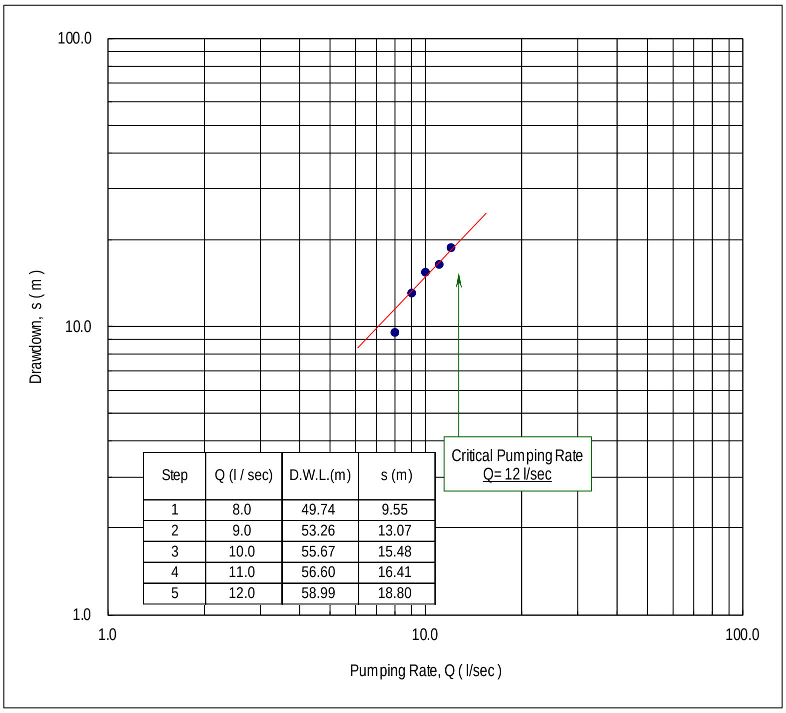
1) Pumping Test of Ashraf TW-No.2Test Well

① Step Drawdown Test



Step Drawdown Test Ashraf TW-No.2
(Time - Water Level)

Figure-13. Result of Step Drawdown Test

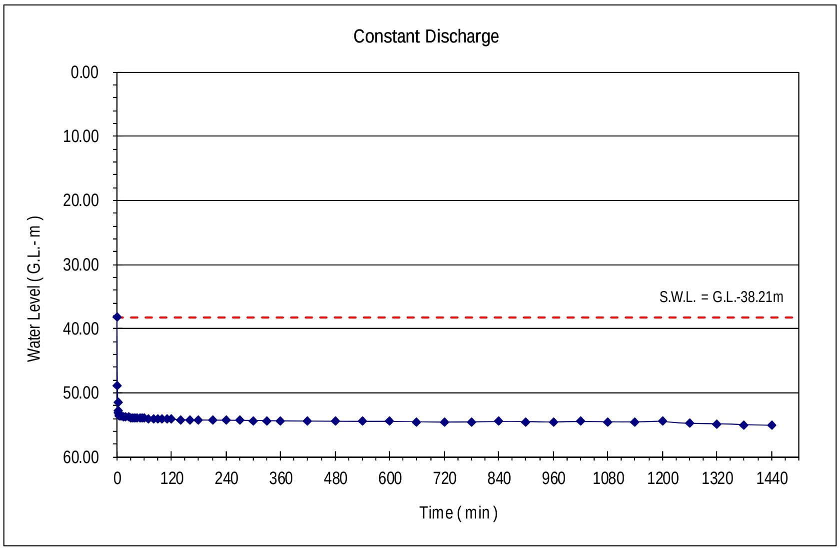


Step	Q (l / sec)	D.W.L.(m)	s (m)
1	8.0	49.74	9.55
2	9.0	53.26	13.07
3	10.0	55.67	15.48
4	11.0	56.60	16.41
5	12.0	58.99	18.80

Step Drawdown Test Ashraf TW-No.2
(Pumping Rate - Drawdown)

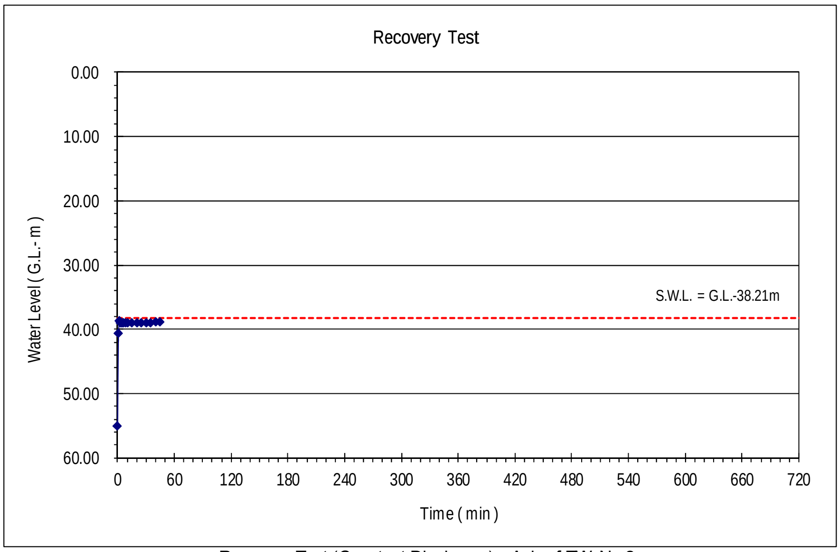
Figure-14. Discharge – Drawdown logarithmic graph

② Constant Discharge Test



Constant Discharge Test -Ashraf TW-No.2
(Time - Water Level)

Figure-15. Result of Constant Discharge Test

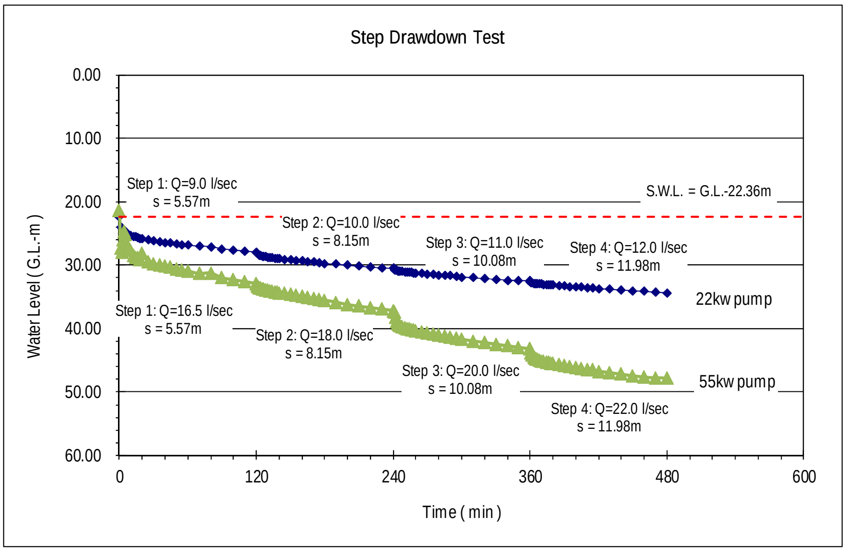


Recovery Test (Constant Discharge) - Ashraf TW-No.2
(Time - Water Level)

Figure-16. Result of Recovery Test

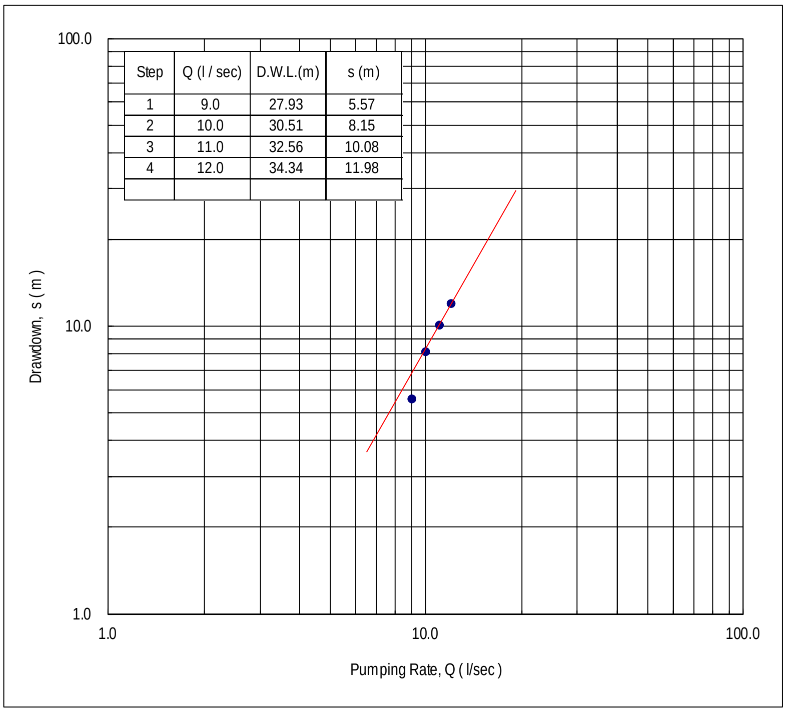
2) Pumping Test of Ashraf TW-No.3 Well

① Step Drawdown



Step Drawdown Test Ashraf TW-No.3
(Time - Water Level)

Figure-17. Result of Step Drawdown Test

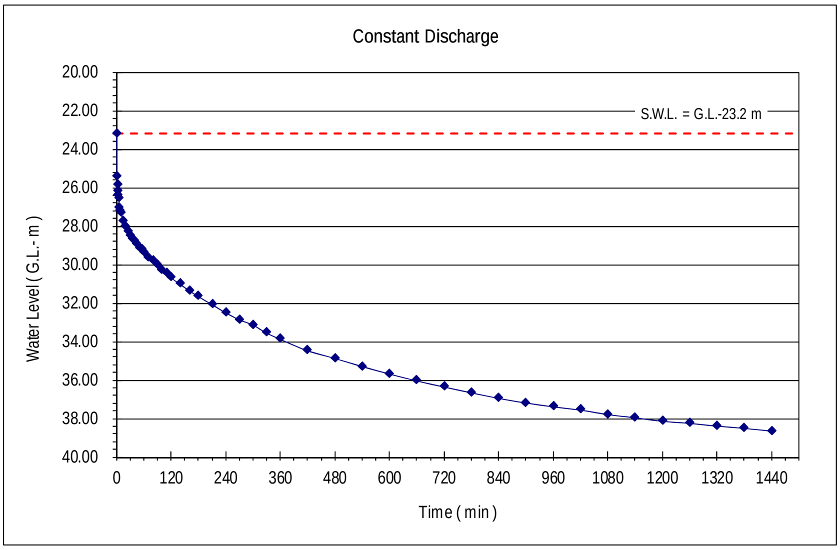


Step	Q (l / sec)	D.W.L.(m)	s (m)
1	9.0	27.93	5.57
2	10.0	30.51	8.15
3	11.0	32.56	10.08
4	12.0	34.34	11.98

Step Drawdown Test Ashraf TW-No.3
(Pumping Rate - Drawdown)

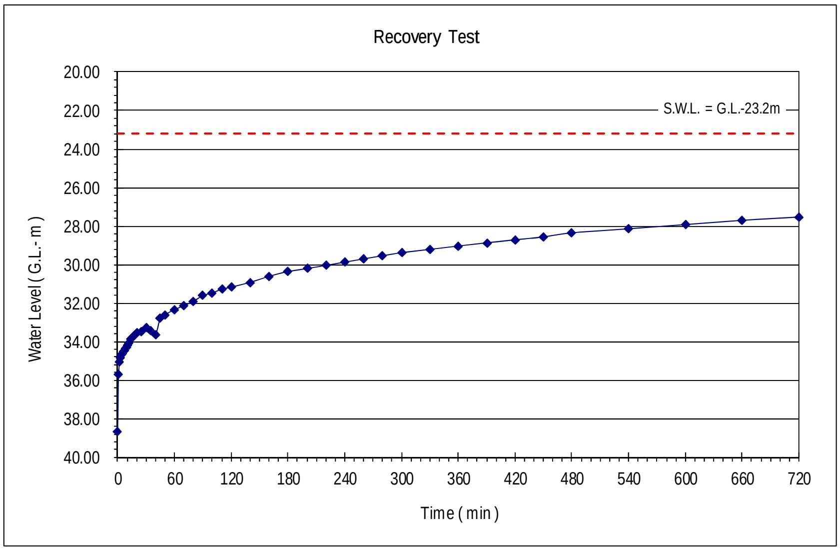
Figure-18. Discharge – Drawdown logarithmic graph

② Constant Discharge Test



Constant Discharge Test - Ashraf TW-No.3
(Time - Water Level)

Figure-19. Result of Constant Discharge Test



Recovery Test (Constant Discharge) - Ashraf TW-No.3
(Time - Water Level)

Figure-20. Result of Recovery Test

Table-1 Result of Pumping Test of Test Wells

【Step Drawdown】

	Charchara TW-No.1		Charchara TW-No.2		Charchara TW-No.3		Ashraf TW-No.2		Ashraf TW-No.3	
Step	Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)
1	80.0	1.03	76.0	3.13	80.0	4.46	8.0	9.55	9.0	5.57
2	85.0	1.07	81.0	3.21	85.0	4.52	9.0	13.07	10.0	8.15
3	90.0	1.09	86.0	3.56	90.0	4.59	10.0	15.48	11.0	10.08
4	93.0	1.11	91.0	4.04	93.0	4.66	11.0	16.41	12.0	11.98
5	95.0	1.23	96.0	4.50	95.0	4.69	12.0	18.80	—	—
	Critical yield Q (L/sec)	Optimum yield Q (L/sec)	Critical yield Q (L/sec)	Optimum yield Q (L/sec)	Critical yield Q (L/sec)	Optimum yield Q (L/sec)	Critical yield Q (L/sec)	Optimum yield Q (L/sec)	Critical yield Q (L/sec)	Optimum yield Q (L/sec)
	93.0	65.1	85.0	59.5	91.0	63.7	12.0	8.4	10.0	7.0

【Constant Discharge Test】

Charchara TW-No.1		Charchara TW-No.2		Charchara TW-No.3		Ashraf TW-No.2		Ashraf TW-No.3	
Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)	Discharge rate Q (L/sec)	Drawdown s (m)
93.0	0.88	85.0	4.29	91.0	4.58	12.0	16.85	12.0	38.65

*test was not carried out at Ashraf No.1well due to casing was damaged

APPENDIX-7 (7)　MULTIPLE WELL PUMPING TEST

Initially, it was planned to carry out a multiple well pumping test using all existing and test wells. However, due to the limitation of the quantity of pumps owned by the local contractor, the possibility of well interference was examined by operating simultaneously a combination of various wells of Charchara area and Ashraf area. The combination of wells for the survey in each area is shown below.

Table-1.　Combination of Wells for the Interference Test

Area	Interference test	Well combination
Charchara	Charchara (a)	Charchara TW-No.1 (test well) Charchara No.5 (existing well, non-operative) Charchara No.4 (existing well, operative))
	Charchara (b)	Charchara TW-No.2 (test well) Charchara No.2 (existing well, operative) Charchara No.3 (existing well, operative) Charchara No.4 (existing well, operative)
	Charchara (c)	Charchara TW- No.3 (test well) Charchara No.1 (existing well, operative) Charchara No.2 (existing well, operative) Charchara No.6 (existing well, non-operative)
Ashraf	Ashraf (a)	Ashraf TW-No.2 (test well) Ashraf TW-No.3 (test well)) Ashraf No.1 (existing well, operative) Ashraf No.2 (existing well, operative)

*non-operative: no pump installed in the well

(1)　Charchara (a) Test: Charchara TW-No.1, Charchara No.5, Charchara No.4

1)　Methodology of the Test

- The 110 kw pump was installed in Charchara TW-No.1 test well, and 24 hour’s constant discharge test was conducted at the rate of 95 L/sec. It was tried to pump with discharge rate of 93 L/sec which is the critical yield of the well, but due to difficulties in adjust the discharge rate, it was carried out with discharge rate of 95.L/sec.
- The 55 kw pump was installed in Charchara No.5 well, and 24 hours’ constant discharge test was started three hours after the Charchara TW No.1 test well has started pumping. The discharge rate was 35 L/sec, which is smaller than the amount of the optimum yield of 41 L/s in the Charchara No.5.

- The fluctuation of water level and discharge rate (by existing water meter) was observed in Charchara No.4 well that was in usual operation.

2) Transition of the Test

① Charchara TW-No.1 Test Well (SWL: G.L.-1.47m)

After start of the pumping, water level lowered to G.L.-2.74m immediately and it was further lowered to G.L.-2.81m gradually before the Charchara No.5 well was started three hours later. When Charchara No.5 well was started, the dynamic water level lowered 1 to 2cm immediately, and finally it was regarded to be at the equilibrium when the dynamic water level reached G.L.-2.91m. This amount of additional drawdown, i.e. 2.91 – 2.81 m = 0.10 m, was regarded to be the influence of the interference by Charchara No.5well. The discharge rate of Charchara TW No.1 test well was constant all through the constant discharge test.

② Charchara No.5 Well (SWL: G.L.-2.20m)

Charchara No.5 well is 281 m apart from Charchara TW-No.1 test well, and 110m apart from Charchara No.4 well. After the start of the test, the dynamic water level lowered to G.L.--6.30m immediately, and it was further lowered gradually to G.L.-6.75m after 10 hours. The dynamic water level recovered to G.L.-6.71m later and regarded to be at the equilibrium. When Charchara TW-No.1 test well stopped pumping after 21 hours, the dynamic water level of Charchara No.5 well recovered to G.L.-6.70m. The discharge rate of Charchara No.5 well remained constant all through the test.

③ Charchara No.4 Well (DWL before Charchara TW-No.1test well start pumping：G.L.-2.90m)

This well is around 380m apart from Charchara TW-No.1 test well.

According to the local contractor’s measurement of water level at Charchara No.4 well, the drawdown observed was 27cm after both Charchara TW-No.1 test well and Charchara No.5 well has started pumping. At the same time, the dynamic water level measured by the JICA Survey team was G.L.-3.70m and the level measured by the local contractor was G.L.-3.88m and a difference of 18cm was found. Therefore, it was considered reasonable to consider the drawdown of about 10cm as influence caused by interference. The discharge rate of the Charchara No.4 well remained almost constant at about 30.0 L/sec during the 27 hours’ test.

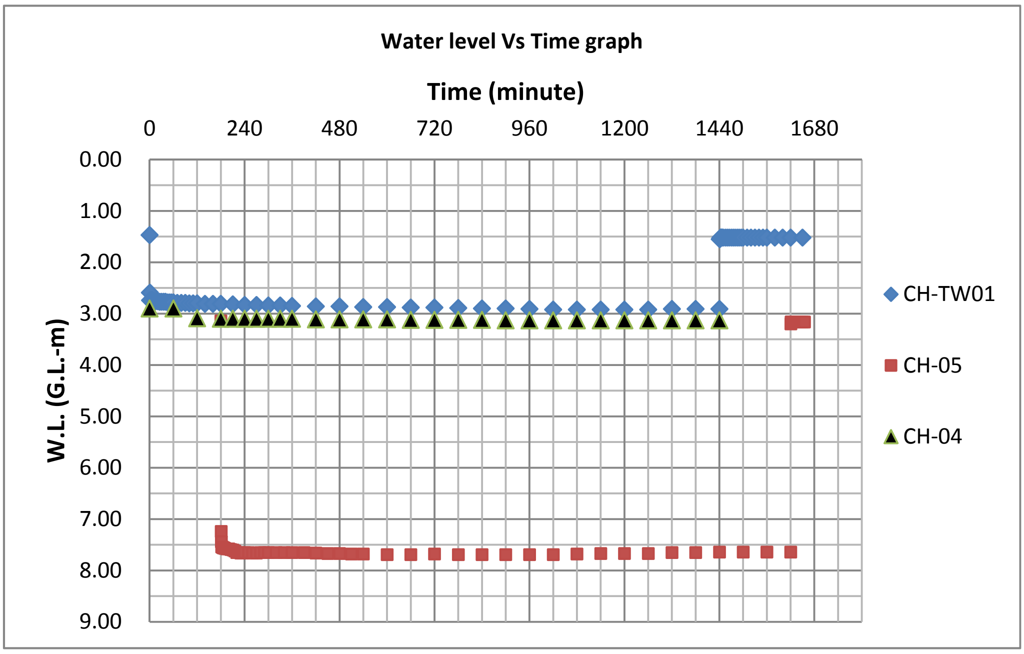


Figure-1. Result of Charchara (a) Interference Test

(2) Interference Test Charchara (b) : Charchara TW-No.2、Charchara No.2、Charchara No.3、Charchara No.4

1) Methodology of the Test

- The 110 kw pump was installed to the Charchara TW-No.2 test well, and tried to conduct constant discharge test at the discharge rate of 85.0 L/sec which is the critical yield of Charchara TW-No.1 test well. However, it was found difficulties in to adjust the discharge rate and the test was carried out with a discharge rate of 90.0 L/sec for 24 hours.
- In Charchara No.2, No.3 and No.4 wells, that were in usual operation, were observed the fluctuations of water level and the discharge rate

2) Transition of the Test

① Charchara TW-No.2 Well (SWL: G.L.-1.75m)

The water level lowered 4.35m (G.L.-6.10m) in 2 minutes after the start of the pumping. The drawdown lowered gradually to 4.43m (G.L.-6.18m) in 5 hours, and when the operation of Charchara No.3 well stopped at this moment, the dynamic water level raised by 5 cm (G.L.-6.13 m). When the operation of the Charchara No.3 well was resumed 7 hours after the start of the pumping, the dynamic water level lowered by 6 cm (G.L.-6.19 m). When the operation of the Charchara No.2, No.3 and No.4 wells were stopped 20 hours after the start of pumping, after stopped by two hours, the operation was resumed the water level lowered 4cm (G.L.-6.17m). It was not observed any changes in the discharge rate during 24 hours pumping with rate of 90 L/sec. In the recovery test, the water level recovered 4.39m (G.L.-1.88m) in 1 minute, and it recovered 2.50m (G.L.-1.80m) after 3 hours.

② Charchara No.2 Well (DWL before start the test: G.L.-3.88m)

This well is located about 284m apart from Charchara TW-No.2 test well and it was in usual operation when started the test.

The dynamic water level of the Charchara No.2 lowered 8 cm (G.L.-3.96 m) 45 minutes after Charchara TW-No.2 test well start pumping, and it seemed to be at the equilibrium. 5 hours later the operation of Charhchara No.2 well stopped and the water level recovered 32 cm (G.L.-3.64m). The operation of Charchara No.2 well resumed 2 hours later, and the dynamic water level lowered 11cm (G.L.-3.99m) 15 hours later and then reached the equilibrium. And 21 hours after the start of the test, the operation of Charchara No.2 well stopped again and the water level recovered 33cm (G.L.-3.66m). During the test, the discharge rate of the Charchara No.2 well remained stable around 11 L/sec.

When the pumping of the Charchara TW No.2 stopped after 24 hours test, the dynamic water level reached equilibrium 1 hour later with water level 3cm (G.L.-3.91m) lower than the initial dynamic water level.

③ Charhcara No.3 Well (DWL before start the test: G.L.-4.67m)

This well is located about 220m apart from Charchara TW-No.2 test well.

The dynamic water level lowered 2cm (G.L.-4.69m) 4 hours after the start of Charchara TW-No.2 test well pumping, and when the operation of the Charchara No.3 well stopped at the moment, the water level recovered 91cm (G.L.-3.78m) immediately. When the operation of Charchara No.3 well resumed 2 hours later, the water level again lowered 91 cm. The amount of additional drawdown when the Charchara TW-No.2 test well stopped pumping after 24 hours was 3cm (G.L.-4.70m), although the maximum amount of the additional drawdown was 5cm (G.L.-4.72m) observed 17 hours after the start of Charchara TW-No.2 test well pumping.

The dynamic water level of the Charchara No.3 well recovered 5cm (G.L.-4.65m) immediately after the pumping of the Charchara TW-No.2 test well stopped at the end of the test. The water meter was not installed to the Charchara No.3 well when the test was conducted.

④ Charchara No.4 Well (DWL before start the test: G.L.-3.01m)

The drawdown affected by the interference of Charchara TW-No.2 test well pumping was recorded to be 5cm (G.L.-3.06m) 21 hours after the start of the test. The operation of Charchara No.4

well stopped 21 hours after the start of the test and, the water level recovered 12cm (G.L.-2.99m). The water level again lowered 12cm (G.L.-2.99 m) when Charchara No.4 well resumed the operation 2 hours later. At the end of the test, Charchara TW-No.2 stopped pumping and the water level of Charchara No.4 well rose 7cm (G.L.-2.99m) which is 2cm higher than the water level measured before the start of the test. The discharge rate of 30 L/sec continued the same during the test.

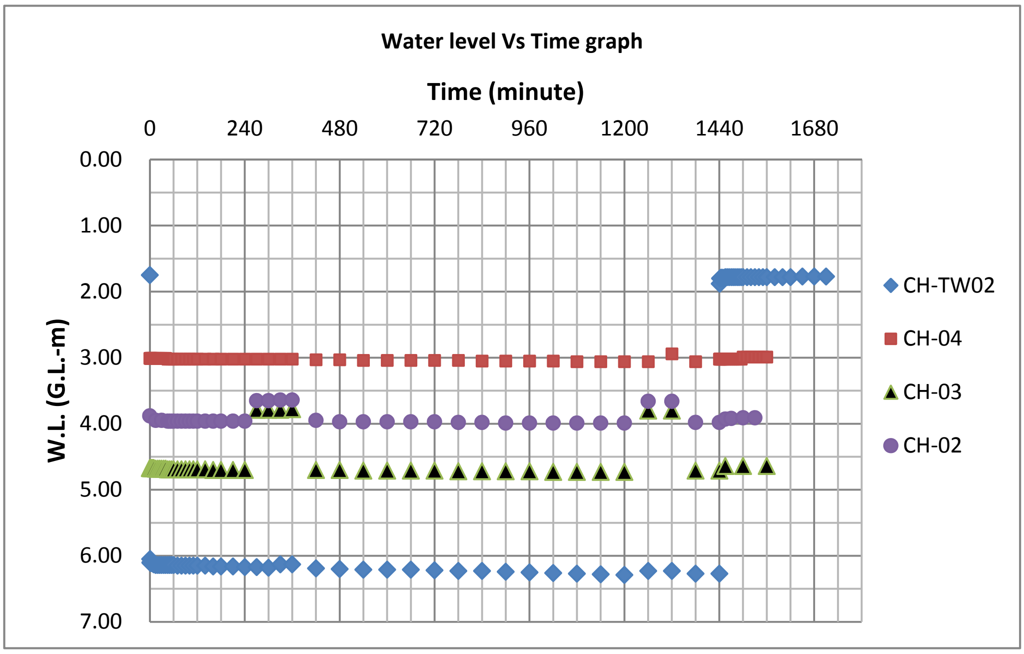


Figure-2. Result of Charchara (b) Interference Test

(3) Interference Test Charchara (c) : Charchara TW-No.3、Charchara No.1、Charchara No.2、Charchara No.6

1) Methodology of the Test

- 110 kw pump was installed in Charchara TW-No.3 test well and pumped for 24 hours with discharge rate of 91.0 L/sec that is the critical yield of the well
- A large capacity pump was installed at Charchara No.6 well and constant discharge test was started 2 hours later after the start of Charhcara TW-No.3 test well. The discharge rate of the test was 65 L/sec which is higher than the optimum yield of 51.5 L/sec.
- The measurement of water level fluctuation and the discharge rate by reading the water meters were carried out at Charchara No.1 and No.2 wells during the test.

2) Transition of the Test

① Charchara TW-No.3 Test Well (SWL: G.L.-5.09m)

The drawdown was 4.62m (G.L.-9.71 m) 40 minutes after the start of the test, and it lowered 10 cm (G.L.-9.81m) immediately after the pumping started at Charchara No.6 well. The drawdown caused by the influence of the interference of Charchara No.6 well pumping was culminated at 35cm (G.L.-10.06m) 22 hours after the start of the test, and it seemed that reached the equilibrium.

The discharge rate remained same during the test. In the recovery test, water level recovered to G.L.-5.20m in 4 minutes.

② Charchara No.6 Well (SWL: G.L.-1.90m)

This well is located around 233m apart from Charchara TW-No.3 test well.

The drawdown was 3.33m (G.L.-5.23m) 40 minutes after the start of the test, and it continued for 3 hours. It culminated at 3.39m (G.L.-5.26m) 21 hours after the start of the test. The operation of Charchara TW-No.3 test well stopped 22 hours after the start of the test, the dynamic water level rose16cm (G.L.-5.10m) which was regarded to be the influence of the interference caused by the pumping of Charchara TW-No.3 test well. The discharge rate remained same during the test. In the recovery test, water level recovered to G.L.-1.91m after 25 minutes.

③ Charchara No.1 Well (DWL before start the test:: G.L.-4.63m)

This well islocated around 434m apart from Charchara TW-No.3 test well and around 434m from Charchara No.6well.

The drawdown within 2 hours after the start of Charhcara TW-No.3 was 9cm (G.L.-4.72m). However, when the operation of Charchara No.1 well stopped due to power outage 2 hours after the start operation of Charchara TW-No.3 test well and it was almost the same time of the start of Charchara No.6 well, water level raised to G.L.-2.50m. 24 hours after when Charchara TW-No.3 test well stopped the operation, it rose 2.38cm. After 2 hours that Charchara No.6 well stopped the operation and the water level rose 2.24cm. Thus, it is supposed that the influence of interference caused by pumping Charchara TW-No.3 test well was 12cm and the influence caused by Charchara No.6 well was 14cm. It was observed that the discharge rate remained the same during the 26 hours of test apart of when power outage happened.

④ Charchara No.2 Well (DWL before start the test:: G.L.-3.86m)

This well is located around 210m apart from Charchara TW-No.3 test well and around 440m from Charchara No.6 well.

The drawdown caused by the influence of interference of the Charhcara No.6 well pumping was

4cm (G.L.-3.90m). It culminated at 17cm (G.L.-4.03m) after 23 hours, and when the Charchara TW-No.3 test well stopped 24 hours after the start of the test, the dynamic water level rose 9cm (G.L.-3.94m). Thedischarge rate remained same during the test.

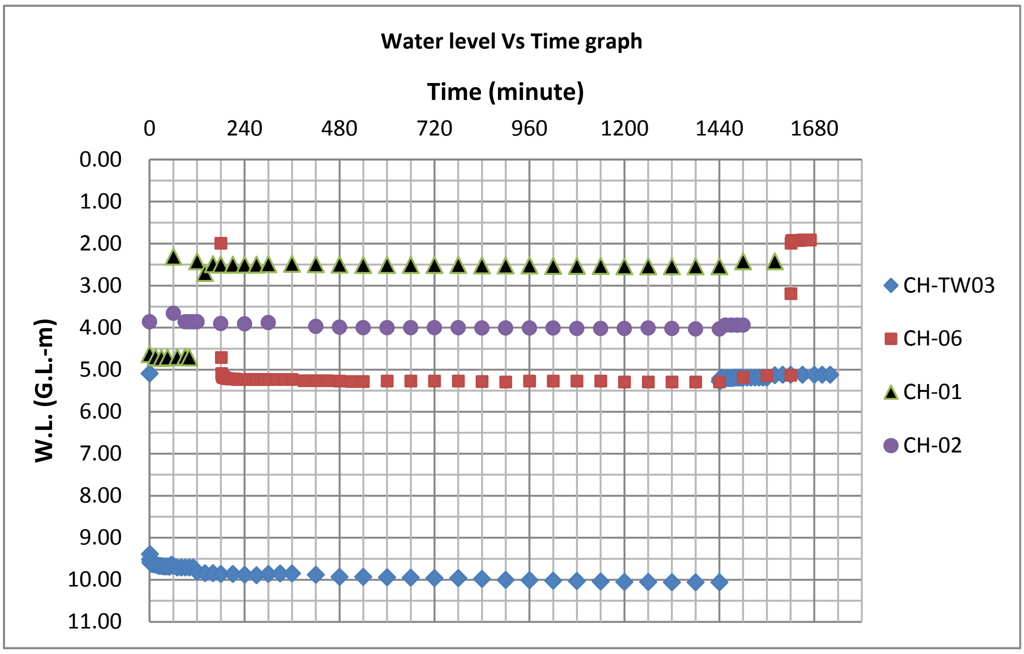


Figure-3. Result of Charchara (c) Interference Test

(4) Ashraf (a) interference Test：Ashraf TW-No.2、Ashraf TW-No.3、Ashraf No.1、Ashraf No.2

1) Particular Remarks on Aquifer of Ashraf Well Field

In Ashraf area, same as in Charchara area, it was supposed that this area is recharged from the western side of the Abay River passing through underneath the bottom of the river. However, the static water level of Ashraf aquifer, comparing with the static water level of Charchara No.2, No.3 and No.4 wells of Charchara Well Field, the elevation is about 10cm lower. And according to the on-site water quality analysis it was confirmed that the temperature of water is slightly higher and the concentration of nitrate is slightly lower compared to Charchara Well Field.

From these facts, it is inferred that the Ashraf aquifer, same as Charachara aquifer is an aquifer appears to be an aquifer of Qv2A lava flow layer, but located below the Charchara aquifer.

In the Ashraf Well Field 2 existing wells, i.e. the Ashraf No.1 and No.2 well, were alternately operated, being the former operating for 4 hours and being the latter operating for twenty 20 hours a day. In the Ashraf No.2 the pump was broken in January 2016 and it was replaced with a larger capacity pump, and the pumping rate increased from 18.3 L/sec with previous pump to 22.7 L/sec with new pump and the drawdown during the operation of Ashraf No.2 well increased from 2m to

7m.

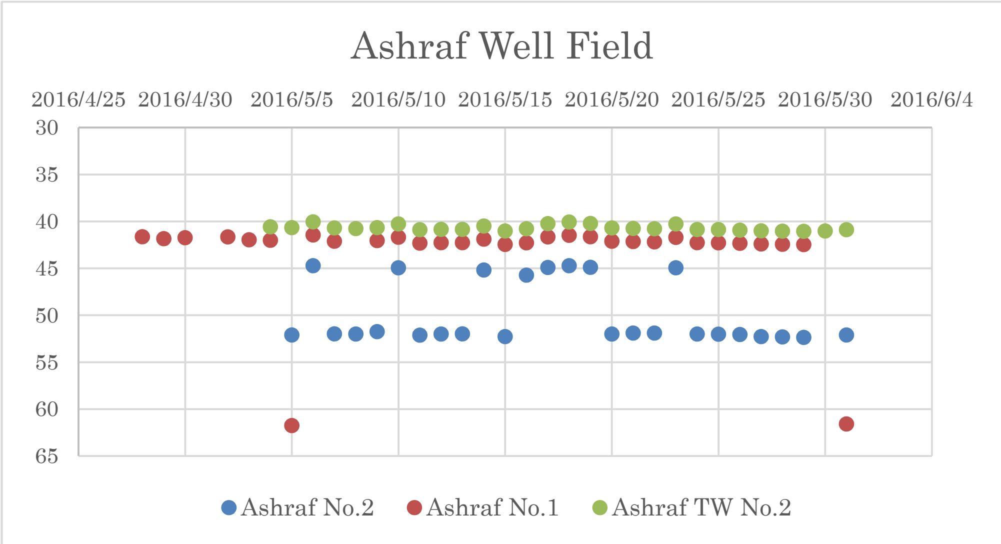


Figure-4. Variation of water Level in Ashraf Well Field (2016/Mar./26~Jun./3)

Figure-4 shows the variation of water level of each well of Ashraf Well Field during approximately 1 month. The drawdown of Ashraf No.1 and No.2 well was about 20m and 7m respectively. From middle of April, there was a precipitation of the light rain season and the water level of the wells was almost stable. The variation of the water level of Ashraf No.1 well and Ashraf No.2 well shows the same trend and it can be seen that decreases when Ashraf No.2 well starts to operate and decrease when operation stops.

2) Location of Wells of Ashraf Well Field

Figure-5 shows the location of the wells of Ashraf Well Field. The distance between Ashraf No.1 well and Ashraf No.2 is 140m, the distance between Ashraf No.1 well and Ashraf TW-No.2 test well is 137m and the distance between Ashraf TW-No.2and Ashraf TW-No.3 test wells is 262m.

Figure-5.　Location Map of Wells of Ashraf Well Field

3)　Methodology of the Test

- 55kw pump was installed in Ashraf TW-No.3 test well and the discharge rate was 17 L/sec
- 22kw pump was installed in Ashraf TW-No.2 test well and the discharge rate was 12 L/sec. The pump started operation 1 hour after started the operation of Ashraf TW-No3 test well.
- Ashraf No.1 and Ashraf No.2 wells were operating alternately as usual. However a power outage occurred 2 times during the execution of the test.

4)　Transition of the Test

Regarding Ashraf TW-No.3 test well, it was found that the water level is significantly different form the other 3 wells and was not influenced by the interference of other 3 wells during the test. And the aquifer of Ashraf TW-No.3 test well would be considered as an aquifer apart from the aquifer of the other 3 wells. The schematic profile of Ashraf Well Field is shown below.

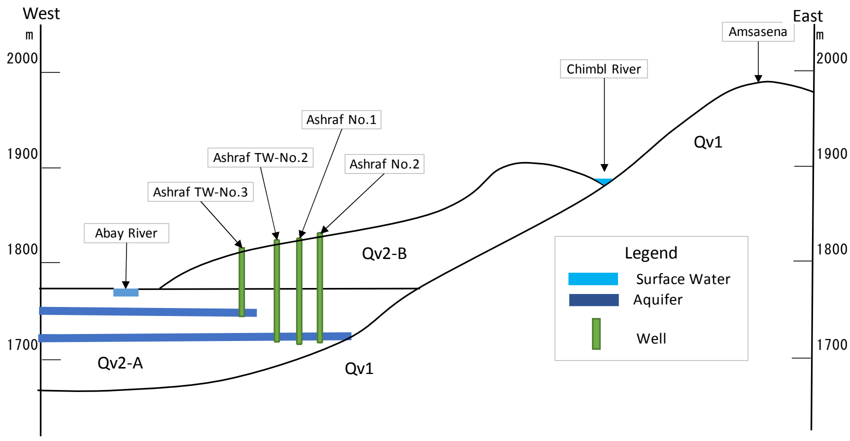


Figure-6.　Schematic Profile of Ashraf Well Field

The drawdown of Ashraf TW-No.2 was 8.13m in 55 minutes after starting the operation. When the operation of Ashraf No.2 well stopped due to the first power outage, the water level of Ashraf TW-No.2 test well rose 31cm. And after 4 hours when operation of Ashraf No.2 resumed, it was observed a drawdown of 8.96m.

The difference of 1.14m between the water level of Ashraf TW-No.2 test well recovered during the power outage and the operation resumed in Ashraf No.2 well could be considered as an influence of the interference caused by Ashraf No.2 well to Ashraf TW-No2 test well.

On the other hand, the water level of Ashraf No.2 suddenly decreased 37cm 1hour after Ashraf TW-No.2 starts operation and this drawdown could be considered as the influence of interference cause by Ashraf TW-No.2 test well to Ashraf No.2 well.

Since Ashraf No.1 and No2 wells operate alternately, although there is no mutual interference during operation. But after around 3.5 hours power outage and operation of Ashraf No.2 well resumed, the water level of Ashraf No.1 well decreased 37cm and this drawdown could be considered as the influence of interference cause by Ashraf No.2 well ton Ashraf No.1 well.

During the test there was one opportunity where Ashraf No. 2 well was not operating and Ashraf No.1 well was operating, and at this time the water level of the adjacent Ashraf TW-No.2 test well has risen.

It can be understood as that the influence of interference caused by Ashraf No.2 well on Ashraf TW-No.2 test well is too large that hided the Influence caused by Ashraf No.1 well.

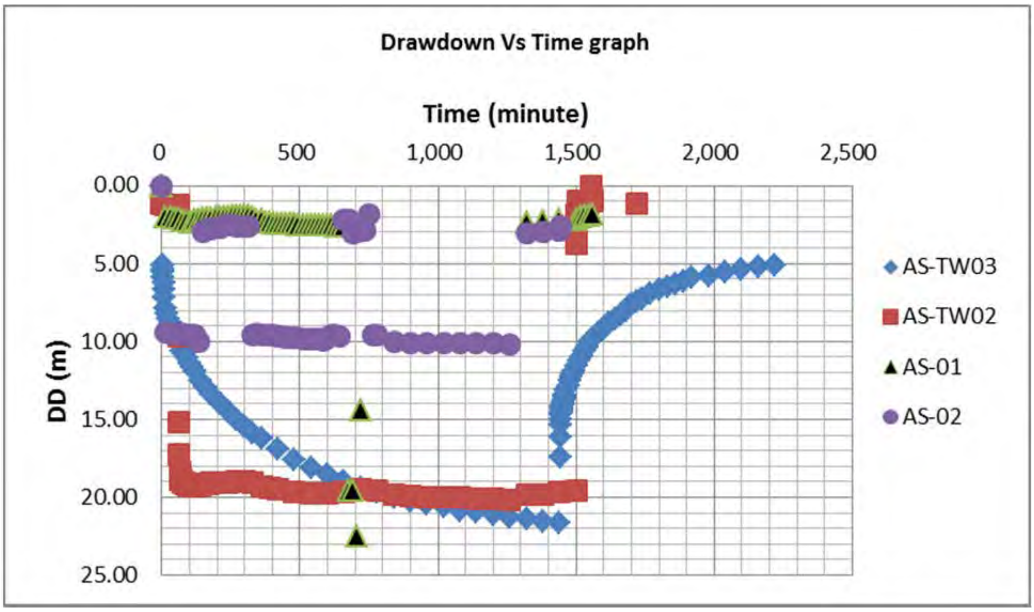


Figure-7. Result of Well Interference Test in Ashraf Well Field.

Appendix-7 (8) Results of Water Quality Test

Parameters	Unit	CES 58 *1	Existing Wells					Springs		
		Max. Permissible Level	Charchara No.1	Charchara No.3	Charchara No.4	Ashraf No.2	Gudobahar No.1	Areke	Lome	Tikur Wuha
Temperature *2	°C	---	24.3	24.3	24.4	25.1	24.0	23.9	23.9	23.8
Electric Conductivity *2	mS/m	---	31.5	26.8	25.4	34.5	23.5	19.8	20,.1	20.9
pH *2	---	6.5 - 8.5	6.79	6.91	6.88	6.78	6.85	6.27	6.34	6.36
Turbidity *3	NTU	5	<1.0	2.0	1.0	3.0	3.0	2.0	<1.0	2.0
Colour	TCU	15	ND	1.0	0.0	<0.0	0.0	<0.0	<0.0	<0.0
Odour	---	unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable
Taste	---	unobjectionable	Good	Good	Good	Good	Good	Good	Good	Good
Total hardness (as CaCo3)	mg/l	300	84.3	83.2	68.4	96.1	69.7	56.1	58.0	69.8
Total dissolved solids (TDS)	mg/l	1,000	144.0	120.0	108.0	167.0	107.0	91.4	86.0	91.5
Total Iron (as Fe)	mg/l	0.3	<0.01	<0.01	<0.01	0.11	<0.01	0.05	0.15	0.01
Manganese (as Mn)	mg/l	0.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia (NH3+NH4)	mg/l	1.5	<0.013	<0.013	<0.013	0.019	<0.013	<0.013	<0.013	<0.013
Residual, free chlorine *2	mg/l	0.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Anionic surfactants, as mass concentration of MBAS	mg/l	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium (as Mg)	mg/l	50	21.0	17.3	14.9	17.8	16.4	11.5	11.0	12.8
Calcium (as Ca)	mg/l	75	61.0	64.0	53.0	76.0	46.0	42.0	43.0	55.0
Copper (as Cu)	mg/l	2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc (as Zn)	mg/l	5	0.58	1.07	0.52	1.06	2.49	4.31	3.01	5.44

Parameters	Unit	CES 58 *1	Existing Wells					Springs		
		Max. Permissible Level	Charchara No.1	Charchara No.3	Charchara No.4	Ashraf No.2	Gudobahar No.1	Areke	Lome	Tikur Wuha
Sulfates (as SO4)	mg/l	250	<5.0	10.0	9.0	15.0	11.0	<5.0	<5.0	<5.0
Chloride (as Cl)	mg/l	250	<10.0	<10.0	<10.0	21.0	<10.0	13.0	17.0	16.0
Total alkalinity (as CaCO3)	mg/l	200	150.0	151.0	133.0	223.0	116.0	110.0	100.0	110.0
Sodium (as Na)	mg/l	200	<10.0	<10.0	<10.0	<10.0	<10.0	22.0	25.0	10.0
Potassium (as K)	mg/l	1.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Aluminium (as Al)	mg/l	0.2	Nil	Nil	Nil	Nil	0.01	0.01	Nil	0.01
Bicarbonate (HCO3) *4	mg/l	---	17.08	12.20	9.76	19.52	9.76	7.32	7.32	4.88
Barium (as Ba)	mg/l	0.7	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Total mercury (as Hg)	mg/l	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cadmium (as Cd)	mg/l	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (as As)	mg/l	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide (as CN)	mg/l	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite (as NO2)	mg/l	3	0.036	0.0066	0.0066	0.056	0.013	0.023	0.023	0.013
Nitrate (as (NO3)	mg/l	50	16.8	13.3	<2.2	7.1	17.9	13.3	14.1	12.4
Phenotic coumpound (as phenols)	mg/l	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (as Pb)	mg/l	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron (as B)	mg/l	0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium (as Se)	mg/l	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoride (as F)	mg/l	1.5	0.13	0.16	0.16	0.2	<0.08	<0.08	<0.08	<0.08

Parameters	Unit	CES 58 *1	Existing Wells					Springs		
		Max. Permissible Level	Charchara No.1	Charchara No.3	Charchara No.4	Ashraf No.2	Gudobahar No.1	Areke	Lome	Tikur Wuha
Chromium (as Cr)	mg/l	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.039
DDT	mg/l	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor and heptachlor epoxide	mg/l	0.03	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
Hexchlorobenzene	mg/l	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (Gamma - BHC)	mg/l	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	mg/l	20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin / Dieldrine	mg/l	0.03	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
1,2 Dichloroethane	mg/l	30	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
1,1,1 Trichloroethane	mg/l	2001	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Trichloroethene	mg/l	70	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorobenzenes (total)	mg/l	20	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hexachlorobutadiene	mg/l	0.6	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
Coliform organisms	number/100 ml	must not be detectable								
E. Coli	number/100 ml	must not be detectable								

*1: CES 58: Compulsory Ethiopian Standard (First edition, 2013) Drinking Water - Specifications ICS:13:060.20

*2: Parameters measured on site

*3: 1 FAU = 1 NTU (formazin measured as type of standard)

*4: mg/l = meq/l x equivalent weight (Equivalent weght of Bicarbonate= 61)

Parameters	Unit	CES 58 [*1]	Public Taps		Test Wells				
		Max. Permissible Level	Public Tap - Zone B	Public Tap - Zone C	Charchara TW-No.1	Charchara TW-No.2	Charchara TW-No.3	Ashraf TW-No.2	Ashraf TW-No.3
Temperature [*2]	°C	---	24.1	26.8	23.2	22.7	23.4	23.4	25.2
Electric Conductivity [*2]	mS/m	---	27.4	27.0	24.2	29.5	30.6	36.0	48.7
pH [*2]	---	6.5 - 8.5	7.05	6.82	6.62	6.70	6.60	6.92	7.22
Turbidity	NTU	5	3.00	<1.0	<1.0	<1.0	1.46	Trace	1.00
Colour	TCU	15	5.00	<0.0	ND	ND	Colourless	Colourless	ND
Odour	---	unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable	Odourless	Odourless	Odourless
Taste	---	unobjectionable	Good	Good	Good	Good	Tastless	Tastless	Tastless
Total hardness (as CaCo3)	mg/l	300	73.30	74.10	60.60	141.00	164.00	188.00	106.00
Total dissolved solids (TDS)	mg/l	1,000	120.00	127.00	125.00	128.00	172.00	222.00	310.00
Total Iron (as Fe)	mg/l	0.3	0.11	0.04	0.03	<0.01	0.03	0.03	0.08
Manganese (as Mn)	mg/l	0.5	<0.05	<0.05	<0.05	<0.05	Trace	Trace	Trace
Ammonia (NH3+NH4)	mg/l	1.5	<0.013	<0.013	<0.013	<0.013	0.23	0.21	0.19
Residual, free chlorine [*2]	mg/l	0.5	0.0	0.0	N/A	N/A	N/A	N/A	N/A
Anionic surfactants, as mass concentration of MBAS	mg/l	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium (as Mg)	mg/l	50	14.30	14.10	10.60	14.00	10.56	14.40	6.24
Calcium (as Ca)	mg/l	75	59.00	60.00	39.00	39.00	48.00	51.20	32.00
Copper (as Cu)	mg/l	2	<0.10	<0.10	<0.10	<0.10	Trace	Trace	Trace
Zinc (as Zn)	mg/l	5	1.29	4.63	3.02	2.38	0.04	0.04	

Parameters	Unit	CES 58 [*1]	Public Taps		Test Wells				
		Max. Permissible Level	Public Tap - Zone B	Public Tap - Zone C	Charchara TW-No.1	Charchara TW-No.2	Charchara TW-No.3	Ashraf TW-No.2	Ashraf TW-No.3
Sulfates (as SO4)	mg/l	250	<5.0	<5.0	<5.0	<5.0			<5.0
Chloride (as Cl)	mg/l	250	22.00	24.00	<10.0	<10.0	5.96	5.54	5.96
Total alkalinity (as CaCO3)	mg/l	200	150.00	150.00	132.00	163.00	162.00	200.00	280.28
Sodium (as Na)	mg/l	200	18.0	<10.0	12.0	29.0	10.2	35.0	85.0
Potassium (as K)	mg/l	1.5	<5.0	<5.0	<5.0	<5.0	0.7	2.0	2.7
Aluminium (as Al)	mg/l	0.2	Nil	Nil	0.04	0.035	Trace	Trace	Trace
Bicarbonate (HCO3)	mg/l	---	12.20	9.76	9.76	9.76	197.64	244.00	341.94
Barium (as Ba)	mg/l	0.7	Trace	Trace	Trace	Trace	1.0	Trace	Trace
Total mercury (as Hg)	mg/l	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cadmium (as Cd)	mg/l	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (as As)	mg/l	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide (as CN)	mg/l	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite (as NO2)	mg/l	3	0.013	0.0066	0.001	0.01	0.005	0.007	0.025
Nitrate (as (NO3)	mg/l	50	12.0	12.0	<2.2	7.6	17.7	0.02	<0.9
Phenotic coumpound (as phenols)	mg/l	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (as Pb)	mg/l	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron (as B)	mg/l	0.3	<0.05	<0.05	<0.05	0.05	Trace	Trace	Trace
Selenium (as Se)	mg/l	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoride (as F)	mg/l	1.5	<0.08	<0.08	<0.08	<0.08	0.46	0.20	0.52
Chromium (as Cr)	mg/l	0.05	<0.01	0.022	<0.01	<0.01	Trace	0.01	Trace

Parameters	Unit	CES 58 [*1]	Public Taps		Test Wells				
		Max. Permissible Level	Public Tap - Zone B	Public Tap - Zone C	Charchara TW-No.1	Charchara TW-No.2	Charchara TW-No.3	Ashraf TW-No.2	Ashraf TW-No.3
DDT	mg/l	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor and heptachlor epoxide	mg/l	0.03	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
Hexchlorobenzene	mg/l	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (Gamma - BHC)	mg/l	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	mg/l	20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin / Dieldrine	mg/l	0.03	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
1,2 Dichloroethane	mg/l	30	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
1,1,1 Trichloroethane	mg/l	2001	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Trichloroethene	mg/l	70	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorobenzenes (total)	mg/l	20	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hexachlorobutadiene	mg/l	0.6	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
Coliform organisms	number/100ml	must not be detectable							
E. Coli	number/100ml	must not be detectable							

*1: CES 58: Compulsory Ethiopian Standard (First edition, 2013) Drinking Water - Specifications ICS:13:060.20

*2: Parameters measured on site

*3: 1 FAU = 1 NTU (formazin measured as type of standard)

*4: mg/l = meq/l x equivalent weight (Equivalent weght of Bicarbonate= 61)

Appendix-7 (9)　Results of Socio-Economic Survey

1　Objectives and Methodology

A household survey was conducted to confirm the present situation of water supply, the awareness of residents, and the use of water sources etc. The target zone was divided into eleven areas. Then, residents of each area were interviewed on gender aspects, water supply situation, household income, and water billing and payment. Interviews were conducted about the use of different public water supply options as well as other water sources.

・Target Areas

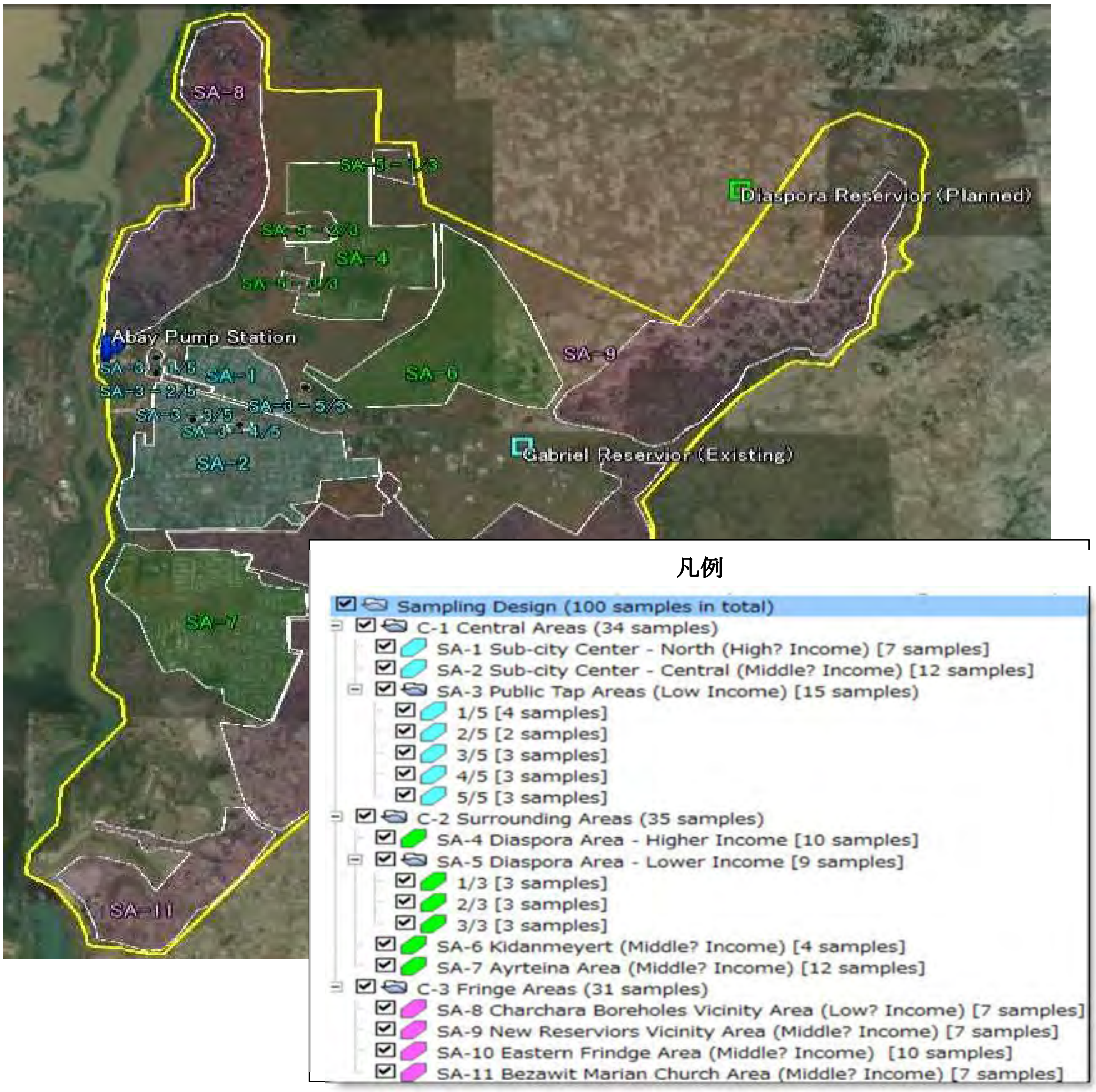


Figure 1　Target Areas

The 11 sampling areas were categorized into the following three geographical area categories: C-1 (Central Areas), C-2 (Surroundig Areas), and C-3 (Fringe Area). These sampling areas include communities of minority ethnic groups located in Charchara and Diaspora districts. In addition, they include residential areas of low-income groups that are using existing public faucets. 7 to 15 households were randomly selected as samples from each target area.

2 Results

(1) Size and Income for Households in the Sampling Areas

Table 1 describes the size, income, and electricity expenditures for households from each sampling area.

Table 1 Size, Income, and Electricity Expenditures for Households in Each Sampling Area

Geographical Area Category	C-1: Central Areas				C-2: Surrounding Areas					C-3: Fringe Areas					Average of the Categories`s values
Sampling Area ID and Name	SA-1: Sub-city Center – North	SA-2: Sub-city Center – Central	SA-3: Public Tap Areas	Average of the Areas' values	SA-4: Diaspora Area – Higher Income	SA-5: Diaspora Area – Lower Income	SA-6: Kidanmeyert Area	SA-7: Ayrteina Area	Average of the Areas' values	SA-8: Charchara Boreholes Vicinity Area	SA-9: New Reservoirs Vicinity Area	SA-10: Eastern Fringe Area	SA-11: Bezawit Marian Church Area	Average of the Areas' values	
Number of Sampled Households	5.7	5.8	6.7	6.0	5.8	5.3	4.5	5.4	5.3	5.6	4.9	5.2	5.0	5.2	5.5
Average Total Household Income (Birr/month)	4,417	3,646	2,600	3,554	4,900	2,844	1,088	3,825	3,164	1,357	1,595	1,666	1,231	1,462	2,727
Income level of the Area	High	Middle	Low	—	High	Middle	Very Low	Middle	—.	Very Low	Very Low	Very Low	Very Low	—	—
Electricity Expense (Birr/month)	255	175	97	176	313	133	147	217	202	111	79	74	76	85	154
Electricity Expense % to the Total Income	5.8	4.8	3.7	4.8	6.4	4.7	13.5	5.7	7.6	8.2	4.9	4.4	6.2	5.9	6.1
the Households Washing their Hand with Soap	67	100	93	87	70	71	25	83	62	14	14	30	29	22	57
Average frequency of having water-borne diseases (times/year/ household)	1.4	2.7	1.2	1.8	2.0	3.2	2.3	1.5	2.3	3	5.5	1.5	3.6	3.4	2.5

As it is shown in Table 1, the 11 sampling areas were classified into four income groups based on their sampled households' average total household income as follows.

Very Low Income Group:	Less than Br 2,000/month	1,000 ETB /month	National poverty line set in 2010-2011
Low Income Group:	Br 2,001 to Br 3,000/ month	←	
Middle Income Group:	Br 3,001 to Br 4,000/ month		
High Income Group:	Greater than Br 4,000/month	← 3,000 ETB /month	Global poverty line set by the World Bank in 2015

In addition, different colors were used to illustrate the four income groups.

(2) Waterborne Diseases

Details about waterborne diseases are shown in Table 2.

Table 2 Causes of Morbidity of Infants and Children under 5 Years old in Hidar 11 Kebele in 2014-2015

Rank	Diseases	No of Cases	(%)
1	Diarrhea (non-bloody)	895	31.6
2	Acute upper respiratory infections	639	22.5
3	Pneumonia	449	15.8
4	Helminthiasis	238	8.4
5	Skin Infection & subcutaneous tissue	230	8.1
6	Other or unspecified disease of the eye	116	4.1
7	Bloody Diarrhea	88	3.1

Source: The Hidar 11 Health Center

(3) Use of Different Types of Public Water Supply and the Other Water Sources

Table 3 shows uses and costs associated with different water supply options and other water sources. Next, it highlights average water supply hours, level of satisfaction of public water supply users, and the reasons of satisfaction and dissatisfaction.

Table 3 Uses and Costs related to Different Water Supply Options and Other Water Sources

Area Category			C-1: Central Areas				C-2: Surrounding Areas					C-3: Fringe Areas				
Sampling Area ID and Name			SA-1: Sub-city Center – North	SA-2: Sub-city Center – Central	SA-3: Public Tap Areas	Average of the Areas values	SA-4: Diaspora Area – Higher Income	SA-5: Diaspora Area – Lower Income	SA-6: Kidanmeyert Area	SA-7: Ayrteina Area	Average of the Areas values	SA-8: Charchara Boreholes Vicinity Area	SA-9: New Reservoirs Vicinity Area	SA-10: Eastern Fringe Area	SA-11: Bezawit Marian Church Area	Average of the Areas values
Income Level of the Area			High	Middle	Low	-	High	Middle	Very Low	Middle	- .	Very Low	Very Low	Very Low	Very Low	-
Average Total Per Capita Water Consumption (L/day/capita)			86	87	38	70	58	36	36	67	49	32	20	33	18	26
Average Total Monthly Expenditure for Water (other than the bottled water)	(Birr/month/ household)		53	75	41	56	37	33	22	47	37	10	21	27	-	19
	% to the Total Income		1.2	2.1	1.6	1.6	0.8	1.2	2.0	1.2	1.3	0.7	1.3	1.6	-	1.2
% of the Sampled Households using a Contain Type of Public Water Supply or Other Water Source, Average Per Capita Water Consumption among its Users (L/day/capita) in [ ], and Average Monthly Cost (Birr/month/household) among its Users in { }	Public Water Supply	Any Public Water Supply	100 [85]{53}	100 [75]{66}	93 [29]{28}	97	100 [45]{27}	100 [22]{24}	75 [24]{30}	100 [63]{44}	94	0	0	80 [22] {13}	0	20
		House ConnectionSupply	71 [76]{64}	33 [76]{65}	13 [69]{45}	39	70 [46]{26}	33 [21]{23}	0	42 [89]{57}	36	0	0	0	0	0
		Unshared Yard Connection	29 [106]	67 [76]{66}	53 [27]{28}	50	30 [45]{29}	22 [21]{23}	50 [24]{22}	58 [47]{35}	40	0	0	40 [31]{26}	0	10
		Shared Yard Connect.-Owner	0	0	0	0	0	22 [34]{15}	0	0	6	0	0	0	0	0
		Shared Yard Connect.-Neigh.	14	0	0	5	0	22 [11]{45}	25 [20]{45}	0	12	0	0	0	0	0
		Public Tap	0	0	33 [11]{17}	11	0	0	0	0	0	0	0	40 [15] {0}	0	10
		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Well	Unshared Own Well	0	0	13	4	0	0	0	0	0	43 [15]	43 [9]	0	0	21
		Shared Own Well	0	0	0	0	0	0	0	0	0	14 [4]	14 [10]	0	0	7
		Shared Other's Well	0	0	0	0	0	0	50 [6]	0	13	43 [13]	29	10	0	20
		Community Well	0	0	0	0	0	0	25 [8]	0	6	0	0	0	0	0
		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Natural Water Source	Spring	0	0	0	0	0	0	25 [8]	0	6	0	14 [10]	0	43 [8]	14
		River	0	0	13 [15]	4	10	11 [5]	75 [14]	0	24	14 [20]	29 [6]	60 [8]	71 [11]	44
		Stream	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Lake	0	0	0	0	0	0	0	0	0	14 [20]	0	0	0	4
		Pond	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rain Water Harvesting		43 [3]	67 [15]	67 [6]	59	70 [12]	89 [10]	25 [3]	25 [9]	52	71 [16]	71 [11]	90 [9]	71 [9]	76
	Water Vender	From Neigh-bor's Yard Tap	0	0	20 [6]{39}	7	10 [8]{30}	22 [9]{30}	0	25 [3]{12}	14	0	0	10 [10]{45}	0	3
		From Public Tap	0	0	20 [9]{32}	7	10	22 [5]{15}	0	0	8	0	0	0	0	0
		From Other	14	25 [7]{36}	0	13	40 [8]{23}	11 [10]{15}	0	0	13	29 [8]{34}	14 [2]{8}	30 [11]{30}	14 [7]	22
	Other		0	0	0	0	20 [0.2]{0}	0	0	0	5	0	0	10 [10]{30}	0	3

Table 4 : Water Supply Hours, Level of Satisfaction, and Reasons of Satisfaction and Dissatisfaction

Area Category			C-1: Central Areas			C-2: Surrounding Are				C-3: Fringe Areas			
Sampling Area ID and Name			SA-1: Sub-city Center – North	SA-2: Sub-city Center – Central	SA-3: Public Tap Areas	SA-4: Diaspora Area – Higher Income	SA-5: Diaspora Area – Lower Income	SA-6: Kidanmeyert Area	SA-7: Ayrteina Area	SA-8: Charchara Boreholes Vicinity Area	SA-9: New Reservoirs Vicinity Area	SA-10: Eastern Fringe Area	SA-11: Bezawit Marian Church Area
Income Level of the Area			High	Middle	Low	High	Middle	Very Low	Middle	Very Low	Very Low	Very Low	Very Low
% of Public Water Supply Users			100	100	100	100	100	75	100	0	0	80	0
Average Water Supply Hours	(Days per week)		6.0	5.8	5.3	2.4	2.5	4.3	6.0	-	-	4.8	-
	(Hours per day)		20.0	17.8	15.5	9.0	11.6	18.7	17.2	-	-	19.5	-
% of the Households having Significant Seasonal Differences in Water Supply Conditions among the Public Water Supply Users			71	75	60	90	44	100	75	-	-	38	-
Described Differences in Water Supply Conditions between Dry and Rainy Seasons			Shortage in dry season & poor quality in rainy season			Shortage and low pressure in dry season	Shortage in dry season		Shortage in dry season & poor quality in rainy season			Shortage in dry season	
% of the Satisfied Households among the Public Water Supply Users			43	50	20	0	0	0	50	-	-	50	-
Reasons of Dissatisfaction expressed by the Dissatisfied Users (multiple reasons allowed) in % (e.g. 30% if selected by 3 users out of 10 dissatisfied users)	Common	a. Low amount	50	83	67	80	89	100	-	-	-	-	-
		b. Limited hours	25	67	83	90	100	100	-	-	-		-
		c. Low pressure	50	50	42	90	33	0	-	-	-	38	-
		d. Low quality	25	50	25	10	0	0	-	-	-	0	-
		1. bad smell	*0*	*33*	*0*	*0*	-	-	-	-	-	-	-
		2. bad taste	*0*	*0*	*33*	*100*	-	-	-	-	-	-	-
		3. turbidity	*100*	*100*	*100*	*0*	-	-	-	-	-	-	-
		4. colored	*0*	*67*	*67*	*0*	-	-	-	-	-	-	-
		5. not safe	*0*	*0*	*0*	*0*	-	-	-	-	-	-	-
		e slow leakage repair	0	33	33	30	0	67	-	-	-	0	-
		f. expensive connection	0	0	0	20	0	0	-	-	-	0	-
	Own Connection	g. expensive	50	50	17	0	0	67	-	-	-	13	-
		h. meter malfunction	25	0	0	10	0	0	-	-	-	0	-
		i. bad services	25	0	0	30	33	33	-	-	-	0	-
	Shared Yard Tap Neighbo	j. limited access	0	-	-	-	0	0	-	-	-	-	-
		k. too far	0	-	-	-	0	0	-	-	-	-	-
		l. expensive	0	-	-	-	22	0	-	-	-	-	-
	Public Tap	m. limited access	-	-	50	10	-	-	-	-	-	50	-
		n. too far	-	-	8	0	-	-	-	-	-	38	-
		o. expensive	-	-	0	0	-	-	-	-	-	13	-
		p. needs repair	-	-	0	0	-	-	-	-	-	25	-
		q. more functions	-	-	0	0	-	-	-	-	-	13	-
		r. too many users	-	-	58	10	-	-	-	-	-	38	-
		s. bad management	-	-	8	0	-	-	-	-	-	0	-
	Common	t. other	0	0	8	0	-	-	-	-	-	0	-
Reasons of Satisfaction In %	a. good and affordable price		100	33	33	-	-	-	83	-	-	-	-
	b. sufficient amount		100	67	100	-	-	-	100	-	-	-	-
	c. sufficient pressure		33	83	100	-	-	-	83	-	-	-	-
	d. sufficient water quali		33	50	67	-	-	-	100	-	-	-	-
	e. good water quality		33	0	67	-	-	-	50	-	-	-	-
	f. good water services		0	33	0	-	-	-	0	-	-	-	-
	g. others		0	0	0	-	-	-	0	-	-	-	-

Appendix-7 (10) Socio-economic Information of Affected Households

Sheet for Socio-economic Survey of Affected People

No.	Project Affected Persons at Selected Project Sites	Area Acquired for the Project (m2)	Socio Economic Survey (as of December, 2016)													
			Information of Affected Household						Possession of Landholding Certificate at the Time of Land Acquisition (Yes or No)	Total Area of Other Land Holdings (m2)	Percentage of Area Acquired by the Project	Total Household Income (ETB/month)	Source of Income		Cultural	
			Size of Household (persons)	Gender of Household Head (male or female)	Number of Women	Number of Children (0-14 y.o.)	Number of Elderly (65 y.o.)	Number of persons with disabilities					Primary Source	Secondary Source	Ethnicity	Religion
I	Charchara TW-No.1															
1		539	4	F	2	1	—	—	Yes	8,000	6.7	2,600	Agriculture	—	Amhara	Christianity
2		320	6	M	4	4	—	—	Yes	5,000	6.4	2,000	Agriculture	—	Amhara	Christianity
3		416	5	M	2	2	—	—	Yes	4,000	10.4	2,200	Agriculture	—	Amhara	Christianity
	Sub Total	1,275														
II	Charchara TW-No.2															
1		378	9	M	7	1	—	1	Yes	10,000	3.8	4,600	Agriculture	—	Amhara	Christianity
2		378	6	M	3	2	—	1	Yes	2,675	14.1	2,500	Agriculture	—	Amhara	Christianity
3		378	7	F	3	2	—	—	Yes	12,000	3.1	4,067	Agriculture	—	Amhara	Christianity
4		504	7	M	3	—	—	1	Yes	2,900	17.4	4,200	Agriculture	—	Amhara	Christianity
5		504	4	F	3	1	—	—	Yes	6,900	7.3	3,000	Agriculture	—	Amhara	Christianity
6		378	6	F	3	1	—	—	Yes	3,675	10.3	1,200	Agriculture	—	Amhara	Christianity
7		378	4	M	2	1	—	—	Yes	4,675	8.1	2,900	Agriculture	—	Amhara	Christianity
8		378	5	M	3	2	—	—	Yes but lost	2,675	14.1	2,900	Agriculture	—	Amhara	Christianity
9		378	3	M	1	1	—	—	Yes	2,675	14.1	2,300	Agriculture	—	Amhara	Christianity
10		378	6	M	2	2	—	—	Yes	2,675	14.1	1,320	Agriculture	—	Amhara	Christianity
11		378	4	M	2	1	—	—	Yes	3,675	10.3	3,700	Agriculture	—	Amhara	Christianity
12		378	7	M	2	—	—	—	Yes	1,675	22.6	2,000	Agriculture	—	Amhara	Christianity
13		378	3	M	2	1	—	—	Yes	6,000	6.3	3,350	Agriculture	—	Amhara	Christianity
	Sub Total	5,166														
III	Charchara TW-No.3 & New Pump Station															
1		1,075	3	M	2	1	—	—	Yes	10,000	10.8	1,750	Agriculture	Driver	Amhara	Christianity
2		2,150	10	F	4	—	2	—	Yes	12,500	17.2	458	Agriculture	—	Amhara	Christianity
	Sub Total	3,225														
IV	Asharaf TW-No.2															
1		3,611	6	M	3	1	2	—	Yes	16,000	22.6	1,179	Agriculture	—	Amhara	Christianity
	Sub Total	3,611														
V	Asharaf TW-No.3															
1		3,149	5	F	2	—	1	—	Yes	16,000	19.7	663	Agriculture	—	Amhara	Christianity
	Sub Total	3,149														
VI	Diaspora Reservoir Expansion Site															
1		473	10	M	4	3	—	1	Yes	20,000	2.4	833	Agriculture	—	Amhara	Christianity
2		244	6	M	3	1	—	—	Yes	24,000	1.0	1,313	Agriculture	—	Amhara	Christianity
3		594	5	F	5	1	1	—	Yes	10,000	5.9	629	Agriculture	—	Amhara	Christianity
4		239	9	M	8	5	—	—	Yes	16,000	1.5	863	Agriculture	—	Amhara	Christianity
5		225	8	M	2	4	—	—	Yes	20,000	1.1	863	Agriculture	—	Amhara	Christianity
6		1,065	7	F	4	3	—	—	Yes	18,000	5.9	1,542	Agriculture	—	Amhara	Christianity
	Sub Total	2,840														
Total		19,266														

Appendix-7 (11) Minutes of the Stakeholders Meeting

Minutes of the Stakeholders Meeting

Venue: Addis Amba Hotel - Bahir Dar City - Ethiopia
Date: 14 April 2016 (9:30 am to 1:30 pm
Chair: Ato Yimer Habte, Deputy Head, ANRS WIEDB[1]
Ato Abiy Sesay, Head, BDWSSS[2]
Presenters:

1. Ato Belsti Yaye - Deputy Head at BDWSSS
2. Ato Netsanet - Environmentalist at WIEDB
3. Ato Girma Seyoum – Sociologist (MS Consultancy)
4. Ato Getachew Fetene – Environmental Expert (MS consultancy)

In Attendance: Representatives of relevant regional bureaus, PAPs, NGOs, religious establishments… (Attendance list attached)

The meeting was opened by an opening address from Ato Yimer Habte, Deputy Head, ANRS WIEDB. He outlined the objectives of the water supply project and required environmental and social impact assessment (EIA) study. He emphasized the importance of the meeting for discussing findings of the EIA study. He then called the presenters to make their presentations.

The first presenter was Ato Belsti Yaye, Deputy Head at BDWSSS, on the overall project background and activities to alleviate the water scarcity of Bahir Dar City and the target area of the project, the eastern part of the City. He outlined the role of JICA in this effort and works achieved since the inception of the project. He described the areas to be covered by the project, the facilities to be constructed, the likely positive impacts of the project and the project alternatives for design.

Ato Netsanet, Environmentalist at WIEDB made the next presentation. His presentation focused on the definitions of environmental impact, the process of its assessment, the need for the assessment and the areas of environmental assessment to be focused on.

This was followed by presentations of local consultants on detailed environmental and social impact assessments that were undertaken for the project. Ato Getachew Fetene, environmental expert, presented the environmental assessment findings and Ato Girma Seyoum, sociologist, the social assessment findings. These covered the potential positive and negative impacts and the mitigation measures that will be required.

The major potential positive impacts of the project that were presented are improved health and economic conditions in the target area resulting from sufficient water supply and better water quality. As presented by the experts, the major potential environmental impacts are manifested mainly as soil erosion, clearance of vegetation cover, and impacts of liquid and solid waste on protected areas during construction. Moreover, it was indicated that the negative impacts of other development

[1] **WIEDB: Water Irrigation and Energy Development Bureau**
[2] **BDWSSS: Bahir Dar Water Supply and Sanitation Services**

activities like polluting industries, social malpractice on the water quality, the consequences of the significant increase in liquid wastes (following raise in the total volume of potable water supply), lowering of groundwater table, etc. Regarding social impacts loss of developments on the land and the land itself; effects on water supply services and water resources as result of the projects implementation (including temporary intermission of water during construction); poor sanitation practices around boreholes and reservoirs; wastage of limited water resources and others were presented.

After the presentations the chairman opened the floor for discussions and called for comments and questions. The issues raised by participants were the following:

- The project has impact on different utilities provided in the area. There is a committee to manage this condition. The study should consider the activity of this committee in managing the problem and has to contact and discuss with it on the management of damage that will result due to project activities.
- The project was started (digging boreholes for testing) before getting acceptance by the ANRS Environment, Forest and Wildlife Protection Development Authority.
- The plan of the Project should avoid conflict with other plans (e.g. industrial area development in Ashraf)3 Some of the industries planned to be constructed near the Asheref well field area may pollute and others may overuse the ground water resources). Does the study considered these situations?
- The traditional toilets around the well field area should get attention and the usual polluting sanitation practice of the community should be changed to protect ground water sources.
- Compensation cannot be a mitigation measure if it is not accompanied by measures to support PAPs capacity to engage in productive ventures to utilize the payments. Measures in this direction should thus be considered. Compensation payments should be aligned with current practices of payments for telephone and power lines
- There should be a monitoring plan to conform the implementation of recommended impact mitigation measures. This plan should show clearly the role of each stakeholder. The monitoring activity should use the formats developed by Environment Forest Wildlife Protection and Development Authority’s format.
- Proposed boreholes are concentrated in the same areas. Wouldn’t this lead over withdrawal of groundwater and finally to subsidence?
- Is the replenishment capacity of the boreholes studied properly? As well as the impact of other agricultural (use of fertilizer, pesticide, herbicide) and economic practices on the project?
- Regarding the impacts of the project which extend beyond the authority of the project owners, who is responsible for the coordination of other stakeholders to managed the impacts?
- As explained, it seems that the project is restricted to potable water supply only. However, the project should also cover sewerage system development as a component since water and sanitation are interrelated.
- Suggested use of HDPE is not appropriate in consideration of local soil and other conditions.

[3] Bottled water factory, Leather industry, etc.

- The construction of the Zenzelma campus of Bahir Dar University is going on without sufficiently involving the university. The university has requested additional land to construct treatment plant and other facilities which support the management of environmental problems of the area. The University needs support and immediate response from the city administration regarding this additional land request.
- The activities of the project in the area behind the Zenzelma Campus of Bahir Dar University did not consider the university's outstanding land request for expansion in the area, its current efforts to provide water to residents in the area and its plans to tackle waste emission from its compound.
- In spite of the unreserved cooperation of its local administration and its potential as source of water, the population of Zenzelama Kebele is not getting its due share in water supply services from BDWSSS.
- Compensation payments are very low and not commensurate with loss incurred by PAPs (farmers). For example, land loss for which Br 500 is received in compensation is compared with Br 10,000 income if continued to farm on it. If loss is unavoidable, what alternative employment is possible to restore the livelihood of the affected people?
- The responsible organ for compensation should be defined clearly. Also it should be clear if loss is temporary or permanent. Compensation should be accompanied by employment support (e.g. training, organizing and guiding PAPs to continue with gainful livelihood).
- Compensation valued at Br 80,000 finally paid only Br 27,000. Likewise developments on the land valued at Br 2,700 paid only Br 600. As a result, the farmer was forced to accept the offer to avoid bureaucratic hassle and extended time required in court proceedings. Although neighbor went through court process and managed to obtain slightly better payment but was not worth the effort.

The chairman called on the presenters to respond to the issues raised and discussions continued.

Ato Netsanet dwelt on:

- There is need for the city administration to be fully prepared to tackle pending environmental risks. He gave the example of the situation in Ashraf as critical. The environmental and sanitation situations is much below national standards. Basic toilet requirements are not met.
- It is well known and recognized that compensation payments are very low. But it is managed within existing government laws and means. But efforts continue to be made to make revisions and supplement the payments with other support (such as training and employment opportunity in project).
- In the process of compensation payments, PAPs should also clearly understand their entitlements and be able to argue their case.
- HDPE has limitations but is the best that is currently available.
- The problem of Zenzelma is not unique. Attempts are being made to meet the needs of different sections of the city and it's outskirts in stages.

Ato Belsti's Responses addressed:

- Zenzelama is not only a source of water. Construction is now going on and significant part of the outskirts of the town will be covered by the project.

- Some PAPs are already employed as guards to support the PAPs whose land has been acquired.
- To improve the situation of low compensation payments, revisions are made in the tariff for the payments. The last revision was made three months ago and is being applied in the calculation of payments at present.
- Responsibility for the payments of compensation is always that of the project owner. In this case it is BDWSSS. It determines the location and size of its land requirements and passes it to the city administration. The measurement of the land to be acquired, estimation and calculation of the amounts to be paid is determined by the city administration.

The consultants on the EIA study also explained that:

- Due to the urgent demand for the project, some preliminary parts of the project (digging test boreholes) which help the planning of the project started earlier. As a consultant, we are advising and all important protection measures have been implemented to avoid unnecessary impacts.
- All the recommendations and points for considerations raised in the discussion will be considered in the EIA study

After some clarification discussions, the chairman summarized the understandings reached at the meeting:

- Compensation should always be managed within the existing legal framework.
- Our role should be how to facilitate the process and make it transparent and acceptable within the law.
- There should be trust between the authorities and PAPS. We should work together within the capacity of the administration.
- JICA's minimum standards and requirements should be strictly adhered to. JICA's past support with other projects in the country and here is credible and can be counted on. We have to live up to their standards.
- For implementation there will be a steering committee with membership drawn from relevant entities.
- The University's problem has to be addressed by the city administration. We will look into technical problems jointly through a technical committee.
- The cooperation of all stakeholders is called for in order to proceed with implementation.

❖ The meeting was concluded with a closing statement from Ato Abiy Sesay, Head of BDWSSS and Mr. Shozo Mori, JICA's consultant in charge of supervising the study.

❖ Ato Abiy pointed to the usefulness of the discussions and the need for joint efforts to find solution to outstanding problems. He thanked the presenters and JICA's diligence for the success of this project. He promised to play his part to make implementation a success.

❖ Mr. Mori thanked all participants for their attendance and sincere participation. He stressed on the need for continued consultation. He encouraged participants not to hesitate to forward any comments or suggestions they might have in the remaining period of the study.

Stakeholders Meeting Participants List

Name	Position	Telephone	Organization / Category
Shozo Mori	Socio-Economic Survey / E&S Considerations / O&M Planning		JICA Survey Team
Yuji Maruo	Deputy Chief Consultant / Water Supply Planning / Hydrogeological Survey / Water Quality Analysis		JICA Survey Team
Shogo Sakamoto	Facility Planning and Design / Construction Planning		JICA Survey Team
Kazuhiro Arita	Procurement Planning / Cost Estimation		JICA Survey Team
Naoaki Yonetani	Coordinator		JICA Survey Team
Wubetu Lemenh	Supporting Local Staff		JICA Survey Team
Getachew Fetene	Study Manager / Environmentalist		MSC- JICA's Sub Contract
Girma Seyoum	Sociologist		MSC- JICA's Sub Contract
Itsuro Takahashi	Project Formulation Advisor, Water and Sanitation		JICA Ethiopia Office
Ephrem Fufa	Water Sector Programme Officer		JICA Ethiopia Office
Zemene Tsuhay	Bureau Head		BoWIED
Yimer Habtie	Deputy Bureau Head		BoWIED
Asrat Kassie	Water Supply Core Process Owner		BoWIED
Netsanet Chalachew	Environmentalist		BoWIED
Asnake Akaineh	Head of Public Relation		BoWIED
Belstie Yagu	Water Supply Design Process Owner		BoWIED
Negash Atnafu	Expert in Lake Tana Biosphere Reserve		BoCTPD
	Trade Bureau		
	Health Bureau		
	Woman and Children Bureau		
Tesfaye Asnakew	Process Owner of EIA Department		EFWPDA
W/Gebriel G/Kidau	EIA Expert		EFWPDA
Abiy Sesay Garedew	General Manager		DBWSSS
Alemu Yigirem	Water Production, Distributioion and Quality Control Case Team Cordinator		DBWSSS
Haile Fufa	Head of Public Relation		DBWSSS
Ashebir Yahaanes	Head of Finance		DBWSSS
Addisu Fetene	Rural Water Supply Case Team Coordinator		DBWSSS
Wondim Gashu	Hidar 11 Branch Manager		DBWSSS
Yeshambel Ejigu	Customer Service Head of Hider 11 Branch		DBWSSS
	Mayor		BDCA
Melsachew Mengistu	Head of Bahir Dar Abay River Millennium Park Office		BDCA
Tesfaye Amera	Head of Plan Implementation Department		BDCA
Mastwal Tefera	Expert in Land Department		BDCA
Mengisti Amsalu	Trade, Industry and Market Development Department Head		BDCA
Tewabe Aniley	Manager of Hidar 11 Kebele Office		BDCA
Atu Bikese	Manager of Zenzelma Kebel Office		BDCA
Adera Endalamaw	Chair Person of Wereb Kola Tsiyon Kebele Office		BDCA
Habitamu Tamir	Water Resource Administration Director		Abbay Basin Authority
Birlew Abebe	Head		
Tadesse Adgo	Project Coordinator, NABU Bahir Dar Project		NABU (NGO)

Name	Position	Telephone	Organization / Category
	Office		
Semaegizher Eshetn	Program Manager of Bahir Dar Whole Sanitation Chain		ORDA (NGO)
Ayana Desaline	Wash Program Coordinator		One Wash (NGO)
Melake Selam Desse Kasse	Administrator		Bezawit Maryam Church, Wereb Kebele
Kess Yohannes	Administrator		Kidanemeheret Church,
Aba Menberu 0	Administrator		St Gabriel Church
Mohamad Omar	Son/Assistant of Sheh		Amanber Mosk, /Diaspora/
Anmut Dagne	Farmer near existing Charchara Borehole No.5		Potential New Pump Stations
Gebru Tatahun	Farmer near Diaspora Area		Potential New Pump Stations
Yihenew & Maru Ayalew	Farmer at Charchara Test Borehole No.3		Potential New Pump Stations
Fantahun Shiferaw	Farmer in Zenzelma along Road No.3		Potential New Reservoir Site
Tefera Dessi	Famer/Kesis around Diaspora Reservior		Potential Reservoir Extension Site
Adiss Admasu	Hiwet Animal Husbandry (Asssociation for People with HIV/AIDS) near Charchara Existing Boreholes No.6		Borehole Sites to be developed
Asmare Tiruneh	Farmer at Ashraf New Test Boreholes No.2		Borehole Sites to be developed
Deres Gebrye	Famer near Ashraf New Test Boreholes No.3		Borehole Sites to be developed
Muche Mande	Famer at Charchara Test Borehole No.1		Borehole Sites to be developed
	Farmer around Charchara Test Borehole No.2		Borehole Sites to be developed
Gedefa Jember	Farmer around Chimbl Test Borehole No.2		Borehole Sites to be developed
Mariamcher Tamir	Administration Head		Zenzelma Campus of Bahir Dar University
Desalegn Jemberu	Factory owner (St Gebreal rervoir area)		With water connection
Mengesha Kebede	Head worker		Existing Bono Workers in Hidar 11
Ato Kefe	Head worker		New Bono Workers around the University
Sewuale Kendie	Resident Representative		Higher Income Group
Ato Tehone	Resident Representative		Lower Income Group - Negede
Ato Minyichil	Resident Representative		Lower Income Group - Other

BoWIED: (Amhara National Regional State) Bureau of Water, Irrigation and Energy Development
BoCTPD: Bureau of Culture, Tourism and Parks Development
EFWPDA: Environment, Forest and Wildlife Protection and Development Authority
DBWSSS: Bahir Dar city Water Supply and Sewerage Services
BDCA: Bahir Dar City Administration
NABU: Nature and Biodiversity Conservation Union
ORDA: Organization for Rehabilitation and Development in Amhara

የመዝገብ ቁጥር/Reg. No: AmR/EIA/INF-872

ቀን/Date: መስከረም 30 ቀን 2009ዓ.ም (11/11/2016-21-2016)

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የአማራ ብ.ክ.መ. የአካባቢ፣የደንና የዱር እንስሳት ጥበቃና ልማት ባለስልጣን በአዋጅ ቁጥር 232/2008 አንቀጽ17 እና 181/2003 በተሰጠው ስልጣን መሠረት ባህር ዳር ከተማ አስተዳደር፣ ህዳር 11 ቀበሌ ለሚገኘው ባህርዳር መጠጥ ውሃ አቅርቦት ፕሮጀክት ባለቤት የሆኑት የውሃ ሀብት ልማትና ኢነርጂ ቢሮ ያቀረቡት EIA ዘገባ ቁጥር AmR/INF-872/2009 ተቀባይነት ያገኘ ስለሆነ በሰነዱ ስምምነት መሠረት ከመስከረም 30 ቀን 2009ዓ.ም ጀምሮ እንዲሰሩ ይህ የይሁንታ ማረጋገጫ ምስክር ወረቀት ተሰጥቷል፡፡

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Environmental Impact Assessment Licence Certificate

The A.N.R.S. Environment, Forest and Wildlife Protection and Development Authority by virtue of power vested in it by proclamation No 232/2015 article 17 and 181/2011 has issued this project operation certificate to *Bureau of Water Resaurce and Energy* for the Bahir Dar Water Suppy located in *Bahir Dar City Administration, Bahir Dar* Woreda, Hidar 11 Kebele in wittiness to the approval of the *EIA* No *AmR/INF-872/2009*. Hence, the proponent is acknowledged to establish and operate the project in accordance with the agreed EIA document starting from *11/11/2016*

Note:

- *The certificate is valid only when renewed every 1 year by the competent agency.*
- *This certificate does not exonerate the proponent from liability to any environmental damage*

ሰነዱንለመጨረሻየመረመረው (Final Reviewer)

ስም/Name ወ/ገብርኤል ገ/ኪዳን (W/Gebriel G/Kidan)

ፊርማ/Sign ....

ቀን/Date-መስከረም 30 ቀን 2009ዓ.ም

የስራ ሂደት መሪ/Process Leade

ስም/Name

ፊርማ/Sign ....

ቀን/Date-መስከረም 30 ቀን 2009ዓ.ም

የታደሰበት ቀንና ዓ.ም (Renewal date)	ያረጋገጠው ባለሙያ(Checked by)	ያጸደቀው ኃላፊ (Approved by)

Appendix-7 (13) Project Monitoring Sheet

Project Monitoring Report
on
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN BAHIR DAR CITY IN THE AMHARA REGEONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC ETHIOPIA
Grant Agreement No. XXXXXXX

2017, January

Organizational Information

Signer of the G/A (Recipient)	Person in Charge (Designation) Contacts Address: Phone/FAX: Email:
Executing Agency	Bureau of Water, Irrigation and Energy Development, Amhara National Regional State, Federal Democratic Republic of Ethiopia (BoWIED) Person in Charge Deputy Bureau Head Yimer Habtie Contacts Address:Bahir Dar City Ethiopia Phone/FAX: Email:
Operating Agency	Bahir Dar city Water Supply and Sewerage Service (BDWSSS) Person in Charge General Manager Abiy Sisay Garedew Contacts Address: Bahir dar City, Ethiopia Phone/FAX: Email:
Line Ministry	Ministry of Water, Irrigation and Electricity Person in Charge Director, Water Supply and Sanitation Directorate Nuredine Mohamed Contacts Address:Addis Abeba, Ethiopia Phone/FAX: Email:

General Information:

Project Title	The Project for Improvement of Water Supply in Bahir Dar city in The Amhara Regional State in The Federal Democratic Republic Ethiopia
E/N	Signed date: Duration:
G/A	Signed date: Duration:
Source of Finance	Government of Japan: Not exceeding JPY ________ mil. Government of (__________): ________________

1: Project Description	

1-1. Project Objective

The objective of the Project is to improve the volume of water supply by/through the development of deep wells, expansion of distribution networks, construction of distribution reservoirs, etc. in the Urban Planning Area and a part of outside of the Urban Planning Area (Wereb Kola Tsiyon) in Zone 2 of Bahir Dar City (hereinafter referred to as "the target area"), thereby contributing to decrease the number of patients suffering waterborne diseases and reduce labor for drawing water in the target area.

1-2. Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

Higher-level objectives: Improving the health of local residents, improving the economic sustainability, and improving the safe living condition. Situation of the target groups: As the population increases, water supply demand is expected to increase drastically, but the expansion of water sources and water supply facilities in the city is not catching up with demand. The first leading disease is water-born diseases, accounting for about one third of the total number of diseases.

1-3. Indicators for measurement of "Effectiveness"

Quantitative indicators to measure the attainment of project objectives		
Indicators	Original (Yr 2015)	Target (Yr 2025)
Average Daily Distribution Water Amount (Target Area) (m^3/day)	3,000	14,500

Qualitative indicators to measure the attainment of project objectives
1. Decrease of the number of patients suffering waterborne diseases in the target area. 2. Reduction of labor for drawing water in the target area.

2: Details of the Project

2-1. Location

Components	**Original** *(proposed in the outline design)*	**Actual**
Construction and expansion of water supply facilities.	The Urban Planning Area and a part of outside of the Urban Planning Area (Wereb Kola Tsiyon, Zenzelma campus of Bahir Dar University) in Zone 2.	

2-2. Scope of the work

Components	Original* *(proposed in the outline design)*	Actual*
1. Construction of Borehole facilities	N=9	
2. Construction of Booster Pump Station	N=1	
3. Construction of Distribution Reservoirs	1,000 m^3:N=1, 4,000 m^3:N=1	
4. Construction of Receiving Tank	1,000 m^3:N=1	
5. Construction of Receiving Pits	700 m^3:N=1, 200 m^3:N=1	
6. Raw Water Transmission Pipeline	About 3.7 km	
7. Construction of Transmission Pipieline	About 11.2 km	
8. Construction of Distribution Pipe-network	About 41.9 km	
9. Procurement of Spare parts	Spare parts for submergible motor pump,transmission pumps,chlrorinaters, Electrical generators etc.	

Reasons for modification of scope (if any).

(PMR)

2-3. Implementation Schedule

Items	Original		Actual
	(proposed in the outline design)	*(at the time of signing the Grant Agreement)*	
Construction and expansion of water supply facilities	Starting : May, 2018 Ending :September,2020		

Reasons for any changes of the schedule, and their effects on the project (if any)

2-4. Obligations by the Recipient

2-4-1 Progress of Specific Obligations
See Attachment 2.

2-4-2 Activities
See Attachment 3.

2-4-3 Report on RD
See Attachment 11.

2-5. Project Cost

2-5-1. Cost borne by the Grant (Confidential until the Bidding)

Components		Cost (Million Yen)	
Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
1. Construction			
2. Procurement			
3. Software Component			
4. Consultant Services			
5. Contingencies expenses			
Total			

Note: 1) Date of estimation: January, 2017
2) Exchange rate: 1 US Dollar = 115.95 Yen

2-5-2. Cost borne by the Recipient

Components		Cost (1,000 Yen)	
Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
1. Land acquisition		2,987	
2. Supply of primary power		11,891	
3. Installation of water supply pipe and water meter		45,468	
4. Installation of distribution branch pipes		11,556	
5. Installation of public tap stands		341	
Total		72,243	

Note: 1) Date of estimation: June, 2016
2) Exchange rate: 1 US Dollar = 111.76 Yen

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

2-6. Operating Agency

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original *(at the time of outline design)* Name: Bahir Dar city Water Supply and Sewerage Service (BDWSSS) Role: Responsible for operation and maintenance of the water supply facilities Financial situation: As a result of the organizational reform in September 2014, revenues have increased and the financial situation is improving. Institutional and organizational arrangement (organogram): Organization is comprised of three Main Processes as follows; ・Revenue, Finance, Procurement and Material management Process ・Water supply Process ・Human Resources Process Human resources (number and ability of staff): The total number of staff is 326. Currently, BDWSSS carries out O&M of existing water supply facilities in Bahar Dar city, and it can be considered that it is possible to O&M by engineers of BDWSSS.
Actual *(PMR)*

2-7. Environmental and Social Impacts

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

3: Operation and Maintenance (O&M)

3-1. Physical Arrangement

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

Original *(at the time of outline design)* Pump Operator 7, Dosing Pump Technician 3, Security Guard 18
Actual *(PMR)*

3-2. Budgetary Arrangement

- Required production cost and income from water tariff

Original *(estimated at the time of outline design)* Production cost: 1,241,524 ETB/month, Income: 1,358,408 ETB/month
Actual *(PMR)*

4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

Assessment of Potential Risks (*at the time of outline design)*

Potential Risks	Assessment
1. Water Pollution	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	During Construction: Muddy storm water runoff resulting from soil erosion at the construction sites in Charchara may flow into Lake Tana. According to a water quality data measured in 2010, TSS at the location (within the lake) was around 3 times higher than the standard value during the rainy season. If the construction is carried out around Charchara during rainy season, this situation might get worse to some extent. During Operation: As a result of this project, the discharge of untreated or inadequately-treated wastewater and soil runoff may increase, thus conditions of Chimbl River, etc. may get worse to some extent. Although this project has no influence on groundwater, there is a possibility of causing groundwater pollution if development in the industrial area progresses on the upstream side of the Ashraf well area.
	Mitigation Measures:
	Implement integrated erosion prevention measures at project construction sites (e.g. limiting excavation work, constructing proper drains, construction access roads with gravel pavement) Earthmoving activates should be avoided during rainy season as much as possible to minimize soil erosion.
	Action required during the implementation stage:
	The same as above.
	Contingency Plan (if applicable):
2. Solid Waste	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	During Operation: Impacts of the solid wastes generated during the operation to the surrounding environment can be avoided by disposing them at the disposal sites for solid and liquid wastes under BDCA's management. However, indirect environmental impacts may occur to some extent because hygienic treatment of landfill has not been done at the disposal site.
	Mitigation Measures:
	Surplus soil and construction debris generated during construction should be collected and disposed properly in designated disposal sites. Surplus soil should not be piled up at locations which can be washed away by storm water runoff. Sufficient reuse of construction materials including

Potential Risks	Assessment
	excavated soil and pipe pieces.
	Action required during the implementation stage:
	The same as above.
	Contingency Plan (if applicable):
3. Soil Erosion	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	During Construction: Small-scale soil erosion may occur at the new facility sites during rainy season
	Mitigation Measures:
	Construct storm water drainage to reduce soil erosion during rainy season. Keep drains and vegetation coverage in good condition at and around water supply facilities to mitigate the impacts of soil erosion and soil washed away on fauna and flora.
	Action required during the implementation stage:
	The same as above.
	Contingency Plan (if applicable):
4. Ground-water Flow	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	During Operation: The monitoring of groundwater level is required because the recharge of groundwater during rainy season may less than the annual total pump discharge from these wells and the groundwater level may gradually decline over years.
	Mitigation Measures:
	Do not exceed the optimum pumping rate set at 70% of maximum discharge from each well in order to avoid the decline of groundwater level at surrounding wells due to excessive groundwater extraction. Prioritize the operation of the wells having less interference with other wells and less drawdown of groundwater. Enhance awareness raising activities for leakage reduction and water conservation in order to mitigate the decline of groundwater level over years. Reduce the annual amount of groundwater extraction from a well filed if the groundwater level decreases over years.
	Action required during the implementation stage:
	Contingency Plan (if applicable):
5. Traffic	Probability: High/Moderate/Low
	Impact: High/Moderate/Low

Potential Risks	Assessment
	Analysis of Probability and Impact:
	During Construction: Special considerations are required for the locations, where pipeline road crossings are needed, to avid blocking the traffic.
	Mitigation Measures:
	Traffic control personals should be in place during the construction. Pipeline road crossings should be conducted during time periods having especially low traffic. Construction signboards with lights is required in order to avoid traffic accidents around construction sites during nights. Good coordination with transport and traffic related governmental offices are required for smooth installation of pipes. Use of high density polyethylene (HDPE) pipes for quick installation and leakage reduction.
	Action required during the implementation stage:
	The same as above.
	Contingency Plan (if applicable):

5: Evaluation and Monitoring Plan (after the work completion)

5-1. Overall evaluation

Please describe your overall evaluation on the project.

5-2. Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3. Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

BDWSSS monitor the flow rate by reading the water meter installed at the booster statin and trasmission pipes at ashraf areas as part of their daily operation and maintenance activities.

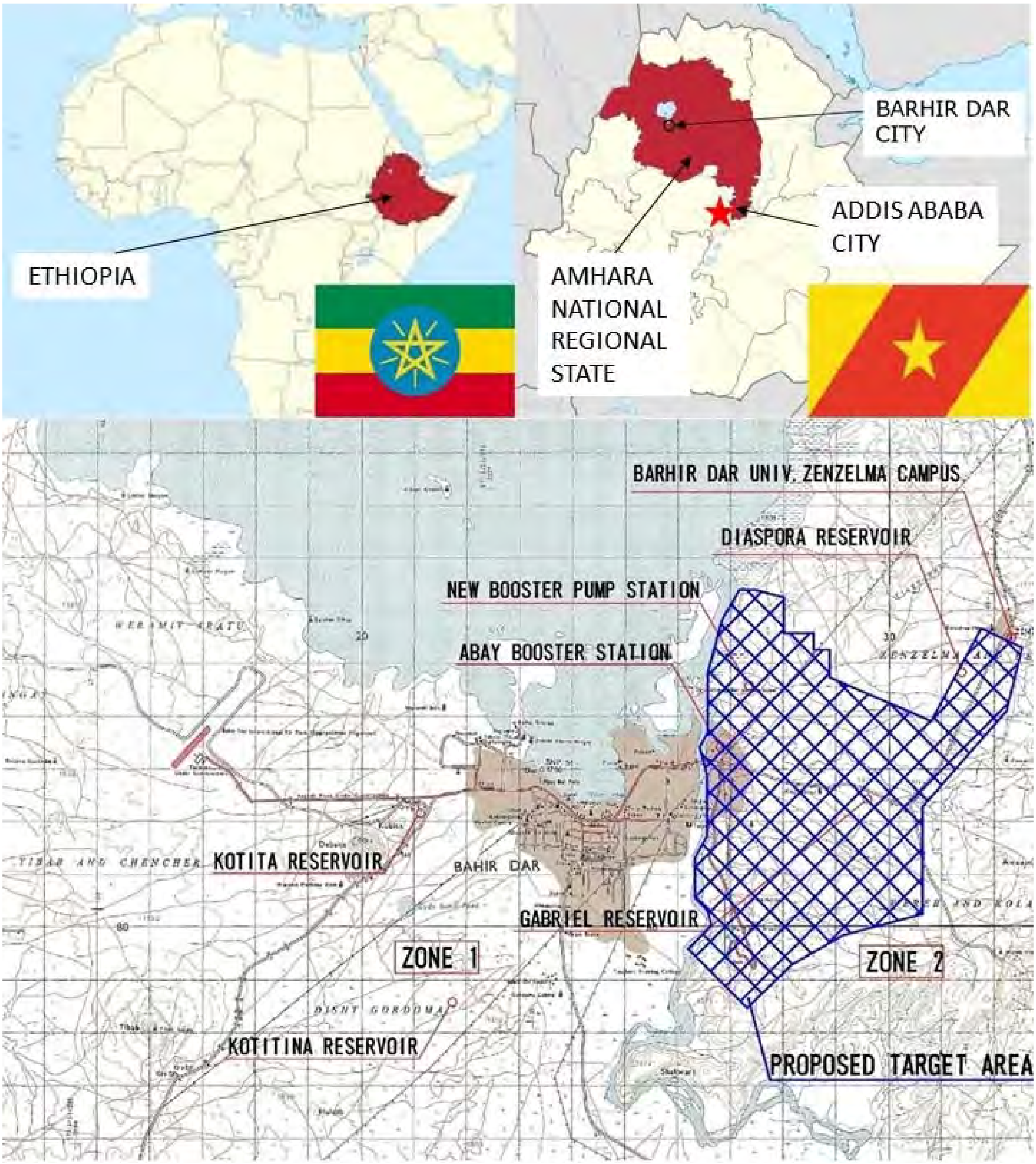
Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social (Land acquisition) Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final)only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final)only)
10. Drawing (PMR (final)only)
11. Report on RD (After project)

Attachment 1 : Project Location Map



Attachment 5：Environmental Monitoring Form (During Construction)

1. Water Pollution, Soil Erosion, Bottom Sediments and Protected Area

Monitoring Item	Conditions during Reporting Period	Frequency
Conditions of the fences enclosing the major water supply facilities including their buffer spaces for preventing water pollution		Once a month (before completion of the construction)
Implementation of soil erosion control measures at project sites		Once a month
Earthwork during rainy season		Once a month（rainy season）
Lake water quality near the protected area which may be affected by the soil erosion from the project sites（Turbidity and TSS (Total Suspended Solid)		Once a year（rainy season）

2. Solid Waste

Monitoring Item	Conditions during Reporting Period	Frequency
Disposal of construction wastes at disposal sites designated by BDCA		Once a month
Storage of surplus construction soil, construction materials at places where rainwater won't wash away		Once a month
Reuse of surplus construction soil and efficient uses of construction materials such as remaining cut pipes		Once a month

3. Fauna and Flora

Monitoring Item	Conditions during Reporting Period	Frequency
Minimization of logging of mature trees while planting native young trees instead		Once a month

4. Noise / Vibration

Monitoring Item	Conditions during Reporting Period	Frequency
Periods of laying water pipes in residential areas (confirming whether laying pipes during daytime on weekdays as far as possible at site while checking the construction schedule)		Once a week
Use of sound-proof sheet in case that pipe laying during night time and weekends cannot be avoided		Once a week

5. Air Pollution

Monitoring Item	Conditions during Reporting Period	Frequency
Watering to prevent excessive dust during pipe installation in residential areas, etc.		Once a week
Whether construction machineries and vehicles discharging exhaust gas are well maintained		Once a month

6. Soil Pollution

Monitoring Item	Conditions during Reporting Period	Frequency
Whether construction machineries and vehicles, which may leak fuel and machine oil, are well maintained		Once a month

7. Traffic, Children and Residents

Monitoring Item	Conditions during Reporting Period	Frequency
Whether the installation of pipes across roads is conducted during the time having especially low traffic		Once a week
Ex-ante coordination with the organization managing roads and traffic for smooth pipe installation along roads		Once a month
Allocation of sufficient traffic control personnel at construction sites		Once a week
Whether electrically-lighted signboards are placed to avoid traffic accident around the construction sites during night		Once a week
Whether pipe installation sites are enclosed so that children and others won’t fall into the ditches and whether refill of the ditches after laying pipes are not delayed		Once a week
Usage status of HDPE pipe which can be laid quickly and is hard to cause water leakage		Every day

8. Land Use

Monitoring Item	Conditions during Reporting Period	Frequency
Management of surplus construction soil around the construction sites		Once a month
Whether pipe installation under farmlands during rainy season is avoided as far as possible		Twice a month
Whether pipe installation ditches are refilled with original fertile surface soil after laying pipes under farmlands		Twice a month

9. Public Health and Workers

Monitoring Item	Conditions during Reporting Period	Frequency
Support to the construction workers such as education on HIV-AIDS, distribution of condoms and prevention of prostitution		Once a month
Cleanness at camp for construction workers and implementation of on-site prevention measures against water-borne and mosquito-borne diseases		Once a month
Accident prevention measures carried out at construction sites		Once a month

10. Landscape and Cultural Property

Monitoring Item	Conditions during Reporting Period	Frequency
Construction hours of pipe installation around religious places, tourist sites, etc. (e.g. avoiding pipe installation during the events and service hours of these places)		Once a week
Whether construction machineries, materials, etc. are placed at and around the construction sites in the way not disturbing the surrounding sceneries		Once a month

11. Property and Public Facility

Monitoring Item	Conditions during Reporting Period	Frequency
Coordination with the organizations managing utility lines such as underground telephone and electricity cables to avoid damages on their utility lines		Once a month
Ex-ante coordination to minimize the interruption of other utility services when relocation of other utility lines is unavoidable.		Once a month

12. Land Use Right

Monitoring Item	Conditions during Reporting Period	Frequency
See attachment 5 Social (Land acquisition) Monitoring Form		Once a month (before the construction starts)

Attchment 5 : Social (Land acquisition) Monitoring Form

No.	Project Affected Persons at Selected Project Sites	Size of Acquired Land (m^2)	Paid Land Compensation (Birr)	Date of Payment	Records of Livelihood Support	Records of complains and their handlings
I	Charchara TW-No.1					
1						
2						
3						
	Sub Total					
II	Charchara TW-No.2					
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
	Sub Total					
III	Charchara TW-No.3 & New Pump Station					
1						
2						
	Sub Total					
IV	Asharaf TW-No.2					
1						
	Sub Total					
V	Asharaf TW-No.3					
1						
	Sub Total					
VI	Diaspora Reservoir Expansion Site					
1						
2						
3						
4						
5						
6						
	Sub Total					
Total	26 Persons					

Note : * Prefer the standard land compensation (standard compansation based on price of typical crops) to the compensation for eucalyptus trees because they will sell the euclyptus trees before the implementation of land aquistion.

Attachment 6 : Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

	Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial total Price C=A×B	1% of Contract Price D	Condition of payment	
						Price (Decreased) E=C−D	Price (Increased) F=C+D
1	Cement	●●t	●	●	●	●	●
2	Aggregate	●●t	●	●	●		
3	Reinforcing Steel Bar						
4	Timber						
5	Gasoline						
6	Diesel						

2. Monitoring of the Unit Price of Specified Materials
(1) Method of Monitoring : Check local market

(2) Result of the Monitoring Survey on Unit Price for each specified materials

	Items of Specified Materials	1st ●month, 2018	2nd ●month, 2018	3rd ●month, 2018	4th	5th	6th
1	Cement						
2	Aggregate						
3	Reinforcing Steel Bar						
4	Timber						
5	Gasoline						
6	Diesel						

(3) Summary of Discussion with Contractor (if necessary)

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Attachment 7 : Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)

(Actual Expenditure by Construction and Equipment each)

	Domestic Procurement (Recipient Country) A	Foreign Procurement (Japan) B	Foreign Procurement (Third Countries) C	Total D
Construction Cost	(A/D%)	(B/D%)	(C/D%)	
Direct Construction Cost	(A/D%)	(B/D%)	(C/D%)	
others	(A/D%)	(B/D%)	(C/D%)	
Equipment Cost	(A/D%)	(B/D%)	(C/D%)	
Design and Supervision Cost	(A/D%)	(B/D%)	(C/D%)	
Total	(A/D%)	(B/D%)	(C/D%)	